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STATEMENT OF SOURCES

To the best of my knowledge and belief, the work presented in this dissertation is original, except as acknowledged in the text. All sources used in the study have been cited and no attempt has been made to project the contributions of other researchers as my own. Further, the material has not been submitted, either in whole or in part, for a degree at this or any other university.

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THESIS ABSTRACT

The value of information technology investments is becoming a topical issue for corporate governance under the recent regulations enacted in the US (*Sarbanes Oxley Act,* US Congress, 2002). Increasingly, it is becoming clear that the absence of a definitive approach to evaluating IT investments is an impediment to the governance of corporations.

Enterprise Resource Planning (ERP) information systems are a key IT implementation that has been promoted in both vendor and practitioner communities alike as a panacea for *informed* enterprise performance management. This research sets out a methodology for the evaluation of ERP's contribution to enterprise value.

This issue is important because billions of dollars of corporate funds have been invested in these systems since the early 1990s. Shareholders and management require a justification of ERP based upon its proven contribution to enterprise and shareholder value.

The study develops a theory for the value relevance of ERP information by showing how ERP meets the requirement of a management and organizational innovation. Such an innovation promotes enterprise operations, improves enterprise performance, supports value creation, and increases shareholder wealth.

A model is presented for testing the value of ERP adoption. Empirical testing proceeds in two phases. The first phase develops a model for forecasting normal performance. Performance is shown to be a function of autoregressive earnings moderated by macroeconomic factors impacting operations. The latter are associated with the business cycle. The estimated coefficients of the model are used for predicting the earnings performance of the firm. The residuals of actual earnings less the predicted represent abnormal performance. This represents the unique improvement in performance over the prior year after adjusting for macroeconomic effects.

The second phase tests the value relevance of ERP information. A returns–earnings model developed by previous research is adapted with ERP–earnings interaction terms representing the ERP system's effect on performance.

Two classes of tests are performed on the model: tests of performance relevance of ERP systems, and tests of value relevance. The former tests ERP performance across several

accounting metrics identified as indicators of firm performance level change. The latter tests the market response to these changes in a bid to determine if, in the perception of the market, the changes in the performance level attained to by the firm are associated with ERP adoption. These tests are performed for each year of a 5–year period following adoption.

The results of the tests of performance relevance show that ERP–adopter firms do not achieve significant abnormal earnings in years 1 and 2 of the test period. They realize significant, negative, abnormal earnings in year 3. In years 4 and 5, they attain significant, positive, abnormal earnings. The tests of value relevance show that the market responds significantly to ERP adoption in year 2 of the test, but not in other years. The early response immediately after the year of adoption would seem to indicate a significant early expectation from these systems. However, this does appear to translate into long–term value relevance for ERP.

TABLE OF CONTENTS

ILLUSTRATIONS

FIGURES

TABLES

TABLES (CONT.)

TABLES (CONT.)

TABLES (CONT.)

ABBREVIATIONS

Abbreviation	Replacement Text
AASB	Australian Accounting Standards Board
ABM	Activity Based Management
ACF	Auto–Correlation Function
APICS	American Production & Inventory Control Society
APS	Advanced Planning & Scheduling/ Advanced Planning Systems
ASX	Australian Stock Exchange
ATO	Asset Turnover Ratio
B2C	Business–to–Consumer (e–Commerce)
BI	Business Intelligence
c-Commerce	Collaborative Commerce
e-Commerce	Electronic Commerce
COGS	Cost of Goods Sold
CPFR	Collaborative Planning, Forecasting & Replenishment
CPM	Corporate Performance Management
CRP	Capacity Requirements Planning
CRM	Customer Relationship Management
EAI	Enterprise Application Integration
EBIT	Earnings Before Interest and Tax
EPS	Earnings Per Share
ERC	Earnings Response Coefficient
ERM	Enterprise Resource Management
ERP	Enterprise Resource Planning
ERPII	Enterprise Resource Planning (second wave)
EVA	Economic Value Added
FMS	Flexible Manufacturing Systems
GB	Gigabyte(s)
GIC	General Industry Classification
4GL	4^{th} Generation Language
GLS	Generalised Least Squares
GM (%)	Gross Margin (%)
GMM	Generalized Method of Moments
GUI	Graphical User Interface
IAS	International Accounting Standard
IASB	International Accounting Standards Board
IEEP/ES	Integrated Extended Enterprise Planning/Execution System
IRM	Information Resources Management
IS	Information System(s)
ISACA	IS Audit and Control Association
IT	Information Technology
ITGI	IT Governance Institute
KMS	Knowledge Management System
MES	Manufacturing Execution Systems
MESA	MES Association
MFP	Multi–Factor Productivity

MIS	Management Information System(s)
MPC	Manufacturing Planning & Control
MPD	Mean Paired Difference
MPS	Master Production Schedule
MRP	Material Requirements Planning
MRPII	Manufacturing Resources Planning
NPAT	Net Profit After Tax
NPV	Net Present Value
OLAP	On Line Analytical Processing
OLS	Ordinary Least Squares
PCA	Principal Components Analysis
PEC	Persistence of Earnings Coefficient
P/E	Price–Earnings Ratio
PLM	Product Lifecycle Management
RAM	Random Access Memory
RAID	Redundant Arrays of Independent Disks
RBV	Resource–based View (of the firm)
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
ROIC	Return on Invested Capital
ROP	Re-Order Point System
ROS	Return on Sales
SBU	Strategic Business Unit
SCE	Supply Chain Execution
SCM	Supply Chain Management
SCO	Supply Chain Optimization
SCP	Supply Chain Planning
SFA	Sales Force Automation
SFC	Shop Floor Controls
SG&A	Selling, General & Administration Expense
SIC	Standard Industry Classification
SMP	Symmetric Multiprocessing
SQL	Structured Query Language
SR	Sales Revenue
SRM	Supplier Relationship Management
TCE	Transaction Cost Economics
TMS	Transportation Management Systems
TRS	Total Returns to Shareholders
VBM	Value–Based Management
WACC	Weighted Average Cost of Capital
WMS	Warehouse Management Systems

1. Problem Identification

1.1 PREAMBLE

The *raison d'etre* for a profit–oriented enterprise is wealth–creation for and on behalf of its ownership stakeholders (Knight 1998; Slater & Olson 1996). The capacity for wealth–creation gives continuity to its existence and serves to sustain and enhance its intrinsic value (Davenport 2000a; Davenport, Harris & Cantrell 2004). The capacity begins with a value management focus in governance practices that seeks to enact strategies for continuing value enhancement[1].

Such strategies are integrated under the rubric of 'performance management'[2]. The integration serves to deliver (a) proper alignment of organizational strategies with product–market strategy, thus making for (b) control of strategy content and strategy implementation, which in turn mandates (c) measurement of organizational drivers and decision variables that directly impact value creation[3]. Such a system of performance management would make for continuous improvement of operations and thus, value enhancement.

The foregoing value management remit delivers context to enterprise–wide strategies for developing and disseminating information possessed of a high degree of relevance to resource allocation and coordination decisions for value enhancement[4]. The term "decision relevance" refers to the value–relevant ("economically–significant") attribute of information (Barua & Mukhopadhyay 2000; Feltham 1968; Hirshleifer 1973; Marschak & Miyasawa 1968) that defines the capacity to inform the right decision for a

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[1] (Ittner & Larcker 2001; Kleiman 1999; Koller 1994; Koller, Goedhart & Wessels 2005; Malmi & Ikaheimo 2003; Ratnatunga & Alam 2007)

[2] (Chalmeta & Grangel 2005; Chenhall 2005; Jarrar 2004; Kaplan & Norton 1996; Koller, Goedhart & Wessels 2005; Lawrie & Cobbold 2004; Muralidharan 1997, 2004; Neely & Jarrar 2004; Otley 1999; Robson 2004; Schultz 2004; Slater & Olson 1996)

[3] (Bose 2006; Davenport et al. 2001; Ittner & Larcker 2001; Kaplan & Norton 1996; Koller, Goedhart & Wessels 2005; Malmi & Ikaheimo 2003; Rucci, Kirn & Quinn 1998; Schultz 2004)

[4] (Chalmeta & Grangel 2005; CorVu 2005a; Davenport et al. 2001; Henrie 2005; IT Governance Institute (ITGI) 2005a; Ittner & Larcker 2001; Kaplan & Norton 1996; Otley 1999; Papalexandris et al. 2005; Ratnatunga & Alam 2007; Rodrigues, Stank & Lynch 2004; Schultz 2004)

given decision context[5]. This makes towards a normative or rational decision strategy (Todd & Benbasat 2000) leading to decision effectiveness (DeLone & McLean 1992) or decision performance (Todd & Benbasat 2000). It serves to support effective strategic (resource planning and allocation) and operational (resource coordination and control) decision–making towards enterprise value improvement[6].

Central to supporting sound decision–relevance is the quality of information[7] (Barua, Kriebel & Mukhopadhyay 1989) delivered by enterprise information resources[8]. Quality depends on the effectiveness of the information resources management (IRM)[9] function[10].

Sound IRM in turn requires effective information technology[11] governance[12] that matches information technology strategy to performance management (IT Governance

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[5] (Ahituv 1989; Bauer 2003; Chalmeta & Grangel 2005; Davenport, Harris & Cantrell 2004; DeLone & McLean 1992; Feldman & March 1981; Strong, Lee & Wang 1997; Wang & Strong 1996)

[6] (Anthony 1965, 1988; Davenport 2000a; Davenport, Harris & Cantrell 2004; Defee & Stank 2005; Koller 1994; Malmi & Ikaheimo 2003; Muralidharan 1997; Rodrigues, Stank & Lynch 2004; Schultz 2004)

[7] Information Quality: "The degree to which information has content, form, and time characteristics that give it value to specific end users", (O'Brien & Marakas 2006, p. 559). Decision relevance ("payoff–relevance") is effectively a function of "information quality" and decision context (Barua, Kriebel & Mukhopadhyay 1989).

[8] Information Resources: "The intangible information assets of a firm, including data, information, knowledge, processes, patents, and so on." (McNurlin & Sprague Jr 2006, p. 614)

[9] Information Resources Management: "A management concept that views data, information, and computer resources (computer hardware, software, networks, and personnel) as valuable organizational resources that should be efficiently, economically, and effectively managed for the benefit of the entire organization" (O'Brien & Marakas 2006, p. 559). This involves "… the planning, organizing, acquiring, maintaining, securing, and controlling of IT resources" (Turban et al. 2006, pp. G-6)

[10] (Davenport, Harris & Cantrell 2004; DeLone & McLean 1992, 2003; IT Governance Institute (ITGI) & Information Systems Audit and Control Association (ISACA) 2003; Lee et al. 2002; McNurlin & Sprague Jr 2006; Redman 1995, 1998, 2004; Turban et al. 2006; van den Hoven 2001; Weston Jr. 2003; Xu et al. 2002)

[11] Information Technology: The technology component of an information system comprising "Hardware, software, telecommunications, database management, and other information processing technologies used in computer–based information systems" (O'Brien & Marakas 2006, p. 559)

[12] IT governance: "*consists of the leadership and organizational structures and processes that ensure that the enterprise's IT sustains and extends the enterprise's strategies and objectives*" (pp.11). The 5 main foci of IT governance are: value delivery and risk management (value outcomes); strategic alignment and performance measurement (value drivers); and resource management (the one value driver that overlays all of the preceding). These in turn are driven by stakeholder value [(IT Governance Institute (ITGI) & Information Systems Audit and Control Association (ISACA) 2003, pp. 11-)]

Institute (ITGI) 2005a). This makes for the controlled acquisition and deployment of information technology resources[13] toward developing a robust information system resource[14] (DeLone & McLean 1992; IT Governance Institute (ITGI) 2005b; McNurlin & Sprague Jr 2006; Xu et al. 2002).

In summary, value–oriented corporate governance focuses performance management strategies to create a strong IT governance function (amongst others) for effective management of information resources[15]. This in turn delivers a robust information system that makes for information quality towards decision relevance. The latter promotes effectiveness of decision–making in the planning, allocation, coordination and control of limited enterprise resources for successful performance outcomes[16].

A successful information system results from a strategic fit with the enterprise's performance or business model (IT Governance Institute (ITGI) 2005a; Ittner & Larcker 2001; Payne, Holt & Frow 2001; Rucci, Kirn & Quinn 1998). The developing climate of corporate governance accountability to capital markets demands that IT Governance be required to take appropriate steps to reliably measure IT's contribution to enterprise value (IT Governance Institute (ITGI) 2005a; Schultz 2004)[17]. It is central to this thesis that such measure of benefit value must address and measure IT's capacity to engender

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[13] Information Technology Resources: comprises hardware, software, database management and communications technologies combined with information resources comprising data, information, knowledge and processes—in sum, the components of an information system

[14] Information System: "A physical process that supports an organization by collecting, processing, storing, and analysing data, and disseminating information to achieve organizational goals", (Turban et al. 2006)

[15] "Research firm Gartner estimates that by 2008, more than 80 percent of publicly traded companies will have a formalized CPM (corporate performance management) strategy and road map as key elements in their compliance and governance framework" (Taylor 2005, p. 33)

[16] This summation captures an empirically–validated particularization of the I/S Success Model (DeLone & McLean 1992, 2003). The particularization is: information quality (decision relevance) leads to individual impacts (decision effectiveness), which leads to organizational impacts (enterprise value). A recent validation study integrates the model with the Balanced Scorecard performance perspectives (Lin, Ping-Yu & Ping-Ho 2006)

[17] Schultz (p. 14–15) states that the Sarbanes Oxley Act [US Congress, 2002] prescribes not only "stringently accurate financial disclosures" but also in effect "… more complete and more timely operational data underlying those disclosures" since enterprises must now have the capacity "… to assess their performance in relative real–time, within 48 hours of when something happens" in order to "… immediately report occurrences likely to substantively affect their financial performance…"

a sustained enterprise value improvement for and on behalf of its primary stakeholders: the owners, and that the decision–relevant quality of its information product is key to this enterprise–level value delivery.

1.2 GENERAL PROBLEM

According to Todd and Benbasat (2000), information technologies that support decision–making have become so pervasive and transparent in the enterprise that they are no longer even viewed as separate decision–making systems. These technologies are so tightly entwined with the business that "… *the influence of IT on decision making is, in many ways, synonymous with the impact of IT on the success or failure of the organization as a whole*" (italics added) (Todd & Benbasat 2000, p. 2).

In the light of this verdict it is surprising that the value delivered by these investments is considered yet uncertain (IT Governance Institute (ITGI) 2005a; Wiseman 1992). This despite several trillions of dollars having been invested in information technology assets since the 1950s[18] (De Souza et al. 2003; Strassman 1997a).

Early information economics approaches to estimating value adopted decision theoretic methods to model the incremental expected payoff from a proposed investment in information processing assets. This required the specification of all (a) economic events for which related information system messages obtain; (b) consequent decision–maker actions dependent on "information structure"[19]; (c) associated economic outcomes and (d) probabilities associated with events, messages and outcomes (Feltham 1968; Hilton 1981; Mock 1971).

In complex, stochastic, organization–wide systems where the range of message–mediated event/action pairings is theoretically infinite and therefore not knowable *ex ante* to the decision–maker—with consequent high levels of uncertainty as to both message and outcome values—the approach lends itself to unacceptably high levels of

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[18] Information Technology Assets: Hardware, software, database management and communication technologies (which, combined with information resources, make up information technology resources)

[19] "Information structure" describes the relative "fineness" (i.e. level of detail) of the "state space partition" (Barua & Mukhopadhyay 2000)

mathematical complexity and/or impracticality (Feltham 1968; Nystrom 1974). The methodology therefore remains clearly maladaptive to all but the most structured (and therefore relatively less complex) and predictable of information systems.

Additionally, accounting–based information systems hold value propositions based in feedback and learning. These are likewise too complex to be made amenable to value quantification under decision theoretic methods (Mock 1971). In particular, if the value of an information system were to remain the equivalent of the economic value of information provided by the system[20] (Ahituv 1989; Hilton 1981), and if message signals from complex stochastic systems could increase subjective uncertainty[21] (Nystrom 1974), then decision theoretic approaches to modelling information systems value fail the test of external validity (Mock 1973).

Later research applied microeconomic production theory to model diverse decision–maker payoff functions. These estimate differential payoffs from the impact of diverse information attributes on decision–making (Kriebel & Raviv 1980; Mukhopadhyay & Cooper 1992). While the models are highly amenable to reasonably well–structured decision contexts (e.g. inventory management, production scheduling) normal to a very local level (department, work–group) of the enterprise, they are inadequate for enterprise–wide value–in–use contexts (Barua & Mukhopadhyay 2000; Mukhopadhyay & Cooper 1992). Such contexts are characterized by relatively high levels of uncertainty from the complex interplay of organizational–level, individual decision–maker–level, and information systems–level variables (Barua & Mukhopadhyay 2000).

At the organization–level are management objectives, strategy, structure, process, culture, technology and environment (Weill 1992). At the individual decision–maker level are decision participants' cognitive style, structure and functioning (Huber 1983; Mock 1971; Nystrom 1974; Pratt 1982), the foci of cognitive science–based approaches in information science (Nystrom 1974; Pratt 1982; Repo 1989). At the information systems–level are the information quality attribute variables—both intrinsic (e.g.

[20] Rather than the value of "information structure" and other information attributes modelled in information theoretic approaches (Barua & Mukhopadhyay 2000; Repo 1989)

[21] i.e. uncertainty as to the integrity of the decision–maker cognitive structure of the decision problem as could be expected in learning–related decision–making contexts with long–term payoff horizons

accuracy, completeness) and extrinsic (e.g. relevance[22])—as modelled in information theoretic approaches (Ahituv 1989; Barua, Kriebel & Mukhopadhyay 1989).

The diversity amongst these variables could reasonably be expected to impact "decision performance" (Todd & Benbasat 2000) and *ipso facto* information value. Therefore, information economics–related approaches to information systems' value modelling are not suited to organization–wide "value in use" contexts[23] (Repo 1989).

Subsequent research did however attempt to integrate decision theoretic approaches and cognitive science–oriented approaches in search of a more unifying theory of information value (Mock & Varsarhelyi 1978). Though the research results were inconclusive and the researchers appear to have doubted the usefulness of the theories, yet other researchers viewed the two approaches as being mutually supportive (Hilton 1980). However, it would appear that this particular thrust in information economics research did not gather momentum, perhaps owing in part to the confounding effect of complex organization–level variables on any unifying theory of information value.

Clearly, information economics approaches to modelling the value of information toward a model for decision–making on information systems selection and/or use would remain bedevilled with theoretical and methodological problems (Repo 1989). It would seem that the value of information can only be determined *ex post*: *"[i]t is only after the message has been received, the impact analyzed, the appropriate action taken and the true state of the world obtained that one can put a value on the message"*[24].

The citation highlights the implicit inevitability of the confounding influences from cognitive and organizational factors in determining any intrinsic value in information. Value must thus flow from actions consequent to decisions informed by messages (Feltham 1968), and such value–adding messages must *ipso facto* aggregate the value of

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[22] Extrinsic, since related to decision participants' cognitive style, structure, and functioning: "All relevance assessment is subjective and hence variable according to the assessor's understanding of the message content and understanding of the information need, his purpose in making the assessment, and the general context in which a particular assessment is made" (Vickery & Vickery 1987, p. 266)

[23] They are instead more suited to production economics' "value in exchange" propositions (Repo 1989)

[24] From a doctoral dissertation (Lawrence 1979, p. 17) as cited in Repo (1989, p. 71)

an information system (Hilton 1981). It clearly may no longer be meaningful to attempt an *ex ante* valuation of an information system.

In as much the intrinsic value of information (i.e. *ex ante* value) remains ill–defined and unresolved, and a scientific theory of information value–in–use[25] (i.e. *ex post* value) remains a felt need (Ahituv 1989), the lack of definitive empirical research into the enterprise–level value–relevance of on–going information technology investments remains very significant. This relative paucity of clear, categorical research is in stark contrast to the enormous sums expended on IT assets since the 1950s.

Whether these assets may have served to improve the long–term value of the firm, and therefore the wealth of its owners, has not yet been conclusively demonstrated. This research proposes a methodology for the demonstration of value relevance of IT investments. It further proposes "decision relevance" as *the* construct of singular relevance to the theory of the economic value of information *in use*. Loosely translated as the information's "fitness for purpose"—meaning the *perception*, *ex ante*, of the information's potential for value creation more than is possible without its use[26]—it may be seen as the summary result of all *perceived* value attributes both intrinsic and extrinsic to the information such as timeliness, completeness, accuracy, relevance and uncertainty reduction, amongst others. In this sense, "decision relevance" takes on a wider meaning than is accorded to diverse 'relevance' concepts by information theorists and scientists (Barua, Kriebel & Mukhopadhyay 1989; Hirshleifer 1973; Vickery & Vickery 1987) in that it subsumes both information theoretic and cognitive science–based approaches to information value[27].

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[25] The concept of "value–in–use" effectively subsumes the user, the use, and the effects of use (Repo 1989).

[26] "… concepts of value relevance and decision relevance differ. In particular, accounting information can be value relevant but not decision relevant if it is superseded by more timely information" (Barth, Beaver & Landsman 2001). Thus, while decision relevance subsumes value relevance but not *vice versa*, a test of value optimization is not made necessary for the specificity of the research question, which singularly addresses value relevance; nor is such test posited possible in a "value in use" setting. Value creation is considered *prima facie* evidence of optimization, and therefore of decision relevance

[27] "Decision relevance" addresses the IS *implementation* perspective in referencing *all* information attributes (both intrinsic and extrinsic) that contribute to enterprise value. This contrasts with, for example, "payoff relevance" (Barua, Kriebel & Mukhopadhyay 1989) that addresses the IS *design* perspective in the context of the economic significance ("payoff relevance") of intrinsic attributes.

Thus the question is: have the various iterations of information systems evolution been decision relevant to the enterprise? In other words, have they actually met their remit for empowering enterprise management to lift enterprise performance to a higher threshold? And has this remit then effectively served to improve the value of the firm in capital markets?

If enterprise performance has continuously improved on account of these successive information system implementations, then this may well be the clearest evidence that the decision–relevant quality of the information supplied by each such iteration has been an improvement over each preceding iteration. These implementations would then have contributed directly to firm earnings and shareholder value. There has been very little definitive evidence of the value relevance of information technology implementations.

1.3 SPECIFIC PROBLEM

One possible value–relevant initiative is the emergence of Enterprise Resource Planning (or ERP) systems, which have been described—together with the internet—as probably the most important information technology development to emerge into widespread use in the 90s decade (Seddon, Shanks & Willcocks 2003). Their value derives from the following: (a) their capacity to engender the integration of fragmented enterprise operations through rationalization, standardization and integration of enterprise business processes, information technology applications, and data across organizational sub–units[28], (b) the resulting data consistency and visibility across the supply chain making for informed resource coordination and deployment decisions that lead to operational synergies[29], (c) the ensuing better reliability and currency of data/information for

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"Decision relevance" is enterprise–wide "payoff relevance" of intrinsic *and* extrinsic information attributes

[28] (Austin, Cotteleer & Escalle 1999, 2003; Davenport 2000b; Dillon 1999; Ghoshal & Gratton 2002; Gupta 2000; Jenson & Johnson 1999; Ross & Vitale 2000)

[29] (Austin, Cotteleer & Escalle 1999, 2003; Defee & Stank 2005; Dillon 1999; Kelle & Akbulut 2005; Light 1999; Ross & Vitale 2000; Utecht, Hayes & Okonkwo 2004)

knowledge discovery and decision support[30], (d) the resultant capacity to better advance value discipline–oriented competitive strategies[31], and (e) the concomitant capacity to better design and direct strategy implementation and content controls[32].

Thus, (a) and (b) make for garnering efficiencies of operation (via improved resource coordination and control), and give rise to information quality improvements. The latter makes for (c), knowledge discovery and decision support, which in turn paves the way for (d), conceiving more effective strategy formulation and planning (resource planning and allocation). It also paves the way for (e), which allows for 'double–loop feedback' learning, thus bringing the enterprise strategic planning and control cycle full circle (Bauer 2003; CorVu 2005b, 2005a; Davenport 2000b; Hansen & Mowen 2003; Holsapple & Sena 2005; Muralidharan 1997; Otley 1999).

ERP systems must thus deliver decision–relevance via the securing of data integrity and visibility at all management levels, as well as across functional, departmental, business unit and enterprise boundaries. This makes for strategic/tactical oversight and decision support towards synergistic integration of strategy and operations across all components of the value chain (Botta-Genoulaz, Millet & Grabot 2005; Davenport 2000b; Holsapple & Sena 2005; Jenson & Johnson 1999; Lawrie & Cobbold 2004; Mohamed 2002; Ross & Vitale 2000).

In sum, ERP promises a comprehensive enterprise–wide performance management capability delivered upon ERP–enabled information infrastructures—the successful outcome being enduring enterprise value creation from continuously improving returns. This is enabled via sustained improvements to productivity and customer value from ERP–engendered structural changes to bottom–line and top–line operations. The latter is driven by process rationalization supplemented with knowledge discovery, decision

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[30] (Apte et al. 2002; Austin, Cotteleer & Escalle 1999, 2003; Bendoly 2003; Bose 2006; Davenport, Harris & Cantrell 2004; Davenport et al. 2001; Holsapple & Sena 2003, 2005; Hormozi & Giles 2004; Li, L & Zhao 2006; Neely & Jarrar 2004)

[31] (Davenport 2000b; Hormozi & Giles 2004; Lengnick-Hall & Lengnick-Hall 2006; Lengnick-Hall, Lengnick-Hall & Abdinnour-Helm 2004; Light 1999)

[32] (CorVu 2005b; Defee & Stank 2005; Kaplan & Norton 1996; Lawrie & Cobbold 2004; Muralidharan 2004; Schreyogg & Steinmann 1987)

support, and the implementation of strategy–aligned business initiatives[33] (Davenport, Harris & Cantrell 2004; Ghoshal & Gratton 2002; Lengnick-Hall & Lengnick-Hall 2006; Li, L & Zhao 2006; Li, Z, Chaudhry & Zhao 2006; Newell et al. 2003; Weill, Subramani & Broadbent 2002; Weston Jr. 2003).

Such knowledge–promoting implementations are better positioned to deliver unprecedented competencies offered by ERP implementations (Chen, IJ 2001). The net result of this is effective enterprise–wide capacity planning, allocation, and utilization in managing enterprise resources for maximal throughput and optimal performance (Michalewicz et al. 2007; Weston Jr. 2003).

Yet, a survey conducted by Davenport (2000b; 2001) found that less than 10% of 60 firms that had invested billions of dollars of shareholder funds in ERP implementations[34] were able to demonstrate substantial progress in leveraging their ERP data for decision–making or for knowledge–creation. Johnston (2002) quotes a Harvard researcher to the effect that 14% of ERP implementations are either troubled or abandoned and up to 40% of those otherwise successful barely meet or fall short of expected benefits. Jakovljevik (2002) cites a year 2001 worldwide membership survey of The Conference Board where approximately 40% of survey participants report their organizations had not achieved their business cases for ERP implementations a year after implementing. Ptak & Schragenheim (2004) report that articles published in recent magazines provide anecdotal evidence indicating 75-90% of firms implementing ERP "… will not achieve the bottom-line business results that were identified in the project justification…" (2004, p. 302)[35]. Collectively, these sources would appear to indicate

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[33] While process rationalization promotes the quality of information available for managerial decisions, knowledge discovery yields decision support and makes for predictive modelling (Michalewicz et al. 2007; Xu et al. 2002)

[34] The cost of an ERP implementation can range from USD50m to over USD1.0b—with the lowest end of the market alone incurring a not insignificant outlay of USD2-4m (Chen, IJ 2001; Davenport 1998)

[35] This finds more recent confirmation from a leading enterprise software evaluator, Technology Evaluation Centers: "…a staggering **70 percent** of new ERP initiatives **fail** to meet expectations—wasting time, money, and resources along the way" (Technology Update, 27/01/07). Also, Australian Banking & Finance, 1 August 2000, reports research by PA Consulting Group that shows 92% of companies dissatisfied with results of ERP implementations with only 8% achieving positive performance improvement (Factiva database, 2000)

the benefits of ERP implementations are to a greater or lesser extent not being realized[36].

Nevertheless, major ERP–related strategic benefits such as streamlined data visibility and access, improved customer response, and strengthened supplier relationships, which are critical to firm survival and growth, are not readily quantified in accounting metrics (Chen, IJ 2001; Strassman 2004)[37]. Furthermore, they translate into bottom line performance with lagged effects[38] (Brynjolfsson & Yang 1996; Chen, IJ 2001; Devaraj & Kohli 2002; Nicolaou 2004; Poston & Grabski 2001).

Under these conditions, share markets may be expected to signal the strategic value of the investment under the Efficient Markets Hypothesis for which evidence abounds (Ball & Brown 1968; Fama 1970, 1991). Furthermore, it is proposed that they may also reward the firm for any perceived improvement to the quality of earnings[39] resulting from ERP implementation. Improvements in share returns may thus be associated with ERP adoption regardless of the particular timing of the direct bottom line benefit.

It is therefore posited that any measure of ERP benefit value determination must consider capital market effects. It would appear that previous research has not attempted this (Benco 2004; Hitt, Wu & Zhou 2002; Hunton, Lippincott & Reck 2003; Nicolaou 2004; Poston & Grabski 2000, 2001) beyond conducting event studies surrounding announcement dates of intended ERP investments (Benco 2004; Hayes, Hunton & Reck 2001; Hunton, McEwen & Wier 2002)[40], despite evidence of post–implementation

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[36] Given the seeming consistency of these numbers as between different sources at different times, it is remarkable that the industry remains on a phenomenal growth curve. In the year 2004 alone, the Enterprise Applications software market was worth USD23.6b, with growth estimated at a compound annual rate of 6-7% through 2006-2009 (Reilly 2005)

[37] "The worth of the accumulated knowledge of employees, of software, of databases, of organizational capabilities, and of customer relationships does not show up on the general ledger, even though the worth of IT is best reflected in what it contributes to the capacity of people to deliver greater value to customers" (Strassman 2004, p. 6).

[38] It is noteworthy that the ERP roll–out can extend from a brief 6 months to an extended 5 years and more depending on the implementation strategy adopted (Davenport 2000b)

[39] Share markets may price earnings quality (Aboody, Hughes & Liu 2005; Chan et al. 2006)

[40] The last, an experimental behavioural study of market analyst responses to a hypothetical ERP investment announcement

performance dips (Deloitte Consulting 1999; Hitt, Wu & Zhou 2002; Jakovljevic 2002; Markus & Tanis 2000; McAfee 2002; Nicolaou 2004; Ross & Vitale 2000).

This research investigates whether there is evidence that implementations of ERP systems have translated into long–term shareholder value. The importance of this question lies in the proposition that, if the billions invested in ERP implementations are to be justified from a shareholder perspective, then such justifications must be based on not just the ERP industry–touted operational/strategic benefits to firm performance alone, but also on demonstrable market perceptions that the promised benefits are supported by sustainable performance improvements in ERP–adopter firms. Such perceptions would be expected to manifest in the share return response to ERP–engendered unexpected earnings and/or improved quality of earnings and/or enhanced strategic value of the firm.

While extensive research has demonstrated that markets do respond to earnings (Ball & Brown 1968; Cheng & Cheung 1993; Easton & Harris 1991; Easton, Harris & Ohlson 1992; Lev, Baruch & Ohlson 1982; Lipe 1986), there is also evidence that these earnings signals contain noise (Collins et al. 1994; Lieber, Melnick & Ronen 1984). Because of this noise, capital markets do attempt to assess whether earnings improvements are permanent or transitory (Cheng, Liu & Schaefer 1996; Kormendi & Lipe 1987). If ERP implementations result in improved earnings through a quantum and/or an expected permanency to a quantum, this fact should be reflected in market returns.

In sum, it is posited that the market perspective would permit conclusive determination of the enterprise value relevance of ERP implementations. This perspective would be expected to yield evidence of valuation premiums on firms that have significantly advanced their future earnings profiles via ERP–engendered enhancements to enterprise operations and value. Short time–window event studies around ERP announcement dates (Chatterjee, Pacini & Sambamurthy 2002; Dos Santos, Peffers & Mauer 1993; Hayes, Hunton & Reck 2001; Richardson & Zmud 2002) cannot deliver this causal proof. Likewise, other associative studies (Anderson, MC, Banker & Ravindran 2001; Bharadwaj, Bharadwaj & Konsynski 1999; Brynjolfsson, Hitt & Yang 1998; Brynjolfsson & Yang 1999; Hitt & Brynjolfsson 1996; Hitt, Wu & Zhou 2002; Krishnan & Sriram 2000) appear theoretically underdeveloped to this end, and therefore not designed to lend causality to their findings.

1.3.1 RESEARCH DESIGN

To test the value relevance of ERP implementations, five yearly regressions of share returns on earnings and earnings changes both with and without ERP–interaction terms are performed with a sample of 60 matched pairs of ERP adopter/non–adopter firms. The regressions are performed for each fiscal year of a five–year period immediately following the date of implementation. The sample is selected from firms listed on the Australian Stock Exchange (ASX).

The firms are matched across industry and firm size. It is expected that this matching would effectively control for scope (industry) and scale (size) effects. Matched pair designs have been used in ERP–related studies for controlling scope and scale effects (Hunton, Lippincott & Reck 2003; Nicolaou 2004) in lieu of control variables in regression functions (Bharadwaj, Bharadwaj & Konsynski 1999; Hitt, Wu & Zhou 2002).

In order to derive the earnings change in a fiscal year, the current earning attributable to the "persistence[41]" effect of the firm's earnings time–series (Kormendi & Lipe 1987) moderated by the theorized macro–economic effect (Bilson, Brailsford & Hooper 2001; Rose, Wesley & Giroux 1982) is predicted with an autoregressive earnings prediction model factored with macroeconomic variables. To test for an ERP effect on share returns, ERP–earnings interaction terms are included in a separate returns regression model.

If ERP adoption would make for shareholder value, then the share market returns would be expected to begin to show a significant effect from an ERP–earnings interaction any time within the 5–year post–implementation period. This extended test period makes allowance for any possible effect on share returns from immediate post–implementation performance dips recorded in the literature (Holsapple & Sena 2003; Nicolaou 2004; Poston & Grabski 2001).

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[41] "Persistence" refers to the perceived effect on expected future earnings from new earnings information in the firm's earnings report. Miller, MH and Rock (1985) show that "persistence" must determine the magnitude of the share return response to the new information

1.3.2 DATA COLLECTION

As in all research, the validity of the findings would depend not only on the robustness of the theoretical model developed and the research design employed, but also of the integrity of the data sets used for populating the model. Company financial data are obtained from company annual reports available with Aspect Huntley's Annual Reports Online database. Other financial data are culled from Aspect Huntley's FinAnalysis. Macroeconomic data are obtained from the Australian Bureau of Statistics (ABS) and the Reserve Bank of Australia (RBA).

The firms in the treatment group are identified from announcements of ERP implementations culled from the Factiva database and Aspect Huntley's DatAnalysis database of Signal G filings. Information relating to key implementations available on industry sources' web sites (i.e. vendors, industry analysts etc) is also used where appropriate. The firms are contacted directly for confirmation of ERP implementation where necessary.

The control group of firms are determined firstly by establishing, via annual report inspection, that ERP–adoption, if any, occurred outside the test period for the corresponding matched adopter firm. Secondly, by contacting the companies direct for confirmation they had not implemented enterprise systems in the period of the test.

The data set covers the period 1995-2005. Within this period, 5 continuous years of data are used for each treatment group firm from the fiscal year of implementation.

1.4 SUMMARY OF RESULTS

The expected result from this research is that ERP implementations are shareholder value relevant. This covers the 'strategic proposition' (Dubin 1978) of this research. The subsidiary propositions dealing with diverse aspects of enterprise performance relevance of ERP implementations (e.g. improvements to returns on assets and to value driver ratios such as the operational expense ratio), are expected to be largely upheld.

1.5 CONTRIBUTION OF THE RESEARCH

The theoretical development, research method, and results contribute to the existing body of research on ERP systems in several ways.

1.5.1 CONTRIBUTION TO THEORY

The theoretical development may provide linkage to extending the theory of transaction cost economizing to the task level and thus serve to complete what is in effect 'work in progress' in the transaction cost economizing theory of the firm where organizational structure is deemed important (via information communication structure linked to business process and decision rights).

It also provides a theory of information value–in–use by (1) expanding the uncertainty–reduction construct of "decision relevance" in information theory to subsume all information attributes that effectively make for "fitness for purpose", and (2) by linking the new decision–relevant quality attribute of information with the value–relevance construct at the enterprise level.

It thus contributes to completing what effectively is "work–in–progress" in information economics towards an embracing theory of information value in use. This research also develops the theory for ERP's performance relevance to enterprise operations, and therefore its value relevance in the stock market.

1.5.2 CONTRIBUTION TO RESEARCH

This research advances the extant research on enterprise resource planning by extending the testing period for firm performance effects beyond the 3rd year post implementation. Testing for effects over 5 years post implementation is deemed necessary (Poston & Grabski 2001) considering that some firms may need an extended period for fully realizing the benefits from ERP implementations.

The research may be the first instance of testing the long term enterprise value effects of ERP implementations. It may also be the first research that tests for shareholder value relevance of ERP implementations. The previous research on value did not attempt tests of relevance in so far that they confined themselves to market (and industry analyst) responses to implementation announcements (i.e. event studies) (Hayes, Hunton & Reck 2001; Hunton, McEwen & Wier 2002). Capital market theory implicitly links "persistence" effects with value (Kormendi & Lipe 1987; Miller, MH & Rock 1985)—an implication apparently not heeded in extant ERP research.

It may also be the first research that controls for macro–economic and firm–specific (i.e. time series earnings persistence) affects in enterprise performance reports. It delivers a methodology for controlling for these affects, and thus paves a way for the deriving of 'cleaner' extractions of the 'things of interest'—in the instance of the present research, an estimate of the earnings change associated with firm–specific factors. It may also be the first research that demonstrates a method for the evaluation of share market response to management innovations and management accounting numbers.

It also contributes to archival research in management accounting in two ways. Moers (2007) suggests management accounting research addresses topics beyond its traditional field of executive compensation, and uses data sources beyond published financial data. This research highlights the importance of controlling for macro economy effects on firm performance and addresses a residual computation methodology for firm earnings. It also addresses a method for deriving the value of an information technology investment. It draws data from multiple archival sources, and may in fact be one of the first studies in management accounting to do so.

1.5.3 CONTRIBUTION TO PRACTICE

In general, the research question is of significant interest to enterprise vendors, strategic management practitioners, industry professionals (IT/ IS executives, managers and consultants), share market analysts and the investor community in general, as well as votaries of enterprise systems.

The research method introduces a methodology that can be adopted for determining the value relevance of any information technology implementation. This has implications for IT governance practice and corporate governance. The methodology may be able to be extended to any system, technique, or management initiative that purports to improve operational performance.

The research supplies inputs into project planning (via a methodology for investment evaluation), IT governance theory and practice, and corporate governance.

1.5.4 CONTRIBUTION TO EDUCATION

In the information technology management education in particular and business studies in general, there is a general lack of awareness of the importance of determining the proper value of enterprise initiatives. This research underscores the importance of this issue and presents a methodology for evaluating the value relevance of enterprise initiatives. Further, it heightens awareness that major projects cannot but be evaluated in the long–term and gives an appreciation of the length of time that is needed for evaluating the performance effects of IT initiatives.

1.6 STRUCTURE OF THE THESIS

Chapter 2 reviews the literature on ERP information systems and develops the theory and related propositions on the performance relevance of ERP implementations, and their potential relevance for shareholder value.

Chapter 3 develops the model for testing the propositions and presents the research design. This includes the theoretical constructs and their operationalization for the testing of the hypotheses that determine if there is evidence that ERP implementations improve enterprise performance and deliver shareholder value. Chapter 3 also presents data collection and sample selection.

Chapter 4 presents the model estimation and the results of the tests of hypotheses.

Chapter 5 discusses the findings of the study and its implications for research, practice, and education. It presents the study's contribution to the existing body of literature, discusses its limitations, and its impacts on the directions for future research.

2. THEORY DEVELOPMENT

2.1 INTRODUCTION

The chapter develops the theory underlining the research question: are ERP systems value–relevant to enterprises? Section 2.2 describes ERP systems, framing their development and emergence in a historical timeline that serves to lend context to their developing promise of value. Section 2.3 examines the question of 'value' introducing the concept of 'shareholder value' as the measure of interest. It discusses ERP's potential for 'shareholder value' by way of its contribution to the 'shareholder value paradigm'. It then expands on the nature of the key construct postulated to make ERP value relevant: 'decision relevance'. Section 2.4 gives context to the posited value relevance of the 'decision relevance' construct by demonstrating its potential for allowing enterprises overcome the key limitations to profitable growth identified in the Transaction Cost Economic Theory of the Firm. Section 2.5 summarises the evidence in the research literature on ERP value effects and highlights the knowledge gap on value relevance. The propositions that flow from the foregoing are summarised in section 2.6. The chapter concludes with the chapter summary in section 2.7.

2.2 ENTERPRISE RESOURCE PLANNING SYSTEMS

Sub–sections 2.2.1 to 2.2.4 introduce the ERP phenomenon giving context to their emergence and their promise of enterprise value relevance. Sub–section 2.2.5 defines the scope of the research question in context. Comprehensive treatment of these subsections is included in the respective appendices as indicated.

2.2.1 ERP SOFTWARE DESCRIBED (APPENDIX A)

Enterprise Resource Planning is an integrated, software–centric information system (Klaus, Rosemann & Gable 2000). ERP software is a suite of application program modules designed to set up an interactive environment for enterprise users to analyse and manage business processes associated with the production and distribution of goods and services (Jakovljevic 2005). The software thus serves to help integrate enterprise–wide business processes and the information needed for the execution of those processes (Seddon, Shanks & Willcocks 2003). These descriptions serve to emphasize integration of program applications, business processes and data across the enterprise to create a unified (non–fragmented) information system in support of enterprise operations.

2.2.2 ERP PURPOSE (APPENDIX B)

The broad purpose underlying the ERP software design features is to equip enterprises with a tool to optimise their underlying business processes to enable them create a seamless, integrated information flow from suppliers through to manufacturing and distribution (McDermott 1999). This serves enterprise–wide supply chain processes that increasingly seek to manage individual customer relationships with a cross–enterprise supply chain perspective; this being a strategy rendered increasingly necessary in the face of growing consumer demands, globalization and competition (Ferguson 2000).

2.2.3 ERP DEFINED (APPENDIX C)

The 10th edition of the APICS[42] Dictionary defines enterprise resource planning as "[a] method for the effective planning and controlling of all the resources needed to take, make, ship, and account for customer orders in a manufacturing, distribution or service company" (Miller, GJ 2002). This definition captures the essence of the software's core purpose without referencing the software itself—which purpose is the purpose of an enterprise resource planning information system; i.e. the planning and controlling of resources for effective enterprise performance.

2.2.4 ERP'S EMERGENCE AND GROWTH (APPENDIX D)

ERP software systems may be viewed as the latest generation in the continuing evolution of business software systems dating back to the 1950s. Understanding its evolutionary context is prerequisite for comprehending its current application and future direction (Deloitte Consulting 1999; Ptak & Schragenheim 2004).

The following chart summarizes the evolution of business information systems culminating with ERP. It depicts their progressive integration commencing with early, "rudimentary" inventory Reorder Point/ Bill of Materials interfaces (ROP/BOM) and ending with fully–integrated ERPII systems of the present day[43]. This integration is two–dimensional: scope and scale. While "scope" addresses extent of coverage across

42 APICS – American Production and Inventory Control Society; currently, the Association for Operations Management

43 For the context of this writing, interfaced systems share data off line. Partially–integrated systems share some data on–line or in real time. Fully–integrated systems share data on line and in real time

business processes, "scale" refers to the degree of seamlessness of integration across applications, data, and processes.

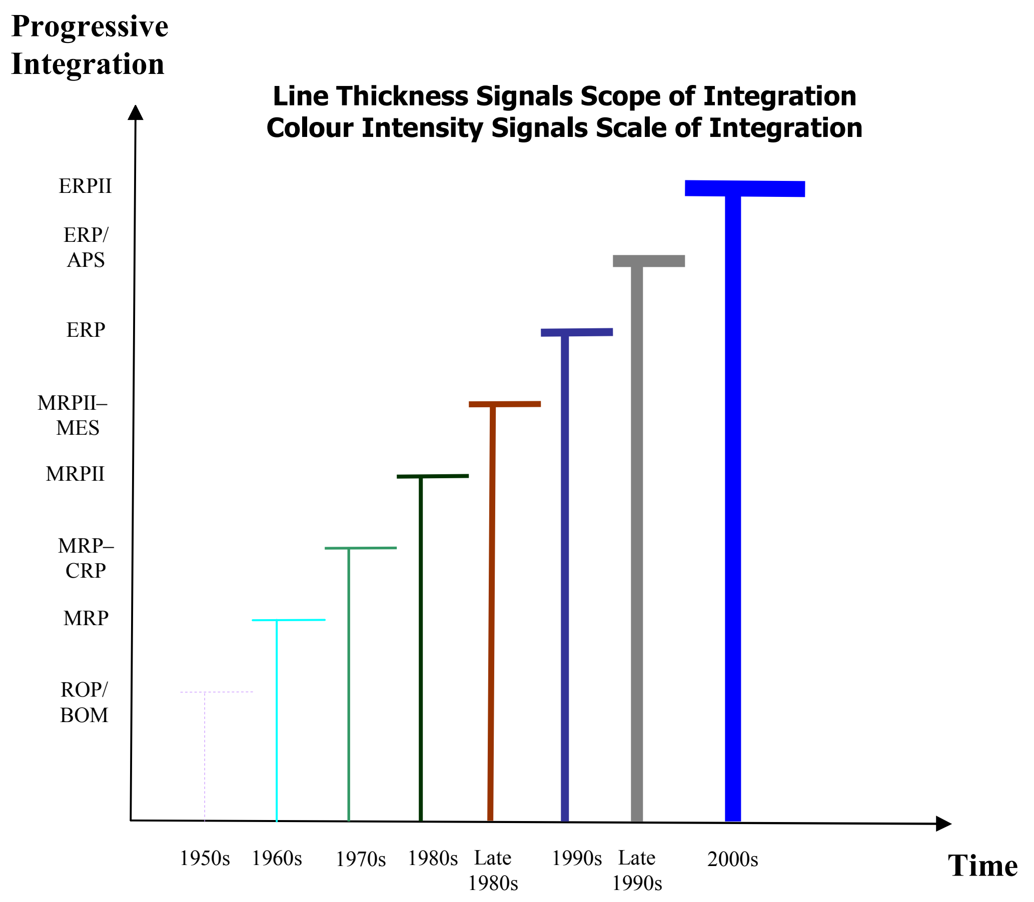

FIG. 2.1 ERP SOFTWARE EVOLUTION TIMELINE

Legend:

ROP	–	Reorder Point Systems
BOM	–	Bill of Materials Systems
ROP/BOM	–	BOM–interfaced ROP
MRP	–	Materials Requirements Planning
CRP	–	Capacity Requirements Planning
MRP–CRP	–	CRP–integrated MRP
MRPII	–	Manufacturing Resource Planning
MES	–	Manufacturing Execution Systems

MRPII–MES	–	MES–integrated MRPII
ERP	–	Enterprise Resource Planning
APS	–	Advanced Planning Systems
ERP/APS	–	APS–interfaced ERP
ERPII	–	"Enterprise Systems[44]", ERP's 2nd wave of development

The starting phase (ROP/BOM) exhibited zero integration (addressing basic inventory planning requirements with interfacing BOM systems). Likewise, the penultimate phase (ERP/APS) saw interfacing between separately evolving systems, ERP and APS, developing into full integration only with the emergence of ERPII. In effect, this latter interim interfacing phase records a regression in scale of integration (fig. 2.1). (Appendix D presents the comprehensive discussion on the evolutionary development leading to this state and beyond).

2.2.5 SCOPE OF THE RESEARCH IN RELATION TO ERP'S EMERGENCE (APPENDIX E)

"Enterprise Systems" or ERPII began to develop at the turn of the millennium (Fig. 2.1). According to Gartner Group, ERPII would not reach maturity until the year 2005 (Bond et al. 2000). Treatment of these "enterprise systems" is outside the scope of the research question currently testable since the research design calls for 5 years' post–implementation performance data (section 3.4). This research study therefore limits itself to addressing the 1st phase of development of enterprise–wide systems, Enterprise Resource Planning or ERP (with or without the APS interface for manufacturing[45]).

2.3 VALUE OF INFORMATION

Section 2.2.4 (and appendix D) addressed the evolution of ERP information systems and its potential significance to the question of enterprise value. The motivation for this treatment stems from two sources: (1) the fundamental question of the economic value

[44] "Enterprise Systems" is a term coined to embrace ERP and its 2nd wave extensions commencing with Supply Chain Management (SCM)—dubbed ERPII (Seddon, Shanks & Willcocks 2003; Weston Jr. 2003)

[45] Early APS systems supplanted the preceding MRP/CRP/MRPII planning and control functionality before advancing this functionality to embrace the external supply chain under ERPII (appendix D)

of information, and (2) the topical issue of the significance of this value to the owners (shareholders) of the enterprise.

As discussed in chapter 1, the question of the economic value of information has remained unresolved in information economics. Information has no intrinsic value beyond the value that can be ascribed to it in the context of its use (Hilton 1981). This context has been hard to capture and measure in econometric terms (Repo 1989).

The value can be measured only by its net economic benefit, if any. In an enterprise, this may be measured by the excess return over the return that would have accrued if it had not been available for use less the cost of its production (Feltham 1968).

This value, clearly, is not to be readily determined. Hence, an objective assessment of whether the processes of information production and use in the enterprise are generating added value or diminishing it is not normatively feasible.

An alternative approach might be to investigate if, under the Efficient Markets Hypothesis (Fama 1970, 1991), the share market responds to such information production and use. A positive market response to earnings delivered via decision–relevant information would supply indirect evidence of the economic value of information to the enterprise.

2.3.1 SHAREHOLDER VALUE: THE MARKET RESPONSE TO EARNINGS INFORMATION

The share market reacts to firms' earnings data: stock price volatility and/or volume traded peak (a) in the week following the earnings announcement (Beaver 1968), (b) the day before and day of announcement (Morse 1981), and (c) intra–day, within hours of the announcement (Patell & Wolfson 1984). The progressive narrowing of the time window over which these returns are measured increasingly limits possible confounding effects from any concurrent, non–earnings–related information. That share prices react to earnings data is now very well established through the foregoing studies and others referenced below.

Ball and Brown (1968) show a clear relationship between the direction of the earnings signal and the direction of the returns response. The magnitude of the abnormal return cumulated over the 6–month period following the earnings release bears a direct relationship with the magnitude of the earnings forecast error (Joy, Litzenberger & McEnally 1977). A grouping of securities into 25 portfolios [n] in each of 10 years by the class of their earnings forecast errors reveals a rank correlation [r] of 0.74 between their class means and the corresponding mean abnormal returns (Beaver, Clarke & Wright 1979)[46]. The foregoing studies, amongst others, conclusively establish a clear positive relationship between share price returns and earnings levels.

Benston (1967) and Ball and Brown (1968) find that much of the price change associated with earnings change occurs prior to the announcement of annual earnings. The Beaver, Clarke & Wright (1979) study confirms this characteristic of the earnings–return relation over a 12–month period ending 3 months after the earnings release date. They find a weak average correlation (r=0.38) between returns and earnings at the individual firm level. A separate study (Beaver, Lambert & Ryan 1987) reports an average earnings response coefficient of only 0.31. Importantly, Lev (1989) reports that 19 studies into the earnings–returns relation published in the 1980s decade typically explain less than a tenth of the variance in returns at the individual security level. The explanatory power of earnings in the earnings–return relation is demonstrably weak.

Nevertheless, the consistency of earnings/returns correlations point to reported earnings containing information as to the "future benefit" accruing to equity holdings[47] (Beaver 1998; Easton 1985; Garman & Ohlson 1980; Ohlson 1979, 1983). While this "benefit" is the stream of expected future dividends (Easton 1985), the dividend irrelevancy proposition (Miller, MH & Modigliani 1961), which finds support in the 'clean surplus' relation in financial reporting (Ohlson 1995), permits earnings to proxy dividend distributions (Ohlson 1995). Miller, MH and Rock (1985) show the share return must remain a function of "persistence" i.e. the present value of revisions to future earnings.

Kormendi and Lipe (1987) enquire into how share returns might mirror earnings persistence. They find that the earnings response coefficient (or ERC)[48] that measures

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[46] At values of n=10 and n=5, the correlation is greater at r>0.94 and r>0.97 respectively (Beaver, Lambert & Morse 1980)

[47] … after the classical valuation model, which states the firm's stock price should equal the present value of expected future benefits (Miller, MH & Modigliani 1961)

[48] The ERC is defined as "… the effect of a dollar of unexpected earnings on stock returns, and typically measured as a slope coefficient in the regression of abnormal stock returns on the appropriately scaled unexpected earnings" (Cho & Jung 1991, p. 85)

the magnitude of a firm's return response to "earnings innovation[49]" is positively correlated with the present value of revisions to expected future earnings from the innovation. Since the revisions are a function of the time series properties of earnings, the time series persistence of earnings coefficients (PEC), in effect, informs the ERC.

In sum, the "shareholder value" construct adopted in this research takes on "earnings innovation" as its referent and is defined as *the expected future equity earning associated with a current earnings innovation and evidenced in the share price return response to the innovation*[50].

2.3.2 ERP AS EARNINGS INNOVATION AGENT: A SHAREHOLDER VALUE PARADIGM[51]

The central issue concerning this research therefore is whether ERP implementations may be deemed to be significantly associated with such earnings innovations[52]. The test for this association being by way of ERCs of the ERP–earnings interaction terms of the returns–earnings relation proposed in this research as the model for the ERP–associated impact on share price returns[53].

The share price return is a function of the net present value (NPV) of the expected future benefits accruing to the equity shareholding of the enterprise[54]—effectively the stream of expected incremental earnings resulting from the earnings innovation (Kormendi & Lipe 1987; Ohlson 1995). The size of the return is thus a function of (1) a decrease to the costs of operations, and/or (2) an increase to the revenue from operations

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[49] "Earnings innovation" is an estimate of the "new earnings" in the earnings report. This "new information in earnings" is represented as the residual of an autoregressive time series earnings model fitted to the firm's history of earnings (Kormendi & Lipe 1987, p. 324)

[50] This broad formulation is aimed at subsuming both historical time series earnings persistence and any improvements thereto (that may be triggered by ERP adoption) captured by the ERC

[51] While this and the following sections develop the theory for ERP's value relevance, appendix D (the addendum to section 2.1.4) relates ERP's evolutionary development to the Shareholder Value Paradigm

[52] From here on, the term "earnings innovation" will connote "new earnings" with persistence effects

[53] The model is based on the market models adopted in the accounting literature extended with terms to represent ERP's mediation in the returns–earnings relation. The complete model is presented in chapter 3

[54] … after the classical valuation model

that (3) persist/s over time, at (4) a constant or reducing[55] cost of capital, this last effectively impounding risk into the discount rate adopted for NPV calculations (Brealey & Myers 1996; Christopher & Ryals 1999; Kaplan & Norton 1996; Kormendi & Lipe 1987; Srivastava, Shervani & Fahey 1998).

From a perspective of strategy execution, the above four enterprise market value drivers take respective effect from the following four causal drivers: (1) consumption of relatively fewer inputs for given quantitative output (from capital deepening[56] and process innovation[57] leading to enhanced productivity); (2) consumption of relatively fewer inputs for given qualitative output (from product/process innovation leading to superior product variety, logistics, quality, functionality, pricing and other value intangibles); (3) sustaining improvement in causal drivers 1, 2 & 4 (from structural changes to organizational processes—including information processing and decision rights distribution—leading to process/data integration towards enhancing organizational competencies/ capabilities); and (4) improvement in capital utilization (from improved forecasting, improved working capital management, higher capacity utilization, effective product design, optimized supply chain, efficient plant layout, reduced order–to–cash cycle times, efficient cash management, and others)[58].

Process engineering/innovation (driver 3) is the more significant causal value driver as it implements structural changes that are the more permanent and thus enduring ("persistent") for value creation (Dedrick, Gurbaxani & Kraemer 2003; Ittner & Larcker 2001; Rodrigues, Stank & Lynch 2004). Executional drivers (1, 2 & 4) are increasingly a function of the way operations are strategically structured (driver 3) for process

[55] The cost of capital could be expected to fall with an improvement in the time series persistence of the earnings innovation over and above what is normal to the firm from its past history of earnings—effectively, with an improvement in driver 3

[56] Increases in labour productivity achieved with additional capital invested in labour inputs. Investment in IT contributes to capital deepening (Dedrick, Gurbaxani & Kraemer 2003; Pilat 2004)

[57] Increases in multifactor productivity (MFP) achieved without additional capital invested in multifactor inputs. This is possible via technical progress in the production process. Investment in IT contributes to overall efficiency and lower transaction costs, and promotes more rapid innovation, all of which increase MFP (Dedrick, Gurbaxani & Kraemer 2003; Pilat 2004)

[58] (Anderson, EW, Fornell & Lehmann 1994; Dedrick, Gurbaxani & Kraemer 2003; Defee & Stank 2005; Ittner & Larcker 2001; Kaplan & Norton 1996; Reichheld & Sasser Jr 1990; Shank & Govindarajan 1992; Srivastava, Shervani & Fahey 1998)

performance (Defee & Stank 2005; Harris & Ruefli 2000; Ittner & MacDuffie 1995; Rodrigues, Stank & Lynch 2004).

Such structural/ executional drivers (Ittner & MacDuffie 1995; Shank & Govindarajan 1992) are the key determinant of enterprise value because it is their relative permanence that makes for sustainability of earnings performance improvements and lowered risk[59]. Both perceived permanence of the earnings improvement and associated perceived risk levels determine the share return response to an earnings innovation (Kormendi & Lipe 1987; Srivastava, Shervani & Fahey 1998).

The relation between structuring for value (driver 3) and the value so realized (drivers 1,2 & 4) is moderated by the quality of the information system as implemented (Rodrigues, Stank & Lynch 2004; Rucci, Kirn & Quinn 1998). Information quality for decision–making is secured with sound IRM instanced through effective IT governance aligned via sound strategies for performance management (DeLone & McLean 1992; IT Governance Institute (ITGI) 2005b; IT Governance Institute (ITGI) & Information Systems Audit and Control Association (ISACA) 2003; Xu et al. 2002). Effectiveness of IRM so made possible is thus the arbiter of decision relevance and consequently, economic value of information for enterprise value outcomes.

The implementations of ERP systems are expected to evidence the effectiveness of IRM and IT Governance in adopter firms via the enhancing of decision relevance of the information product within enterprises[60]. The proof for this latter effect is posited to be the significance of the ERP interaction with earnings levels and earnings changes in determining the share return response to the innovation.

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[59] The persistence of earnings improvements at lowered risk levels is likely to be associated with transformational IT investments (comprising product/process innovation that reflects strategic intent) more so than with informational investments (for operations planning and control) and transactional investments (for productivity advances through capital deepening) (Dedrick, Gurbaxani & Kraemer 2003; Richardson & Zmud 2002). This would be expected to follow in as much that transformational investments are more likely to be associated with improvements to (or creation/redesign of) structural drivers more or less unique to the individual enterprise (driver 3). Transformational investments are associated with driver 2, informational with driver 4 and transactional with driver 1

[60] Considerable theoretical bases for and some empirical evidence of decision relevance and/or impact on decision making can be gleaned from the literature: (Apte et al. 2002; Austin, Cotteleer & Escalle 1999, 2003; Bendoly 2003; Bose 2006; Davenport 2000b; Davenport, Harris & Cantrell 2004; Davenport et al. 2001; Defee & Stank 2005; Dillon 1999; Gabriels & Jorissen 2007; Ghoshal & Gratton 2002; Gupta 2000; Holsapple & Sena 2003, 2005; Hormozi & Giles 2004; Jenson & Johnson 1999; Kelle & Akbulut 2005; Lengnick-Hall & Lengnick-Hall 2006; Lengnick-Hall, Lengnick-Hall & Abdinnour-Helm 2004; Li, L & Zhao 2006; Light 1999; Neely & Jarrar 2004; Ross & Vitale 2000; Utecht, Hayes & Okonkwo 2004)

In sum, share returns are improved through the perceived persistence quality of earnings innovations and/or improved persistence quality of earnings (as a whole), a function of the 3rd driver pairing of the value paradigm presented above—at constant or decreasing risk levels, the function of the 4th pairing. The persistence quality, to be realized, would necessarily have to flow out of structural enhancements to operations (driver 3) that deliver product/process changes (drivers 1, 2 & 4) for superior performance. These improvements both facilitating and being facilitated by unimpeded information flows and performance measurement strategies in a synergistic relationship toward sustaining long–term value creation; all of which are fostered by effective information resources management (IRM) strategies at the root of which are the particular value–oriented performance management strategies operated in the enterprise. The significance of the ERP–earnings interaction effect on share returns is posited to provide the required evidence of ERP's decision relevance towards contributing to shareholder value.

2.3.3 ERP SYSTEMS AND DECISION RELEVANCE

The ERP–earnings innovation association is thus premised upon ERP's capacity to deliver information for decision–making that is more relevant to new earnings generation than whatever system that existed prior to its implementation—

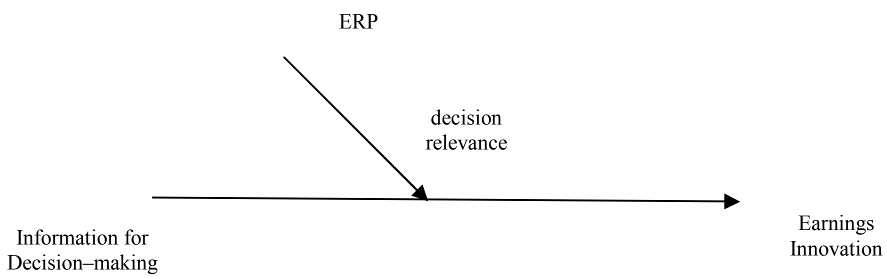

FIG. 2.2 INFORMATION–EARNINGS RELATION MODERATED BY ERP

For the purposes of the present research, the decision–relevant characteristic of an information system (ERP) is defined to be its "semantic relevance"[61] (Shwayder 1968)

[61] Semantic relevance is the capacity to affect the impressions of the decision–maker (Shwayder 1968) toward the appropriate decision. This subsumes a construct in *logic* (the "logic relating to the conditions in which a system or theory can be said to be true" *Encarta Dictionary,* UK) as well as *linguistics*. The former is expressed by the extrinsic attributes of information quality that are entirely contextual and

for informing decisions *perceived* to (a) differ from those of a prior system i.e. be "relevant", and (b) add more value (Ahituv 1989; Feltham 1968). "Decision relevance" is accordingly an *ex ante* standard that may be rendered as a *subjective* "fitness for purpose", purpose depending on context—in the instance of an ERP implementation, value creation in an organizational context.

When the information system is demonstrated to add more value, i.e. demonstrated to be "result relevant" (Shwayder 1968), *ex ante* "decision relevance" is empirically validated[62].

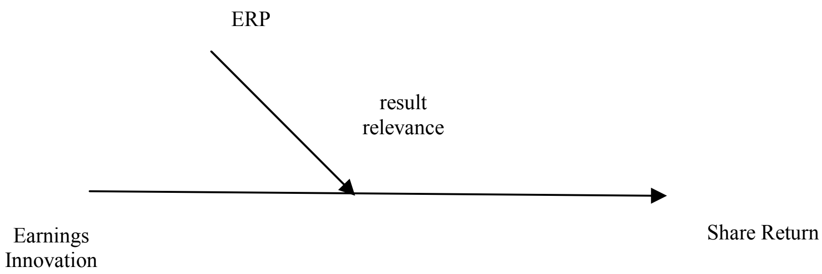

FIG. 2.3 EARNINGS–RETURN RELATION MODERATED BY ERP

The demonstration of "result relevance" would be evidenced by the earnings response coefficients (ERC) of the ERP–earnings interaction terms in the earnings–returns relation[63]. This evidence would effectively render the information system *ex post* "value relevant", within the meaning ascribed by extant accounting research[64].

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representational (e.g. value added, relevance, reliability, timeliness, currency, understandability), the latter by intrinsic attributes independent of decision context (e.g. accuracy, consistency, completeness, freedom from bias). "Semantic relevance" hence refers to information quality attributes that foster *clarity of the problem space*. The extrinsic attributes subsume cognitive and organizational variables, and intrinsic attributes information theoretic variables

[62] Semantic, decision, and result relevance form a hierarchical structure of relevance with respect to information for decision–making (Shwayder 1968)

[63] … after Cheng, Liu & Schaefer (1996)

[64] After Beaver (1998): "If the coefficient on a particular financial statement variable is significant and of the predicted sign, market prices act as if that variable is being priced conditional on the other variables in the equation and that item is defined as (shareholder) *value relevant*" (p. 116)

A strict interpretation of "decision relevance" would however implicitly subsume the notion of value optimization (since "semantic relevance" impounds the "timeliness" construct). A test of value optimization is not made necessary for the specificity of the research question, which singularly addresses value relevance[65]; nor is such test posited possible in a "value in use" setting. Thus, *ex post* value relevance is considered to be *prima facie* evidence of *ex ante* decision relevance *as defined* for this research[66].

It is posited that such relevance issues from ERP's capacity to engender (1) information infrastructure improvements that make for better (a) transaction processing (at the task level), and (b) information processing for short– and mid–term (operational and management control) decisions; and (2) information superstructure features that make for better knowledge processing for long–term transformational (strategic control) decisions (Ahituv 1989; Anthony 1965, 1988; Dedrick, Gurbaxani & Kraemer 2003; Richardson & Zmud 2002; Weill 1992). The latter relates to the former via the data consistency and availability fostered by the former to make possible the latter[67].

It therefore follows that if the implementation of ERP can be associated with continuing earnings innovation in the reported earnings of the firm, then this would evidence the continuing decision–relevance of ERP implementations. The time–series persistence of these earnings innovations evidences their shareholder value in terms of the definition developed for this research (section 2.3.1). ERP implementations would thus be shareholder value relevant. It is proposed that the transaction cost economic theory of the firm would offer the appropriate theoretical framework for the premise that ERP implementations are "decision relevant", and *ipso facto* "value relevant".

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[65] "… concepts of value relevance and decision relevance differ. In particular, accounting information can be value relevant but not decision relevant if it is superseded by more timely information" (Barth, Beaver & Landsman 2001, p. 80)

[66] … after Shwayder (1968)

[67] The literature evidences considerable theoretical and some empirical bases for ERP's decision relevance and general impact on decision–making (Apte et al. 2002; Austin, Cotteleer & Escalle 1999, 2003; Bendoly 2003; Bose 2006; Davenport 2000b; Davenport, Harris & Cantrell 2004; Davenport et al. 2001; Defee & Stank 2005; Dillon 1999; Gabriels & Jorissen 2007; Ghoshal & Gratton 2002; Gupta 2000; Holsapple & Sena 2003, 2005; Hormozi & Giles 2004; Jenson & Johnson 1999; Kelle & Akbulut 2005; Lengnick-Hall & Lengnick-Hall 2006; Lengnick-Hall, Lengnick-Hall & Abdinnour-Helm 2004; Li, L & Zhao 2006; Light 1999; Neely & Jarrar 2004; Ross & Vitale 2000; Utecht, Hayes & Okonkwo 2004)

2.4 ENTERPRISE RESOURCE PLANNING SYSTEMS AND THE THEORY OF THE FIRM

The Transaction Cost Economics Theory of the Firm (Coase 1937, 1988, 1992; Commons 1934, 1951; Williamson 1975, 1979, 1981a, 1981b) asserts, in essence, that the genesis of the modern corporation could be attributed to the ability of the emergent entrepreneurial function to organize economic activity more cost–effectively with organizational mechanisms than with the price mechanism in the open market (Coase 1937; Williamson 1981a, 1981b). If however firms were to achieve growth with resource coordination effected through the internal organizational mechanism than through the external price mechanism, they would need to address three constraints to generating cost–effective growth: (1) the rising cost of organizing transactions within the firm, (2) the increasing failure to place factors of production in their best uses, and (3) the rising supply price of factors of production (Coase 1937, 1988).

While (1) and (3) leads to increasing marginal cost, (2) leads to opportunity cost, both of which would eventuate in sub–optimal earnings returns. ERP's potential as a catalyst for earnings innovation would therefore rest with its potential to help reduce these limitations on a continuing basis. This would allow firms transcend their limitations to achieve profitable growth.

2.4.1 COASE'S 1ST LIMITATION – THE RISING COST OF ORGANIZING TRANSACTIONS

2.4.1.1 PROBLEM DESCRIPTION

Coase (1988, p43) states that with firm growth "… a point must be reached where the costs of organizing an extra transaction within the firm are equal to the costs involved in carrying out the transaction in the open market or to the costs of organizing by another (firm)." Firms exceeding this point could therefore be expected to sub–optimize their earnings returns through cost–inefficient operations relative to open market contracting or outsourcing.

The "costs of organizing an extra transaction" within the firm, as Coase envisions it, effectively stem from "planning, adapting and monitoring task completion" (Williamson 1981a, p. 553). Since by "transaction" is meant the transfer of a good or service "… across a technologically separable interface (where) *one stage of processing or* *assembly activity* terminates and another begins (*italics added*)" (Williamson 1981b, p. 1544), it may seem that Williamson envisions "task" to be a production activity with a discrete outcome within a sub–process/process or sub–assembly/ assembly.

The eventual outcome is that the firm's management systems become stretched to the point they become increasingly *inefficient* in *organizing* factors toward task completion. Coase avers that, if unchecked, this would lead to what the economist might term "diminishing returns to management" (Coase 1988, p. 43).

2.4.1.2 HOW THE PROBLEM WOULD NEED TO BE ADDRESSED

An enquiry into if and how an information system (IS) may enhance earnings returns by helping advance the point of "diminishing returns to management" further along the firm revenue growth curve must necessarily commence with an investigation into the sources and nature of cost. In the context of transaction cost economics (TCE), "cost" is of two classes: production cost and transaction cost—which classes are not independent and need therefore to be addressed simultaneously (Williamson 1979, 1981b). However, while the net effect of the two classes relative to revenue generated could yield earnings innovation, the chief economizing concern remains singularly with transaction cost. This is because production cost economizing, except for the effect of exogenous factor prices, is effectively and necessarily a trade off with transaction cost economizing (Williamson 1981b): the greater the controls over production cost (and hence the greater the production cost economies), the greater the incurrence of transaction cost for the purpose; and conversely, the lesser the controls, the lesser the cost. The purpose of transaction cost economizing then is to organize for increasingly cost–efficient transacting of production cost control, for which an IS as ERP is in effect the touted strategic solution. The entrepreneurial remit then is the successful attainment of transaction cost economizing relative to production cost levels in real terms, i.e. in terms adjusted for exogenous factor price movements.

Production costs effectively incur the following classes of transaction costs (Williamson 1981b, p. 1544): (1) "pre–contract costs (for) extensive pre–contract negotiation that covers all relevant contingencies (so as to) avoid the need for periodic intervention to realign the interface during execution so that (the) contract may be brought successfully to completion", and (2) "harmonizing costs (for) *planning, adapting, and monitoring task completion ...*".

Normatively, “pre–contract” costs are under well–structured legal frameworks and oversight. These latter therefore would appear less subject to uncertainty from lack of decision relevant information. Hence, the scope for an IS to contribute value with decision support is likely to be minimal.

Pre–contract costs are thus of less import from an information systems standpoint even if they may bear an inverse relationship with “harmonizing costs”. The latter costs, on the other hand, can be expected to have a direct role in generating bottom line benefits through productivity improvements.

“Harmonizing”, in the first instance, involves *planning*, which in effect entails aligning organizational resource (via its allocation and coordination) with agreed objectives and purposes for contractual performance. In the second instance, it involves subsequent *adapting* of the plan at the point of execution to changing conditions in the execution environment, both unforeseen and *ex ante* unforeseeable (Williamson 1979): hence, “control” in management accounting parlance.

“Planning” and “adapting” therefore entail the organizing and reorganizing of resources towards the common, higher–level goal of contractual performance. This is achieved by coordinating and deploying the resources toward the successful execution of associated lower–level tasks. Success in execution demands the *monitoring* of tasks for the adopting of “adapting” measures, as needed, and for the allocation of reward for contractual performance. “Monitoring” would therefore entail measurement for controlling, and metering for rewarding work performed: hence, “management control”.

In sum, the “harmonizing” transaction cost would appear to represent the cost of transacting the planning and control of resources entailed in production of goods and services toward the ultimate goal of securing contractual performance. Harmonizing cost under Williamson’s formulation is, in sum, the cost of transacting task completion across the supply chain.

Transaction cost economizing is to be accomplished “... by assigning transactions to governance structures in a discriminating way” (Williamson 1981a, p. 548). Such discrimination identifies the appropriate structure that offers the framework for the most cost–efficient assignment and execution of “harmonizing” activities (Williamson 1979, 1981b).

While governance structure is, "… the institutional framework within which the integrity of a transaction is decided" (Williamson 1979, p. 235) or "… the institutional matrix within which transactions are negotiated and executed" (Williamson 1979, p. 239), "… the object of governance is to (1) protect the interests of the respective parties and (2) adapt the relationship to changing circumstances" (Williamson 1979, p. 258). This, in the institutional framework constituting the firm, involves "… the *organization* of internal transactions, *including* the design of employment relations (*italics added*)" (Williamson 1981a, p. 548) so as to deliver "… the more comprehensive *adaptive capability* afforded by *administration* (italics added)" (Williamson 1979, p. 253). Williamson's conception of the function of governance is therefore the *planning* for transactions execution in such a way as to allow for effective *monitoring* towards making them *adaptive* to changing conditions in the interests of securing cost–effective contractual performance.

Williamson's focus of interest is institutional economics and the law, and hence his 'operationalizing' of transaction cost—despite the distinct management control undertone attaching to the "harmonizing cost" definition—is biased towards the organizing of internal transactions from a high–level contractual relations governance perspective between and within institutional hierarchies. This focus excludes the *performance management* perspective between and within organizational structures. His caveat is that "… although more descriptive detail than is associated with (economics') neoclassical analysis is needed (in giving) micro analytic attention to differences among governance structures and *micro analytic definition of transactions*… a relatively crude assessment will (yet) often suffice (as) comparative institutional analysis commonly involves an examination of discrete structural alternatives for which *marginal analysis is not required* (italics added)" (Williamson 1981b, p. 1544). With marginal analysis thus ruled out, he does not need to stretch his analyses to the lower, task–level structures[68] where marginal micro analyses would be singularly decision–relevant toward cost–efficient management of resources.

[68] For the purpose of the current study, "task–level structures" are diverse business processes designed for the efficient organization of work in the execution of diverse transaction types *within* institutional governance structures

Additionally, even though he does state that efficient information processing is "an important and related concept"[69] (p. 234), he nevertheless would appear to also underline this assertion with reference to high–level hierarchical contractual governance requirements.

Even if such assessment of transaction cost is to be limited to a "comparative institutional undertaking" (Williamson 1979, p. 234), the assessment would yet need to be addressed (in present times) in a more holistic sense to include full micro analytic content at task level. Transaction cost economizing can only be given full effect with complete articulation of cost–efficient harmonizing of resources both within and across "technologically separable interfaces".

It is therefore a corollary to this research that the application of transaction cost economizing theory of the firm would find completeness through an extension of its theoretical framework to the economic organization of material, human and information resources deployed in the execution of tasks, such economy attained with parsimony of work organization supported with decision–relevant information at tactical/operational levels of governance[70]. As much that a 'theory' of such information–laced transaction cost economizing work organization is yet to be developed, it is the intent of this research to determine if the application of an IS such as ERP systems to aid in the governance of internal operations at the tactical planning and operational task control levels serves this purpose in a manner significant enough to bring forth earnings innovation.

Toward this end, and since the *"organization"* of "internal transactions" is a determinant of overall governance structure, and furthermore, since governance structure "… turns on physical asset and human asset specificity (which) are often correlated" (Williamson 1981a, p. 556)[71], any technology–driven solution specifically targeting transaction cost reduction would need to address at the very outset parsimony

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[69] *Viz.* "… but for the limited ability of human agents to receive, store, retrieve, and process data, interesting economic problems vanish…" (Williamson 1979, p. 234)

[70] Management Control and Task Control levels (Anthony 1965, 1988)

[71] i.e. physical assets and human assets are often closely coupled in an unique firm–specific way (Amit & Schoemaker 1993; Conner 1991; Williamson 1975)

of design of the business processes that determine the configuration of tasks and *ipso facto* the consumption of both human and material[72] resources required for those tasks. Furthermore, given that structure embraces both the organization design and the associated information and data that traverse the lines of communication and authority modelling the design (Chandler 1962), it follows then that the design of business processes must embrace both the integration of work and the integration of data and information flows with the work at the physical (task) level. The comprehensive integration thus delivered may well tend towards the suggested "… complete theory of value (that would) recognize that firm structure… matters" (Williamson 1981b, p. 1550).

Transaction cost reduction must thus entail the parsimonious integration of work and data flows through efficient and effective business process design. This in turn can be expected to yield improvements in the area of business productivity and cost savings. This latter in turn would offer *prima facie* evidence that transaction cost economizing would have transpired, the point of "diminishing returns to management" extended, and thus, Coase's 1st limitation addressed. It is proposed that the evidence for this would be found in an improvement in the relative proportions of operating overhead ("transaction cost") to prime cost of throughput ("production cost"). This improvement could be expected to in turn effect improvements in various expense ratios, thus potentially leading to improved margins.

2.4.1.3 ERP'S POTENTIAL: THE THEORETICAL EVIDENCE

In line with the foregoing analysis, the theoretical evidence for ERP's potential for "harmonizing cost" economizing outcomes is contained in the appendix—in particular, Appendix B. To the degree that these outcomes are empirically validated, ERP could be seen to advance decision relevance in the governance of enterprises, and they therefore can be posited to be shareholder value relevant.

2.4.1.4 THE EMPIRICAL EVIDENCE

The evidence would need to meet the criteria in driver 1 of shareholder value paradigm listed in section 2.3.2: a decrease to the costs of operations (that) relates to consumption

[72] Long–term and working capital assets

of proportionately fewer inputs for given quantitative output (i.e. value propositions sourced in capital deepening leading to labour productivity, and in process innovation leading to multi–factor productivity).

The empirical evidence is separable into (a) primary anecdotal reports of productivity improvements and cost savings from the academic, professional and trade journals; and (b) secondary research findings from the academic literature. The latter has been represented in foregoing sections, particularly section 2.2.4 and associated appendix D. Further evidences are cited below.

<u>CSR Wood Panels</u>

CSR Wood Panels (Aubrey 1999) achieved millions of dollars in cost savings by reconfiguring its delivery system under an ERP implementation. The savings stemmed from reduced cost of warehousing and freight expense.

ERP–engendered productivity gains enabled CSR to overcome difficulties meeting its delivery dates. More than 95% of its deliveries, post–implementation, were on time, generating a further source of cost savings.

Another source of productivity improvement allowed customers to place orders on line and have them allocated to specific products in inventory with delivery within 24 hours. The resulting improved dependability and speed of service contributed to improving productivity.

Streamlined delivery service, structural organizational change, the ripple effect of easily visible and accessible information and heightened customer satisfaction have all leveraged CSR to a position of considerable competitive strength. Considerable cost savings have also resulted from greatly–improved forecasting that has led to vastly reduced product obsolescence.

<u>Fujitsu</u>

Fujitsu's SAP implementation reduced cycle time for a quotation from 20 days to 2 days, achieving a 90% improvement. They also achieved a reduction in financial closing times from 10 days to 5 days, an improvement of 50% (Jenson & Johnson 1999).

Among several other productivity improvements, entering pricing data into the system fell from 80 days to 5 minutes. The turnaround time for shipping parts improved from 44 to 3 days (Jenson & Johnson 1999).

Westcoast Energy

Westcoast Energy Inc. projects their ERP implementation has generated bottom line cost savings of $2.5m per annum from the elimination of non–value–adding activities from their business processes (Poston & Grabski 2001).

Purina Mills

Poston & Grabski (2001) also report Purina Mills Inc. reduced their headcount costs by 43% through the consolidation of their business processes.

SCA Packaging

Kalling (2003) reports the Swedish MNC, SCA Packaging, achieved an annual labour cost reduction of approximately EURm1.0 from the reduction of customer service and sales personnel consequent to an ERP implementation in one of its plants.

AMP

AMP's implementation led to the rationalization of cost structures through leveraging size and purchasing power to produce economies of scale across the organization (Tebutt 1998).

Other

Murphy and Simon (2002) report the NPV of productivity improvements and inventory reductions resulting from a new system implementation were estimated at $18.8m & $49.1m respectively across a 10–year period of useful life. The actual dollar benefit from productivity improvements and cost savings in the first year of operation was over $225m sourced in part from reduced IT operations and from streamlined production processes.

ERP allowed for better coordination amongst sub–units and administrative efficiencies through a substantial improvement in inventory processing leading to the elimination of costly data entry and calculation errors and enhancing the company's ability to make customer commitments and meet them on time (Gattiker & Goodhue 2004).

Collectively, the foregoing references would appear to support ERP's potential contribution to cost reduction, productivity improvements, and revenue gains (through satisfied customers). Thus the following is propositioned:

Proposition 1: ***ERP–adopter firms attain a reduction in the proportion of transaction cost to production cost relative to non–adopter firms.***

Proposition 2: ***ERP–adopter firms derive a lower cost of goods sold relative to non–adopter firms.***

Proposition 3: ***ERP–adopter firms achieve higher earnings relative to non–adopter firms.***

2.4.2 COASE'S 2ND LIMITATION – THE INCREASING FAILURE TO PLACE FACTORS OF PRODUCTION IN THEIR BEST USES

2.4.2.1 PROBLEM DESCRIPTION

Coase (1937, p. 394; 1988, p. 43) states that with firm growth "… a point must be reached where the loss through the waste of resources is equal to the marketing costs of the exchange transaction in the open market or to the loss if the transaction was organized by another (firm)". Firms exceeding this growth point could therefore be expected to sub–optimize their earnings returns through increasing inefficiencies in internal operations relative to open market contracting or outsourcing.

Coase's "loss through the waste of resources" within the firm effectively stem from a failure to "… place the factors of production in the uses where their value is greatest" (1937, pp. 394-5). These resource deployment inefficiencies are associated with increases "in the spatial distribution of the transactions organized (and) in the dissimilarity of the transactions" (1937, p. 397). In sum, with firm growth transactions would tend to be "… either different in kind or in different places" (p. 397)[73].

The eventual outcome is that firms' management systems become stretched in consequence to the point that they are increasingly *ineffective* in *managing* factor resourcing for optimal returns. The consequent failure to "place the factors of

[73] Effectively, this represents an increase in the variety of transactions (scope) and/or their spatial distribution (scale). The increase in scope and scale of operations is evident in today's global business environment as delineated in section 2.1.2 and associated appendix B.

production in the uses where their value is greatest" would, if unchecked, lead eventually to "diminishing returns to management" (1937, p. 395).

2.4.2.2 HOW THE PROBLEM WOULD NEED TO BE ADDRESSED

In section 2.4.1.2, an enquiry into if and how ERP may enhance earnings returns by advancing the point of "diminishing returns to management" further along the firm revenue growth curve commenced with an investigation into the sources and nature of cost. There it was determined that production cost control entailed the incurrence of transaction costs and that the entrepreneurial remit was thus to seek measures that would serve to economize on transaction cost without prejudice to production cost control. The focus remained on achieving cost–efficient production cost controls.

In the circumstance of increases in scale and scope of global proportions however, the attainment of transaction cost economies in production cost control in resolution of Coase's 1st limitation (section 2.4.1) will in itself not prevent operational inefficiencies. This is because the failure to "… place the factors of production in the uses where their value is greatest" would be the outcome of limitations in human information processing capacity the making of optimal resource allocation and coordination decisions in the face of increasing scale and scope of operations consequent on globalization[74].

Instead, transaction cost economizing would need to focus on ways to maximize revenue potential consistent with optimal factor returns. The present enquiry therefore focuses on revenue generation itself towards advancing the point of diminishing returns. The optimal deployment of factors for improving revenue generation and returns is to be achieved by refocusing the entrepreneurial remit on achieving *effectiveness* in operations. The focus therefore is on cost–effectiveness of resource deployment.

This shifts the focus of enquiry to resource optimization i.e. the best possible use for factor resources consistent with optimizing the return from their use. This problem has clear input from decision relevance in general and decision support methodologies in particular towards effectiveness of decision–making (DeLone & McLean 1992; Holsapple & Sena 2003; Kelle & Akbulut 2005; Kilpatrick 1999; Ptak & Schragenheim 2004).

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[74] i.e. humans need to cope with their own "bounded rationality" in the presence of "complexity" (Williamson 1973, 1975, 1981a, 1981b)

2.4.2.3 ERP'S POTENTIAL: THE THEORETICAL EVIDENCE

ERP's ability to resolve Coase's 2^{nd} limitation will therefore hinge on its capacity to deliver on its implied promise of decision effectiveness. As outlined in section 1.1, the promise begins with the securing of information quality (DeLone & McLean 1992, 2003; Lin, Ping-Yu & Ping-Ho 2006). As delineated in section 2.2.2 (and appendix B), ERP facilitates requisite information quality by securing infrastructure integration (Davenport 2000a, 2000b; Jenson & Johnson 1999; Lee et al. 2002; Light 1999; Redman 1998; Wang & Strong 1996; Xu et al. 2002).

With infrastructure and information quality assured, ERP's potential to address resource optimization has been analysed in section 2.2.5 and appendix E. The conclusion reached is that the use of ERP at the strategic planning levels for resource planning and allocation was not well developed until at least the advent of ERPII. Accordingly, it is propositioned that revenue growth is but weakly associated with adoption of ERP systems.

This yet may appear counter–intuitive in the light that ERP is clearly associated with managing increasing complexity from scope and scale growth (Davenport 2000a, 2000b; Jenson & Johnson 1999; Light 1999). Yet, as argued in appendix E, such complexity management has more operational and tactical orientation than strategic. Hence, the expectation is a weak or moderate association with revenue growth.

Further, Coase argues that firm size would tend to increase with inventions that (a) lessen the effect of spatial distribution and thus bring the factors of production nearer together, (b) help reduce the cost of organizing spatially and (c) help improve "managerial technique" (Coase 1937, p. 397). It is argued, consistent with section 2.2.2 (together with appendix B), that ERP must contribute substantially to the 1^{st} and 2^{nd} of the three dimensions of innovation–derived benefit. This eventuates from its role of organizational change agent in lifting Coase's 1^{st} limitation to firm growth as detailed in section 2.4.1.2.

The implication therefore is that ERP's very contribution to managing the increasing complexity from increasing growth and size of operations would yet lead to sub–optimizing revenue returns in the long run from increasing scale and scope diseconomies. It would therefore seem reasonable that revenue creation and growth would be more associated with the more innovative management practices allowed by

ERPII (as described in section 2.2.4.7 and section 2.2.5). The latter is beyond the time window of the present study as detailed in section 2.2.5.

2.4.2.4 THE EMPIRICAL EVIDENCE

The evidence needs to meet the criteria for driver 2 and 4 in the shareholder value paradigm of section 2.3.2: an increase to the revenue from operations (that) relates to consumption of relatively fewer inputs for given qualitative output (i.e. value propositions from product/process innovation leading to superior product variety, logistics, quality, functionality, pricing and other value intangibles) at a constant or reducing cost of capital resulting from improved capital utilization.

CSR Wood Panels

The ERP system implemented by CSR Wood Panels allowed the company to increase its proportion of direct deliveries to customers from 40 percent to more than 95 percent with over 95 percent of deliveries made on time. Customers were also able to book in an order on line and have the product delivered within 24 hours. The consequent improvement in dependability and speed of service caused customer satisfaction to increase significantly. These benefits allowed CSR to gain a position of considerable competitive strength (Aubrey 1999).

Fujitsu

Fujitsu's SAP implementation improved on–time delivery rates by 60-85 percent (Jenson & Johnson 1999).

SCA Packaging

Kalling (2003) reports the Swedish MNC, SCA Packaging, achieved a reduction in customer response times from hours or days to minutes from improvements to communications and information access. Similarly, average delivery time was reduced from 2 weeks to 4 working days. These improvements (together with the cost reductions detailed in section 2.4.1.3) helped realize an ERP investment payback of less than 2 years.

Other

Murphy & Simon (2002) report the estimated NPV for an ERP project as a whole increased by over 800% for an IRR of 124% when customer satisfaction was factored into the conventional tangible benefit value calculations. Gattiker & Goodhue (2004) report that perpetual inventory accounting increased the subject company's ability to make customer commitments and keep them.

While the foregoing (section 2.4.2.2 & 2.4.2.3) theoretical development would appear not to strongly favour effective capital utilization and revenue growth, the empirical evidence would appear to suggest some improvement. Therefore:

Proposition 4: ERP–adopter firms improve capital utilization relative to non–adopter firms.

2.4.3 COASE'S 3RD LIMITATION – THE RISING SUPPLY PRICES OF FACTORS OF PRODUCTION

2.4.3.1 PROBLEM DESCRIPTION

Coase (1937, p. 395) states that with firm growth a point must be reached where "… the supply price of one or more of the factors of production may rise…". Firms exceeding this growth point could therefore be expected to eventually sub–optimize their earnings returns through increasing costs of internal operations relative to open market contracting or outsourcing.

Coase's rising "supply price of one or more (of the) factors" effectively stems from factor preference for contracting with smaller firms because " "other advantages" of a small firm are greater than those of a large firm" (Coase 1937, p. 395). These "other advantages" would appear to relate to the lower levels of complexity and uncertainty in small firm environments for which factors purportedly have a distinct preference. The resultant dearth of factor resources leads to upward pressure on factor prices (Coase 1988).

Coase terms this limitation experienced at the upper end of the market "the supply price of organizing ability" (Coase 1937, p. 395) on the basis of the distinct preference managers are purported to exhibit towards the relative independence afforded by small firm environments. This would yet merit re–evaluation under conditions of business operation extant in present times.

Presently, it would seem reasonable that larger firms would need to meet higher supply prices internally to compensate for increased complexity of operations. This would be because higher levels of complexity would demand from the part of each factor commensurately higher levels of responsibility and accountability together with higher levels of skill. Similarly, it is conceivable that for for the same reason *viz.* complexity, independent contractors would find that the cost of contracting with a larger firm would be relatively higher, a cost that may not be invariably borne with ease. In general, the more complex the environment, the less qualified the available factors, and hence the dearer the price of the adequately qualified. Higher factor prices would likely be an inevitable adjunct to increased complexity.

Additionally, it is argued that higher factor prices in the present business era stem from bounded rationality in the presence of complexity and uncertainty from the part of buyers. This operates in tandem with opportunism in the presence of information impactedness on the part of factor suppliers (Williamson 1973, 1975, 1981a, 1981b).

"Bounded rationality" is the limits on individuals' capacities to receive, store, retrieve, and process information without error (Williamson 1973). Increasing complexity in the business environment impose these limitations. They in turn give rise to uncertainty borne of the interaction of bounded rationality with complexity.

"Information impactedness" is the condition attending upon a contract where one of the parties to the contract has access to significant information of strategic import to contract negotiations under circumstances that render it too costly or impractical for the other to secure information parity. Information impactedness is thus an information asymmetry condition that confers unfair advantage to one party over the other (Williamson 1973).

"Opportunism" is the effort in the presence of information impactedness, to obtain an unfair advantage in contract negotiations (Williamson 1973). The most commonly recognized being "… the strategic disclosure of asymmetrically distributed information by (at least some) individuals to their advantage" (Williamson 1973, p. 317). This information asymmetry would thus appear to confer an advantage to the factor supplier because conditions of bounded rationality may not allow the buyer to recognize the potential asymmetry; or the very impactedness of the information in question may render it prohibitive for seeking information parity. The consequence clearly would be opportunistic behaviour that could put upward pressure on factor prices.

2.4.3.2 HOW THE PROBLEM WOULD NEED TO BE ADDRESSED

An enquiry into this question needs to begin with the sources of complexity impacting the enterprise. This is because the key to reducing the cost of the supply price of factors of production must ultimately lie with the ability to reduce complexities of business process and information flow resulting from task and environmental complexity.

2.4.3.3 ERP'S POTENTIAL: THE THEORETICAL EVIDENCE

It would seem that ERP's ability to streamline the supply chain, both internally and externally, would effectively make for input into this issue. Arguably, such ability would reduce complexity and streamline operations, allowing for the removal of pockets of information impactedness. The degree of actual realization of the potential would necessarily condition the delivery of information quality and decision relevance toward decision effectiveness.

The degree of success in this regard realized by ERP's 1st phase of development is not exactly categorical (section 2.2.5, Appendix E). However, it is argued it is reasonable to expect some success given limited improvements to information flows that ERP 1st phase implementations have delivered (section 2.2.5, Appendix E).

2.4.3.4 THE EMPIRICAL EVIDENCE

The needed evidence relates to the criteria for driver 1 of the shareholder value paradigm outlined in section 2.3.2: a decrease to the costs of operations (that) relates to consumption of proportionately fewer inputs for given quantitative output (i.e. value propositions sourced in capital deepening leading to labour productivity, and in process innovation leading to multi–factor productivity). While the issue does not affect productivity in terms of factor units consumed, it does concern the economics of productivity by containing (monetary units of) cost.

Direct evidence of ERP's role in containing or reducing the supply price of factors is sparse in the literature. It is yet argued that the examples cited in section 2.4.1.3 and section 2.4.2.3 would suggest that such containment or reduction might have transpired.

Cisco Systems

Furthermore, Cisco Systems Inc. saved tens of millions of dollars USD per annum through supply chain innovations that made for (a) rapid response strategies; (b) vastly improved supply chain management; and (c) vastly improved supplier payments processing among others (Austin, Cotteleer & Escalle 1999, 2003). These benefits could not have ensued if the complexity levels were not reduced through supply chain innovations, and arguably therefore, with attendant containment or reduction of cost.

SCA Packaging,

Similarly, Kalling (2003) reports that the more successful business units of the Swedish MNC, SCA Packaging, had focused on "… changing their businesses (through) labour cost rationalisation, business process reengineering, organizational specialization and integration, meeting supply chain performance targets etc. (and had) put more emphasis on actually changing (local) strategy and structure, without explicitly attempting to optimise the system" (p. 53). It would seem certain that complexity levels would have been improved by the business units' focus on these changes. The fact that there had been "… less need for communication through time–consuming meetings" (p. 53) would appear to offer evidence for this.

With the foregoing (admittedly sparse) theoretical bases, and (potential) empirical evidence, the following is propositioned:

Proposition 5: ERP–adopter firms attain a reduction in their operating expense relative to non–adopter firms.

2.4.4 ERP's Benefit Value Relative to Transaction Cost Economics Theory of the Firm: The Summary Conclusion

From the theoretical analyses in the foregoing sections, ERP's 1st phase would appear to advance the point of "diminishing returns to management" through productivity gains and cost savings more so than through innovative customer value propositions. The net effect should be an improvement in the bottom line subject to the additional overhead that might be needed to maintain the system in prime operating condition.

There however appears to be no evidence in the literature that the system overhead does exceed the potential cost reduction. For example, Hitt, Wu & Zhou (2002) found that "ERP adopting" firms performed better over a wide range of financial metrics including ROA than "ERP non–adopting" firms. Their study was however restricted to the period of implementation and the period immediately following implementation owing to the unavailability of mid– and long–term data.

The first longitudinal impact study into performance effects of ERP adoption (Hunton, Lippincott & Reck 2003) found that the average ROI and ROA over 3 years following implementation were significantly lower for non–adopters but only because their performance declined whilst that of adopters remained steady. They found no significant difference between pre– and post–adoption.

In a similar vein, Nicolaou (2004) found that adopters show a differential performance *vis a vis* non–adopters that is higher on the ROI measure two years after adoption, and on the ROA measure four years after adoption. The key new insight supplied by this research appears to be the favourable differential on ROA in the 4^{th} year post implementation, thus showing a positive performance effect within an extended measurement time window over that of the previous research.

The foregoing research suggests that ERP implementations may not lead to a negative net benefit. From this limited (and largely associative) empirical evidence, the following further proposition is indicated:

Proposition 6: ERP–adopter firms attain a better performance relative to capital employed than non–adopter firms.

2.5 SHAREHOLDER VALUE RELEVANCE OF ENTERPRISE RESOURCE PLANNING SYSTEMS

2.5.1 SUMMARY OF EVIDENCE

From the foregoing theoretical development and propositions (section 2.4), it is clear that ERP system implementations could be expected to lead to shareholder value creation. This is because the evidence of their fulfilment of the 1^{st}, 2^{nd}, and 4^{th} drivers of the shareholder value paradigm (section 2.3.2) is persuasive.

However, to establish shareholder value relevance, ERP implementations must yield evidence of their agency for earnings innovation[75]. The evidence for this in the research literature is virtually non–existent.

The first study into the impact of ERP adoption on firm performance (Poston & Grabski 2000, 2001) showed no improvement in residual income[76] for each of the 3 years following implementation. The research was designed to establish an associative relationship rather than a causal one. It was also not concerned with establishing shareholder value.

Hayes, Hunton and Reck (2001) conducted an event study of share market responses to ERP investment announcements. They found a positive market response with significant interaction effects from firm size and financial health. Their study—being by definition a short time window study—was not concerned with persistence effects.

A later behavioural study (Hunton, McEwen & Wier 2002) showed professional financial analysts significantly increased earnings forecast revisions consequent to an announcement and that these increases are significantly smaller for small/unhealthy firms than for small/ large healthy firms. This study together with the preceding Hayes, Hunton and Reck (2001) study provide rather strong convergent evidence that capital markets may expect positive net cash flows consequent upon ERP implementations and hence, that ERP systems could be value relevant.

In a large sample test, Hitt, Wu & Zhou (2002) found that ERP adopting firms were consistently rewarded by financial markets both during and after implementation despite a dip in performance and productivity immediately following implementation. The metric they used for this assessment was however the Tobin's q measure of the market value of assets divided by their replacement cost. Their study therefore was effectively associative and not designed to demonstrate persistence effects[77].

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[75] Earnings innovation is 'new earnings with persistence effects', as defined for this research (section 2.2.2). 'Persistence' fulfils the 3rd driver of the value paradigm

[76] RI defined as net operating income less imputed interest at 12%

[77] Diverse Tobin's q approaches to measuring value have been adopted in the literature. These have been critiqued in section 3.4.3

Long–term shareholder value of ERP implementations appears not to have been categorically demonstrated in the literature. Such value is posited to result from a market expectation of increased earnings in the long–term. The cited event/behavioural studies however provide some evidence that ERP implementations may well signal such expectations. From this limited evidence and in the context of the preceding theoretical development, the shareholder value relevance of ERP implementations is propositioned:

Proposition 7: ERP implementations are shareholder value relevant.

2.6 SUMMARY OF PROPOSITIONS

Proposition 1: ERP–adopter firms attain a reduction in the proportion of transaction cost to production cost relative to non–adopter firms.

Proposition 2: ERP–adopter firms derive a lower cost of goods sold relative to non–adopter firms.

Proposition 3: ERP–adopter firms achieve higher earnings relative to non–adopter firms.

Proposition 4: ERP–adopter firms improve capital utilization relative to non–adopter firms.

Proposition 5: ERP–adopter firms attain a reduction in their operating expense relative to non–adopter firms.

Proposition 6: ERP–adopter firms attain a better performance relative to capital employed than non–adopter firms.

Proposition 7: ERP implementations are shareholder value relevant.

2.7 CHAPTER SUMMARY

The chapter developed the theory underlying the proposition that Enterprise Resource Planning systems are a value relevant innovation for effective enterprise governance. It first described and differentiated ERP systems from other classes of enterprise systems and defined the period spanning its first phase of development, effectively setting the scope for this study. The concept of information value was introduced and the concept of shareholder value derived as the key value measure of interest. The chapter then described how ERP would be value relevant, presenting the attributes that would enable ERP meet the requirements of the value paradigm. Specifically, the decision–relevant characteristic of its information product was postulated to alleviate complexity consequent on firm growth that constrains effectiveness of decision–making for sound enterprise outcomes. The chapter then described why the foregoing renders ERP value relevant by showing that ERP’s decision–relevant characteristic would serve to alleviate and/or uplift the three limitations to profitable firm growth (Coase 1937, 1988). The chapter then presented the incomplete state of knowledge on ERP’s value relevance with evidence from extant research. The propositions developed to address the knowledge gap was summarised in conclusion.

3. RESEARCH METHOD

3.1 INTRODUCTION

In accordance with the theory development and the resulting propositions in chapter 2, this chapter outlines the research methodology that serves to investigate whether there is evidence that implementations of ERP systems in profit–oriented enterprises may translate into superior returns to the enterprise and its owners; and further, how strong this evidence might or might not be.

Section 3.2 presents an overview of the research design. Section 3.3 presents the constructs. Section 3.4 operationalizes the constructs. Section 3.5 develops the model to be tested. Section 3.6 lays out the tests of hypotheses. Section 3.7 describes data collection and sample selection. Section 3.8 summarizes the chapter.

3.2 OVERVIEW OF RESEARCH DESIGN

The propositions listed in section 2.6 would yield the following research question:

"Are Enterprise Resource Planning Systems (ERP) implementations associated with superior firm performance?"

The research question and its underpinning propositions imply that ERP–adopter firms may exhibit superior performance following ERP implementations over non–adopter firms.

Accordingly, the research method is designed to test a treatment group of ERP–adopter firms against a matched control group of non–adopter firms. The objective is to determine if there is evidence of (a) significant difference in performance between the two groups across criteria addressed by the propositions, and (b) ERP adoption being the agency for such difference. Table 3.1 presents a summary of the criteria and the corresponding tests (propositions 1–6 involve paired two–sample *t*–tests of means and proposition 7 entails a pooled cross–sectional regression).

TABLE 3.1: PROPOSITIONS, VARIABLES, EMPIRICAL INDICATORS, AND TESTS

Prop#	Proposition	Variable		Empirical Indicator		Test
		Dependent	Independent	Dependent	Independent	
1	ERP–adopters attain a reduction in the proportion of transaction cost to production cost relative to non–adopters	Operating Overhead/ Throughput Cost	ERP adopter/ non–adopter	Mean paired difference (MPD) for SG&A/ Sales Revenue	ERP adopter/ non–adopter	t–test: paired two sample for means—significance test of MPD for SG&A/Sales
2	ERP–adopters derive a lower cost of goods sold relative to non–adopters	Cost of Sale	ERP adopter/ non–adopter	MPD for Cost of Sale/ Sales Revenue	ERP adopter/ non–adopter	As above for Cost of Sale/ Sales
3	ERP–adopters achieve higher earnings relative to non–adopters	Return on Sale	ERP adopter/ non–adopter	MPD for EBIT/Sales Revenue	ERP adopter/ non–adopter	As above for EBIT/Sales
4	ERP–adopters improve capital utilization relative to non–adopters	Asset Turnover	ERP adopter/ non–adopter	MPD for Sales Revenue/ Total Asset	ERP adopter/ non–adopter	As above for Sales/Total Asset
5	ERP–adopters attain a reduction in their operating expense relative to non–adopters	Operating Expense Ratio	ERP adopter/ non–adopter	MPD for Operating Expense/ Sales Revenue	ERP adopter/ non–adopter	As above for Operating Expense/ Sales

TABLE 3.1 (CONT): PROPOSITIONS, VARIABLES, EMPIRICAL INDICATORS, AND TESTS

Prop#	Proposition	Variable		Empirical Indicator		Test
		Dependent	Independent	Dependent	Independent	
6	ERP–adopters attain a better performance relative to capital employed than non–adopters	Return on Assets (ROA)	ERP adopter/ non–adopter	MPD for EBIT/Total Asset	ERP adopter/ non–adopter	As above for EBIT/Total Asset
7	ERP implementations are shareholder value relevant	Share Return	Earnings Level/Change variables, ERP variable, Leverage variable	Share Price Change/ Beg. Period Price	ROA, ERP interaction with ROA, ΔROA, ERP interaction with ΔROA, Leverage, ERP dummy	Pooled cross–sectional regression—significance tests of regression coefficients (ΔROA is difference between actual and predicted—latter derived via 1st order autoregressive time–series model factored with macroeconomic variables)

The matching of firm pairs is directed towards controlling the differential performance effects of scale (firm size) and scope (industry membership) between treatment and control group firms. Matching by industry and size has been adopted in the literature for controlling for these effects (Alford 1992; Cheng & McNamara 2000). It is expected that such matching would offer the best control for firm/industry–related confounds that could prejudice ERP implementation–specific performance comparisons *between* firms.

In addition, business cycle–related effects that impact performance could confound the ERP implementation–specific performance *change* effect *within* firms. This is controlled for with an autoregressive time series ROA predictor model factored with principal components of the business cycle indicators, derived via principal component analysis (PCA)[78]. The model is designed to predict the *base performance level* of the firm (as measured by ROA) consistent with its "structural and executional performance drivers" (Ittner & MacDuffie 1995; Shank & Govindarajan 1992) that enfold the firm's *intrinsic performance capacity* (that could be expected to have developed over time), moderated by extant macro–economy influences.

It is contended that controlling for these several potential confounds in the manner described would make for the derivation of a valid measure of operational performance *change* for comparison between matched pairs of firms. The change is the difference between the realized ROA and the ROA predicted as above. It is contended that this would be a legitimate derivation of performance change attributable to firm–specific factors (including ERP adoption).

The performance change so derived is applied in the following pooled cross–sectional regression model to estimate the returns–earnings relation inclusive of the ERP–interaction effect[79]:

$$y = \beta_0 + \chi_0 x + \chi_1 ERPx + \delta_0 \Delta x + \delta_1 ERP\Delta x + \gamma_0 ERP + \theta_0$$

[78] Indicator variables are identified from leading macro–economic theories of the business cycle and leading/coincident indicator theory (Hall 1990; Lahiri & Moore 1991)

[79] The model is based on the Easton and Harris (1991) share returns model. This model explains share returns in terms of the firm's earnings level and change variables, and other value–relevant information

The parameter y represents the share return, x represents ROA and Δx the ROA change. The ERP parameter is designed as a 'characteristic variable' (or 'dummy') that serves to signal its postulated interaction–with–earnings effect on share price in ERP–adopter firms. In addition, the single ERP–only term models ERP adoption as an 'other' item of information posited to be singularly relevant to shareholder value[80]. For control group firms, the 'dummy' is set to zero.

Table 3–1 describes the tests performed on the model for the respective propositional statements developed in chapter 2 (and listed in section 2.6). Proposition 7 represents the strategic proposition (Dubin 1978), and therefore effectively the test of the 'main effect' from ERP implementations, which is "value relevance". Table 3.2 (following page) presents the corresponding hypotheses.

The sample of 60 matching firm pairs is drawn from the period 1995–2001. The performance data span 5 years of post–implementation operation and therefore are drawn from within the period 1995–2005.

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[80] In accordance with the Ohlson (1995) market capitalization model. For purposes of the present research, the term represents the postulated strategic significance of ERP adoption on share returns independent of any ERP–earnings affect

TABLE 3.2: PROPOSITIONS AND HYPOTHESES

Prop#	Proposition	Hypo#	Hypothesis
1	**ERP–adopter firms attain a reduction in the proportion of transaction cost to production cost relative to non–adopter firms**	**1**	**ERP–adopter firms exhibit a lower SG&A to Sales Revenue ratio relative to non–adopter firms**
2	**ERP–adopter firms derive a lower cost of goods sold relative to non–adopter firms**	**2**	**ERP–adopter firms exhibit a lower ratio of COGS to Sales Revenue relative to non–adopter firms**
3	**ERP–adopter firms achieve higher earnings relative to non–adopter firms**	**3**	**ERP–adopter firms exhibit a higher ratio of EBIT to Sales Revenue relative to non–adopter firms**
4	**ERP–adopter firms improve capital utilization relative to non–adopter firms**	**4**	**ERP–adopter firms exhibit a higher ratio of Sales Revenue to Total Assets Employed relative to non–adopter firms**
5	**ERP–adopter firms attain a reduction in their operating expense relative to non–adopter firms**	**5**	**ERP–adopter firms exhibit a lower ratio of Operational Expense to Sales Revenue relative to non–adopter firms**
6	**ERP–adopter firms attain a better performance relative to capital employed than non–adopter firms**	**6**	**ERP–adopter firms exhibit a higher ROA than non–adopter firms**

TABLE 3.2 (CONT): PROPOSITIONS AND HYPOTHESES

Prop#	Proposition	Hypo#	Hypothesis
7	ERP implementations are shareholder value relevant	7A	The coefficient of the interaction between the empirical indicator for the earnings level variable and the empirical indicator for ERP implementation variable is significantly greater than zero
		7B	The coefficient of the interaction between the empirical indicator for the earnings change variable and the empirical indicator for ERP implementation variable is significantly greater than zero
		7C	The coefficient of the ERP–implementation empirical indicator is significantly greater than zero

3.3 THE KEY CONSTRUCTS

In accordance with the summary research question (and model) presented in section 3.2, the key constructs to be measured are (a) Enterprise Resource Planning Systems (ERP) implementation and (b) superior firm performance.

3.3.1 ENTERPRISE RESOURCE PLANNING SYSTEMS (ERP) IMPLEMENTATION

As discussed in section 2.2.1 (and associated appendix A), the ERP implementation construct subsumes the *enterprise–wide* implementations of ERP software together with the attendant redesign of organizational structure and business process. The structure and process redesign result in the integration of the enterprise's core mechanisms for value–delivery and supporting mechanisms for administrative control. Such mechanisms include both operational processes and integrated information processes, effectively determined by ERP software implementation.

3.3.2 SUPERIOR FIRM PERFORMANCE

"Superior firm performance" subsumes the *change* concept of performance. Such performance change is posited to exhibit two financial dimensions: a change in earnings returns on (a) corporate funds invested in enterprise operations and (b) shareholder funds invested in corporate shares. The former relates to enterprise earnings returns, and the latter to shareholder earnings[81] returns. Enterprise earnings returns are subsumed in an "enterprise performance" construct and shareholder earnings returns in a "shareholder value" construct.

3.3.2.1 <u>ENTERPRISE PERFORMANCE</u>

"Enterprise performance" relates to the change in current earnings derived through *operational* activities of the enterprise. It thus subsumes the 1st, 2nd and 4th elements of the shareholder value paradigm introduced in section 2.3.2[82] and excludes any impacts

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[81] 'shareholder earnings' as measured by market ratios as earnings per share (EPS) and earnings yield

[82] The value paradigm dimensions are: (1) a decrease to the costs of operations, and/or (2) an increase to the revenue from operations that (3) persist/s over time, at (4) a constant or reducing cost of capital. These reflect the following causal drivers: (1) consumption of relatively fewer inputs for given quantitative output; (2) consumption of relatively fewer inputs for given qualitative output; (3) sustaining improvement in causal drivers 1, 2 & 4; and (4) improvement in capital utilization (section 2.2.2)

from financing and investing activities. Propositions 1–6 relate to "enterprise performance".

3.3.2.2 SHAREHOLDER VALUE

"Shareholder value" is the expected change in future earnings in consequence of "enterprise performance" as defined above. "Shareholder value" results when the change in enterprise earnings (and EPS) is perceived by the share market to be associated with the 3rd driver of the value paradigm, i.e. when the change exhibits the quality attribute of "persistence" (Miller, MH & Rock 1985). "Persistence" is the expression of the market expectation that the current earnings change will continue through succeeding financial periods, thus allowing its full future benefit effect to be factored into current market returns consistent with the Miller, MH & Modigliani (1961) classical valuation model. "Shareholder value" is thus "earnings innovation" (Kormendi & Lipe 1987) with "persistence" (Miller, MH & Rock 1985) as discussed in section 2.3.1.

In sum, "Shareholder value" is the extension of the 1st, 2nd, and 4th drivers into the 3rd, effectively subsuming all 4 drivers of the value paradigm in the single construct. Proposition 7 relates to "shareholder value".

3.4 OPERATIONALIZING THE CONSTRUCTS

3.4.1 ERP IMPLEMENTATION

ERP system software suites are designed and produced by diverse vendors. The leading vendors in the year 2005 accounting for 72% of industry revenue were SAP, Oracle, Sage Group, Microsoft and SSA Global. The top 5 in the year 1999 accounting for 59% of revenue were: J.D. Edwards, Baan, Oracle, PeopleSoft and SAP (Reilly 2005).

Different vendors have had the stronger representation in the various industry sectors in different time periods (e.g. SAP were traditionally strong in the manufacturing sector), and in different application suites (e.g. PeopleSoft's strength in human resources). As a result, any single ERP implementation could theoretically (as well as practically) mix and match different vendor representations across different business units and applications.

Regardless of this representational diversity which could theoretically lead to differential performance effects amongst adopter firms, the ERP–implementation construct is designed to address a functional perspective as defined by Klaus, Rosemann & Gable (2000) and Sumner (2005), and described in section 2.2.1 (and appendix A)[83]. This perspective embraces the following functionality aids or extensions that were to a greater or lesser degree integral with the core ERP software implementations as of the end of the year 2000: (a) on line analytical processing (OLAP), data mining, and other decision support applications implemented with data warehousing products (section 2.2.5 and appendix E), and (b) supply chain optimization applications implemented with advanced planning and scheduling (APS) software (section 2.2.4. and appendix D) in manufacturing sector firms.

These aids/extensions signal the transition of the industry from the ERPI phase into the fully–integrated ERPII phase (section 2.2.4. and appendix D) at the turn of the millennium. This transition demarcates the ERP evolutionary timeline boundary for this study.

The rationale for not limiting the study to single vendor implementation 'instances' is that the research question does not call for such controls as ERP systems are considered a generic category of information systems regardless of cross–vendor installations that could have performance implications. The rationale for including non–integrated (and very likely, 3rd party) external aids/extensions are: (1) ERP's decision relevance capacities find fuller expression with OLAP, data mining, and other decision support aids, and (2) it would be arduous or impractical to differentiate enterprises that have not implemented full–blown decision support application aids from those that have.

Within the above broad boundary parameters, the ERP–implementation construct subsumed in the research question embraces in essence ERPI (section 2.2.4. and appendix D). The construct is represented by the empirical indicator "ERP" in the model construction developed in section 3.5, and is measured as a 'dummy' or 'characteristic variable' as follows:

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[83] The key business functions include "… sales order processing, procurement, materials management, production planning, human resources, logistics, distribution, maintenance, financial accounting, management accounting, strategic planning, and quality management (Klaus, Rosemann & Gable 2000; Sumner 2005)"—section 2.1.1 (and appendix A*)*

ERP = 0 signals no ERP system implemented by a firm (control group)

ERP = 1 signals an ERP system implemented by a firm (treatment group)

3.4.2 ENTERPRISE PERFORMANCE

The information technology literature adopts two key enterprise–level summary measures, Return on Equity (ROE) and Return on Assets (ROA), as empirical indicators of enterprise performance (Dehning & Richardson 2002; Hitt & Brynjolfsson 1996).

The use of ROE as an enterprise–level performance metric (Hitt & Brynjolfsson 1996; Hitt, Wu & Zhou 2002; Rai, Patnayakuni & Patnayakuni 1997; Strassman 1997b; Tam 1998) is problematic because it is a poor pointer to future profitability (Penman 1991). It manifestly impounds exogenous (non–operational) effects from such things as capital flows from share issues, share buy–backs and redemptions, and debt issues and redemption, as well as taxation treatment and income statement charges/credits of an exceptional, non–recurring nature. It confounds operational performance effects of managerial decisions—which are decisions relating to the allocation, deployment and coordination of enterprise resources—with aspects of financial (treasury and earnings management) performance. It therefore holds scant value as a measure of operating efficiency and effectiveness at the enterprise level. Thus, for the purposes of this research, it does not serve as an appropriate operationalization of the enterprise performance construct (section 3.3.2.1).

In contrast to ROE, the use of ROA (Barua, Kriebel & Mukhopadhyay 1995; Hitt & Brynjolfsson 1996; Hitt, Wu & Zhou 2002; Hunton, Lippincott & Reck 2003; Weill 1992) offers a purely operational summary metric. ROA excludes financial leverage and operating profit leakages whilst impounding the financial performance effects of cost management and revenue management (i.e. profitability), and asset utilization (i.e. capital efficiency) (Dehning & Stratopoulos 2002; Milbourn & Haight 2005). This is so since ROA is the composite measure of return on sales (ROS) and asset turnover (ATO). While ROS is influenced by cost containment and revenue enhancement, ATO is improved by revenue enhancement and capital efficiency propositions such as capacity utilization (Dehning & Stratopoulos 2002; Milbourn & Haight 2005). Hence, ROS has direct input into the 1st and 2nd drivers of the value paradigm of section 2.3.2[84] whilst ATO inputs into the 2nd and 4th. ROA can thus be seen to be a composite measure that subsumes the 1st, 2nd and 4th drivers of the value paradigm.

ERP implementations, should they bear agency for earnings innovation (as defined for this research *vide* section 2.3.2), could be expected to have a permanent effect on cost management and/or revenue generation and/or asset utilization. The permanency is attained through their expected moderating effect on the "structural and executional drivers" (Ittner & MacDuffie 1995; Shank & Govindarajan 1992) of enterprise performance (section 2.3.2)[85]. ROA is thus the one measure that promises to capture ERP–engendered permanent changes to *intrinsic performance capacity*.

3.4.2.1 THE ROA ESTIMATOR

Toward deriving a ROA *change* variable consistent with firm–specific factors only, a ROA prediction model is estimated. The model is designed to capture *intrinsic performance capacity* as moderated by macro–economic factors that impinge on such capacity, either favourably (in times of growth) or unfavourably (in recessionary periods)[86].

The fundamental rationale for the model is that a firm's *realized* ROA impounds its intrinsic earnings *capacity*—derived from diverse structural and executional drivers of performance that operationalize management 'capability' and other "resource position advantages" (Wernerfelt 1984)—moderated by environmental variables impacting the industry sector or the economy as a whole. An estimate of this intrinsic capacity moderated by the latter exogenous factors is necessary for deriving a *base* earnings level

[84] The value paradigm dimensions are: (1) a decrease to the costs of operations, and/or (2) an increase to the revenue from operations that (3) persist/s over time, at (4) a constant or reducing cost of capital. These reflect the following causal drivers: (1) consumption of relatively fewer inputs for given quantitative output; (2) consumption of relatively fewer inputs for given qualitative output; (3) sustaining improvement in causal drivers 1, 2 & 4; and (4) improvement in capital utilization (section 2.2.2)

[85] This effect would make for "persistence" (Miller, MH & Rock 1985), thus incorporating the 3rd driver

[86] It is widely reported that the economies of several countries underwent a period of slowed/negative growth during the years straddling the new millennium. In contrast, the mid–90s saw a period of growth. The data for the present study covers the period 1995–2005

prediction for the firm–year preparatory to determining the residual earnings *change* resulting from earnings innovations such as ERP.

The intrinsic capacity based in structural and executional drivers could be expected to reflect in the time series persistence of operational earnings. This implies an autoregressive time series ROA prediction model[87].

The key macroeconomic influences are determined with the aid of economic theories of the business cycle[88]. Theories relating to leading and coincident indicators of the business cycle (Lahiri & Moore 1991) are used to identify business cycle indicator variables.

Business Cycle Theory and Leading/Coincident Indicator Theory has been adopted in the bankruptcy prediction research literature to model macroeconomic indicators of bankruptcy risk (Hol 2007; Rose, Wesley & Giroux 1982). The choice of these indicators as moderators of *intrinsic performance capacity* is based on the rationale that if macroeconomic factors affect the performance of bankrupting firms, they must *ipso facto* influence firm performance irrespective of the particular financial health status of the firm. This rationale would appear to find corroboration—albeit indirectly—through various capital market studies that report associations between macroeconomic variables and share market performance (Chaudhuri, K & Smiles 2004; Groenewold & Fraser 1997).

The indicators thus identified for this research accord with (a) Business Cycle/ Leading and Coincident Indicator Theory (Gabisch & Lorenz 1989; Hall 1990; Lahiri & Moore 1991), (b) bankruptcy research literature (Hol 2007; Levy & Bar-Niv 1987; Melicher & Hearth 1988; Rose, Wesley & Giroux 1982), and (c) capital market research literature (Bilson, Brailsford & Hooper 2001; Chen, N-F, Roll & Ross 1986; Faff & Brailsford 1999; Homa & Jaffee 1971).

These measures of the economy's performance are subjected to a principal components analysis to produce a reduced set of economic factors underpinning the movement in the

[87] After Kormendi & Lipe (1987)

[88] Monetary Theory, Underconsumption Theory, Investment–based Theories, and Cost–Price Theory (Hall 1990)

business cycle. These are then input into the following function for estimating the coefficients needed for predicting enterprise ROA[89]—

$$ROA_{pt} = f(ROA_{et}, E_{1,t-\delta}, E_{2,t-\delta} \ldots E_{n,t-\delta})$$

where,

ROA_{pt} is Return on Assets predicted at time t

ROA_{et} is Return on Assets estimated at time t

E_1, E_2...E_n are macroeconomic variables, and

$t-\delta$ is the lagged period where $\delta \geq 0$

ROA is defined as—

$$\text{EBIT} \div \text{TA}$$

where,

EBIT is Earnings Before Interest and Tax, and

TA is Total Assets at beginning–of–period book values

The predicted ROA is netted against the actual ROA to derive the measure of performance change[90]. This change parameter captures the incremental performance for input into the value relevance model (section 3.5).

3.4.3 SHAREHOLDER VALUE

The information technology research literature adopts diverse share market–related approaches to measuring shareholder value. These market measures include event studies centred around announcement dates, 1–year Total Returns to Shareholders, market valuation of IT–related intangible assets (market capitalization studies), enterprise market value differential associated with IT spending (i.e. IT spending–coefficient studies), market value regressions (on book values and IT assets), and the

[89] The function is further expanded under section 3.5, Model Development

[90] To derive a valid measure of the performance change, three further controls are implemented during data collection and analysis. They are for the effects of (a) changes to accounting policies (b) questionable earnings management practices, and (c) divestiture/ acquisition of major assets. Financial statements are required to disclose significant changes to accounting policies (IAS8 of the IASB). Further, an analysis of the cash flow ratios will reveal any excessive earnings management effects (Schwartz & Soo 1996). Since the share market can be expected to discern the quality of reported earnings of the enterprise and penalize firms accordingly with 'below–par' returns (Aboody, Hughes & Liu 2005; Chan et al. 2006), controlling for these effects during data collection and analysis could have a bearing on the analysis and conclusions

Ohlson (1995) model of Market Value (Dehning & Richardson 2002; Hitt, Wu & Zhou 2002).

Event studies compute share returns across a limited time 'event window' before, during and after information technology–related announcement events with a view to determining if the share market reacts to these announcements (Chatterjee, Pacini & Sambamurthy 2002; Dos Santos, Peffers & Mauer 1993; Hayes, Hunton & Reck 2001; Richardson & Zmud 2002). They do not extend the study over a longer period post–announcement to seek evidence of persistence effects in share returns. Therefore, event studies of this nature are not designed to assess shareholder value as defined for this research.

Total Returns to Shareholders (TRS) has been used as a single–year measure of total shareholder return (Hitt & Brynjolfsson 1996; Tam 1998). Defined as the share price change between the end date and beginning date of a single year plus total dividends paid and proposed, divided by the share price at the beginning date, this ratio effectively gives the 1–year share return.

TRS has been found to be more highly correlated with changes in market expectation for the stock than with changes in cash flows or economic profit over time (Koller, Goedhart & Wessels 2005). Hence, TRS would appear to measure long–term value with error. TRS would seem therefore to imperfectly capture the effects of long–term timing of cash flows and attendant risk.

Market capitalization models (Brynjolfsson & Yang 1999) seek to derive the value of intangible assets deemed associated with computer capital stock use[91] using the *q* theory of investment[92] supported with the marginal productivity theory in economics. The intangibles are deemed to evidence the value relevance of IT computer capital

[91] Intangible assets include software, communications architecture, organizational re–design 'assets' (including the structure of decision making and incentive systems), employee training, collaborative work, shared learning, and other intangible innovations associated with organizational transformation (Brynjolfsson, Hitt & Yang 1998; Brynjolfsson & Yang 1999)

[92] The "*q* theory" of investment states that the rate of investment (or the speed at which investors would wish to increase capital stock) should be related to the economic value of the stock relative to its replacement cost (Tobin 1969). This should effectively tend the Tobin's *q* multiple to unity over a period of 'adjustment' (Brynjolfsson & Yang 1999). Should it not so tend, an associated 'intangible' asset not measured by the accounting system of the enterprise is deemed to account for the unexplained value 'premium' (Brynjolfsson & Hitt 1995; Brynjolfsson, Hitt & Yang 1998; Brynjolfsson & Yang 1996).

investments in as much as they are deemed to attract the stock market valuation premium for the firm (Brynjolfsson, Hitt & Yang 1998; Brynjolfsson & Yang 1999).

These studies effectively assert that the market differential on computer capital stock (effectively, the *q* multiple as applies to computer assets) must represent the economic value of the intangible assets deemed complementary to capital stock use in generating future earnings (Brynjolfsson, Hitt & Yang 1998). Effectively therefore, and in accordance with the theory of capital asset valuation, *q* would appear to be a function of the present value of the expected stream of cash flows resulting from the deployment of the *corresponding capital stock*: the higher the PV, *ceteris paribus*, the higher the *q* for the 'complementary' organizational assets.

Even though *q* would appear to offer a value parameter index that impounds both timing and risk, it would also appear that the association between the asset in question (capital stock) and the *magnitude* of the market premium (i.e. the *q* multiple) is not established in these studies. The model adopted is not designed for testing the strength of the deemed associative relationship between the intangible correlates of capital stock investment and market value. In the absence of an appropriate research design and consequent test, the shareholder value relevance (amount, timing, and risk of future cash flows) from IT capital stock use is not categorically demonstrated[93].

Studies that relate market value differentials to IT spending (Bharadwaj, Bharadwaj & Konsynski 1999) seek to determine the coefficient of IT spending to market value in (successive) single–year regressions using Tobin's *q* as the market value–related criterion variable.

Similar with the *q* market multiple construct of the preceding market capitalization model studies, these coefficients reflect in effect the market value multiples of IT spending (investment). The research model uses hierarchical regressions of Tobin's *q* values on multiple theoretically–grounded value–determining variables with IT spending the designated "control" for measuring its differential effect on Tobin's *q* (Bharadwaj, Bharadwaj & Konsynski 1999).

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[93] It would appear that the *q* multiple is more an *ex post* valuation approach for an indefinite group of intangible organizational 'assets' *deemed* 'created' by computer capital stock use than a methodology for demonstrating shareholder value of IT capital stock

Such approaches yet disregard the fact that market values are the function of expected cash flows, and hence earnings[94]—and not the function of spending. Beyond suggesting in effect that 'IT spending may have value', they do not appear to show if this value is generated via earnings as their research method does not admit of such testing. These studies therefore are unable to categorically substantiate the source/s of value.

Market value regression studies (Hitt, Wu & Zhou 2002) regress market value on book value of assets, and on IT capital (i.e. ERP) value based on Tobin's *q* estimates. This is a simplified version of Brynjolfsson and Yang (1999) and exhibits the same or similar theoretical weakness. Unless the research is designed to offer proof that IT capital (ERP) adoption affects market value via an earnings effect, the underlining theory is not 'falsifiable' (Popper 1968). Therefore, the demonstration that IT capital adoption is significantly associated with the market value of the firm says little more than that the two variables are correlated. From the standpoint of this research, causality is not adequately demonstrated.

The IT research literature has also adopted the Ohlson (1995) model of market value (Anderson, MC, Banker & Ravindran 2001; Krishnan & Sriram 2000). The model holds that market value is determined by above–normal earnings, book value of equity, and other value–relevant information (Ohlson 1995). Thus—

$$P_t = y_t + \alpha_1 x_t^a + \alpha_2 v_t$$

where, P is market value of equity

t is time t

y is book value of equity

x^a is above–normal earnings

v is other non–earnings information, and

α_1 & α_2 are response coefficients

The model thus admits information beyond assets—the principal focus of the studies cited above. It incorporates current earnings as well as other (non–earnings) data that may well be 'value relevant' in terms of a 'direct effect' on share price.

[94] Consistent with (a) the dividend irrelevancy proposition (Miller, MH & Modigliani 1961), and (b) the 'clean surplus' relation (Ohlson 1995)

The Ohlson model is theoretically aligned with the classical valuation (NPV) model referenced in section 2.3.2. This is because its chief predictor of value, earnings, is equivalent to dividends ("future benefits") under the 'clean surplus' formulation (Ohlson 1995) that supports the original 'dividend irrelevancy' proposition (Miller, MH & Modigliani 1961). It therefore serves to fill the breach in the previously–cited studies of the IT–performance relation that disregarded the pivotal role of earnings for determining the value relevance of IT.

Significantly, the model also links well with the key accounting measure of value that appears not to have been be adopted in the IT research literature—Economic Value Added (EVA) or economic profit. The model improves on the EVA measure in that the earnings response coefficient (ERC) of its 'above–normal earnings' term (α_1) supplies the persistence parameter that is absent from the EVA method (Koller 1994; Koller, Goedhart & Wessels 2005; Kormendi & Lipe 1987; Slater & Olson 1996).

The α_1 ERC thus provides a single composite parameter value that impounds persistence effects i.e. the amount, timing and risk of future cash flows. This effectively represents the operationalizing of the "shareholder value" construct (sections 2.3.1 and 3.3.2.2). The model thus holds promise for the objective of this research, which is the testing of whether ERP implementations in firms are value relevant.

3.5 MODEL DEVELOPMENT

The key proposition relating to the summary research question (section 3.2) is:

Proposition 7: ERP implementations are shareholder value relevant.

The proposition states in effect that ERP implementations deliver earnings innovation with persistence effects that serves to moderate the returns–earnings relation. Since persistence is represented in the ERC (Kormendi & Lipe 1987), the proposition may be tested via a regression of share returns on earnings changes with the appropriate ERP–earnings interaction term to model ERP's moderating effect.

As discussed (section 3.4.3), Ohlson (1995) models market value of equity as a function of book value of equity supplemented with current profitability as measured by abnormal earnings and with other value–relevant information:

$$P_t = y_t + \alpha_1 x_t^a + \alpha_2 v_t$$

where, P is market value

t is time t

y is book value

x^a is abnormal earnings

v is other non–earnings information, and

α_1 is the response coefficient that measures the share price response to a dollar of x^a, and

α_2 is the response coefficient that measures the share price response from the net cumulative effect of v

An alternate model (Easton & Harris 1991), presents stock returns as a function of both current earnings and earnings changes:

$$R_t = \gamma_0 + \gamma_{1t}[A_t / P_{t-1}] + \gamma_{2t}[\Delta A_t / P_{t-1}] + \varepsilon_t$$

where, A is earnings

ΔA_t is earnings change

P is share price

γ_1 and γ_2 are earnings response coefficients

t is time t

R is stock return, and

$R_t = (\Delta P_t + d_t) / P_{t-1}$

where ΔP_t is share price change during time *t-1* to *t*, and

d_t is dividend paid during time *t-1* to *t*

While Ohlson models market value, Easton and Harris models share returns[95], the criterion variable of interest for this research. The strength of the Ohlson formulation however is that (a) it gives due recognition to the importance of 'other' information that might be expected to directly influence the share return, and (b) provides for the concept of the 'above–normal earning', which appears more conservative a change concept than the 'earnings change' of the Easton and Harris model.

[95] The two models are nevertheless not inconsistent with one another (Easton & Harris 1991)

These attributes of the Ohlson model accommodate (a) the possible strategic value of ERP as a value relevant proposition in itself apart from its interaction effect with earnings (section 1.3), and (b) the more conservative change concept that excludes the macro–economic effect on performance (section 3.4.2.1).

The strength of the Easton and Harris formulation however is that it explicitly models share returns as a function of the earnings level as well as the earnings change. While the latter is already shown to be better served for this research context by the above–normal earnings concept of the Ohlson model, the former allows for a test of ERP's possible value relevance as a catalyst for improving the firm's quality of earnings[96].

The proposed value relevance model is thus based on Easton and Harris (1991) with adaptations to incorporate (a) the above–normal earnings term and (b) the 'other information' term of the Ohlson (1995) model[97]. The model is thus rendered more suitable for the test of value relevance since it makes for a comprehensive shareholder value construct subsuming not just (a) earnings innovation with persistence effects, but also (b) quality improvements in reported earnings, and (c) strategic value propositions independent of any earnings effect.

Accordingly, and after Easton and Harris (1991):

$$y = \beta_0 + \beta_1 x + \beta_2 \Delta x + \theta$$

where

y is the share return

x is earnings scaled by beginning–period share price

Δx is earnings change scaled by beginning–period price

β_1 and β_2 are earnings response coefficients, and

θ represents the error term.

Expanding the ERCs to give expression to ERP's interaction with the earnings terms—

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[96] The Wald test used for the purpose is described in chapter 4, Analysis and Results

[97] These adaptations are not inconsistent with the prototype Easton & Harris (1991) model since (a) the model's error variable would otherwise subsume any direct effect on share returns from ERP implementations, the proposed model merely making this effect explicit by means of an independent term for ERP, and (b) the earnings change variable is restricted to a stricter formulation of the 'change' concept.

$$y = \beta_0 + (\chi_0 + \chi_1 ERP)x + (\delta_0 + \delta_1 ERP)\Delta x + \theta$$

Therefore,

$$y = \beta_0 + \chi_0 x + \chi_1 ERPx + \delta_0 \Delta x + \delta_1 ERP\Delta x + \theta$$

where

ERP is a characteristic variable[98] flagging implementation/ non–implementation (1/0) of ERP—

Since the error term θ may subsume any direct effect of the ERP implementation on share return i.e. 'other information' (Ohlson 1995)—

$$y = \beta_0 + \chi_0 x + \chi_1 ERPx + \delta_0 \Delta x + \delta_1 ERP\Delta x + \gamma_0 ERP + \theta_0$$

This completes the theoretical value relevance model based on Easton and Harris (1991) and Ohlson (1995). The ERP Δx term gives effect to ERP as earnings innovation. The ERP*x* term represents ERP as enhancer of earnings quality. The ERP term assesses the relevance of ERP as a strategic value proposition in its own right.

In deriving the final functional form of the model for estimation and prediction, and in accordance with the theory development in section 3.4.2, the better earnings measure for capturing ERP's effect on performance is EBIT than the NPAT[99] that underpins the theoretical model. Hence, and in accordance with the ROA estimator model for deriving the earnings change variable Δx proposed (section 3.4.2.1) and developed (below), the x variable is defined as EBIT scaled by beginning–period total assets rather than beginning–period share price to give, in effect, realized (actual) ROA[100].

The earnings change variable Δx is deemed, in accordance with section 3.4.2.1, the difference between the realized ROA value and the predicted value. The prediction uses coefficients derived for the purpose via the ROA estimator model (section 3.4.2.1)—

98 Characteristic variables have been used in the information technology literature to differentiate ERP adopters from non–adopters (Hitt, Wu & Zhou 2002) as well as in the accounting literature to differentiate earnings and cash flow–related contexts (Cheng, Liu & Schaefer 1996)

99 Net Profit After Tax

100 Scaling is a measure that controls for heteroscedasticity in the residuals, and hence, different scaling parameters on either side of the regression function is not considered material to the result

$$ROA_{pt} = f(ROA_{et}, E_{1,t-\delta}, E_{2,t-\delta} ... E_{n,t-\delta})$$

where,

ROA_{pt} is Return on Assets (predicted) at time t

ROA_{et} is Return on Assets (estimated) at time t

E_1, E_2...E_n are macroeconomic variables, and

$t-\delta$ is the lagged period where $\delta \geq 0$

The ROA_{et} term subsumes an autoregressive earnings function estimated as[101]—

$$ROA_{et} = k + \sum_{i=1}^{N} a_i \Delta ROA_{t-i} + \varepsilon$$

where,

k is the earnings constant, and

N is the number of time series periods

The functional form of the ROA estimator incorporating the macroeconomic moderator variables can now be specified—

$$ROA_t = k + \sum_{i=1}^{N} a_i \Delta ROA_{t-i} + b_1 E_{1t-\delta} + b_2 E_{2t-\delta} + ... + b_n E_{nt-\delta}$$

This represents the final functional form of the ROA estimator.

In finalizing the functional form of the value relevance model based on ROA, two further considerations are addressed: (a) the influence of leverage on the share return, and (b) the final functional form for the share return dependent variable.

The leverage effect is implicit in the Easton and Harris (1991) model since the share return is modelled on the earnings available to shareholders, NPAT, which is moderated by leakages and leverage in accordance with the following accounting association—

ROE = *f*(ROA, leakages, leverage)[102]

where,

[101] The specification follows from classical valuation theory (Miller, MH & Modigliani 1961) as theoretically (Miller, MH & Rock 1985) and empirically (Kormendi & Lipe 1987) extended to firm reported earnings

[102] Derived from the DuPont model which aggregates financial ratios to ROE (Penman 1991):
ROE = NPAT/Sales * Sales/ Assets * Assets/ Equity, where NPAT=EBIT less leakages

leakages are post–EBIT charges net of credits

leverage is Total Assets/ Equity Interest

Moreover, the capital gearing measure of leverage itself has a direct effect on perceived risk, a compound of business risk and individual firm financial risk. While business risk is similar amongst firms within a single industry and is therefore controlled for by matching firm pairs by industry, financial risk, which reflects in capital gearing at the firm level, is not, and therefore needs to be modelled. The indicative leverage measure is the debt/equity measure of capital gearing[103]. The model thus takes the functional form[104]—

$$R_t = \beta_0 + \beta_1 ROA_t + \beta_2 ERP.ROA_t + \beta_3 \Delta ROA_t + \beta_4 ERP.\Delta ROA_t + \beta_5 DER_t + \beta_6 ERP + \theta$$

where,

R_t is the share return at time t

ROA_t is the return on assets (realized) at time t

ΔROA_t is the actual ROA less its predicted value for time t

DER_t is the debt–to–equity ratio at time t, and

ERP is the characteristic variable for ERP adoption/ non–adoption

This represents the final functional form of the value relevance estimator.

The functional form of the share return dependent variable in the above model builds upon the Easton & Harris (1991) formulation, which is—

$$R_t = (P_t - P_{t-1} + D_t) / P_{t-1}$$

where,

R_t is the share return at time t

P_t is share price at time t

P_{t-1} is share price at time $t-1$, and

D_t is dividends paid during time $t-1$ *to* time t

[103] This is derived from the DuPont model as follows: leverage = Assets/Equity = 1 + Debt/Equity = 1 + non–interest–bearing debt/Equity + D/E ratio. The last term represents financial risk (via the numerator representing interest–bearing debt and therefore covenanted liabilities), therefore influencing risk and hence share return response

[104] Leakages are excluded from the model development and would be subsumed in the error term. Besides, the only recurrent leakages are likely to be interest and taxes. Interest, which depends upon level of gearing, is yet incorporated in financial risk term, DER

This formula however is adequate only for single distributions of profits within a return estimation period. Where there are multiple distributions across a single period, or where there are non–dividend distributions such as rights/bonus issues or share buy–backs, the share price dilution factor formulation is indicated in place of the above.

Accordingly, the return is based on the following formula (Bellamy 1998)—

$$R_{t-n,t} = P_t \div (P_{t-n} * \prod_{t-n+1}^{t} D_t)$$

where,

$R_{t-n,t}$ is the share return over the period *t-n* to *t*

P_t is the share price at time *t*

P_{t-n} is the share price at time *t-n*, and

D_t is the dilution factor[105] at time *t*

This formula is adapted to a single period (one–year) application for this study—

$$R_t = P_t \div (P_{t-1} * \prod_{x=1}^{n} D_x)$$

where,

R_t is the share return at time *t*

P_t is the share price at time *t*

P_{t-1} is the share price at time *t-1*, and

D_x is the dilution factor *x* of *n* in the period *t-1* to *t*

3.6 HYPOTHESIS GENERATION: THE TEST OF PROPOSITIONS

3.6.1 TEST DESIGN AND METHOD

As presented in Table 3.1 (section 3.2), propositions 1–6 are tested with significance tests of the respective empirical indicators of performance (i.e. the mean paired difference of the respective criterion variables) using the paired two–sample *t*–test for means. This test is prescribed for comparing two populations under a matched pairs

[105] Dilution factors allow for the calculation of the share return at time *t* after adjusting for such events as dividend declarations, bonus issues, rights issues, and share buy backs to time *t* (Bellamy 1998)

experimental design where the need is to test the mean of the differences between matched members of two populations (Keller 2005). This differs from the standard *t*–test, which is prescribed for the randomized experimental design where the requirement is to test the significance of the difference between means of two populations (Keller 2005).

Proposition 7 is tested via significance tests of the respective response coefficients of the value relevance regression model developed in section 3.5. As discussed in this section, the response coefficients capture the value relevance of ERP implementations. Five regressions are performed across a matched sample of 60 adopter/ non–adopter firms, one for each fiscal year of a five–year period from the year of ERP systems adoption. The sample is selected from firms listed on the Australian Stock Exchange (ASX).

The selection matches each company that implemented an ERP with a company that did not in each of the five years post adoption. The matching effectively controls for differential scale/ scope effects (i.e. firm size/ diversification) on performance. The need to control for these factors—that may otherwise confound the effects of ERP adoption—is considered sufficiently valid a reason to justify the non–adoption of a completely randomized design. Matched pair designs have been used in ERP–related studies for controlling industry effects and scale effects (Hunton, Lippincott & Reck 2003; Nicolaou 2004) in lieu of modelling control variables to represent these effects in regression functions (Bharadwaj, Bharadwaj & Konsynski 1999; Hitt, Wu & Zhou 2002)

Since the design matches 60 firms that have implemented and operated ERP systems with firms that have not in each of five years post implementation, there are a total of 600 data points (firm/years). This translates into over 120 individual firms across five years[106].

[106] The exact number depends on the actual number of matching control group firms that do not retain their comparability with their respective matched treatment group firm continuously over the five–year period. Firms that do not retain their comparability over the five years (due to mergers and divestitures, management changes, conversion to enterprise systems or other firm–specific causes) are substituted with appropriate matching replacements

3.6.2 TEST OF PROPOSITION 1

Proposition 1: ERP–adopter firms attain a reduction in the proportion of transaction cost to production cost relative to non–adopter firms.

In accordance with the theoretical development in section 2.4.1, production cost is the prime cost of production throughput (direct materials and labour) and transaction cost is the manufacturing overhead, and selling, general and administration (SG&A) overhead.

Since for manufacturing enterprises, the prime cost is not generally made publicly available, production cost could be approximated to the total cost of throughput (prime cost plus manufacturing overhead). This is equivalent to cost of goods sold (COGS) plus ending inventory less beginning inventory. Since manufacturing overhead is thus included in throughput cost, transaction cost would be required to be SG&A only. Likewise, for non–manufacturing enterprises in the distribution sector of the economy (wholesalers, retailers and distributors), 'production' cost is effectively the cost of goods sold (COGS) plus ending inventory less beginning inventory, and transaction cost is SG&A overhead.

For non–manufacturing enterprises in the service sector of the economy, 'production cost' is the direct expense (e.g. 'production' wages for professional or client/customer service grades) incurred in generating revenue, and transaction cost is SG&A overhead.

Not every enterprise however discloses their COGS or their Percentage Gross Margin (GM) in their published financial reports[107]. Further, the services sector will not have a COGS or a GM in their financial reporting. Therefore, sales revenue is adopted as an approximate proxy to production cost. Accordingly, the SG&A to Sales Revenue ratio is adopted as a proxy measure for the transaction cost to production cost ratio.

This choice raises issues of internal validity given sales revenue is a function of quantity as well as price, the latter impounding as it does varying cost mark–ups. It is yet proposed that the matching of firms by both industry group and size would exert reasonable control for differences in pricing mark ups between firms. Hence, it is

[107] Disclosure of Cost of Goods Sold was not a requirement under the Australian Accounting Standards until the year 2001

contended that SG&A to Sales Revenue is a reasonable proxy for transaction cost to production cost.

Hypothesis 1: *ERP–adopter firms exhibit a lower ratio of SG&A to Sales Revenue relative to non–adopter firms.*

Let the treatment group firms be denoted by *t* and
the control group firms denoted by *c*

Let SG&A be denoted by *s*, and sales revenue by *r*

Let $Z = s/r \times 100$ and

$Z_d = Z_c - Z_t$

$H1_0: \quad Z_d \leq 0$

$H1_1: \quad Z_d > 0$

If the null hypothesis is not supported, then ERP–adopter firms exhibit a lower ratio of transaction cost to production cost relative to non–adopter firms.

3.6.3 Test of Proposition 2

Proposition 2: *ERP–adopter firms derive a lower cost of goods sold relative to non–adopter firms.*

Subject to regulatory requirements, not all firms are required to disclose their COGS[108]. A proxy measure of Operating Expense percent of Sales is used where needed, operating expense being defined as sales revenue less EBIT.

Accordingly,

Hypothesis 2: *ERP–adopter firms exhibit a lower ratio of COGS to Sales Revenue relative to non–adopter firms.*

Let the treatment group firms be denoted by *t* and
the control group firms denoted by *c*

Let COGS be denoted by *d*, sales revenue by *r*

[108] Disclosure of Cost of Goods Sold was not a requirement under the Australian Accounting Standards until the year 2001

Let $Z = d/r \times 100$ and

$Z_d = Z_c - Z_t$

$H2_0: \quad Z_d \leq 0$

$H2_1: \quad Z_d > 0$

If the null hypothesis is not supported, then ERP adopter firms exhibit a lower cost of goods sold relative to non–adopter firms.

3.6.4 TEST OF PROPOSITION 3

Proposition 3: ERP–adopter firms achieve higher earnings relative to non–adopter firms.

Earnings is operationalized as operational earnings or EBIT.

Accordingly,

Hypothesis 3: ERP–adopter firms exhibit a higher ratio of EBIT to Sales Revenue relative to non–adopter firms.

Let the treatment group firms be denoted by *t* and
the control group firms denoted by *c*
Let EBIT be denoted by *n*, and sales revenue by *r*

Let $Z = n/r \times 100$ and

$Z_d = Z_c - Z_t$

$H3_0: \quad Z_d \geq 0$

$H3_1: \quad Z_d < 0$

If the null hypothesis is not supported, then ERP–adopter firms exhibit higher earnings relative to non–adopter firms.

If the null hypotheses $H1_0$, $H2_0$, and $H3_0$ are not supported, then the evidence would suggest that ERP systems serve to lift Coase's (1937; 1988) 1st limitation to firm growth described in section 2.4.1.

3.6.5 TEST OF PROPOSITION 4

Proposition 4: ERP–adopter firms improve capital utilization relative to non–adopter firms.

Capital utilization is operationalized with reference to total assets employed.

Accordingly,

Hypothesis 4: *ERP–adopter firms exhibit a higher ratio of Sales Revenue to Total Assets Employed relative to non–adopter firms.*

Let the treatment group firms be denoted by *t* and
the control group firms denoted by *c*
Let total assets be denoted by *a*, and sales revenue by *r*

Let $Z = r/a \times 100$ and

$Z_d = Z_c - Z_t$

$H4_0: \quad Z_d \geq 0$

$H4_1: \quad Z_d < 0$

If the null hypothesis is not supported, the ERP–adopter firms exhibit a higher level of capital utilization relative to non–adopter firms. The evidence would suggest that ERP systems serve to lift Coase's (1937; 1988) 2nd limitation to firm growth described in section 2.4.2.

3.6.6 TEST OF PROPOSITION 5

Proposition 5: *ERP–adopter firms attain a reduction in their operating expense relative to non–adopter firms.*

Operating Expense is operationalized as Sales Revenue less EBIT.

Accordingly,

Hypothesis 5: *ERP–adopter firms exhibit a lower ratio of Operational Expense to Sales Revenue relative to non–adopter firms.*

Let the treatment group firms be denoted by *t* and
the control group firms denoted by *c*
Let total operational expense be denoted by *e* and sales revenue by *r*

Let $Z = e/r \times 100$ and

$Z_d = Z_c - Z_t$

$H5_0: \quad Z_d \leq 0$

$H5_1: \quad Z_d > 0$

If the null hypothesis is not supported, then ERP–adopter firms exhibit a lower operating expense relative to non–adopter firms. The evidence would suggest that ERP systems serve to lift Coase's (1937; 1988) 3rd limitation to firm growth described in section 2.4.3.

3.6.7 TEST OF PROPOSITION 6

Proposition 6: ERP–adopter firms attain a better performance relative to capital employed than non–adopter firms.

Firm Performance is operationalised as EBIT. Capital Employed is operationalized as Total Assets Employed.

Accordingly,

Hypothesis 6: ERP–adopter firms exhibit a higher ROA than non– adopter firms.

Let the treatment group firms be denoted by *t* and
the control group firms denoted by *c*
Let total assets be denoted by *a* and EBIT by *n*

Let $Z = n/a \times 100$ and

$Z_d = Z_c - Z_t$

$H6_0: \quad Z_d \geq 0$

$H6_1: \quad Z_d < 0$

If the null hypothesis is not supported, then ERP–adopter firms exhibit a better performance relative to capital employed than non–adopter firms. The evidence would suggest that ERP systems serve to improve operational performance.

3.6.8 TEST OF PROPOSITION 7

Proposition 7: ERP implementations are shareholder value relevant.

Value Relevance is the expanded Shareholder Value construct of section 3.5. It is operationalized via the response coefficients of the ERP terms of the following value relevance model (from section 3.5):

$$R_t = \beta_0 + \beta_1 ROA_t + \beta_2 ERP.ROA_t + \beta_3 \Delta ROA_t + \beta_4 ERP.\Delta ROA_t + \beta_5 DER_t + \beta_6 ERP + \theta$$

where,

R_t is the share return at time t

ROA_t is the return on assets (realized) at time t

ΔROA_t is the change in ROA at time t

DER_t is the debt–to–equity ratio at time t

ERP is the characteristic variable for ERP adoption/ non–adoption

β_2 is the ERC for the value relevance of ERP as agent for earnings quality improvement

β_4 is the ERC for the value relevance of ERP as agent for earnings innovation,

β_6 is the ERC for the value relevance of ERP as a strategic proposition of value

Accordingly, three hypotheses flow from the proposition:

Hypothesis 7A: The coefficient of the interaction between the empirical indicator for the earnings level variable and the empirical indicator for the ERP implementation variable is significantly greater than zero.

$H7A_0$: $\beta_2 \leq 0$

$H7A_1$: $\beta_2 > 0$

If the null hypothesis is not supported, then there is evidence to indicate that ERP implementations serve to improve quality of earnings.

Hypothesis 7B: The coefficient of the interaction between the empirical indicator for the earnings change variable and the empirical indicator for the ERP implementation variable is significantly greater than zero.

$H7B_0$: $\beta_4 \leq 0$

$H7B_1$: $\beta_4 > 0$

If the null hypothesis is not supported, then there is evidence to indicate that ERP implementations serve as catalysts for earnings innovation.

Hypothesis 7C: The coefficient of the ERP–implementation empirical indicator is significantly greater than zero.

$$H7C_0: \quad \beta_6 \leq 0$$

$$H\ 7C_1: \quad \beta_6 > 0$$

If the null hypothesis is not supported, then there is evidence to indicate that ERP implementations have strategic value in their own right irrespective of any agency for earnings quality improvements or earnings innovations.

Should any one of the three hypotheses be supported, the evidence is that ERP implementations are shareholder value relevant. If none are supported, the implication is that there is no evidence to indicate that ERP systems deliver shareholder value. Table 3.3 summarises the six performance relevance hypotheses (1–6), and the three value relevance hypotheses (7A–7C).

TABLE 3.3 SUMMARY OF HYPOTHESES

Hypothesis 1: *ERP–adopter firms exhibit a lower ratio of SG&A to Sales Revenue relative to non–adopter firms.*	$H1_0: Z_d \leq 0$ $H1_1: Z_d > 0$
Hypothesis 2: *ERP–adopter firms exhibit a lower ratio of COGS to Sales Revenue relative to non–adopter firms.*	$H2_0: Z_d \leq 0$ $H2_1: Z_d > 0$
Hypothesis 3: *ERP–adopter firms exhibit a higher ratio of EBIT to Sales Revenue relative to non–adopter firms.*	$H3_0: Z_d \geq 0$ $H3_1: Z_d < 0$
Hypothesis 4: *ERP–adopter firms exhibit a higher ratio of Sales Revenue to Total Assets Employed relative to non–adopter firms.*	$H4_0: Z_d \geq 0$ $H4_1: Z_d < 0$
Hypothesis 5: *ERP–adopter firms exhibit a lower ratio of Operational Expense to Sales Revenue relative to non–adopter firms.*	$H5_0: Z_d \leq 0$ $H5_1: Z_d > 0$
Hypothesis 6: *ERP–adopter firms exhibit a higher ROA than non– adopter firms.*	$H6_0: Z_d \geq 0$ $H6_1: Z_d < 0$
Hypothesis 7A: *The coefficient of the interaction between the empirical indicator for the earnings level variable and the empirical indicator for the ERP implementation variable is significantly greater than zero.*	$H7A_0: \beta_2 \leq 0$ $H7A_1: \beta_2 > 0$
Hypothesis 7B: *The coefficient of the interaction between the empirical indicator for the earnings change variable and the empirical indicator for the ERP implementation variable is significantly greater than zero.*	$H7B_0: \beta_4 \leq 0$ $H7B_1: \beta_4 > 0$
Hypothesis 7C: *The coefficient of the ERP–implementation empirical indicator is significantly greater than zero.*	$H7C_0: \beta_6 \leq 0$ $H7C_1: \beta_6 > 0$

3.7 DATA COLLECTION

This section presents sample selection method and data sources. Section 3.7.1 describes the procedures followed in selecting the treatment group of ERP–adopter firms and in matching the control group of non–adopters to the treatment group of adopters. Section 3.7.2 discloses data sources.

3.7.1 SAMPLE SELECTION

3.7.1.1 TREATMENT GROUP

A Company Data Base of 202 potential ERP–adopter firms was compiled from information gathered from diverse sources (Table 6.1, page F-201[109]). Initially, the Factiva news database was searched for the years 1995 through 2005 for occurrences of the primary search terms "ERP" and "Enterprise Resource Planning" combined with one or more of the qualifying search terms, "implement*", "instal*", "rol*", "phas*", "set*", "dev*", "prod*", "ad?pt*", occurring within 100 words of the primary terms (for years 1995–2001, and 2004), and within 10 words of the primary terms (for years 2002–2003, and 2005 half–year)[110].

The news items containing these terms were then listed by year. These yearly listings were vetted for reports categorical of ERP implementation, which reports were then cross–checked and referenced to the company annual report/s corresponding to the year of the news report. Where the corresponding annual report/s were found to contain no reference to an ERP implementation, the entire annual report database for each such company was examined to determine if the implementation might be evidenced in a subsequent/preceding year. Where the expected disclosure was yet not in evidence or was otherwise less than categorical (e.g. Lion Nathan, Westpac), a Google search (e.g. [company name] +ERP, or [company name] +SAP etc.) was conducted to help discover a year of implementation. Where all such avenues to determining the exact year of adoption were unsuccessful, a direct approach was attempted via email/phone call to the chief information/finance officer for the company.

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[109] The page numbers of tables located in Appendix F are prefixed 'F'

[110] Years 2002–2003 and 2005 (half–year) were searched initially. The low frequency of 'hits' prompted the search parameters to be expanded for all other years to within 100 words of the primary search terms

Where all of the afore–described approaches failed to establish the initial year of "going live" enterprise–wide, the company was excluded from the treatment group (e.g. Harvey Norman). The treatment group database (Table 6.2, page F-210) therefore comprises those companies for which the balance of evidence categorically demonstrates a commencement of enterprise–wide implementation that would allow for year 1 of the 5–year post–adoption test period to be categorically determined[111].

An enterprise–wide implementation is defined as an integration of information and processes across the enterprise that enables decision–making in real time comprehensive enough to make for effective planning and control of core operations. This core real–time integration is generally regarded as having been made possible with the release of the later versions of SAP R/2—more particularly the versions that were released since c1990.

In general however, this research treats the concept of enterprise–wide core integration in the more restrictive sense of having occurred only with the release of ERP versions that feature the 3–tier client–server architecture (i.e. client–server platform versions that come with independent database, business logic, and presentation layers that together in effect enable effective real–time distributed processing). Hence and in general, all diverse–vendor systems implemented post SAP R/3–release date (July 1992) are treated as prima facie "enterprise–wide" in the absence of evidence to the contrary—such evidence being proactively sought wherever the issue was deemed to be less than categorically clear (e.g. Oracle adoption where the evidence points to a possible "financials" only adoption). Therefore and in general, 2–tier ERP architectures (such as SAP R/2) are not considered to be "enterprise–wide core integration" whenever the evidence shows the company in question was not small enough at the time for a (more or less) centralized system. Therefore, in the context of the particular sample developed for the purpose of this research, the release date of SAP R/3 marks the dawn of enterprise–wide ERP.

[111] The year of commencement of an ERP implementation was selected instead of the year of completion since stock market returns are expected to be influenced by the earliest information relating to an ERP implementation. The fact that an ERP roll–out can take anywhere from 6 months to 5 years to complete (Davenport 2000b) with an average time–to–complete of around 18 months (Hendricks, Singhal & Stratman 2007; Poston & Grabski 2001) also contributed to the choice. (Different units of the firm can be expected to begin benefiting as the roll–out progresses, and thus performance improvements should be in evidence as the roll–out progresses)

Where more than one implementation at different time periods more than 5 years apart are in evidence (e.g. Foster's Group upgraded to a different vendor platform 6 years after their first ERP implementation), the first such enterprise–wide implementation is adopted for determining year 1.

Companies that had consolidated or "upgraded" disparate "enterprise system" platforms[112] to a uniform, single–vendor platform were generally considered to have gone "enterprise–wide" only upon such "global" implementation of the single–vendor instance (e.g. Austrim Nylex). Where the cut–off point was not to be so cleanly established, the company/companies concerned were treated as adopters/non–adopters on the balance of evidence.

For example, Comalco, which had integrated its separate c1990 SAP R/2 systems in 1997, 3 years prior to its acquisition by Rio Tinto, but which did not integrate with its parent until September 2006 (under the common instance of SAP ECC 6.0), is treated as non–adopter in the period of the study. On the other hand, Rio Tinto, which went "global" only with the adoption of SAP ECC 6.0 in 2006/07, is nonetheless treated as an adopter in the period of the study for having extensively rolled out Mincom's MIMS ERP in March 1998 (i.e. the acquisition of Comalco in June 2000 was in effect not treated as core).

Subject to the above policy specification for adopter/non–adopter categorization, every effort was made to ensure that every "adopter" company qualified as such by the specified criteria for determining enterprise–wide adoption. The total number of ASX–listed firms thus qualified as ERP–adopters from the Factiva database was 40. A further 16 were added from AspectHuntley's Signal G extracts[113].

A further 5 were taken from ERP–adopter lists compiled for previous research[114]. Additional firms in the treatment group sample were obtained from miscellaneous sources, primarily, by Google search, and by qualifying professed ERP "non–adopters"

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[112] Usually multinationals with far–flung operations that had "proliferated" their enterprise systems by way of multiple acquisitions with disparate platforms

[113] Signal G returns give full text company announcements lodged with the ASX pursuant to the ASX listing rules

[114] Source: Bernhard Wieder, University of Technology, Sydney

for adoption (the reverse of qualifying "adopters" for non–adoption—section 3.7.1.2). These references were also subjected to the same confirmation procedures described for the Factiva news database search results and Signal G extracts.

Of the resulting sample of 83 firms, 23 are disqualified for reasons disclosed in the column titled "Circumstances Surrounding Adoption". This leaves a final treatment sample of 60 firms (Table 6.2, page F-210).

3.7.1.2 CONTROL GROUP

As indicated in section 3.6, the research design for this study is based on matching ERP adopter firms with non–adopter firms across industry and firm size. The purpose for the matching is to help bring about a measure of parity between firms across each of the factors known to affect cross–sectional financial performance. The factors in question are risk and earnings growth variability across firms (Alford 1992). Without adequate matching, the variability could be expected to yield differential residuals over predicted performance, thus confounding a measure of ERP's effect on firm performance. Hence, if proper residuals are to be extracted from the sample of firms, then an appropriate system for matching firms across risk and growth needs to be adopted.

Alford (1992) found that, for the purpose of classifying firms by valuation multiple (i.e. price/earnings, price/book) for valuation purposes, the performance of the Standard Industry Classification (SIC) system at the 3–digit level of its code structure is equal to or better than that of schemes that use risk and/or earnings growth factors[115]. Neither did the latter factors turn out marginally useful with the 3–digit level of SIC classification. These results improve with firm size, the efficacy of the SIC being greater for large firms (Alford 1992; Cheng & McNamara 2000). Thus, the 3–digit industry level of the SIC appears to be an adequate surrogate for risk and earning growth components, particularly in the matching of larger firms for valuation multiples.

Since the magnitude of the share return is clearly related to the valuation multiple, the above criteria are relevant for the matching of firms by the magnitude of share return. Hence, industry matching alone would suffice for matching firms for comparable share return response levels (i.e. pricing multiples over earnings/book values).

[115] i.e. as surrogated by firm size and ROE (Alford 1992)

While the 3–digit level of the SIC provides the appropriate base for selecting firms by matching share return response levels, the question arises as to whether this same base may well suffice for the matching of firms for comparable earnings returns. Distilling a potential earnings differential (and therefore a potential share returns differential) on account of ERP adoption requires controlling for prior factors that could influence this differential.

The question then is: does the fact of industry membership (or 3–digit level of the SIC) also serve as a control for earnings changes (i.e. residual earnings over predicted performance), the variable of primary interest in this research? The answer is in the negative since earnings are a function of scale (size) as much as the other things of interest (e.g. ERP implementation). While scope is controlled for with matching industry group membership, size, which surrogates for business risk, is best matched by the operating asset base.

Accordingly, the control group (ERP non–adopter) firm is matched to the treatment group (ERP–adopter) firm by industry group membership and asset base. The latter matching is based on 85–115 percent[116] of the end–of–period total assets[117] of the treatment group firm. However, the relatively small number of firms listed in several industry sectors of the Australian Stock Market[118] does necessitate falling back on Alford's 1992 findings in regard to the adequacy of the SIC 3–digit level in matching firms across both risk and growth factors for valuation purposes. In these instances, matching by industry group is considered adequate.

This policy is also supported by the fact that though earnings are a function of scale economies (controlled for by firm size), the parameter of primary interest for the regressions performed in this research is the earnings *change* variable, rather than the earnings level variable. It is expected that the earnings *change* would not capture scale

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[116] Given the limited number of firms listed on the ASX, an 85–115 percent range is considered optimal for size matching. A narrower spread is not found to be supported by the available industry sector mass

[117] The end–of–period assets falls in line with the apparent policy adopted in AspectHuntley's FinAnalysis data base, the data base of choice for firm financial data for this research

[118] The available firms in the period covered by the study (1995–2005) ranged as low as 23 in the Utilities sector and 32 in the Telecommunications sector, with only the Materials and Industrial sectors allowing adequate enough critical mass for matching across the firm size dimension

effects unless there has been a material change to the size of operations[119]. Any such change however gets controlled for through the ROA measure for capturing earnings change. The ROA measure scales earnings by total assets. This is considered an adequate control for scale effects.

While the SIC protocol may well be adequate, the General Industry Classification System (GIC) has been found to be significantly better at explaining stock returns, cross–sectional variation in valuation, growth rates, and key financial ratios across groups of homogeneous firms[120] (Bhojraj, Lee & Oler 2003). GIC leads to lower valuation errors (Weiner 2005), and the 3-digit level of the SIC code would appear to correspond with the industry group level of the GIC code (Weiner 2005).

Accordingly, the control group (ERP non–adopter) firm is matched to the treatment group (ERP–adopter) firm by industry group level of the GIC code supplemented with firm size (wherever feasible).

Subject to the foregoing, potential control group member firms were identified by determining that the firm had not implemented an ERP system for at least a portion of the matching treatment group firm's 5–year post–adoption test period. While a majority of matching control group firms had not adopted ERP throughout the 5–year test period, the minority that had adopted at any point in the currency of the test period were replaced in the year of adoption with another non–adopter firm[121]. Further, while non–adopter firms may be matched to multiple adopter firms with non–overlapping test periods[122], no non–adopter firm is matched to more than one adopter firm in any one year of the test period.

The test for ERP adoption (as delineated in s3.7.1.1) was applied to professed "non–adopters" as well as "adopters" (as this would otherwise have risked repercussions on

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[119] Material changes through acquisitions/divestitures are controlled for through adjusting for such effects on the earnings variable

[120] Homogeneity is defined by the system of classification. Unlike other classification algorithms commonly adopted in the literature (e.g. SIC and NAICS), the superiority of the GIC derives from the fact that it has been established to meet the needs of investment professionals and not primarily shaped by firms' production technologies (Bhojraj, Lee & Oler 2003)

[121] , e.g. Optima ICM replaced with Codan Ltd, IT sector (Table 4.3)

[122] e.g. Coffey International, Industrials sector (Table 4.3)

the integrity of the control group). Thus, companies that indicated they did not have an ERP system were qualified as non–adopters subject to the test of the criteria for adoption. Under this policy Rib Loc Group, for example, which had indicated the system they had was "not ERP[123]", were yet treated as an "ERP adopter" and thus pre–empted from control group membership. The 60 matched pairs of firms are listed in Table 6.3 (page F-214).

3.7.2 DATA SOURCE

The chief data source for ERP adoption–related information is the Factiva news data base. The chief data source for annual reports, total asset and ROA data, and other company–related data is the AspectHuntley database comprised of Annual Reports Online, DatAnalysis, and FinAnalysis. While DatAnalysis' Signal G extracts[124] offer an ERP–adoption information source supplementary to Factiva, Annual Reports Online supplies a source of information on technology adoption (including ERP) in company annual reports, and FinAnalysis provides financial analysis data pertaining to listed companies including ROA.

The chief source of share price data for the sample companies is the Securities Industry Research Centre of Asia–Pacific (SIRCA) share price data base. The secondary source is AspectHuntley' FinAnalysis historical share price data. In the single instance these sources were unable to fulfil the requirement (Tenon Ltd—formerly Fletcher Challenge Forests—Oct 1998 share price) an approximate price was obtained by searching the internet.

The chief data source for macroeconomic data is the web database of the Australian Bureau of Statistics. This was supplemented in the main by the web database of the Reserve Bank of Australia. Other supplementary sources include the International

[123] Rib Loc Group was qualified to have implemented a Sage ERP in 1998, but the Finance and Administration Manager called it a "financial system". In general, companies don't always seem to be aware the system they have in place is ERP. For example, Monadelphous denied ever implementing an ERP, but their IT manager subsequently confirmed a J.D. Edwards system roll out over 2000–2004. Envestra initially denied implementing an ERP, yet their IT Consultant confirmed a full SAP roll out. Such denials would seem to suggest that ERPs may be implemented for operational purposes more than for supplying senior management with information/knowledge for strategic uses

[124] Signal G returns give full text company announcements lodged with the ASX pursuant to the ASX listing rules

Monetary Fund's International Financial Statistics service, IFS Online, and the statistics portal for Australia from the Organization for Economic Cooperation and Development. The National Australia Bank made available their time series data on capacity utilization rates and business conditions indices.

Collection of ERP–adopter data (for sample selection) spanned the period 1995–2001. Corresponding data for the analysis (i.e. financial data, share price data, macroeconomic data) spanning the five years of post–implementation operations were culled from the periods 1995 through 2005.

3.8 CHAPTER SUMMARY

The chapter commenced with an overview of the research design for the test of the propositions, introducing the theoretical value relevance model to be tested. The functional model was then developed, showing how the test of value relevance is articulated. First, the constructs applying to the model, "ERP Implementation", "Enterprise Performance", and "Shareholder Value" were developed and operationalized. Second, the constructs were represented in the model as follows: "ERP Implementation" was represented by an ERP indicator variable; "Enterprise Performance" was represented by the Return on Assets (ROA) parameter of earnings performance; and "Shareholder Value" was shown to derive from ERP's posited value relevance roles as (a) catalyst for earnings quality improvement (b) catalyst for earnings innovation, and (c) a strategic value proposition to the firm. These were represented as follows: (1) earnings quality was modelled with an ERP–earnings level interaction term, (2) earnings innovation was modelled with an ERP–earnings change interaction term, and (3) strategic value was captured by an ERP indicator term.

The seven propositions from chapter 2 were converted into nine testable hypotheses, hypotheses 1–6 representing various performance relevance parameters, and hypothesis 7 (with three sub–hypotheses) representing the three ERP value relevance dimensions. The appropriate test design was shown to be a matched pair. The appropriate method for testing of hypotheses 1–6 was shown to be the *t*–test for the mean paired difference of the different performance relevance parameters. The appropriate method for the test of hypothesis 7 was shown to be regression tests of significance of the three value relevance coefficients. The chapter concluded with the methodology for sample selection and data collection.

4. ANALYSIS AND RESULTS

4.1 INTRODUCTION

This chapter presents the data analyses procedures and results of the tests of hypotheses. Section 4.2 presents the analysis of the data gathered for (a) determining key macroeconomic factors likely to affect performance (b) predicting firm earnings based on these factors and past earnings, and (c) deriving the residual over the predicted earning. Section 4.3 presents tests of hypotheses and determining if the test results evidence enterprise performance relevance and shareholder value relevance of ERP systems implementations. Section 4.4 provides a summary of the chapter.

4.2 ANALYSIS

The analysis seeks to establish (a) whether ERP adopter firms perform better than non–adopter firms, and if so, (b) whether there is evidence that the superior performance is caused by ERP adoption.

In order to establish superior performance, the need at the outset is to establish the benchmark for each firm against which post–ERP adoption performance may be measured. As delineated in chapter 3, these firm–specific benchmarks are postulated to be prior earnings of the firm (the firm's autoregressive earnings component or earnings persistence component in current earnings) moderated by macroeconomic factors.

Accordingly, section 4.1.1 determines the factors likely to moderate firm performance while section 4.1.2 estimates an earnings prediction model that incorporates the factors so as to derive a benchmark for measuring residuals of actual earnings over predicted.

4.2.1 MACRO–ECONOMIC EFFECTS ON FIRM PERFORMANCE

Thirty–five macroeconomic indicators of the business cycle were identified with reference to business cycle theory and leading/coincident indicator theory (Gabisch & Lorenz 1989; Hall 1990; Lahiri & Moore 1991). These indicators represent a significant cross–section of leading, coincidental, and lagging indicators of the business cycle. It is expected the diversity would offer the necessary critical mass to make for a proper delineation of the key macroeconomic influences affecting the business cycle[125]. The delineation is made on the basis of a factor analysis of the indicators. It is expected that the factor analysis would yield the principal macroeconomic influences that are likely to moderate enterprise *intrinsic performance capacity*. The indicators used for this analysis are categorized by relevant economic theory and attributes (i.e. leading, coincident, and lagging) (Table 6.4, page F-216[126]).

Principal Component Analysis (PCA) is the adopted factor analytic method for the study on account that it is the one method that maximizes the variance accounted for in a correlation matrix—the components extracted being themselves linear combinations of the variables factored with initial communalities at unity. In addition, since the linear combinations are uncorrelated in themselves, the factors are free from multi–collinearity[127]. The method therefore makes for comprehensive factoring. Further, the method helps identify real factors in that the variable combinations point to the key influences in the domain they represent—the macro–economy. This makes for interpretability of the factors[128] (Child 2006; Kline 1994). PCA is thus considered advantageous to this exploratory study since it aids comprehensive delineation of the underlying macroeconomic factor structure deemed to moderate firm earnings.

The disadvantage with the principal component approach however lies in this very comprehensiveness of factoring since it implies that all of the variance in the correlation matrix is common amongst factors (i.e. they have communalities of one), and none therefore can be *unique* to the variables *per se*. This clearly is never the case since it presumes the absence of measurement error in the least—if not any variance that is *specific* to each variable itself (Kline 1994). The method therefore is flawed as the factor structure that emerges cannot but be influenced by this assumption. The effect would be particularly significant where the off–diagonal correlations in the correlation matrix are small (Kline 1994; Rummel 1970). The correlation matrix in this study

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[125] The explanatory power of a model could generally be expected to improve the larger the set of (theoretically–grounded) variables used

[126] The page numbers of tables located in Appendix F are prefixed 'F'

[127] A significant consideration for the estimation of the earnings prediction model (s4.2.2)

[128] This contrasts sharply with other methodologies of factoring that yield hypothetical factors (Kline 1994).

reveals a 15.1% proportion of small values in the range $-0.1 < r < +0.1$. These numbers as a whole are deemed insignificant to cause a major distortion of the emergent factor structure (i.e. the proportion of small values is relatively small). Nevertheless, Rummel (1970) suggests that an assumption of unity values for the communalities where the number of variables in the correlation matrix is less than 70 can yet have a major effect on the factor pattern.

Given the central problem with the PCA, which is the unity communalities assumption, alternative approaches to the determination of the common variance were considered. However, there appears to be no reliable method for determining initial communalities of less than unity. Furthermore, alternative methods do not yield totally reliable results significantly different from the PCA (Kline 1994).

An approach that finds favour amongst practitioners as an independent corroborator of the principal components is the Maximum Likelihood Approach (Kline 1994). However, the MLA could not be executed as the correlation matrix turned out not to be positive definite[129].

The components extracted under PCA are rotated to maximize their explanatory power. Simple structure rotation aims to secure few high loadings on factors with the remaining loadings at zero or near zero. The procedure thus serves to enhance interpretability given its fewer high loadings than the corresponding unrotated matrix, whilst yet maintaining mathematical integrity of the original structure. Simple structure rotations have been shown to be reliable in that they "… yield interpretable, replicable factors which resemble the real factors in matrices where these are known" (Kline 1994, p. 66). They thus offer the best solution to the problem of rotation (Kline 1994).

The Varimax method of rotation (Kaiser 1958) is adopted given the objective of the analysis is to seek independent (uncorrelated) macroeconomic factors that moderate earnings[130]. The Varimax aims at simple structure whilst retaining orthogonality of factor axes. Orthogonality ensures independence. Further, the communalities of the

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[129] "Positive definite" is the condition where all of the eigenvalues in the factored matrix are positive or zero (i.e. no negative values), a condition apparently required for the MLA approach

[130] This is to pre–empt multicollinearity in subsequent regressions for estimating the earnings prediction model

variables and the ability to reproduce the original correlation matrix of the variables remain unaffected with rotation, thus further securing equivalence of rotated components with the original structure. Varimax represents the most efficient orthogonal procedure for securing simple structure (Kline 1994).

The PCA was initially conducted for the level values of the indicator variables. The Scree Plot (Fig. 6.1, page F-191) shows the first 4 components to be of interest. Table 6.5 (page F-218)gives the rotated component matrix with the 4 component extractions. However, the percentage total variance explained by the rotated 4th component (4.4%) (Table 6.6, page F-219) is too low to be of interest[131]. More significantly, several rows in the Rotated Component Matrix (Table 6.5, page F-218) do not contain at least one zero (or near zero) loading. Furthermore, the first component does not meet the minimum threshold[132] for zero (or near zero[133]) loadings. These several issues would suggest the Rotated Component Matrix fails to meet the simple structure criterion.

Further, while it would appear that component 3 captures a business activity factor (i.e. significant loadings from the business conditions indices, and the capacity utilization index), and component 2 captures an interest rate factor (i.e. significant loadings from the 3 interest rate indicators used in the analysis: Cash Rate, 13–week Treasury Bill, 3–year Treasury Bond), component 1, accounting for nearly 62% of the total variance, appears too general for interpretation. It presents a composite of household income, consumption expenditure, taxation, national output, aggregate corporate profits, money supply, stock market indices, and national investment (Table 6.5, page F-218).

The several factors presented above would strongly suggest that the matrix of macroeconomic indicator level variables cannot possibly yield reliable, interpretable results. The indicator change variables are therefore analysed with a view to discovering a possible simpler, and therefore more reliable, and interpretable structure.

Table 6.7 (page F-221) presents the Rotated Component Matrix with seven component extractions. [While the Scree Plot (Fig. 6.1, page F-191) reveals nine components of

[131] A threshold of 9% is suggested by Kline (1994)

[132] Which minimum is the number of extracted factors (Kline 1994; Thurstone 1947) i.e. 4 in this instance

[133] A factor loading of 10% (one percent of the variance) or less is deemed ‘near zero’ in this research

interest, the eigenvalues of the 8th and 9th (Table 6.8, page F-222) are below the adopted threshold of one]. The matrix easily satisfies the criteria for simple structure (Kline 1994; Thurstone 1947). However, the percentage variance accounted for by all but the 1st and 2nd components fall below the 9% threshold for significance adopted in this study[134] (Table 6.8, page F-222).

With regard to the interpretability of the components themselves, component 1 now accounts for just half of the excessive variance of the previous result (i.e. 31% versus 62%) (Table 6.8, page F-222), and reveals—in contrast to the multiple macroeconomic indicator class loadings it featured in the previous result—a singular national output/ business activity factor (Table 6.7, page F-221). This is evident from the fact that all key national output indicators (GDPr, ConsExp, GDPc, GFCF_Pvt) and all business activity indicators (BCI_last3, Final_Sal, BInvent, BCI_next3, CapUtilRat, Retail_Sal, IPX,) load significantly[135]. Component 2 retains its strong interest rate flavour with the further addition of associated indicators for inflation (CPI and GDP_IPD), as well as the (negatively–correlated) indicator for national productivity (GDPperHour). The two components, accounting for a total of 60% of the variance, thus signal a national output factor (component 1) and an inflation/interest rate factor (component 2). While the former could be viewed as an explicit influence on business activity, the latter could be expected to moderate profits through credit availability and cost of capital.

Of the remaining factor extractions, the 6th and 7th are considered irrelevant as possible moderators of *intrinsic earnings capacity* as they each contain only a single significant loading: metal index change (Metal) and foreign direct investment change (FDInvst), the former clearly unrelated, and the latter only indirectly related to earnings performance. Component 5 would appear to capture a money supply factor (M1) with a moderate influence from a constituent of the M2 money supply: gross savings (GrsSav). This component too is considered not directly relevant to enterprise *intrinsic earnings capacity* (since changes to money supply influences inflation and interest rates, and this latter is already captured in component 2, interest rates factor).

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[134] After Kline (1994)

[135] A loading of .707 and above accounting for 50% of the variance and above is deemed significant

Of the remainder, component 4 contains significant loadings from portfolio investment (PfolioInvst) and gross operating surplus (GOS), while component 3 holds loadings from the two stock indices (ASX200 and ASXInds), the former loading significantly. It would therefore seem that whilst the former (component 4) would suggest a moderate aggregate profits effect[136], the latter (component 3) may yet point to the greater influence on firm earnings through the effect of security prices on earnings (Beaver, Lambert & Morse 1980; Beaver, Lambert & Ryan 1987; Collins, Kothari & Rayburn 1987). In addition, since component 3 accounts for more of the variance than component 4 (7.9% versus 7.4%), component 3 may be considered more significant to a possible moderating influence on *intrinsic earnings capacity* (i.e. share performance can attract capital for business expansion whilst moderating cost of capital).

The foregoing analysis shows that while component 1 is relevant on the one hand, and components 5, 6 and 7 are redundant or irrelevant on the other, components 2 is not quite sharply defined, and components 3 and 4 are even less so[137]. This would indicate an extension to the present analysis with a view to a more definitive determination.

A further fresh extraction with the number of components limited to 5 is performed[138] (Table 6.10, page F-225). While component 5 explains a less–than–significant proportion of variance (at 9% threshold), each of components 1-4 are of interest. However, the rotated component matrix (Table 6.9, page F-224) does not yet allow categorical determination of the underlying influences for components 3 and 4 suffice to say that gross operating surpluses (GOS) and durable goods orders (DurGood) increase their loadings on component 4 appreciably while portfolio investment (PfolioInvst) turns insignificant, its loading falling by an appreciable margin.

Accordingly, a 3–factor extraction is performed with GOS further increasing its salience to a loading of .903 (Table 6.11, page F-227), whilst all other variables that loaded on

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[136] GOS – Taxes on Resident Corporations = PAT (After–tax Corporate Profits) (Table 4.3)

[137] The lack of sharp delineation for each of components 3 through 7 may reflect in their not meeting the 9% threshold for significance of the total variance explained suggested by Kline (1994)

[138] PCA iterations for the 6–component extraction and the 4–component extraction do not add to the analysis. They are omitted in the interests of economy

components 7, 6, 5, 4 & 3 in the first (7 factor) iteration[139] further decline. Component 3 thus appears to flag a significant aggregate profits factor having consistently increased its loading. It thus constitutes a 3rd key underlying influence in the economy.

Components 1, 2 and 3, comprising 72% of the total variance (Table 6.12, page F-228), are thus adopted as moderating factors of enterprise *intrinsic earnings capacity*. The rest are considered irrelevant or inadequately significant.

An exploratory factor analysis of variables grounded in theory allows for the delineation of probable key underlying influences represented by the extracted factors. Furthermore, when such analysis is done via PCA, a larger measure of confidence can be placed in individual indicator variables with significant factor loadings as choices of proxy for the underlying influences. This owes to the fact that the extracted components themselves are orthogonal linear combinations of the indicator variables. Therefore, the particular variables that would best proxy the underlying factor influences on enterprise profitability are selected for input into the firm earnings prediction model (section 4.1.2.1).

The best proxy choice would be determined in accordance with (a) their temporal attribute—coincident indicators being preferable for input into an earnings prediction model designed to predict current performance[140], and (b) their significance to the determination of business profitability. Accordingly, and with respect to the particular significance of component 1 (i.e. an aggregate output/ business activity factor), a coincident indicator measure of the physical volume of business (Gabisch & Lorenz 1989) is indicated. This is best reflected in the 3rd–ranked capacity utilization rate (CapUtilRat) with approximately 84% of its variance accounted for by component 1. With regard to component 2, even though interest rates, which are lagging indicators of the business cycle (Gabisch & Lorenz 1989; Hall 1990), may be proxied with the (coincident) consumer price index (CPI) given as much as 91% of the latter variance

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[139] FDInvst, Metal, PfolioInvst, DurGood, M1, GrsSav, ASX200, BudDef & Oil

[140] Coincident indicators are preferred since they provide a guide to recent movements in economic activity whereas leading indicators give advanced warning of impending changes to the business cycle and therefore are more suited to forecasting (*Leading Economic Indicators* 1985)

accounted for by this component[141], it is felt that interest rates would yet better reflect *intrinsic earnings capacity* by way of its direct influence upon relative capital availability (via cost of capital) for internal investment[142]. Accordingly, the 4th–ranked 3–year Treasury bond rate (Tbond3Rat), 89% of which variance is accounted for by component 2, is adopted[143]. The aggregate measure of before–tax profits in the economy, the 1st–ranked gross operating surpluses (GOS) is adopted as the 3rd component[144]. Accordingly, the capacity utilization rate (CapUtilRat), the 3–year Treasury bond rate (Tbond3Rat), and gross operating surplus (GOS) are adopted as the macroeconomic variables input into the firm earnings prediction model.

4.2.2 EARNINGS PREDICTION

This section estimates a model for forecasting earnings, and derives the residuals of the actual earnings over forecast to determine the abnormal earning of firms. The section starts with the model specified in section 3.5 and develops it to incorporate parameters for a pooled regression. The section proceeds to derive the best model fit with the estimation method best suited for the purpose. An OLS regression is attempted first. A GLS regression follows. The best[145] coefficients are found to be given by Generalized Method of Moments (GMM) estimation.

4.2.2.1 MODEL ESTIMATION

The generic functional form of the ROA estimator model for the prediction of firm earnings introduced in section 3.5 is—

$$ROA = k + \sum_{i=1}^{N} a_i \Delta ROA_{t-i} + b_1 E_{1t-\delta} + b_2 E_{2t-\delta} + ... + b_n E_{nt-\delta}$$

[141] It would appear that capital market research finds the inflation rate the most prevalent amongst macroeconomic variables priced by the stock market (Groenewold & Fraser 1997)

[142] The expense itself, being a financing cost that does not affect EBIT for ROA determination, is not considered relevant to *intrinsic earnings capacity* which is an operating income concept. Instead, interest rates are deemed to moderate business investment and therefore operating profitability

[143] The 3–year Treasury Bond rate is regarded more representative of cost of capital for internal investment than the more short term and 1st–ranked 13–week Treasury Bill rate

[144] GOS is regarded as preferable to after–tax profits, PAT, as the former is more related to operating income and hence, *intrinsic earnings capacity*, than the latter

[145] i.e. unbiased, consistent, and efficient

where,

ROA is Return on Assets

k is an earnings constant

N is the number of periods in the ROA time series

$E_1, E_2 \ldots E_n$ are macroeconomic variables, and

$\delta \geq 0$ is the lagged period

This model can now be specified following the PCA of section 4.1.1—

$$ROA = k + \sum_{i=1}^{N} a_i \Delta ROA_{t-i} + b_1 CUR_{t-\delta} + b_2 BRAT_{t-\delta} + b_3 GOS_{t-\delta} + \varepsilon$$

where,

CUR is Capacity Utilization Rate

$BRAT$ is 3–year Treasury Bond Rate

GOS is Gross Operating Surpluses, and

$\delta \geq 0$ is the lagged period

Estimating the autoregressive earnings (ROA) term requires a reasonable length of time series earnings data for each firm. However, the available data points per firm in the sample of 120 firms are in several instances inadequate[146]. Under these conditions, pooling individual firm data for estimating a common set of coefficients is indicated[147].

However, pooling a relatively small cross section of 120 firms drawn from diverse industry sectors and groups would likely bias the estimates for the individual firm with sector/group–specific factors in direct proportion to the industry sector/group weighting of the sample. The estimates for each firm will therefore not be representative of firms of like risk and growth. Therefore, and consistent with the theory for control group matching presented in section 3.7.1.2, the industry group is adopted as the matching control group for the derivation of representative coefficients for the sample firm. The rationale underlying this treatment is that firms in each industry group are likely to have similar risk/growth profiles given the commonality of the industry conditions and

[146] The inadequacy arises from the short time–series dimensions of sample firm listings on the ASX on account of mergers, privatization, and receivership in addition to listings of relatively recent origin

[147] One of the main motivations behind pooling is to widen the database in search of better, more reliable estimates of model parameters (Baltagi 2005)

market expectations experienced by them, and thus, estimates derived from the industry group of the sample firm would be more representative of the firm than estimates derived from a heterogeneous sample of firms.

In light of the foregoing, the full functional form of the model to be estimated may be specified as follows:

$$ROA_{ji} = k_{ji} + \sum_{i=1}^{N} a_{ji} \Delta ROA_{jt-i} + b_1 CUR_{t-\delta} + b_2 BRAT_{t-\delta} + b_3 GOS_{t-\delta} + \varepsilon$$

where,

ROA_{ji} is Return on Assets for the *j*th firm at time *i*

k_{ji} is the firm/period–specific fixed effect[148] for firm *j* at time *i*

$CUR_{t-\delta}$ is the Capacity Utilization Rate at lag t-δ

$BRAT_{t-\delta}$ is the 3yr Treasury Bond interest rate at lag t-δ, and

$GOS_{t-\delta}$ is the Gross Operating Surpluses at lag t-δ

A panel OLS regression of 51 listed companies comprising the Consumer Services industry group of the Consumer Discretionary sector of the ASX is performed. The final output (Table 6.13, page F-230) shows the two period–lagged earnings variables[149], ROA_CHG(-1) (*p*–value=.40) and ROA_CHG(-2) (*p*–value=.77), and two of the three single period–lagged macroeconomic indicator variables[150], BOND_RAT(-1) (*p*–value=.11) and GOS(-1) (*p*–value=.50), not significant at $p<.05$, despite a good model fit[151]. Given this particular context of fit, the small *t* statistics obtained would appear to suggest a high level of multicollinearity amongst the regressor variables. However,

[148] The subscript *i* is specified in the constant k_{ji} to capture the possible period–specific effect other than that impounded in the macroeconomic indicator terms in the regression

[149] A two–period lag is initially adopted after Kormendi & Lipe (1987). Their data for a sample of 145 firms runs for an uninterrupted period 1947–1980, a length of time they nevertheless appear to regard as not adequate for any more than 2 lags. The present sample is from the period 1989–2001

[150] Macroeconomic variables at one period lag would appear to give the better estimates (*vis a vis* earlier period lags)

[151] i.e. $r^2 = 0.98$ and F–test for the null hypothesis that all coefficients excluding the constant are zero (*p*–value=.0) rejected at $p<.01$ (Table 6.13), the Jarque–Bera test statistic for the null hypothesis of normality of the error distribution (*p*–value=.13) upheld at $p< 0.10$ (Fig 6.2), and the Ljung–Box *Q* stat for the test of the null hypothesis that there is no serial correlation in the residuals (*p*–value=.90) upheld at $p<.05$ (Table 6.14)

given that the macroeconomic regressor variables derive from the PCA performed in section 4.1.1, multicollinearity amongst these variables is ruled out.

This leaves a possible multicollinearity between one or more lagged earnings variables and one or more of the macroeconomic variables. Testing for model fit after dropping the most likely candidate, GOS[152], reveals no appreciable change in the *p*–values of the ROA variables (*p*–values=.42 & .71), but a significant improvement in the Bond_Rat[153] *p*–value (=.01) (Table 6.15, page F-232). The overall explanatory power of the model remains virtually the same as before. Given this fact together with the high GOS *p*–value (=.50) in the fully–specified model (Table 6.13, page F-230), the indication may well be that the GOS variable does not add to the explanatory power of the model as a whole.

However, the more fundamental issue reveals itself in the regression excluding all macroeconomic variables (Table 6.16, page F-233). The lagged earnings variables remain insignificant with the 2–period lag ROA *p*–value increased to .93 (from .77), while the overall explanatory power of the model remains unchanged. This would suggest that none of the macroeconomic variables add to the explanatory power of the model, and worse still, the lagged earnings variable consistently insignificant to the determination of the current period earning. This result is counter–intuitive as it is commonly observed that the business cycle does affect firm operating performance[154]. Further, the effect of the lagged earnings variable is well supported in current theory and empirical findings (Kormendi & Lipe 1987).

A final test by dropping the 2–period lag ROA variable and running the regression with just the 1–period lag ROA variable as the only regressor term (Table 6.17, page F-234) reveals the ROA term insignificant (*p*–value=.86) and the overall explanatory power of the model only fractionally lower. Clearly, multicollinearity is not the key factor

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[152] Gross Operating Surpluses are more likely to correlate with ROA than capacity utilization or interest rate

[153] 3–year Bond Rate

[154] Firm failures increase due to bankruptcies during and after a recessionary period (Rose, Wesley & Giroux 1982)

causing the apparent lack of linear relationship of the regressor variables with the dependent variable.

An alternative explanation to the foregoing inconsistent empirical results suggests itself. This being that panel estimations[155] risk biasing the least squares estimator on account of possible influences from cross section–specific and/or time–specific effects from heterogeneous firm and period data (Baltagi 2005).

A regression with no cross section fixed effects specified (Table 6.18, page F-235) reveals the ROA term (*p*–value=.0) significant at $p<.01$ but with the explanatory power of the model reduced quite significantly from .97 to .34. Re–introducing the 2–period–lagged ROA term (Table 6.19, page F-236) improves the explanatory power moderately to .38, and following suit with the macroeconomic variables (Table 6.20, page F-237) increases it further, if marginally, to .39. This improvement to .39 is appreciably below that of the cross–section–fixed–effects–specified model with the least explanatory power, at .97 (Table 6.17, page F-234), suggesting a considerable influence from heterogeneous cross section (firm) fixed effects[156]. This is confirmed when comparing Table 6.17 with 6.18, Table 6.16 with 6.19, and Table 6.13 with 6.20 (pages F-230 to F-237), which consistently show the inclusion of the constant making the ROA lag terms insignificant at $p<.10$ while the constant term itself remains significant at $p<.05$.

Furthermore, the coefficients of the ROA terms are consistently large and non–negative (Tables 6.18, 6.19 and 6.20: pages F-232 – F-234); a result not obtained with the preceding fixed effects specifications (Tables 6.13, 6.16 and 6.17: pages F-230 – F-234). The macroeconomic variables however remain not significant at $p<.10$[157] (Table 6.20, page F-237). Removing GOS from the regression causes the explanatory power to decrease fractionally, while improving appreciably, as before (Table 6.15, page F-232), the significance levels of the remaining two macroeconomic variables, CUR and BOND_RAT. These results suggest specific implications for the final estimation model, and would be evaluated in deriving the final estimates.

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[155] Panel estimation involves the pooling of cross sections across a time dimension (Baltagi 2005)

[156] This considerable influence is tabulated by firm in Table 6.22

[157] CUR(-1) (*p*–value=.79), BOND_RAT(-1) (*p*–value=.45) and GOS(-1) (*p*–value=.93)

However, the foregoing results cannot be entirely relied upon even with cross–sectional fixed effects controlled for. The reason is that autocorrelation between the lagged dependent variable and the error term in dynamic models[158] is unavoidable (Baltagi 2005). The correlation renders OLS and GLS estimators biased and inconsistent even without autocorrelation in the error term (Baltagi 2005)[159].

While period effects are likely to be not significant for micro panel data with a very limited time series dimension (12 years from 1989–2000), a regression with random period effects specification is nonetheless performed. The results do not improve the explanatory power of the model (Table 6.21, page F-238).

Given these multifarious effect limitations under OLS/GLS, the Generalized Method of Moments/ Dynamic Panel Data Modelling (GMM/DPD) method for estimating is indicated (Arellano & Bond 1991). While GMM regressions remove cross–sectional fixed effects through first differencing[160], they also allow for instruments[161] to be specified as substitutes for the first–differenced regressors to control for the latter's correlation with the error term (Arellano & Bond 1991). Furthermore, where dynamic models with uncorrelated errors can be specified, lagged values of the dependent variable become valid instruments in differenced equations (Anderson, TW & Hsiao 1981; Arellano & Bond 1991). Therefore, it would appear that, subject to the independence of the error variable being satisfied, this GMM modelling approach would remain consistent with the autoregressive time–series model for predicting earnings available in the accounting literature[162] (Kormendi & Lipe 1987).

The key assumption underlying GMM estimation therefore is the absence of serial correlation in the error variable. Violation of this key assumption would render the

[158] A "dynamic" model is characterized by the presence of a lagged dependent variable amongst the regressors (Baltagi 2005)

[159] In this context, the absence of first order autocorrelation in the estimated model (Table 6.14) is of interest. [The Durbin–Watson statistic in Table 6.13 is biased and misleading with dynamic models—Eviews 5.1 User Guide]

[160] Or through orthogonal deviations (Arellano & Bover 1995)

[161] Instruments are variables that correlate with the lagged dependent variables amongst the regressor terms but not with the error variable (Arellano & Bond 1991; Gaston & Rajaguru 2007)

[162] From which this research draws its primary theoretical underpinning (chapters 2 and 3)

GMM estimator inconsistent (Arellano & Bond 1991), and the results of the estimation therefore invalid. To test for violation of this key assumption, the literature specifies the test of the second order serial correlation of the (first differenced) error term, along with the Sargan test for over–identifying (instrument variable) restrictions (Arellano & Bond 1991; Gaston & Rajaguru 2007). Subject to this latter auxiliary requirement being satisfied together with the standard assumptions for deriving the unbiased least squares estimator (including the aforementioned lack of serial correlation in the error term), the GMM estimators of the model would result in negligible finite sample biases, as well as smaller variances than those associated with simpler instrumental variable estimators (Arellano & Bond 1991).

Accordingly, estimation of the above model for the Consumer Services industry group using GMM/DPD is undertaken using Eviews v5.1, a program for statistical and econometric analysis and forecasting. The output shows that while the model has (a) sufficient explanatory power at $r^2 = 0.74$ (note 2, Table 6.23[163]: page F-241), (b) the Sargan test for the null hypothesis that instruments are not over–identified supported (*p*–value = .47) at $p<.10$ (note 1, Table 6.23, page F-241), and (c) 2nd order autocorrelation of the first differenced residuals within critical values (i.e. $\pm 1.96SD / \sqrt{n}$) of the autocorrelation function (ACF) (Table 6.24, page F-243), yet (d) the Jarque–Bera test for the null hypothesis of normality of the error variable distribution (J–B test statistic = 2408, *p*–value = .0) fails at $p<0.10$ (Fig. 6.3, page F-193). Hence, outlier treatment is indicated as the primary step toward deriving an adequate industry group–level model specification.

The number of outliers at 1.96 standard deviations of the standardized residual is 8% of the total observations (16 of 198). Since this proportion exceeds the 5% cut–off adopted in this research for mean replacement, the 11 cross–sections (firms) comprised in the 16 outlier observations are removed in their entirety[164] from the estimation sample to leave a total 40 firm cross–sections for the 2nd iteration of the GMM regression.

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[163] The coefficient of determination is manually worked out (note 2, Table 6.23) since the Eviews program output is manifestly in error (i.e. $r^2 = -1.157451$)

[164] Comprising a total of 70 firm/year observations

The 2nd iteration presents improved results (Table 6.25, page F-244) and yet, the Jarque–Bera test statistic for normality at 73.0 (p–value = .0) (Fig 6.4, page F-194) is not sufficiently improved at p<.10. Hence, a further 7 outlier observations lying outside the 1.96 standard deviation range of the residual plot are treated. Since this number comprises 5.5% of the total outlier observations, the 7 cross–sections (firms) involved are removed[165] to leave a sample of 33 firm cross sections for the 3rd GMM iteration.

The 3rd iteration presents normality in the error variable distribution in that the Jarque–Bera test statistic at 0.90 (p–value = .64) is not significant at p<0.10 (Fig. 6.5, page F-195). Yet, while the model shows a good fit (r^2 = .99) and the J–Stat (12.18493) not significant (p–value = .35) at p<.10 (Table 6.26, page F-246), it begins to exhibit 2nd order autocorrelation of the first differenced residuals in that the ACF at the 2nd lag exceeds the $\pm 1.96/\sqrt{n}$ bound (Table 6.27, page F-248). This renders the coefficient estimates inefficient.

Attempts to reduce the serial correlation of the error term to an acceptable level by manipulating the instruments (i.e. re–iterating the estimation regressions, each iteration with different combinations of instrument variables, each in turn with different lag permutations) are unsuccessful with the second order lag of the first differenced residual consistently remaining marginally outside the $\pm 1.96/\sqrt{n}$ bound of the ACF. Excessive serial correlation amongst the residuals would render the estimated coefficients unreliable for prediction purposes.

Although a 4th iteration conducted with 28 firm cross sections meets all basic least squares and auxiliary GMM assumptions[166], this is only achieved by dropping more outliers, which therefore doubly calls to question the validity of the estimated coefficients. It would therefore appear that there is excessive variation within the Consumer Services industry group as a total of (198-68=) 130 firm/year observations comprising a full two thirds of the industry group firm/year membership have had to be

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165 Comprising a total of 42 firm/year observations

166 Jarque–Bera stat (1.215597) non–significant at p<.10 (Fig 6.6), 2nd order autocorrelation of residuals within the $\pm 1.96/\sqrt{n}$ bound of the autocorrelation function (Table 6.29), and Sargan test (J-stat 7.595779, p–value = .47) for over–identifying restrictions not significant at p–value < .10 (Table 6.28, note 1). In addition, the model bears high explanatory power at r^2 = .99 (Table 6.28, note 2) and the t–statistics remain significant for all coefficients barring GOS at p<.01 (Table 6.28)

eliminated across successive GMM estimation iterations in the search for unbiased, consistent, and efficient coefficients. It would therefore seem that such coefficients can only be derived for Consumer Services at the expense of making them in effect not representative of a full two third of the industry group.

Since the Consumer Services industry group appears to exhibit excessive variation, estimation at the corresponding higher level of the GIC system—the industry sector level—is performed in anticipation that the larger pool of firms at the sector level may yet yield representative coefficients (i.e. at a non–excessive outlier attrition rate). The estimation using earnings data in the Consumer Discretionary sector however eventuates with the total number of firm/year observations declining on account of outlier treatment by 68% to 259 observations, (Table 6.30, page F-252), a rate practically the same as that of the Consumer Services industry group. This would therefore suggest that, on average, other industry groups within the Consumer Discretionary sector perform similar to Consumer Services[167].

Likewise, the Consumer Staples sector declines from 437 starting observations to 212 or by 51% of the pool (Tables 6.31 – 6.32, pages F-254 – F-256, Fig 6.7, page F-197) and the Energy from 536 to 68 or by 87% (Tables 6.33 – 6.34, pages F-257 – F-259, Fig 6.8, page F-198). The rest of the larger sectors also show sharp declines from outlier treatment: Health Care drops from 366 to 140 or by 62%, Industrials from 858 to 255 or by 70%, Information Technology from 358 down to 77 or by 78%, and Materials from 731 to 245 or by 66%. The two smallest sectors, Telecommunication & Utilities, which are combined to make for critical mass (55 companies), fail yet to eventuate usable[168] coefficients in a like manner to the previously–estimated Consumer Services industry group (51 companies).

It would appear therefore that barring the Consumer Staples sector, which barely retains 50% of its original firm/year membership, the rest of the sectors lose two–thirds or more

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[167] GMM estimations are better suited to panels exhibiting large numbers of cross sections with limited time series data (Wooldridge 2002). Further, for fixed time periods, time series regression models yield consistent estimators as the number of cross–sections tends to infinity (Anderson, TW & Hsiao 1981). The evidence therefore suggests that in the context of the limited cross–sections available at the industry group/sector levels, sampling from within these levels may well be contrary–indicated for GMM estimations

[168] Coefficients that are efficient, consistent and unbiased

of their respective pools on account of elimination of outliers. An excessively high outlier attrition rate raises issues of external validity of the estimation. In this instance, the validity of coefficients for the sample companies is in question.

In this particular context, the credibility of the estimated coefficients are called to question. The Consumer Discretionary sector yields a 1–period lag ROA coefficient of .09 while the CUR (capacity utilization) coefficient reports at .26 (Table 6.30, page F-252), hardly a credible outcome in the light of previous studies showing a higher correlation with the autoregressive earnings term. Other sector coefficients fare hardly better, with the Energy sector, for example, reporting negative for the lagged ROA variable, and abnormally–high positives for the CUR and BOND_RAT (Table 6.33, page F-257).

While Arellano & Bond (1991) successfully apply GMM/DPD analysis to estimate employment equations for an unbalanced[169] panel of 140 companies quoted in the London stock exchange, these companies were selected for their test from a single industry group (manufacturing) on the basis of each exhibiting seven continuous years of observations in the period spanning 1976–1984. By contrast, companies in the present sample exhibit earnings observations with much less matching time series dimensions across the respective memberships in each pool[170].

As indicated at the outset, the dearth of adequate time series observations for several companies necessitated pooling in the first instance. It would now therefore appear in sum that the ASX may not be large enough to offer the critical mass that would allow for an adequate number of suitably homogeneous firm/year observations on any specific level of the GIC system that would make for the derivation of usable coefficients under GMM. The level most likely to offer a homogeneous pool for derivation of efficient, consistent, and unbiased coefficients is likely to be the industry level (i.e. one level below the industry group level for which initial estimations were performed using

[169] A panel is unbalanced when its cross sections exhibit missing observations in their time dimensions

[170] This translates to firms having varying numbers of years of earnings data resulting in more observations on some firms than on others that may as well correspond to different points in time

Consumer Services[171]). However, since the industry group level is unlikely to be able to yield usable coefficients (given the results of the Consumer Services estimation), it is unlikely that a lower tier of the GIC, with its corresponding smaller sub–set of the upper–tier membership, can offer the necessary mass to yield usable coefficients.

In this context, it is also noteworthy that the final number of firm/year observations in the respective ASX industry sector level pools comes in below the final quantity of 611 usable observations in the Arellano & Bond (1991) study of 140 manufacturing companies. Significantly, this number is even larger than the total number of observations available *before* outlier attrition from any sector other than the Industrials (with 858 firm/years) and the Materials (with 731).

In the light of the foregoing, there appears to be little alternative to estimating the model for the entire pool of ASX–listed companies[172]. Even though the ASX level pool is more heterogeneous, there is yet a greater likelihood of deriving usable coefficients from a larger pool. The output of this GMM estimation reveals the following (Tables 6.37–6.38: pages F-262 – F-264; Fig 6.10, page F-200):

a) The model yields acceptable coefficients at the $p<.01$ level of significance, with all assumptions satisfied including the Jarque–Bera summary test statistic (=.73 not significant at $p<.10$), the Sargan test statistic (=63.1 not significant at $p<.10$), and the 2nd order autocorrelation of the first differenced residual within the $\pm 1.96/\sqrt{n}$ bound of the ACF.

b) The explanatory power of the model remains high at R sq=0.99.

c) The key coefficients are within range of the credible with (a) the highest coefficient at 0.61 being ROA(-1), a result that appears to fall within reason in

[171] With 51 starting companies at this level, the results of the estimation were inconclusive. The membership at the industry levels are mostly less in number

[172] While the ASX pool would comprise a large enough cross–section, the 12 years earnings and macroeconomic data selected for estimating the model would comprise a limited time series per cross section, a combination that is well suited to panel estimation (Wooldridge 2002). In general, it would appear the time series would need to be of reasonable length, reasonableness dependent upon the number of available observations. Whilst Gaston & Rajaguru (2007) adopt a 20–year period for their study, Arellano & Bond (1991) estimate employment equations using an unbalanced (i.e. unequal number of observations per cross section) panel over a 6 year period. Anderson &Hsiao (1982) show that for fixed time periods, time series regression models yield consistent estimators as the number of cross–sections tends to infinity

light of the autoregressive earnings function in firms (Kormendi & Lipe 1987), (b) the interest rate term, BOND_RAT(-1) in the negative at -0.16 as would be reasonable to expect, and (c) the capacity utilization rate, CUR(-1), at a not unreasonable 0.21.

d) The only unusual result would appear to be the negative coefficient for the profits term, GOS, at -0.05. This might be explained by the fact that, in an Australian context, the annual wage bargaining in a good year in the business cycle would tend to drive down the following year's earnings result on account of a higher wages award granted relative to a 'bad' year in the cycle. The opposite may not always hold true, or at least, not to the same degree, which may explain, at least in part, the relatively low GOS coefficient. This seeming anomaly points to the need for further investigation, which, being beyond the scope of the current research, is briefly addressed in section 5.7, Implications for Future Research.

The positive result from an ASX–wide panel estimation *vis a vis* individual sector–wide estimations may be attributed to the increase in the number of cross–sections under the former to 946 firms[173] and the consequent ability to absorb the rate of outlier attrition that would appear normal to the ASX without undue violation of the external validity (i.e. credibility) of the estimated coefficients. While the 946 original cross–sections eventually reduce by 58% to 393 through attrition, the reduced number is yet, consistent with Anderson & Hsiao (1982) findings, large enough to support consistent estimators relative to what was feasible with the smaller industry group and sector regressions.

The superiority of the GMM estimation over that of OLS/GLS approaches is seen in the panel least squares regression for the ASX–wide pool (Table 6.35 – 6.36: page F-260 – 261; Fig 6.9, page F-199), which while yielding coefficients not too dissimilar to that of the GMM estimation together with tight fit (r^2=.99), yet leads to violations of assumptions[174]. On the other hand, the relative merits of the effective reduction in the

[173] In contrast to the maximum number available on a sector basis, which was 385 firm cross–sections in respect of the Materials sector of the GIC

[174] Jarque–Bera statistic for the null hypothesis of normality rejected at $p < .01$ (Fig 6.9), and first order autocorrelation of the residual exceeding the $\pm 1.96/\sqrt{n}$ bound (Table 6.36). The Durbin–Watson statistic,

pool of companies for purposes of deriving usable coefficients for earnings prediction across a heterogeneous sample from diverse sectors and industry groups is discussed in section 5.6.3, Other Limitations. An alternative GMM approach beyond the scope of the present study is suggested in section 5.7, Implications for Future Research.

A question in regards to the overlap of the chosen period for the estimation (1989–2000) with that of ERP adoption needs to be addressed. Starting from about mid–1992 (when SAP R/3 was announced), ERP began to be increasingly adopted by ASX–listed firms[175], and therefore, the period 1993–2000 for the above estimation overlaps with that of ERP adoption. This does raise a possible question of whether the coefficients estimated from the data would not be biased from the effects of concurrent ERP adoption. Yet, any estimation using data culled from the pre–ERP era is impracticable or will lead to biased coefficients for the following reasons: (a) the unavailability prior to 1989 of some macroeconomic data for a length of time adequate for yielding unbiased estimators[176], and (b) the risk that firm performance prediction using macroeconomic indicator coefficients estimated from prior business cycle data would yield predictions not representative of the business conditions obtained in the 1990s decade and after[177].

4.2.2.2 RESIDUAL DERIVATION

Tables 6.39 – 6.43 (pages F-265 – F-274)present the residuals comprising the difference of the actual earnings return over the return predicted by the model estimated in section 4.1.2.1 for each year of the study for the sample of companies.

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at 1.99, shows near–perfect absence of autocorrelation (Table 6.35) but this is misleading when there is a lagged dependent variable amidst the regressors (Eviews v5.1 User Guide)

[175] The earliest year of adoption in the present sample is 1995

[176] e.g. the capacity utilization rate is unavailable for periods prior to the 3rd quarter 1988

[177] Business cycles vary in their effects on macroeconomic performance parameters (Hall 1990). It is widely reported that the economies of several countries underwent a period of slowed/negative growth during the years straddling the new millennium. In contrast, the mid–90s saw a period of growth. The data for the present study covers the period 1989–2000

4.3 RESULTS

4.3.1 PERFORMANCE RELEVANCE

The performance relevance of ERP adoption is presented across several performance dimensions subsumed in hypotheses 1–6 (Table 3.3). As discussed in section 3.6, the appropriate method for the test of these hypotheses is the paired two sample *t*–test for means. This test differs from the standard *t*–test for comparing two populations in that while the latter is designed for randomly–drawn, independent samples, the former is designed for the matched pairs experiment. While the latter is a test for the difference between the means of two populations, the former tests the mean of the differences between matched members from two populations. The software used for these tests is the MS Excel Data Analysis and Data Analysis Plus modules. While the former provides for the paired two sample *t*–test, the latter allows for the determination if the respective means are significantly different from zero (i.e. the *t*–test of the mean). The output of the former is misleading in that it presents the means, variances, and sample sizes for each population sample instead of the mean, variance, and sample size of the distribution of differences of the matched pairs. However, the *t* statistic and *p* values are valid.

4.3.1.1 <u>TEST OF HYPOTHESIS 1</u>

Hypothesis 1 (section 3.6.2) is unsupported for the complete panel across industry sector/years. The two–sample *t*–test of the mean difference between matched pairs (*p*–value = .13) is insignificant at $p<.05$ test level (Table 6.44, Panel 1: page F-275). The null hypothesis that there is no difference between the two groups of firms in their ratio of SG&A expense to sales revenue is thus supported. The ERP–adopter firm however outperforms the non–adopter by a factor of 10 approximately, on average. It is clear that the variability in the distribution of differences must remain high.

The *t*–tests of the respective means (Table 6.44, Panel 2: page F-275) show that while the mean of the sample of adopter firms (*p*–value = .0) is significantly different from zero at $p < .05$, the mean of the control group of non–adopters (*p*–value = .11) is not significantly different from zero on account of the relatively high level of variability in non–adopter sample. It would seem that this variability renders the results of the *t*–test for the paired differences indefinite.

4.3.1.2 TEST OF HYPOTHESIS 2

Hypothesis 2 (section 3.6.3) is not tested as no firms in the sample have disclosed their gross margins or costs of goods sold[178]. Substituting any unavailable data with the operating expense percent (as indicated in section 3.6.3) would be tantamount to a test of hypothesis 5 for the entire sample of companies. This test is therefore not performed.

4.3.1.3 TEST OF HYPOTHESIS 3

Hypothesis 3 (section 3.6.4) is unsupported for the pool of companies across industry sector/years (Table 6.45, Panel 1: page F-276). The paired two–sample *t*–test of the mean difference is insignificant (*p*–value = .13) at the $p<.05$ level, indicating insufficient evidence to support the alternative hypothesis that ERP–adopter firms exhibit a higher ratio of operating income (EBIT) to sales revenue than non–adopter firms. Even though the ERP–adopter firm outperforms the non–adopter by a factor of 41 approximately, on average, the adopter sample yet exhibits a higher level of variability than the control sample of non–adopters (Table 6.45, Panel 2, page F-276) to permit total confidence in the superiority of their performance over the non–adopter control sample. This test is therefore inconclusive.

4.3.1.4 TEST OF HYPOTHESIS 4

Hypothesis 4 (section 3.6.5) is unsupported for all companies in the sample cross–industry sector/years (Table 6.46, Panel 1: page F-277). The paired two–sample *t*–test for means is insignificant (*p*–value = .49) at $p<.05$, lending strong support to the null hypothesis that there is no significant difference in capacity utilization (asset turnover) between the ERP–adopters and non–adopters. The means of the respective distributions are significantly different from zero at $p<.05$ (Table 6.46, Panel 2: page F-277), allowing greater confidence in the result. Together, they lend strong evidence that ERP adopters do not improve the effectiveness of their operation relative to non–adopters.

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[178] The performance data for the tests are mostly from periods prior to the enactment of the A regulatory requirement for disclosure (in Australia)

4.3.1.5 TEST OF HYPOTHESIS 5

Hypothesis 5 (section 3.6.6) is unsupported for the entire pool of companies across industry sector/years (Table 6.47, Panel 1: page F-278). The paired two–sample *t*–test for means is insignificant (*p*–value = .12) at the p<.05 level, lending support to the null hypothesis that ERP–adopters do not attain to a lower operating expense ratio than that of ERP non–adopters. This result is underlined by the means of the adopter and non–adopter samples being different from zero (*p*–value = .0, in each case) at *p*<.05 level of significance (Table 6.47, Panel 2: page F-278).

4.3.1.6 TEST OF HYPOTHESIS 6

Hypothesis 6 (section 3.6.7) is unsupported for the entire pool of companies across industry sector/years (Table 6.48, Panel 1, page F-279). The paired two–sample *t*–test for mean difference turns out insignificant at *p*<.05 with a *p*–value of .21, indicating wholly insufficient evidence to support the alternative hypothesis that ERP–adopters attain to a better return on capital employed (return on assets) than that of ERP non–adopters.

However, when the test is performed on an yearly basis, years 4 and 5 are significant at p<.05 with *t* stats of -1.81 (*p*–value = .04) and -2.19 (*p*–value = .02) respectively (Table 6.48, Panels 5 & 6: page F-280) indicating that in the later years post–adoption, ERP adopters appear to attain to a better performance relative to capital employed than non–adopter firms.

While the foregoing hypotheses deal with the question of performance relevance of ERP systems, hypotheses 7A, 7B & 7C relates to the question of value relevance of ERP systems adoptions.

4.3.2 VALUE RELEVANCE

Value relevance determines if the share market views ERP adoption to be relevant to enterprise value creation. This is established if one or more of the coefficients of the ERP terms in the following value relevance model are significant (section 3.6.8) —

$$R_t = \beta_0 + \beta_1 ROA_t + \beta_2 ERP.ROA_t + \beta_3 \Delta ROA_t + \beta_4 ERP.\Delta ROA_t + \beta_5 DER_t + \beta_6 ERP + \theta$$

where,

R_t is the share return at time t

ROA_t is the return on assets at time t

ΔROA_t is the actual ROA less its predicted value for time t

DER_t is the debt–to–equity ratio at time t, and

ERP is the characteristic variable for ERP adoption or non–adoption

β_2 is the ERC for the value relevance of ERP as agent for earnings quality improvement

β_4 is the ERC for the value relevance of ERP as agent for earnings innovation,

β_6 is the ERC for the value relevance of ERP as a strategic proposition of value

Accordingly, annual share returns for the pool of 120 firms are initially computed. The 12–month period adopted for the purpose commences upon the expiration of 3 months from the financial year end date for each firm. This three month period is deemed to be the most likely lag period before financial results are publicly available (via annual reports, announcements etc.) and the dividend, if any, is declared (proposed) by the Board. This elected period is supported by precedents in the literature (Cheng, Liu & Schaefer 1996) as well as by relevant dilution factor[179] dates reported in the SIRCA[180] ASX Daily Data database.

4.3.2.1 <u>TEST OF HYPOTHESIS 7</u>

The hypotheses 7A, 7B & 7C (section 3.6.8) are tested on a yearly basis by means of least squares estimations. With respect to year 1 of ERP adoption (Table 6.50, page F-283), all of the three sub–hypotheses remain unsupported given that none of the ERP terms are significant even at $p<.10$. The negative coefficient of the ERP–earnings change interaction term (ERPCHX) relative to the positive and significant (at $p<.10$) coefficient of the earnings change term (CHX) suggests the share market may view that ERP adoption detracts from earnings performance in year 1. This is particularly suggested given the positive and significant (at $p<.05$) coefficient of the earnings change term (CHX) in the regression of share returns on earnings without the ERP interaction terms (Table 6.51, page F-284). However, the *p*–value of the ERPCHX term (*p*–value = .15) is not significant enough even at $p<0.10$ for a provisional conclusion.

[179] Dilution factors are reported for the calculation of the adjusted share return upon such events as dividend declarations, bonus issues, rights issues, share buy backs etc (Bellamy 1998)

[180] Securities Industry Research Centre of Asia–Pacific (SIRCA)

This overall result appears consistent with the result of the *t*–tests in that, despite ERP adopters exhibiting a very positive mean residual ROA (at 14.6%) relative to ERP non–adopters (at -1.7%) (Table 6.49, Panel 1: page F-281), yet the *p*–value of the paired two–sample *t*–test remains insignificant marginally above $p<.10$ (Table 6.48, Panel 2: page F-279), and further, the *t*–test of the mean of both adopters and non–adopters itself is not significantly different from zero (Table 6.49, Panel 1: page F-281). In sum, there is no evidence that ERP is value relevant in the 1st year of adoption.

In year 2 (Table 6.52, page F-285), the ERPCHX term and the CHX term exhibit a similar relationship to that of year 1, with the coefficient of the CHX term of the regression excluding ERP terms (Table 6.53, page F-286) positive and significant at $p<.01$. However, as in year 1, despite the suggestion that ERP adoption detracts from earnings performance, the coefficient of ERPCHX term (*p*–value = .09) is not adequately significant at $p<.05$ for a categorical conclusion. This result appears consistent with the mean residual earning of the adopter sample (Table 6.49, Panel 2: page F-281), which turns out negative and not significantly different from zero at $p<.10$.

However, despite the foregoing, the ERP–earnings interaction term, ERPX, remains positive and significant (*p*–value = .0) at $p<.01$ (Table 6.52, page F-285). This would suggest, in the context of the smaller (negative) and less significant (at $p<.05$) coefficient of the earnings term X (*p*–value = .04), that the market attaches greater credence to, and thus a higher value on the *reported* earnings of ERP adopters over that of non–adopters. It would seem that the earnings of ERP adopters are given a premium value for superior quality. A Wald Test for the sum of the earnings terms X and ERPX being equal to zero (null hypothesis) was not supported at $p<.01$ lending strong support to this position.

The negative coefficient for the ERP characteristic term, ERP, at significance level $p<.01$ (Table 6.52, page F-285), would strongly suggest the market views ERP adoption *per se* negatively value relevant as a strategic proposition for firm value enhancement. This result appears consistent with the negative result for the ERP–earnings change (ERPCHX) interaction since the market is likely to view ERP adoption most value relevant if it can be seen to improve earnings performance appreciably, rather than merely improve strategic value.

Year 3 bucks the trend from years 1 and 2 in that the ERP–earnings change interaction (ERPCHX) is clearly not value relevant, it being not significant (*p*–value = .77) at the

$p<.10$ level (Table 6.54, page F-287). The relationship amongst the CHX terms (Tables 6.54–.55, page F-287–F-288) and the ERPCHX term (Table 6.54, page F-287) underscores the market's apparent lack of confidence in ERP's capacity to deliver improved earnings.

The negative value relevance trend strongly evidenced in the foregoing analyses is further confirmed by the ERP–earnings interaction (ERPX) term relative to the earnings level (X) term (Tables 6.54–.55, pages F-287–288). The coefficient of the former turns *negative* while remaining higher than the coefficient of the earnings (X) term, a notable about turn from year 2. It would appear that in year 3, the market begins to view ERP adoption as detracting from the quality of reported earnings as well.

This overall result would appear consistent with the paired two–sample *t*–test for means which is significant at $p<.10$ (Table 6.48, Panel 4: page F-280) but in favour of non–adopter performance over adopter performance (i.e. a positive *t*–stat at 1.36). The summary conclusion therefore is that ERP adoption is clearly not value relevant to the market in the 3rd year of adoption.

The weakening trend for the ERP–earnings interactive relation is further underscored in year 4 by the relationship amongst the X terms (Tables 6.56–.57, page F-289 – F-290) and the ERPX term (Table 6.56, page F-289). The coefficient of the ERPX term does not remain significant even at $p<.10$ while the coefficients of the X terms themselves are significant. This suggests the market no longer associates ERP adoption with earnings quality over and above that of ERP non–adopter firms. The ERP–earnings change interaction term remains insignificant as in year 3.

The overall result is in contrast to the paired two sample *t*–test for means, significant at $p<.05$ in favour of adopter performance over non–adopter (Table 6.48, Panel 5, page F-280). However, the mean residual earning of the adopter sample being not significantly different from zero at $p<.10$, while the mean residual of the non–adopter sample being significantly different *and* negative at $p<.05$ (Table 6.49, Panel 4, F-282), would appear to suggest that relative better performance of the ERP adopter sample is not the result of clear positive earnings performance (i.e. improvement), but rather the result of a weakening of performance on the part of the non–adopters *vis a vis* their year 3 result.

Year 5 (Table 6.58, page F-291) appears to present an anachronistic result in that while the paired two–sample *t*–test for means is significant in favour of adopters at $p<.05$

(Table 6.48, Panel 6: page F-280), and the *t*–test of the adopter sample mean residual is positive and significant at $p<.05$ while that of the non–adopters is negative and not significant at $p<.10$ (Table 6.49, Panel 5: page F-282), the share market appears not to accord any value to these very positive results as evidenced by the significance levels of the ERP terms of the regression results for year 5 (Table 6.58, page F-291).

In sum, it would appear that, despite some limiting evidence of market expectation in adoption year 2[181], the market is less than enthusiastic of the positive effect of ERP implementations on firm performance. This is particularly evidenced by the earnings change interaction term, ERPCHX, turning out consistently negative or non–significant at $p<.10$, in the context of the consistently positive and significant (at $p<.10$) earnings change term, CHX. Table 4.1 gives a summary of the findings for the 3 hypotheses across the 5 years post adoption.

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[181] i.e. ERPX positive and significant at $p<.01$, ERPCHX negative and marginally significant at $p<.10$, and ERP negative and significant at $p<.01$

TABLE 4.1 ARE ENTERPRISE RESOURCE PLANNING INFORMATION SYSTEMS SHAREHOLDER VALUE RELEVANT?

Value Relevance Hypotheses:

7A *The coefficient of the interaction between the empirical indicator for the earnings level variable and the empirical indicator for the ERP implementation variable* (i.e. ERPX) *is significantly greater than zero.*

7B *The coefficient of the interaction between the empirical indicator for the earnings change variable and the empirical indicator for the ERP implementation variable* (i.e. ERPCHX) *is significantly greater than zero.*

7C *The coefficient of the ERP–implementation empirical indicator* (i.e. ERP) *is significantly greater than zero.*

	YEAR OF ADOPTION				
Hypothesis	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
7A	**Not Supported**	**Supported**[1]	**Not Supported**	**Not Supported**	**Not Supported**
7B	**Not Supported**	**Supported**[2]	**Not Supported**	**Not Supported**	**Not Supported**
7C	**Not Supported**	**Supported**[3]	**Not Supported**	**Not Supported**	**Not Supported**

[1]Coefficient (ERPX) significant and positive at p<.01
[2]Coefficient (ERPCHX) significant and *negative* at p<.10
[3]Coefficient (ERP) significant and *negative* at p<.01

4.4 CHAPTER SUMMARY

The chapter reported the data analysis and results. The chapter commenced with an analysis of the macroeconomic variables associated with the business cycle to determine key factors underlying economic productivity expected to influence enterprise performance. These factors were identified as a business activity factor represented by the capacity utilization rate, a monetary factor represented by interest rates, and a profitability factor represented by operating surpluses in the economy. These factors together with a lagged earnings factor, estimated via an autoregressive earnings function, were subjected to a panel data regression under GMM that showed all factors were, in general, significant to firm earnings performance across ASX–listed companies. The coefficients of the model were then adopted for firm earnings prediction with the residual of actual earnings over predicted extracted for further analysis. The latter analysis revealed a trend over the 5–year post–adoption period that showed that while firms that adopt ERP systems perform progressively better on residual ROA than firms that do not, such performance is nevertheless not significantly better in the earlier years, and in consequence, despite optimism in the first full year of ERP–adoption, the market remains relatively unmoved with the eventual result.

5. CONCLUSIONS AND DISCUSSION

5.1 INTRODUCTION

Uncertainty surrounding the value delivered by information technology innovations has long remained a central problem in informing IT governance decisions on technology resourcing of information production. The uncertainty derives from the inadequacy of conventional value–quantification approaches to *ex ante* quantify the value of a proposed IT initiative at firm level coupled with the lack of a proper system for evaluation *ex post*. Chapter 1 reviewed these issues.

Enterprise Resource Planning is purported to be the one information product that supports resource planning and control, and therefore, the one IT innovation with arguably the greatest revolutionary impact on enterprise management. This dissertation examined whether there is evidence that adoption of ERP leads to improved firm performance and value. The results suggest a long lead time between the announcement of the implementation of an ERP system and positive performance effects. The results further suggest that the market reaction to the improved performance does not fully reflect the improvement associated with ERP adoption.

Two separate tests of the effects of ERP on performance were performed. The first test assesses the impact of ERP systems adoption on operating performance. The second assesses the value relevance of the changes in operating performance. This second test deals with market perceptions of the changes brought about through ERP adoption.

The results of the first test are broadly consistent with prior research. While the second test's results are somewhat at variance with those of the first test, they are nevertheless consistent with the results of a very recent study performed with a completely different research design (Hendricks, Singhal & Stratman 2007).

This chapter addresses the contribution from this research to our understanding of the impact of ERP on practice, research, and education, as well as the limitations of this research. The chapter is organized as follows: section 5.2 summarises the theory and research design. Section 5.3 summarises the results of tests of hypotheses. Section 5.4 discusses these results in terms of their implications for the research question. Section 5.5 identifies the contributions of this study to the research and practitioner communities. Section 5.6 addresses the limitations of this study. Section 5.7 discusses the implications for future research, and section 5.8 summarises the chapter.

5.2 THEORY DEVELOPMENT AND HYPOTHESIS FORMULATION

The theory for the effect of ERP on firm operating performance derives from transaction cost theory of the firm. The latter theory states that as firms expand operations, the cost of transacting internally exceeds the cost of transacting in the open market and the losses through waste of resources exceed the marketing costs of the transaction in the open market. While the former stems from inefficiencies in planning, adapting, and monitoring task completion, the latter stem from the failure to place factors of production in the uses where their value is greatest. Thus, both efficiency and effectiveness are increasingly impaired with growth, and in consequence, firms require organizational and management innovations that promote efficiencies in task completion and improvements in resource utilization. ERP proponents would argue that ERP delivers the required innovation that improves efficiencies of operation and effectiveness of managerial decision–making in the face of burgeoning complexity. Chapter 2 developed the theory to show ERP is an organizational and management innovation that would improve management decision–making. The theory presented was supported with empirical evidence from the literature.

The theory states that firm performance is a direct result of the effectiveness of decision–making. Decision–making is enhanced in complex environments by the provision of relevant and reliable information. The theory states that ERP systems deliver decision relevant information that improves decision–making and therefore performance. The main propositions of the model issue from this theory.

The test of the model was based on two broad measures of performance, accounting measures and market measures. Accordingly, two experiments were designed to test the proposition that ERP improves performance. A matched pair design was used in both experiments to isolate the impact of ERP.

Experiment 1 measured firm performance using 5 accounting measures: selling, general, and administrative expenses, earnings before interest and tax, asset turnover, operational expense, and return on assets.

The test of ERP's effect on return on assets is the stronger of the tests. It proceeded in two stages. In the first stage, ROA was forecast from prior ROA (random walk design) and macroeconomic factors that impact the business cycle. To this end, the latter was first derived from a factor analysis of macroeconomic variables identified in previous research[182]. An autoregressive earnings function was then modelled with lagged ROA and business cycle indicator terms. The coefficient estimates from this model was then applied to the earnings and macroeconomic indicator variables to obtain the ROA forecast for each firm. By subtracting the forecasted ROA from the actual ROA of a period, firm–unique abnormal performance was identified using the same underlying principles used in financial accounting studies such as Ball and Brown (1968). The portfolio of ROA residuals from ERP adopters should not differ from those of non–adopters unless ERP has an effect. In the second stage, a paired two–sample *t*–test for the mean difference in residuals between adopters and non–adopters was performed to test the corresponding hypothesis 6 (Table 5.1).

Experiment 2 measured the market's perception of the impact of an ERP. Specifically, the research tested the impact of an ERP system on share returns of ERP adopters. The Easton and Harris (1991) share returns model was adapted for the purpose. A 'slope dummy' (or characteristic variable) was specified as a measure of ERP impact on the market's response to earnings. The dummy variable was also used to determine if ERP was value relevant in its own right. This experiment was based in capital market theories of firm value, primarily the Efficient Markets Hypothesis and the share returns/valuation models (Easton & Harris 1991; Ohlson 1995) that derive from it.

An ERP Value Relevance Model was thus estimated with share returns as the dependent variable and terms to represent the independent variables, ROA, residual ROA, ERP interaction with ROA, ERP interaction with residual ROA, ERP adoption (*per se* as a possible value relevant characteristic variable), and financial leverage. While the Easton and Harris (1991) model uses net earnings and earnings changes scaled by beginning–period share price as the key independent variables, this study uses a before–tax measure of earnings scaled by assets (i.e. ROA) and the residual change in earnings

[182] The macroeconomic factors affecting the business cycle turned out to be a business activity factor, an interest rate factor, and a profits factor

scaled by assets. The leverage variable (Debt/Equity) was included to make the model more complete as well as to reconcile it to its progenitor, the Easton and Harris (1991) model. The resulting hypothesis 7 is listed in Table 5.1.

5.3 SUMMARY OF THE RESULTS

Column 1 of Table 5.1 presents the seven propositions derived from the theory presented in chapter 2. Column 2 presents the hypotheses developed in chapter 3 from the propositions and the (chapter 3) research design. Column 3 presents the results of the tests of hypotheses reported in chapter 4.

TABLE 5.1 SUMMARY OF PROPOSITIONS, HYPOTHESES, AND RESULTS

Proposition	Hypothesis	Result	Comment
Proposition 1: *ERP–adopter firms attain a reduction in the proportion of transaction cost to production cost relative to non–adopter firms.*	**Hypothesis 1** *ERP–adopter firms exhibit a lower ratio of SG&A to Sales Revenue relative to non–adopter firms.* $H1_0: Z_d \leq 0$ $H1_1: Z_d > 0$	**Table: 6.44** *<u>Years 1-5 pooled</u>* *$H1_0$: Accepted* *$H1_1$: Rejected*	Period–wise tests give similar results.
Proposition 2: *ERP–adopter firms derive a lower cost of goods sold relative to non–adopter firms.*	**Hypothesis 2:** *ERP–adopter firms exhibit a lower ratio of COGS to Sales Revenue relative to non–adopter firms.* $H2_0: Z_d \leq 0$ $H2_1: Z_d > 0$	Not tested due to unavailability of cost of goods sold data in company annual reports	
Proposition 3: *ERP–adopter firms achieve higher earnings relative to non–adopter firms.*	**Hypothesis 3:** *ERP–adopter firms exhibit a higher ratio of EBIT to Sales Revenue relative to non–adopter firms.* $H3_0: Z_d \geq 0$ $H3_1: Z_d < 0$	**Table: 6.45** *<u>Years 1-5 pooled</u>* *$H3_0$: Accepted* *$H3_1$: Rejected*	Period–wise tests give similar results.

TABLE 5.1 (CONT.) SUMMARY OF PROPOSITIONS, HYPOTHESES, AND RESULTS

Proposition	Hypothesis	Result	Comment
Proposition 4: *ERP–adopter firms improve capital utilization relative to non–adopter firms.*	**Hypothesis 4:** *ERP–adopter firms exhibit a higher ratio of Sales Revenue to Total Assets Employed relative to non–adopter firms.* $H4_0: Z_d \geq 0$ $H4_1: Z_d < 0$	**Table: 6.46** *Years 1-5 pooled* *$H4_0$: Accepted* *$H4_1$: Rejected*	Period–wise tests give similar results.
Proposition 5: *ERP–adopter firms attain a reduction in their operating expense relative to non–adopter firms.*	**Hypothesis 5:** *ERP–adopter firms exhibit a lower ratio of Operational Expense to Sales Revenue relative to non–adopter firms.* $H5_0: Z_d \leq 0$ $H5_1: Z_d > 0$	**Table: 6.47** *Years 1-5 pooled* *$H5_0$: Accepted* *$H5_1$: Rejected*	Period–wise tests give similar results.
Proposition 6: *ERP–adopter firms attain a better performance relative to capital employed than non–adopter firms.*	**Hypothesis 6:** *ERP–adopter firms exhibit a higher ROA than non– adopter firms.* $H6_0: Z_d \geq 0$ $H6_1: Z_d < 0$	**Table: 6.48** *Years 1,2,3* *$H6_0$: Accepted* *$H6_1$: Rejected* *Years 4,5* *$H6_0$: Rejected* *$H6_1$: Accepted*	

TABLE 5.1 (CONT.) SUMMARY OF PROPOSITIONS, HYPOTHESES, AND RESULTS

Proposition	Hypothesis	Result	Comment
Proposition 7: *ERP implementations are shareholder value relevant.*	**Hypothesis 7A:** *The coefficient of the interaction between the empirical indicator for the earnings level variable and the empirical indicator for the ERP implementation variable is significantly greater than zero.* H7A$_0$: $\beta_2 \leq 0$ H7A$_1$: $\beta_2 > 0$	**Tables: 6.50 – 6.59** <u>*Years 1,3,4,5*</u> *H7A$_0$: Accepted* *H7A$_1$: Rejected* <u>*Year 2*</u> *H7A$_0$: Rejected* *H7A$_1$: Accepted*	Year 2 coefficient positive and significant at $p<.01$, whilst the earnings level term x is negative and significant. This would appear to indicate the market places value on earnings quality in year 2 as a result of ERP adoption.
	Hypothesis 7B: *The coefficient of the interaction between the empirical indicator for the earnings change variable and the empirical indicator for the ERP implementation variable is significantly greater than zero.* H7B$_0$: $\beta_4 \leq 0$ H7B$_1$: $\beta_4 > 0$	**Tables: 6.50 – 6.59** <u>*Years 1,3,4,5*</u> *H7B$_0$: Accepted* *H7B$_1$: Rejected* <u>*Year 2*</u> *H7B$_0$: Rejected* *H7B$_1$: Accepted*	Year 2 coefficient negative and significant at $p<.10$, whilst the earnings change term is positive and significant. This would appear to indicate the market places negative value on ERP–engendered earnings change in year 2.

TABLE 5.1 (CONT.) SUMMARY OF PROPOSITIONS, HYPOTHESES, AND RESULTS

Proposition	Hypothesis	Result	Comment
	Hypothesis 7C: *The coefficient of the ERP implementation empirical indicator is significantly greater than zero.* $H7C_0$: $\beta_6 \leq 0$ $H7C_1$: $\beta_6 > 0$	**Tables: 6.50 – 6.59** *Years 1,3,4,5* *$H7C_0$: Accepted* *$H7C_1$: Rejected* *Year 2* *$H7C_0$: Rejected* *$H7C_1$: Accepted*	Year 2 coefficient negative and significant at $p<.01$. This would appear to indicate the market places negative value on ERP as a strategic value relevance proposition in itself.

Hypotheses 1, 3, 4 & 5 were rejected for the 5–year pooled sample of firms. In essence, ERP adopters do not exhibit lower selling, general and distribution (SG&A) expenses relative to non–adopters over the test period. They do not exhibit higher earnings, higher capital utilization, or lower operating expenses to sales relative to non–adopters.

Hypothesis 6 was likewise rejected. However, testing on a yearly basis resulted in years 4 and 5 being significant at $p<.05$. On a yearly basis, therefore, hypothesis 6 is rejected in years 1, 2 and 3, and accepted in years 4 and 5. Hypotheses 1–6 represent performance relevance of ERP adoption.

Hypothesis 7, the value relevance hypothesis, is rejected in years 1, 3, 4 and 5. It is supported in year 2. In year 2, the ERP interaction with earnings is significant at $p<.01$. The ERP characteristic term is significant also at $p<.01$, but with a negative sign indicating negative value relevance to share returns. The ERP interaction with earnings change is likewise negative with a significance level $p<.10$. The propositions, corresponding hypotheses, and test results are summarised in Table 5.1.

5.4 DISCUSSION AND IMPLICATIONS

The test of hypothesis 6, the stronger of the tests under experiment 1, was significant and *negative* [the positive *t*–stat of 1.36 (*p*–value = .09) favours non–adopter performance] at $p<.10$ level in year 3, and significant and *positive* at $p<.05$ in years 4 and 5 (*p*–value = .04 and .02 respectively). The finding with respect to years 1 and 2 is broadly similar to that of the first published study of the financial effects of ERP adoption. Poston and Grabski (2000; 2001) found no improvement in a measure of income[183] in each of three years following ERP implementation. The significant and negative result with respect to year 3 corresponds with a finding that ERP adopters performed significantly worse at $p<.01$ in the 2nd year after completion of implementation[184] (Nicolaou 2004). In addition, there is evidence to indicate that the significant finding with respect to year 4 is more the result of a decline in non–adopter

[183] Residual Income—defined as net operating income less imputed interest

[184] The 2nd year after completion in the Nicolaou study roughly corresponds to the 3rd year of adoption in this study. The present study labels the year of commencement of ERP adoption as year 1 and the Nicolau study finds the average time for completion to be 9.92 months

performance than the result of genuine improvement in adopter performance, a finding that is similar to that of Hunton, Lippincott & Reck (2003). Despite the foregoing however, the general trend in residual ROA is an improving one for ERP adopters that turns significant in the later years of adoption. Year 5 in particular gives significant results for both the paired two–sample test of mean difference, and the *t*–test of the mean. The overall result remains broadly consistent with that of a recent study[185].

The rest of the tests under the 1st experiment, the tests of hypotheses 1, 3, 4 and 5[186], are tests of the components of ROA. They were however not significant. This could be due to the lack of power or efficiency in the experimental design in that movements in these variables other than from the effects of ERP were not isolated to derive a residual corresponding to the ROA residual. Nonetheless, it would appear that survey–based and observational studies in the US manufacturing sector (Mabert, Soni & Venkataramanan 2003; Stratman 2001) cited in recent research (Hendricks, Singhal & Stratman 2007) find little evidence of improvements in operational metrics and costs consequent to ERP adoption. In contrast, an Australian study finds evidence of improvements in operational metrics, particularly asset turnover ratios (Matolcsy, Booth & Wieder 2005). The inability to test for hypothesis 2 prevents a complete understanding of what could well be the probable factor behind superior residual ROA performance: namely, that the improvement in ROA residuals is related more to the improvement in gross margins from a reduction in the COGS than to the other components of ROA comprised in the tests of hypotheses 1–5.

This would appear to be of particular interest since COGS is impacted by the supply chain, and improvements along the supply chain will reduce the cost of goods sold. The theory development in chapter 2 noted that superior performance of ERP adopters are likely to derive more from supply chain improvements rather than from other parts of the enterprise operation[187]. Nonetheless, given gross margins are subsumed in EBIT, and the latter as well as asset turnover turned out non–significant in this study on a yearly basis as well as on a pooled basis across the 5 years of the study, it is suspected

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[185] This study (Nicolaou 2004) uses the differential ROA performance between adopters and non–adopters pre– and post–adoption as their measure of ROA residual

[186] Hypothesis 2 was not tested for lack of relevant data (section 4.2.1.2)

[187] In this connection, it is of interest that adoption of Supply Chain Management systems are associated with superior profitability whereas

that residual ROA components would provide a more representative system of measurement to correspond with a residual ROA computation. It is pertinent in this regard, that the pooled ROA computation across the 5 years of the study turned out non–significant.

The overall finding from the tests of hypotheses under experiment 2 is that in general, ERP adoption is not viewed by the market as value relevant across the 3 value relevance dimensions tested under hypothesis 7. The 1st dimension, the subject of hypothesis 7A, tests for the significance of ERP adoption to reported earnings. It effectively addresses the question, "Is ERP adoption significant to market perception of the reliability of the reported earnings of firms?" The answer is in the negative for all years other than year 2.

The 2nd dimension, the subject of hypothesis 7B, tests for the significance of ERP adoption to the abnormal earnings achieved by firms. It addresses the question, "Is ERP adoption significant to market perception of abnormal earnings of firms?" The answer is negative for all years with the exception of year 2.

The 3rd dimension, the subject of hypothesis 7C, tests for the significance of ERP adoption in itself to the value of the firm. It addresses the question, "Is ERP adoption significant to market perception of the value of the firm?"

The significant result in year 2 across all of the three dimensions and the non–significant results in the years 3–5 indicate that the market reacts only when the news of ERP adoption initially permeates the market[188]. This is particularly indicated by the result for the test of hypothesis 7B, the market response to abnormal earning (or residual ROA), which turns out significant, albeit at $p<.10$, while the paired two–sample *t*–test for the mean difference of residual ROA between adopters and non–adopters is not significant at $p<.10$ (hypothesis 6).

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[188] This news, barring any announcements—which are not altogether the norm judging by the limited number of Signal G listings with ERP adoption information filed with the ASX—is likely to be first reported in the year 1 annual report. Presumably, in year 1 itself, the year of ERP adoption, the news does not register in the market given that the significance of this information may not be immediately clear (the market is not likely to have prior knowledge of the significance of ERP adoption). The information likely percolates market thinking in the course of year 2. Further, year 1, being the year of adoption, does not feature a full year of post–ERP–adoption operation, and therefore, ERP adoption is relatively new and need not necessarily be significant to the financial result

The market's lack of enthusiasm for ERP adoption is even more striking in years 4 and 5. This is in view of the fact that these are the *only* years that the paired *t*–test for the mean difference of residual ROA between adopters and non–adopters is significant (p<.05).

These results would appear to suggest that the market, after a period of initial interest over the presumably hyped–up news of ERP adoption, becomes quickly disillusioned with the lack of evidence of improved performance in the financial results of years 2 and 3[189], and as a consequence does not react to improvements in years 4 and 5. The alternative scenario is that ERP adoption is simply not seen as the cause for the improved results in these years. If however the Efficient Markets Hypothesis is efficient in explaining market behaviour in normal times, this would seem wholly unlikely.

These findings are however not inconsistent with previous (short time–window) event studies that found capital markets react positively to announcements of ERP adoption (Hayes, Hunton & Reck 2001; Hunton, McEwen & Wier 2002); and that ERP adopters are consistently rewarded by financial markets both during and after implementation despite dips in performance and productivity immediately following adoption (Hitt, Wu & Zhou 2002).

The overall findings of this research are broadly consistent with the findings of the only other identified published study of the comprehensive performance effect of ERP adoption over an extended period of 5 years (Hendricks, Singhal & Stratman 2007). Using a totally different research design and method, Hendricks *et al* find no evidence of abnormal profit performance over the pooled 5–year period of adoption, a finding consistent with this study. However, in direct contrast to this research, they find abnormal, positive performance for the pooled 2–year implementation period and none for the pooled 3–year period after. The findings in this study give positive, significant performance in years 4 and 5 and none in the earlier years. It is possible however that

[189] The coefficient of the ERP–earnings change interaction term is negative in year 2, indicating that share returns are depressed in consequence of ERP's effect on changed earnings levels of firms. In year 3, the paired *t*–test for the mean difference of residual ROA between adopters and non–adopters is significant at p<.10 in favour of non–adopters, showing that in year 3, adopters fare significantly *worse* than non–adopters

the pooling of their performance data into two periods has averaged their results. A yearly analysis might have shown a result more consistent *vis a vis* the present study.

Their findings on share return performance are more interesting. They find abnormal, significant, negative returns in the pre–implementation period. This is generally consistent with the findings of this research for year 2, which gives two negative and significant results for ERP's interaction with the ROA residual and for ERP adoption as a substantive value relevant event in itself. Conversely, they find abnormal, significant, and positive returns in the post–implementation period. They conclude that there is no evidence of improvements in performance on the basis that only a statistically insignificant proportion[190] of their sample firms perform better than the median (negative) stock return of the matched portfolio group. Since they appear to use this second test as a qualifier on the results of their first test, it might be inferred that, in general, ERP adopter firms in their sample perform no better than non–adopter firms even if a small proportion of their adopter sample must obtain very high abnormal returns. Given that their study was conducted on a larger sample of 186 firms drawn from the wider US market, these results would appear to confirm the findings in this research.

5.5 CONTRIBUTION

The *raison d'etre* for a company listed on an exchange is to provide a return to their shareholders for their investments in the enterprise. The return is commensurate to the value added to the investments by the business operations of the enterprises. The true measure of value of an enterprise initiative is therefore the return consequent to that initiative. This research shows that it is possible to assess the value of an initiative by estimating the market's response to that initiative.

5.5.1 CONTRIBUTION TO PRACTICE

Specifically, this research showed that it is possible to determine the value of the ERP initiative by observing the market's response to the interaction between ERP and ROA on the one hand, and between ERP and the ROA residual on the other. The two interactions give two different perspectives to the market's response: the former speaks

[190] Fifty one percent

to the improvement, if any, to the quality of the earnings reported by the enterprise, while the latter informs the significance of the initiative to the residual above–normal earning for the enterprise. This information gives meaning to the value estimation of an ERP initiative in a way that no other method can.

Further, to determine the residual, it was first necessary to forecast the ROA of firms by deriving their autoregressive earning function and factoring it with the effects from the wider economy. This research demonstrated that, in order to understand the true impact of an information system such as ERP, it is first necessary to control for the influence of the economy on performance, and that it is possible to do so.

At a methodological level therefore, the method used in this study can be applied to any system, technique or managerial aid that purports to improve operating performance. It may be applied to determine the value of an Activity–Based Costing initiative, a Balanced Scorecard approach to determining and developing strategy and/or controlling operations, Value Based Management and Economic Value Added, a Total Quality initiative, Just–in–Time techniques, flexible manufacturing, or any other system, method, or aid developed to improve performance. It may be applied thus to derive the value contributed by the initiative to the enterprise and its stakeholders.

5.5.2 CONTRIBUTION TO RESEARCH

In financial accounting research, Ball and Brown (1968) pioneered the computation of cumulative residuals for the determination of the share market's response to reported accounting income numbers. No previous research would appear to have attempted to evaluate a residuals method to management accounting numbers[191]. This research demonstrated a residual computation method for ROA and related the computed residual to share market performance. This research has demonstrated that the residual so computed was significant to determining share returns in every one of the five years of the study. Hence, it has made a significant methodological contribution to research.

The effect of the macro economy on performance only appears to have been hinted at or alluded to in previous research. It would seem no method has yet been systematically

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[191] A residual analysis method has been developed and presented in the context of contingency studies in management accounting (Duncan & Moores 1989). However, it does not appear any method has been *directly* applied to management accounting numbers in the research literature

developed to control for these effects. This research has demonstrated a method for determining the key macroeconomic factors that affect enterprise performance. This research contributes to both theory and method relating to macroeconomic influences on firm performance.

For the foregoing reason and for the reason that it would appear to be one of the first management accounting studies that draws on stock market data, this research has made a significant methodological contribution to Economic Management Accounting Research, which appears to be increasingly focussing on published enterprise information (Bromwich 2007).

Previous research has not attempted to develop a theory for the performance relevance of ERP to enterprise operations. This research develops the theory for ERP's performance relevance by comprehensively qualifying it as a management and organizational innovation that meets the criteria for enterprise continuance implicit in Ronald Coase's monograph, "The Nature of the Firm" (1937). As a consequence, this research makes an original contribution to the theory of ERP.

There currently is a dearth of management accounting research using archival data outside the executive compensation field (Moers, 2007). This research answers the call for this type of research.

It also answers the call for more cross–disciplinary research in management accounting (Moers 2007). This research straddles the interface of management accounting, information systems, and finance. It analyses ERP's potential contribution to firm growth by developing a theory for its ability to dismantle the barriers to firm growth as propounded in Ronald Coase's theory of the firm (1937). It thus develops a theory as to why ERP systems meet Coase's first and second limitations to firm growth. It further proceeds to test the theory by specifying an experiment that draws upon macroeconomic and capital market theories in Economics and Finance.

In performing the experiment to test the value relevance of ERP and obtaining results that would appear to demonstrate a reasonable level of generalizability vis a vis the findings of Hendrick *et al* (2007), it demonstrated a method for testing value relevance of any management accounting initiative eg. the method could be adapted for testing the value relevance of Balanced Scorecards, Value–based Management, Activity–based Costing and a host of other management–oriented systems.

Moers suggests the use of data sources beyond published financial data. This research may be amongst the first management accounting studies to draw from sources other than financial data. It may also be seen to make a contribution to the 'Decision Facilitating' stream, which focuses on the use of tools and information for decision–facilitating purposes (Moers 2007). It may also contribute to information economics research, which has shifted away from the operational research theme of seeking the optimal information system (section 1.2) to "… trying to understand the reasons for and consequences of using different information systems …" (Bromwich 2007, p. 152).

5.5.3 CONTRIBUTION TO EDUCATION

In business studies in general and information technology management education in particular, there is a general lack of awareness of the importance of determining the proper value of enterprise initiatives. This research underscores the importance of this issue and presents a methodology for evaluating the value relevance of enterprise initiatives. Further, it heightens awareness that major projects cannot but be evaluated in the long–term and gives an appreciation of the length of time that is needed for evaluating the performance effects of IT initiatives.

5.6 LIMITATIONS

5.6.1 EXTERNAL VALIDITY

The research method employed in this thesis belongs in the class of field study methods with archival data (Brownell). In contrast to the laboratory experimental method of research, the field study method "… does not identify families of research designs or systematic procedures for the assessment of internal and external validity and reliability" (Brownell, p59). The examination of the question of external validity in this research therefore proceeds along the lines laid out for laboratory experimental research (Whitley jnr. 2002).

External validity is analysed with reference to the twin aspects of generalizability and ecological validity. While the former represents generalizability *across* different research structures, the latter represents generalizablitity *to* the population of interest (Whitley jnr 2002).

5.6.1.1 GENERALIZABILITY

Generalizability addresses the obtainability of the same or similar findings for different populations of interest and/or in different research settings (laboratory or field) and/or using different research procedures (method and design), and/or using different units of analysis. It examines if any variations in the structure have led to different findings (Whitley Jr. 2002).

The only other identified ERP research study that uses a different structure is Hendricks *et al* (2007). They examine the changes in long–term financial performance consequent to ERP adoption announcements of 186 firms listed on US stock exchanges. They operationalize abnormal performance for a single firm by deriving a benchmark performance criterion in a matching portfolio of firms. The matching is by prior performance rather than by industry/size. Their broadly similar conclusions (section 5.4) using different research procedures for a different population of interest would seem to offer a measure of external validity to the results of the present study.

5.6.1.2 ECOLOGICAL VALIDITY

Ecological validity focuses on the similarity between a study and the natural setting to which the results of the study will be applied. It examines the match between the research structure and its natural setting, as well as the similarity of the issues addressed in the study and those of importance in the natural setting. In sum, ecological validity addresses the applicability of the results to the population of interest (Whitley Jr. 2002).

The natural setting for this study is the Australian stock market. The experimental units are derived from the listed companies in the ASX. The study is conducted with "live" archival data naturally created by the experimental units. The results of the study therefore apply to the population of companies listed in the ASX.

The results of the study do not apply to enterprises not listed in the ASX. These include sole proprietorships, partnerships, unlisted companies, and governmental authorities at the local, state, and commonwealth (federal) levels. They also do not apply specifically to firms listed in other stock markets, although the generalizability of the results is strengthened by the Hendricks *et al* (2007)findings.

The results are particularly relevant to ASX–listed companies because the experimental group is drawn from all industry sectors of the ASX other than the Finance sector[192]. The value of information technology investments is increasingly becoming a moot topic in corporate governance forums across the world. By addressing the value relevance of a key information technology initiative of the past decade and a half, this research strengthens the ecological validity of its findings because it addresses a topic held to be important in its natural setting.

Nevertheless, the study exhibits a single key limitation. The thinness of the Australian market necessitated the estimation of coefficients for the ROA estimator model for each firm using ROA data from the wider pool of ASX–listed companies. The more appropriate approach would have been to use data at the industry group level, if not the industry or firm level. However, the number of available firms was not adequate to offer the critical mass needed to derive usable Generalized Method of Moments estimators even at the industry group level. To what degree the results obtained may be distorted and therefore not reflected in the population of interest is not knowable. It is possible that in a larger market such as the US, more representative coefficients would be obtainable at the industry group level, if not the industry or firm level for a better model test.

5.6.2 INTERNAL VALIDITY

The study of ERP's value relevance was conducted with a natural experiment[193]. It was thus not possible to test for causal relations between the predictor variable (ERP adoption) and criterion variable (share return) through the standard research method for testing causality. The method requires (a) random assignment of experimental units (firms) to treatment and control conditions (b) experimenter manipulation of the predictor variable, and (c) control of extraneous factors that may confound the predictor variable's effect on the criterion variable (Judd, Smith & Kidder 1991; Whitley Jr. 2002). Normatively, a natural experiment is no more than a co–relational study (Whitley Jr. 2002).

[192] The Finance sector was left out of the study because the peculiarities pertaining to the Finance industry operations is considered to distort the study

[193] A natural experiment differs from the laboratory experiment in that a naturally–occurring event outside the experimenter's control determines the treatment condition (Whitley jnr. 2002). The "naturally occurring" event in this study is ERP adoption by firms.

Causality however can be imputed if the experiment is designed to compensate for lack of randomization. The design prescribed is the Group Comparison Approach, most commonly fulfilled by Non–equivalent Control Group Design[194] (Whitley Jr. 2002).

To make possible the inference of causality the design must control for (a) pre-existing differences between treatment and control groups that may differentially affect the criterion variable and thus confound the predictor variable's effect, and (b) bias in selecting experimental (treatment) and/or control units (Whitley Jr. 2002).

(a) Pre–existing difference—

Risk and earnings growth differentials have been traditionally identified as the pre–existing differences between firms that could vitiate comparability (Alford 1992). Pre–adoption differences in business risk and growth rate could be expected to lead to distortion of post–adoption relative ROA performance. Likewise, differential financial risk and growth would be expected to distort relative share returns performance[195].

<u>Differential risk</u>

Two measures of control for differential risk are adopted in this research. Firstly, a leverage term is introduced into the share returns regression model to control for the financial risk differential[196]. Secondly, matching of firms on size within industry is performed to control for the business risk differential.

Firms in the same industry could be expected to experience similar business risk. Firms of like size in the same industry would be expected to be business risk equivalent[197]. Industry/ size matching is commonly adopted in the literature for controlling risk–related confounds (Alford 1992; Cheng & McNamara 2000).

Size matching within industry matching could not be rigorously observed in the present study on account of the insufficiency of firms of matching size ranges. Alford (1992)

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[194] Non–equivalency refers to the lack of randomized design

[195] Owing to the effect capital gearing has on equity profits

[196] This leverage turned out insignificant to the share return, a result which appears to accord with the Alford (1992) finding that adjusting for differences in leverage between matched firms leads to less accurate P/E multiple estimates

[197] Alford (1992) uses size as a risk surrogate

however shows that the industry membership serves as a sufficient surrogate for risk and earnings growth in deriving valuation multiples (such as the P/E ratio), with size surrogating risk. The sufficiency improves with increasing size (or risk). Cheng & McNamara (2000) find that industry membership and earnings growth (surrogated by ROE) give the best results in valuing comparable firms. Hendricks *et al* (2007) find that for the matching of firms on prior ROA performance, prior size matching within industry gives results similar to industry matching alone.

These diverse studies would suggest that size mismatches may not be a significant threat to internal validity when controls for the other pre–existing differences are present. To the degree that size mismatches may yet be significant enough to constitute an internal validity threat, the present research controlled for size–related effects (i.e. business risk differentials) by scaling the earnings variables in the regression models by total assets. It was expected that such scaling would make for more accurate results through controlling for heteroskedasticity in the residuals.

Differential earnings growth

Differential earnings growth rates between firms are not explicitly controlled for in this research. Matching of firms on prior ROA performance[198] was not attempted given the constraint of limited industry group representation of firms in the Australian stock market. In their search for appropriate matches amongst firms listed in the US stock exchanges, Hendricks *et al* (2007) appear to have found it necessary to subordinate the industry control to the prior performance (ROA) control. While this results in a comparison group not consistently matched on the industry parameter, it gives added context to the difficulty in finding proper matches in the much smaller Australian market.

Furthermore, this method of seeking out matching firms would risk internal validity issues in that the matched firms may not exhibit their normal ROA performance in the year of matching. Post–adoption "Regression toward the mean" (Whitley Jr. 2002, pp. 162-3) becomes a clear possibility with the consequent confound to ERP's effect on performance. Since previous research has shown that industry matching alone is yet equivalent to risk and earnings growth matching (Alford 1992; Cheng & McNamara

[198] Cheng & McNamara (2000) control for differential earnings growth by matching firms on ROE.

2000), this research treats the threat to internal validity from non–matching prior performance as negligible.

In so far that prior performance difference might well be a significant pre–existing difference, and since prior performance matching is even more difficult to obtain in the thinner Australian market, this research has been designed from the very outset to achieve a solution that circumvents any threat to internal validity from differential prior performance. The experiment is designed to determine if ERP is significant to residual performance. Residual performance is defined as the differential performance over and above what would be normal to the firm in the year. This *base performance level* for the year is uniquely defined as the persistence factor of a firm's earnings performance moderated by current macroeconomic influences. By distilling thus a residual 'abnormal performance' as a function of prior performance as well as the state of the economy, and then testing for the significance of ERP adoption to its realization, the experiment is designed to deliver causal relations between ERP adoption and residual performance as defined in this research. This final design step supplies the foundation for determining the value relevance of ERP information.

(b) Selection Bias—

Public disclosure of ERP adoption is not a standard requirement (either in law or by regulatory regime). The experimental sample is therefore drawn from those firms that have disclosed ERP adoption through annual reports and/or through the media. Thus, "self–selection" (Moers 2007, p. 401) bias could be a threat to causal relations owing to the risk that characteristics of disclosing firms that differ from non–disclosing firms over one or more dimensions unbeknownst to the researcher may affect the observed values of the criterion variable.

(c) Maturation Threat to Internal Validity—

There is also the possibility of a time–related threat from maturation. Anecdotal evidence suggests that early adopters were disadvantaged for the lack of maturity in the ERP market. In particular, the ERP implementer community comprising consultants and advisors as well as vendors were not sufficiently experienced and/or trained for early implementations[199]. In consequence, the implementations may not have been well–specified with regard to timing of adoption, organizational change and change management. Most learning appears to have occurred by trial and error. The possible adverse effect on the post–adoption performance of early adopters is not known. Neither the benefit to later adopters from the experience and know–how gained by the implementer community. In consequence, the degree of bias in the results of this research from the fourteen pre–1998 adoptions[200] in the experimental group is not known. It is expected that the bias would have resulted in a more conservative estimation of ERP value relevance than warranted.

Summary Assessment

These potential biases from selection and maturation arise because the experimental and control groups are not the outcome of a randomized draw from the entire population of ERP–adopting firms. The population of ERP–adopting firms listed in the ASX is not known.

In general, the nature of the Non–equivalent Control Group Design makes it difficult to rule out differences in the characteristics of the ERP–adopter and non–adopter groups as a possible alternative explanation to the effect of the predictor variable (ERP adoption) on the criterion variable (share returns). Hence, a natural experiment cannot determine causality with absolute certainty (Whitley Jr. 2002). However, greater confidence can be placed in results that could be replicated under different conditions. To this extent, the similar findings of the experiment conducted under a totally different research design by Hendricks *et al* (2007) would appear to suggest that any internal validity threat from self–selection and maturation may well be negligible.

5.6.3 OTHER LIMITATIONS

The thinness of the Australian Stock Market imposed constraints on the derivation of the coefficients under the Generalized Method of Moments (GMM). Firstly, the limited industry group membership did not permit adequate numbers of earnings observations

[199] For the purpose of this study, 'early' represents implementations from 1993 through 1997

[200] Comprising 23% of the sample

for the derivation of proper coefficients at the industry group level. Secondly, this inadequacy extended to the industry sector level in so far that the available firms had often varying numbers of reporting years. The consequent gaps in the data series meant a very high proportion of outliers. The proportion of outliers remained excessive when the test was extended to the entire population of ASX–listed firms. Nevertheless, the coefficients estimated at this level were the most reasonable of the three tiers tested.

The coefficients estimated may not be quite representative of the true coefficients that should be applied to earnings prediction. The best coefficients are derived at the individual firm level, given adequate data points, but failing which, at the industry or industry group level for the individual firm. The extent to which the results of this study may be biased on account of the unavailability of more representative coefficients is not known.

5.7 IMPLICATIONS FOR FUTURE RESEARCH

The present research showed a generally improving trend in the ROA residual, with year 5 being a clear positive result. The study should be extended to a further 3–5 years to establish more firmly if ERP is performance relevant in the longer term. This extension would also establish if the neutral value relevance trend that emerged over the later periods of the study continues into the following periods. If it does, and performance relevance remains uninterrupted, it would have clear implications for the value relevance of ERP adoption.

Future research would need to address a larger pool of companies to make for the derivation of usable coefficients at a more representative level of the industry classification structure (the industry or industry group level). This would ordinarily not be possible in the relatively small Australian market. Since finite sample Generalized Method of Moments (GMM) estimates contain inherent bias, the alternative is to replicate the research using a bootstrap bias–adjusted GMM estimator (Gaston & Rajaguru 2007).

To determine the reason for the anomaly of the components of ROA turning up insignificant while ROA remains significant in the later years of the study (section 5.4), residual ROA components would need to be tested for significance. This is particularly relevant to the Gross Margin ratio (or COGS/SALES), which ratio was not available from the sample of companies selected in this study. COGS is now a disclosure requirement in the Australian Accounting Standards (AASB 102).

A relatively minor implication stems from the negative Gross Operating Surplus coefficient in the GMM estimation for the ASX pool (section 4.1.2.1). This would need investigation to determine if annual wage bargaining is a factor implicated in the negative coefficient, on account that the higher surplus in a 'good' year may drive up the wages award for the following year when the surpluses may be actually less.

In general, this research has demonstrated that any performance–related company research must consider the effect of macroeconomic factors of the business cycle on performance. Disregarding these effects could prejudice the conclusions drawn from the research on the performance relevance of management methods. The methodology offered in this research could be used to determine the contribution of any such initiative (e.g. VBM, TQM, ABM).

5.8 CHAPTER SUMMARY

The chapter summarised the theory underlying ERP value relevance and the theory underlying the methodology for determining ERP value relevance. It then summarised the results of the study and discussed its implications in the light of the theory and the specific research question. Contributions the study makes to the research, practitioner, and education communities were highlighted, and the limitations of the study discussed in terms of possible threats to external and internal validity. Finally, the implications of the study for the direction of future research in ERP and related fields were identified. The summary finding of the research is that while ERP adoption is associated with an improving trend in operational performance over the five years of the study, the share market did not, in the main, hold the view that ERP implementations are value relevant.

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Appendix

Appendix A – ERP Software Described

Enterprise Resource Planning is an integrated, software–centric information system (Klaus, Rosemann & Gable 2000). ERP software is a suite of application program modules designed to set up an interactive environment for enterprise users to analyse and manage business processes associated with the production and distribution of goods and services (Jakovljevic 2005). The software thus serves to help integrate enterprise–wide business processes and the information needed for the execution of those processes (Seddon, Shanks & Willcocks 2003). These descriptions serve to emphasize integration of program applications, business processes and data across the entire enterprise to create a unified (non–fragmented) information system in support of its operation.

To help achieve this integration, ERP software comes with a modular design and with configurable tables that allow the specification of enterprise–specific operational parameters; the flexibility thus offered enabling diverse enterprises implement the software in line with their respective business requirements (Davenport 1998; Markus & Tanis 2000). The software thus impounds extensive enterprise knowledge borne of vendor experience with a diverse range of client implementations (Shang & Seddon 2002). The rich configurable potential thus on offer singularly distinguishes ERP software from other types of software packages (Klaus, Rosemann & Gable 2000).

Despite this however, a complete fit between software features and functionality on the one hand and business operations on the other is more the exception than the rule; and so, ERP systems often force enterprises to change (a) the way they operate their businesses (by applying the vendor–supplied implementation reference models and process templates to configure business processes to fit the software); or (b) the ERP software code (to fit unique business processes) (Davenport 1998). As the latter tends to be cumbersome, expensive and risky, enterprises on the whole adapt themselves to vendor–instigated 'best practice' (Aubrey 1999); albeit with varying levels of success. Hence, ERP systems often tend to impose their peculiar logic on enterprise strategy, structure and culture (Davenport 1998; Gattiker 2002; Gattiker & Goodhue 2002; Huang et al. 2004); even if several successful implementers do recommend a 'hybrid' approach to implementing the software in which changes to the code are allowed, but only to the extent that competitive advantage derived from non–standard business processes is clearly demonstrable (Austin, Cotteleer & Escalle 1999, 2003).

The technical aspects of ERP software design support integration as does the IT infrastructure requirement. These combine to support the creation of an unified and seamless enterprise–wide information system substratum transparent to the user community across the globe: (1) they are based on (a) distributed open systems (i.e. “open” in that they are hardware platform–independent and operating system–independent to maximize their operability across a wide range of hardware/operating system platforms; “distributed” in that they incorporate a 3–tier, internet/intranet–based client/server architecture in which the database, applications and presentation layers form 3 logically–independent levels for optimal workload distribution efficiency); (b) distributed relational database technology integrated with the ERP application software (for multiple, distributed, current copies of a single production database to expedite global access using standard SQL interface); (c) 4GL software code (with increasing object–oriented programming/componentization for faster speed and greater efficiency of processing and developer/implementer productivity); and (d) a GUI (for an icon–based ‘point and click’ interaction for maximum user productivity with the minimum of training); (2) they provide for (a) maximum scalability (to accommodate the rapid growth trajectories of today’s high performance enterprise) through (i) RAM size requirement specifications ranging upward from a 1GB minimum; and (ii) disk storage typically starting around 100GB; and (b) perpetual disk availability at high speed (using, for example, RAID technology for maximum redundancy against disk failure and data access problems); and (3) they demand a high–end operating system able to support (a) multi–tasking, multi–user application and multi–threading capability for high performance; and (b) high–end processor features such as 32–bit (or higher) with symmetric multiprocessing (SMP) capability for scalability (Jakovljevic 2005; Klaus, Rosemann & Gable 2000).

ERP systems thus allow enterprises to have “… a common global business and IT infrastructure” that supports the process–oriented organization of work (Light 1999); this being essential to the delivery of superior service, quality, innovation and speed in the new era of competition (Davenport 2000b; Hammer 1990; Hammer & Champy 1993).

The key business functions supported by the integration include sales order processing, procurement, materials management, production planning, human resources, logistics, distribution, maintenance, financial accounting, management accounting, strategic planning, and quality management (Klaus, Rosemann & Gable 2000; Sumner 2005).

The basic back office/ front office integration thus delivered by the first wave of ERP systems implementations has been latterly augmented and supplemented with newer modules such as Customer Relationship Management (CRM), Product Lifecycle Management (PLM), Supply Chain Management (SCM), Corporate Performance Management (CPM) and others that collectively extend the depth and breadth of the integration across the horizontal (cross–enterprise) and vertical (intra–enterprise) value chain under what has been described as the second wave of ERP or ERPII, designated more formally as, IEEP/ES or Integrated Extended Enterprise Planning/Execution Systems (Moller 2005; Seddon, Shanks & Willcocks 2003; Weston Jr. 2003).

Appendix B – ERP Purpose

The broad purpose underlying the ERP software design features is to equip enterprises with a tool to optimise their underlying business processes to enable them create a seamless, integrated information flow from suppliers through to manufacturing and distribution (McDermott 1999). This serves enterprise–wide supply chain processes that increasingly seek to manage individual customer relationships with a cross–enterprise supply chain perspective; this being a strategy rendered increasingly necessary in the face of growing consumer demands, globalization and competition (Ferguson 2000).

The underlying driver in all of this is that most industries are substantially over capacity relative to global demand, thus necessitating increasing innovation and differentiation to remain competitive in what is essentially a buyers' market (Davenport 2000b).

To position the enterprise strategically for realization of these outcomes, enterprises implement ERP to (1) reengineer their core processes for vendor–instigated 'best practice'; (2) take advantage of economies of manufacturing in/ marketing for low–cost/ low–priced offshore factor/ product markets with software that provides support for multiple currency transactions and differences in culture, language and tax regimes; (3) re–integrate and centralize control of enterprise computing after the disarray that resulted from the local area network–engendered low–cost distributed processing and decision–support era of the '80s and '90s; and (4) integrate enterprise processes that became fragmented across functional boundaries as a legacy of the age of specialization in the industrial era; such fragmentation resulting in data inconsistency from duplicated databases across the enterprise as individual functional departments attempted to exert control over their respective portion of the process; leading to a lack of central data administration and database control; with consequent lack of coordination of the value–delivery process and loss of value–relevant outcomes (Jenson & Johnson 1999).

Light (1999) adds that the rapid emergence of e–commerce demanded that enterprises have business and IT infrastructures to support web–based strategies. Good web access to important information needed by customers, suppliers and employees for decision–making necessitates robust transaction systems with good web connections to them (Davenport 2000b).

Increased dispersion of enterprise operations under globalization pressures necessitate a constant readiness to accommodate changes to strategy, structure, alliances and market relationships, which necessitate an integrated, flexible information infrastructure. The increasing complexity of enterprise operations in turn demand expedient and timely senior executive oversight via integrated systems with web access (Davenport 2000b).

Thus, from the strategy planning and execution perspective, the many strands of the integration theme necessitated by the decision–relevance imperatives for the emerging widened (regional or global) context of enterprise operations are evident.

Appendix C – ERP Defined

The 10th edition of the APICS[201] Dictionary defines enterprise resource planning as "A method for the effective planning and controlling of all the resources needed to take, make, ship, and account for customer orders in a manufacturing, distribution or service company" (Miller, GJ 2002). This definition captures the essence of the software's core purpose without reference to the software itself—which purpose is the purpose of an enterprise resource planning information system i.e. the planning and controlling of resources for effective enterprise performance.

Davenport (1998) references the software and indicates how effectiveness of planning and control may be promoted: through the use of "… commercial software packages (that) promise the *seamless integration* of all information flowing through a company…." (*italics added*). This definition serves to extend the APICS definition by highlighting information flows and their seamless integration through software suites.

Firstly, planning and controlling resources involves decision–making; and decision–making for resource planning, coordination and control requires information. This implies information consistency across the enterprise that can only be enabled with '*seamless integration*' of information through the use of a single information source (rather than multiple sources or databases that engender inconsistency). The latter is made more readily possible with application integration. Commercial software packages make application integration readily enabled 'out of the box'. Deloitte's definition therefore highlights application and information integration that make for information consistency.

Secondly, information flows for decision–making implies delivery of information right in the timing and right for the decision context. Information consistency, and therefore '*seamless integration*' is a necessary condition for enabling this coupling of information quality attributes.

Deloitte Consulting (1999, pp 5) combines and amplifies the key elements in the above formulations to round off the ERP definition: "… a packaged business software system

[201] APICS – formerly, American Production and Inventory Control Society; now, Association for Operations Management

that enables a company to manage the efficient and effective use of its resources …" This being enabled by ERP's key attributes, which are its ability to—

- Automate and integrate the majority of an organization's business processes
- Share common data and practices across the entire enterprise
- Produce and access information in a real–time environment (Deloitte Consulting 1999).

Firstly, the definition expands upon the APICS definition in that it emphasizes what effective planning and controlling of resources must mean: delivering both efficiency and effectiveness in the use of resources, thereby serving to capture both sides of the value equation leading to the shareholder value paradigm introduced in section 2.3.2: (1) reduction of costs through productivity improvements; and (2) increase of revenues through customer–value creation.

Secondly, it extends Davenport's definition in highlighting how information flows for decision–making toward the efficient and effective use of resources may be achieved: through (1) automating and integrating enterprise processes; (2) sharing common data and practices across the enterprise; and (3) producing/ accessing information in real–time.

Automating and integrating processes is enabled through the sharing of common data and practices. In this regard, Huang (2004, pp 101) states that "ERP systems have the potential to integrate seamlessly organizational processes using common shared information and data flows". Additionally, data commonality is enabled with the integration of processes—both business processes that produce data, and information technology processes that capture the data being produced. This synergistic integration makes for real time production of data, which are then converted into information and made available for decision–making in real time through further information technology processes. Both data and process integration thus serve to enable information for decision–making in real time. Application integration alluded to by Davenport and Deloitte, makes for data and process integration as well as the production of information in real time. Decision relevance is hence the product of *seamless integration* of data, processes and applications, both within and across these respective categories, through making for comprehensive information quality.

Deloitte's definition serves to underline that an ERP system is a software–centred and software–driven integration of business processes and data to allow an enterprise to produce and access information in real time for decision–making towards the efficiency and effectiveness of resource use. The role of decision–relevance for sound performance outcomes is implicit.

The common theme underlining these definitions therefore is that ERP makes for good performance outcomes through good decision–making based on high quality, decision–relevant information.

In sum, ERP *is* held out to be value–relevant in that it makes for decision relevance in planning and controlling enterprise resources for superior performance outcomes. This research tests this proposition.

Appendix D – ERP's Emergence and Growth

ERP software systems can be seen as the latest generation in the continuing evolution of business software systems tracing back to the 1950s. Understanding its evolutionary history is essential to comprehending its current application and future direction (Deloitte Consulting 1999; Ptak & Schragenheim 2004).

Appendix D.1 Early inventory/ materials management systems (ROP to MRP–CRP)

The evolution commenced with the development of statistical inventory control software designed for the tracking of stock levels for basic inventory management operations. These "order–point" or "reorder point techniques" (ROP), though initially successful in controlling inventory costs, was eventually mal–adaptive to enterprise profitability (and assumedly, therefore, to shareholder value). This was because they were designed around the use of historical data for establishing inventory parameters (reorder quantity, safety stock etc.) which were to become progressively irrelevant in the context of developing demand volatility. The growing incidence of the resultant costly working capital management inefficiencies epitomized by swings between stock–outs at the one extreme and inventory obsolescence at the other became anathema to a business era in which cost–minimization was increasingly the key to competitive advantage. The IT industry responded with the Material Requirements Planning (MRP) software solution (Deloitte Consulting 1999; Orlicky 1972, 1975; Rondeau & Litteral 2001).

MRP systems allowed manufacturers to change production plans and the associated material/component replenishment orders in tandem with the periodic changes to the Master Production Schedule (MPS) resulting from changes to the Demand (Sales) Forecast and associated Aggregate Production Plan. The key advancement from a resource planning standpoint was MRP's ability to time–phase the MPS consistent with the supply and production lead times for the material and component sub–assemblies required for its fulfilment per their corresponding Bills of Material. This allowed planners to delay committing materials/components to production until production schedules actually consumed resources, thus paving the way for a major breakthrough in planning inventories, working capital and cash flows (Chen, IJ 2001; Jakovljevic

2004; Pelion Systems Inc. 2003). MRP was an improvement therefore over ROP systems in that it served to advance inventory and working capital management in the face of market volatility.

MRP was thus a significant technological development that enabled an improvement in basic business processes relating to production planning and materials management at the operational (tactical) level of decision–making (Duchessi, Schaninger & Hobbs 1989). Clearly, it yielded a significant advance towards decision–relevance for the manufacturing planning and control (MPC) function to effect economies of production and materials management. In addition, it also served to advance revenue generation, since better integration of material resource planning with production plans helped assure product availability for advancing the target marketing paradigm for competitive advantage that was superseding cost minimization during the 70s decade. (Rondeau & Litteral 2001). Clearly, MRP delivered a cost and revenue advantage toward the shareholder value paradigm presented in section 2.3.2.

MRP signalled the emergence of informated resource planning for enterprise operations that was to be the harbinger of the enterprise–wide resource planning paradigm of today's ERP systems (Manetti 2001).

While production planning and materials (inventory) management were thus perhaps the first examples of interlocking enterprise processes that found effective integration in the emerging age of computerized information systems, this integration nonetheless became too limiting with the increasing rate of demand volatility, having been designed upon the periodic regeneration of production plans (weekly, at best) under conditions of stable shop-floor operations with minimal disruption to work flow. With volatility however, and with the attendant consequent uncertainties along the supply chain, manufacturing planning was impaired by machine load–balancing and routing inefficiencies on the shop floor in the face of capacity limitations. The consequent impairment to time and quality from work floor disruption was to become anathema to the evolving quality–based competitive paradigm. Clearly, decision–relevance for MPC was being impaired, assumedly with value delivery to the respective stakeholders (Jakovljevic 2004; Orlicky 1972; Rondeau & Litteral 2001).

This gave birth to capacity requirements planning (CRP) and shop floor routing controls (SFC) to effectively close the manufacturing planning loop and make for better control of shop floor workload distribution, plant capacity and materials requirements. “Closed Loop MRP” (MRP–CRP) was thus a giant step forward for MPC (Jakovljevic 2004; Orlicky 1972; Ptak & Schragenheim 2004; Rondeau & Litteral 2001).

Appendix D.2 Manufacturing Resource Planning (MRPII)

Concurrently, however, the need for control over other manufacturing resources (e.g. labour, plant availability) and the need for financial control over manufacturing operations began to be felt towards further tightening the MPC function (Jakovljevic 2004; Ptak & Schragenheim 2004). Manufacturing Resource Planning (MRP II) was thus born of the extension of MRP/CRP into manufacturing resource/capacity planning (Duchessi, Schaninger & Hobbs 1989; Jakovljevic 2004).

This integration made for more comprehensive MPC through (a) a built–in simulation capability to allow for the simulation of alternative production plans in the quest to optimise both production schedule and capacity utilization within existing resource constraints i.e. capacity planning (Chen, IJ 2001; Duchessi, Schaninger & Hobbs 1989; Rondeau & Litteral 2001); (b) facilitating monitoring and control of shop–floor work–centre throughput capacity i.e. short–run input/output controls as an aspect of SFC systems (Duchessi, Schaninger & Hobbs 1989; Hopp & Spearman 2004; Teamco Systems Innovation 2002-3); and (c) allowing for operations management to obtain shop–floor performance feedback for continuous oversight of manufacturing execution (Duchessi, Schaninger & Hobbs 1989). The resulting greater process control combined with better overhead utilization from improved resource planning and coordination helped deliver world–class manufacturing to enterprises that increasingly came under pressure to base their competitive strategy on quality (Rondeau & Litteral 2001).

MRPII’s built–in simulation capability also facilitated the simulation of alternative manufacturing strategies under diverse resource capacities and specified manufacturing conditions in support of long–range resource planning decisions (Adams & Cox 1985).

The more realistic long–/mid–term resource requirement projections in turn made possible better planning of financial resources for advancing manufacturing strategy in support of product–market strategy—thus supporting the sales and marketing function. (Duchessi, Schaninger & Hobbs 1989).

MRPII effectively closed the planning loop via integration with the financial accounting and management systems (Ptak & Schragenheim 2004).

In sum, MRPII made for an integrated information system for comprehensive MPC through (1) giving full visibility of capacity and material requirement and availability for a given manufacturing strategy and operations plan, and (2) enabling the financial reporting of actual performance. These made for better planning for and utilization of manufacturing capacity, rich analytical insights into the impact of manufacturing on enterprise financial performance, and correctives for exceptions from operational and financial plans. (Jakovljevic 2004; Ptak & Schragenheim 2004).

MRPII was thus a significant extension to enterprise MPC capability through the advancement of decision–relevance from the process–level of operations (shop floor controls) through the more tactical levels of resources coordination and control (procurement, personnel, finance) to the strategy levels of resource planning and allocation (long–term capacity planning and resourcing). So sweeping was its scope for its times that it was described (Duchessi, Schaninger & Hobbs 1989) as having grown through the 1970s into "… a computerized information system for integrating *all* business functions and for planning and controlling *all* company resources *(italics added)*."

Firms reported major improvements to plant efficiency, production scheduling, production morale, coordination with marketing and finance, customer service and competitive position whilst concurrently reducing inventory levels, component shortages, safety stocks, lead times and manufacturing costs (Duchessi, Schaninger & Hobbs 1989). These improvements therefore embraced (1) productivity improvements; (2) customer value delivery; and (3) returns on investment (through improved inventory turnover, capacity planning and utilization) in the shareholder value paradigm introduced in section 2.3.2.

Nonetheless, the 4th and key ingredient of this paradigm—the persistence of the improvement in earnings returns on assets employed—propositioned in this thesis as the eventual and definitive arbiter of value [after (Kormendi & Lipe 1987)] would have clearly been under increasing pressure from the progressive instability of business conditions that took shape with the advent of time–based competition in the latter part of the 80s decade and accelerated onwards through to present times (Jakovljevic 2004; Rondeau & Litteral 2001).

Appendix D.3 Time–based Competition and the Emergence of Manufacturing Execution Systems (MRPII–MES)

Time–based competition, in essence, is the ability to make structural changes to organization in short order to enable expedient execution of business processes needed for rapid response to customer demands on timing, place, and mode of performance (Ptak & Schragenheim 2004; Stalk 1988). This entails the redesign and reengineering of the business processes that execute the entire product cycle from concept to delivery (Willis & Jurkus 2001). The aim is to shorten lead times for concept–to–market, enquiry–to–quote, order–to–ship, and other critical time–related horizontal business processes; improve quality; and deliver superior customer service through the creation of a total customer–focussed, time–driven value package whilst reducing cost (Marks 1997; Stalk 1988).

The corresponding 'rapid response systems' required for time–based competition began to be implemented at the shop floor level through the introduction of flexible manufacturing systems (FMS). The net result was increasing volatility on the shop floor from products and processes that demanded change on a weekly basis and production schedules that demanded regeneration even on an hourly basis. This, in turn, demanded a level of responsiveness from the MPC system that would accommodate real–time planning and control of shop floor operations (Rondeau & Litteral 2001; Stalk 1988).

In this context, MRPII's 'regimented' approach to resource planning (via backward scheduling from required delivery dates of material/ capacity requirements under the time constraints of production/material/component lead times) became increasingly mal–adaptive to the levels of agility required of the shop floor for delivering on rapid response strategies. Also, in consequence of increasing shop–floor workflow scheduling instability, the decision relevance for shop floor monitoring and control delivered by SFC and CRP periodic reporting no longer compensated for the erroneous infinite work–centre capacity assumption embedded in MRP/CRP material/capacity requirements generation design. The IT industry responded with the Manufacturing

Execution Systems (MES) software solution (Jakovljevic 2004; Rondeau & Litteral 2001).

MES effectively delivered the link that the MPC function lacked for rapid response by supplying the interface for vertically integrating the SFC systems that dynamically controlled manufacturing operations at the process level with their corresponding planning systems (MRPII). Such integration served to deliver flexible real–time manufacturing planning, feedback and control through the real time exchange of manufacturing execution planning information between the MES and upstream MRPII systems on the one hand, and control and feedback information between the MES and downstream SFC systems on the other (Marks 1997; Rondeau & Litteral 2001).

MES thus created a further competitive advance to enterprises through real–time integration of information and decision–making at the planning and execution levels of manufacturing operations to help realise customer–focused rapid response strategies. Manufacturing operations were now both horizontally and vertically integrated, eliminating non–value adding costs and enhancing value delivery to customers (Marks 1997). A survey conducted by the Manufacturing Execution Systems Association (MESA) revealed significant reductions in manufacturing cycle time, WIP levels, data entry time, process lead times and waste (Rondeau & Litteral 2001). Clearly, MES advanced decision relevance that served to further enhance the 1st and 2nd links of the value paradigm through improvements to productivity and customer value delivery.

MPC support for rapid response strategies could only be limiting however as this MES–MRPII nexus served only to speed up shop–floor responsiveness. Pivotal as this was for time–based competition, MES was itself not designed to integrate manufacturing and business processes across the enterprise; such integration being the inevitable requirement for delivery of complete customer–focused value. MES's ability to deliver long–term business value was therefore always in question (Ferguson 2000; McDermott 1999; Rondeau & Litteral 2001). Clearly, its ability to deliver sustainable shareholder value via persistence of earnings responses (the 4th link of the value paradigm) was never automatically assured.

Appendix D.4 The Birth of Enterprise Resource Planning (ERP)

Hence, the non–manufacturing suites of information products that had been evolving concurrently with the manufacturing suite of MRP products, albeit in pockets of automation within functional boundaries of the enterprise, began to be integrated to form a single business–wide system to supply the needed consistency and coherence for delivering on customer rapid response strategies. Integrated with the manufacturing suite, they effectively made for enterprise–wide management of operations; and hence the concept of "Enterprise Resource Planning" was born, courtesy Gartner 1990 (Bond et al. 2000; Jakovljevic 2004). ERP was thence extended to non–manufacturing enterprises to meet the demand for "backbone" transaction processing capabilities (Bond et al. 2000; Ptak & Schragenheim 2004).

ERP systems were thus touted to extend the planning and control paradigm beyond manufacturing planning and shop floor control to enfold the internal value–delivery process within an integrated, enterprise–wide technology/ process architecture; enforcing thus horizontal (cross–functional) business process integration from raw material/component sourcing and logistics through manufacturing to distribution as well as (upstream) demand planning; improving in consequence organizational speed and flexibility across the internal supply chain to help realize the vaunted rapid response strategy for customer value delivery (Chen, IJ 2001; Jenson & Johnson 1999; McDermott 1999; Rondeau & Litteral 2001).

These developments in front office/back office integration that effectively served to birth ERP marked the end of the first phase of the enterprise computing era that commenced with the development of informated planning and control via MRP (Bond et al. 2000; Manetti 2001; Weston Jr. 2003). The dominant theme appears to have been the integration of the enterprise supply chain end-to-end, with backing from the support cast of finance, human resources and other functions to comprehensively enable efficient and effective resource planning and control for profitability outcomes that would serve to advance the 3rd link in the value paradigm.

Whether these developments did actually deliver shareholder value has not apparently been demonstrated. This issue remains apposite in the light of increasing pressures from time–based competition that could well have rendered the 4th link in the value paradigm relatively non–viable.

Appendix D.5 Advanced Planning Systems (ERP/APS)

Despite the seemingly comprehensive enterprise integration, rapid response strategies yet remained compromised by a key design limitation in ERP's pedigree in MRP/CRP/MRPII that effectively caused ERP to be inflexible in optimizing production scheduling and shop–floor work–centre load balancing in the context of multiple constraints under increasing extended supply chain volatility. These deficiencies were addressed with Advanced Planning & Scheduling (APS) software, developed to interface with ERP. APS effectively adopted, merged, and enhanced MRP/MPS functionality into a faster, more powerful engine for dynamically optimizing production scheduling and shop floor workload distribution amidst volatility (ERPConsultant 1995; Gupta 2000; Jakovljevic 2004; Kilpatrick 1999; McVey 1999, 2002; Wiers 2002).

APS was concomitantly enhanced by extending its embedded MRPII planning concepts beyond manufacturing to enfold the entire supply chain to facilitate intelligent supply chain planning amidst burgeoning volatility. The enhancement allowed for APS's sophisticated algorithms to be extended beyond manufacturing capacity planning and production scheduling to the modelling and analysing of multiple extended supply chain planning constraints that affect forecasting and logistics. This enhancement allowed for optimal or near–optimal solutions with software–instigated recommendations for managing bottlenecks in the chain, in effect birthing Supply Chain Optimization (SCO) (Chen, IJ 2001; ERPConsultant 1995; Kelle & Akbulut 2005; Kilpatrick 1999; McVey 1999).

Firms reported phenomenal gains from Advanced Planning Systems (APS) (as Advanced Planning & Scheduling with SCO came to be termed) through dramatic reductions to inventory, supply and order fulfilment times, and transportation costs, and through improvements to forecasting accuracy (Chen, IJ 2001; Latamore 2000). Order fill rates and on–time delivery performance improved 30%, order cycle times decreased 50%, inventories more than 50%, and capacity utilization improved 10%, for a combined improvement of strategic proportions that served to advance customer loyalty, deliver competitive advantage and improve profitability (Kilpatrick 1999; Latamore 2000). An AMR Research study revealed that firms achieved extraordinary payback periods of 1 year and less, some realizing as much as 300% of their investment (Latamore 2000); and a study of 75 projects involving the implementation of sophisticated supply chain network optimization methodologies showed adopting enterprises improved their financial results 5-20% (Van Landeghem & Vanmaele 2002).

Collectively, these accounts strongly suggest persistence of earnings improvements gains toward shareholder value in accordance with the value rationale spelled out in section 2.3.2.

There is however a dearth of this type of pointer to persistent value for the "pure play" ERP implementation. This may be owing to the relatively greater complexity and duration for their implementation (Beard & Sumner 2004); or to the difficulty of quantifying their intangible strategic benefit value (Murphy & Simon 2002); or perhaps more due to their seemingly limited decision support capability (as analysed in sub-section 2.2.5); or, perhaps due to the increasing globalization under increasing competition, supply chain management had begun to demand web–based strategies for their effective operation, and to this end, the ERP backbone based in the older MRP/MPS technologies had become mal–adaptive on account of its relative slowness and non–scalability to the emergent web–based supply chain integration paradigm (Chen, IJ 2001; Gupta 2000; Jakovljevic 2004; Jenson & Johnson 1999; Kilpatrick 1999; Moller 2005).

Appendix D.6 ERP–Integrated Supply Chain Management – the emergence of *ERPII*

APS was hence further enhanced and integrated with ERP for aiding real time centralized management of end-to-end supply chain processes. Further integration by way of Warehouse Management (WMS) and Transportation Management Systems (TMS) effectively delivered comprehensive web–based Supply Chain Management (SCM), linking all processes from initial raw material procurement to the ultimate logistics routing of the end product across all links in the chain (Chen, IJ 2001; Gupta 2000; Jakovljevic 2004; Kilpatrick 1999; Moller 2005).

The integration in effect delivered ERP its first substantive decision–support capability by way of APS's sophisticated algorithms for modelling and analysing multiple supply chain planning constraints (Chen, IJ 2001). This key development therefore appears illustrative of the absence of significant, substantive decision support functionality in ERP's 1st phase of development alluded to by some (Kilpatrick 1999). Holsapple and

Sena (2003) however report substantial levels of perceived decision support characteristics amongst ERP users (as analysed in sub–section 2.2.5).

With the integration, ERP advanced beyond its intra-enterprise focus into its “second wave” extended enterprise orientation, dubbed ERPII (Bond et al. 2000; Chen, IJ 2001; Seddon, Shanks & Willcocks 2003; Weston Jr. 2003). The underlying principle for extended enterprise systems development and integration is the collaborative planning, execution and control of supply chain operations amongst supply chain partners comprising the extended enterprise aimed at winning and retaining the customer via value–relevant supply chain strategies for service delivery in an increasingly competitive and hostile environment (Jakovljevic 2004). This principle clearly relates to the persistence of earnings theme for shareholder value improvement.

The delivery of web–based SCM supplied the needed infrastructure for implementing collaborative supply chain strategies. Toward this end, upstream SCM issues dealing with supplier relations, partnerships, competence development and technology transfer that formed traditional barriers to collaborative supply chain development and management were separated from downstream issues such as demand management, order fulfilment, replenishment and collaboration with customers. Thus, while upstream SCM spawned Supply Chain Planning (SCP), Supply Chain Execution (SCE) and Supplier Relationship Management (SRM), downstream SCM effectively extended the customer service part of the value proposition that subsumed Order Management, Warehouse Management, Yard Management and Transportation Management to embrace sales and marketing in order that the flow of market–based information could be increased both in frequency and level of detail to allow for Collaborative Planning, Forecasting and Replenishment (CPFR). The goal of these strategies was the promotion of collaborative commerce (c–Commerce) through the sharing of marketing, sales and production information amongst supply chain partners toward attainment of the real–time, adaptive supply chain in quest of the capability for mass customization of products and services. (Bond et al. 2000; Davenport 2000a; Jakovljevic 2003, 2004; Moller 2005; Turban et al. 2006; Van Landeghem & Vanmaele 2002).

Despite the rationalizing, specializing, and streamlining, value delivery has remained not without its drawbacks and the effective integration of the extended enterprise will remain a project for some time into the future (Akkermans et al. 2003; Davenport &

Brooks 2004; Kelle & Akbulut 2005). This has to do with issues such as the lack of accurate logistics costs and service information toward optimizing planning decisions across the supply chain; the lack of real time inventory visibility and event feedback information for responding to supply chain contingencies in adapting manufacturing and materials plans; and diverse tactical/logistics issues within the domains of Warehouse Management Systems (WMS) and Transportation Management Systems (TMS) Solutions (Jakovljevic 2003, 2004; Trunick 2003).

The extended ERP or ERPII model, also termed the Integrated Extended Enterprise Planning/Execution Systems (IEEP/ES), currently embraces all of the above supply chain–oriented systems plus the following systems that develop strategic capabilities: (a) Customer Relationship Management (CRM) that manages (i) customer and market information for generating customer intelligence for delivering customer–value and better customer care; and (ii) collaborative processes between vendors and customers for customer value creation; (b) Product Lifecycle Management (PLM) that manages collaborative supply chain processes for product innovation; (c) Corporate Performance Management (CPM) that supplies the integrative, comprehensive, high–level software tool for strategy formulation through to strategy implementation and content control; (d) Business Intelligence (BI) that supplies applications for (i) structured reporting (scorecards, dashboards etc.) and alerting (ii) information and knowledge discovery and (iii) decision support; (e) Enterprise Application Integration (EAI) that supplies middleware for the integration of disparate software architectures (eg. cross–platform/ legacy); (f) B2C (e–Commerce); and (g) a host of other less 'visible' technological productivity aids (Bond et al. 2000; Bose 2006; CorVu 2005b; Davenport, Harris & Cantrell 2004; Jakovljevic 2004; Microstrategy 2002; Moller 2005; Muralidharan 2004; Turban et al. 2006; Weston Jr. 2003).

For non–manufacturing enterprises that for the most part have no need for SCM, and for those others that have not implemented SCM separately, the delivery of BI effectively birthed ERPII by allowing the leveraging of the data supplied through the foregoing systems for decision support (Turban et al. 2006)

These software application suites comprising the ERP's second wave extension are collectively termed "Enterprise Systems" (Seddon, Shanks & Willcocks 2003; Weston Jr. 2003).

Appendix E – Scope and Definition of The Research Question in Relation to "Enterprise Systems"

The development of the ERPII extension appears to have gathered momentum at the turn of the millennium and according to Gartner Group, would not have matured until the year 2005 (Bond et al. 2000). Treatment of these "enterprise systems" would therefore extend this literature survey beyond the scope of the research question currently testable; (the research method calls for 5 years' post–implementation performance data—s3.4). The research question therefore limits itself to addressing the 1st phase of development of enterprise systems.

For manufacturing enterprises, this phase of ERP includes non–integrated APS or SCO systems, which systems would appear to have been implemented as an integral part of the enterprise information system up until about the turn of the century (ERPConsultant 1995; Latamore 2000; Turban et al. 2006). These systems cover the complete supply chain, both internal and external, and are thus subsumed in "Supply Chain–Related Systems" as defined by Turban et al (2006, p. 296), ERP itself being the internal component of this chain. APS/SCO delivers the external component; MRP and MRPII being subsumed in one or the other (Akkaya 1995; Wiers 2002).

This phase may also include precursors to the more fully–developed and ERP–integrated enterprise systems that were latterly implemented under the ERPII banner; these precursors being such antecedents to CRM as Sales Force Automation (SFA); to BI as Data Mining; and to PLM as Product Configuration (Chen, IJ 2001; Markus & Tanis 2000; White 1999), amongst others.

There thus arises the question of the relevance of the particular moniker "Enterprise Resource Planning" over the more generic "Enterprise Systems".

"Enterprise Systems" are so termed because they are enterprise–wide in application and thus differentiate from departmental information systems confined to individual functional areas of the enterprise (Turban et al. 2006). The former hence are "cross–functional" and are thus designed to support core business processes that span departmental boundaries (Jenson & Johnson 1999).

"Enterprise Systems" are therefore a whole class of computerized information systems designed in effect to deliver decision relevance to the management of core work processes across enterprise operations to make for enterprise adaptability, flexibility and responsiveness in a volatile business environment (Weston Jr. 2003). They are, from this research perspective, software–driven aids to decision–making towards proper execution of work processes to accord with whatever imperatives that may be current at the time for strategy planning, strategy control and strategy implementation.

While strategy planning embraces planning of enterprise resources for strategy implementation, strategy control embraces the high–level monitoring and control of both the strategy planning content and the strategy implementation process; the latter being the coordinating and control of enterprise resources deployed in strategy execution (Anthony 1965; CorVu 2005b; Davenport 2000a; Davenport, Harris & Cantrell 2004; Lawrie & Cobbold 2004; Muralidharan 2004; Rodrigues, Stank & Lynch 2004). Since "coordination" of resources is a form of "planning" at the tactical level of strategy implementation or management control (Anthony 1965), it can be seen that planning for resources at both strategy and operational levels is central to the purpose of enterprise systems. An example of an enterprise system focused on the strategy planning and control level processes is CPM (CorVu 2005b, 2005a), while ERP itself is focused on operations (Turban et al. 2006).

Since therefore execution of processes occurs at the highest levels of strategy planning all the way through the lowest task levels of strategy execution, and since such comprehensive execution of processes is intimately detailed with resource planning, coordination and control, this research prefers to retain the original moniker, "enterprise resource planning" or "ERP" as the better descriptor of what enterprises achieve with the software use: planning of enterprise resources. As defined for this research therefore, the term embraces all software applications used in the enterprise to generate information and knowledge by processing the data collected and stored via the ERP system to yield decisions relevant to resource management (Weston Jr. 2003); these other applications being precursors of the now more firmly–bedded suites such as CRM and BI in the ERPII lexicon.

Strictly however, the ERP moniker does not render full justice to what the software enables enterprises achieve—both the planning and the ongoing management (control) of resources for value outcomes. Hence "enterprise resource management" or ERM is the more appropriate term (Ptak & Schragenheim 2004). This however is not in common usage.

This research seeks to retain focus on the business concept of planning, coordinating and controlling resources towards shareholder value outcomes. Referencing the enterprise–wide information systems concept of "enterprise systems" would hence serve only to deflect this emphasis on to what effectively is a classificatory descriptor.

The resource planning focus in its most comprehensive expression also recognizes that the value outcomes are to be realized with the application of the information resources management (IRM) function to the management of information resources (data, information, knowledge and processes) to make for information quality and hence decision relevance (DeLone & McLean 1992; McNurlin & Sprague Jr 2006). Both information resources as well as their management function therefore need to be planned in integral part of enterprise resource planning. While IRM is clearly outside the purview of the business application of ERP software itself, its coordination and control oversight of ERP nevertheless is aided with system performance monitors that monitor system resources (O'Brien & Marakas 2006). More to the point therefore, is that IRM is a function of IT Governance, which is a significant sub–set of Corporate Governance that is detailed with instituting proper governance structures for the management of shareholder funds and for their proper accountability (IT Governance Institute (ITGI) & Information Systems Audit and Control Association (ISACA) 2003). So, governance oversees the management of resources including the IRM resources for shareholder value outcomes. The corporate level (as distinct from the product–market or enterprise level) strategic nature of the ERP initiative is implicit. ERP is a strategic initiative for shareholder value outcomes, both from a corporate governance standpoint as well as a product–market (SBU) standpoint. The moniker "Enterprise Systems" cannot capture this theme for want of a "resource planning" focus.

Nonetheless, the question does arise as to whether ERP's 1st phase of development could have delivered enterprise resource "planning" support. "Planning" implies decision–making. Decision making is aided by information. Information needs to be produced; and the quality of the production process determines the quality of the information. Information quality delivers decision–relevance. Decision relevance therefore is dependent on the quality of the production processes. The quality of the production processes depends on the technology of production and the organization of resources for its effective operation. So, in the final analysis, decision relevance subsumes the organization and management of production resources as much as the technology of production. (Davenport, Harris & Cantrell 2004; DeLone & McLean 1992; Lee et al. 2002; Redman 1995; Turban et al. 2006; Xu et al. 2002).

The technology of production is clearly Enterprise Resource Planning software technology premised on relational database technology and other infrastructure as described in section 2.2.1. The organization of resources must necessarily devolve on the organization of production process designed into the software.

In the event, ERP software has been designed for the efficient organization of production processes for delivering effective operational outcomes. This would necessarily have to follow since Enterprise Resource Planning is not intended merely as an efficient information technology, but more importantly, it is intended as an effective business process management technology (i.e. industry best practice being designed into the software); and business processes consume and create data. It follows then that if the technology has led to the efficient and effective organization of production processes, information quality should ensue. The threshold for delivering decision relevance would have been secured.

There is evidence that the 1st phase of ERP was directed more toward the securing of the platform through engendering process, data and application integration for improving the efficiency of business processes and for facilitating operations control (Ptak & Schragenheim 2004; Turban et al. 2006; White 1999). The question then is: was the securing adequate to make for delivery of decision–relevant information for supporting the planning function at strategic and/or operational levels?

Toward this determination, there is a appreciable body of literature that evidences or asserts that ERP’s first phase delivered little or no decision support (Chen, IJ 2001; Kelle & Akbulut 2005; Kilpatrick 1999; Ptak & Schragenheim 2004; Van Landeghem & Vanmaele 2002; White 1999). The focus of ERP in its first manifestation, these sources effectively aver, was the integration of the enterprise operation—a prerequisite for generating useful information towards planning support. The decision support provided, if any, was no more than for the reorganizing of operations—a reorganization that was facilitated by the technology for integration—and for its subsequent control consistent with specific processes designed into the implementation. Quantitative, multivariate methods for optimizing operations under multiple constraints and uncertainty (i.e. tactical level operations planning) were not generally available until the development of SCM and its consequent integration into ERP via APS. Neither was enterprise level strategic planning (or replanning) spanning the functions of sales and marketing, operations and finance supported (Ptak & Schragenheim 2004)[202]. Also, BI applications that signalled the emergence of decision support under the ERPII flag did not start to develop until the late 1990s (Turban et al. 2006; White 1999)

Conversely, however, other studies would appear to provide a measured perspective on ERP's 1st phase contribution to decision support (Holsapple & Sena 2003, 2005). These latter sought to examine the extent to which enterprise users perceived, planned for, and realized decision support benefits through ERP implementations.

Holsapple and Sena (2003) surveyed the extent to which decision support characteristics are perceived to be exhibited in ERP systems across 16 key dimensions traditionally associated with decision support systems. They found these criteria moderately satisfied at best. While the highest (moderate) scores were obtained for (1) provision of public repositories of organizational knowledge with shared access; (2) inclusion of a repository of knowledge for identifying/solving problems encountered in decision-making; (3) provision of mechanisms to support communication amongst decision participants within the enterprise; (4) provision of mechanisms to facilitate communication among decision participants across organizational boundaries; (5) provision of mechanisms to structure and regulate tasks performed by individual decision-makers; and (6) allowing flexibility in determining the timing of requests (i.e. ad hoc/scheduled enquiry/reporting); yet middling (moderate) scores were obtained for (1) provision of mechanisms to structure and regulate tasks performed by multiple participants to a joint decision; (2) provision of mechanisms to structure and regulate the making of interrelated decisions; and (3) provision of mechanisms to structure and regulate tasks performed in trans–organizational decision–making; and most

[202] I.e. Ptak and Schragenheim (2004) effectively state that "sales and operations planning"—effectively "supply and demand chain planning" (Van Landeghem & Vanmaele, 2002)—is not holistically supported on an enterprise–wide scale.

significantly, two of the lowest scores obtained were those for (1) derivation of new knowledge via automated calculation, analysis and reasoning; and (2) selection and delivery of knowledge to meet unanticipated needs; the latter in particular returning a somewhat below moderate score. The average across the 16 dimensions was at moderate level; (5 of the 16 are not listed in the foregoing as they are not critical to the present analysis).

While the extent of decision–support characteristics perceived to be exhibited by ERP was moderate at best across the 16 dimensions, the degree of importance attached by survey participants to these desired features was well above moderate for all but one (non–critical) dimension; these ratings remaining more or less consistent across successive post–adoption phases of ERP use over a 3–year period from implementation (Holsapple & Sena 2003). These elevated importance ratings would therefore serve to underscore the significance of the perceived extent of decision–support characteristics ratings.

Holsapple and Sena (2005) found user–perception of decision–support benefits derived from the use of ERP systems to be “substantial” (p. 582). While these ratings appear to further substantiate the perceived extent ratings, they do reveal that the perceived benefit for trans–enterprise decision processes is somewhat modest relative to the perceived benefit for enterprise processes. This finding, combined with the middling (moderate) score returned for the perceived extent rating, provides a strong pointer to lower levels of decision support benefits along the supply chain in the control of value delivery if not the planning for it.

Holsapple and Sena (2005) also find the perceived benefits of (a) supporting knowledge and information discovery and (b) stimulating new ways of thinking in problem–solving or on decision context to be rated amongst the lowest. This finding, combined with the aforementioned relatively low scores returned for derivation of new knowledge via automated calculation and for unanticipated needs, would appear to lend support to the assertions in the literature that ERP is relatively weak in lending decision–support for the planning functions in the enterprise.

The most significant of their findings however is the somewhat below–par rating for “(the system) improves satisfaction with decision outcomes”, attributed by the researchers to the “difficulty of use” of “early versions of ERP systems” (Holsapple &

Sena 2005, p. 583). This rationalization yet would seem wholly inconsistent with the very satisfactory ratings returned across many dimensions that have much to do with "ease of use" such as coordination of tasks amongst decision participants and communications amongst them.

The authors' rationalization of this seeming anomaly in their survey appears weak. Various dimensions of coordination and communication (i.e. interrelated decision-making, joint decision-making etc.) comprise better than a third of the benefit dimensions on their survey instrument and furthermore, "(the system) improves the reliability of decision processes or outcomes" (p. 583) scores the second highest rating in the survey. The latter in particular would seem somewhat inconsistent with the relatively low score for "(the system) improves satisfaction with decision outcomes" (p. 583). From the detail of the demographic given, it would appear that the clear majority of the respondents would have been seasoned users of relatively senior rank.

Given these inconsistencies and given that this is the one rating out of the 19 that were tested in their survey instrument to return a less–than moderate score, the finding is of some significance and bears further evaluation.

Prior to the dawning of the era of decision support with SCM–integrated supply chain planning and scheduling under multiple constraints and uncertainty, enterprises resorted to applications developed from disparate software technologies such as on–line analytical processing (OLAP) and data mining—and applied to data stored in data warehouses, marts, operational data stores and multi–dimensional data bases across the enterprise—in their efforts to augment decision relevance through knowledge discovery (Bose 2006; Chaudhuri, S & Dayal 1997; Chopoorian et al. 2001; Tyler 1997; White 1999). These technologies tended to favour retrospective, integrative, descriptive analyses than forward–looking, integrated, predictive analyses (Chopoorian et al. 2001; Ramesan 2003; Turban et al. 2006). Even though data mining was in fact oriented towards prediction, its use, being yet integrative at this early stage of its development, was a time–consuming, disjointed manual process, fraught with problems and errors (Ramesan 2003). In short, these technologies were yet to mature fully and thus tended to be used more for planning at functional levels of the enterprise [i.e. a very limited range of planning—more control than planning (Anthony 1965)] than at enterprise (and corporate) levels (Oguz 2002; Ramesan 2003). Furthermore, their application, being integrative and thus effectively developmental, demanded an experienced skills set for their effective deployment, which, the technology being relatively new, was also relatively sparse (Chopoorian et al. 2001); training being the biggest issue ahead of cost of implementation, data quality and meeting end–user expectations (Tyler 1997). Implementing a data warehouse itself requires extensive business modelling that may take many years to be successfully developed (Chaudhuri, S & Dayal 1997); and constitutes a long, complex organization–wide effort prone to failure if not carefully managed (Bose 2006). These several difficulties and drawbacks to their use find support from White (1999), who states that many enterprises found they could not build data warehouses and decision–processing applications in a timely manner. Even assuming proficiency of use, the quality of data contained in the data warehouses and marts during the infancy of their adoption and adolescence would appear to have been in question (Bose 2006; Chopoorian et al. 2001; Tyler 1997). In the light of all of the foregoing, the extent to which these technologies were effective in leveraging decision support is questionable, Tyler (1997) stating that data warehousing can only be as useful as end–users can make it. Automation of decision support with later integrated BI technologies was not an option either since both intelligent and other decision–processing technologies had not arrived in enterprise systems until the turn of the millennium (Chopoorian et al. 2001; Oguz 2002; Turban et al. 2006; White 1999). Effectively, decision–relevance for enterprise level planning could not have quite arrived even at the end of the ERP's 1st phase (Oguz 2002). While there is evidence that early implementations were analysing no more than 7% of enterprise data (Tyler 1997), Davenport et al (2001) quoting another study (Davenport 2000b) would appear to suggest no more than 10% of enterprises at the turn of the millennium were making substantial progress converting data into knowledge; largely, in effect, for want of a proper data–driven performance management strategy (Davenport et al. 2001). This finds corroboration from Taylor (2005), who states that until the end of the 90s decade, the performance management software market itself was segmented into discrete vendor classes supplying (a) basic query, reporting and analysis solutions; (b) performance management applications; and (c) enterprise resource planning transaction systems that supplied basic reporting capabilities (as well as the data for the foregoing software classes). "This typically resulted in a patchwork of processes and tools that undercut the very goals (of integration and consistency) they were intended to address" (Taylor 2005,

p. 29), leaving users with limited access to the information needed to guide decisions and forcing them to spend disproportionate amounts of time reformatting, combining and reconciling information, with IT and finance departments straining at the seams to meet minimal service demands (Taylor 2005).

It is therefore contended that despite the hype surrounding decision support delivered by early ERP votaries, it is not likely that such support extended much beyond two–dimensional reporting and query–based enquiry processing tools supplied with ERP augmented with pre–BI technologies as OLAP and data mining more amenable to retrospective analytics[203] (Jakovljevic 2004; Thompson 2004; Turban et al. 2006; Zaman 2005). The contribution of such methodologies to delivering decision relevance for strategic and tactical planning would seem not to be exactly categorical and clear (Chopoorian et al. 2001; Davenport et al. 2001).

In summation therefore, the contribution to decision relevance from the 1st phase of ERP implementation could not have extended much beyond decision–support for coordinating and controlling resources at the tactical and operational levels at best. It is propositional therefore that the enterprise value derived through generation of decision–relevant information could not but have been moderate at best.

In concluding the evaluation of a choice of moniker, it may yet be argued, despite the seemingly limited realization of ERP planning benefits, that "coordination" at the operational levels is yet a type of "planning" (Anthony 1965). Furthermore, it is the intent of this research to maintain the focus on business uses, and the business uses of ERP is evidentially moving in the direction of greater planning support.

Given the orientation toward predictive approaches to extending decision relevance offered with the 'extended' resource planning methodologies such as CRM, PLM and SCM with support from BI where applicable (Ramesan 2003), it is propositional to this research that the 1st phase of ERP could not have served to 'close the loop' on decision relevance for shareholder value creation. 'Closing the loop' implies extending decision support for both planning and control beyond operational (task) levels to tactical and

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[203] Dan Tebutt, writing in *The Australian* (04/05/99), states: "… developers such as Peoplesoft, SAP and Oracle have long promoted data–mining tools as the foundation for extracting competitive advantage from costly enterprise resource planning systems." (Extracted from the Factiva database)

strategy levels. Whilst the former are more function– and control–oriented, the latter are more enterprise– and planning–oriented.

This research propositions these limited realizations and tests for their sustainable shareholder value relevance.

6. FIGURES AND TABLES

Appendix F

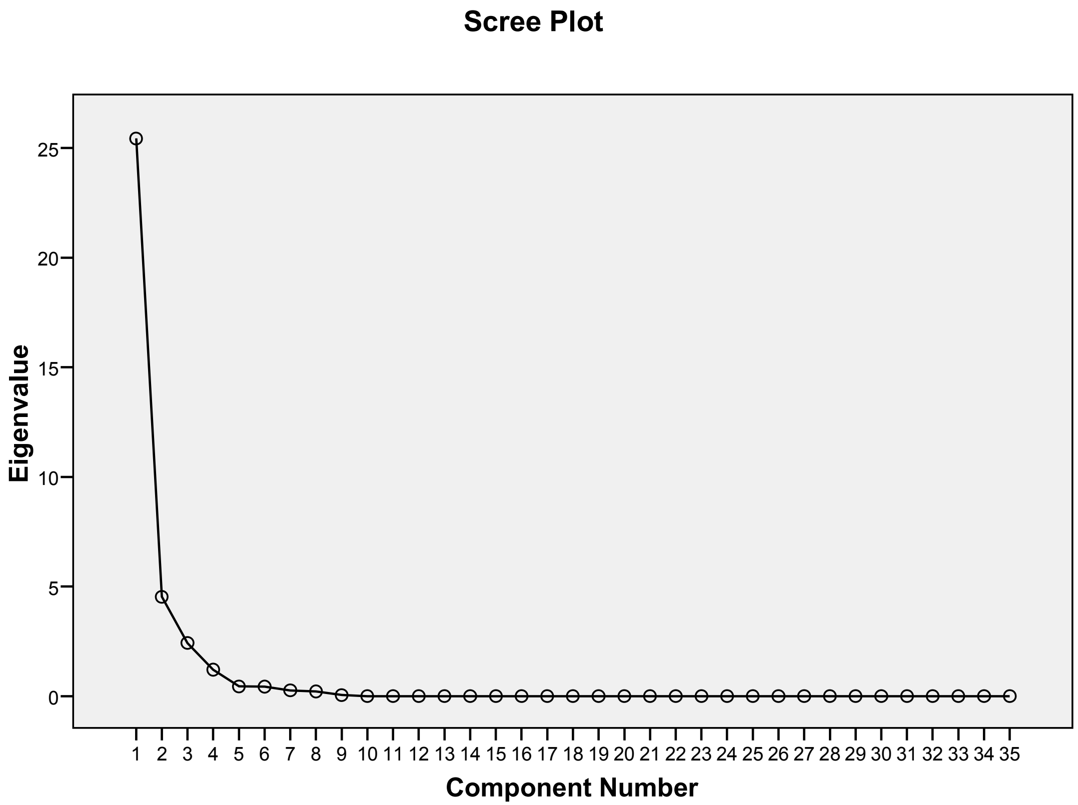
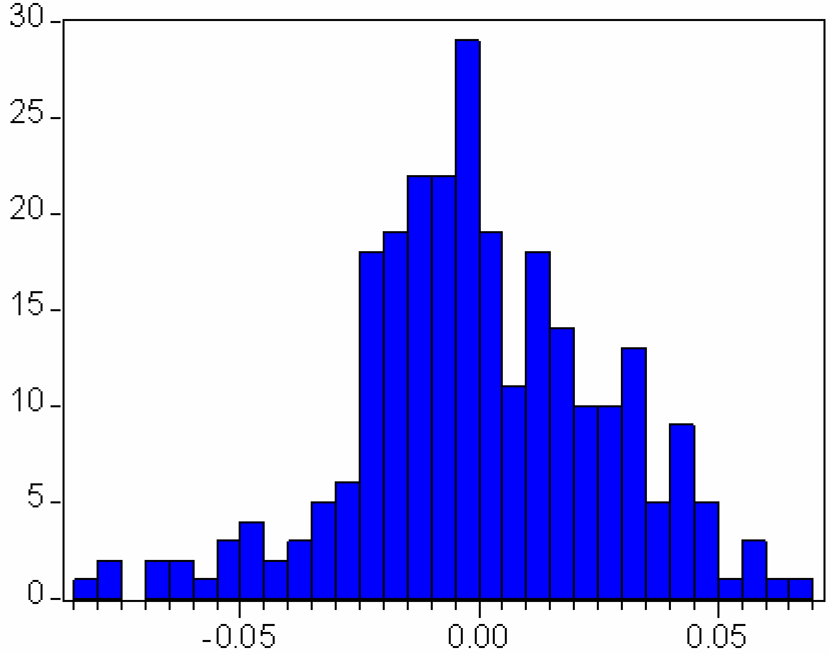


FIG. 6.1 SCREE PLOT



Series: Standardized Residuals
Sample 1992 2000
Observations 261

Mean	-4.96e-18
Median	-0.002493
Maximum	0.065193
Minimum	-0.081112
Std. Dev.	0.026536
Skewness	-0.219989
Kurtosis	3.425773
Jarque-Bera	4.076634
Probability	0.130248

Jarque-Bera is a test statistic for testing whether the series is normally distributed. The statistic measures the difference of skewness and kurtosis with those from the normal distribution.

Under the null hypothesis of a nomal distribution, the J-B is chi-sq. distributed with 2df. The reported probability indicates if the J-B exceeds (in absolute value) the observed value under H0 - a small p-value leading to rejection.

Eviews 5.1 User Guide p312

FIG. 6.2 HISTOGRAM OF RESIDUALS CONSUMER SERVICES INDUSTRY (PANEL OLS REGRESSION)

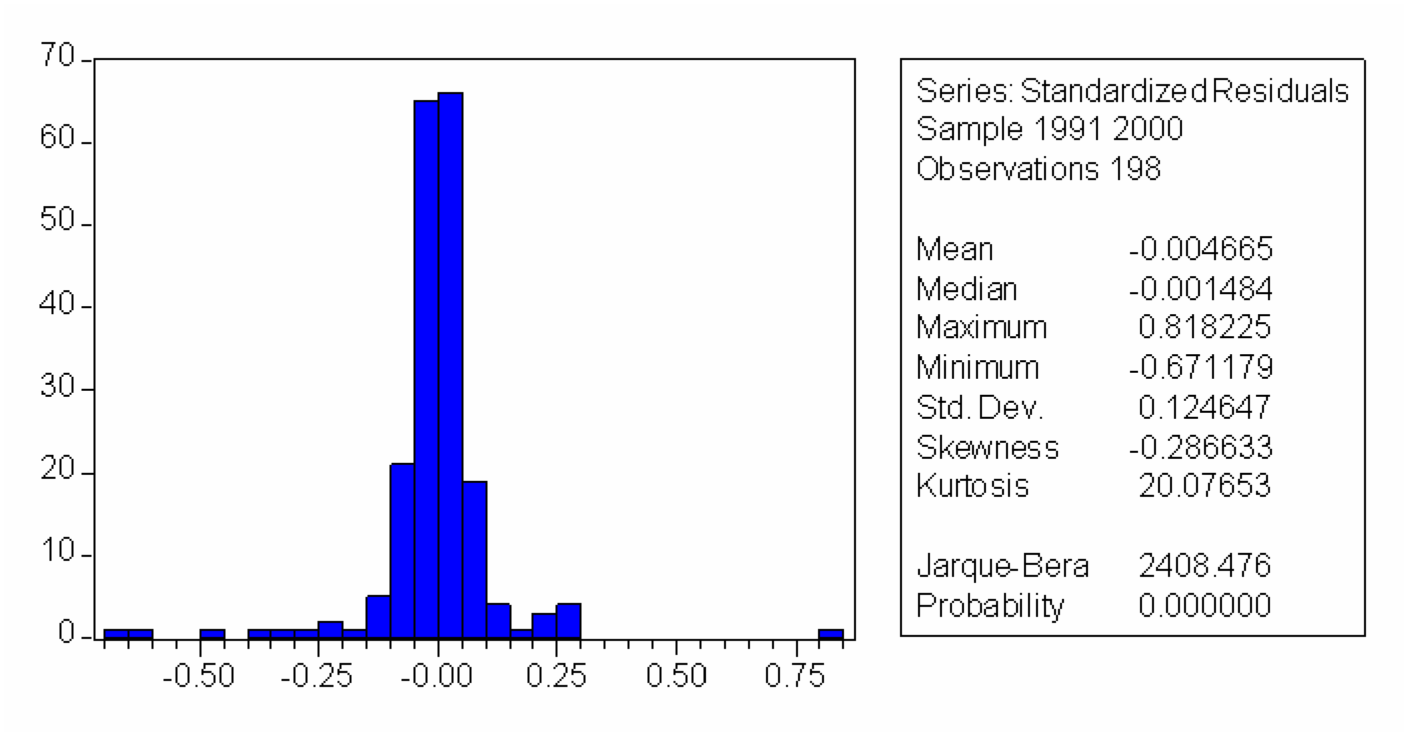


FIG. 6.3 HISTOGRAM OF RESIDUALS CONSUMER SERVICES INDUSTRY UNDER GENEARALIZED METHOD OF MOMENTS (ITERATION 1)

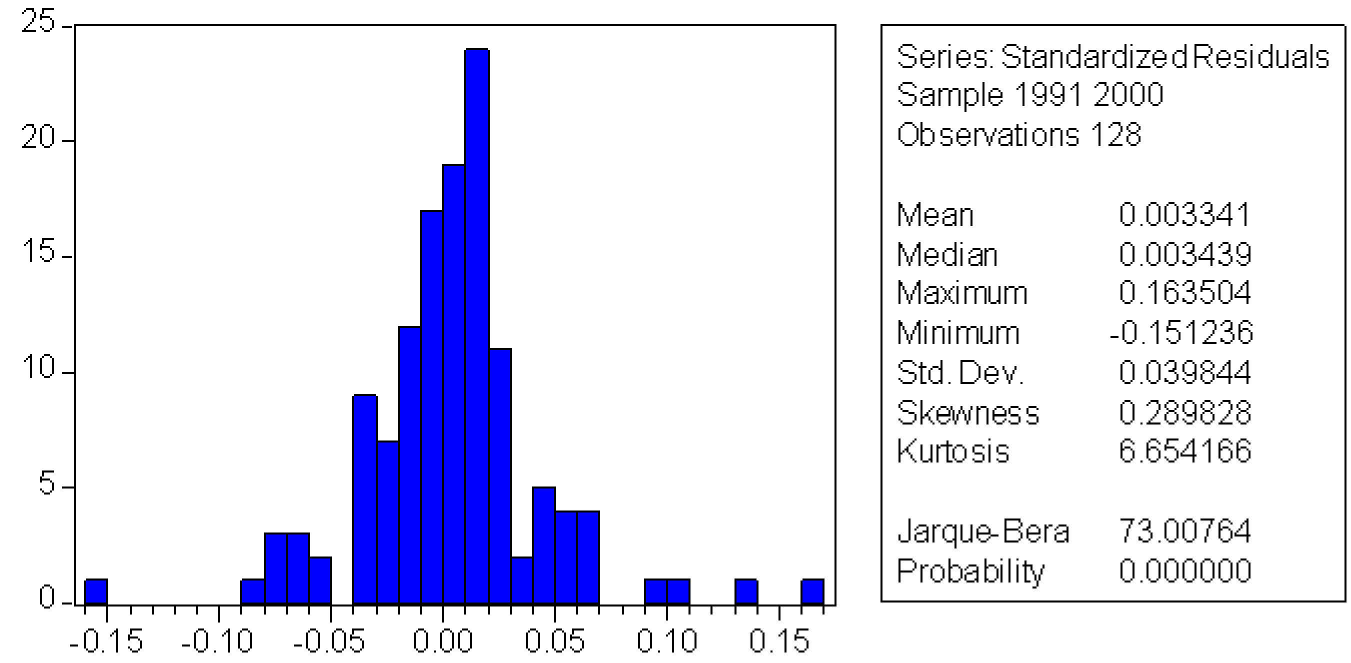


FIG. 6.4 HISTOGRAM OF RESIDUALS CONSUMER SERVICES INDUSTRY UNDER GENEARALIZED METHOD OF MOMENTS (ITERATION 2)

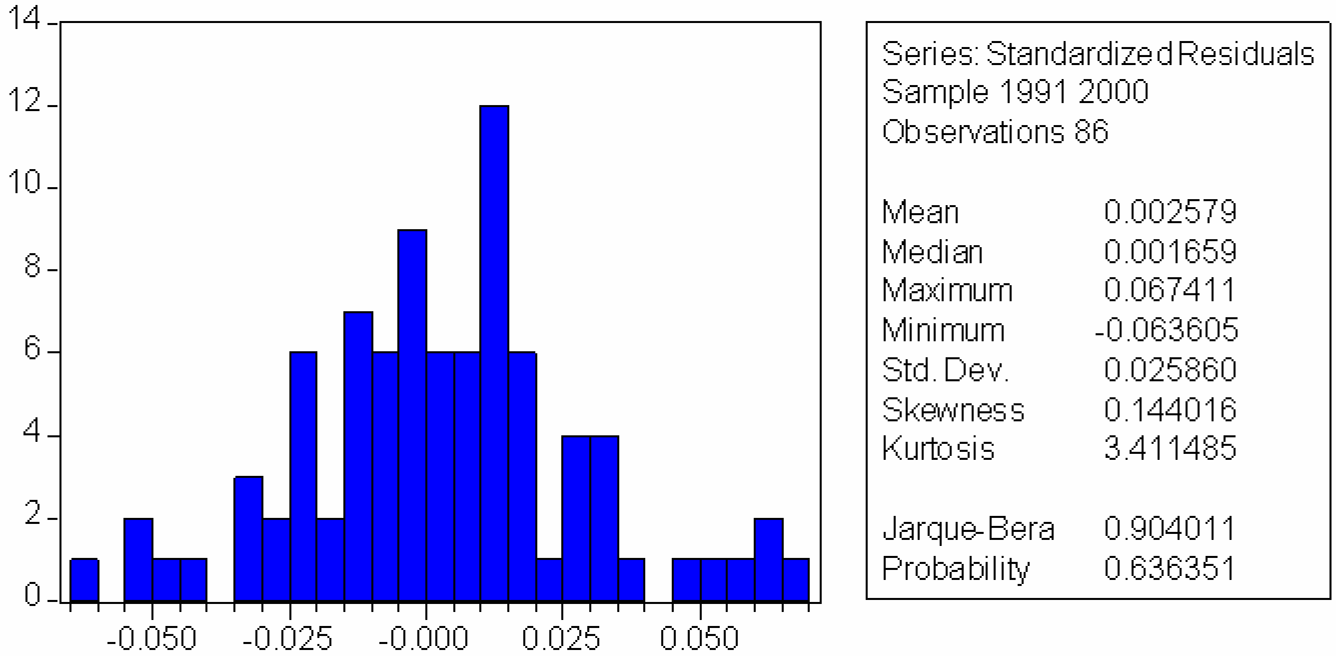


FIG. 6.5 HISTOGRAM OF RESIDUALS CONSUMER SERVICES INDUSTRY UNDER GENEARALIZED METHOD OF MOMENTS (ITERATION 3)

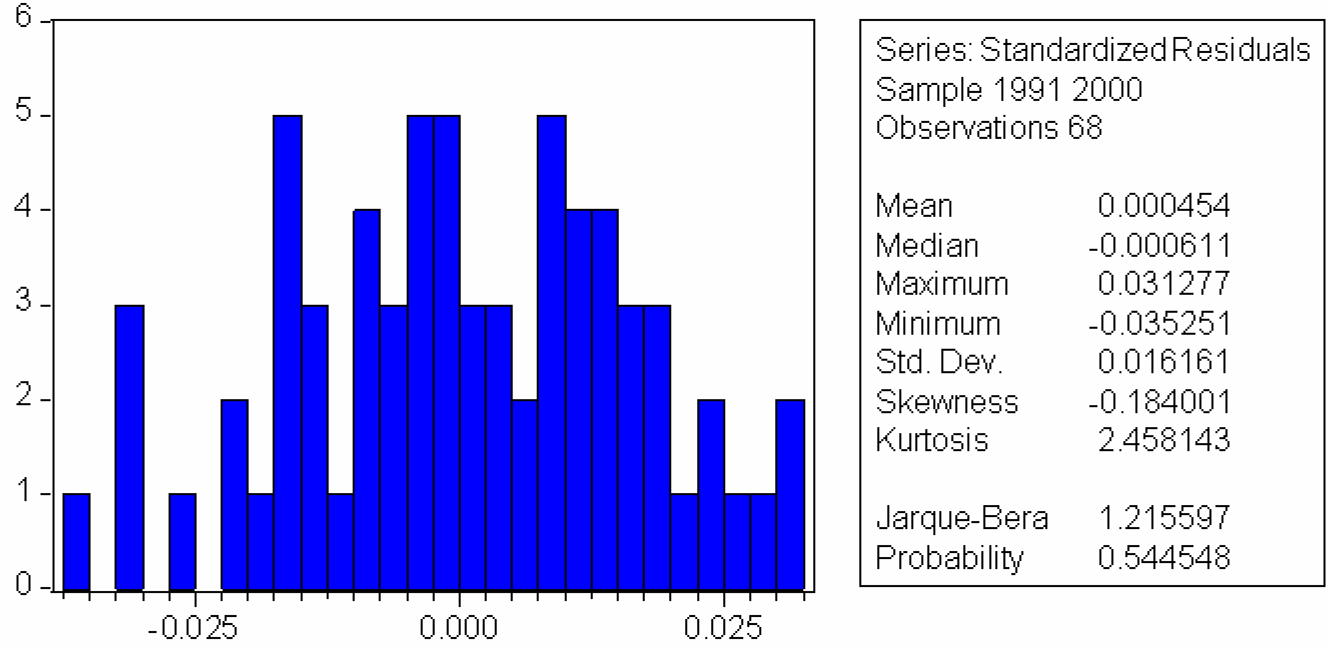


FIG. 6.6 HISTOGRAM OF RESIDUALS CONSUMER SERVICES INDUSTRY UNDER GENEARALIZED METHOD OF MOMENTS (ITERATION 4)

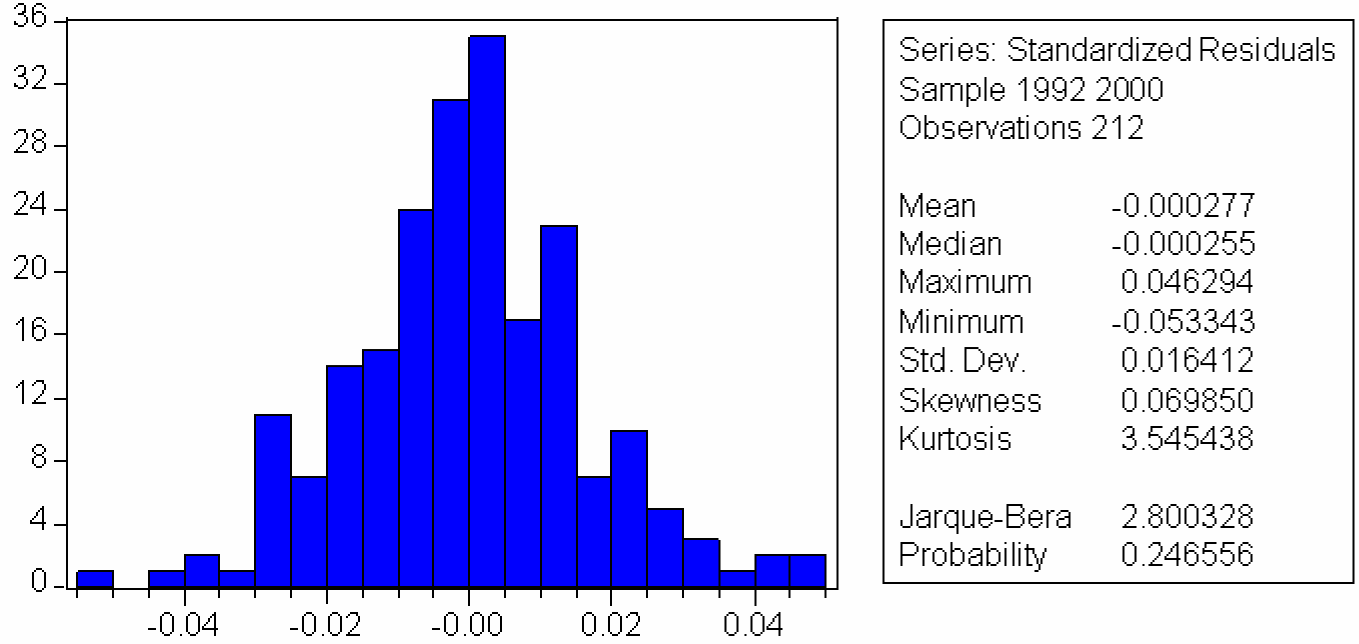


FIG. 6.7 HISTOGRAM OF RESIDUALS CONSUMER STAPLES SECTOR UNDER GENERALIZED METHOD OF MOMENTS

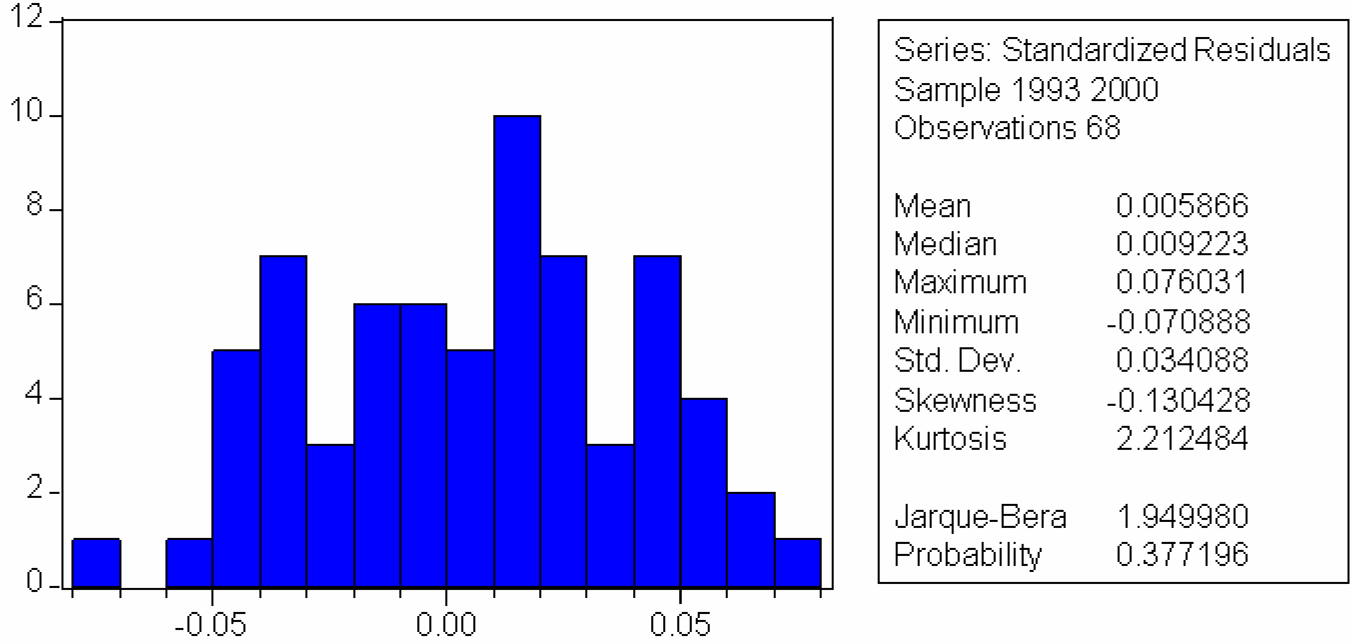


FIG. 6.8 HISTOGRAM OF RESIDUALS ENERGY SECTOR UNDER GENEARALIZED METHOD OF MOMENTS

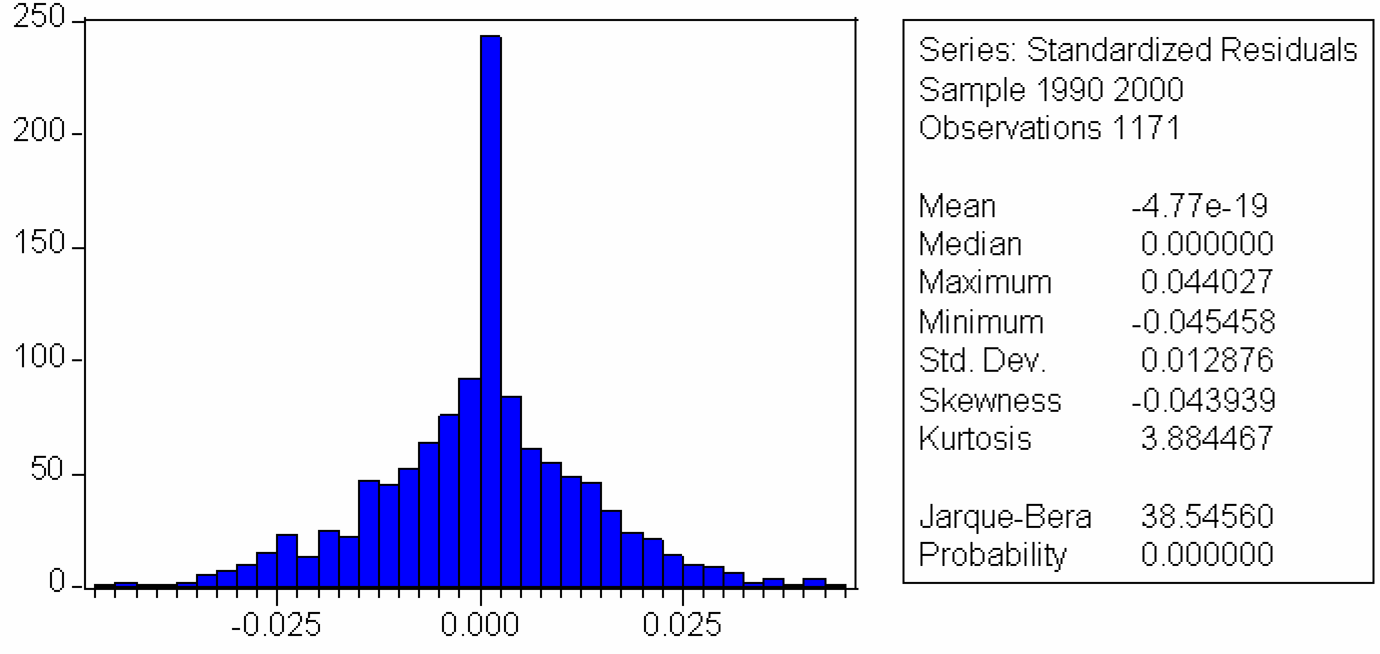


FIG. 6.9 HISTOGRAM OF RESIDUALS FOR THE ASX POOL OF COMPANIES UNDER PANEL LEAST SQUARES

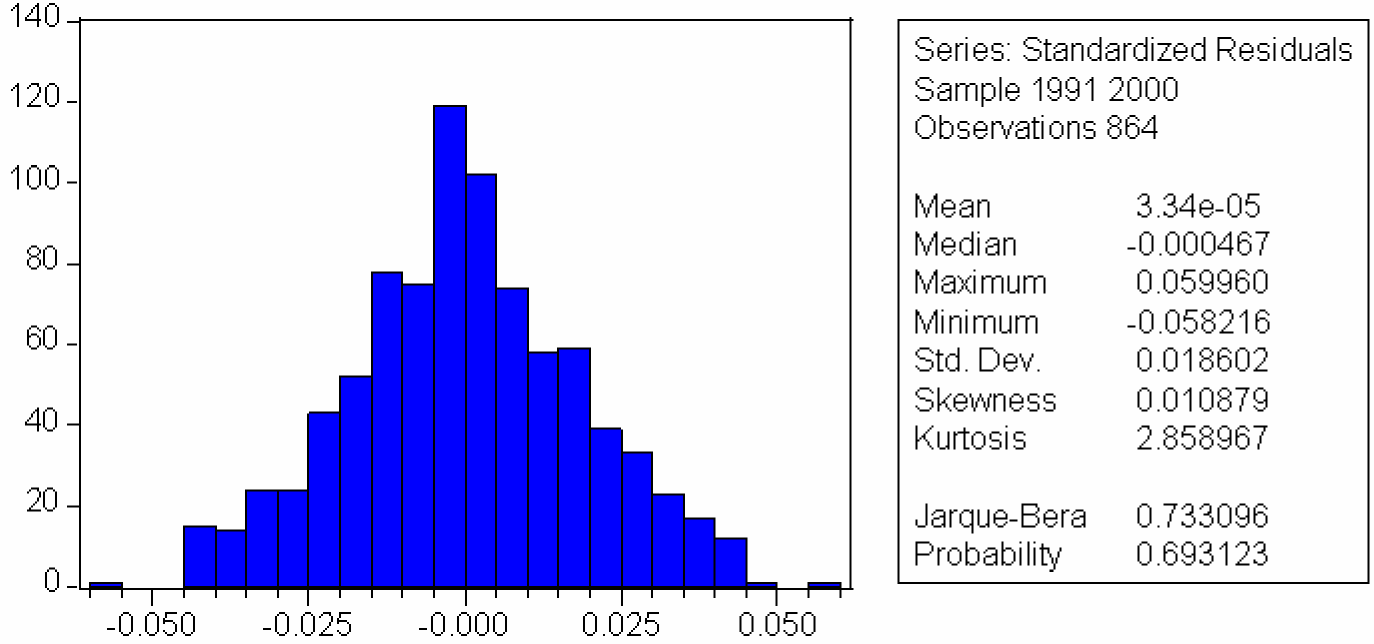


FIG. 6.10 HISTOGRAM OF RESIDUALS FOR THE ASX POOL UNDER GENERALIZED METHOD OF MOMENTS

TABLE 6.1 COMPANY DATA BASE
202 COMPANIES

Company	Particulars of adoption/non–adoption
Adelaide Bank	ERP 05/06. Looking CRM components 02-03
Advance H'care AHG	ERP99. Formerly Innovax. L91. AR99
Ad Magnesium ANM	NE. L83
AGD Mining AGZ	NE. L07/94. DL08/06. AR-
Agincourt Res AGC	NE. L01/'00
AJ Lucas Grp AJL	ERP04,Gr Pl intgrtd WorkBench,e-wide,Mark SummergreeneCFO
Alcoa AAI	ERP 96? (CIO 08/'96). MIMS pre01? (se). L08/'00. AR-
Alesco ALS	ERP 95."Upg dbl pwr" (AR95).Pre96(se).Aq & divst(John Camrn)
Alinta ALN	ERP98? L10/00. DL & RL 10/06. Merged AGL 06.AR-. se+W200
Alpha Tech ASU	ERP 98/99. L87. g +AR98–01
Alumina Ltd AWC	ERP 98. Former WMC (see below). L61
AMBRI ABI	ERP 02 Syteline."Running" by 04 (Fact).CRM.L06/00. g + AR-
Amcom Tele AMM	NE. L94. AR-
Amcor AMC	ERP 05 (Fact05). SCM late–90s (se). AR05/06
AMP	ERP PPS 11/'98 (Tebutt). SAP R/2 pre98. L06/98. AR-
Ampolex AMX	NE. DL on t/over Mobil 01/97. ARs available 94-97
Anaconda Nickel MRE	ERP 98 (Simon Weedon, IT Mgr). L94. W52
ANZ	ERP roll–out '97-'02. "Standardizing" '00-'01. L69. AR-
API	ERP 04-06. Movex. Prev Lg. L06/97. se + ACFB +AR04-06
Aristocrat Leisur ALL	ERP 07/'00. Completed mid–01. EPM. L07/96. g +AR00/01
Arnotts	NE. MIS '94. DL12/97. AR94
Atlas Grp Hlds AHS	ERP 10/04. L03. AR03–05. W200
Ausmelt	ERP06, Solomon. 5 Msf mix. Not true ERP—Wayne Pennell FM
Austar	ERP 99/00. L07/99

Company	Particulars of adoption/non–adoption
Austereo Group	ERP Pre04. L01. Majority owned by Village Roadshow
Aust. Gas Light Co AGL	ERP 97/98. L 1871 . Merged ALN 06. AR98+se. W200
Austrim Nylex NLX	ERP MAPICS +CA PRMS. Disparate due aqs 97–01
AWB Ltd. AWB	ERP 01/02. L08/'01. AR01&04. W200
Berklee BER FB	NE. L89. AR-
Beyond In'tl BYI	NE. L87. IS upgraded (AR97)
BHP Billiton	ERP 07/01—80% "globally". mySAP04. MIMS pre01(se)?AR00+
Blackmores BKL	ERP OneWorld Xe '01/'02. L85. AR01
BlueScope Steel	ERP Movex '04/'06. O'seas ops. '05. L02
Boral	Boral Building Services '00. Parent??? AR94–06—NE
Brambles	CHEP div. '01/'02. Parent??? L54. AR01/02—NE except.
Brickworks BKW	NE. L62. AR-
Brit Am Tobac. BAM	ERP end–98. L87. DeL 05/'01. AR98
BRL Hardy BRL	ERP Pre03—see folder. No ERP before '05 (Tilly Parker for FC)
Buderim Ginger BUG	ERP Movex 06/'03. L89. g
Caltex Australia CTX	ERP roll out 95–99. L80. AR98
Capral Alum CAA	ERP 99. Troubled. Fixed 02. Former Alcan. L86. se+AR97+
Carter Holt Har CHY	ERP 95–99. L91. DL04/'06. se & AR96–99
CBA	PPS Payroll, SCM '02. Web Services 02/03.
CBH Resources	ERP Pasminco aq. '03/'04. Parent???
Cellnet Group	ERP Movex 00/01. L99. g +ARO 06/'01
Chalmers CHR	NE. L60. ACFB. AR-
Chiquitita CHQ	ERP 00. Implemented by 10/00. L01/96. g +AR00
Citadel Pool Dev CID	NE. L04/97
Citect CTL	ERP 00. L07/97. DL 04/06. g

Company	Particulars of adoption/non–adoption
Citrofresh Int’l CTF	NE. L10/99 (as Plexus Int’l). AR-
Coca–Cola A’til CCL	Prob. IBS Aust. L70. AR-
Cochlear COH	ERP02. Compl.06/’05. L95. g + AR02–05.
Codan CDA	ERP 11/05 SAP. Replaces disparate sys (se). L11/03. AR05–06
Coffey In’tl COF	ERP Epicor ‘05/’06. L90
Coles Group CGJ	ERP Probably 03. PPS 99? L29. AR-
Comalco CMC	NE. Lg 03 (email: Glenn Chapman). L90. DL06/’00. AR-. W52.
Compumedics CMP	ERP 00/01. L12/00. AR-. g
Corporate Exp’s CXP	ERP Pre01. EAI for SCI 01. L95. AR-. Phone
CPI Grp CPI	ERP Movex 94/95. Fully 98/99. L92. AR+. W52. Phone
Crane Group	ERP00–04. Troubled. MicroStrategy BI 01. GWA comp
CSL Limited	ERP upg 99–03. On AS400 bfor upg? Phone
CSR Building Prod	ERP end03 but spun–off/demerged 70% assets to Rinker 03
CSR Limited	ERP SSA 06/’03. QAD SCM pre98. Conglomerate
David Jones (DJS)	NE. L11/95. AR-
DCA Group	NE. L87. I-MED, MIA & Amity divs non–intgtd financials. AR05
Deep Green Minerals	NE. L81. DL12/04. AR-
Diary Farm In’tl DFI	NE. Upg 93/94. $60m upg 98. L90. DL12/98. AR95&97/98
Downer EDI DOW	ERP07 via int’gtn dsp’rte sys via Hyperion CPM. L90. Fact +se
Electo Optic Sys EOS	ERP in progress 05. L00. se
Ellex Mdical Lasers ELX	NE. “No ERP” Accountant, Melanie 22/03/07
Email Ltd. EML	ERP 98–01. DL03/’01. se + AR98/00.
Energy Develop’nt ENE	ERP 97 Pronto. L93. Mainly financials. John Egan (Finance)
Energy Res. Aust. ERA	ERP 99. L80. AR98–99
Energy World Corp EWC	NE. Email Ian Jordan, Exec., “does not have an ERP” 18/09/07. NI

Company	Particulars of adoption/non–adoption
Envestra ENV	ERP 02/03. L08/97. Matt Davies, Snr Sup Eng, Kaz Grp (Telstra)
Evans Deakin	ERP99. T/over. DL04/'01
Fairfax FXJ	ERP 98/99. L92. se + AR98/99.
FH Faulding FHF	ERP? Upg99. DL11/01 on Mayne Nick, now SYB. AR99. W52.
Fisher&Pkl H'cr FPH	ERP 03/04. MRP MK Manf. 97. L11/01. AR04
Fisher&Pkl App FPA	ERP 97/98. L11/01. ARs unavailable for confirmation
Fletcher Bldg FBU	ERP ??? Aq Laminex Grp 11/02. L03/'01. AR-
Fletcher Ch'ln Forests	see Tenon
Flight Centre FLT	NE. L12/95. AR-
Fosters Group FGL	Oracle 95. JDE 01/02. L82. Imputed AR95–97
Gale Pacific GAP	ERP ??? Upg 00. L12/'00. AR-
Georg West Fd WEG	ERP98/99. Common e–wide SAP repl disparate. DL09/02. AR98
GES In'tl GEE	NE. Apparent disparate sys. L86. DL11/03
Gibson Industries	ERP 97. DL 12/97 on t/over by Ecolab
GIO Australia Hldg	NE. Lg. DL 01/'00 AMP t/over AR-
Goodman Fl'der GMF	ERP SCM 98. DL 06/'03. RL 12/'05 as GFF
GPT Grp GPT	NE. L71. AR-
Green's Foods GFD	ERP 97/98. e-Comm pre99. L93. AR97+
GWA GWT	ERP 04. R/out cross grp from 04/05 repl. disparate. L93. AR04/05
Hartec	see Longreach
Harvey Norman HVN	ERP '01? Fin 01 & FA10/02—email Jenny Kellet. L09/87. AR-.
Healthscope HSP	ERP 99, Accpac + Finance One (David Allison, CFO). NI
Horizon Oil (HZN)	NE. L81. AR-
Howard Smith SMI	ERP 97. L62. DL10/01 on t/o Wesfarmers. g +AR96/97
Hutchison Tel HTA	ERP, CRM BI/BA '01/'02. L08/99. Imputed AR00–02.

Company	Particulars of adoption/non–adoption
IAMA Ltd	??? Decision on hold til late 98. Aq by WES (WES AR01)
Iluka Resources (ILU)	ERP 03. AR03
Incitec ICT	ERP 96–98. SCM 00-01. L62. DL04/'03 on Orica. AR98
Ind. Prac. Network IPN	NE. "Not implemented" Mark Armstrong FC 22/03/07
Innovax	See Advanced Healthcare AHG
Jupiter's JUP	ERP 02 (Ashley Gilson, IT Mgr). L84. DL12/03 t/o Tabcorp
KAZ Computer KAZ	ERP 01. L03/00. DL03/04. AR-. (ONLY 2 YEARS)
Kleenheat Gas	Division of Wesfarmers
Kresta Holdings KRS	ERP 12/98. MFG/Pro. L71. AR98 (less than categorical)
Leighton Hldgs. LEI	ERP 02-04 (Thiess SBU). Other 5 SBUs? Fact +se +AR04
Lemarne Corp	Spectra Lighting Div 99/00. Oth. 3 div? AR92–06
Lend Lease Corp LLC	ERP???. Major upg (not categorical) $26m. L62. AR00.
Life Therapeutics	ERP 02–03. Great Plains, Prakash Patel, FC/CS. L86
Lighting Corp LCL	NE. "We don't have an ERP system" Mark Pearson CFO 27/03/07
Lion Nathan LNN	ERP 00. MFG/Pro (AR folder). L91. AR-
Longreach LRX	ERP 98, MRP95. Formerly Hartec. L94. DL11/06. g +AR95,98,99
Ludowici LDW	ERP 01/02. L71. AR01–02
Magna Pacific MPH	ERP 05 Navison. L88. AR05
McDonald Dowell MDC	NE."None prior to/ since t/over" Michael Benator, GFM 27/03/07
McGuigan Wines MGW	ERP 07 (Live 04/06) EnterpriseOne. Rpl Lg+LgERPs. Fact + se
McPherson's MCP	NE—disparate MIS in separate v'cals. IBS ASW 01. L62. AR97+
MIM Holdings	ERP12/00 "almost comp" (se). L62. DL 06/'03. g + AR-
Monadelphous MND	ERP 00–04,Hank De Vos IT Mgr via Amanda Fordham,HR.AR04
NAB	ERP 00. Troubled. Litigation 04. CRM 00-03 late 12mths
National Can Ind NCI	ERP 97. TIMSv10 (?). L84. g +AR97

Company	Particulars of adoption/non–adoption
National Foods NFD	ERP MFG/Pro 95. P'sive consol thru 98. L91. DL 06/'05. AR95+
Network NWK	ERP 03 Clear Enterprise. L07/00. g +AR03
North A Dia'ds NAD	NE—"does not have complex comp. sys", AR99. L79. AR-
Nova Health NHL	NE—Great Plains financials on aq by HSP (David Allison, CFO)
Novogen NRT	ERP 00.Impl 99-00, Mark Hinze, acct. Accpac.L94. se + AR- NI
Norwood Abbey NAL	ERP 01, Navision (Ray Close, Steven Freshwater, Acct). L00.
Occ'nal & M'cal OMI	NE. "No ERP" Jaape Borger FC 22/03/07
Onesteel OST	ERP (new) 11/01. BHP spin–off. L10/00. AR-
OPSM Group OPS	ERP 99/00. SCM from TIG Int'l. L62. DL 02/'05. AR98–00
Optima ICM OPI	ERP 03. CRM. L12/99. g
Orica	ERP 95–98. Aq Incitec 04/'03. eCom 98 (se). AR95
Origin Energy ORG	ERP 97/98. "New ESs across co." Conf. with CIO. L61. AR 97/98
Oroton ORL	ERP 99/00. 2nd ERP 04 (Fact05). L87. AR00
Pacifica PBB	ERP 95–99.MAPICS.PBRdiv Oz 95. Grp–wide by 99. AR99.W52
PaperlinX PPX	ERP 02–04. L04/'00. Former Amcor print. div. DM. g +AR01/04
Pasminco PAS	ERP end–99. Vol liq—trad supend. 09/01. DL 03/'06. AR00
Pauls Ltd PLS	ERP 95. SFA. DL08/98. Parmalat Aust. Pty. ARs unavailable
PCH Grp PCG	NE. L86. AR-
P&O Steam Nav. PSN	NE. L87. DL03/06. g + AR-
PMP Limited	ERP, CRM, EIS 02. MRP upg 05. e–Proc 00. AR checked
Polartechnics PLT	NE. "No ERP system" Richard 22/03/07
Progr'md M'nt Ser PRG	ERP 01-05, Navison. Ian Jones, GM Fin & Adm (email)
Qantas QAN	ERP???. L95. AR-. W52. Phone Co.
Q'land Cotton QCH	ERP 98–00. L92. g + AR98+
Quickflix	??? CRM 03/'04. L06/'05

Company	Particulars of adoption/non–adoption
Ramsay H'care RHC	L09/97
Repco RCL	NE. Lg. Pacific Dunlop spin–off 09/'01. L11/03
Resmed	ERP 02/'00. L11/'99
Rib Loc Grp	ERP 98, but "financial sys", Andrew Zeb, Fin & Adm Mgr. NI
Ridley Corp RIC	ERP upg in 2 divs. e-Comm pre-1999. L87. AR06
Rinker Grp RIN	L03/03
Rio Tinto RIO	ERP 98. MIMS 03/98. R/3. E–wide '07 (Jenny Stinson, FC). L61
RM Williams RMW	ERP 98/99. Movex. DL 12/03. AR99
Rock Bldg Soc ROK	NE. Lg. L92. AR97
Santos STO	ERP 98/99. Lg repl'd. Upg to Oracle 11i '02–'05. se+AR98
SDI Ltd	ERP 04 (Fin. Contr). Global roll–out. L85. g +AR05
SDS Corp	NE."No ERP system here"Phillip Eakons,Fin'ce Officer 28/03/07
Sigma Co. Ltd. SIP	ERP 10/04. IBS Pharma. L10/02
Skycity Entertainment	ERP "Introd across group" (Aust, VR'show). L03/99. AR05
Smorgon Steel SSX	ERP 01–03.SCM.Symix. Repl disp't sys. L02/99. se + AR01+
Snack Foods SFL	ERP ??? Financials.11i upg 01/02.L92.DL02.AR01.Mis'ng. Drop
Sonic H'care SHL	NE. L71. AR-
Southcorp	ERP 00/01. Aq by Foster's 05
St. George Bank	??? CRM 09/'05. No ERP evidence
Stokes (Aust) SKS	ERP 99.Distrib by Uniware (Jim). L79. AR98/99
Suncorp Mtway SUN	NE.MIMS/PPS financials.No ERP.Gary Woods, Mgr. Shared Syst
SuperCheap Auto	ERP 02. Integrated 20 stores 03, but listed 07/04
Symbion Health SYB	ERP00 (Tim Roper). M'ple aq.Prev'ly Mayne that t/o FHF.L62. se
Tab (NSW) TAB	ERP ??? L06/98. DL t/o 08/04 by Tabcorp. No TAB staff remain
Tabcorp TAH	ERP 05/98. Full operation '99. L94. AR98/Fact

Company	Particulars of adoption/non–adoption
Tat Hong Hldg	ERP 99 Movex. L09/97. DL11/05. g
Tecom Corp of NZ TEL	ERP 96 "Substantially implemented" Mark Dwight HOI, fmerly Fin
Telstra TLS	ERP 00? Live 03/'01 per AR02? SAP licenses AR05? L97.
Tenon TNN	ERP 99. F'merly Fl'cher Chl'ng Forests. L85. DL10/04. g +AR99
The Laminex Grp	Not listed. Aq by Fletcher Building 02.
The Warehouse WHS	ERP ???. L11/00. AR02 ("new IS functions")
Tower Limited TWR	ERP 96, but L09/99. AR-
Transfield TSE	ERP '02/'03. Upg '04/'05. L05/'01
Transurban TCL	ERP 10/02. L03/96
Unitab UTB	NE. F'ly Tab Qld. L99. DL 11/06 on T'sall's t/o. (Stephen Lawrie)
Ventracor	ERP03 Navison.Pre–03 Sage Financials only.Ian Blyghe, FC.L93
Village R'dshw VRL	ERP Pre04. Owns Austereo. Aq. by SkyCity 01. L87. se
Vision Systems VSL	NE. "No ERP implemented" Hoe Lee, FC 28/03/07
Volante Group VGL	ERP 02. L12/99. DL05/'06. AR02/03
Waste Manage WAM	ERP 95c. O'cle05. NZX listed. DL 06/06 merger. ARs unavail. se
Waterco WAT	ERP 99 Main (?). L89. g + AR99 (less than categorical)
Wattyl WYL	ERP 99. PRISM on AS/400 (as of 09/99). JDE Fin (se). AR95
Wesfarmers WES	??? K'heat div pre00. CRM01—ERP implied–Fact. AR-
WESFI	ERP 99.L72.DL 04/01 t/over. 1yr data. g+AR98. Prev ARs unavl
Western Metals WMT	ERP 12/99. MIMS. L86. AR99/00
Westpac WBC	ERP 96. CRM '01. L70. AR-
Wine Planet	ERP 99/00. DL 05/01 on t/o by Foster subsidiary. g +AR 96+
WMC Ltd WMC	ERP live 12/98. DM 11/02—AWC .6 & WMR .4. AR97/98
WMC Res'ces WMR	ERP 03. L12/02 on 40%WMC. DL 06/'05 on t/o by BHP
W'dside Petr'lm WPL	ERP 98. L71. se+AR98

Company	Particulars of adoption/non–adoption
Woolworths	ERP 03/04. i2 Technologies SCM. se
Zinifex ZFX	NE but restructured Pasminco. L04/'04.

Sources: Default: Factiva news database (1995–2001, 2003, 2004); other: AspectHuntley ASX Signal G extracts (1997–2005), the Wieder databases (W52 & W200), the ACFB database, & Google search extracts; all sources supplemented (where needed) with Google search extracts and complemented by company annual reports (1994–2006) from AspectHuntley Annual Reports Online

Legend: ACFB: Australian Centre for Family Business database; AR: annual report; AR-: Not disclosed in ARs; DL: de–listed; DM: de–merged; Fact05: Factiva '05 extraction; FB: family business; g: Signal G extracts; L: listed (ASX); Lg: legacy (incl. part–enterprise–wide ERP) systems; NE: no ERP (or no evidence of ERP); NI: Not included in treatment group sample; RL: re–listed; se: search extracts; W–Wieder database

TABLE 6.2 TREATMENT GROUP
(83 ERP–ADOPTERS, 9 UNCONFIRMED, 74 CONFIRMED, 14 REJECTED = 60)

Company	Circumstances Surrounding Adoption
Advance H'care AHG	ERP 99. Formerly Innovax. L91. g+AR99.
Agenix AGX	ERP 98. ??? Upg 01&02. Won't discl prod. Daniel Diesl CIO (by ph.)
Alcoa AAI	ERP 96? (CIO 08/'96). MIMS pre01? (se). L08/'00. AR- **
Alesco ALS	ERP 95."Upg dbl pwr" (AR95).Pre96(se).Aq & divst(John Camrn)
Alpha Tech ASU	ERP 98/99. L87. g +AR98–01
Alumina Ltd AWC	ERP 98. Former WMC (see below). L61
AMP	ERP 11/98 PPS (Tebutt). SAP R/2 pre98. L06/98. AR-
A'conda Nickel MRE	ERP 98 (Simon Weedon, IT Mgr). L94. W52
ANZ	ERP 97-02 roll–out. "Standardizing" 00-01. L69. AR-
Aristocrat Leisur ALL	ERP 07/'00. Completed mid–01. EPM. L07/96. AR00/01
Austar	ERP 99/00. L07/99
Austr. Gas Light AGL	ERP 97/98. L 1871 . Merged ALN 06. AR98+se. W200
Austrim Nylex NLX	ERP ?? MAPICS +CA PRMS. Disparate due aqs 97–01 **
AWB Ltd. AWB	ERP 01/02. L08/'01. AR01&04. W200
BHP Billiton	ERP 07/01—80% "globally". mySAP04. MIMS pre01(se)?AR00+ **
Blackmores BKL	ERP '01/'02 OneWorld Xe. L85. AR01
Brit Am Tobac. BAM	ERP end–98. L87. DeL 05/'01. AR98
Caltex Australia CTX	ERP 95–99 roll out. L80. AR98
Capral Alum CAA	ERP 99. Troubled. Fixed 02. Former Alcan. L86. se+AR97+
Carter Holt Har CHY	ERP 95–99. L91. DL04/'06. se & AR96–99
Cellnet Group	ERP 00/01 Movex. L99. g +ARO 06/'01
Chiquitita CHQ	ERP 00. Implemented by 10/00. L01/96. g +AR00
Citect CTL	ERP 00. L07/97. DL 04/06. g
Cochlear COH	ERP 02. Compl. 06/'05. L95. g + AR02–05.

Company	Circumstances Surrounding Adoption
Compumedics CMP	ERP 00/01. L12/00. g + AR-
Corporate Expr. CXP	ERP 95 Masterpack. Richard Arkell email. EAI for SCI 01. L95.AR-
CPI Grp CPI	ERP 94/95 Movex. Fully 98/99. L92. AR+. W52. Phone
Crane Group	ERP 00–04. Troubled. MicroStrategy BI 01. GWA comp
CSL Limited	ERP upg 99–03. On AS400 bfor upg? **
Email Ltd. EML	ERP 98–01. DL03/'01. g + AR98/00.
Energy Develop. ENE	ERP 97 Pronto. L93. Mainly financials. John Egan (Finance)
Energy Res Aus ERA	ERP 99. L80. AR98–99
Envestra ENV	ERP 02/03. L08/97. Matt Davies, Snr Sup Eng, Kaz Grp (Telstra)
Evans Deakin	ERP 99. T/over. DL04/'01
Fairfax FXJ	ERP 98/99. L92. se + AR98/99.
Fosters Group FGL	ERP 95. Oracle. JDE 01/02. L82. Imputed AR95–97
Georg West Fd WEG	ERP 98/99. Common e–wide SAP repl disparate. DL09/02. AR98
Goodman Fl'der GMF	ERP 98. SCM. DL 06/'03. RL 12/'05 as GFF
Green's Foods GFD	ERP 97/98. e-Comm pre99. L93. AR97+
Howard Smith SMI	ERP 97. L62. DL10/01 on t/o Wesfarmers. g +AR96/97
Hutchison Tel HTA	ERP 01/02. CRM BI/BA. L08/99. Imputed AR00–02.
Incitec ICT	ERP 96–98. SCM 00-01. L62. DL04/'03 on Orica. AR98
KAZ Computer KAZ	ERP 01. L03/00. DL03/04. AR-. (ONLY 2 YEARS)
Kresta Holdings KRS	ERP 12/98. MFG/Pro. L71. AR98 (less than categorical)
Lemarne Corp	ERP ??? Spectra Lighting Div 99/00. Oth. 3 div? AR92–06 **
Lend Lease Corp LLC	ERP 97,"upg ever since"(Victoria, PA to CIO).Upg ERP(?) AR00.L62
Lion Nathan LNN	ERP 99. MFG/Pro. Katherine Stubbs, PA to CIO. L91. AR-
Longreach LRX	ERP 98, MRP95. Formerly Hartec. L94. DL11/06. g +AR95,98,99
Ludowici LDW	ERP '01/'02. L71. AR01–02

Company	Circumstances Surrounding Adoption
Monadelphous MND	ERP 00–04,Hank De Vos IT Mgr via Amanda Fordham,HR.AR04
MIM Holdings	ERP 12/00 "almost comp" (se). L62. DL 06/'03. AR-
NAB	ERP 00. Troubled. Litigation 04. CRM 00-03 late 12mths
National Can Ind NCI	ERP 97. TIMSv10 (?). L84. g +AR97
National Foods NFD	ERP 95. MFG/Pro. P'sive consol thru 98. L91. DL 06/'05. AR95+
Norwood Abbey NAL	ERP 01, Navision (Ray Close, Steven Freshwater, Acct). L00.
Onesteel OST	ERP 11/01 (new). BHP spin–off. L10/00. AR-
OPSM Group OPS	ERP 99/00. SCM from TIG Int'l. L62. DL 02/'05. AR98–00
Orica	ERP 95–98. Aq Incitec 04/'03. eCom 98 (se). AR95
Origin Energy ORG	ERP 98. "New ESs across co." Conf. with CIO. AR 97/98.
Oroton ORL	ERP 99/00. 2nd ERP 04 (Fact05). L87. AR00
Pacifica PBB	ERP 95–99.MAPICS.PBRdiv Oz 95. Grp–wide by 99. AR99.W52
PaperlinX PPX	ERP 02–04. L04/'00. Former Amcor print. div. DM. g +AR01/ 04
Progr'md M'nt S PRG	ERP 01-05, Navison. Ian Jones, GM Fin & Adm (email)
Q'land Cotton QCH	ERP 98–00. L92. g + AR98+
Ramsay H'care RHC	L09/97 **
Resmed RMD	ERP 12/00., Greg James, CFC (prev. Pronto not e–wide). L11/99
Ridley Corp RIC	ERP ??? upg in 2 divs. e-Comm pre-1999. L87. AR06 **
Rio Tinto RIO	ERP 98. MIMS. Operational in 03/98. R/3. L61
RM Williams RMW	ERP 98/99. Movex. DL 12/03. AR99
Santos STO	ERP 98/99. Lg repl'd. Upg to Oracle 11i '02–'05. se+AR98
Skycity Entertainment	ERP ??? "Introd across group" (Aust, VR'show). L03/99. AR05 **
Smorgon Steel SSX	ERP 01–03. SCM. Infor Symix. Repl disp't sys pre-99. L02/99. se
Southcorp	ERP 00/01. Aq by Foster's 05
Stokes (Aust) SKS	ERP 99.Distrib by Uniware (Jim). L79. AR98/99

Company	Circumstances Surrounding Adoption
Symbion Health SYB	ERP 00 (Tim Roper). M'ple aq.Prev'ly Mayne that t/o FHF.L62. se
Tabcorp TAH	ERP 05/98. Full operation '99. L94. AR98/Factiva
Tat Hong Hldg	ERP 99 Movex. L09/97. DL11/05. g
Telcom Corp NZ TEL	ERP 96 "Substantially implemented" Mark Dwight HOI, f'merly Fin
Telstra TLS	ERP 00? Live 03/'01 per AR02? SAP licenses AR05? L97 **
Tenon TNN	ERP 99. F'merly Fl'cher Chl'ng Forests. L85. DL10/04. g +AR99
Waterco WAT	ERP 99 Tetra, upg Sage 05 (Shane Goh, IT Mgr). L89. g + AR99 (nc)
Wattyl WYL	ERP 95-99. PRISM on AS/400. JDE Fin (se). John Croker. AR95
Western Metals WMT	ERP 12/99. MIMS. L86. AR99/00
Westpac WBC	ERP 96. CRM '01. L70. AR-
WMC Ltd WMC	ERP 12/98. DM 11/02—AWC .6 & WMR .4. AR97/98–also see AWC
W'dside Petr'lm WPL	ERP 98. L71. se+AR98

Sources: Default: Factiva news database (1995–2001, 2003, 2004); other: AspectHuntley ASX Signal G extracts (1997–2005), the Wieder databases (W52 & W200), the ACB database, & Google search extracts; all sources supplemented (where needed) with Google search extracts and complemented with company annual reports (1994–2006) from AspectHuntley Annual Reports Online

Legend: AR: annual report; AR-: No ERP disclosure in ARs; DL: ASX de–listed; DM: operations de–merged into 2 or more companies; Fact05: Factiva '05 extraction; FB: family business; g: Signal G extracts; L: listed (ASX); Lg: Legacy (incl. part–enterprise–wide ERP) System; nc: not categorical; NE: no ERP (or no evidence of ERP); RL: re–listed; se: Google search extracts; W: Wieder database; **: ERP adoption pending confirmation

TABLE 6.3 MATCHED PAIRS

ERP Adopters		ERP Non-adopters		Sector ID
ALL	Aristocrat Leisure Limited	UTB	UNiTAB Limited	Consumer Discretionary
AUN	Austar United Communic'tn	MPH	Magna Pacific (Holdings) Limited	CD-10
FXJ	Fairfax Media Limited	BYI	Beyond International Limited	
KRS	Kresta Holdings Limited	MCP	McPherson's Limited	
OPS	OPSM Group Limited	DJS	David Jones Limited	
ORL	OrotonGroup Limited	WHS	Warehouse Group Ltd	
PBB	Pacifica Group Limited	BER	Berklee Limited	
RMW	RM Williams Holdings	HVN	Harvey Norman Holdings Ltd	
TAH	Tabcorp Holdings Limited	JUP	Jupiters Limited	
WAT	Waterco Limited	ATP	Atlas South Sea Pearl Limited	
AWB	AWB Limited	FOA	Foodland Associated Limited	Consumer Staples
CHQ	Costaexchange Ltd	SPC	SPC Ardmona Limited	CS-9
FGL	Foster's Group Limited	CGJ	Coles Group Limited	
GFD	Green's Foods Limited	MGW	McGuigan Simeon Wines	
GMF	Goodman Fielder Ltd	WOW	Woolworths Limited	
LNN	Lion Nathan Limited	BPC	Burns Philp	
NFD	National Foods Limited	BRL	BRL Hardy Limited	
QCH	Queensland Cotton Holdings	PMV	Premier Investments Limited	
SRP	Southcorp Limited	FCL	Futuris Corporation Limited	
CTX	Caltex Australia Limited	STO	Santos Limited/Oil Search	Energy
ORG	Origin Energy Limited	CNA	Coal & Allied Industries Limited	E-5
STO	Santos Limited	SRL	Straits Resources Limited	
WPL	Woodside Petroleum Limited	OCA	Oil Company/ Oil Search	
ERA	Energy Resources of Australia	NVS	Novus Petroleum Limited	
AGX	Agenix Limited	LFE	Life Therapeutics Limited	Health Care
AHG	Advance Healthcare Group	PLT	Polartechnics Limited	HC-8
BKL	Blackmores Limited	IPN	Independent Practitioner Netwk	
CMP	Compumedics Limited	OMI	Occupational & Medical Innov	
COH	Cochlear Limited	VSL	Vision Systems Limited	
RMD	ResMed Inc.	API	Australian Pharmaceutical Ind	
NAL	Norwood Abbey Limited	ELX	Ellex Medical Lasers Limited	
SYB	Symbion Health Limited	DVC	DCA Group Limited	
ALS	Alesco Corporation Limited	MDC	McConnell Dowell Corp	Industrials
CRG	Crane Group Limited	GWT	GWA International Limited	I-8
LDW	Ludowici Limited	AJL	AJ Lucas Group/ Lighting Corp	
SKS	Stokes (Australasia) Limited	AET	Ausmelt Limited	
CXP	Corporate Express	COF	Coffey International Limited	
TAT	Tat Hong Holdings Limited	DOW	Downer EDI Limited	
MND	Monadelphous Group	SDS	SDS Corporation Limited	
PRG	Programmed Maint. Serv.	COF	Coffey International Limited	

ERP Adopters		ERP Non-adopters		Sector ID
CTL	**Citect Corporation Limited**	VGL	Volante Group/Integrated Research	**Information Technology**
ASU	**Alpha Technologies Corp**	STR	Service Stream Ltd	**IT-4**
CLT	**Cellnet Group Limited**	OPI	Optima ICM/ Codan Limited	
LRX	**Longreach Group Limited**	GEE	GES International Limited	
AWC	**Alumina Limited**	AMC	Amcor Limited	**Materials**
CAA	**Capral Aluminium Limited**	ABC	Adelaide Brighton Limited	**M-14**
MRE	**Anaconda Nickel**	NCM	Newcrest Mining Limited	
CHY-NZ	**Carter Holt Harvey Limited**	MIM	M.I.M. Holdings Limited	
CPI	**CPI Group Limited**	ANM	Advanced Magnesium Limited	
ICT	**Incitec Limited**	SGW	Sons of Gwalia Limited	
NCI	**National Can Industries Limited**	LRL	Leyshon Resources Limited	
OST	**OneSteel Limited**	NUF	Nufarm Limited	
ORI	**Orica Limited**	PAS	Pasminco Limited	
PPX	**PaperlinX Limited**	AMC	Amcor Limited	
RIO	**Rio Tinto Limited**	BHP	BHP Billiton Limited	
SSX	**Smorgon Steel Group Limited**	SGW	Sons of Gwalia/ Adelaide Brighton	
TNN	**Tenon Limited**	ILU	Iluka Resources Limited	
WYL	**Wattyl Limited**	BKW	Brickworks Limited	
TEL	**Telcom Corp of NZ**	TLS	Telstra	**Telecom & Utilities**
AGL	**Australian Gas Light**	ENV	Envestra	**T&U-2**

TABLE 6.4 BUSINESS CYCLE PREDICTOR VARIABLES

Predictor Variables[204]		**Adopted Equivalents**[205]	
Ref	**Macroeconomic Variable/Indicator**	**Source**[206]	**Description**
Leading and Coincident Indicators			
CLI	Composite Index of Leading Indicators	OECD CLI (Trend Restored)	CLI Trend Restored (mirrors reference series)
			CLI 6-month Rate of Change Annualized
ASX200	Composite Stock Price Index	F-07/column E	S&P/ASX200 & Percent Change
ASXInds	Industrial Stock Price Index	F-07/column C	S&P/ASX200 Industrials & Percent Change
BCI_next3	Composite Index of Coincident Indicators	NAB	BCI Next 3 months & Change Percent
BCI_last3			BCI Last 3 months & Change Percent
GDPc	Gross Domestic Product in current dollars	5206001/row 73	GDP Current Index [2000=100] & Change Percent
GDPr	Constant Dollar GNP	13500/ws01/column J	Real GDP Volume Index [2000=100] & Change Percent
HousInc	Household Income	G-12/column Q	Total Household Income Index [2000=100] & Change Percent
ConsExp	Personal Consumption Expenditure	13500/ws07/column I	Private Consumption Expenditure Volume Index [2000=100] & Change Percent
UnempRat	Unemployment Rate	G-07/column I	Unemployment Rate & Change
Supply (Cost–Push Theories)			
CPI	Consumer Price Index	13500/ws13/column J	CPI & Change Percent
GDP_IPD	GDP Implicit Price Deflator	520408/row 50	GDP Implicit Price Deflator & Change Percent
LabCst	Unit Labour Cost Index	5206038/column I	Labour Cost (Real) Index & Change Percent
GOS	Gross Operating Surpluses	5206034/row 14	GOS

[204] Main source: Rose, Peter S., Andrews, Wesley T., and Giroux, Gary A. (1982), *"Predicting Business Failure: A Macroeconomic Perspective"*, Journal of Accounting, Auditing & Finance, vol 6, no 1, p20-31, who in turn cull from the leading and coincident indicator series developed by USDC and NBER, and from business cycle theory

[205] Adopted from publicly available sources: Australian Bureau of Statistics (ABS), Reserve Bank of Australia (RBA), International Monetary Fund's International Financial Statistics Service, (IMF–IFS), and the Organization of Economic Cooperation and Development (OECD). Business Conditions Index series and the Capacity Utilization Index series obtained courtesy National Australia Bank (NAB)

[206] References with an alphabetic prefix are RBA, and those with a numeric sequence are ABS. References from other sources are prefixed

Predictor Variables[204]		**Adopted Equivalents**[205]	
Ref	**Macroeconomic Variable/Indicator**	**Source**[206]	**Description**
PAT	After–tax Corporate Profits	5206034/row 14 - 5206018/row 17	GOS – Taxes on Income: Resident Corporations, Index & Change Percent
Oil	Oil Price Index	IMF-IFS Table 22821.9212352	Petroleum Average Spot Price Index & Change Percent
Metal	Resource Price Index	G-05/column K	RBA Base Metals Price Index & Change Percent
Monetary Theories			
CashRat	Prime Bank Rate	A-02/column E	Cash Rate & Change
Tbill13Rat	Treasury Bill Rate – 13 week	IMF-IFS 84858	13-week Treasury Bills Rate & Change
Tbond3Rat	Treasury Bonds Rate – 3 yr	IMF-IFS 84858	Treasury Bonds: 3 years Rate & Change
M1	Money Supply M1	13500/ws25/column G	M1 Volume Index [2000=100] & Change Percent
M3	Money Supply M3	D-01/column K	M3 – 12-month-ended Growth Rate (Change Percent)
Savings–Investment Theories			
GrsSav	Gross Savings	G-12/column V + 5206014/column BJ	[Disposable Income Savings+ Consumption of Fixed Capital] Index
GFCF_Pvt	Gross Private Domestic Investment	5206002/row 115 / row 132	Private GFCF Index
BInvest	Total Business Investment	5204071	End–year Net Capital Stock (at current prices) Index [2000=100]
BInvent	Business Inventories	13500_Table 3/ws12/column S	End–year Inventories Index
IPX	Industrial Production Index	13500_Table 9/ws11/column J	Industrial Production Volume Index [2000=100]
GDPperHr	Output per Hour	5204025/row 22	GDP per Hour Worked Index (chain volume)
CapUtilRat	Capacity Utilization Rate	NAB	Capacity Utilization Rate
DurGood	Durable Goods Sales	5206008/row 55	Furnishings & Household Equipment (Chain Volume) Index
Final_Sal	Final Sales in constant dollars	5206020/row 101 / 520408/column B	Total Sale: Current Prices / GDP IPD
Retail_Sal	Retail Sales	G-08/column C	Retail Trade Sale
FDInvst	Foreign Direct Investment	OECD FDI column L-U / F11/column C	FDI In/Out Flows / US$ Rate
PfolioInvst	Portfolio Investment	H-04/column H-G	Gross Foreign Assets – Non–official Sector: Portfolio Investment (Assets/Out flows)
BudDef	Government Budget Deficit	E-01/column AH	Headline Surplus (Deficit)
CoTax	Tax Revenue from Corporations	E-01/column F / 520405	Taxation Companies

TABLE 6.5 ROTATED COMPONENT MATRIX (LEVELS)

Level Variables	Component			
	1	2	3	4
CoTax	.965			.198
ASXInds	.964	.176	.134	
ConsExp	.959	.187	.197	
M3	.954	.222	.181	
GDPr	.952	.169	.246	
HousInc	.952	.178	.205	.129
BInvest	.950	.256	.171	
Final_Sal	.948		.299	
GFCF_Pvt	.946		.303	
BInvent	.945		.291	
GDPc	.942	.241	.216	
Retail_Sal	.942	.167	.249	.110
IPX	.935	.154	.292	.112
ASX200	.927	.234	.203	.124
PfolioInvst	.926	.312	.195	
GDPperHr	.912	.350	.180	
M1	.909	.317	.264	
PAT	.899	.349	.256	
CPI	.853	.373	.173	.281
GDP_IPD	.843	.463	.148	.208
CLI	.828	.481	.246	
DurGd	.806	.416	.370	.198
BudDef	.737	-.541		-.274
LabCst	-.627	-.485	-.330	
CashRat	-.419	-.891		
Tbill13Rat	-.468	-.860	.124	-.115
Oil	-.289	-.773	-.115	.345
Tbond3Rat	-.628	-.735	.173	-.130
UnempRat	-.571	.668	-.458	
BCI_last3	.363	.199	.894	
BCI_next3	.407	.296	.839	.132
Metal		-.246	.825	
CapUtilRat	.466	-.352	.800	
GrsSav		-.133	.558	.759
FDInvst	.578	.222		.652

TABLE 6.6 TOTAL VARIANCE EXPLAINED
(LEVELS)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	25.429	72.653	72.653	25.429	72.653	72.653	21.689	61.969	61.969
2	4.532	12.949	85.602	4.532	12.949	85.602	5.646	16.130	78.100
3	2.426	6.932	92.534	2.426	6.932	92.534	4.708	13.451	91.551
4	1.209	3.455	95.989	1.209	3.455	95.989	1.553	4.438	95.989
5	.445	1.272	97.260						
6	.434	1.241	98.502						
7	.263	.753	99.254						
8	.212	.607	99.861						
9	.049	.139	100.000						
10	1.18E-015	3.36E-015	100.000						
11	9.50E-016	2.71E-015	100.000						
12	5.67E-016	1.62E-015	100.000						
13	5.49E-016	1.57E-015	100.000						
14	4.78E-016	1.37E-015	100.000						
15	3.50E-016	9.99E-016	100.000						
16	3.13E-016	8.94E-016	100.000						
17	2.78E-016	7.94E-016	100.000						
18	2.33E-016	6.64E-016	100.000						
19	1.83E-016	5.22E-016	100.000						
20	1.61E-016	4.60E-016	100.000						
21	1.33E-016	3.80E-016	100.000						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
22	4.34E-017	1.24E-016	100.000						
23	-1.20E-017	-3.43E-017	100.000						
24	-4.40E-017	-1.26E-016	100.000						
25	-1.22E-016	-3.49E-016	100.000						
26	-1.36E-016	-3.90E-016	100.000						
27	-1.73E-016	-4.95E-016	100.000						
28	-1.91E-016	-5.47E-016	100.000						
29	-2.50E-016	-7.14E-016	100.000						
30	-2.91E-016	-8.32E-016	100.000						
31	-3.72E-016	-1.06E-015	100.000						
32	-4.08E-016	-1.17E-015	100.000						
33	-4.80E-016	-1.37E-015	100.000						
34	-5.04E-016	-1.44E-015	100.000						
35	-7.50E-016	-2.14E-015	100.000						

TABLE 6.7 ROTATED COMPONENT MATRIX (CHANGES)

Change Variables	Component						
	1	2	3	4	5	6	7
GDPr	.943	-.192	.169			.129	
BCI_last3	.942	-.149	.131			-.222	
Final_Sal	.932	-.185	-.144	.159	.189		
BInvent	.902	.290	-.100				
BCI_next3	.901	-.273	.176			-.239	
CapUtilRat	.857	.187	.154		-.260		.353
IPX	.848	-.150	-.105		.281	-.104	
ConsExp	.844	.186			-.463		
Retail_Sal	.759				-.428	-.285	-.380
GDPc	.738	.512	.128	.274		.274	.111
GFCF_Pvt	.729	-.512			.371	-.154	
UnempRat	-.598	-.326	-.109		.521	-.337	-.349
M3	.549	.460	.480			.376	.320
BInvest	.506	.463		.266	-.303	.335	.461
Tbill13Rat		.975					.147
CPI		.974				.132	
Tbond3Rat	-.114	.973				-.112	.104
CashRat		.958				.140	.122
GDP_IPD	-.250	.886		.193		.213	.108
CoTax	.461	.759		-.354	-.182	.114	
GDPperHr		-.735			.145	.558	.227
CLI	-.597	-.720	.238		.141	.121	-.101
ASXInds		-.705	.566				
LabCst		.691	.480	.433	-.157		.264
HousInc	.677	.683	.157			.197	
ASX200		-.472	.846		.110		
BudDef	.573	-.134	-.590	.120	.121	.324	.381
Oil	.347	.415	.576	-.102	-.368	.188	-.213
PfolioInvst	-.157	.103		.847	-.131	.168	.156
GOS	.330		-.185	.813	.385		
DurGood	.102		.133	.705	.253	-.372	-.448
M1		-.563	-.102	.276	.731	-.155	
GrsSav	.296	.514	.476	.113	.587		-.135
Metal	.309	-.242		-.104	.162	-.853	
FDInvst	-.125	-.231					-.902

TABLE 6.8 TOTAL VARIANCE EXPLAINED (CHANGES)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.508	35.737	35.737	12.508	35.737	35.737	10.936	31.247	31.247
2	9.536	27.247	62.984	9.536	27.247	62.984	10.148	28.995	60.242
3	3.250	9.287	72.271	3.250	9.287	72.271	2.762	7.892	68.134
4	2.826	8.075	80.345	2.826	8.075	80.345	2.594	7.412	75.546
5	2.575	7.356	87.701	2.575	7.356	87.701	2.517	7.192	82.739
6	1.479	4.225	91.926	1.479	4.225	91.926	2.248	6.421	89.160
7	1.233	3.523	95.449	1.233	3.523	95.449	2.201	6.289	95.449
8	.851	2.431	97.880						
9	.742	2.120	100.000						
10	2.13E-015	6.09E-015	100.000						
11	8.96E-016	2.56E-015	100.000						
12	7.49E-016	2.14E-015	100.000						
13	7.09E-016	2.03E-015	100.000						
14	4.85E-016	1.38E-015	100.000						
15	4.32E-016	1.23E-015	100.000						
16	3.31E-016	9.45E-016	100.000						
17	3.14E-016	8.98E-016	100.000						
18	2.99E-016	8.55E-016	100.000						
19	2.50E-016	7.15E-016	100.000						
20	1.97E-016	5.64E-016	100.000						
21	9.75E-017	2.79E-016	100.000						
22	4.74E-017	1.35E-016	100.000						
23	-5.74E-017	-1.64E-016	100.000						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
24	-9.27E-017	-2.65E-016	100.000						
25	-1.42E-016	-4.05E-016	100.000						
26	-2.05E-016	-5.86E-016	100.000						
27	-2.99E-016	-8.54E-016	100.000						
28	-4.23E-016	-1.21E-015	100.000						
29	-4.77E-016	-1.36E-015	100.000						
30	-5.16E-016	-1.47E-015	100.000						
31	-5.33E-016	-1.52E-015	100.000						
32	-6.70E-016	-1.91E-015	100.000						
33	-7.79E-016	-2.22E-015	100.000						
34	-1.08E-015	-3.08E-015	100.000						
35	-1.70E-015	-4.85E-015	100.000						

TABLE 6.9 ROTATED COMPONENT MATRIX (CHANGES)

Change Variables	Component				
	1	2	3	4	5
BCI_last3	.964	-.147			.138
BCI_next3	.928	-.268			.171
Final_Sal	.925	-.170		.293	-.129
GDPr	.900	-.230	.245	.144	.180
BInvent	.887	.289	.153		
IPX	.851	-.158		.201	
ConsExp	.834	.234	.242	-.192	
CapUtilRat	.833	.156	.419	-.164	.188
Retail_Sal	.813	.100	-.273	-.203	
GFCF_Pvt	.738	-.526		.302	
GDPc	.655	.461	.447	.275	.209
Tbill13Rat	-.104	.956	.236		
Tbond3Rat	-.120	.955		.106	.115
CPI	-.105	.940	.185	-.102	.170
CashRat	-.131	.937	.281		
GDP_IPD	-.304	.857	.303	.144	
GDPperHr	-.117	-.806	.449		
ASXInds		-.759			.491
CLI	-.606	-.743	-.139		.151
CoTax	.450	.735	.169	-.359	.110
LabCst		.640	.352	.249	.550
HousInc	.622	.631	.328		.246
BInvest	.426	.436	.746		
UnempRat	-.543	-.300	-.636	.388	-.159
FDInvst	-.106	-.157	-.587		
M3	.463	.348	.572	-.103	.534
Metal	.434	-.206	-.569		
GOS	.256		.258	.882	-.159
DurGood	.113	.143	-.422	.749	.170
M1		-.591	-.234	.669	-.162
PfolioInvst	-.230	.126	.410	.560	
ASX200		-.559	-.133		.785
Oil	.312	.385	.111	-.302	.640
BudDef	.516	-.140	.543	.171	-.588
GrsSav	.250	.412		.469	.532

TABLE 6.10 TOTAL VARIANCE EXPLAINED (CHANGES)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.508	35.737	35.737	12.508	35.737	35.737	10.566	30.187	30.187
2	9.536	27.247	62.984	9.536	27.247	62.984	9.813	28.036	58.223
3	3.250	9.287	72.271	3.250	9.287	72.271	4.108	11.738	69.962
4	2.826	8.075	80.345	2.826	8.075	80.345	3.277	9.362	79.324
5	2.575	7.356	87.701	2.575	7.356	87.701	2.932	8.377	87.701
6	1.479	4.225	91.926						
7	1.233	3.523	95.449						
8	.851	2.431	97.880						
9	.742	2.120	100.000						
10	2.13E-015	6.09E-015	100.000						
11	8.96E-016	2.56E-015	100.000						
12	7.49E-016	2.14E-015	100.000						
13	7.09E-016	2.03E-015	100.000						
14	4.85E-016	1.38E-015	100.000						
15	4.32E-016	1.23E-015	100.000						
16	3.31E-016	9.45E-016	100.000						
17	3.14E-016	8.98E-016	100.000						
18	2.99E-016	8.55E-016	100.000						
19	2.50E-016	7.15E-016	100.000						
20	1.97E-016	5.64E-016	100.000						
21	9.75E-017	2.79E-016	100.000						
22	4.74E-017	1.35E-016	100.000						
23	-5.74E-017	-1.64E-016	100.000						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
24	-9.27E-017	-2.65E-016	100.000						
25	-1.42E-016	-4.05E-016	100.000						
26	-2.05E-016	-5.86E-016	100.000						
27	-2.99E-016	-8.54E-016	100.000						
28	-4.23E-016	-1.21E-015	100.000						
29	-4.77E-016	-1.36E-015	100.000						
30	-5.16E-016	-1.47E-015	100.000						
31	-5.33E-016	-1.52E-015	100.000						
32	-6.70E-016	-1.91E-015	100.000						
33	-7.79E-016	-2.22E-015	100.000						
34	-1.08E-015	-3.08E-015	100.000						
35	-1.70E-015	-4.85E-015	100.000						

TABLE 6.11 ROTATED COMPONENT MATRIX

Change Variables	Component		
	1	2	3
BCI_last3	.952	-.203	
GDPr	.946	-.177	.128
CapUtilRat	.914	.225	-.185
BCI_next3	.910	-.331	
Final_Sal	.890	-.205	.354
BInvent	.889	.259	
ConsExp	.859	.226	-.165
IPX	.811	-.212	.253
GDPc	.748	.566	.198
Retail_Sal	.739		-.194
HousInc	.696	.670	
GFCF_Pvt	.695	-.553	.369
UnempRat	-.671	-.434	.394
M3	.622	.505	-.255
BudDef	.546		.399
Tbill13Rat		.983	
CashRat		.982	
CPI		.950	-.210
Tbond3Rat		.943	
GDP_IPD	-.238	.936	
LabCst	.137	.764	
ASXInds	.134	-.698	-.116
CoTax	.482	.692	-.405
CLI	-.599	-.686	
BInvest	.560	.627	
GDPperHr		-.593	.123
ASX200		-.519	-.217
Metal	.316	-.403	
GrsSav	.284	.403	.244
FDInvst	-.216	-.337	
GOS	.284		.903
M1		-.592	.713
DurGood			.625
PfolioInvst	-.143	.311	.530
Oil	.395	.388	-.505

TABLE 6.12 TOTAL VARIANCE EXPLAINED (CHANGES)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.508	35.737	35.737	12.508	35.737	35.737	11.157	31.878	31.878
2	9.536	27.247	62.984	9.536	27.247	62.984	10.643	30.409	62.287
3	3.250	9.287	72.271	3.250	9.287	72.271	3.494	9.984	72.271
4	2.826	8.075	80.345						
5	2.575	7.356	87.701						
6	1.479	4.225	91.926						
7	1.233	3.523	95.449						
8	.851	2.431	97.880						
9	.742	2.120	100.000						
10	2.13E-015	6.09E-015	100.000						
11	8.96E-016	2.56E-015	100.000						
12	7.49E-016	2.14E-015	100.000						
13	7.09E-016	2.03E-015	100.000						
14	4.85E-016	1.38E-015	100.000						
15	4.32E-016	1.23E-015	100.000						
16	3.31E-016	9.45E-016	100.000						
17	3.14E-016	8.98E-016	100.000						
18	2.99E-016	8.55E-016	100.000						
19	2.50E-016	7.15E-016	100.000						
20	1.97E-016	5.64E-016	100.000						
21	9.75E-017	2.79E-016	100.000						
22	4.74E-017	1.35E-016	100.000						
23	-5.74E-017	-1.64E-016	100.000						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
24	-9.27E-017	-2.65E-016	100.000						
25	-1.42E-016	-4.05E-016	100.000						
26	-2.05E-016	-5.86E-016	100.000						
27	-2.99E-016	-8.54E-016	100.000						
28	-4.23E-016	-1.21E-015	100.000						
29	-4.77E-016	-1.36E-015	100.000						
30	-5.16E-016	-1.47E-015	100.000						
31	-5.33E-016	-1.52E-015	100.000						
32	-6.70E-016	-1.91E-015	100.000						
33	-7.79E-016	-2.22E-015	100.000						
34	-1.08E-015	-3.08E-015	100.000						
35	-1.70E-015	-4.85E-015	100.000						

TABLE 6.13 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/28/07 Time: 23:30
Sample (adjusted): 1992 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 261

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.435265	0.175125	-2.485450	0.0137
ROA_CHG(-1)	-0.012673	0.015149	-0.836513	0.4038
ROA_CHG(-2)	0.007153	0.024483	0.292172	0.7704
CUR(-1)	0.552869	0.244334	2.262760	0.0247
BOND_RAT(-1)	0.369992	0.229470	1.612372	0.1084
GOS(-1)	-0.030810	0.045104	-0.683103	0.4953

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.987553	Mean dependent var	0.007317
Adjusted R-squared	0.984290	S.D. dependent var	0.237854
S.E. of regression	0.029812	Akaike info criterion	-4.002994
Sum squared resid	0.183085	Schwarz criterion	-3.251850
Log likelihood	577.3907	F-statistic	302.6743
Durbin-Watson stat	1.983774	Prob(F-statistic)	0.000000

TABLE 6.14 AUTOCORRELATION FUNCTION (ACF) AND PARTIAL CORRELATION FUNCTION (PCF) OF THE RESIDUALS – CONSUMER SERVICES

Date: 08/29/07 Time: 14:18
Sample: 1989 2000
Included observations: 261

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|. |	.|. |	1	0.008	0.008	0.0172	0.896
*|. |	*|. |	2	-0.103	-0.103	2.8329	0.243
*|. |	*|. |	3	-0.143	-0.143	8.2966	0.040
*|. |	*|. |	4	-0.111	-0.125	11.610	0.021
.|. |	*|. |	5	-0.044	-0.081	12.134	0.033
.|. |	*|. |	6	-0.034	-0.089	12.444	0.053
.|. |	*|. |	7	-0.041	-0.101	12.904	0.074
.|. |	*|. |	8	-0.031	-0.092	13.163	0.106

The columns AC and PAC are the ACF and PCF of the residuals, together with the Ljung–Box *Q* statistics for high–order serial correlation. If there is no serial correlation in the residuals, the autocorrelations and partial autocorrelations at all lags should be nearly zero, and all *Q* statistics should be insignificant with large *p*–values.

The null hypothesis of the test is that there is no serial correlation in the residuals up to the specified order.

Eviews 5.1 User Guide p495

The dotted lines in the plots of the ACF and PCF are the approximate two standard error bounds computed at $\pm 2 / \sqrt{n}$. If a correlation is within these bounds, it is not significantly different from zero at (approximately) the 5% significance level.

Eviews 5.1 User Guide p327

Conclusion – Since asterisks in the plots signify correlations outside the bounds at each respective lag, and therefore significantly different from zero at the 5% level, the plot shows the first order correlation insignificant at $p<.05$. This is supported with the small *Q* stat (.0172) at high *p*–value (.896). The null hypothesis of no first order serial correlation is upheld.

Note – The Durbin–Watson statistic is not appropriate as a test for serial correlation since there is a lagged dependent variable on the right hand side of the equation

Eviews 5.1 User Guide p496

TABLE 6.15 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP EX. GOS INDICATOR VARIABLE REGRESSOR

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/29/07 Time: 13:20
Sample (adjusted): 1992 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 261

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.375075	0.151149	-2.481498	0.0139
ROA_CHG(-1)	-0.012273	0.015118	-0.811756	0.4179
ROA_CHG(-2)	0.009028	0.024297	0.371544	0.7106
CUR(-1)	0.439182	0.178658	2.458231	0.0148
BOND_RAT(-1)	0.461958	0.185587	2.489167	0.0136

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.987525	Mean dependent var	0.007317
Adjusted R-squared	0.984331	S.D. dependent var	0.237854
S.E. of regression	0.029774	Akaike info criterion	-4.008394
Sum squared resid	0.183499	Schwarz criterion	-3.270907
Log likelihood	577.0955	F-statistic	309.1730
Durbin-Watson stat	1.982962	Prob(F-statistic)	0.000000

TABLE 6.16 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP EX. MACROECONOMIC INDICATOR VARIABLE REGRESSORS

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/29/07 Time: 13:36
Sample (adjusted): 1992 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 261

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007235	0.001869	3.870036	0.0001
ROA_CHG(-1)	-0.013117	0.015260	-0.859599	0.3910
ROA_CHG(-2)	0.002012	0.024470	0.082209	0.9346

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.987074	Mean dependent var	0.007317
Adjusted R-squared	0.983919	S.D. dependent var	0.237854
S.E. of regression	0.030162	Akaike info criterion	-3.988181
Sum squared resid	0.190138	Schwarz criterion	-3.278009
Log likelihood	572.4576	F-statistic	312.9323
Durbin-Watson stat	1.934012	Prob(F-statistic)	0.000000

TABLE 6.17 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP WITH SINGLE ROA LAG ONLY

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/29/07 Time: 20:48
Sample (adjusted): 1991 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 276

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007673	0.002237	3.429973	0.0007
ROA_CHG(-1)	-0.003084	0.017990	-0.171448	0.8640

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.979153	Mean dependent var	0.007696
Adjusted R-squared	0.974520	S.D. dependent var	0.232421
S.E. of regression	0.037100	Akaike info criterion	-3.585121
Sum squared resid	0.309696	Schwarz criterion	-2.916134
Log likelihood	545.7467	F-statistic	211.3536
Durbin-Watson stat	1.629837	Prob(F-statistic)	0.000000

TABLE 6.18 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP WITH NO FIXED EFFECTS SPECIFIED

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/29/07 Time: 21:08
Sample (adjusted): 1991 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 276

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA_CHG(-1)	0.843008	0.070560	11.94747	0.0000

R-squared	0.340975	Mean dependent var	0.007696
Adjusted R-squared	0.340975	S.D. dependent var	0.232421
S.E. of regression	0.188680	Akaike info criterion	-0.493910
Sum squared resid	9.790054	Schwarz criterion	-0.480793
Log likelihood	69.15964	Durbin-Watson stat	0.981160

TABLE 6.19 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP WITH NO FIXED EFFECTS SPECIFIED (AND REINTRODUCING ROA LAG 2)

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/29/07 Time: 21:20
Sample (adjusted): 1992 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 261

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA_CHG(-1)	0.877241	0.070633	12.41965	0.0000
ROA_CHG(-2)	0.568076	0.137693	4.125656	0.0000

R-squared	0.385358	Mean dependent var	0.007317
Adjusted R-squared	0.382985	S.D. dependent var	0.237854
S.E. of regression	0.186835	Akaike info criterion	-0.509549
Sum squared resid	9.040990	Schwarz criterion	-0.482235
Log likelihood	68.49614	Durbin-Watson stat	0.893646

TABLE 6.20 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP WITH NO FIXED EFFECTS SPECIFIED FOR THE FULL MODEL

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/29/07   Time: 21:25
Sample (adjusted): 1992 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 261

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA_CHG(-1)	0.869846	0.071327	12.19526	0.0000
ROA_CHG(-2)	0.567824	0.139054	4.083486	0.0001
CUR(-1)	-0.091217	0.334102	-0.273020	0.7851
BOND_RAT(-1)	1.059035	1.397148	0.757998	0.4491
GOS(-1)	0.018932	0.229877	0.082356	0.9344

R-squared	0.392070	Mean dependent var	0.007317
Adjusted R-squared	0.382571	S.D. dependent var	0.237854
S.E. of regression	0.186898	Akaike info criterion	-0.497541
Sum squared resid	8.942255	Schwarz criterion	-0.429256
Log likelihood	69.92915	Durbin-Watson stat	0.894013

TABLE 6.21 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP WITH RANDOM PERIOD EFFECTS SPECIFIED

Dependent Variable: ROA
Method: Panel EGLS (Period random effects)
Date: 08/29/07 Time: 21:47
Sample (adjusted): 1992 2000
Cross-sections included: 50
Total panel (unbalanced) observations: 261
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.099490	1.083971	-1.014318	0.3114
ROA_CHG(-1)	0.869535	0.071886	12.09599	0.0000
ROA_CHG(-2)	0.569836	0.140157	4.065686	0.0001
CUR(-1)	1.402706	1.510836	0.928431	0.3541
BOND_RAT(-1)	1.303469	1.428569	0.912430	0.3624
GOS(-1)	-0.121685	0.269989	-0.450705	0.6526

Effects Specification

	S.D.	Rho
Period random	0.000000	0.0000
Idiosyncratic random	0.188362	1.0000

Weighted Statistics

R-squared	0.394552	Mean dependent var	0.007317
Adjusted R-squared	0.382680	S.D. dependent var	0.237854
S.E. of regression	0.186881	Sum squared resid	8.905751
F-statistic	33.23512	Durbin-Watson stat	0.893627
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.394552	Mean dependent var	0.007317
Sum squared resid	8.905751	Durbin-Watson stat	0.893627

TABLE 6.22 LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY GROUP TABLE OF CROSS SECTION (FIRM) FIXED EFFECTS

	CO	Effect
1	ABS	0.087229
2	AGI	-0.854271
3	AIG	0.054941
4	ALL	0.156183
5	ATH	-0.017980
6	BCL	-0.490309
7	BIR	0.056630
8	BLE	-0.395548
9	BRI	0.041688
10	CAI	0.062506
11	CBT	0.018866
12	CLK	0.059868
13	CXE	0.014487
14	EBG	0.004568
15	EBT	-0.189442
16	ERJ	-0.096701
17	ESL	0.062908
18	FLT	0.122347
19	HAM	0.028112
20	HWT	0.279719
21	HWW	0.050083
22	HYO	-0.358910
23	IAS	0.036485
24	ITG	0.025913
25	JUP	0.058475
26	KDS	-1.460252
27	LAS	-0.034173
28	MAC	-0.017894
29	MFS	0.039113
30	MNA	-0.036121
31	MSH	0.036975
32	NHH	0.038914
33	OCE	0.034994
34	ODG	0.019922

TABLE 6.22 (CONT.) LEAST SQUARES REGRESSION FOR CONSUMER SERVICES INDUSTRY TABLE OF CROSS SECTION (FIRM) FIXED EFFECTS

	CO	Effect
35	PDR	-0.000856
36	QTI	0.010778
37	RCT	-0.008291
38	SAQ	0.134847
39	SAX	-0.000539
40	SDR	0.047406
41	SGS	0.034317
42	SKC	0.108226
43	TAB	0.546701
44	TAH	0.101888
45	TBC	-1.551426
46	TCO	0.014682
47	TLC	0.017533
48	TVL	-0.158957
49	UTB	0.719875
50	WEB	-0.110553

TABLE 6.23 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR CONSUMER SERVICES INDUSTRY GROUP

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 08/19/07 Time: 11:16
Sample (adjusted): 1991 2000
Cross-sections included: 36
Total panel (unbalanced) observations: 198
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	0.019521	0.006554	2.978527	0.0033
CUR(-1)	2.229043	0.302079	7.379001	0.0000
BOND_RAT(-1)	-0.386165	0.054556	-7.078304	0.0000
GOS(-1)	-0.250105	0.043163	-5.794441	0.0000

Effects Specification

Cross-section fixed (first differences)

R-squared	-1.157451	Mean dependent var	0.004971
Adjusted R-squared	-1.190814	S.D. dependent var	0.084921
S.E. of regression	0.125696	Sum squared resid	3.065078
J-statistic	22.77902	Instrument rank	27.00000

1. Sargan test for over-identifying restrictions (i.e over-identification of instrument variables):

   H0: Number of Instruments is not over-identified
   H1: Number of instruments is over-identified

   Test Specification:
   Under the null hypothesis that over-identifying restrictions

are valid, the J-Statistic is chi-squared distributed with (p-k) df where p = instrument rank, k = estimated coefficients.

Eviews 5.1 Command Specification:

scalar pval = @chisq(J-statistic, df)
where,
df = p - k

Calculation:

df = 27 - 4 = 23
scalar pval = @chisq(22.77902,23) = 0.47

Conclusion:

There is no evidence to support H1.
Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -1.157451. This is patently incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:

   y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

   R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.74

TABLE 6.24 ACF AND PCF FOR THE CONSUMER SERVICES INDUSTRY GROUP UNDER GENERALIZED METHOD OF MOMENTS ESTIMATION

Date: 08/19/07 Time: 11:17

Sample: 1989 2000

Included observations: 171

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>***|. |</td><td>***|. |</td><td>1</td><td>-0.405</td><td>-0.405</td><td>28.484</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>*|. |</td><td>2</td><td>0.109</td><td>-0.066</td><td>30.560</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>3</td><td>-0.008</td><td>0.015</td><td>30.570</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>4</td><td>-0.035</td><td>-0.031</td><td>30.790</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>5</td><td>0.007</td><td>-0.026</td><td>30.799</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>6</td><td>0.015</td><td>0.012</td><td>30.840</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>7</td><td>-0.086</td><td>-0.087</td><td>32.179</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>8</td><td>0.062</td><td>-0.009</td><td>32.886</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>9</td><td>-0.002</td><td>0.030</td><td>32.886</td><td>0.000</td></tr>
</table>

Note: The bar plots for the 2 functions do not show (on export into MS Word). However, the 2^{nd} order correlation of the first differenced residual is within the ±1.96SD / √n as follows:

$$\pm 1.96 / \sqrt{n} = \pm 1.96 / \sqrt{171} = \pm 0.149$$

r at lag 2 of the ACF is +0.109

r at lag 2 is inside the ± 1.96SD bound

TABLE 6.25 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR CONSUMER SERVICES INDUSTRY GROUP (2ND ITERATION)

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 08/19/07   Time: 17:40
Sample (adjusted): 1991 2000
Cross-sections included: 25
Total panel (unbalanced) observations: 128
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	-0.011288	0.001640	-6.882216	0.0000
CUR(-1)	0.323785	0.003928	82.43452	0.0000
BOND_RAT(-1)	0.664080	0.018981	34.98691	0.0000
GOS(-1)	0.018838	0.005645	3.337442	0.0011

Effects Specification

Cross-section fixed (first differences)

R-squared	-1.103651	Mean dependent var	-0.000288
Adjusted R-squared	-1.154546	S.D. dependent var	0.027568
S.E. of regression	0.040466	Sum squared resid	0.203047
J-statistic	15.53211	Instrument rank	20.00000

1. Sargan test for over-identifying restrictions (i.e over-identification of instrument variables)

H0: Number of Instruments is not over-identified
H1: Number of instruments is over-identified

Test Specification:

Under the null hypothesis that over-identifying restrictions are valid, the J-Statistic is chi-squared distributed with (p-k) df where p = instrument rank, k = estimated coefficients.

Eviews 5.1 Command Specification:

scalar pval = @chisq(J-statistic, df)
where,
df = p - k

Calculation:

df = 20 - 4 = 16
scalar pval = @chisq(15.53211,16) = 0.49

Conclusion:

There is no evidence to support H1.
Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -1.103651. This is patently incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:

y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.97

TABLE 6.26 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR CONSUMER SERVICES INDUSTRY GROUP (3RD ITERATION)

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 08/19/07 Time: 18:35
Sample (adjusted): 1991 2000
Cross-sections included: 18
Total panel (unbalanced) observations: 86
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	-0.016133	0.001592	-10.13072	0.0000
CUR(-1)	0.165634	0.036936	4.484369	0.0000
BOND_RAT(-1)	-0.095775	0.039060	-2.451992	0.0163
GOS(-1)	-0.065354	0.019116	-3.418783	0.0010

Effects Specification

Cross-section fixed (first differences)

R-squared	-1.320751	Mean dependent var	0.000188
Adjusted R-squared	-1.405656	S.D. dependent var	0.017060
S.E. of regression	0.026461	Sum squared resid	0.057413
J-statistic	12.18493	Instrument rank	15.00000

1. Sargan test for over-identifying restrictions (i.e over-identification of instrument variables):

   H0: Number of Instruments is not over-identified
   H1: Number of instruments is over-identified

   Test Specification:
   Under the null hypothesis that over-identifying restrictions are valid, the J-Statistic is chi-squared distributed with (p-k) df where p = instrument rank, k = estimated coefficients.

Eviews 5.1 Command Specification:

scalar pval = @chisq(J-statistic, df)

where,

df = p - k

Calculation:

df = 15 - 4 = 11

scalar pval = @chisq(12.18493,11) = 0.35

Conclusion:

There is no evidence to support H1.

Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -1.320751. This is incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:

y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.99

TABLE 6.27 ACF AND PCF FOR THE CONSUMER SERVICES INDUSTRY GROUP UNDER GENERALIZED METHOD OF MOMENTS ESTIMATION (3)

Date: 08/30/07 Time: 14:13
Sample: 1989 2000
Included observations: 77

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
****| . |	****| . |	1	-0.506	-0.506	20.486	0.000
. |** |	. | . |	2	0.244	-0.017	25.301	0.000
**| . |	.*| . |	3	-0.257	-0.188	30.722	0.000
. |*. |	. | . |	4	0.169	-0.044	33.104	0.000
. | . |	. |*. |	5	-0.029	0.082	33.175	0.000
. | . |	. | . |	6	-0.025	-0.046	33.228	0.000
. | . |	. | . |	7	0.005	-0.020	33.230	0.000
. | . |	. | . |	8	0.001	0.021	33.230	0.000

Note: The bar plots for the 2 functions do not print (on export into MS Word). However, the 2nd order correlation of the first differenced residual is outside the ±1.96SD / √n as follows:

$$\pm 1.96 / \sqrt{n} = \pm 1.96 / \sqrt{77} = \pm 0.223$$

r at lag 2 of the ACF is +0.244

r at lag 2 is outside the ± 1.96SD bound

TABLE 6.28 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR CONSUMER SERVICES INDUSTRY GROUP (4TH ITERATION)

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 08/19/07 Time: 22:38
Sample (adjusted): 1991 2000
Cross-sections included: 13
Total panel (unbalanced) observations: 68
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	-0.014947	0.000666	-22.46027	0.0000
CUR(-1)	0.092310	0.033346	2.768223	0.0074
BOND_RAT(-1)	0.066903	0.022795	2.934989	0.0046
GOS(-1)	0.002895	0.010648	0.271911	0.7866

Effects Specification

Cross-section fixed (first differences)

R-squared	-0.874840	Mean dependent var	-0.000101
Adjusted R-squared	-0.962723	S.D. dependent var	0.011808
S.E. of regression	0.016542	Sum squared resid	0.017513
J-statistic	7.595779	Instrument rank	12.00000

1. Sargan test for over-identifying restrictions:

H0: Number of Instruments is not over-identified
H1: Number of instruments is over-identified

Test specification:

Under the null hypothesis that over-identifying restrictions are valid, the J-Statistic is chi-squared distributed with (p- k) df where p is instrument rank, k is estimated coefficients

Eviews 5.1 Command Specification:

scalar pval = @chisq(J-statistic, df)

where,

df = p – k

Calculation:

df = 12 - 4 = 8

scalar pval = @chisq(7.595779,8) = 0.47

Conclusion:

There is no evidence to support H1.

Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -0.874840. This is incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:

y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.99

TABLE 6.29 ACF AND PCF FOR THE CONSUMER SERVICES INDUSTRY GROUP UNDER GENERALIZED METHOD OF MOMENTS (4) ESTIMATION

Date: 08/19/07 Time: 22:40						
Sample: 1989 2000						
Included observations: 63						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
***| . |	***| . |	1	-0.407	-0.407	10.946	0.001
. |*. |	. | . |	2	0.122	-0.053	11.943	0.003
.*| . |	.*| . |	3	-0.183	-0.183	14.220	0.003
. |*. |	. | . |	4	0.108	-0.038	15.030	0.005
.*| . |	.*| . |	5	-0.101	-0.086	15.756	0.008
. | . |	. | . |	6	0.064	-0.036	16.054	0.013
. | . |	. | . |	7	-0.002	0.023	16.055	0.025
. | . |	. | . |	8	0.011	0.000	16.063	0.041
. | . |	. | . |	9	-0.010	0.005	16.070	0.065

Note: The bar plots for the 2 functions do not print (on export into MS Word). However, the 2nd order correlation of the first differenced residual is within the ±1.96SD / √n as follows:

$$\pm 1.96 / \sqrt{n} = \pm 1.96 / \sqrt{63} = \pm\ 0.246$$

r at lag 2 of the ACF is +0.122

r at lag 2 is inside the ± 1.96SD bound

TABLE 6.30 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR CONSUMER DISCRETIONARY SECTOR

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 08/08/07 Time: 00:51
Sample (adjusted): 1991 2000
Cross-sections included: 45
Total panel (unbalanced) observations: 259
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	0.091458	0.008339	10.96702	0.0000
CUR(-1)	0.262716	0.029534	8.895429	0.0000
BOND_RAT(-1)	-0.086505	0.014208	-6.088307	0.0000
GOS(-1)	-0.060345	0.008459	-7.133712	0.0000

Effects Specification

Cross-section fixed (first differences)

R-squared	-0.479323	Mean dependent var	-9.31E-05
Adjusted R-squared	-0.496726	S.D. dependent var	0.013687
S.E. of regression	0.016745	Sum squared resid	0.071500
J-statistic	32.91308	Instrument rank	34.00000

1. Sargan test for over-identifying restrictions:

H0: Number of Instruments is not over-identified
H1: Number of instruments is over-identified

Test Specification:

Under the null hypothesis that over-identifying restrictions are valid, the J-Statistic is chi-squared distributed with (p-k) df where p = instrument rank, k = estimated coefficients.

Eviews 5.1 Command Specification:

scalar pval = @chisq(J-statistic, df)

where,

df = p - k

Calculation:

df = 34 - 4 = 30

scalar pval = @chisq(32.91308,30) = 0.33

Conclusion:

There is no evidence to support H1.

Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -0.479323. This is incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:
   y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

   R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.99

TABLE 6.31 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR CONSUMER STAPLES SECTOR

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 07/31/07 Time: 02:11
Sample (adjusted): 1992 2000
Cross-sections included: 35
Total panel (unbalanced) observations: 212
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	0.178681	0.014224	12.56176	0.0000
CUR	-0.304011	0.026744	-11.36752	0.0000
BOND_RAT(-1)	-0.135824	0.008909	-15.24503	0.0000
GOS(-2)	-0.012640	0.006151	-2.055022	0.0411

Effects Specification

Cross-section fixed (first differences)

R-squared	-0.935593	Mean dependent var	-0.000482
Adjusted R-squared	-0.963510	S.D. dependent var	0.011798
S.E. of regression	0.016532	Sum squared resid	0.056849
J-statistic	28.73266	Instrument rank	31.00000

1. Sargan test for over-identifying restrictions:

H0: Number of Instruments is not over-identified
H1: Number of instruments is over-identified

Test Specification:

Under the null hypothesis that over-identifying restrictions are valid, the J-Statistic is chi-squared distributed with (p-k) df where p = instrument rank, k = estimated coefficients.

Eviews 5.1 Command Specification:

scalar pval = @chisq(J-statistic, df)

where,

df = p - k

Calculation:

df = 31 - 4 = 27

scalar pval = @chisq(28.73266,27) = 0.37

Conclusion:

There is no evidence to support H1.

Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -0.935593. This is incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:
   y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

   R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.90

TABLE 6.32 ACF AND PCF FOR THE CONSUMER STAPLES SECTOR UNDER GENERALIZED METHOD OF MOMENTS ESTIMATION

Date: 07/31/07 Time: 02:16
Sample: 1989 2000
Included observations: 183

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
***|. |	***|. |	1	-0.423	-0.423	33.229	0.000
.|. |	**|. |	2	-0.004	-0.223	33.233	0.000
.|. |	*|. |	3	0.032	-0.083	33.426	0.000
.|. |	.|. |	4	-0.014	-0.042	33.462	0.000
.|. |	.|. |	5	0.025	0.011	33.585	0.000
.|. |	.|. |	6	-0.012	0.007	33.612	0.000
.|. |	.|. |	7	-0.015	-0.015	33.656	0.000
.|. |	.|. |	8	-0.000	-0.021	33.656	0.000

Note: The bar plots for the 2 functions do not print (on export into MS Word). However, the 2nd order correlation of the first differenced residual is within the ±1.96SD / √n as follows:

$$\pm 1.96 / \sqrt{n} = \pm 1.96 / \sqrt{183} = \pm 0.144$$

r at lag 2 of the ACF is -0.004

r at lag 2 is inside the ± 1.96SD bound

TABLE 6.33 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR THE ENERGY SECTOR

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 08/25/07 Time: 14:08
Sample (adjusted): 1993 2000
Cross-sections included: 18
Total panel (unbalanced) observations: 68
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,GOS,-3) CUR(-3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	-0.174530	0.016496	-10.58017	0.0000
CUR(-1)	2.214702	0.266430	8.312520	0.0000
BOND_RAT(-1)	1.737814	0.124831	13.92133	0.0000
GOS(-1)	-0.270755	0.039478	-6.858429	0.0000

Effects Specification

Cross-section fixed (first differences)

R-squared	-1.519688	Mean dependent var	-0.003950
Adjusted R-squared	-1.637798	S.D. dependent var	0.021795
S.E. of regression	0.035398	Sum squared resid	0.080194
J-statistic	13.99217	Instrument rank	18.00000

1. Sargan test for over-identifying restrictions:

H0: Number of Instruments is not over-identified
H1: Number of instruments is over-identified

Test Specification:

Under the null hypothesis that over-identifying restrictions are valid, the J-Statistic is chi-squared distributed with (p-k) df where p = instrument rank, k = estimated coefficients.

Eviews 5.1 Command Specification:

scalar pval = @chisq(J-statistic, df)

where,

df = p - k

Calculation:

df = 18 - 4 = 14

scalar pval = @chisq(13.99217,14) = .45

Conclusion:

There is no evidence to support H1.

Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -1.519688. This is incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:

y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.99

TABLE 6.34 ACF AND PCF FOR THE ENERGY SECTOR UNDER GENERALIZED METHOD OF MOMENTS ESTIMATION

Date: 08/25/07 Time: 14:22
Sample: 1989 2000
Included observations: 55

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
***| . |	***| . |	1	-0.371	-0.371	8.0101	0.005
. | . |	**| . |	2	-0.054	-0.222	8.1794	0.017
. |*. |	. | . |	3	0.088	-0.022	8.6513	0.034
.*| . |	.*| . |	4	-0.113	-0.114	9.4408	0.051
. | . |	.*| . |	5	-0.005	-0.099	9.4421	0.093
. | . |	. | . |	6	0.052	-0.021	9.6182	0.142

Note: The bar plots for the 2 functions do not print (on export into MS Word). However, the 2nd order correlation of the first differenced residual is within the ±1.96SD / √n as follows:

$$\pm 1.96 / \sqrt{n} = \pm 1.96 / \sqrt{55} = \pm 0.264$$

r at lag 2 of the ACF is -0.054

r at lag 2 is inside the ± 1.96SD bound

TABLE 6.35 PANEL LEAST SQUARES ESTIMATION FOR THE ASX POOL OF LISTED COMPANIES

Dependent Variable: ROA
Method: Panel Least Squares
Date: 08/25/07 Time: 17:36
Sample (adjusted): 1990 2000
Cross-sections included: 307
Total panel (unbalanced) observations: 1171
White cross-section standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.076387	0.018174	-4.202990	0.0000
ROA(-1)	0.559426	0.027245	20.53326	0.0000
CUR(-1)	0.193800	0.025864	7.493021	0.0000
BOND_RAT(-1)	-0.140411	0.019377	-7.246339	0.0000
GOS(-1)	-0.045657	0.006890	-6.626416	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.993581	Mean dependent var	0.045622
Adjusted R-squared	0.991267	S.D. dependent var	0.160705
S.E. of regression	0.015018	Akaike info criterion	-5.336592
Sum squared resid	0.193975	Schwarz criterion	-3.991242
Log likelihood	3435.575	F-statistic	429.3791
Durbin-Watson stat	1.999835	Prob(F-statistic)	0.000000

TABLE 6.36 ACF AND PCF FOR THE ASX POOL UNDER LEAST SQUARES ESTIMATION

Date: 08/26/07 Time: 02:15
Sample: 1989 2000
Included observations: 1171

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|* |	.|* |	1	0.072	0.072	6.0302	0.014
*| |	*| |	2	-0.071	-0.077	11.953	0.003
*| |	*| |	3	-0.092	-0.082	21.839	0.000
*| |	*| |	4	-0.083	-0.077	29.892	0.000
*| |	*| |	5	-0.098	-0.102	41.175	0.000
*| |	*| |	6	-0.109	-0.120	55.165	0.000
*| |	*| |	7	-0.069	-0.091	60.785	0.000
.| |	*| |	8	-0.025	-0.066	61.534	0.000
.| |	*| |	9	-0.020	-0.074	61.989	0.000
.| |	*| |	10	-0.006	-0.062	62.027	0.000

Note: The bar plots for the 2 functions do not print (on export into MS Word). However, the 2nd order correlation of the first differenced residual is outside the ±1.96SD / √n as follows:

$$\pm 1.96 / \sqrt{n} = \pm 1.96 / \sqrt{1171} = \pm\ 0.057$$

r at lag 2 of the ACF is -0.071

r at lag 2 is outside the ± 1.96SD bound

TABLE 6.37 GENERALIZED METHOD OF MOMENTS ESTIMATION FOR THE ASX POOL OF LISTED COMPANIES

Dependent Variable: ROA
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 08/05/07 Time: 18:50
Sample (adjusted): 1991 2000
Cross-sections included: 151
Total panel (unbalanced) observations: 864
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(ROA,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ROA(-1)	0.608623	0.036041	16.88674	0.0000
CUR(-1)	0.207806	0.034346	6.050323	0.0000
BOND_RAT(-1)	-0.159261	0.026503	-6.009258	0.0000
GOS(-1)	-0.048146	0.007109	-6.772468	0.0000

Effects Specification

Cross-section fixed (first differences)

R-squared	-1.059015	Mean dependent var	-0.000624
Adjusted R-squared	-1.066197	S.D. dependent var	0.012963
S.E. of regression	0.018634	Sum squared resid	0.298614
J-statistic	63.06264	Instrument rank	55.00000

1. Sargan test for over-identifying restrictions:

H0: Number of Instruments is not over-identified
H1: Number of instruments is over-identified

Test Specification:

Under the null hypothesis that over-identifying restrictions are valid, the J-Statistic is chi-squared distributed with (p-k) df where p = instrument rank, k = estimated coefficients.

Eviews 5.1 Command Specification:

```
scalar pval = @chisq(J-statistic, df)
```

where,

df = p - k

Calculation:

df = 55 - 4 = 51

scalar pval = @chisq(63.06264,51) = 0.12

Conclusion:

There is no evidence to support H1.

Over-identifying restrictions remain valid.

2. Explanatory power of the model:

The R-square of the model is reported at -1.059015. This is incorrect. The correct R-square is calculated as follows:

a. The distribution of the 1st differences of the dependent variable is determined as follows:

y = ROA - ROA(-1)

b. The squared standard deviation of the distribution is multiplied by the number of observations to derive the sum of squares for treatments (SST)

c. The SST is divided into the 'Sum Squared Resid' above and the result substracted from 1 as follows:

R-sq = 1 - SSR/SST

d. The resulting R-sq is 0.99

TABLE 6.38 ACF AND PCF FOR THE ASX POOL OF COMPANIES UNDER THE GENERALIZED METHOD OF MOMENTS ESTIMATION

Date: 08/31/07 Time: 03:39
Sample: 1989 2000
Included observations: 785

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
****|. |	****|. |	1	-0.490	-0.490	189.13	0.000
.|. |	**|. |	2	0.045	-0.257	190.71	0.000
.|. |	*|. |	3	0.017	-0.115	190.93	0.000
.|. |	.|. |	4	0.002	-0.041	190.94	0.000
.|. |	.|. |	5	0.002	-0.007	190.94	0.000
.|. |	.|. |	6	-0.006	-0.004	190.97	0.000
.|. |	.|. |	7	-0.012	-0.022	191.08	0.000
.|. |	.|. |	8	0.013	-0.008	191.22	0.000
.|. |	.|. |	9	-0.000	0.002	191.22	0.000

Note: The bar plots for the 2 functions do not print (on export into MS Word). However, the 2nd order correlation of the first differenced residual is within the ±1.96SD / √n as follows:

$$\pm 1.96 / \sqrt{n} = \pm 1.96 / \sqrt{785} = \pm 0.069$$

r at lag 2 of the ACF is +0.045

r at lag 2 is inside the ± 1.96SD bound

TABLE 6.39 ROA RESIDUALS YEAR 1

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
ALL	Aristocrat Leisure Limited	UTB	UNiTAB Limited	-0.1416	-1.5159	Year 1
AUN	Austar United Communic'tn	MPH	Magna Pacific (Holdings) Limited	7.6736	0.0283	CD-10
FXJ	Fairfax Media Limited	BYI	Beyond International Limited	0.0097	0.0060	
KRS	Kresta Holdings Limited	MCP	McPherson's Limited	0.5239	0.0320	
OPS	OPSM Group Limited	DJS	David Jones Limited	-0.0177	0.0141	
ORL	OrotonGroup Limited	WHS	Warehouse Group Ltd	0.4137	0.0300	
PBB	Pacifica Group Limited	BER	Berklee Limited	-0.0012	-0.0678	
RMW	RM Williams Holdings	HVN	Harvey Norman Holdings Ltd	-0.0307	0.0123	
TAH	Tabcorp Holdings Limited	JUP	Jupiters Limited	0.0083	-0.0129	
WAT	Waterco Limited	ATP	Atlas South Sea Pearl Limited	-0.0024	0.3686	
AWB	AWB Limited	FOA	Foodland Associated Limited	-0.0252	-0.0352	Year 1
CHQ	Costaexchange Ltd	SPC	SPC Ardmona Limited	-0.0465	0.0161	CS-9
FGL	Foster's Group Limited	CGJ	Coles Group Limited	-0.0029	0.0120	
GFD	Green's Foods Limited	MGW	McGuigan Simeon Wines	0.0189	-0.0067	
GMF	Goodman Fielder Ltd	WOW	Woolworths Limited	-0.0193	0.0005	
LNN	Lion Nathan Limited	BPC	Burns Philp	-0.0357	0.0340	
NFD	National Foods Limited	BRL	BRL Hardy Limited	-0.0456	0.0018	
QCH	Queensland Cotton Holdings	PMV	Premier Investments Limited	-0.1174	0.0025	
SRP	Southcorp Limited	FCL	Futuris Corporation Limited	-0.0028	0.0047	
CTX	Caltex Australia Limited	STO	Santos Limited/Oil Search	0.0069	0.0284	Year 1
ORG	Origin Energy Limited	CNA	Coal & Allied Industries Limited	0.0047	0.1736	E-5
STO	Santos Limited	SRL	Straits Resources Limited	-0.0033	0.0134	
WPL	Woodside Petroleum Limited	OCA	Oil Company/ Oil Search	0.0438	-0.0209	
ERA	Energy Resources of Australia	NVS	Novus Petroleum Limited	0.0018	0.0260	
AGX	Agenix Limited	LFE	Life Therapeutics Limited	-0.0043	0.0559	Year 1
AHG	Advance Healthcare Group Ltd	PLT	Polartechnics Limited	-0.0224	0.4353	HC-8
BKL	Blackmores Limited	IPN	Independent Practitioner Netwk	0.0059	0.0067	
CMP	Compumedics Limited	OMI	Occupational & Medical Innov	0.0611	0.1940	
COH	Cochlear Limited	VSL	Vision Systems Limited	0.0450	-0.0463	
RMD	ResMed Inc.	API	Australian Pharmaceutical Ind	-0.0878	0.0091	

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
NAL	**Norwood Abbey Limited**	ELX	Ellex Medical Lasers Limited	**0.3221**	**0.2563**	
SYB	**Symbion Health Limited**	DVC	DCA Group Limited	**-0.0167**	**-0.0330**	
ALS	**Alesco Corporation Limited**	MDC	McConnell Dowell Corp	**-0.0062**	**0.0396**	Year 1
CRG	**Crane Group Limited**	GWT	GWA International Limited	**-0.0149**	**0.0067**	I-8
LDW	**Ludowici Limited**	AJL	AJ Lucas Group/ Lighting Corp	**0.0076**	**-0.0411**	
SKS	**Stokes (Australasia) Limited**	AET	Ausmelt Limited	**-0.0408**	**-0.3511**	
CXP	**Corporate Express**	COF	Coffey International Limited	**-0.0671**	**-0.0959**	
TAT	**Tat Hong Holdings Limited**	DOW	Downer EDI Limited	**-0.0624**	**0.0245**	
MND	**Monadelphous Group**	SDS	SDS Corporation Limited	**-0.0040**	**0.0193**	
PRG	**Programmed Maint. Serv.**	COF	Coffey International Limited	**-0.0040**	**-0.0917**	
CTL	**Citect Corporation Limited**	VGL	Volante Group/Integrated Research	**-0.1437**	**-0.0627**	Year 1
ASU	**Alpha Technologies Corp**	STR	Service Stream Ltd	**0.3978**	**0.0254**	IT-4
CLT	**Cellnet Group Limited**	OPI	Optima ICM/ Codan Limited	**-0.0138**	**-0.0384**	
LRX	**Longreach Group Limited**	GEE	GES International Limited	**-0.5290**	**-0.4270**	
AWC	**Alumina Limited**	AMC	Amcor Limited	**-0.0326**	**-0.0182**	Year 1
CAA	**Capral Aluminium Limited**	ABC	Adelaide Brighton Limited	**-0.0157**	**-0.0301**	M-14
MRE	**Anaconda Nickel**	NCM	Newcrest Mining Limited	**-0.0028**	**-0.0005**	
CHY-NZ	**Carter Holt Harvey Limited**	MIM	M.I.M. Holdings Limited	**0.0055**	**0.0010**	
CPI	**CPI Group Limited**	ANM	Advanced Magnesium Limited	**-0.0036**	**-0.0179**	
ICT	**Incitec Limited**	SGW	Sons of Gwalia Limited	**0.0253**	**-0.0412**	
NCI	**National Can Industries Limited**	LRL	Leyshon Resources Limited	**0.0186**	**0.0321**	
OST	**OneSteel Limited**	NUF	Nufarm Limited	**-0.0325**	**-0.0316**	
ORI	**Orica Limited**	PAS	Pasminco Limited	**0.0103**	**-0.0013**	
PPX	**PaperlinX Limited**	AMC	Amcor Limited	**-0.0145**	**-0.0270**	
RIO	**Rio Tinto Limited**	BHP	BHP Billiton Limited	**-0.0128**	**-0.0109**	
SSX	**Smorgon Steel Group Limited**	SGW	Sons of Gwalia/ Adelaide Brighton	**-0.0120**	**-0.0050**	
TNN	**Tenon Limited**	ILU	Iluka Resources Limited	**0.7953**	**0.0690**	
WYL	**Wattyl Limited**	BKW	Brickworks Limited	**-0.0057**	**0.0043**	
TEL	**Telcom Corp of NZ**	TLS	Telstra	**0.0079**	**0.0126**	Year 1
AGL	**Australian Gas Light**	ENV	Envestra	**-0.0303**	**-0.0433**	T&U-2

TABLE 6.40 ROA RESIDUALS YEAR 2

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
ALL	Aristocrat Leisure Limited	UTB	UNiTAB Limited	-0.0636	0.5941	Year 2
AUN	Austar United Communic'tn	MPH	Magna Pacific (Holdings) Limited	-3.3992	-0.0175	CD-10
FXJ	Fairfax Media Limited	BYI	Beyond International Limited	0.0008	-0.0148	
KRS	Kresta Holdings Limited	MCP	McPherson's Limited	-0.2944	-0.0259	
OPS	OPSM Group Limited	DJS	David Jones Limited	0.0912	-0.0120	
ORL	OrotonGroup Limited	WHS	Warehouse Group Ltd	-0.0125	-0.0960	
PBB	Pacifica Group Limited	BER	Berklee Limited	-0.0063	0.0144	
RMW	RM Williams Holdings	HVN	Harvey Norman Holdings Ltd	-0.0084	0.0061	
TAH	Tabcorp Holdings Limited	JUP	Jupiters Limited	0.0134	0.0122	
WAT	Waterco Limited	ATP	Atlas South Sea Pearl Limited	-0.0001	-0.0767	
AWB	AWB Limited	FOA	Foodland Associated Limited	-0.0162	-0.0236	Year 2
CHQ	Costaexchange Ltd	SPC	SPC Ardmona Limited	0.0059	0.0122	CS-9
FGL	Foster's Group Limited	CGJ	Coles Group Limited	-0.0115	-0.0243	
GFD	Green's Foods Limited	MGW	McGuigan Simeon Wines	-0.0315	0.0146	
GMF	Goodman Fielder Ltd	WOW	Woolworths Limited	-0.0134	-0.0093	
LNN	Lion Nathan Limited	BPC	Burns Philp	0.0058	0.0265	
NFD	National Foods Limited	BRL	BRL Hardy Limited	0.0280	0.0050	
QCH	Queensland Cotton Holdings	PMV	Premier Investments Limited	0.0309	0.0116	
SRP	Southcorp Limited	FCL	Futuris Corporation Limited	-0.0104	-0.0116	
CTX	Caltex Australia Limited	STO	Santos Limited/Oil Search	-0.0117	0.0061	Year 2
ORG	Origin Energy Limited	CNA	Coal & Allied Industries Limited	-0.0029	-0.1602	E-5
STO	Santos Limited	SRL	Straits Resources Limited	0.0150	-0.0543	
WPL	Woodside Petroleum Limited	OCA	Oil Company/ Oil Search	0.0422	0.0809	
ERA	Energy Resources of Australia	NVS	Novus Petroleum Limited	0.0095	0.0524	
AGX	Agenix Limited	LFE	Life Therapeutics Limited	0.0284	-0.3843	Year 2
AHG	Advance Healthcare Group Ltd	PLT	Polartechnics Limited	0.0490	-0.1926	HC-8
BKL	Blackmores Limited	IPN	Independent Practitioner Netwk	-0.0243	-0.1707	
CMP	Compumedics Limited	OMI	Occupational & Medical Innov	-0.1309	-0.1166	
COH	Cochlear Limited	VSL	Vision Systems Limited	-0.0425	0.0144	

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
RMD	ResMed Inc.	API	Australian Pharmaceutical Ind	0.0550	-0.0007	
NAL	Norwood Abbey Limited	ELX	Ellex Medical Lasers Limited	-0.1988	0.3110	
SYB	Symbion Health Limited	DVC	DCA Group Limited	0.0170	-0.0154	
ALS	Alesco Corporation Limited	MDC	McConnell Dowell Corp	-0.0131	-0.0457	Year 2
CRG	Crane Group Limited	GWT	GWA International Limited	-0.0024	-0.0008	I-8
LDW	Ludowici Limited	AJL	AJ Lucas Group/ Lighting Corp	0.0001	-0.0437	
SKS	Stokes (Australasia) Limited	AET	Ausmelt Limited	-0.0190	0.2496	
CXP	Corporate Express	COF	Coffey International Limited	0.0342	-0.0259	
TAT	Tat Hong Holdings Limited	DOW	Downer EDI Limited	-0.0010	-0.0259	
MND	Monadelphous Group	SDS	SDS Corporation Limited	-0.0285	-0.0198	
PRG	Programmed Maint. Serv.	COF	Coffey International Limited	-0.0072	0.1392	
CTL	Citect Corporation Limited	VGL	Volante Group/Integrated Research	0.0630	0.1828	Year 2
ASU	Alpha Technologies Corp	STR	Service Stream Ltd	-0.2554	-0.0244	IT-4
CLT	Cellnet Group Limited	OPI	Optima ICM/ Codan Limited	-0.0335	-1.6705	
LRX	Longreach Group Limited	GEE	GES International Limited	0.7527	0.0834	
AWC	Alumina Limited	AMC	Amcor Limited	0.0031	0.0138	Year 2
CAA	Capral Aluminium Limited	ABC	Adelaide Brighton Limited	-0.0162	0.0863	M-14
MRE	Anaconda Nickel	NCM	Newcrest Mining Limited	-0.0128	0.0369	
CHY-NZ	Carter Holt Harvey Limited	MIM	M.I.M. Holdings Limited	-0.0023	0.0291	
CPI	CPI Group Limited	ANM	Advanced Magnesium Limited	-0.0327	0.0408	
ICT	Incitec Limited	SGW	Sons of Gwalia Limited	-0.0402	0.0868	
NCI	National Can Industries Limited	LRL	Leyshon Resources Limited	-0.0113	0.0216	
OST	OneSteel Limited	NUF	Nufarm Limited	0.0260	-0.0012	
ORI	Orica Limited	PAS	Pasminco Limited	-0.0340	0.0109	
PPX	PaperlinX Limited	AMC	Amcor Limited	0.0110	0.0080	
RIO	Rio Tinto Limited	BHP	BHP Billiton Limited	0.0130	-0.0170	
SSX	Smorgon Steel Group Limited	SGW	Sons of Gwalia/ Adelaide Brighton	0.0223	-0.0213	
TNN	Tenon Limited	ILU	Iluka Resources Limited	-0.4506	-0.0005	
WYL	Wattyl Limited	BKW	Brickworks Limited	-0.0302	-0.0181	
TEL	Telcom Corp of NZ	TLS	Telstra	-0.0055	0.0163	Year 2
AGL	Australian Gas Light	ENV	Envestra	0.0141	-0.0749	T&U-2

TABLE 6.41 ROA RESIDUALS YEAR 3

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
ALL	Aristocrat Leisure Limited	UTB	UNiTAB Limited	0.0464	-0.0296	Year 3
AUN	Austar United Communic'tn	MPH	Magna Pacific (Holdings) Limited	-0.4867	-0.0024	CD-10
FXJ	Fairfax Media Limited	BYI	Beyond International Limited	0.0114	-0.0124	
KRS	Kresta Holdings Limited	MCP	McPherson's Limited	0.3298	0.0290	
OPS	OPSM Group Limited	DJS	David Jones Limited	-0.1172	-0.0073	
ORL	OrotonGroup Limited	WHS	Warehouse Group Ltd	0.0442	0.0692	
PBB	Pacifica Group Limited	BER	Berklee Limited	-0.0012	-0.0385	
RMW	RM Williams Holdings	HVN	Harvey Norman Holdings Ltd	-0.0574	-0.0177	
TAH	Tabcorp Holdings Limited	JUP	Jupiters Limited	-0.0985	0.0042	
WAT	Waterco Limited	ATP	Atlas South Sea Pearl Limited	-0.0224	0.0237	
AWB	AWB Limited	FOA	Foodland Associated Limited	-0.0215	0.0227	Year 3
CHQ	Costaexchange Ltd	SPC	SPC Ardmona Limited	0.0708	-0.0138	CS-9
FGL	Foster's Group Limited	CGJ	Coles Group Limited	0.0085	0.0198	
GFD	Green's Foods Limited	MGW	McGuigan Simeon Wines	0.0228	-0.0061	
GMF	Goodman Fielder Ltd	WOW	Woolworths Limited	0.0224	0.0131	
LNN	Lion Nathan Limited	BPC	Burns Philp	0.0221	-0.0237	
NFD	National Foods Limited	BRL	BRL Hardy Limited	0.0194	0.0043	
QCH	Queensland Cotton Holdings	PMV	Premier Investments Limited	0.0167	-0.0081	
SRP	Southcorp Limited	FCL	Futuris Corporation Limited	0.0148	-0.0054	
CTX	Caltex Australia Limited	STO	Santos Limited/Oil Search	-0.0413	-0.0147	Year 3
ORG	Origin Energy Limited	CNA	Coal & Allied Industries Limited	0.0835	0.0449	E-5
STO	Santos Limited	SRL	Straits Resources Limited	0.0476	0.0970	
WPL	Woodside Petroleum Limited	OCA	Oil Company/ Oil Search	-0.0606	-0.0939	
ERA	Energy Resources of Australia	NVS	Novus Petroleum Limited	0.0253	-0.0493	
AGX	Agenix Limited	LFE	Life Therapeutics Limited	-0.0767	0.3843	Year 3
AHG	Advance Healthcare Group Ltd	PLT	Polartechnics Limited	-0.0382	-0.0774	HC-8
BKL	Blackmores Limited	IPN	Independent Practitioner Netwk	0.0044	0.3214	
CMP	Compumedics Limited	OMI	Occupational & Medical Innov	0.0755	0.0589	
COH	Cochlear Limited	VSL	Vision Systems Limited	-0.0476	-0.0021	

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
RMD	ResMed Inc.	API	Australian Pharmaceutical Ind	-0.0070	-0.0035	
NAL	Norwood Abbey Limited	ELX	Ellex Medical Lasers Limited	0.0589	-0.3293	
SYB	Symbion Health Limited	DVC	DCA Group Limited	-0.0132	0.0223	
ALS	Alesco Corporation Limited	MDC	McConnell Dowell Corp	-0.0028	0.0147	Year 3
CRG	Crane Group Limited	GWT	GWA International Limited	0.0249	0.0056	I-8
LDW	Ludowici Limited	AJL	AJ Lucas Group/ Lighting Corp	-0.0026	0.0639	
SKS	Stokes (Australasia) Limited	AET	Ausmelt Limited	-0.0196	-0.0703	
CXP	Corporate Express	COF	Coffey International Limited	-0.0554	0.0485	
TAT	Tat Hong Holdings Limited	DOW	Downer EDI Limited	-0.0184	0.0485	
MND	Monadelphous Group	SDS	SDS Corporation Limited	0.0397	-0.0046	
PRG	Programmed Maint. Serv.	COF	Coffey International Limited	0.0112	-0.0086	
CTL	Citect Corporation Limited	VGL	Volante Group/Integrated Research	0.0108	-0.0827	Year 3
ASU	Alpha Technologies Corp	STR	Service Stream Ltd	0.1773	0.0373	IT-4
CLT	Cellnet Group Limited	OPI	Optima ICM/ Codan Limited	0.0338	2.6119	
LRX	Longreach Group Limited	GEE	GES International Limited	-0.1568	0.6644	
AWC	Alumina Limited	AMC	Amcor Limited	0.0250	0.0131	Year 3
CAA	Capral Aluminium Limited	ABC	Adelaide Brighton Limited	0.0793	0.0053	M-14
MRE	Anaconda Nickel	NCM	Newcrest Mining Limited	0.0005	0.0201	
CHY-NZ	Carter Holt Harvey Limited	MIM	M.I.M. Holdings Limited	-0.0377	-0.0205	
CPI	CPI Group Limited	ANM	Advanced Magnesium Limited	0.0232	-0.0222	
ICT	Incitec Limited	SGW	Sons of Gwalia Limited	-0.0295	-0.0395	
NCI	National Can Industries Limited	LRL	Leyshon Resources Limited	0.0081	0.0442	
OST	OneSteel Limited	NUF	Nufarm Limited	0.0071	0.0033	
ORI	Orica Limited	PAS	Pasminco Limited	0.0206	0.0087	
PPX	PaperlinX Limited	AMC	Amcor Limited	-0.0206	0.0145	
RIO	Rio Tinto Limited	BHP	BHP Billiton Limited	-0.0207	0.0664	
SSX	Smorgon Steel Group Limited	SGW	Sons of Gwalia/ Adelaide Brighton	-0.0110	-0.0153	
TNN	Tenon Limited	ILU	Iluka Resources Limited	0.0315	0.0074	
WYL	Wattyl Limited	BKW	Brickworks Limited	0.0300	0.0072	
TEL	Telcom Corp of NZ	TLS	Telstra	0.0102	-0.0039	Year 3
AGL	Australian Gas Light	ENV	Envestra	-0.0057	0.0552	T&U-2

TABLE 6.42 ROA RESIDUALS YEAR 4

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
ALL	Aristocrat Leisure Limited	UTB	UNiTAB Limited	0.0254	0.1093	Year 4
AUN	Austar United Communic'tn	MPH	Magna Pacific (Holdings) Limited	0.9362	-0.0146	CD-10
FXJ	Fairfax Media Limited	BYI	Beyond International Limited	-0.0269	0.0215	
KRS	Kresta Holdings Limited	MCP	McPherson's Limited	-0.3686	-0.0347	
OPS	OPSM Group Limited	DJS	David Jones Limited	0.0792	0.0136	
ORL	OrotonGroup Limited	WHS	Warehouse Group Ltd	-0.0783	-0.0341	
PBB	Pacifica Group Limited	BER	Berklee Limited	-0.0134	0.0358	
RMW	RM Williams Holdings	HVN	Harvey Norman Holdings Ltd	-0.0102	-0.0029	
TAH	Tabcorp Holdings Limited	JUP	Jupiters Limited	0.0729	0.0140	
WAT	Waterco Limited	ATP	Atlas South Sea Pearl Limited	-0.0199	-0.0885	
AWB	AWB Limited	FOA	Foodland Associated Limited	0.0264	-0.0019	Year 4
CHQ	Costaexchange Ltd	SPC	SPC Ardmona Limited	-0.0495	0.0055	CS-9
FGL	Foster's Group Limited	CGJ	Coles Group Limited	0.0267	-0.0015	
GFD	Green's Foods Limited	MGW	McGuigan Simeon Wines	-0.0136	0.0275	
GMF	Goodman Fielder Ltd	WOW	Woolworths Limited	0.0005	0.0093	
LNN	Lion Nathan Limited	BPC	Burns Philp	-0.0163	-0.0007	
NFD	National Foods Limited	BRL	BRL Hardy Limited	0.0116	-0.0043	
QCH	Queensland Cotton Holdings	PMV	Premier Investments Limited	-0.0065	0.0225	
SRP	Southcorp Limited	FCL	Futuris Corporation Limited	-0.0351	-0.0029	
CTX	Caltex Australia Limited	STO	Santos Limited/Oil Search	0.0562	-0.0281	Year 4
ORG	Origin Energy Limited	CNA	Coal & Allied Industries Limited	-0.1562	0.0162	E-5
STO	Santos Limited	SRL	Straits Resources Limited	-0.0451	-0.0138	
WPL	Woodside Petroleum Limited	OCA	Oil Company/ Oil Search	0.0272	0.0606	
ERA	Energy Resources of Australia	NVS	Novus Petroleum Limited	-0.0399	-0.0069	
AGX	Agenix Limited	LFE	Life Therapeutics Limited	0.0867	-0.2714	Year 4
AHG	Advance Healthcare Group Ltd	PLT	Polartechnics Limited	0.0492	0.0950	HC-8
BKL	Blackmores Limited	IPN	Independent Practitioner Netwk	0.0764	-0.2069	
CMP	Compumedics Limited	OMI	Occupational & Medical Innov	0.1226	-0.0717	
COH	Cochlear Limited	VSL	Vision Systems Limited	-0.0323	-0.0028	

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
RMD	ResMed Inc.	API	Australian Pharmaceutical Ind	0.0080	-0.0072	
NAL	Norwood Abbey Limited	ELX	Ellex Medical Lasers Limited	0.0567	-0.0294	
SYB	Symbion Health Limited	DVC	DCA Group Limited	-0.0072	-0.0233	
ALS	Alesco Corporation Limited	MDC	McConnell Dowell Corp	-0.0027	0.0053	Year 4
CRG	Crane Group Limited	GWT	GWA International Limited	0.0000	0.0066	I-8
LDW	Ludowici Limited	AJL	AJ Lucas Group/ Lighting Corp	0.0019	-0.0123	
SKS	Stokes (Australasia) Limited	AET	Ausmelt Limited	0.0432	-0.0307	
CXP	Corporate Express	COF	Coffey International Limited	0.0286	-0.0795	
TAT	Tat Hong Holdings Limited	DOW	Downer EDI Limited	0.0928	0.0096	
MND	Monadelphous Group	SDS	SDS Corporation Limited	0.0014	0.0784	
PRG	Programmed Maint. Serv.	COF	Coffey International Limited	0.0021	-0.0299	
CTL	Citect Corporation Limited	VGL	Volante Group/Integrated Research	-0.0585	-0.1787	Year 4
ASU	Alpha Technologies Corp	STR	Service Stream Ltd	-0.0564	-0.0898	IT-4
CLT	Cellnet Group Limited	OPI	Optima ICM/ Codan Limited	-0.0770	-0.8035	
LRX	Longreach Group Limited	GEE	GES International Limited	0.1090	-0.0326	
AWC	Alumina Limited	AMC	Amcor Limited	0.0380	0.0032	Year 4
CAA	Capral Aluminium Limited	ABC	Adelaide Brighton Limited	-0.1411	-0.1249	M-14
MRE	Anaconda Nickel	NCM	Newcrest Mining Limited	-0.0393	-0.0336	
CHY-NZ	Carter Holt Harvey Limited	MIM	M.I.M. Holdings Limited	0.0069	0.0153	
CPI	CPI Group Limited	ANM	Advanced Magnesium Limited	-0.0212	0.0722	
ICT	Incitec Limited	SGW	Sons of Gwalia Limited	0.0314	0.0173	
NCI	National Can Industries Limited	LRL	Leyshon Resources Limited	-0.0067	-0.0405	
OST	OneSteel Limited	NUF	Nufarm Limited	-0.0088	0.0008	
ORI	Orica Limited	PAS	Pasminco Limited	-0.0293	-0.0427	
PPX	PaperlinX Limited	AMC	Amcor Limited	-0.0166	-0.0101	
RIO	Rio Tinto Limited	BHP	BHP Billiton Limited	0.0244	-0.0058	
SSX	Smorgon Steel Group Limited	SGW	Sons of Gwalia/ Adelaide Brighton	-0.0060	0.0658	
TNN	Tenon Limited	ILU	Iluka Resources Limited	0.2071	-0.0248	
WYL	Wattyl Limited	BKW	Brickworks Limited	-0.0207	0.0171	
TEL	Telcom Corp of NZ	TLS	Telstra	-0.0280	0.0049	Year 4
AGL	Australian Gas Light	ENV	Envestra	0.0009	-0.0041	T&U-2

TABLE 6.43 ROA RESIDUALS YEAR 5

Matched Pairs				Residual ROA		Year
ERP Adopters		ERP Non-adopters		Adopt	N-Adopt	Sector
ALL	Aristocrat Leisure Limited	UTB	UNiTAB Limited	0.1003	0.0154	Year 5
AUN	Austar United Communic'tn	MPH	Magna Pacific (Holdings) Limited	0.1425	0.0411	CD-10
FXJ	Fairfax Media Limited	BYI	Beyond International Limited	-0.0119	-0.2952	
KRS	Kresta Holdings Limited	MCP	McPherson's Limited	0.5352	0.0192	
OPS	OPSM Group Limited	DJS	David Jones Limited	-0.0252	-0.0002	
ORL	OrotonGroup Limited	WHS	Warehouse Group Ltd	0.0381	-0.0198	
PBB	Pacifica Group Limited	BER	Berklee Limited	0.0241	0.0012	
RMW	RM Williams Holdings	HVN	Harvey Norman Holdings Ltd	0.0414	0.0076	
TAH	Tabcorp Holdings Limited	JUP	Jupiters Limited	0.0196	-0.0032	
WAT	Waterco Limited	ATP	Atlas South Sea Pearl Limited	0.0795	-0.0537	
AWB	AWB Limited	FOA	Foodland Associated Limited	0.0105	-0.0016	Year 5
CHQ	Costaexchange Ltd	SPC	SPC Ardmona Limited	-0.0172	-0.0243	CS-9
FGL	Foster's Group Limited	CGJ	Coles Group Limited	-0.0259	0.0018	
GFD	Green's Foods Limited	MGW	McGuigan Simeon Wines	0.0084	-0.0339	
GMF	Goodman Fielder Ltd	WOW	Woolworths Limited	0.0109	0.0054	
LNN	Lion Nathan Limited	BPC	Burns Philp	0.0097	-0.0078	
NFD	National Foods Limited	BRL	BRL Hardy Limited	-0.0248	0.0025	
QCH	Queensland Cotton Holdings	PMV	Premier Investments Limited	0.0119	-0.0289	
SRP	Southcorp Limited	FCL	Futuris Corporation Limited	0.0486	0.0218	
CTX	Caltex Australia Limited	STO	Santos Limited/Oil Search	0.0083	0.0445	Year 5
ORG	Origin Energy Limited	CNA	Coal & Allied Industries Limited	0.1019	-0.0565	E-5
STO	Santos Limited	SRL	Straits Resources Limited	0.0143	-0.0158	
WPL	Woodside Petroleum Limited	OCA	Oil Company/ Oil Search	0.0240	0.0121	
ERA	Energy Resources of Australia	NVS	Novus Petroleum Limited	0.0366	0.0008	
AGX	Agenix Limited	LFE	Life Therapeutics Limited	-0.0483	0.0691	Year 5
AHG	Advance Healthcare Group Ltd	PLT	Polartechnics Limited	-0.0405	-0.0227	HC-8
BKL	Blackmores Limited	IPN	Independent Practitioner Netwk	0.0633	0.1398	
CMP	Compumedics Limited	OMI	Occupational & Medical Innov	-0.3258	-0.0647	
COH	Cochlear Limited	VSL	Vision Systems Limited	0.1255	-0.0283	

RMD	**ResMed Inc.**	API	Australian Pharmaceutical Ind	**-0.0226**	**-0.0019**	
NAL	**Norwood Abbey Limited**	ELX	Ellex Medical Lasers Limited	**-0.1026**	**0.0153**	
SYB	**Symbion Health Limited**	DVC	DCA Group Limited	**0.2439**	**0.0170**	
ALS	**Alesco Corporation Limited**	MDC	McConnell Dowell Corp	**0.0408**	**0.0195**	**Year 5**
CRG	**Crane Group Limited**	GWT	GWA International Limited	**0.0517**	**0.0039**	**I-8**
LDW	**Ludowici Limited**	AJL	AJ Lucas Group/ Lighting Corp	**0.0373**	**-0.0136**	
SKS	**Stokes (Australasia) Limited**	AET	Ausmelt Limited	**0.0437**	**-0.1166**	
CXP	**Corporate Express**	COF	Coffey International Limited	**0.1518**	**0.0159**	
TAT	**Tat Hong Holdings Limited**	DOW	Downer EDI Limited	**-0.0020**	**-0.0017**	
MND	**Monadelphous Group**	SDS	SDS Corporation Limited	**0.0373**	**-0.0281**	
PRG	**Programmed Maint. Serv.**	COF	Coffey International Limited	**0.0370**	**0.0083**	
CTL	**Citect Corporation Limited**	VGL	Volante Group/Integrated Research	**0.0426**	**0.1912**	**Year 5**
ASU	**Alpha Technologies Corp**	STR	Service Stream Ltd	**-0.0998**	**-0.0763**	**IT-4**
CLT	**Cellnet Group Limited**	OPI	Optima ICM/ Codan Limited	**0.0552**	**-0.0617**	
LRX	**Longreach Group Limited**	GEE	GES International Limited	**-0.2857**	**0.0627**	
AWC	**Alumina Limited**	AMC	Amcor Limited	**-0.0436**	**-0.0270**	**Year 5**
CAA	**Capral Aluminium Limited**	ABC	Adelaide Brighton Limited	**0.1180**	**0.0757**	**M-14**
MRE	**Anaconda Nickel**	NCM	Newcrest Mining Limited	**0.0212**	**-0.0215**	
CHY-NZ	**Carter Holt Harvey Limited**	MIM	M.I.M. Holdings Limited	**0.0146**	**-0.0150**	
CPI	**CPI Group Limited**	ANM	Advanced Magnesium Limited	**0.0633**	**-0.0927**	
ICT	**Incitec Limited**	SGW	Sons of Gwalia Limited	**0.0331**	**-0.0207**	
NCI	**National Can Industries Limited**	LRL	Leyshon Resources Limited	**0.0116**	**-0.1163**	
OST	**OneSteel Limited**	NUF	Nufarm Limited	**0.0079**	**0.0134**	
ORI	**Orica Limited**	PAS	Pasminco Limited	**0.0165**	**0.0039**	
PPX	**PaperlinX Limited**	AMC	Amcor Limited	**0.0293**	**0.0089**	
RIO	**Rio Tinto Limited**	BHP	BHP Billiton Limited	**0.0125**	**-0.0386**	
SSX	**Smorgon Steel Group Limited**	SGW	Sons of Gwalia/ Adelaide Brighton	**0.0527**	**-0.0103**	
TNN	**Tenon Limited**	ILU	Iluka Resources Limited	**-0.0447**	**-0.0098**	
WYL	**Wattyl Limited**	BKW	Brickworks Limited	**0.0416**	**0.0111**	
TEL	**Telcom Corp of NZ**	TLS	Telstra	**0.0165**	**0.0009**	**Year 5**
AGL	**Australian Gas Light**	ENV	Envestra	**0.0410**	**0.0154**	**T&U-2**

TABLE 6.44 PAIRED T-TEST FOR THE DIFFERENCE IN SG&A EXPENSE TO SALES RATIOS: TEST OF HYPOTHESIS H1

Panel 1
t-Test: Paired Two Sample for Means

	N-Adopt	*Adopt*
Mean	13.052	1.333371
Variance	32381.24	27.81468
Observations	300	300
Pearson Correlation	-0.01508	
Hypothesized Mean Difference	0	
df	299	
t Stat	1.12697	
P(T<=t) one-tail	0.130329	
t Critical one-tail	1.649966	
P(T<=t) two-tail	0.260659	
t Critical two-tail	1.96793	

Panel 2
t-Test: Mean

	N-Adopt	*Adopt*
Mean	13.052	1.3334
Standard Deviation	179.9479	5.274
Hypothesized Mean	0	0
df	299	299
t Stat	1.2563	4.379
P(T<=t) one-tail	0.105	0
t Critical one-tail	1.65	1.65
P(T<=t) two-tail	0.21	0
t Critical two-tail	1.9679	1.9679

TABLE 6.45 PAIRED T-TEST FOR THE DIFFERENCE IN EBIT MARGINS TEST OF HYPOTHESIS H3

Panel 1
t-Test: Paired Two Sample for Means

	N-Adopt	*Adopt*
Mean	-11.9597	-0.29211
Variance	32365.1	26.99663
Observations	300	300
Pearson Correlation	-0.00367	
Hypothesized Mean Difference	0	
df	299	
t Stat	-1.12273	
P(T<=t) one-tail	0.131226	
t Critical one-tail	1.649966	
P(T<=t) two-tail	0.262453	
t Critical two-tail	1.96793	

Panel 2
t-Test: Mean

	N-Adopt	*Adopt*
Mean	-11.9597	-0.2921
Standard Deviation	179.903	5.1958
Hypothesized Mean	0	0
df	299	299
t Stat	-1.1514	-0.9738
P(T<=t) one-tail	0.1252	0.1655
t Critical one-tail	1.65	1.65
P(T<=t) two-tail	0.2504	0.331
t Critical two-tail	1.9679	1.9679

TABLE 6.46 PAIRED T-TEST FOR THE DIFFERENCE IN ASSET TURNOVER
TEST OF HYPOTHESIS H4

Panel 1
t-Test: Paired Two Sample for Means

	N-Adopt	*Adopt*
Mean	1.176158	1.178709
Variance	3.875023	0.630686
Observations	300	300
Pearson Correlation	0.086878	
Hypothesized Mean Difference	0	
df	299	
t Stat	-0.02147	
P(T<=t) one-tail	0.491444	
t Critical one-tail	1.649966	
P(T<=t) two-tail	0.982887	
t Critical two-tail	1.96793	

Panel 2
t-Test: Mean

	N-Adopt	*Adopt*
Mean	1.1762	1.1787
Standard Deviation	1.9685	0.7942
Hypothesized Mean	0	0
df	299	299
t Stat	10.3488	25.7075
P(T<=t) one-tail	0	0
t Critical one-tail	1.65	1.65
P(T<=t) two-tail	0	0
t Critical two-tail	1.9679	1.9679

TABLE 6.47 PAIRED T-TEST FOR THE DIFFERENCE IN OPERATING EXPENSE RATIOS TEST OF HYPOTHESIS H5

Panel 1
t-Test: Paired Two Sample for Means

	N-Adopt	*Adopt*
Mean	2.067915	1.213383
Variance	142.0329	18.99325
Observations	300	300
Pearson Correlation	-0.00673	
Hypothesized Mean Difference	0	
df	299	
t Stat	1.16386	
P(T<=t) one-tail	0.122704	
t Critical one-tail	1.649966	
P(T<=t) two-tail	0.245409	
t Critical two-tail	1.96793	

Panel 2
t-Test: Mean

	N-Adopt	*Adopt*
Mean	2.0679	1.2134
Standard Deviation	11.9178	4.3581
Hypothesized Mean	0	0
df	299	299
t Stat	3.0054	4.8224
P(T<=t) one-tail	0.0014	0
t Critical one-tail	1.65	1.65
P(T<=t) two-tail	0.0028	0
t Critical two-tail	1.9679	1.9679

TABLE 6.48 PAIRED T-TESTS FOR THE DIFFERENCE BETWEEN ROA RESIDUALS TEST OF HYPOTHESIS H6

Panel 1
Yr 1-5

t-Test: Paired Two Sample for Means years 1-5

	N-Adopt	*Adopt*
Mean	-0.00172	0.023845
Variance	0.052279	0.252229
Observations	300	300
Pearson Correlation	0.029702	
Hypothesized Mean Difference	0	
df	299	
t Stat	-0.81144	
P(T<=t) one-tail	0.208878	
t Critical one-tail	1.649966	
P(T<=t) two-tail	0.417756	
t Critical two-tail	1.96793	

Panel 2
Yr 1

t-Test: Paired Two Sample for Means Year 1

	N-Adopt	*Adopt*
Mean	-0.01681	0.146007
Variance	0.052661	1.005418
Observations	60	60
Pearson Correlation	0.074415	
Hypothesized Mean Difference	0	
df	59	
t Stat	-1.24639	
P(T<=t) one-tail	0.108773	
t Critical one-tail	1.671093	
P(T<=t) two-tail	0.217546	
t Critical two-tail	2.000995	

Panel 3
Yr 2

t-Test: Paired Two Sample for Means Year 2

	N-Adopt	*Adopt*
Mean	-0.0206	-0.06624
Variance	0.06195	0.208676
Observations	60	60
Pearson Correlation	0.001633	
Hypothesized Mean Difference	0	
df	59	
t Stat	0.68014	
P(T<=t) one-tail	0.249538	
t Critical one-tail	1.671093	
P(T<=t) two-tail	0.499076	
t Critical two-tail	2.000995	

Panel 4 **Yr 3**

t-Test: Paired Two Sample for Means Year 3

	N-Adopt	*Adopt*
Mean	0.064327	-0.00014
Variance	0.12635	0.008405
Observations	60	60
Pearson Correlation	-0.01321	
Hypothesized Mean Difference	0	
df	59	
t Stat	1.356059	
P(T<=t) one-tail	0.090124	
t Critical one-tail	1.671093	
P(T<=t) two-tail	0.180248	
t Critical two-tail	2.000995	

Panel 5 **Yr 4**

t-Test: Paired Two Sample for Means Year 4

	N-Adopt	*Adopt*
Mean	-0.02776	0.014248
Variance	0.0144	0.020321
Observations	60	60
Pearson Correlation	0.068614	
Hypothesized Mean Difference	0	
df	59	
t Stat	-1.80834	
P(T<=t) one-tail	0.037826	
t Critical one-tail	1.671093	
P(T<=t) two-tail	0.075651	
t Critical two-tail	2.000995	

Panel 6 **Yr 5**

t-Test: Paired Two Sample for Means Year 5

	N-Adopt	*Adopt*
Mean	-0.00775	0.025353
Variance	0.003825	0.011314
Observations	60	60
Pearson Correlation	0.113199	
Hypothesized Mean Difference	0	
df	59	
t Stat	-2.1947	
P(T<=t) one-tail	0.016067	
t Critical one-tail	1.671093	
P(T<=t) two-tail	0.032133	
t Critical two-tail	2.000995	

TABLE 6.49 T-TEST OF MEANS OF THE RESIDUALS FOR THEIR DIFFERENCE FROM ZERO
TEST OF HYPOTHESIS 6

Panel 1
Yr 1

t-Test: Mean	*Non-adopt*	*Adopt*
Mean	-0.0168	0.146
Standard Deviation	0.2295	1.0027
Hypothesized Mean	0	0
df	59	59
t Stat	-0.5674	1.1279
P(T<=t) one-tail	0.2863	0.132
t Critical one-tail	1.6711	1.6711
P(T<=t) two-tail	0.5726	0.264
t Critical two-tail	2.001	2.001

Panel 2
Yr 2

t-Test: Mean	*N-Adopt*	*Adopt*
Mean	-0.0206	-0.0662
Standard Deviation	0.2489	0.4568
Hypothesized Mean	0	0
df	59	59
t Stat	-0.6409	-1.1232
P(T<=t) one-tail	0.262	0.1329
t Critical one-tail	1.6711	1.6711
P(T<=t) two-tail	0.524	0.2658
t Critical two-tail	2.001	2.001

Panel 3
Yr 3

t-Test: Mean	*N-Adopt*	*Adopt*
Mean	0.0643	-0.0001
Standard Deviation	0.3555	0.0917
Hypothesized Mean	0	0
df	59	59
t Stat	1.4018	-0.0121
P(T<=t) one-tail	0.0831	0.4952
t Critical one-tail	1.6711	1.6711
P(T<=t) two-tail	0.1662	0.9904
t Critical two-tail	2.001	2.001

Panel 4
Yr 4

t-Test: Mean	*N-Adopt*	*Adopt*
Mean	-0.0278	0.0142
Standard Deviation	0.12	0.1426
Hypothesized Mean	0	0
df	59	59
t Stat	-1.7917	0.7742
P(T<=t) one-tail	0.0392	0.2209
t Critical one-tail	1.6711	1.6711
P(T<=t) two-tail	0.0784	0.4418
t Critical two-tail	2.001	2.001

Panel 5
Yr 5

t-Test: Mean	*N-Adopt*	*Adopt*
Mean	-0.0077	0.0254
Standard Deviation	0.0618	0.1064
Hypothesized Mean	0	0
df	59	59
t Stat	-0.9705	1.8463
P(T<=t) one-tail	0.1679	0.0349
t Critical one-tail	1.6711	1.6711
P(T<=t) two-tail	0.3358	0.0698
t Critical two-tail	2.001	2.001

TABLE 6.50 ORDINARY LEAST SQUARES ESTIMATION OF SHAREHOLDER VALUE RELEVANCE OF ERP INFORMATION: YEAR 1

Dependent Variable: Y
Method: Least Squares
Date: 09/14/07 Time: 20:04
Sample: 1 120
Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.036622	0.056005	-0.653905	0.5145
X	0.562299	0.522743	1.075671	0.2844
ERPX	0.062745	0.674857	0.092976	0.9261
CHX	0.405226	0.221540	1.829135	0.0700
ERPCHX	-0.325514	0.226920	-1.434490	0.1542
ERP	0.016004	0.077023	0.207777	0.8358
LEV	0.013209	0.005023	2.629601	0.0097

R-squared	0.118757	Mean dependent var	0.042163
Adjusted R-squared	0.071966	S.D. dependent var	0.388684
S.E. of regression	0.374437	Akaike info criterion	0.929777
Sum squared resid	15.84295	Schwarz criterion	1.092380
Log likelihood	-48.78660	F-statistic	2.538003
Durbin-Watson stat	1.860085	Prob(F-statistic)	0.024204

Legend

C	–	Constant
X	–	Earnings
ERPX	–	ERP interaction with earnings
CHX	–	Earnings change
ERPCHX	–	ERP interaction with earnings change
ERP	–	ERP Characteristic term
LEV	–	Leverage term

TABLE 6.51 ORDINARY LEAST SQUARES REGRESSION OF SHARE RETURNS ON EARNINGS EX. ERP TERMS: YEAR 1

Dependent Variable: Y
Method: Least Squares
Date: 09/14/07 Time: 19:57
Sample: 1 120
Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.029411	0.040945	-0.718294	0.4740
X	0.533523	0.324360	1.644851	0.1027
CHX	0.096217	0.047365	2.031393	0.0445
LEV	0.013322	0.004976	2.676990	0.0085

R-squared	0.100302	Mean dependent var	0.042163
Adjusted R-squared	0.077034	S.D. dependent var	0.388684
S.E. of regression	0.373413	Akaike info criterion	0.900503
Sum squared resid	16.17474	Schwarz criterion	0.993419
Log likelihood	-50.03018	F-statistic	4.310711
Durbin-Watson stat	1.870691	Prob(F-statistic)	0.006385

Legend

C	–	Constant
X	–	Earnings
CHX	–	Earnings change
LEV	–	Leverage term

TABLE 6.52 GENERALIZED LEAST SQUARES ESTIMATION OF SHAREHOLDER VALUE RELEVANCE OF ERP INFORMATION: YEAR 2

Dependent Variable: Y
Method: Least Squares
Date: 09/18/07 Time: 01:51
Sample: 1 120
Included observations: 120
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.368496	0.117136	3.145892	0.0021
X	-1.799785	0.896576	-2.007397	0.0471
ERPX	2.752577	0.912936	3.015083	0.0032
CHX	1.890228	0.974434	1.939822	0.0549
ERPCHX	-1.667478	0.978458	-1.704190	0.0911
ERP	-0.355809	0.113493	-3.135084	0.0022
LEV	0.004902	0.008672	0.565299	0.5730

R-squared	0.124287	Mean dependent var	0.180850
Adjusted R-squared	0.077789	S.D. dependent var	0.620545
S.E. of regression	0.595920	Akaike info criterion	1.859143
Sum squared resid	40.12866	Schwarz criterion	2.021747
Log likelihood	-104.5486	F-statistic	2.672960
Durbin-Watson stat	2.119312	Prob(F-statistic)	0.018342

Legend

C	–	Constant
X	–	Earnings
ERPX	–	ERP interaction with earnings
CHX	–	Earnings change
ERPCHX	–	ERP interaction with earnings change
ERP	–	ERP Characteristic term
LEV	–	Leverage term

TABLE 6.53 GENERALIZED LEAST SQUARES REGRESSION OF SHARE RETURNS ON EARNINGS EX. ERP TERMS: YEAR 2

Dependent Variable: Y
Method: Least Squares
Date: 09/18/07 Time: 02:04
Sample: 1 120
Included observations: 120
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.193158	0.073565	2.625675	0.0098
X	-0.273434	0.435135	-0.628389	0.5310
CHX	0.419069	0.084826	4.940335	0.0000
LEV	0.005539	0.009130	0.606739	0.5452

R-squared	0.047424	Mean dependent var	0.180850
Adjusted R-squared	0.022788	S.D. dependent var	0.620545
S.E. of regression	0.613433	Akaike info criterion	1.893275
Sum squared resid	43.65087	Schwarz criterion	1.986192
Log likelihood	-109.5965	F-statistic	1.925002
Durbin-Watson stat	2.080339	Prob(F-statistic)	0.129378

Legend

C	–	Constant
X	–	Earnings
CHX	–	Earnings change
LEV	–	Leverage term

TABLE 6.54 ORDINARY LEAST SQUARES ESTIMATION OF SHAREHOLDER VALUE RELEVANCE OF ERP INFORMATION: YEAR 3

Dependent Variable: Y
Method: Least Squares
Date: 09/11/07 Time: 02:53
Sample: 1 120
Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.107867	0.109695	0.983335	0.3275
X	1.727707	0.680757	2.537921	0.0125
ERPX	-1.764784	0.856300	-2.060942	0.0416
CHX	0.966735	0.161090	6.001229	0.0000
ERPCHX	0.230820	0.784299	0.294302	0.7691
ERP	0.061470	0.094227	0.652366	0.5155
LEV	-0.009655	0.033524	-0.288006	0.7739

R-squared	0.279867	Mean dependent var	0.198297
Adjusted R-squared	0.241630	S.D. dependent var	0.499348
S.E. of regression	0.434854	Akaike info criterion	1.228951
Sum squared resid	21.36809	Schwarz criterion	1.391555
Log likelihood	-66.73705	F-statistic	7.319256
Durbin-Watson stat	2.049463	Prob(F-statistic)	0.000001

Legend

C	–	Constant
X	–	Earnings
ERPX	–	ERP interaction with earnings
CHX	–	Earnings change
ERPCHX	–	ERP interaction with earnings change
ERP	–	ERP Characteristic term
LEV	–	Leverage term

TABLE 6.55 ORDINARY LEAST SQUARES REGRESSION OF SHARE RETURNS ON EARNINGS EX. ERP TERMS: YEAR 3

Dependent Variable: Y
Method: Least Squares
Date: 09/14/07 Time: 15:21
Sample: 1 120
Included observations: 120

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.199191	0.080593	2.471567	0.0149
X	0.533657	0.348700	1.530416	0.1286
CHX	0.924440	0.155019	5.963379	0.0000
LEV	-0.025546	0.032460	-0.787007	0.4329

R-squared	0.250497	Mean dependent var	0.198297
Adjusted R-squared	0.231113	S.D. dependent var	0.499348
S.E. of regression	0.437859	Akaike info criterion	1.218926
Sum squared resid	22.23958	Schwarz criterion	1.311842
Log likelihood	-69.13554	F-statistic	12.92308
Durbin-Watson stat	1.952757	Prob(F-statistic)	0.000000

Legend

C	–	Constant
X	–	Earnings
CHX	–	Earnings change
LEV	–	Leverage term

TABLE 6.56 GENERALIZED LEAST SQUARES ESTIMATION OF SHAREHOLDER VALUE RELEVANCE OF ERP INFORMATION: YEAR 4

Dependent Variable: Y
Method: Least Squares
Date: 09/16/07 Time: 01:43
Sample: 1 120
Included observations: 120
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.120037	0.101017	-1.188282	0.2372
X	1.024098	0.459239	2.229988	0.0277
ERPX	1.010216	0.932927	1.082846	0.2812
CHX	0.529705	0.305721	1.732640	0.0859
ERPCHX	0.300698	0.395348	0.760592	0.4485
ERP	-0.012783	0.099481	-0.128501	0.8980
LEV	0.037787	0.038281	0.987103	0.3257

R-squared	0.091621	Mean dependent var	0.033008
Adjusted R-squared	0.043388	S.D. dependent var	0.481480
S.E. of regression	0.470919	Akaike info criterion	1.388301
Sum squared resid	25.05940	Schwarz criterion	1.550905
Log likelihood	-76.29805	F-statistic	1.899569
Durbin-Watson stat	2.096193	Prob(F-statistic)	0.086901

Legend

C	–	Constant
X	–	Earnings
ERPX	–	ERP interaction with earnings
CHX	–	Earnings change
ERPCHX	–	ERP interaction with earnings change
ERP	–	ERP Characteristic term
LEV	–	Leverage term

TABLE 6.57 GENERALIZED LEAST SQUARES REGRESSION OF SHARE RETURNS ON EARNINGS EX. ERP TERMS: YEAR 4

Dependent Variable: Y
Method: Least Squares
Date: 09/16/07 Time: 00:20
Sample: 1 120
Included observations: 120
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.108594	0.086372	-1.257280	0.2112
X	1.422518	0.427835	3.324922	0.0012
CHX	0.630887	0.205188	3.074676	0.0026
LEV	0.032971	0.036937	0.892624	0.3739

R-squared	0.082201	Mean dependent var	0.033008
Adjusted R-squared	0.058465	S.D. dependent var	0.481480
S.E. of regression	0.467193	Akaike info criterion	1.348617
Sum squared resid	25.31925	Schwarz criterion	1.441533
Log likelihood	-76.91702	F-statistic	3.463131
Durbin-Watson stat	2.081519	Prob(F-statistic)	0.018629

Legend

C	–	Constant
X	–	Earnings
CHX	–	Earnings change
LEV	–	Leverage term

TABLE 6.58 GENERALIZED LEAST SQUARES ESTIMATION OF SHAREHOLDER VALUE RELEVANCE OF ERP INFORMATION: YEAR 5

Dependent Variable: Y
Method: Least Squares
Date: 09/14/07 Time: 14:12
Sample: 1 120
Included observations: 120
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.171516	0.096786	1.772115	0.0791
X	0.928835	0.467992	1.984722	0.0496
ERPX	-1.790978	1.528363	-1.171828	0.2437
CHX	2.199843	1.081854	2.033400	0.0444
ERPCHX	1.197034	1.637803	0.730878	0.4664
ERP	0.182717	0.198865	0.918799	0.3602
LEV	0.028897	0.028432	1.016360	0.3116

R-squared	0.123268	Mean dependent var	0.354105
Adjusted R-squared	0.076716	S.D. dependent var	0.790071
S.E. of regression	0.759161	Akaike info criterion	2.343356
Sum squared resid	65.12473	Schwarz criterion	2.505960
Log likelihood	-133.6014	F-statistic	2.647966
Durbin-Watson stat	2.020480	Prob(F-statistic)	0.019311

Legend

C – Constant
X – Earnings
ERPX – ERP interaction with earnings
CHX – Earnings change
ERPCHX – ERP interaction with earnings change
ERP – ERP Characteristic term
LEV – Leverage term

TABLE 6.59 GENERALIZED LEAST SQUARES REGRESSION OF SHARE RETURNS ON EARNINGS EX. ERP TERMS: YEAR 5

Dependent Variable: Y
Method: Least Squares
Date: 09/14/07 Time: 16:27
Sample: 1 120
Included observations: 120
Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.219341	0.117551	1.865921	0.0646
X	0.443383	0.520966	0.851079	0.3965
CHX	2.695550	0.897940	3.001926	0.0033
LEV	0.034508	0.028969	1.191221	0.2360

R-squared	0.112794	Mean dependent var	0.354105
Adjusted R-squared	0.089849	S.D. dependent var	0.790071
S.E. of regression	0.753742	Akaike info criterion	2.305232
Sum squared resid	65.90277	Schwarz criterion	2.398149
Log likelihood	-134.3139	F-statistic	4.915856
Durbin-Watson stat	2.042441	Prob(F-statistic)	0.002986

Legend

C	–	Constant
X	–	Earnings
CHX	–	Earnings change
LEV	–	Leverage term