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DISCUSSION PAPER 10.25

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Abstract

As they involve expectations about the future and long lead times for planning and construction, the evolution of investment projects is usually complex and volatile. This paper analyses an important aspect of this volatility by studying the nature of the investment process, from the initial bright idea to the final construction and operational phase of a project. We refer to this process as the "project pipeline". Using a rich source of information on recent Australian resource development projects, an index-number approach is employed to measure the escalation of costs of projects in the pipeline and the time spent there (the lead time). The determinants of the probability of ultimate success of projects is analysed with a binary choice model. Finally, a Markov chain approach is used to model the transitions of projects from one stage in the pipeline to the next, and to examine the implications of regulatory reform that has the effect of speeding up the flow of projects.

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1. INTRODUCTION

By its very nature, the decision to invest is a forward-looking one involving uncertainty whereby apparent modest changes in expectations regarding future benefits and costs can be magnified into large changes in net present values. This, together with its relative size and postponeability, accounts for the volatile nature of investment in the aggregate and why it is one of the key drivers of the business cycle in most modern economies.

The actual undertaking of an investment project is itself the result of the completion of several preliminary steps that can be formal or informal. This involves an investment pipeline that could start with someone having a bright, but preliminary, idea and then possibly lead on to an early planning stage, a feasibility study to take to capital markets, the actual construction phase and then, finally, the project is completed and becomes operational. A successful project typically needs to pass through each step sequentially, so that many potential projects are weeded out by this long, complex and arduous process. The uncertainty involved with this investment planning pipeline is aptly described by the old adage *there's many a slip 'twixt cup and lip*.

In the context of the Australian resource (mining and energy) projects considered below, there are well-defined steps that are known to the industry, financial markets and government. But surprisingly little is known about the functioning of this pipeline, such as the proportion of projects ultimately completed, the existence of bottlenecks due to infrastructure shortages and other constraints on the smooth workings of the system. Related issues of interest are the degree of cost escalation from beginning to end of projects, lead times required for investments, the probability that projects proceed from one phase in the pipeline to another and the economic determinants of these moves. In the context of a substantial commodities boom currently (2010) being experienced, what is the role for public policy to facilitate the swift flow of new resource projects? At present, answers are not available.

In this paper we use what seems to be a previously unexplored rich source of information on resource projects to provide evidence on the microeconomics of investment. Access Economics, an economics consultancy firm, publishes each quarter the Investment Monitor that tracks all Australian investment projects costing more than $A20 million. Using a variety of methods, we use these data to shed light on the above issues. The next section describes the projects under consideration, while Section 3 provides an analysis of the relation between proposed and completed projects, and concludes that approximately 20-30 percent of projects never eventuate. Next, we introduce an index-number approach in Section 4 to summarise cost escalation and lead-times of projects. Section 5 deals with the identification of the determinants of the ultimate success of projects by using a probit model. In Sections 6 and 7, we use a Markov chain approach to model the transitions of projects from one stage in the investment pipeline to the next, and the implications of regulatory reform that has the effect of speeding up the process. A summary and concluding comment are contained in Section 8.

2. THE PROJECTS

Access Economics' Investment Monitor assigns each investment project a unique record number, so it can be tracked over time. Also recorded is the identity of the company undertaking the project, the cost, a short qualitative statement of the project's status (e.g., "coal lease granted", "feasibility study underway"), date started, date completed, the industry classification and the number of individuals employed in the construction and operation phases. Most importantly, the status of each project is classified as belonging to one of six possible categories: (1) possible, (2) under consideration, (3) committed, (4) under construction, (5) completed, and (6) deleted. We use the Monitor to track 208 projects closely related to mining and energy for the 37-quarter period 2001 to 2010.[2] To provide some appreciation of the nature of these data, Table 1 provides the history of 10 selected projects. The sixth row, for example, refers to project number 5105, which is a mine expansion by Compass Resources. This project first entered the Monitor in 2002:2 as possible (state 1), by 2008:1 was under consideration (state 2) and was completed (state 5) in 2009:4. The cost of this project was initially estimated to be $A200m, but ended up at $870m.

A histogram of project values is given in Figure 1. As can be seen, the average value of projects is $242m, but the distribution is skewed with a large number of small projects that cost less than $50m, as well as three valued at over $1b. As it is a distinct outlier, we omit from further consideration the $14b shale oil project. Table 2 summarises the data in terms of the average number and value of projects in each state. Column 3 shows that on average about 19 percent of the total value of projects are classified as possible, 28 percent as under consideration, 9 percent committed, 35 percent under construction, 7 percent completed and 2 percent are deleted. Column 4 of the table shows that on average the value of completed projects is less than one-half that of projects in the possible category ($117m vs $263m). As we move through the project pipeline, from possible to under consideration, to committed, to under construction, to completed, the value of projects declines successively, at least on average. This pattern may suggest that smaller projects are more easily completed, or be interpreted as an early warning signal that many proposed projects will possibly never be realised.

Projects that are ultimately completed could be described as "successful", while the "failures" are those that are not completed and deleted from the list. Table 3 and Figure 2 present some information on the nature of the differences between these two groups. Panel A of Figure 2 reveals that on average the failures are substantially more expensive, while, from panel B, their lifetime (the time a project remains on the Monitor) cost increases are lower. But standardising for differing project lengths, the two groups of projects have about the same annualised cost increase, 7.3 and 7.5 percent, from panel B. Panel A also shows that on average, both types of projects have about the same length of life. Panels C and D of the figure deal with the probability of success: Other things equal, a project is substantially less likely to fail if it first enters the investment pipeline at a more advanced stage – on average, there is a 27-percent

[2] For further details of the data, see Appendix A1.

probability of failure if a project starts in the possible state, 15 percent for under consideration and 5 percent for committed.[3] From the last row of panel A of Table 3, the unconditional probability of failure is 12 percent. In Section 5 below we analyse the factors that contribute to making a project a success.

Given the reliance on equity funding, it would be reasonable to expect the stock market to be a leading indicator of investment in resource projects. Buoyant share prices might herald the anticipation of a stronger economy in the future, a more profitable resources sector and a lowering of the cost of capital, which would all be likely to stimulate new projects. Figure 3 presents preliminary evidence that provides some support for this idea, with the average return on the market being about 5.7 percent in the 12 months before completed projects leave the Monitor list and only less than 1 percent for those that are deleted (panel A). However, as indicated by the spread of the observations, there is substantial dispersion around these mean returns. From panel B of this figure, there is a small positive (negative) relation between returns and the number of completed (deleted) projects.

3. HOW MUCH PLANNED SPENDING EVER EVENTUATES?

When a project first appears on the Monitor an estimate of the cost is also recorded. Over time, as the project moves through the investment pipeline, the cost can be revised upwards or downwards. In three of the ten example projects in Table 1 the estimated cost increases over the lives of the projects. This could be caused by planning errors or factors outside the control of project managers, such as unexpected bad weather that is disruptive to construction, skills shortages, or other macroeconomic shocks that inflate costs. If these factors were truly unexpected, then principles of efficient forecasting would point to costs increases for some projects at certain times being more or less offset by other costs decreases. In such a case, the initial estimated cost would be unbiased estimate of its final counterpart. But studies of planned and actual costs of investment projects carried out by Flyvbjerg et al. (2003) indicate this not to be the case. There is a *systematic* tendency for costs to be underestimated; in other words, the estimates are biased. This result is also borne out by the official survey of investment expectations carried out by the Australian Bureau of Statistics (2009), where here again actual tends to exceed expected.[4] In this section, we investigate the behaviour of costs of the resource projects.

Panel A of Figure 4 deals with the lifetime costs of the 183 successful projects. As the vast majority of points lie above the 45-degree line, costs have a distinct tendency to escalate. From the slope of the regression line, costs increase by 13 percent over the life of an average successful project. In other words, for every dollar forecasted to be spent at the commencement of one of these projects, \$1.13 ends up being actually spent. If we also take account of the unsuccessful projects, then for all projects, this 13 percent bias falls, but is still positive at 9 percent, as shown in panel C of the figure.

[3] These results are on the basis of the number of projects (panel C). Using the value of projects gives a similar result of a strongly declining probability of failure with a more advanced entry state (panel D).

[4] See Appendix A2 for details.

The media in Australia frequently reports key results from the Monitor.[5] There is a tendency to focus on the total value of projects, without reference to their status and the likelihood of eventual success. That this is misleading can be seen from the last row of panel B of Table 3, which shows that on average 19 percent of this total value is associated with projects that fail. A similar result emerges from panel C of Figure 5, which plots ending values against starting counterparts, now including failed projects by setting their ending values to zero. On average for all projects (successful and unsuccessful), one dollar of planned spending leads to only 72 cents of expenditure actually taking place.

The results of this section can be summarised with the following rough rules of thumb: While costs of completed project tend to be underestimated by something around 10 percent on average, between 20 and 30 percent of all planned projects never eventuate. More formally, suppose a project is initially scheduled to cost $X and has lead time τ. If P and A are planned and actual expenditure, then

$$E_t\left(A_{t+\tau} \middle| P_t = X\right) = \alpha X,$$

where $\alpha \approx 1.1$ if it is known that the project will be completed; on the other hand, if the project's destiny is unknown, then $\alpha \approx 0.7 - 0.8$. As discussed above, some guidance to the ex ante likelihood that a project will be completed is provided by its starting state and value.

4. INDEXES OF COST AND LEAD TIME

This section considers in more detail the escalation of costs over the lives of projects by summarising the data in the form of indexes. We also present related summary measures of lead times. To allow for the substantial differences in the size of projects, we use weighted indexes with the weights reflecting project values.

A Value-Weighted Cost Index

Let v_{Bp} and v_{Fp} be the beginning (as indicated by the B subscript) and ending (F subscript) costs, or values, of project p. Then, if there are n projects, the corresponding total values are

$$V_B = \sum_{p=1}^{n} v_{Bp} \text{ and } V_F = \sum_{p=1}^{n} v_{Fp} \ .$$

Define the beginning and ending value shares for project p, as well as their arithmetic average, as

$$w_{Bp} = \frac{v_{Bp}}{V_B},\ w_{Fp} = \frac{v_{Fp}}{V_B}, \overline{w}_p = \frac{1}{2}\left(w_{Bp} + w_{Fp}\right),$$

each of which is positive and has a unit sum. A project's value share is a natural measure of its relative economic size.

[5] For example, in an article entitled "Investment Pours in: $28bn New Projects", The Australian newspaper (7 November 2007) cited the Monitor to report on that "the investment boom has built up a new head of steam, with 130 new projects worth a total of $28 billion announced in the September quarter". As another example, Alan Mitchell, Economics Editor of The Australian Financial Review, writes "Access Economics' September quarter Investment Monitor …shows the scope of mining to drive growth" (AFR October 30-31, p. 48).

If the cost of a project escalates over its life, $v_{Fp} > v_{Bp}$, while it falls if the reverse is true. We can summarise the average change over all projects by means of a cost index. For this purpose, let the logarithmic change in the cost of a project over its life be $Dv_p = \log\left(v_{Fp} / v_{Bp}\right)$. An index of the average cost escalation for all projects is

$$(1) \qquad DV = \sum_{p=1}^{n} \bar{w}_p \, Dv_P .$$

This is a value share weighted-average of the cost changes of the n projects and is of the form of a Divisia index.

Index (1) has an attractively simple sampling interpretation (Theil, 1967, pp. 136–137). For convenience, write the cost change of project p as x_p, and consider a discrete random variable X that can take the n possible values $x_1, \ldots, x_n$. To derive the probabilities attached to these n realisations, suppose that the names of projects are drawn at random from this distribution such that each dollar of project cost has an equal chance of being selected. Cost could be measured on a beginning- or ending-of-life basis and either would be equally acceptable. But a superior choice that avoids the beginning-ending asymmetry is a neutral measure that is mid-way between the two extremes, or the arithmetic average value share, $\bar{w}_p$, if cost is measured relative to the total. This means that the probability of drawing x_p is $\bar{w}_p$. Accordingly, the expected value of the random variable X is $E\left(X\right) = \sum_{p=1}^{n} \bar{w}_p x_p$, which coincides with index (1). Thus, the index DV, defined by equation (1), can be interpreted as the expected value of the distribution of cost changes. In this sense, DV is an appealing way of summarising cost increases.

<u>Sub Indexes</u>

Next, we recognise that each project is identified by its starting and ending state. As the behaviour of costs over the life of a project is likely to differ according to the beginning and end-of-life states, we consider cost escalation according to these states. If each project commences life in one of G_B possible starting states, we can denote the corresponding sets by $\mathbf{B}_1, ..., \mathbf{B}_{G_B}$. The share of the total value of all projects that commence life in the ith state is then

$$\bar{W}^{\mathbf{B}_i} = \sum_{p \in \mathbf{B}_i} \bar{w}_p, \ i = 1, \ldots, G_B, \text{ which satisfies } \sum_{i=1}^{G_B} \bar{W}^{\mathbf{B}_i} = 1.$$

This represents the economic importance of state $\mathbf{B}_i$. We can also measure the relative importance of project $p \in \mathbf{B}_i$ by that project's within group, or conditional, share:

$$\bar{w}_p^{\mathbf{B}_i} = \frac{\bar{w}_p}{\bar{W}^{\mathbf{B}_i}}, \quad p \in \mathbf{B}_i, \quad \text{with } \sum_{p \in \mathbf{B}_i} \bar{w}_p^{\mathbf{B}_i} = 1.$$

Then, the index of cost escalation of all projects $p \in \mathbf{B}_i$ is

(2) $$\mathrm{DV}^{\mathbf{B}_i} = \sum_{p \in \mathbf{B_i}} \bar{w}_p^{\mathbf{B}_i} \, \mathrm{Dv}_p.$$

Multiplication of both sides of definition (2) by the share for state i, $\bar{W}^{\mathbf{B}_i}$, yields

$$\bar{W}^{\mathbf{B_i}} \times \mathrm{DV}^{\mathbf{B_i}} = \sum\nolimits_{p \in \mathbf{B}_i} \bar{W}^{\mathbf{B}_i} \times \bar{w}_p^{\mathbf{B}_i} \, \mathrm{Dv}_p = \sum\nolimits_{p \in \mathbf{B}_i} \bar{w}_p \, \mathrm{Dv}_p.$$

As $\sum\nolimits_{i=1}^{G_B} \sum\nolimits_{p \in \mathbf{B}_i} \bar{w}_p \, \mathrm{Dv}_p = \sum\nolimits_{p=1}^{n} \bar{w}_p \mathrm{Dv}_p$, it follows that

$$\sum_{i=1}^{G_B} \bar{W}^{\mathbf{B}_i} \times \mathrm{DV}^{\mathbf{B}_i} = \mathrm{DV},$$

which means that indexes (1) and (2) have the convenient property of being consistent in aggregation.

Now consider the G_F ending states, to be written $\mathbf{F}_1, ..., \mathbf{F}_{G_F}$. Similar to the above, ending-state shares can be defined:

$$\bar{W}^{\mathbf{F}_j} = \sum_{p \in \mathbf{F}_j} \bar{w}_p, \; \bar{w}_p^{\mathbf{F}_j} = \frac{\bar{w}_p}{\bar{W}^{\mathbf{F}_j}}, \quad p \in \mathbf{F}_j, \; j = 1, \ldots, G_F,$$

as well as a corresponding cost escalation index

$$\mathrm{DV}^{\mathbf{F}_j} = \sum_{p \in \mathbf{F}_j} \bar{w}_p^{\mathbf{F}_j} \, \mathrm{Dv}_p.$$

The index $\mathrm{DV}^{\mathbf{F}_j}$ answers the question, what is the (weighted) average change in costs over the lives of all projects that end in state $\mathbf{F}_j$, $j = 1, \ldots, G_F$. The G_F indexes, $\mathrm{DV}^{\mathbf{F}_1}, \ldots, \mathrm{DV}^{\mathbf{F}_{G_F}}$, are also consistent in aggregation, that is, $\sum\nolimits_{j=1}^{G_F} \bar{W}^{\mathbf{F}_j} \times \mathrm{DV}^{\mathbf{F}_j} = \mathrm{DV}$.

Application to Resource Projects

We now apply the above concepts to the n=207 resource development projects. Here, there are $G_B = 4$ beginning states, viz., possible, under consideration, committed and under construction (to be denoted by the subscript $i = 1, ..., 4$), while there are $G_F = 2$ ending states, completed and deleted (denoted by $j = 5, 6$). As each project has its own beginning and ending state, we may consider the "joint" state $\mathbf{B}_i \cap \mathbf{F}_j$, $i = 1, ..., 4$, $j = 5, 6$, and denote this joint occurrence by the superscript $\mathbf{B}_i\mathbf{F}_j$. Thus, the corresponding shares and sub-indexes are

$$\bar{W}^{\mathbf{B}_i\mathbf{F}_j} = \sum_{p \in \mathbf{B}_i \cap \mathbf{F}_j} \bar{w}_p, \qquad \bar{w}_p^{\mathbf{B}_i\mathbf{F}_j} = \frac{\bar{w}_p}{\bar{W}^{\mathbf{B}_i\mathbf{F}_j}}, p \in \mathbf{B}_i \cap \mathbf{F}_j, \; i = 1, ..., 4, \; j = 5, 6,$$

$$\mathrm{DV}^{\mathbf{B}_i\mathbf{F}_j} = \sum_{p \in \mathbf{B}_i \cap \mathbf{F}_j} \bar{w}_p^{\mathbf{B}_i\mathbf{F}_j} \mathrm{Dv}_p, \; i = 1, ..., 4, \; j = 5, 6, \qquad \sum_{i=1}^{4} \sum_{j=5}^{6} \bar{W}^{\mathbf{B}_i\mathbf{F}_j} \times \mathrm{DV}^{\mathbf{B}_i\mathbf{F}_j} = \mathrm{DV}.$$

The table below shows schematically the manner in which the joint, or two-way, indexes, $\mathrm{DV}^{\mathbf{B}_i\mathbf{F}_j}$, can be thought of as entries in a 4×2 table. The corresponding one-way indexes, $\mathrm{DV}^{\mathbf{B}_i}$ and $\mathrm{DV}^{\mathbf{F}_j}$, are (weighted) row and column sums. The overall index of cost change, DV, is a (weighted) sum of the row or column totals. These are convenient aggregation properties.

SCHEMATIC RESPRESENTATION OF
JOINT COST INDEXES BY STARTING AND ENDING STATES

Starting state i	Ending state j		
	5. Completed	6. Deleted	Total
(1)	(2)	(3)	(4)
1. Possible			$DV^{\mathbf{B}_1}$
2. Consideration	$\left[DV^{\mathbf{B}_i\mathbf{F}_j}\right]$		$DV^{\mathbf{B}_2}$
3. Committed			$DV^{\mathbf{B}_3}$
4. Construction			$DV^{\mathbf{B}_4}$
Total	$DV^{\mathbf{F}_5}$	$DV^{\mathbf{F}_6}$	DV

Panel A.1 of Table 4 contains the cost indexes. Thus, for example, projects that start life as under consideration and end up completed experience a lifetime cost increase of 20 percent, on average; by contrast, costs of committed projects that are completed increase by only 6 percent. For all projects, costs escalate by about 17 percent (last entry in column 4 of panel A.1). As the time that projects stay on the Monitor differs, it is convenient to standardise these costs increases by placing them on an annual basis. To do this, define the age at "death" of project p as $a^p = t_F^p - t_B^p$, where $t_F^p \left(t_B^p\right)$ is the date when the project leaves (enters) the Monitor. When a project is completed, this age can be interpreted as the lead time taken for a project to move from the beginning planning stages to being operational; in the case in which the project is never completed, its age is the period it remains on the Monitor before being deleted. Then, using the same value weights as before, a weighted average of age, by beginning and ending state, is $A^{\mathbf{B}_i\mathbf{F}_j} = \sum_{p \in \mathbf{B}_i \cap \mathbf{F}_j} \bar{w}_p^{\mathbf{B}_i\mathbf{F}_j} a_P$, while for all projects, the corresponding measure is $A = \sum_{i=1}^{4} \sum_{j=5}^{6} \bar{W}^{\mathbf{B}_i\mathbf{F}_j} \times A^{\mathbf{B}_i\mathbf{F}_j}$. These average ages are given in panel A.2 of Table 4 and, as can be seen, there is a tendency for age to fall if the project starts at a later stage in the investment pipeline, which is to be expected. The average age for all projects is 11 quarters, or just under 3 years (last entry in column 4 of panel A.2). Figure 6 gives a visualisation of these timelines.[6]

The lifetime change in costs for a given projects is $Dv_p = \log\left(v_{Fp} / v_{Bp}\right)$. As age is measured in terms of quarters, if we multiple Dv_p by $400/a^p$, cost escalation is then approximately in terms of

[6] Mayer (1960) studied lead times for the construction of industrial plants, electric power plants or plant additions in the US. He found that for all types of plants, on average the time from the "start of drawing of plans to start construction" to be 7 months, while construction absorbed 15 months, so that average age of these projects was 7 + 15 = 22 months, or about 7 quarters. In view of the differences between US industrial plants half a century ago and resource projects in Australia today, this finding seems not too far from our estimate of the average age of completed resource projects that commence as "committed", that is, 8 quarters. On the other hand, Mayer and Sonenblum (1955), using records from the US Defence Plant Corporation and Office of Defence Mobilisation for World War II and the Korean War, find an average construction time of about 3 quarters. This is considerably shorter than our estimate of about 7 quarters. Mayer and Sonenblum also have results for 100+ individual industries and while for the mining industries the construction periods are mostly larger than the above 3-quarter economy-wide average, the underlying sample sizes are very small.

percent per annum, which is directly comparable across projects of differing age. We redo the above cost indexes on this basis and the results are presented in panel A.3 of Table 4.[7] The last entry in the last column reveals that for all projects, costs increase by 7.3 percent per annum on average. Over the period 2001-2010, as the CPI increased by 2.8 percent p. a., project costs have increased more than twice as fast as the economy-wide inflation rate.[8]

Second-Order Moments

Consider again the index of costs of all projects, equation (1), $DV = \sum_{p=1}^{n} \bar{w}_p Dv_p$, which is a weighted first-order moment of lifetime cost changes of the n projects. The corresponding second-order moment is

$$\Pi_v = \sum_{p=1}^{n} \bar{w}_p \left(Dv_p - DV\right)^2,$$

which is a weighted variance measuring the dispersion of costs. The higher this variance, the less the mean can be relied upon to provide an adequate description of the data.[9] According to the last entry of column 7 of panel B.1 of Table 4, the standard deviation of costs, $\sqrt{\Pi_v}$, is about 50 percent, so in view of the corresponding cost index being about 17 percent, we can conclude that there is considerable dispersion among the individual projects. The other elements of panel B contain the variances of the corresponding sub-categories. We can also compute in exactly the same way the weighted variances of age and annual cost increases, Π_a and $\Pi_{v/a}$. These, together with the variances of the sub-categories, are contained in panels B.2 and B.3. As can be seen, there is less dispersion in age (7 quarters), but that of annual cost changes is of the same order as lifetime cost dispersion (once we allow for the mean annual cost changes being about half that of lifetime costs). Accordingly, the dispersion of lifetime costs is not just a reflection of differing length of lives.

Next, consider the weighted covariance and correlation between lifetime cost changes and age:

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[7] Some qualifications to the results of Table 4 are in order. First, as there are only 10 projects experiencing transitions from consideration to deleted (Table 3), not too much reliance should be placed on the index value in this cell. Second, it is also to be noted that the annualised cost change from consideration to deleted is large because one project had a 110-percent cost increase over its life of 2 quarters, so that on an annualised basis, its cost increases by 220 percent p. a. Third, note that the average annual cost change for possible to deleted takes a small negative value (first entry in column 3 of panel A.3), while the corresponding entries in panels A.1 and A.2 are both positive. This result comes about by the particular pattern of the relationship between cost and age for projects in this category, as well as the weighting scheme. In the next sub-section, more will be said about the reliability of the indexes.

[8] The underlying data are as follows:

Year and quarter (1)	All Groups CPI (2)	Logarithmic ratio (3)	Annual average growth (%) $100 \times (3)/9$ (4)
2001:1	132.7	-	-
2010:1	171.0	$\log(171.0/132.7) = 0.254$	2.82

Source: Reserve Bank of Australia, www.rba.gov.au/statistics/tables/xls/g02hist.xls?accessed=1608-16:10:58

[9] Under the stochastic approach to index numbers, the n cost changes of the projects are interpreted as noisy readings on the "underlying" cost change, which is a parameter to be estimated. Under certain conditions, DV emerges as the GLS estimator with standard error $\Pi_v/\sqrt{n}$. For details, see, e. g., Clements et al. (2006).

(3) $\Gamma_{va} = \sum_{p=1}^{n} \bar{w}_p \left(Dv_P - DV\right)\left(a_P - A\right), \quad \rho_{va} = \frac{\Gamma_{va}}{\sqrt{\Pi_v \Pi_a}}.$

According to the last entry of column 10 of panel C.1 of Table 4, $\rho_{va} = 0.2$, so cost and age are only weakly correlated, which is consistent with the result of the previous paragraph. Panel B.2 shows that annual cost changes and age are essentially uncorrelated, while in panel C.3 we see that lifetime and annual costs changes are positively correlated.[10]

5. DETERMINANTS OF SUCCESS

The Investment Monitor records that date of birth and death of each project. Death occurs when the project is either completed or deleted, two mutually exclusive events that can be regarded as "success" or "failure". Thus, ex ante, there is a certain probability p of the project succeeding, while 1-p is the probability of failure. In this section, we use a probit model to investigate the determinants of the probability of success.

Let Y be a random variable that takes the value 1 if the project succeeds and 0 if it fails. Let the probability of success be conditional on a vector $\mathbf{x}$ of explanatory variables, so that $\text{Prob}\left(Y = 1 \mid \mathbf{x}\right) = F\left(\boldsymbol{\beta}'\mathbf{x}\right)$ and $\text{Prob}\left(Y = 0 \mid \mathbf{x}\right) = 1 - F\left(\boldsymbol{\beta}'\mathbf{x}\right)$, where $\boldsymbol{\beta}$ is the vector of coefficients and $F(.)$ is the cumulative distribution. Therefore, the expected value, conditional on $\mathbf{x}$, is $E\left(Y \mid \mathbf{x}\right) = 1\left[F\left(\boldsymbol{\beta}'\mathbf{x}\right)\right] + 0\left[1 - F\left(\boldsymbol{\beta}'\mathbf{x}\right)\right] = F\left(\boldsymbol{\beta}'\mathbf{x}\right)$. We use the probit model, which is based on the cumulative normal distribution, to explore the role of project characteristics and the state of the stock market as possible determinants of success. The characteristics considered are the value and age of the project, while the performance of the stock market is measured by the return on the ASX 200 Index over the 12 months immediately preceding project completion/deletion.[11] We also include dummy variables to control for the starting state of the project, "consideration" and "committed". Additionally, we also include a "Mining Sector" dummy to examine any industry-related determinants.[12]

Table 5 presents the maximum likelihood estimates of the various versions of the probit model. In the column headed 1 (for equation 1), we relate the probability to only the starting states "Consideration" and "Committed" with "Possible" as the base case. As expected on the basis of the information in panel C of Figure 2, the signs of the coefficients of these dummies are positive, although the coefficient of "Consideration" is significant only at the 10 percent level. In equation 2, we include project value and age as additional determinants and find that more expensive projects have a lower probability of success, which agrees with panel A of Figure 2, while for older ones, the probability is higher. This result regarding age is in contrast with the bivariate analysis of panel A of Figure 2, which

[10] These correlations are computed analogously to that in equation (3).
[11] We use the starting value of the project as its cost. A project's age is the length of time it remains listed in the Monitor. The return on the market is the logarithm of the ratio of the ASX 200 Index in the quarter immediately preceding its completion/deletion to its value 12 months before.
[12] There are 76 mining projects and 78 electricity, gas and water.

shows that the average age of the successful and failed projects is very similar; evidently, controlling for starting state of projects and value is important. However, it should be noted that value and age coefficients are not highly significantly.

Alternative functional forms for the value and age variables are investigated in equations 5-7. A comparison of equations 2 and 6 shows that using the logarithm of age improved things somewhat (the coefficient becomes significant and McFadden's R^2 increases by 12 percentage points).[13] When log value is used, however, its coefficient becomes less significant (compare equations 5 and 7 with equation 2). Industry effects are allowed for in equations 4-7. Here, the coefficient of the mining sector dummy is always positive and significant, so that mining projects have a higher probability of success, other things remaining unchanged. In equations 8-11, we investigate the interactions between the dummy variables, value and age. We find little evidence of significant interaction between any of the dummies and age. Furthermore, in equation 11, when we allow for all possible interactions, most coefficients become insignificant. However, projects that start as "Committed" or in the mining sector have a positive and mostly significant interaction effect with value (equations 9-11). In all cases, a more buoyant stock market increases the probability of success, but this effect in not highly significant (equations 3-11).[14] This last result goes in the same direction as that of Figure 3, where successful projects are associated with higher returns. Finally, we also examined the impact of cost changes on the probability of success and, as discussed in Appendix A1, this additional variable is insignificant. This finding is at least partially consistent with the result from Figure 2 where the annual cost increase is approximately the same for both types of projects.

Consider successful project i with characteristics $\mathbf{x}_i$. If the probit model is working satisfactorily, its predicted probability $\hat{p}_i$ will be greater than some cut-off value $p*$, where $\hat{p}_i = F(\hat{\beta}'\mathbf{x}_i)$ and $\hat{\beta}$ is the vector of estimated coefficients. Conversely, failed projects should have an outcome of $\hat{p}_i < p*$. We use $p* = 0.67$ to compute the percentage of correctly predicted cases for successful projects.[15] The last three

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[13] But note that equation 6 also includes a mining project dummy, to be discussed subsequently.
[14] For some further explorations of the role of the stock market, see Appendix A1.
[15] Setting the cut-off probability to be greater than one-half can be justified on decision theory grounds (Zellner et al., 1990). Consider the loss associated with incorrectly predicting the outcome of a project. For a successful (failed) project that is predicted to be a failure (success), let the cost associated with this error be $c_1 > 0$ $(c_2 > 0)$. Cost is scaled such that correct predictions (success/success or failure/failure) are costless, so the structure of the loss function is:

Predicted outcome	Actual outcome	
	Success	Failure
Success	0	c_1
Failure	c_2	0

If $\hat{p} > 0$ is the probability of success, the expected loss (EL) of predicting a successful and failed project is

$$\text{EL}(\text{Success}) = \hat{p} \times 0 + (1-\hat{p}) \times c_1 = (1-\hat{p})c_1, \ \text{EL}(\text{Failure}) = \hat{p} \times c_2 + (1-\hat{p}) \times 0 = \hat{p}c_2.$$

If $\text{EL}(\text{Success}) < \text{EL}(\text{Failure})$, then $(1-\hat{p})c_1 < \hat{p}c_2$, or when $\hat{p}$ exceeds the cut-off probability $p* = c_1/(c_1 + c_2)$. When this condition holds, we predict the project to be a success. The costs incurred of committing to a project (by predicting that it will be a success) that ultimately fails are most likely to be substantial (such as in the case of "the project that sent the rows of Table 5 contain the results. While one cannot be too hard and fast in this matter, possibly equations 9 or 10 of the table best capture the determinants of success in a parsimonious manner. For these equations, the Akaike, Schwarz and Hannan-Quinn information criterion scores are among the lowest and their predictive records among the best. In what follows, we use equation 9 for further analysis.

Consider the marginal effects implied by the probit model. For a continuous variable x_i, the derivative of $E(Y|\mathbf{x})$ is $E(Y|\mathbf{x})$ is $ME_i = \partial E(Y|\mathbf{x})/\partial x_i = \left[dF(\boldsymbol{\beta}'\mathbf{x})/d(\boldsymbol{\beta}'\mathbf{x})\right]\beta_\iota = f(\boldsymbol{\beta}'\mathbf{x})\beta_\iota$, where $f(.)$ is the standard normal density function. Likewise, for the interaction terms, $ME_i = f(\boldsymbol{\beta}'\mathbf{x})d\beta_\iota$, where d represents the dummy variable. For a binary independent variable, the marginal effect is the change in the cumulative probability function when the value of the dummy variable changes from 0 to 1. That is, for a dummy variable d, the marginal effect is $\text{Prob}(Y=1|\mathbf{x}_*,\ d=1) - \text{Prob}(Y=1|\mathbf{x}_*,\ d=0)$, where $\mathbf{x}_*$ denotes the vector of all other independent variables. This marginal effect is evaluated at every observation and we take the sample mean.

Table 6 gives the marginal effects implied by equation 9 of Table 5. As can be seen, an increase of \$100m in the cost of a project results in a fall in the probability of success of about 3.6 percentage-points. This refers to a project that first enters the Monitor in the state "possible" (the base case). But for a project starting as "under consideration", the probability of success falls by about 4.4 percentage points $\left[=-3.59+(-0.81)\right]$ per \$100m increase in project cost.[16] For projects starting as committed or mining projects, there is a positive relationship between probability of success and cost. This can be seen by adding the marginal effects of value to the respective dummy interaction term: For committed projects, the probability of success increases by 6.4 percentage points $[-3.59+9.99]$ for a \$100m cost increase; for mining projects, the same cost increase leads to a 2.4 percentage point $[-3.59+5.96]$ rise in the probability. It is to be noted that both these interaction terms are statistically significant in equation 9 of Table 5.

As age (a) has a logarithmic effect on probability, the marginal effect in Table 6 of 11.01 percentage points is interpreted as $\partial E(Y|\mathbf{x})/\partial(\log a)$. It is more convenient to express this in terms of the impact of an increase in age by one quarter, $\partial E(Y|\boldsymbol{x})/\partial a = (1/a)\partial E(Y|\mathbf{x})/\partial(\log a)$. As average age is approximately 10 quarters, the marginal effect on the probability of success of an increase by 1 quarter is $11/10 \approx 1$ percentage point. Table 6 also reveals that a 1-percent increase in stock returns

company broke"). On the other hand, however, there are possibly more modest costs in making the converse mistake of not committing to a project that could have turned out to be successful (the "one that got away"). Accordingly, it is reasonable to suppose that $c_1 > c_2$. In this asymmetric case, the expected loss is minimised by predicting a success when $p* > 1/2$; otherwise, we predict a failure. When, for example, $c_1 = 2c_2$, the cut-off probability is $p* = 0.67$.

[16] However, as the coefficient of the consideration interaction term is not significant, this result should not be treated with some caution.

increases the probability of success by a small 0.14 percentage points. Projects starting under consideration and committed are, respectively, 12 and 20 percentage points more likely to be completed than projects starting as possible. Finally, mining projects are 10 percentage points more likely to be successful.[17]

The above marginal effects are averages over all projects. Some further insights are obtained by plotting the predicted probability against the value of one explanatory variable at a time, with all others held constant (at means). Figure 7 shows the distinct tendency for the probability to decline with cost and increase with age, especially for short-lived projects. The performance of the stock market has a much more modest impact.

6. A MARKOV CHAIN MODEL

In each quarter, projects are classified as being in one of six states, possible, under consideration, committed, under construction, completed or deleted. The progression of a project through these states can be thought of as a stochastic process occurring in discrete time whereby at the end of each quarter t, a project either remains in its current state or jumps to one of the five other states in t+1. Let X_t be the state occupied by a project in t and $p_{ij} = \text{Prob}\left(X_{t+1} = j \mid X_t = i\right)$ be the conditional probability of the project moving from state i to state j at the end of t, with $\sum_{j=1}^{6} p_{ij} = 1,\ i = 1, \dots, 6.$ These probabilities can be arranged in a 6×6 transition matrix $\mathbf{P} = [p_{ij}]$, which has unitary row sums. A key assumption is that the transitions exhibit first-order Markov dependence, so that, for i, j = 1,...,6,

$$p_{ij} = \text{Prob}\left(X_{t+1} = j \mid X_t = i\right) = \text{Prob}\left(X_{t+1} = j \mid X_0 = x_0, X_1 = x_1, ..., X_{t-1} = x_{t-1}, X_t = i\right).$$

The process is also assumed to be time homogenous, which means that the probabilities remain stable over time.[18]

Let c_{ijh} be the number of projects that move from state i to j over transition h, where h=1,...,36. The transition matrix is then estimated as the average of the normalised counts: $\hat{\mathbf{P}} = \left[\hat{p}_{ij}\right] = \left[(1/36)\sum_{h=1}^{36} c_{ijh} / c_{i\bullet h}\right],$ where $c_{i\bullet h} = \sum_{j=1}^{6} c_{ijh}$ is the total number of moves from i over transition h.[19] We apply this procedure to both the 207 and 154 projects (see the discussion of Appendix A1 for this distinction) and Table 7 gives the results. As the two transition matrices are similar, in what

[17] Again, as a qualification, the coefficients of the coefficients of "returns", "consideration" and "mining" dummies are not highly significant.

[18] Clements et al. (2010), using an earlier version of the Investment Monitor data, show that the assumptions of first-order Markov dependence and homogeneity are not grossly contradicted by the evidence. A good reference on the theory of Markov chains is A. G. Pakes, "Lecture Notes on Markov Chains and Processes," School of Mathematics and Statistics, The University of Western Australia, 2009.

[19] If we used value rather than count data, then the $(i, j)^{\text{th}}$ transition probability is interpreted as probability of a dollar's worth of a project making the transition. With an earlier version of the Investment Monitor data, Clements et al. (2010) show that the use of values does not appreciably affect the results.

follows, we focus on the one in panel B derived from the 154 projects. The estimated transition probabilities have several interesting properties:

- For each state of origin, the highest probability move is no move. That is, the diagonal probability is the largest in each row, so that $\max_j \hat{p}_{ij} = \hat{p}_{ii}$, $i = 1, \ldots, 6$.
- Consider the elements $\hat{p}_{55}$ (which refers to the probability that the project remains completed) and $\hat{p}_{66}$ (remains deleted). In the Monitor, after projects initially hit these states, they are no longer recorded in subsequent quarters, so there are zero counts for transitions originating in states 5 and 6 in columns 4-7 of Table 7. Accordingly, we set $\hat{p}_{kk} = 1$ and $\hat{p}_{kj} = 0,\ k = 5, 6,$ $j = 1, \ldots, 4,$ so states 5 and 6 are absorbing. When a project enters either of these states it remains there forever.
- As no projects move "backwards", the matrix has a upper triangular structure whereby $\hat{p}_{ij} = 0, i > j$. The system is thus irreversible in the sense that projects flow from lower states to higher ones, but not vice versa. Thus, for example, once a project is under construction it cannot regress back to under consideration.
- The largest off-diagonal element is $\hat{p}_{34} = 0.303$, which indicates there is a 30- percent chance of a currently-committed project commencing construction in the subsequent quarter. Another large off-diagonal is $\hat{p}_{45} = 0.166$, for construction $\rightarrow$ completed. These relatively high values at this "end" of the investment pipeline imply that the second part of the overall system is faster than the first.
- The probability of projects leaving state 3 for state 4 $(\hat{p}_{34} = 0.303)$ exceeds that of leaving state 4 $(\hat{p}_{45} + \hat{p}_{46} = 0.166 + 0.011 = 0.177)$. When there is initially the same volume of projects in states 3 and 4, this will result in a bottleneck of projects in state 4, under construction.
- The probability of moving directly to deleted from possible $(\hat{p}_{16} = 0.074)$ is substantially higher than that from under consideration $(\hat{p}_{26} = 0.029)$. Additionally, the probability of moving directly from possible to completed $(\hat{p}_{15} = 0.010)$ is substantially lower than from under consideration to completed $(\hat{p}_{25} = 0.058)$. Evidently, projects classified as possible have a lower chance of success than those that are under consideration, which agrees with the earlier results of Table 3 and the probit estimates of Table 5.

The above discussion deals with one-quarter transitions. We now turn to the multi-period transitions. For a project currently in state i, the probability of moving to state j in the next quarter $t+1$ is p_{ij}, while for $t+2$ the probability is $\sum_{k=1}^{6} p_{ik} p_{kj}$, which will be denoted by $p_{ij}^{(2)}$. This $p_{ij}^{(2)}$ involves the direct move over the two quarters $i \rightarrow j \rightarrow j$, with probability $p_{ij} p_{jj}$, plus the five "indirect" moves $i \rightarrow k \rightarrow j,\ k = 1, \ldots, 6,\ k \neq j$, which has probability $\sum_{k=1, k \neq j}^{6} p_{ik} p_{kj}$. To formulate the whole set of multi-period transitions, let s_{it} be the proportion of projects in state i $(i = 1, \ldots, 6)$ in quarter t and $\mathbf{s}_t' = [s_{1t}, \ldots, s_{6t}]$ be the corresponding vector. It then follows that for $\tau > 0$ steps into the future, $\mathbf{s}_{t+\tau}' = \mathbf{s}_t' \mathbf{P}^{\tau}$, where $\mathbf{P}^{\tau}$ is the τ-step transition matrix, defined as $\mathbf{P}$ multiplied by itself τ times. The $(i, j)^{th}$ element of $\mathbf{P}^{\tau}, p_{ij}^{(\tau)}$, is the probability of a project moving from state i to j over τ periods and accounts for both the one-period and subsequent-period transitions, of both the direct and indirect kind. More formally, if X_t is the state occupied by a project in period t, then $p_{ij}^{(\tau)} = \text{Prob}\left(X_{t+\tau} = j \mid X_t = i\right)$.

Figure 8 uses the transition matrix given in panel B of Table 7 to plot the estimated $p_{ij}^{(\tau)}$ against τ for $i = 1, \ldots, 4,\ j = 5$ (completed), 6 (deleted). Consider the probability of the completion of a project that starts life as possible and compare that with one that starts as under consideration. The difference between the corresponding one-quarter transitions of Table 7 is $\hat{p}_{15} - \hat{p}_{25} = .010 - .058 = -4.8$ percent, while it can be seen from panel A of Figure 8 that the difference after 36 quarters is much larger at $p_{15}^{(36)} - p_{25}^{(36)} = .536 - .802 = -26.6$ percent. In words, a project that commences as under consideration has an 80-percent chance of being completed after 36 quarters, while one starting as possible has only a 54-percent chance. From the probit analysis of Table 6, the corresponding marginal effect on the probability of success is 11.9 percent. The reason for the difference 26.6 vs 11.9 is that the probit model holds constant the other characteristics of projects, while the Markov chain does not. Panel A of Figure 8 also shows that projects starting as committed or under construction have a more than 90-percent chance of ultimately being completed. Panel B of this figure shows that the corresponding multi-period probabilities of deletion are approximately the complement of the completion probabilities.

7. REDUCING RED AND GREEN TAPE

Recently, there has been considerable concern regarding the functioning of the investment project approval process in the state of Western Australia, which has a large resources sector. The seriousness of this issue is illustrated by the WA Minister for Mines and Petroleum describing as "the need for an efficient and timely approvals process" as his "number one priority in government".[20] In this section, we investigate the implications of changes in key transition probabilities that could stem from regulatory reform that eliminates bottlenecks in the investment pipeline.

It can be shown that $1/\left(1 - p_{ii}\right)$ is the mean occupancy time in state i, so that as p_{ii} falls, projects move faster through the system. But as $\sum_{j=1}^{n} p_{ij} = 1$, where n is the number of states, a change in p_{ii} implies that some of the off-diagonal probabilities also have to be adjusted accordingly. Let $\mathbf{P} = \left[p_{ij}\right]$ be the original $n \times n$ transition matrix, which we adjust by adding the matrix $\mathbf{A}$ to give the new transition matrix $\mathbf{P} + \mathbf{A}$. If $\boldsymbol{\iota}$ is a vector of n unit elements, the row-sum constraint can be expressed

[20] See Norman Moore, "Address to the Australian Institute of Company Directors," 18 February 2009, Perth. In this speech, the Minister goes on to indicate the importance of the resources sector by stating "all Western Australians, and indeed all Australians, should have an interest in the viability of the [resources] industry due to the incredible wealth and employment opportunities it creates". The clear implication is a link between the efficiency of the approvals process and prosperity of the broader economy.

as $\mathbf{P}\boldsymbol{\iota} = (\mathbf{P}+\mathbf{A})\boldsymbol{\iota} = \boldsymbol{\iota}$, which implies that $\mathbf{A}\boldsymbol{\iota} = \mathbf{0}$, a vector of zeros. In words, the elements of each row of the adjustment matrix **A** must sum to zero. We consider two approaches to this adjustment problem.

One approach is to subtract a fraction $0 < \alpha_i < p_{ii}$ from the diagonal element of the i^{th} row of the transition matrix and then evenly redistribute this quantity across the other elements of the row by adding $\alpha_i/(n-1)$ to each of the off-diagonal transitions. Thus, the $(i,j)^{th}$ element of the i^{th} row of **A** takes the form $a_{ij} = -\alpha_i$ if i = j, $\alpha_i/(n-1)$ otherwise, which satisfies $\sum_{j=1}^{n} a_{ij} = 0$. Let δ_{ij} be the Kronecker delta $(\delta_{ij} = 1 \text{ if } i = j, \text{ zero otherwise})$ and let $\delta_{ij}\boldsymbol{\iota}'$ be a vector of zeros except for the i^{th} element, which is unity; that is, $\delta_{ij}\boldsymbol{\iota}'$ is the i^{th} row of the $n \times n$ identity matrix **I**. Then, the i^{th} row of **A** can be expressed as $\mathbf{a}_i' = \alpha_i \left[1/(n-1)\right](1 - n\delta_{ij})\boldsymbol{\iota}'$, and the $n \times n$ adjustment matrix is

$$\mathbf{A} = \begin{pmatrix} \mathbf{a}_1' \\ \vdots \\ \mathbf{a}_n' \end{pmatrix} = \frac{1}{n-1}\hat{\boldsymbol{\alpha}}(\boldsymbol{\iota}\boldsymbol{\iota}' - n\mathbf{I}), \text{ with } \hat{\boldsymbol{\alpha}} = \begin{pmatrix} \alpha_1 & & \mathbf{0} \\ & \ddots & \\ \mathbf{0} & & \alpha_n \end{pmatrix}.$$

A second approach to the adjustment problem is to employ some type of weighting scheme. Thus, rather than evenly distribute α_i across the row, we add to the off-diagonal transitions $a_{ij} = w_{ij}\alpha_i,\ i \neq j$, with the weights w_{ij} satisfying $\sum_{j=1, j\neq i}^{n} w_{ij} = 1,\ i = 1, \ldots, n$. Under this approach, we have, for $i, j = 1, \ldots, n$, $a_{ij} = \alpha_i\left[w_{ij} - \delta_{ij}(w_{ij}+1)\right]$. The weights could reflect the idea that some pairs of states are closer "economic neighbours" than others, so that if a project spends less time in one state, then it is more likely to locate in a closer neighbour, rather than a more distant one.

To implement the above ideas, we start with the transition matrix of panel B of Table 7. In order to examine the essence of the issues, we simplify the structure of this matrix by setting to zero all the transitions that are less than 0.05. Consistent with the idea of regulatory reform "speeding up" the process, the row sum constraints are enforced by increasing the transitions to construction, p_{i4}. This yields the "base case" matrix given in the left-hand side of panel A of Figure 9. As the first three states – possible, consideration, committed – all precede the construction phase, we shall consider the impact of regulatory reform by changing the nature of the system so that the average project spends less time in these states and commences construction sooner. To do this, the mean occupancy time in each of the pre-construction phases, $1/(1-p_{ii}),\ i = 1,2,3$, is reduced by 25 percent. This implies that the own-state probabilities (to be denoted by p_{ii}^{new} and p_{ii}^{old}) satisfy $\left(p_{ii}^{new} - p_{ii}^{old}\right)/\left(1 - p_{ii}^{new}\right) = 0.25,\ i = 1,2,3$. The transitions into construction, $p_{i4},\ i = 1,2,3$, are then increased to satisfy the row-sum constraints, as before. This procedure can be regarded as an application of the weighted approach described above. The right-hand side of panel A of Figure 9 contains the new transition matrix.

Next, we examine the multi-period transitions associated with the new matrix, $p_{ij}^{new(\tau)}$. Panel B of Figure 9 plots the changes in these probabilities, $\Delta p_{ij}^{(\tau)} = p_{ij}^{new(\tau)} - p_{ij}^{old(\tau)}$, against the horizon, τ, for transitions into the two absorbing states, completed and deleted. As can be seen from part (i) of this panel, the major impact is a substantial increase in the probability of projects moving from possible to completed; over horizons of up to about three years, this $\Delta p_{ij}^{(\tau)}$ increases steadily and then declines a bit, with the new level, $p_{ij}^{new(\tau)}$, ending up about 10 points higher. The change in the probability from possible to deleted is almost the mirror image of the above, so this asymptotes to about -10 percent [see part (ii) of panel B]. Over the first several years of the horizon, there are also some modest changes in two other $\Delta p_{ij}^{(\tau)}$.

Finally, how substantial is the speeding up effect? We answer this by examining the distribution of projects over the four transition states, $\mathbf{s}_t = [s_{1t}, \ldots, s_{4t}]'$, where s_{it} is the share of projects in state i at time t. The impact of speeding things up can then be assessed by examining the difference between the new and old distributions $\Delta \mathbf{s}_t = \mathbf{s}_t^{new} - \mathbf{s}_t^{old}$.[21] As can be seen from Figure 10, going faster leads to an increase in the proportion of projects in the construction phase by about 20 percentage points. As about 26 percent of projects are under construction on average (Table 3), the higher speed causes this percentage to almost double. This means that the number of projects under construction also doubles under the condition that the total remains unchanged. Figure 10 also reveals that the 20-point increase the construction share is offset by reductions in the proportions in the other three transition states, especially under consideration. In summary, these results illustrate the gains to be had by increasing the flow rate of projects down the investment pipeline into construction.

8. SUMMARY AND CONCLUDING COMMENTS

Why is investment so volatile, uncertain and difficult to understand? Because it involves fragile expectations about the future, gestation periods are often long, projects tend to be lumpy and have an options value attached to delay are among the usual explanations of the wide swings of investment. But a further part of a convincing account of investment behavior is the nature of the complex process many projects must pass through if they are to eventually reach fruition. In the case of investments in resource projects (mining and energy), this process can include the initial discovery of a mineral deposit, arranging for preliminary financial backing, a feasibility study, environmental and regulatory approvals, a bankable proposal, satisfying onerous legal and financial requirements, and substantial capital raising -- all before the commencement of construction, the point at which expenditure is usually treated as "investment". Clearly, only the strongest projects can survive such a process (at least on average). We term this process the "investment project pipeline".

[21] See Appendix A1 for details of the procedure.

We studied the workings of the investment pipeline in the context of a number of resource projects in Australia. Using detailed information on all projects undertaken over the last decade that cost at least $A20m, we obtained estimates of the probability of success of projects, the economic determinants of that probability, lead-times and potential bottlenecks due to infrastructure and other shortages. Further results dealt with indexes of cost escalation over the lives of projects and the implications of a "speeding up" of the pipeline as a result of regulatory reform.

As an illustrative example of our results, the table below gives information regarding Australian resource investment projects proposed in 2010. The total planned cost is $18.4b (the last entry in column 2), but on the basis of our findings the expected future cost could be substantially less. The precise amount depends on the information set we condition on when computing the expected value:

- Applying the rule of thumb that only 75 percent of all projects (by value) succeed, the expected cost falls to $13.8b (col 4).
- Using information of the differing starting states of projects, the expected cost is $13.3b (col 6).
- Employing publicly-available microeconomic data on the individual projects, together with our probit model, the expected cost is $16.0b (col 8).

These and other results of the paper could be of use in understanding the macroeconomics of investment, and be of value to the industries in question, to capital markets and for economic management purposes.

INVESTMENT PROJECTS, MARCH 2010

Starting State	Planned Cost ($m)	Expected Future Cost					
		1st Pass (Unconditional probabilities)		2nd Pass (State Dependent Probabilities)		3rd Pass (Probabilities from probit model)	
		Probability	Expected Value ($m)	Probability	Expected Value ($m)	Probability	Expected Value ($m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Possible	9,220	0.75	6,915	0.58	5,348	1.00	9,219
2. Under Consideration	7,469	0.75	5,602	0.84	6,274	0.72	5,385
3. Committed	920	0.75	690	0.98	902	0.86	788
4. Under Construction	800	0.75	600	1	800	0.72	574
Total	18,409	0.75	13,807	0.72	13,323	0.87	15,966

Note: See Appendix A3 for details.

APPENDIX A1

THE DATA, FURTHER RESULTS AND SPEED LIMITS

The Data

The project data are from Access Economics Investment Monitor, 2001:1 – 2010:1; this publication states that the data are collected "from a variety of State and Federal Departments and private sources". Table A1.1 provides details of project categories, or states, while Table A1.2 indicates the industries that we consider involve mining and energy (or "resource") projects.[22] This leads to 1,180 separate resource projects. We identified several issues with the data which lead to projects being discarded from our sample, as set out in Table A1.3. Some details follow.

Non-Cost Issues

A total of 13 projects experienced a change in major industry classification during their time on the Monitor. Table A1.4 provides information regarding these projects. We carefully checked each project's description and identified the following causes of the industry change:

- *Change in project scope*. Five projects experienced a significant change in their project description which led to the industry change (panel A, Table A1.4). For example, the description of project 4979 (first row of this panel) went from an "expansion to the Liddell coal mine" to an "expansion of the washplant for Liddell Coal", which resulted in a large cost increase from $20m to $85m. This project now belongs to "Manufacturing" (see column 7). Thus, we discard the five projects that changed scope during their lifetime.
- *Ambiguous information*. The eight projects listed in panel B of Table A1.4 had some ambiguity in their records that deserve attention. The first seven projects here did not change their description, yet their industry did. Evaluating these descriptions, we decided that five of these projects should not belong to our sample and thus excluded them. Finally, the last row of panel B contains a special case, project 8344. The origins of this project stems from a 2006:1 plan to construct a cattle feedlot at Moira Station at a cost of $80m (Project 8214). In the subsequent quarter, it was decided to build an integrated cattle feedlot, ethanol plant and biomass power station instead – thus, project 8344 was created. But at the same time, project 8214 still continued on. In 2006:3, project 8344's description was changed to an ethanol plant and biomass

[22] It is worth noting that the Australian Bureau of Agriculture and Resource Economics also publish information on possible resource projects. See, e. g., Lampard et al., who describe this work as follows: "ABARE's list of major minerals and energy projects expected to be developed over the medium term is compiled every six months. Information contained in the list spans the mineral resources sector and includes energy and minerals commodities projects and mineral processing projects. The information comes predominantly from publicly available sources but, in some cases, is supplemented by information direct from companies. The list is fully updated to reflect developments in the previous six months. The projects list is released around May and November each year." (M. Lampard et al., 2009, Minerals and Energy, Major Development Projects November 2009 Listing. ABARE: Canberra.) Additionally, the Australian Bureau of Statistics publish survey-based quarterly estimates of actual and expected investment expenditure by selected industry, one of which is mining. (ABS, Private New Capital Expenditure and Expected Expenditure Cat. No. 5625.0.) The ABS data will be considered in Appendix A2.

power station neighbouring the cattle feedlot. This led to a fall in cost from $200m to $120m and a change in classification to "Electricity, Gas & Water". Eventually, the construction of the cattle feedlot was completed in 2009Q1, while the power generation plant was completed in 2010:1. As we wanted to keep the power generation part of the project but exclude the feedlot, we redefined project 8344 by changing its starting cost to $120m, keeping the starting date unchanged and classifying it as a resource project.

As shown in column 8 of Table A1.4, the above considerations led to 10 of the 13 projects being discarded. This is recorded in row 6 of Table A1.3. As indicated by row 14 of Table A1.3, 53 projects are discarded due to non-cost issues, leaving 1,180-53=1,127.

Cost Issues

In September 2009, the Monitor changed its selection criterion by increasing the cut-off cost for inclusion in the publication from $5m to $20m. This results in 72 projects dropping from the sample during that quarter (see row 15 of Table A1.3). To ensure consistency, we should adjust all data prior to September 2009 to reflect this change. This poses a challenge as many projects had unknown ("na") starting life costs. If we were to delete all "na" projects, we would run the risk of omitting potentially large projects with valuable information. On the other hand, retaining all "na" projects means that the sample will almost certainly include some small (<$20m) projects from pre-September 2009. To avoid these problems, we proceed as follows. First, we restrict our sample to end at June 2009 (before the implementation of the new cost filter), so that we now have a mixture of projects which are >$20m and <$20m. This involves 1,031 projects. Next, we map out the entire cost history of each project as follows:

- When each of the 1,031 projects first appears in the database, its initial cost will be "na", "$< \$20\text{m}$" or "$\geq \$20\text{m}$". During its lifetime, a project can move between these cost categories.
- By June 2009 if a project has finished, we examine its ending cost. Projects that finish with "na" or "$< \$20\text{m}$" are discarded, while we retain projects ending with a cost $\geq \$20\text{m}$.
- If by June 2009 a project has not yet reached an absorbing state (completed or deleted), we keep the project regardless of its cost category.

As indicated by Figure A1.1 (as well as row 16 of Table A1.3), this procedure results in 196 projects being discarded.

There was also a large spike in the number of deleted and completed projects in September 2009. This was due to Access cleaning up the Monitor database by assigning any redundant and/or out-of-date projects to an absorbing state – completed (31 projects) and deleted (93). Since we have no way of determining if these projects were really successful/failed or just simply removed from the database, we delete these 31+93=124 projects, as shown in row 17 of Table A1.3. Row 18 of Table A1.3 reveals that a total of 392 projects are omitted due to the issues relating to the "<$20m" filter. This leaves 1,127-392=735 projects (row 18 of Table A1.3).

Recording and Other Issues

There are some additional data recording issues that need to be discussed:

- *Unobserved births.* Some projects have incomplete life histories as their date of birth and/or death lies outside the sample period. Incomplete birth histories refer to those projects recorded as being in one of the six states in the first period of the sample, 2001:1, that are not identified as new projects in the Monitor. In order to obtain a more representative picture of the operation of the system, we proceed by deleting the 255 projects with missing birth records, as indicated in row 19 of Table A1.3.
- *Unobserved deaths.* For similar reasons, we delete projects that do not enter the completed or deleted state by the end of the sample period, 2010:1. This involves 261 projects (row 20 of Table A1.3).
- *Backward moves*. If a project moves "backwards" from under construction back to committed, for example, this is equivalent to "reverse aging" or getting younger with the passage of time, which does not make sense. We thus remove all projects that exhibit a backwards move at any point in the sample period. There are a total of 70 such projects (row 21 of Table A1.3).

There is some overlap between the above problems. After deleting the projects with these problems, and avoiding double counting by allowing for the overlap, the number of projects falls from 735 to 248 (row 22 of Table A1.3).

Next, we investigated if the remaining 248 projects had known starting and ending values. We eliminated 40 projects that did not meet this requirement (row 23 of Table A1.3), which gives rise to the remaining 208 projects displayed in Figure 1 of the text. One further project was removed as it was a large outlier with cost of $14b (row 24 of Table A1.3). The details of these 208-1=207 projects are reported in Table A1.5. These 207 observations are used in Sections 2-4 of the text of the paper.

Of the above 207 projects, all 53 that started their life as "Under Construction" were always eventually successful (see panel B of Table A1.5). We thus discard these projects from the sample used for estimating the probit models Section 5 of the text, which yields a sample of 207-53=154 projects; see rows 25 and 26 of Table A1.3. The Markov chain analysis of Sections 6 uses both the 207 and 154 projects, but concentrates more on the 154 case. Section 7 ("Reducing Red Tape and Green Tape") is based on the 154 projects.

Table 2 of the text gave information of the projects by state in terms of averages over all quarters of the whole period. Table A1.6 contains the underlying data.

Further Estimates of Probit Models

Table 5 of the text contains estimates of the probit models. One explanatory variable in these models is the state of the stock market, defined as the return on the ASX 200 index over the 12-month period before completion/deletion. Table A1.7 explores the impact on the results of using alternative measures of market returns. Equation A1 of this table starts by reproducing the base case, equation 9 of Table 5, which uses the “year to end” return. As can be seen, relative to other definitions, the return coefficient is most significant when the “year to end” concept is used. Moreover, the coefficients of the other variables are not particularly sensitive to how returns are measured.

Table A1.8 starts with the base case, equation 9 of Table 5, and augments it by including two measures of changes in the cost of projects, lifetime and annualised. These results show that costs are insignificant determinant of the probability of success..

The Distribution of Projects and Speed Limits

In any quarter t+1, the number of projects in a given state j comprises two components, (i) those already in the system that occupied state i $\left(i=1,\ldots,6\right)$ in the previous quarter t and have now moved to j; and (ii) projects that are new to the system in $t+1$ and locate directly in j. To account for both types of projects, let N_t be the total number of projects in t and $\Delta N_{t+1}=N_{t+1}-N_t$, so that $N_{t+1}=N_t+\Delta N_{t+1}$. If s_{it} is the proportion of the pre-existing projects in state i, then $s_{it}\cdot N_t$ is the corresponding number, and, using the Markov chain, $N_t\sum_{i=1}^{6}s_{it}p_{ij}$ is the number of these projects in state j next period. Regarding the flow of new projects, the number in j in t+1 is $\Delta N_{t+1}s_{j,t+1}^{new}$, where $s_{j,t+1}^{new}$ is the corresponding proportion. As the total is the sum of both types, $N_{t+1}s_{j,t+1}=N_t\sum_{i=1}^{6}s_{it}p_{ij}+\Delta N_{t+1}s_{j,t+1}^{new}$ is the total in j at t+1, and the proportion is

(A1.1) $$s_{j,t+1}=\alpha_t\left[\sum_{i=1}^{6}s_{it}p_{ij}\right]+\left(1-\alpha_t\right)s_{j,t+1}^{new},$$

where $\alpha_t=N_t/N_{t+1}$ is the share of pre-existing projects in the total number. This equation shows that next period’s proportion is a weighted average of two terms, one involving the flow of pre-existing projects through the system and the other the new projects.

To implement equation (A1.1), we proceed as follows:

- We used the initial cleaned sample of 735 projects (Table A1.3, row 18) to obtain (i) the average proportion of projects in each state $\bar{\mathbf{s}}=\left[0.32,0.35,0.06,0.22,0.04,0.01\right]$; and (ii) the number of new projects that enter the system each quarter.
- We use $\bar{\mathbf{s}}$ as the initial distribution in equation (A1.1); that is, we use the average proportions in the first term on the right of this equation at time t=0, $\alpha_0\left[\sum_{i=1}^{6}s_{i0}p_{ij}\right]$. Then for each $t\geq1$, we use

equation (A1.1) to compute two distributions: that derived from (i) the original 154-project transition matrix given in panel B of Table 7; and (ii) its sped-up counterpart contained in the right-hand side of panel A of Figure 9. The resulting distributions are renormalised such that the proportions in states 1 to 4 to have a unit sum (as states 5 and 6 are absorbing) and are denoted by $\mathbf{s}_t^{old}, \mathbf{s}_t^{new}$.

- The effect of speeding up is then calculated as the difference between the two distributions $\Delta\mathbf{s}_t = \mathbf{s}_t^{new} - \mathbf{s}_t^{old}$, and the result are displayed in Figure 10.

APPENDIX A2

THE ACCURACY OF INVESTMENT PLANNING

This appendix summarises three sets of other evidence on the relationship between planned and actual investment. This evidence is related to the escalation of costs over the lives of projects, as well as the extent to which expectations are noisy, possibly biased, predictors of future investment.

Transport Infrastructure Projects

Flyvbjerg et al. (2002) analyse investments in public works projects by comparing planned costs that are estimated before they are undertaken with the subsequent actual costs. Using the experience of on a number of public transport projects, they find a systematic tendency for substantial underestimation of costs that would bias benefit costs calculations in favour of accepting the projects.[23] These authors use information on 258 projects with a value of about $US90 billion in terms of 1995 prices. The projects include bridges, tunnels, highways, freeways, high-speed rail, urban rail and conventional (interurban) rail. The projects are located in 20 countries, with 181 in Europe, 61 in North America and the remaining 16 located elsewhere. The construction costs range from $US1.5 million to $US8.5 billion (1995 prices) and were incurred between 1927 and 1998. The authors point out that the data are likely to be subject to reporting biases, such as project managers revealing data that shows them in a good light. Thus, while the data are less than perfect, Flyvbjerg et al. (2002, p. 295) describe their data "the best obtainable sample given the current state of the art in this field of research". Additionally, although the exact impact of the biases are difficult to assess, Flyvbjerg et al. feel that an adjustment for the biases would increase the estimated costs overruns.

Table A2.1 summarises the results and as can be seen, for all three types of projects, on average the costs overruns are positive, with the actual costs of the order of one-third higher than planned. The last column of the table reveals that the overruns are all highly significant. Flyvbjerg et al. (2002, p. 282) describe their results in terms of

[23] For related material, see Flyvbjerg et al. (2003).

> Costs are underestimated in almost 9 out of 10 projects. For a randomly selected project, the likelihood of actual costs being larger than estimated costs is 86 percent. The likelihood of actual costs being lower than or equal to estimated costs is 14 percent….Underestimation of costs at the time of decision to build is the rule rather than the exception for transport infrastructure projects. Frequent and substantial cost escalations is the result.

Flyvbjerg et al. also examine whether there is a systematic tendency for the underestimation of costs to decrease over time. If the underestimation were unintentional, then managers could be expected to learn from past mistakes and for subsequent projects, produce higher quality estimates that more closely approximated actual costs. But Flyvbjerg et al. show that this is not the case with their data. They speculate (p. 286) that the source of the problem is that:

> Strong incentives and weak disincentives for underestimation may have taught project promoters what there is to learn, namely, that cost underestimation pays off. If this is the case, underestimation must be expected and it must be expected to be intentional.

To explain cost underestimations, Flyvbjerg et al. (2002) consider technological, economic, psychological and political reasons. They conclude that because of economic and political incentives, underestimation is a deliberate ploy by proponents to help make their proposed projects become a reality. In their uncompromising words:

> The use of deception and lying as tactics in power struggles aimed at getting projects started and at making a profit appear to best explain why costs are highly and systematically underestimated in transportation infrastructure projects. (Flyvbjerg et al. 2002. p. 290)

<u>Megaprojects</u>

In addition to the transport infrastructure projects, Flyvbjerg et al. (2002) also summarise "spectacular" examples of cost underestimation that have occurred in megaprojects. As Table A2.2 shows, these overruns are much large than those of Table A2.1, but this is simply a reflection of the selection of projects by the authors that qualify as being "spectacular" in their costs overruns. Consequently, while the experience with these projects is of substantial historical interest, their cost overruns cannot be considered to be representative of the experience of all projects.

<u>Australian Investment Expectations</u>

The Australian Bureau of Statistics collects quarterly survey data on actual and anticipated (or expected) capital expenditure in Australia (see, e.g., ABS, 2009). This section describes the survey and investigates the quality of expectations.

The survey is conducted by mail and based on a random selection of approximately 8,000 businesses that belong to three broad industry groups, viz., mining, manufacturing and other (ABS, 2009). In each survey, businesses are asked to provide three sets of data: (i) actual expenditure incurred for the quarter, (ii) short-term forecast expenditure and (iii) longer-term forecast expenditure. The actual forecast horizon varies from quarter to quarter and panel A of Figure A2.1 shows that in the December 2007 survey, for instance, respondents were requested to provide expected expenditure for the period

July 2008 to June 2009, which is referred to as a "long-term" expectation.[24] Included in the June 2008 survey is actual expenditure for that quarter and expected expenditures for the periods (i) July-December 2008 and (ii) January-June 2009. Panel A of the figure contains three sets of expectations/forecasts of future investment, each represented by a row in the shaded region. It is to be emphasised that these three forecasts all refer to the same predictand, viz., actual investment for the year 2008/09. The only difference between these forecasts is the time at which they were made: the forecast horizon declines as we move from the top to the bottom row of the shaded region of panel A (from 6 to 5 to 4 quarters).

The expectations of panel A of Figure A2.1 are to be compared with the subsequently realised investment, as indicated by panel B. Panel C takes the mining industry as an example to show the contrast between actual and expected in 2008/09. Actual for the year is the sum of the quarterly figures, which is $37,977m, while the corresponding 6-quarter-ahead expectation, made in December 2007, is $31,717. Thus, actual investment is about 20 percent greater than that expected for this horizon. For the 5- and 4-quarter ahead horizons, actual is 7 percent above and 13 percent below expected, respectively, as is indicated in panel C.

The ABS prepares seven estimates of actual and expected expenditure for each year. However, we consider only four of these estimates. What the ABS calls "Estimate 1" corresponds to the 6-quarters-ahead forecast, while Estimates 2 and 3 correspond to the 5 and 4-quarters-ahead forecasts. These are the three forecasts we use. As Estimates 4, 5 and 6 contain a portion of actual expenditure in calculating expected, we do not use them. Estimate 7 corresponds to actual expenditure.

Column 2 of Table A2.3 gives the mean expectional errors over the period 1987-2008 for the three industry groups, as well as the total. In 9 out of the 12 cases, these are positive and significant, implying that actual exceeds expected investment. That is, expectations are biased, a result that is puzzling. Presumably, costs are incurred when expectations are not met, both when actual exceeds expected (as then with so much investment taking place, per unit installation costs could be higher) and vice versa (production could fall short of target when new plant is unexpectedly delayed). There would thus be incentives to avoid such errors and drive them to zero, at least on average. But that is not supported by the non-zero mean errors. It is noteworthy, however, that the errors decline with the horizon, a pattern that agrees with the idea that as there is less uncertainty about a closer future, short-term forecasts tend to be more accurate.

The quality of expectations can also be analysed by regressing actual for year t $\left(A_t\right)$ on the corresponding expected $\left(E_{t-h/4}\right)$:

(A2.1) $$A_t = \alpha_h + \beta_h E_{t-h/4} + \varepsilon_{ht},$$

[24] Although not indicated in Figure A2.1, respondents were also requested to supply actual expenditure for the December 2007 quarter, as well as expected expenditure for January to June 2008.

where for horizon h (h = 6, 5, 4 quarters), α_h is an intercept and β_h is a slope coefficient and ε_{ht} is a zero-mean disturbance term. If expectations are unbiased, then $\alpha_h = 0$ and $\beta_h = 1$. The estimates of equation (A2.1) are given in columns 3-6 of Table A2.3 and as can be seen, the unbiasedness hypothesis is rejected more often than not. Next, consider a logarithmic version of model (A2.1), $\log A_t = \phi_h + \lambda'_h \log E_{t-h/4} + \mu_{ht}$, with μ_{ht} a new zero-mean disturbance. Subtracting $\log E_{t-h/4}$ from both sides, we have

(A2.2) $$\log \frac{A_t}{E_{t-h/4}} = \phi_h + \lambda_h \log E_{t-h/4} + \mu_{ht},$$

where $\log\left(A_t / E_{t-h/4}\right)$ is the logarithmic error and $\lambda_h = \lambda'_h - 1$. Under model (A2.2), the unbiasedness of expectations amounts to $\phi_h = \lambda_h = 0$. The estimates of this model are given in columns 7-10 of Table A2.3 and again unbiasedness tends to be rejected.

APPENDIX A3

NEW PROJECTS, MARCH 2010

Section 8 of the paper contains a table with information on the planned and expected costs of new projects. Details of this material are as follows:

- There were 16 new projects reported in the Investment Monitor in March 2010 and we consider the 10 with known cost; the cost of these projects is then aggregated by starting state. These projects are not part of our sample of the 207/154 used elsewhere in the paper.
- The expected value of a project is the product of the planned cost and the probability of the project succeeding. The total expected value is the sum of these products over projects.
- There are three sets of probabilities of success. The first-pass probabilities of column 4 of the table are the same for each starting state of projects, 0.75, based on the midpoint of approximate range of $\alpha \approx 0.7 - 0.8$, discussed at the end of Section 3 of the paper.
- The second-pass probabilities of column 6 of the table use information of starting states and are from panel D of Figure 2.
- The third-pass probabilities of column 8 are based on the predicted probabilities of success of the individual projects, based on the estimates of the probit model. That is, these probabilities are of the form $\hat{p}_i = F\left(\hat{\boldsymbol{\beta}}'\mathbf{x}_i\right)$, where F(.) is the cumulative normal distribution, $\hat{\boldsymbol{\beta}}'$ is the vector of estimated coefficients from equation 9 of Table 5 and $\mathbf{x}_i$ is the vector of the values of variables pertaining to project i. Since the projects considered here are new, the values of the variable log age and returns are set to 0.

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TABLE 1
EXAMPLES OF PROJECTS

(States, 1=possible, 2=under consideration, 3=committed, 4=under construction, 5=completed, 6=deleted; cost in parentheses, $m)

	Project Number	2001:1	2001:2	2001:3	2001:4	2002:1	2002:2	2002:3	2002:4	2008:1	2008:2	2008:3	2008:4	2009:1	2009:2	2009:3	2009:4	2010:1
1.	4204	4 (47)	4 (47)	4 (47)	4 (47)	5 (47)												
2.	4386		2 (200)	2 (200)	2 (200)	2 (200)	2 (200)	6 (200)										
3.	4520	1 (110)	1 (110)	4 (110)	4 (110)	4 (110)	4 (110)	4 (110)	4 (110)	4 (110)	4 (110)	4 (110)	4 (110)	5 (110)				
4.	4678				4 (100)	4 (100)	4 (100)	4 (100)	4 (100)									
5.	4793					1 (670)	1 (670)	1 (800)	1 (800)	2 (1,000)	2 (1,000)	2 (1,000)	2 (1,000)	2 (1,000)	2 (1,000)	2 (1,000)	2 (1,000)	6 (1,000)
6.	5105						1 (200)	1 (200)	1 (200)	2 (870)	2 (870)	2 (870)	2 (870)	2 (870)	2 (870)	2 (870)	5 (870)	
7.	6348									4 (90)	4 (90)	4 (90)	4 (90)	5 (90)				
8.	7526									4 (350)	4 (350)	4 (405)	4 (405)	4 (405)	4 (405)	4 (405)	4 (405)	5 (405)
9.	8262									4 (209)	4 (250)	4 (250)	5 (250)					
10.	8901									2 (105)	2 (105)	2 (105)	2 (105)	2 (105)	2 (105)	2 (105)	2 (105)	5 (105)

Notes:

1. To interpret this table consider, for example, the first entry in the second column, 4 (47). This indicates that project 4204 occupied state 4 (under construction) in the quarter 2001:1. This project is estimated at that date to cost $47m.
2. Project details are as follows:

Project No.	Company	Project	Industry	Sub-industry
4204	Transend Networks	Transmission system upgrade	Electricity, Gas & Water	Electricity supply
4386	National Power Australia	Gas fired power plant (230 MW) to supply SAMAG plant, Port Pirie	Electricity, Gas & Water	Electricity supply
4520	Sydney Gas Co	Johndilo coal bed methane project	Mining	Oil & Gas extraction
4678	Akzo Nobel	Salt project, Onslow, Pilbara region	Mining	Other
4793	EnviroMission	1km high power-generating solar tower, Buronga	Electricity, Gas & Water	Electricity supply
5105	Compass Resources	Browns Polymetallic Project expansion, stage 2	Mining	Metal ores
6348	Pacific Hydro	Clements Gap Wind Farm, Barunga Range	Electricity, Gas & Water	Electricity supply
7526	Felix Resources	Development of Moolarben underground coal mine	Mining	Coal
8262	Precious Metals Australia Ltd	Redevelopment of the Windimurra vanadium project, Windimurra	Mining	Metal ores
8901	BeMax Resources	Snapper (stage 2 of Pooncarie mineral samds project)	Mining	Metal ores

TABLE 2
CHARACTERISTICS OF RESOURCE PROJECTS
(Averages over time)

State (1)	Number of projects (Percent of total) (2)	Value of projects (Percent of total) (3)	Value per project ($m) (4)
1. Possible	15.0	19.4	263
2. Consideration	22.9	28.4	242
3. Committed	10.1	9.1	160
4. Construction	41.3	34.5	163
5. Completed	9.5	7.0	117
6. Deleted	1.2	1.7	126

Note: The total number of projects on average is 59 and the average total value is $12,012m.

TABLE 3
PROJECTS BY STARTING AND ENDING STATE

Starting State	A. Number			B. Total Value		
	Ending State			Ending State		
	5. Completed	6. Deleted	Total	5. Completed	6. Deleted	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(i) Total			(i) Total ($m)		
1. Possible	32	12	44	7,034	5,061	12,095
2. Consideration	56	10	66	11,562	2,123	13,685
3. Committed	42	2	44	6,410	100	6,510
4. Construction	53	-	53	6,065	-	6,065
Total	183	24	207	31,071	7,284	38,355
	(ii) Percentage			(ii) Percentage		
1. Possible	15	6	21	18	13	32
2. Consideration	27	5	32	30	6	36
3. Committed	20	1	21	17	0	17
4. Construction	26	-	26	16	-	16
Total	88	12	100	81	19	100
	(iii) Conditional Percentage			(iii) Conditional Percentage		
1. Possible	73	27	100	58	42	100
2. Consideration	85	15	100	84	16	100
3. Committed	95	5	100	98	2	100
4. Construction	100	-	100	100	-	100
Total	88	12	100	81	19	100

Note: “Total Value” refers to the end of life project value.

TABLE 4
INDEXES OF COST ESCALATION AND LEAD TIME
(Value-weighted)

	Ending State		Total	Ending State		Total	Ending State		Total
	5. Completed	6. Deleted		5. Completed	6. Deleted		5. Completed	6. Deleted	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	A. Averages			B. Standard Deviations			C. Correlations		
	A.1. Lifetime Cost Change (Percent)			B.1. Lifetime Cost Change (Percent)			C.1. Lifetime Cost Change and Length of Life		
1. Possible	40.1	2.4	22.9	99.2	26.1	75.2	0.29	0.49	0.27
2. Consideration	20.2	12.3	18.9	32.2	53.7	36.5	0.27	-0.23	0.15
3. Committed	5.8	0.0	5.7	17.5	16.9	17.5	0.38	0.93	0.39
4. Construction	13.0	-	13.0	35.9	-	35.9	0.19	-	0.19
Total	19.8	5.2	16.9	52.7	36.0	49.8	0.26	0.22	0.24
	A.2. Length of Life (Number of Quarters)			B.2. Length of Life (Number of Quarters)			C.2. Annual Cost Change and Length of Life		
1. Possible	15.2	11.1	13.3	8.4	10.2	9.3	0.04	0.16	0.06
2. Consideration	13.3	7.2	12.3	6.4	6.0	6.3	-0.03	-0.56	-0.21
3. Committed	8.3	5.0	8.3	5.1	6.6	5.1	0.18	0.93	0.19
4. Construction	7.2	-	7.2	5.1	-	5.1	-0.03	-	-0.03
Total	11.4	9.9	11.1	6.4	9.2	7.0	0.03	-0.17	-0.07
	A.3. Annual Cost Change (Percent)			B.3. Annual Cost Change (Percent)			C.3. Lifetime and Annual Cost Change		
1. Possible	10.8	-0.5	5.7	29.5	9.2	22.6	0.94	0.88	0.93
2. Consideration	6.0	36.1	10.8	10.9	96.0	39.7	0.85	0.88	0.68
3. Committed	3.1	0.0	3.1	10.2	7.3	10.2	0.91	1.00	0.91
4. Construction	7.5	-	7.5	18.2	-	18.2	0.86	-	0.86
Total	6.7	9.9	7.3	17.8	51.6	28.0	0.89	0.77	0.68

TABLE 5
DETERMINANTS OF SUCCESS OF PROJECTS: ESTIMATES OF PROBIT MODELS

Variable	Equation										
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Intercept	0.605	0.239	0.120	-0.228	0.402	-1.044	-0.416	-0.263	-0.806	-0.396	-0.170
	(0.202)	(0.348)	(0.362)	(0.394)	(0.659)	(0.525)	(0.743)	(0.698)	(0.580)	(0.453)	(0.703)
Value ($100m)	-	-0.075	-0.072	-0.076	-	-0.078	-	-0.081	-0.210	-0.271	-0.185
		(0.042)	(0.047)	(0.046)		(0.046)		(0.045)	(0.126)	(0.100)	(0.109)
Log value	-	-	-	-	-0.168	-	-0.168	-	-	-	-
					(0.110)		(0.114)				
Age (quarters)	-	0.043	0.045	0.050	0.050	-	-	-	-	-	-
		(0.025)	(0.025)	(0.027)	(0.027)						
Log age	-	-	-	-	-	0.627	0.626	0.277	0.645	0.590	0.339
						(0.204)	(0.205)	(0.289)	(0.209)	(0.199)	(0.281)
Stock Market Returns	-	-	0.867	0.838	0.918	0.821	0.901	0.829	0.830	0.811	0.809
			(0.488)	(0.501)	(0.489)	(0.527)	(0.510)	(0.548)	(0.552)	(0.540)	(0.572)
Dummies for Starting State (Base = Possible)											
Consideration	0.425	0.503	0.582	0.499	0.515	0.538	0.555	-0.174	0.548	0.348	-0.065
	(0.276)	(0.280)	(0.280)	(0.285)	(0.285)	(0.300)	(0.299)	(1.025)	(0.449)	(0.302)	(1.034)
Consideration × Value	-	-	-	-	-	-	-	-	-0.048	-	-0.074
									(0.171)		(0.175)
Consideration × Log age	-	-	-	-	-	-	-	0.340	-	-	0.311
								(0.451)			(0.457)
Committed	1.086	1.259	1.334	1.371	1.372	1.445	1.449	0.291	0.916	-	0.001
	(0.386)	(0.396)	(0.387)	(0.418)	(0.416)	(0.445)	(0.445)	(1.376)	(0.536)		(1.434)
Committed × Value	-	-	-	-	-	-	-	-	0.586	1.591	0.543
									(0.222)	(0.960)	(0.198)
Committed × Log age	-	-	-	-	-	-	-	0.596	-	-	0.499
								(0.837)			(0.856)
Dummy for Industry (Base = Electricity, Gas and Water)											
Mining Sector	-	-	-	0.756	0.738	0.804	0.786	0.159	0.269	-	-0.216
				(0.306)	(0.302)	(0.323)	(0.319)	(0.949)	(0.413)		(0.954)
Mining × Value	-	-	-	-	-	-	-	-	0.349	0.427	0.347
									(0.146)	(0.150)	(0.150)
Mining × Log age	-	-	-	-	-	-	-	0.329	-	-	0.258
								(0.465)			(0.464)

(Continued on next page)

TABLE 5 (continued)
DETERMINANTS OF SUCCESS OF PROJECTS: ESTIMATES OF PROBIT MODELS

Variable	Equation										
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Summary Statistics											
McFadden R^2	0.07	0.12	0.14	0.20	0.20	0.24	0.24	0.26	0.28	0.27	0.29
Akaike Info criterion	0.844	0.825	0.822	0.786	0.787	0.744	0.747	0.769	0.750	0.726	0.780
Schwarz criterion	0.903	0.924	0.940	0.924	0.926	0.882	0.885	0.967	0.947	0.864	1.036
Hannan-Quinn criterion	0.868	0.865	0.870	0.842	0.843	0.800	0.803	0.850	0.830	0.782	0.884
LR statistic	9.297	16.234	18.755	26.170	26.008	32.635	32.273	34.751	37.808	35.503	39.183
[p-value]	[0.010]	[0.002]	[0.002]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
Percentage Correctly Predicted (Success cut-off: $p* = 0.67$)											
Failed projects	0	20.83	20.83	41.67	41.67	45.83	50.00	58.33	50.00	45.83	54.17
Successful projects	100	93.85	94.63	90.77	93.08	93.85	93.08	93.08	93.08	94.62	93.08
Total	84.42	82.47	83.12	83.12	85.06	86.36	86.36	87.66	86.36	87.01	87.01

Notes:
1. Asymptotic standard errors in brackets.
2. All projects that started in the "Under Construction" state ended up being successful. As there is no variation in these data, these observations are omitted.
3. Number of observations is 154, consisting of 130 successes and 24 failures.
4. The likelihood-ratio statistic (LR) tests the null hypothesis $H_0 : \boldsymbol{\beta} = \mathbf{0}$, where $\boldsymbol{\beta}$ is the vector of coefficients other than the intercept. Asymptotically, under H_0, LR follows a χ^2 distribution with q degrees of freedom, where q is the number of coefficients in $\boldsymbol{\beta}$.

TABLE 6
MARGINAL EFFECTS
ON PROBABILITY OF SUCCESS
(Percentage points)

Variable	Marginal Effect
Value ($100m)	-3.59
Consideration × Value	-0.81
Committed × Value	9.99
Mining × Value	5.96
Log age	11.01
Stock Market Returns	0.1417
Consideration	11.89
Committed	19.62
Mining	9.95

Note: For stock market returns, the marginal effect refers to the change in the probability of success for a one percentage-point change in returns.

TABLE 7
TRANSITIONS AND TRANSITION PROBABILITITY MATRICES

State i in period t	Total number of transitions State j in period t+1							Transition probabilities State j in period t+1						
	1	2	3	4	5	6	Total	1	2	3	4	5	6	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
A. All 207 Projects														
1.Possible	240	16	3	12	3	10	284	0.807	0.055	0.013	0.041	0.010	0.074	1
2. Consideration	0	449	20	31	20	11	531	0	0.819	0.038	0.056	0.058	0.029	1
3. Committed	0	0	127	58	8	1	194	0	0	0.635	0.303	0.052	0.010	1
4. Construction	0	0	0	798	152	2	952	0	0	0	0.828	0.164	0.008	1
5. Completed	0	0	0	0	0	0	0	0	0	0	0	1	0	1
6. Deleted	0	0	0	0	0	0	0	0	0	0	0	0	1	1
B. The 154 Projects														
1.Possible	240	16	3	12	3	10	284	0.807	0.055	0.013	0.041	0.010	0.074	1
2. Consideration	0	449	20	31	20	11	531	0	0.819	0.038	0.056	0.058	0.029	1
3. Committed	0	0	127	58	8	1	194	0	0	0.635	0.303	0.052	0.010	1
4. Construction	0	0	0	522	99	2	623	0	0	0	0.823	0.166	0.011	1
5. Completed	0	0	0	0	0	0	0	0	0	0	0	1	0	1
6. Deleted	0	0	0	0	0	0	0	0	0	0	0	0	1	1

TABLE A1.1

STATES OF PROJECTS

State	Status	Definition
1	Possible	No early decision whether to proceed with the project is likely
2	Under Consideration	A decision whether to proceed with a project is expected in the reasonably near future
3	Committed	A decision to proceed has been announced but construction has not yet started
4	Under Construction	Projects which are underway
5	Completed	Projects completed in the preceding quarter
6	Deleted	Projects deleted in the preceding quarter

Note: Definitions according to Access Economics Investment Monitor (2001-2010).

TABLE A1.2

RESOURCE PROJECTS

Industry	Sub-Industry
Mining	Coal
	Metal Ores
	Oil and Gas Extraction
	Other
Electricity, Gas and Water	Electricity Supply
	Gas Supply

Note: Industry and sub-industry classifications are according to Access Economics Investment Monitor. The Monitor field "Major Industry" was limited to include (1) Mining and (2) Electricity, Gas and Water. This means that excluded Major Industries are (1) Agriculture and Forestry, (2) Manufacturing, (3) Trade, (4) Accommodation, (5) Transport and Storage, (6) Communication, (7) Finance, Property and Business Services, (8) Government, (9) Community and Other Services and (10) Mixed Use. Within the "Transport and Storage" industry there exists a sub-industry "Pipeline and Other". Projects within this sub-industry were excluded due to the difficulty in differentiating (a) "Other" and "Pipeline" projects and (b) resource and non-resource related pipelines. As the majority are unlikely to involve the resources sector, projects classified under the sub-industry "Water Supply and Drainage" were also excluded.

TABLE A1.3

FILTERING THE DATA

Data issue (1)	Impact of filter on: Number of projects (2)	Impact of filter on: Total number of projects (3)	Remaining number of projects (4)
1. Initial number of projects	-	-	1,180
I. <u>Non-Cost Items</u>			
2. Projects with only an absorbing state (after 2001:1)	2	-2	
3. Moves from absorbing state to transition state	3	-3	
4. Single projects split into two	5	-5	
5. Wrongly assigned new project number	7	-7	
6. Changed major industry	13	-10	
7. Unknown starting history	5	-5	
8. No ending state record	19	-19	
9. Cost filter not applied properly	2	-2	
10. Repeated ending state	3	-	
11. Record number typo	1	-	
12. Blank record number	1	-	
13. Missing new project indicator	1	-	
14. Sub-total		-53	1,127
II. "<u>At least $20m" Filter</u>			
15. Projects <$20m dropped in 2009:3	72	-72	
16. Projects <$20m dropped in previous quarters	196	-196	
17. Completed or deleted projects in 2009:3	124	-124	
18. Sub-total		-392	735
III. <u>Recording Issues</u>			
19. Unobserved births	255	-255	
20. Unobserved deaths	261	-261	
21. Backward movements	70	- 70	
22. Sub-total (avoiding double counting due to overlap)		-487	248
IV. <u>Other Issues</u>			
23. Unknown starting/ending values	40	-40	
24. Outlier	1	-1	
25. Projects starting "Under Construction"	53	-53	
26. Sub-total/Final number of projects		-94	154

TABLE A1.4
PROJECTS THAT CHANGE INDUSTRY

Record no.	Company	Lifetime cost range ($m)	Project description		Major industry (Minor industry)		Action
			Initial	Subsequent	Initial	Subsequent	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			A. Change in project scope				
4979	Liddell Coal Operations	n/a – 85	Expansion of Liddell Coal mine	Expansion of washplant for Liddell Coal	Mining (Coal)	Manufacturing (Chemicals)	Discard
5742	Newcrest Mining	215 – 424	Telfer Deeps (Mariner) gold mine expansion, Stage 2	Telfer Deeps (Mariner) gold mine expansion, processing plant (18 Mt/a)	Mining (Metal Ores)	Manufacturing (Metal Products)	Discard
8069	Carbon Partners	35 – 70	Development of green-waste facility, Dandenong	Renewable energy facility, Dandenong	Community & Other Services (Personal & Other)	Electricity, Gas & Water (Electricity Supply)	Discard
8830	Xstrata Coal Australia Pty Ltd	100	Mt Owen coal mine expansion, 19 km NE of Singleton	Mt Owen washplant upgrade, 19 km NE of Singleton	Mining (Coal)	Manufacturing (Chemicals)	Discard
9428	Energy Resources Of Australia	27 – 51	Ranger Laterite Uranium processing plant	Ranger laterite uranium treatment plant and radiometric sorter	Manufacturing (Metal Products)	Mining (Other)	Discard
			B. Ambiguous information				
4042	CRC Clean Power	20 – 50	Pilot plant to reduce moisture levels in brown coal (to decrease Greenhouse emissions)	Unchanged	Electricity, Gas & Water (Electricity Supply)	Finance, Property & Business Services (Business Services)	Discard
4293	Hydro Tasmania	17	Flood capacity upgrades to dams on the Forth River	Unchanged	Electricity, Gas & Water (Electricity Supply)	Electricity, Gas & Water (Water Supply & Drainage)	Discard

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TABLE A1.4 (Continued)
PROJECTS THAT CHANGE INDUSTRY

Record no.	Company	Lifetime cost range ($m)	Project description		Major industry (Minor industry)		Action
			Initial	Subsequent	Initial	Subsequent	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
7333	Stanwell Corp / McArthur Coal	1,000 – 1,700	Coke manufacturing plant, Rockhampton	Unchanged	Mining (Coal)	Manufacturing (Chemicals)	Discard
8254	Xstrata Coal Australia Pty Ltd	66 – 110	Redevelopment of McArthur River Mine, Boroloola,	Unchanged	Manufacturing (Metal Products)	Mining (Metal Ores)	Retain
8867	Queensland Gas	n/a	Wallumbilla pipeline – Columboola to Wallumbila	Unchanged	Electricity, Gas & Water (Pipeline & Other Transport)	Transport & Storage (Pipeline & Other Transport)	Discard
9463	Australian Pipeline Trust	n/a	Construction of a gas plant at Wadeye	Unchanged	Transport & Storage (Pipeline & Other Transport)	Electricity, Gas & Water (Electricity Supply)	Retain
9663	Poseidon Nickel	n/a	Construction of “fast start” nickel concentrator, Mt Windarra mine	Unchanged	Manufacturing (Metal Ores)	Mining (Metal Ores)	Discard
8344	Agricultural Equity Investments	200 – 120	Plans to build integrated cattle feedlot, ethanol plant and biomass power station, Deniliquin, NSW	Construction of ethanol plant and biomass power station, neighbouring the cattle feedlot at Moira Station, Riverina district	Agriculture, Forestry & Fishing (Agriculture)	Electricity, Gas & Water (Electricity Supply)	Retain

TABLE A1.5
LIST OF PROJECTS

Number	Project ID in IM	Starting quarter (yy/qtr)	Probit variables: Status	Probit variables: Dummy variables: Consideration	Probit variables: Dummy variables: Committed	Probit variables: Starting value ($m)	Probit variables: Age (Quarters)	Industry	Project description
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
								A. First group of projects	
1.	4467	01Q3	1	0	0	8	11	Coal	Expansion of Coppabella project, Bowen Basin
2.	10018	08Q4	1	1	0	25	5	Coal	Upgrade to the Bengalla coal handling and preparation plant, Hunter Valley
3.	4266	01Q1	1	0	0	50	12	Coal	Moorvale coking coal project, Bowen Basin
4.	4390	01Q2	0	0	1	60	7	Coal	Tahmoor coking coal mine machinery upgrade
5.	7527	05Q1	1	1	0	80	16	Coal	Development of Moolarben open-cut coal mine
6.	7528	05Q1	1	0	1	95	10	Coal	Development of Ashton underground coal mine
7.	4403	01Q2	1	1	0	100	14	Coal	Southland steaming coal mine development (2 mtpa), Hunter Valley
8.	7334	04Q4	1	1	0	100	10	Coal	Dragline excavator for coal field development
9.	7944	05Q3	1	0	0	100	10	Coal	Development of the Sonoma coal mine, Collinsville, Bowen Basin
10.	4401	01Q2	1	1	0	120	14	Coal	Dartbrook underground thermal coal mine expansion (to 3.2 mtpa)
11.	4595	01Q3	1	1	0	120	11	Coal	Ashton Mine (2mtpa), Hunter Valley
12.	4222	01Q1	1	0	1	130	4	Coal	Expansion of Blackwater coal mine (to 5 mtpa)
13.	4402	01Q2	1	0	0	140	11	Coal	Dendrobium underground thermal coal mine development (4 mtpa)
14.	5449	02Q3	0	1	0	150	1	Coal	Development of underground mine, Newlands
15.	7526	05Q1	1	1	0	150	20	Coal	Development of Moolarben underground coal mine
16.	6626	04Q1	1	1	0	156	13	Coal	Wilpinjong Coal mine, Mudgee
17.	6523	04Q1	1	0	1	234	15	Coal	Coal preparation plant, Blackwater mine
18.	6753	04Q2	1	0	0	300	4	Coal	Upgrade of Hail Creek coal mine (8 mtpa)
19.	8239	06Q1	1	1	0	330	6	Coal	Development of the Poitrel coal mine, Central Queensland
20.	8259	06Q1	1	0	0	400	6	Coal	Expansion of the New Acland coal mine, Darling Downs
21.	6589	04Q1	0	0	0	20	21	Electricity supply	20 MW gas-fired power plant, Toowoomba
22.	7368	05Q1	1	0	1	20	6	Electricity supply	Exmouth Power Project
23.	9465	07Q3	1	0	1	20	4	Electricity supply	Upgrade of Kemerton Power Station - a gas-fired peaking plant, Bunbury
24.	7510	05Q1	1	0	1	23	7	Electricity supply	Construction of green energy power plant, Bundaberg
25.	4730	01Q4	0	0	0	25	9	Electricity supply	Waste to energy plant, Coolgardie or Kalgoorlie
26.	5098	02Q2	1	1	0	25	14	Electricity supply	Trial geothermal plant, Cooper Basin
27.	5618	02Q3	1	1	0	25	14	Electricity supply	Upgrade and modernisation of Trevallyn power station, Launceston
28.	5645	02Q3	1	0	1	25	7	Electricity supply	Upgrade of power supply to Scottsdale
29.	6326	03Q3	1	0	1	25	10	Electricity supply	Transmission line linking Bridgetown and Manjimup to Muja Power Station
30.	5136	02Q2	1	0	1	26	7	Electricity supply	Redevelopment of sub-stations including Smithton sub-station ($13m)
31.	6478	03Q4	1	0	1	28	8	Electricity supply	Upgrade Gordon Power Station
32.	5135	02Q2	1	0	1	29	4	Electricity supply	Upgrade of generation assets
33.	4745	01Q4	0	0	0	30	7	Electricity supply	Solid Waste to Energy Recycling Facility (SWERF), Maddington
34.	7981	05Q3	1	1	0	30	10	Electricity supply	Development of a new substation powering the Adelaide Hills, Tungkillo
35.	4365	01Q2	1	0	1	34	4	Electricity supply	Capital expenditure not listed elsewhere

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TABLE A1.5 (continued)
LIST OF PROJECTS

Number	Project ID in IM	Starting quarter (yy/qtr)	Probit variables: Status	Dummy variables: Consideration	Dummy variables: Committed	Starting value ($m)	Age (Quarters)	Industry	Project description
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
36.	5030	02Q2	1	1	0	36	18	Electricity supply	Gas transmission line from Pinjar to Cataby (123km)
37.	5887	03Q1	1	1	0	36	3	Electricity supply	New substation Charmhaven. Gosford and Ourimbah
38.	7675	05Q2	0	1	0	37	7	Electricity supply	Construction of new electricity substation, Baulkham Hills
39.	4271	01Q1	0	0	1	40	2	Electricity supply	Gas fired power plant (50 MW)
40.	4272	01Q1	1	0	1	40	3	Electricity supply	Gas fired power plant (50 MW)
41.	4576	01Q3	1	0	0	40	4	Electricity supply	Expansion of electricity inter-connector between Snowy Mountains and Victoria
42.	5455	02Q3	1	0	0	40	12	Electricity supply	Expansion of Quarantine Point power station (to 200mw)
43.	6931	04Q2	0	1	0	40	20	Electricity supply	Hydroelectric power station (30 MW), Burdekin Falls Dam
44.	5133	02Q2	1	0	1	41	4	Electricity supply	Development and enhancement of electricity distribution network
45.	4728	01Q4	1	0	0	45	21	Electricity supply	Green waste to energy plant, Kemerton
46.	4865	02Q1	1	1	0	50	14	Electricity supply	Upgrade of SA- Vic interconnecter
47.	7112	04Q3	1	0	1	50	22	Electricity supply	Upgrade to Gold Coast electricity transmission and distribution network
48.	8962	06Q4	1	1	0	50	7	Electricity supply	Line construction to provide electricity for Oxiana's Prominent Hill copper-gold mine
49.	4364	01Q2	1	0	1	55	4	Electricity supply	Capital expenditure not listed elsewhere
50.	5886	03Q1	1	0	0	60	12	Electricity supply	Biomass power station using plantation and timber waste
51.	4630	01Q4	1	0	0	65	20	Electricity supply	Wind Farm, Emu Downs, nth of Perth (40mw)
52.	8614	06Q3	1	0	1	66	14	Electricity supply	Construction of a 21-turbine wind farm at Naroghid, 7km south of Camperdown
53.	4820	02Q1	1	0	0	70	19	Electricity supply	Wind farm (70MW), Yabmana
54.	5080	02Q2	1	1	0	72	15	Electricity supply	Expansion of Liddell Power station
55.	6500	03Q4	1	0	0	75	12	Electricity supply	Base-load power stations, Braemar QLD
56.	9723	08Q1	1	1	0	75	8	Electricity supply	15 turbine wind farm, Cullerin Range
57.	9120	07Q2	1	0	0	80	8	Electricity supply	Construction of a new gas-fired power station, Torrens Island
58.	4229	01Q1	1	0	0	90	4	Electricity supply	Gas fired power plant (150 MW), Somerton
59.	6348	03Q3	1	0	1	90	22	Electricity supply	Clements Gap Wind Farm, Barunga Range
60.	6696	04Q1	1	0	1	93	6	Electricity supply	23 turbine wind farm (46MW), Canunda (Millicent)
61.	7676	05Q2	0	1	0	93	7	Electricity supply	Upgrade of the Holroyd-Mason Park electricity line to meet inner metropolitan demand
62.	5822	02Q4	1	0	0	100	12	Electricity supply	80 MW wind farm, Cathedral Rocks, near Port Lincoln
63.	6334	03Q3	1	1	0	100	9	Electricity supply	Upgrade capacity at Loy Yang A plant (by 300 mw)
64.	6423	03Q4	0	1	0	100	12	Electricity supply	Wind farm (60 mw) SW of Wyalla, Eyre Penninsula
65.	7519	05Q1	1	0	1	100	20	Electricity supply	Construction of second cogeneration plant (140MW), Pinjarra Refinery
66.	8032	05Q4	1	1	0	120	16	Electricity supply	Upgrade of the Queensland - New South Wales electricity interconnector (QNI)
67.	8743	06Q3	1	1	0	138	7	Electricity supply	Construction of a new Liquified Natural Gas Plant, Kwinana
68.	5547	02Q3	1	1	0	140	11	Electricity supply	2 renewable energy power stations, Pioneer sugar mill, near Townsville
69.	4983	02Q2	1	0	1	150	10	Electricity supply	Upgrade of Port Augusta power station
70.	5483	02Q3	1	1	0	150	13	Electricity supply	Peak Power Plant (gas or liquid fueled) to meet extra peak capacity (240mw)

(Continued next page)

TABLE A1.5 (continued)
LIST OF PROJECTS

Number	Project ID in IM	Starting quarter (yy/qtr)	Probit variables: Status	Probit variables: Dummy variables: Consideration	Probit variables: Dummy variables: Committed	Starting value ($m)	Age (Quarters)	Industry	Project description
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
71.	4644	01Q4	1	1	0	164	1	Electricity supply	'Valley Power' : peaking power plant, adjacent to Loy Yang B (300mw)
72.	6456	03Q4	1	0	1	180	6	Electricity supply	Wattle Point wind farm (59 turbines), Yorke Peninsula
73.	9076	07Q1	0	0	0	180	2	Electricity supply	Construction of a 180 megawatt open cycle generation peaking plant
74.	4418	01Q3	1	0	1	190	5	Electricity supply	Electricity supply infrastructure upgrade throughout regional Qld
75.	4386	01Q2	0	1	0	200	5	Electricity supply	Gas fired power plant (230 MW) to supply SAMAG plant, Port Pirie
76.	4538	01Q3	1	0	1	200	4	Electricity supply	120 machine wind farm (70 MW), Millicent
77.	6495	03Q4	1	0	0	200	21	Electricity supply	Peak load gas fired power plant (300MW), Wagga Wagga
78.	6672	04Q1	1	0	1	200	6	Electricity supply	54 turbine wind farm, Geraldton (90MW)
79.	8260	06Q1	1	0	0	220	15	Electricity supply	Development of Capital Wind Farm, a 63-turbine wind farm, near Lake George
80.	8815	06Q4	1	0	0	230	12	Electricity supply	Construction of a 200 megawatt gas-fired power station, George Town
81.	4821	02Q1	0	0	0	300	14	Electricity supply	Power station, Perth area (300MW)
82.	7387	05Q1	1	0	0	300	20	Electricity supply	Bluewaters II power station, adjacent to Bluewaters I in Coolangatta industrial estate
83.	9405	07Q3	0	0	0	300	1	Electricity supply	Construction of a 300W gas-fired peaking power station at the Neerabup
84.	9627	07Q4	1	1	0	300	9	Electricity supply	Construction of a new 330MW open cycle gas turbine power station, Neerabup
85.	7530	05Q1	1	1	0	325	15	Electricity supply	Development of gas-fired power station, Tallawarra on Lake Illawarra
86.	7176	04Q3	1	1	0	326	22	Electricity supply	128 turbine wind farm, Waubra
87.	10038	09Q1	1	0	1	350	4	Electricity supply	Stage 3 upgrade of the Lake Bonney wind farms to increase capacity by 39mW
88.	8814	06Q4	1	0	1	360	13	Electricity supply	Hazelwood power station, Gippsland, Victoria
89.	5485	02Q3	0	1	0	450	6	Electricity supply	Base load power plant to replace Muja A & B (300mw)
90.	6799	04Q2	1	1	0	450	23	Electricity supply	Base-load power station (South-west WA)
91.	5036	02Q2	0	0	0	500	13	Electricity supply	Coal-fired power plant, Collie
92.	8175	06Q1	0	1	0	600	12	Electricity supply	Development of a peaking power station, Dalby
93.	4793	02Q1	0	0	0	670	32	Electricity supply	1km High chimney stack as part of green wind power station, Ned's Corner
94.	4582	01Q3	0	0	0	700	4	Electricity supply	Solar tower (200mw), Mildura
95.	7708	05Q2	1	0	0	870	19	Electricity supply	Spring Gully Power Station project, 80km north-east of Roma
96.	9460	07Q3	0	0	0	2,000	6	Electricity supply	Construction of a "Clean coal" power generation plant, Kwinana
97.	6268	03Q2	1	0	1	70	23	Gas supply	County Victoria natural gas network
98.	6124	03Q2	1	1	0	174	23	Gas supply	Reticulation infrastructure to deliver gas from Longford - Bell Bay pipeline part 2
99.	4684	01Q4	1	0	0	6	20	Metal ores	Titanium minerals mine, Ludlow, SW of Bunbury
100.	8894	06Q4	1	1	0	10	4	Metal ores	Flinders Zinc Project, 470km North of Adelaide
101.	6636	04Q1	1	1	0	15	15	Metal ores	Hillgrove gold mine, Armidale
102.	8889	06Q4	1	1	0	15	8	Metal ores	Pardoo hematite iron ore project, 75km east of Port Hedland
103.	4408	01Q2	1	0	1	20	5	Metal ores	Zircon processing facility, Geraldton
104.	7153	04Q3	1	0	0	20	5	Metal ores	Development of Twin Hills gold mine
105.	8296	06Q2	1	0	0	23	3	Metal ores	Restart the lead - zinc, Lennard Shelf mines near Fitzroy Crossing, West Kimberley

(Continued next page)

TABLE A1.5 (continued)
LIST OF PROJECTS

Number	Project ID in IM	Starting quarter (yy/qtr)	Probit variables: Status	Dummy variables: Consideration	Dummy variables: Committed	Starting value ($m)	Age (Quarters)	Industry	Project description
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
106.	4484	01Q3	1	0	1	25	7	Metal ores	Development of mine near Charters Towers
107.	6319	03Q3	1	1	0	25	10	Metal ores	Enterprises deposit, North Stradbroke Island
108.	8177	06Q1	1	1	0	25	11	Metal ores	'Flying Fox' nickel deposit, stage 2, construction of a decline to access T5 deposit
109.	7087	04Q3	1	1	0	27	6	Metal ores	Black star zinc-lead project
110.	9147	07Q2	1	0	1	28	3	Metal ores	Carnilya Hill Nickel mine development
111.	7088	04Q3	1	1	0	36	11	Metal ores	Expansion of Enterprise copper mine, Mt Isa
112.	8263	06Q1	1	0	1	39	6	Metal ores	Development and modification of the Waroona project
113.	4288	01Q2	1	0	0	40	19	Metal ores	Dalgaranga tantalum project full-scale plant, WA Goldfields
114.	7364	05Q1	1	0	1	41	11	Metal ores	Jaguar project, Copper and Zinc deposit
115.	8126	05Q4	1	1	0	47	5	Metal ores	Development of a zircon and titanium mineral sands mine, Mindarie, Murray Mallee
116.	9447	07Q3	1	1	0	60	10	Metal ores	Anduramba Molybdenum project, north west of Brisbane
117.	6344	03Q3	1	0	0	70	13	Metal ores	Nickel mine and processing plant, Forrestania
118.	8164	06Q1	1	0	1	77	7	Metal ores	Development of the Mt Wright gold deposit
119.	8888	06Q4	1	1	0	88	13	Metal ores	Development of Karara hematite iron ore mine, 20km east of Geraldton
120.	6397	03Q3	1	1	0	100	7	Metal ores	Development of Fosterville gold mine
121.	6509	03Q4	0	0	0	100	7	Metal ores	Development of iron ore deposit next to existing operations, Middleback Ranges
122.	4388	01Q2	0	0	0	106	25	Metal ores	Platinum / palladium project underground expansion, Panton, Kimberley
123.	8901	06Q4	1	1	0	114	13	Metal ores	Snapper (stage 2 of Pooncarie mineral samds project), 110km North of Mildura
124.	8262	06Q1	1	1	0	120	11	Metal ores	Redevelopment of the Windimurra vanadium project, Windimurra
125.	7147	04Q3	1	1	0	130	17	Metal ores	Expansion of Cosmos nickel mine
126.	6493	03Q4	1	1	0	142	8	Metal ores	Expansion of West Angelas mine, Pilbara
127.	9570	07Q4	1	1	0	180	9	Metal ores	Murray Basin mineral sands project - 2 stage development
128.	5105	02Q2	1	0	0	200	30	Metal ores	Browns Polymetallic Project expansion, stage 2
129.	9433	07Q3	0	1	0	200	2	Metal ores	Development of the Balla Balla iron ore project, east of Karratha
130.	6355	03Q3	1	0	1	230	6	Metal ores	Expansion of Weipa bauxite plant to supply Gladstone refinery
131.	9127	07Q2	1	1	0	280	8	Metal ores	Development of the Kulwin mineral sands deposit near Ouyen, northern Victoria
132.	9775	08Q2	1	0	0	344	7	Metal ores	Mesa A operation: construction of train loading plant and the associated infrastructure
133.	8252	06Q1	1	1	0	350	16	Metal ores	Development of the Cape Lambert iron ore deposit
134.	6357	03Q3	1	0	0	540	16	Metal ores	Development of Koolanooka iron ore project
135.	7468	05Q1	1	0	1	735	8	Metal ores	Rapid Growth Project 2
136.	8283	06Q2	1	1	0	750	15	Metal ores	Development of Koolanooka iron ore project, Phase 3, near Geraldton
137.	8048	05Q4	1	1	0	1,700	11	Metal ores	Rapid Growth Project 3, incl. upgrade of Area C mine, rail and port capacity, Pilbara
138.	4321	01Q2	0	1	0	20	1	Oil & Gas extraction	Simpson oil field development, near Abuliton Is
139.	4331	01Q2	1	1	0	20	4	Oil & Gas extraction	South Plato and Gibson oil wells (5,000 bd), Varanus Island
140.	5605	02Q3	1	1	0	25	16	Oil & Gas extraction	Development of Camden gas field

(Continued next page)

TABLE A1.5 (continued)
LIST OF PROJECTS

Number	Project ID in IM	Starting quarter (yy/qtr)	Probit variables: Status	Dummy variables: Consideration	Dummy variables: Committed	Starting value ($m)	Age (Quarters)	Industry	Project description
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
141.	6489	03Q4	1	1	0	55	7	Oil & Gas extraction	Development of coal seam methane to supply Townsville Power Station, Moranbah
142.	4520	01Q3	1	0	0	110	30	Oil & Gas extraction	Johndilo coal bed methane project (300 wells and includes 2 pipelines costing $20)
143.	4351	01Q2	1	0	1	130	3	Oil & Gas extraction	Laminaria oil field Phase II expansion (additional 65,000 bd)
144.	6517	04Q1	1	0	1	170	6	Oil & Gas extraction	Development of the John Brookes gas field, Canarvon Basin, offshore WA
145.	8724	06Q3	1	0	0	175	13	Oil & Gas extraction	Development of the Longtom gas field, Bass Strait
146.	9421	07Q3	1	0	1	180	6	Oil & Gas extraction	Expansion of the Woolybutt Oil field, South Lobe, Offshore Carnarvon Basin
147.	7054	04Q2	1	1	0	200	7	Oil & Gas extraction	Development of Casino gas field, Otway Basin
148.	9422	07Q3	1	1	0	300	2	Oil & Gas extraction	Epansion of the Basker, Manta and Gummy oil field development
149.	9706	07Q4	1	0	1	600	9	Oil & Gas extraction	Van Gogh oil Project
150.	4416	01Q3	1	1	0	700	24	Oil & Gas extraction	Thylacine and Geographe gas field development, Otway Basin
151.	8107	05Q4	1	0	1	814	8	Oil & Gas extraction	Development of the Stybarrow offshore oil field, 65km from Exmouth
152.	4217	01Q1	1	0	0	25	12	Other	Ellendale diamond deposit
153.	8099	05Q4	1	1	0	26	5	Other	Upgrade of the Ellendale diamond processing plant, Pipe 9
154.	7358	05Q1	1	0	1	36	5	Other	Develop' diamond processing plant, Ellendale Pipe 4 (Increase by 4.4mta to 7.2mta)
						B. Second group of projects (starting in "Under Construction")			
155.	4760	01Q4	1	0	0	120	13	Coal	Mandalong coal mine (3-4mtpa)
156.	6309	03Q3	1	0	0	101	8	Coal	Broadmeadow coking coal mine, Goonyella
157.	7089	04Q3	1	0	0	90	6	Coal	Installation of long wall system, Ulan coal mine
158.	8832	06Q4	1	0	0	75	2	Coal	Newpac longwall coal mine expansion and upgrade, Hunter Valley
159.	8833	06Q4	1	0	0	38	1	Coal	Tarawonga opencut (formerly East Boggabri), 15 km North East of Boggabri
160.	8840	06Q4	1	0	0	66	1	Coal	Isaac Plains project, 7 km North East of Moranbah
161.	4204	01Q1	1	0	0	47	4	Electricity supply	Transmission system upgrade
162.	4425	01Q3	1	0	0	100	4	Electricity supply	Upgrade of Loy Yang A coal fired power station (by 300 MW) in 2 stages
163.	4992	02Q2	1	0	0	65	4	Electricity supply	23 turbine wind farm, Starfish Hill, Cape Jarvis
164.	6122	03Q2	1	0	0	34	4	Electricity supply	Upgrade of generation assets
165.	6597	04Q1	1	0	0	80	12	Electricity supply	Underground power lines, Darwin
166.	7097	04Q3	1	0	0	139	9	Electricity supply	CityGrid project (upgrade of CBD electricity distribution network), Brisbane
167.	7779	05Q2	1	0	0	20	5	Electricity supply	Capital works and major refurbishment, Barron Gorge power plant
168.	7780	05Q2	1	0	0	9	12	Electricity supply	Capital works and modifications, Stanwell power station
169.	7781	05Q2	1	0	0	115	5	Electricity supply	Capital works and modifications, Tarong Power Plant
170.	8311	06Q2	1	0	0	41	2	Electricity supply	Refurbishment of massive generating machines at the Gordon River power station
171.	8344	06Q2	1	0	0	120	12	Electricity supply	Construction of an ethanol plant and biomass power station at Moira Station
172.	8368	06Q2	1	0	0	400	10	Electricity supply	Construction of the 159MW Lake Bonney stage 2 wind farm, Mount Gambier
173.	8594	06Q3	1	0	0	43	10	Electricity supply	Augmentation and redevelopment of the Wide Bay substation
174.	8595	06Q3	1	0	0	125	10	Electricity supply	Reinforcement of power lines at the Wide Bay substation
175.	8596	06Q3	1	0	0	120	8	Electricity supply	Reinforcement of power supply, Darling Downs

(Continued next page)

TABLE A1.5 (continued)
LIST OF PROJECTS

Number	Project ID in IM	Starting quarter (yy/qtr)	Probit variables: Status	Dummy variables: Consideration	Dummy variables: Committed	Starting value ($m)	Age (Quarters)	Industry	Project description
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
176.	8597	06Q3	1	0	0	84	8	Electricity supply	Reinforcement of power supply, Mackay
177.	8598	06Q3	1	0	0	84	8	Electricity supply	Reinforcement of power supply, Fitzroy
178.	8599	06Q3	1	0	0	40	8	Electricity supply	Reinforcement of power supply, Far North
179.	8648	06Q3	1	0	0	73	7	Electricity supply	Capital works and modifications for 2006/07, Tarong Power Plant
180.	8965	06Q4	1	0	0	400	8	Electricity supply	NewGen Kwinana Power Station
181.	9689	07Q4	1	0	0	25	9	Electricity supply	Replace instrumentation and control systems for the Northern Power station
182.	4445	01Q3	1	0	0	30	5	Metal ores	Dardanup mine and plant / refurbishment of Picton Processing Plant
183.	4931	02Q1	1	0	0	28	11	Metal ores	Upgrade of Yandie Pisolite iron ore mine, Pilbara (increase of 4 mtpa)
184.	6308	03Q3	1	0	0	50	2	Metal ores	Development of Tallering Peak ore deposit for oxide pellet plant
185.	6435	03Q4	1	0	0	270	8	Metal ores	Upgrade of Yandicoogina mine (from 24 mt/a to 36 Mt/a)
186.	6604	04Q1	1	0	0	111	4	Metal ores	Expansion of Iron-Ore capacity, Pilbara (10 mtpa)
187.	7138	04Q3	1	0	0	43	4	Metal ores	Redevelopment of Renison Bell tin mine
188.	7696	05Q2	1	0	0	20	7	Metal ores	Development of the Waterloo nickel sulphide deposit
189.	8030	05Q4	1	0	0	69	5	Metal ores	Black Swan Disseminated 2 project (BSD2), near Kalgoorlie
190.	8046	05Q4	1	0	0	700	10	Metal ores	Upgrade of Yandicoogina mine, Stage 2 (from 36 mt/a to 52 Mt/a)
191.	8872	06Q4	1	0	0	160	1	Metal ores	Weipa bauxite mine expansion
192.	8878	06Q4	1	0	0	150	2	Metal ores	Charters Towers Gold project (Warrior and Sunburst deposit), Charters Towers
193.	8891	06Q4	1	0	0	166	9	Metal ores	Mt Isa zinc - lead concentrator expansion, stages 1 and 2
194.	8916	06Q4	1	0	0	85	7	Metal ores	Browns Oxide Ore Project expansion, near Batchelor
195.	8967	06Q4	1	0	0	24	4	Metal ores	South Miitel Nickel mine expansion
196.	9430	07Q3	1	0	0	35	1	Metal ores	Wallaby underground extension, Granny Smith Gold mine
197.	9609	07Q4	1	0	0	23	6	Metal ores	Development of the McMahon nickel project
198.	9966	08Q3	1	0	0	22	1	Metal ores	Rapid Growth Project 5: earthworks, Pilbara
199.	7413	05Q1	1	0	0	25	12	Oil & Gas extraction	Gas facility, Kogan North
200.	8854	06Q4	1	0	0	150	9	Oil & Gas extraction	Camden gas project (coal seam methane), Camden
201.	8855	06Q4	1	0	0	210	3	Oil & Gas extraction	Karratha LNG Plant, power stations, transport fleet, Karratha
202.	8859	06Q4	1	0	0	50	4	Oil & Gas extraction	Tipton West coal seam methane project, 20km South of Dalby
203.	9419	07Q3	1	0	0	114	1	Oil & Gas extraction	Spring Gully, coal seam methane project, 80km North of Roma, phase 4
204.	9747	08Q1	1	0	0	25	4	Oil & Gas extraction	Mars Phase 2A Project - installation of a solar compressor, Varanus Island
205.	4678	01Q4	1	0	0	100	8	Other	Salt project, Onslow, Pilbara region
206.	6877	04Q2	1	0	0	20	10	Other	Development of Hartley quarry
207.	8821	06Q4	1	0	0	48	1	Other	Expansion of the Ellendale 4 development

Notes: The "status" variable of column 4 = 1 if the project is completed (i. e., successful), 0 if deleted (unsuccessful). The dummy variable "consideration" of column 5 =1 if the project commences in that state, 0 otherwise. The variable "committed" of column 6=1 if the project commences in that state, 0 otherwise. The "base" state for the projects (when the previous two dummies are both 0) is "possible". "Age", given in column 8, is the number of quarters a project remains on the Monitor.

TABLE A1.6
THE PROJECTS

	A. Number							B. Value							C. Average Value ($m)						
	Percent of total							Percent of total													
Quarter	Possible	Consideration	Committed	Construction	Completed	Deleted	Total	Possible	Consideration	Committed	Construction	Completed	Deleted	Total ($m)	Possible	Consideration	Committed	Construction	Completed	Deleted	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
2001:1	42.86	0.00	42.86	14.29	0.00	0.00	7	39.10	0.00	49.76	11.14	0.00	0.00	422	55	0	70	47	0	0	60
2001:2	30.00	25.00	25.00	20.00	0.00	0.00	20	31.21	31.14	20.24	17.40	0.00	0.00	1,477	77	92	60	64	0	0	74
2001:3	29.03	16.13	22.58	25.81	0.00	6.45	31	33.21	32.28	20.38	12.48	0.00	1.64	3,655	135	236	106	57	0	30	118
2001:4	32.43	13.51	5.41	45.95	2.70	0.00	37	34.37	28.35	2.51	33.92	0.85	0.00	4,705	135	267	59	94	40	0	127
2002:1	31.71	12.20	4.88	39.02	12.20	0.00	41	43.32	21.08	2.04	23.35	10.21	0.00	5,787	193	244	59	84	118	0	141
2002:2	30.43	17.39	10.87	34.78	6.52	0.00	46	44.27	21.34	4.83	27.84	1.72	0.00	6,340	201	169	61	110	36	0	138
2002:3	23.53	27.45	3.92	33.33	7.84	3.92	51	27.98	30.76	1.10	23.76	4.72	11.67	7,709	180	169	43	108	91	450	151
2002:4	28.26	26.09	6.52	32.61	4.35	2.17	46	34.48	33.05	2.18	24.63	3.36	2.29	6,545	174	180	48	107	110	150	142
2003:1	31.11	26.67	2.22	37.78	0.00	2.22	45	38.85	32.83	0.39	27.01	0.00	0.93	6,479	180	177	25	103	0	60	144
2003:2	29.79	21.28	6.38	34.04	8.51	0.00	47	35.07	32.09	3.25	26.11	3.47	0.00	6,606	166	212	72	108	57	0	141
2003:3	24.53	24.53	9.43	39.62	0.00	1.89	53	36.90	29.37	7.20	26.16	0.00	0.38	7,849	223	177	113	98	0	30	148
2003:4	24.59	24.59	9.84	37.70	3.28	0.00	61	35.31	27.55	6.55	29.09	1.50	0.00	9,065	213	166	99	115	68	0	149
2004:1	20.59	20.59	11.76	36.76	7.35	2.94	68	31.15	19.56	12.46	29.87	4.20	2.77	9,939	221	139	155	119	83	138	146
2004:2	22.73	24.24	9.09	37.88	6.06	0.00	66	32.79	15.78	17.00	28.84	5.59	0.00	10,357	226	102	294	119	145	0	157
2004:2	22.54	25.35	7.04	45.07	0.00	0.00	71	31.82	18.61	14.81	34.77	0.00	0.00	10,737	214	111	318	117	0	0	151
2004:4	20.83	26.39	6.94	40.28	5.56	0.00	72	31.26	18.78	14.22	31.98	3.76	0.00	10,863	226	107	309	120	102	0	151
2005:1	16.25	26.25	11.25	42.50	3.75	0.00	80	17.91	28.79	8.98	39.88	4.43	0.00	12,649	174	173	126	148	187	0	158
2005:2	13.10	27.38	10.71	44.05	4.76	0.00	84	18.22	27.73	10.56	38.28	5.21	0.00	13,508	224	163	158	140	176	0	161
2005:3	10.98	23.17	7.32	45.12	9.76	3.66	82	16.21	22.27	6.81	41.09	8.26	5.35	13,083	236	153	149	145	135	233	160
2005:4	7.69	26.92	7.69	47.44	10.26	0.00	78	8.75	37.67	10.68	36.61	6.29	0.00	15,266	223	274	272	151	120	0	196
2006:1	6.33	30.38	10.13	41.77	11.39	0.00	79	5.73	48.57	10.18	32.13	3.39	0.00	16,507	189	334	210	161	62	0	209
2006:2	8.00	30.67	12.00	48.00	1.33	0.00	75	5.63	38.57	11.68	43.84	0.28	0.00	17,218	162	289	223	210	48	0	230
2006:3	8.33	26.19	5.95	54.76	4.76	0.00	84	6.21	36.86	2.77	52.51	1.66	0.00	18,420	163	309	102	210	76	0	219
2006:4	3.00	26.00	6.00	54.00	10.00	1.00	100	1.67	34.05	4.36	54.16	5.14	0.61	21,284	119	279	155	213	109	130	213
2007:1	4.44	25.56	5.56	48.89	13.33	2.22	90	2.59	34.42	4.66	50.79	6.91	0.63	20,665	134	309	193	239	119	65	230
2007:2	6.33	29.11	5.06	53.16	6.33	0.00	79	3.16	37.09	3.87	53.25	2.63	0.00	19,496	123	314	189	247	102	0	247
2007:3	3.61	26.51	9.64	49.40	8.43	2.41	83	10.35	32.55	6.31	38.64	10.88	1.28	22,425	773	332	177	211	348	143	270
2007:4	2.53	25.32	11.39	46.84	12.66	1.27	79	9.50	34.56	9.48	37.69	7.35	1.41	21,255	1,010	367	224	217	156	300	269

(Continued on next page)

TABLE A1.6 (continued)
THE PROJECTS

Quarter	A. Number: Percent of total							B. Value: Percent of total							C. Average Value ($m)						
	Possible	Consideration	Committed	Construction	Completed	Deleted	Total	Possible	Consideration	Committed	Construction	Completed	Deleted	Total ($m)	Possible	Consideration	Committed	Construction	Completed	Deleted	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
2008:1	2.86	27.14	11.43	50.00	7.14	1.43	70	10.26	33.10	9.48	41.35	2.76	3.06	19,693	1,010	343	233	233	109	603	281
2008:2	4.62	24.62	12.31	52.31	6.15	0.00	65	12.39	28.05	8.82	45.20	5.54	0.00	19,077	788	334	210	254	264	0	293
2008:3	4.84	20.97	11.29	50.00	12.90	0.00	62	13.04	26.35	9.18	37.33	14.09	0.00	18,123	788	367	238	218	319	0	292
2008:4	5.45	21.82	9.09	49.09	14.55	0.00	55	15.16	29.82	5.85	38.12	11.05	0.00	15,594	788	388	183	220	215	0	284
2009:1	2.08	22.92	8.33	37.50	25.00	4.17	48	0.14	28.22	6.22	35.43	11.87	18.12	14,350	20	368	223	282	142	1,300	299
2009:2	0.00	23.53	11.76	47.06	11.76	5.88	34	0.00	34.83	8.76	50.88	4.94	0.59	10,192	0	444	223	324	126	30	300
2009:3	0.00	28.57	10.71	60.71	0.00	0.00	28	0.00	36.81	8.58	54.61	0.00	0.00	9,644	0	444	276	310	0	0	344
2009:4	0.00	21.43	10.71	50.00	17.86	0.00	28	0.00	26.55	8.58	45.85	19.03	0.00	9,644	0	427	276	316	367	0	344
2010:1	0.00	0.00	0.00	0.00	95.65	4.35	23	0.00	0.00	0.00	0.00	87.19	12.81	7,809	0	0	0	0	310	1,000	340
Average	15.01	22.86	10.08	41.28	9.52	1.24	59	19.41	28.36	9.05	34.49	6.98	1.72	12,012	263	242	160	163	117	126	202

TABLE A1.7

MARKET RETURNS AND PROBABILITY OF SUCCESS:
ESTIMATES OF PROBIT MODELS

Variable	Equation				
	A1	A2	A3	A4	A5
Intercept	-0.806 (0.580)	-0.776 (0.585)	-0.846 (0.583)	-0.773 (0.598)	-0.771 (0.573)
Value ($100m)	-0.210 (0.126)	-0.180 (0.122)	-0.203 (0.125)	-0.189 (0.119)	-0.178 (0.123)
Log age	0.645 (0.209)	0.637 (0.214)	0.652 (0.213)	0.680 (0.237)	0.621 (0.212)
Returns					
Year to end	0.830 (0.552)	-	-	-	-
6 months to end	-	0.316 (0.712)	-	-	-
Year to construction	-	-	0.945 (0.772)	-	-
Lifetime	-	-	-	-0.372 (0.648)	-
Annualised lifetime	-	-	-	-	0.738 (1.176)
Dummies for Starting State (Base = Possible)					
Consideration	0.548 (0.449)	0.551 (0.450)	0.568 (0.447)	0.574 (0.45)	0.53 (0.451)
Consideration × Value	-0.048 (0.171)	-0.081 (0.166)	-0.050 (0.176)	-0.115 (0.169)	-0.072 (0.173)
Committed	0.916 (0.536)	0.879 (0.534)	0.925 (0.535)	0.816 (0.526)	0.921 (0.531)
Committed × Value	0.586 (0.222)	0.583 (0.207)	0.583 (0.219)	0.599 (0.207)	0.545 (0.219)
Dummy for Industry (Base = Electricity, Gas and Water)					
Mining	0.269 (0.413)	0.293 (0.41)	0.253 (0.416)	0.264 (0.414)	0.281 (0.413)
Mining × Value	0.349 (0.146)	0.347 (0.148)	0.385 (0.165)	0.369 (0.142)	0.361 (0.152)
Summary Statistics					
McFadden R^2	0.28	0.27	0.28	0.27	0.27
Akaike Info criterion	0.750	0.761	0.751	0.759	0.759
Schwarz criterion	0.947	0.958	0.949	0.956	0.956
Hannan-Quinn criterion	0.830	0.841	0.831	0.839	0.839
LR statistic [p-value]	37.808 [<0.001]	36.149 [<0.001]	37.539 [<0.001]	36.390 [<0.001]	36.398 [<0.001]

Notes: Returns are calculated as the log change of the market index over the following horizons: Year to end, one year prior to project success/failure; 6 months to end, 6 months prior to project success/failure; year to construction, one year prior to construction commencing, otherwise, one year prior to project success/failure; lifetime, from birth of project until success/failure; and annualised lifetime, lifetime return divided by age, expressed at an annual rate.

TABLE A1.8

COST CHANGES AND PROBABILITY OF SUCCESS: ESTIMATES OF PROBIT MODELS

Variable	Equation		
	A1	A2	A3
Intercept	-0.806 (0.580)	-0.922 (0.588)	-0.809 (0.583)
Value ($'00m)	-0.210 (0.126)	-0.191 (0.129)	-0.210 (0.127)
Log age	0.645 (0.209)	0.666 (0.209)	0.647 (0.207)
Year to End Returns	0.830 (0.552)	0.884 (0.554)	0.832 (0.552)
Lifetime Cost Change	-	0.657 (0.452)	-
Annualised Cost Change	-	-	0.021 (0.529)
Dummies for Starting State (Base = Possible)			
Consideration	0.548 (0.449)	0.601 (0.459)	0.549 (0.450)
Consideration × Value	-0.048 (0.171)	-0.059 (0.173)	-0.048 (0.171)
Committed	0.916 (0.536)	1.017 (0.536)	0.918 (0.537)
Committed × Value	0.586 (0.222)	0.583 (0.226)	0.586 (0.221)
Dummy for Industry (Base = Electricity, Gas and Water)			
Mining Sector	0.269 (0.413)	0.156 (0.419)	0.266 (0.424)
Mining × Value	0.349 (0.146)	0.405 (0.176)	0.349 (0.146)
Summary Statistics			
McFadden R-square	0.28	0.30	0.28
Akaike Info criterion	0.750	0.746	0.763
Schwarz criterion	0.947	0.963	0.980
Hannan-Quinn criterion	0.830	0.833	0.851
LR statistic [p-value]	37.808 [<0.001]	40.42 [<0.000]	37.810 [<0.000]

Note: Costs have been deflated by the CPI to March 2001 dollars. Cost changes are logarithmic.

TABLE A2.1

COST OVERRUNS IN TRANSPORT PROJECTS

Project type	Number of projects	Cost overrun (Percent of planned) Average	Standard deviation	t-value for H_0: Overrun=0
Rail	58	45	38	9.02
Fixed-link	33	34	62	3.15
Road	167	20	30	8.62
All	258	28	39	11.53

Source: Flyvbjerg et al. (2002).

TABLE A2.2

SECOND SET OF COST OVERRUNS

Project	Cost overrun (Percent of planned)
Suez Canal	1,900
Sydney Opera House	1,400
Concorde Supersonic Airplane	1,100
Panama Canal	200
Brooklyn Bridge	100

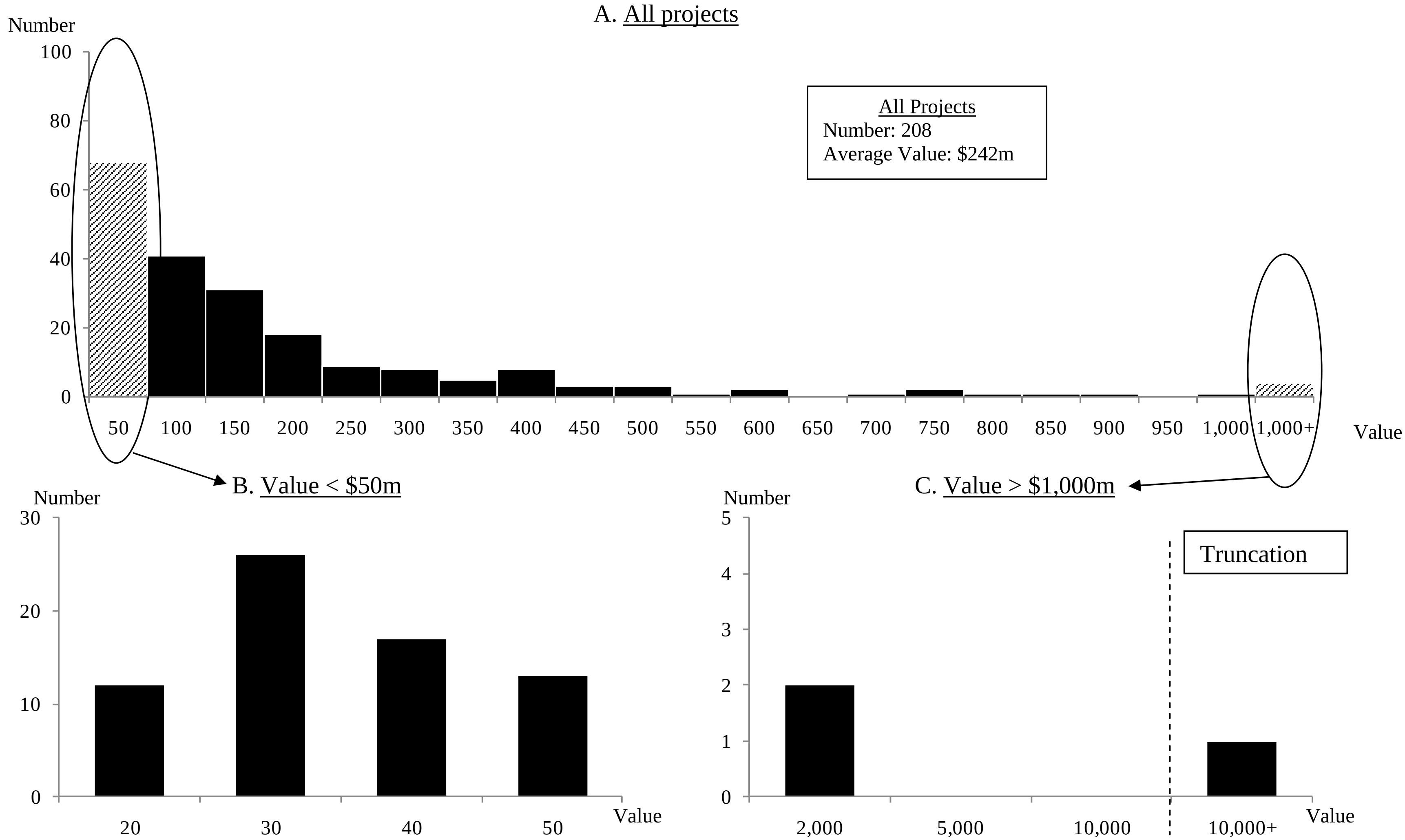
Source: Flyvbjerg et al. (2002).

TABLE A2.3
QUALITY OF INVESTMENT EXPECTATIONS, AUSTRALIA, 1987-2008

Forecast horizon, h (quarters)	Mean error (logarithmic ratios × 100)	Regression results							
		Linear: $A_t = \alpha_h + \beta_h E_{t-h/4}$				Logarithmic: $\log \frac{A_t}{E_{t-h/4}} = \phi_h + \lambda_h \log E_{t-h/4}$			
		Intercept	Slope	*F*-value H$_0$: $\alpha_h = 0,\ \beta_h = 1$	DW	Intercept (× 100)	Slope	*F*-value H$_0$: $\phi_h = 0,\ \lambda_h = 0$	DW
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				A. Mining Industry					
6	12.70 (4.24)	-0.08 (0.93)	1.18 (0.08)	6.55 **	1.72	8.96 (15.58)	0.02 (0.07)	4.31 *	1.70
5	4.64 (3.67)	-0.24 (0.82)	1.10 (0.06)	2.60	1.61	-2.22 (13.93)	0.03 (0.06)	0.90	1.99
4	-2.88 (2.79)	0.60 (0.72)	0.93 (0.05)	1.12	1.05	-5.87 (10.41)	0.01 (0.05)	0.55	1.35
				B. Manufacturing Industry					
6	13.28 (2.79)	1.51 (1.38)	0.97 (0.16)	11.27 **	1.69	59.66 (29.02)	-0.22 (0.14)	13.53 **	1.43
5	6.79 (2.35)	0.89 (1.15)	0.97 (0.12)	4.52 *	1.82	42.77 (25.36)	-0.16 (0.12)	5.41 *	1.62
4	-0.60 (1.89)	0.93 (0.86)	0.90 (0.09)	0.81	2.15	31.05 (19.05)	-0.14 (0.08)	1.45	2.00
				C. Other Selected Industries					
6	37.05 (3.12)	1.80 (2.42)	1.37 (0.10)	70.58 **	1.17	55.22 (24.98)	-0.06 (0.08)	69.16 **	1.00
5	27.74 (2.63)	1.25 (2.08)	1.27 (0.08)	59.58 **	1.14	35.97 (22.28)	-0.03 (0.07)	53.22 **	1.16
4	17.87 (2.34)	1.39 (1.54)	1.14 (0.05)	41.21 **	1.28	38.38 (18.55)	-0.06 (0.06)	30.05 **	1.12
				D. Total					
6	27.03 (2.46)	0.06 (3.25)	1.32 (0.07)	62.43 **	1.09	25.33 (24.70)	0.00 (0.07)	57.19 **	1.08
5	18.74 (2.12)	0.06 (2.97)	1.21 (0.06)	39.28 **	1.27	12.68 (21.71)	0.02 (0.06)	37.26 **	1.42
4	9.85 (1.79)	2.15 (2.37)	1.06 (0.05)	13.23 **	1.06	18.99 (17.36)	-0.02 (0.05)	14.75 **	1.13

Notes: 1. Standard errors are in parentheses.
2. Significance at the 1% and 5% confidence level is indicated by ** and *, respectively.
3. Data are from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5625.0Dec%202009?OpenDocument

FIGURE 1
PROJECT VALUES

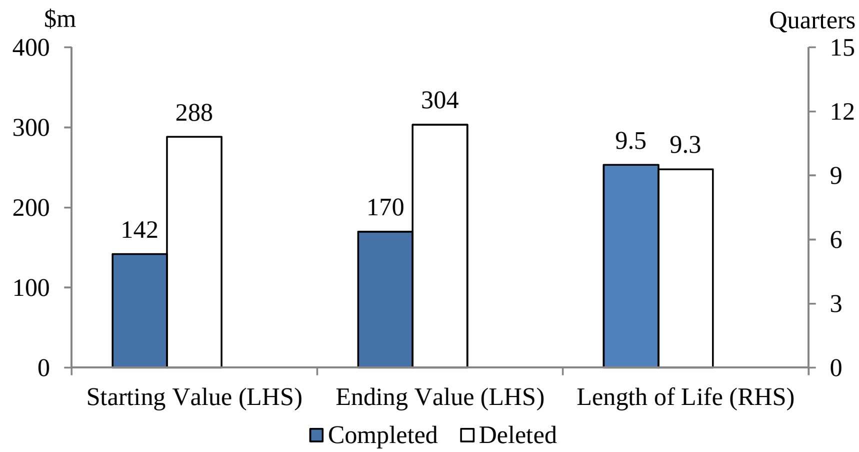


Notes: 1. This figure displays the starting values of projects.
2. The dataset is truncated to exclude one project valued at $14b. This project was listed for two quarters before it was deleted. Details are:

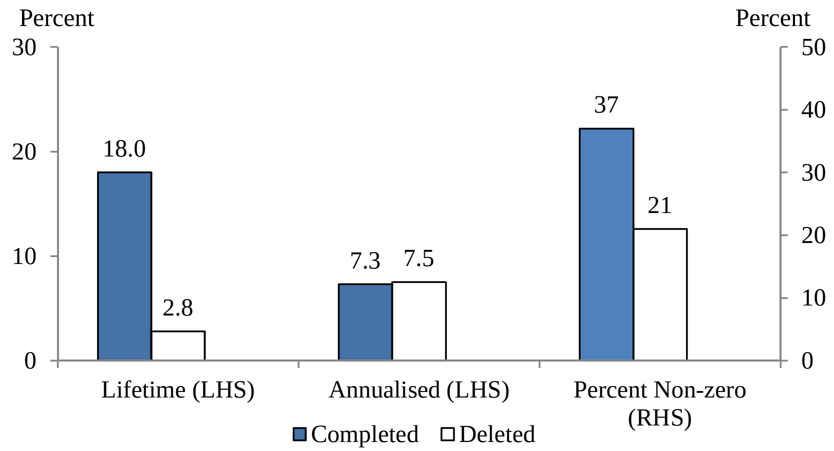
Project No.	Company	Project	Cost ($b)
9960	Queensland Energy Resources	Shale oil project, Proserpine, north Queensland coast	14

FIGURE 2
CHARACTERISTICS OF PROJECTS
(Averages)

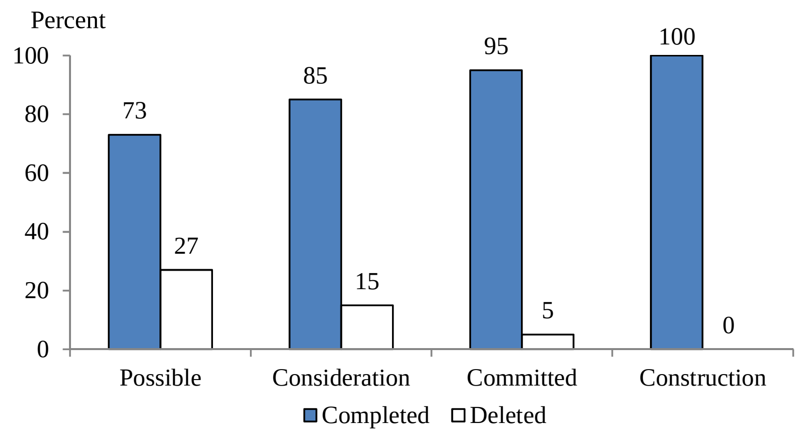
A. Value and Life



B. Cost Changes



C. Success and Failure by Starting State, Project Count



D. Success and Failure by Starting State, Project Value

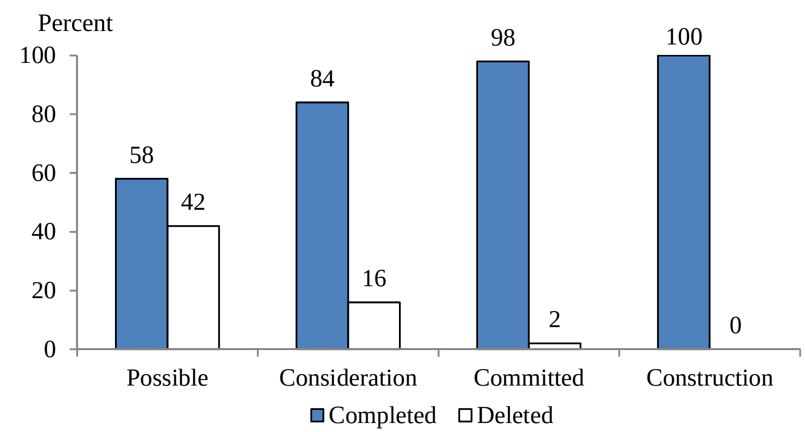
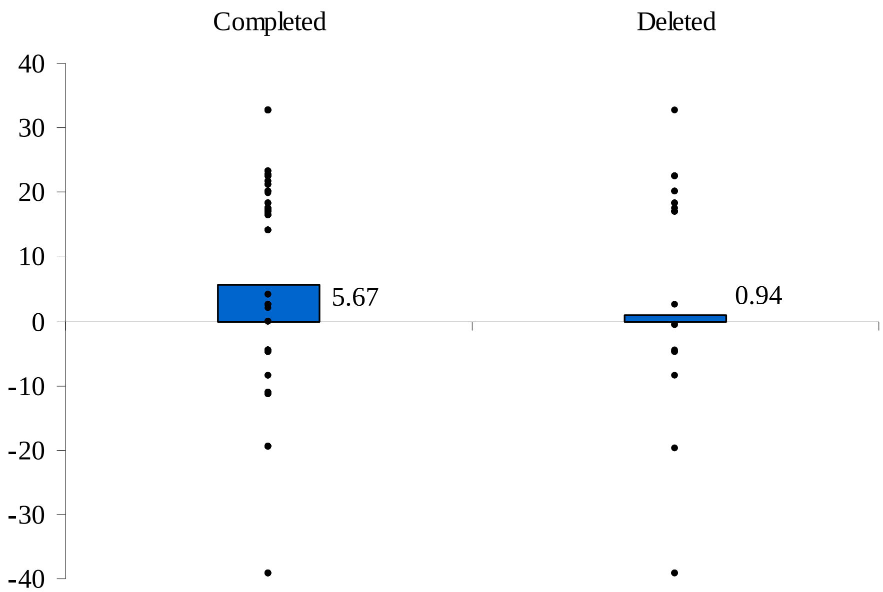


FIGURE 3

THE STOCK MARKET AND PROJECTS

A. Returns by Type of Project



Note: Each point represents the 12-month return on the stock market for the 12 months immediately preceding the completion/deletion of the project. The heights of the two columns represent average returns for the two groups of projects. The market index used is the ASX 200. Returns are the logarithms of the ratios of the index at the end of this period to the beginning value.

B. Returns and Number of Projects

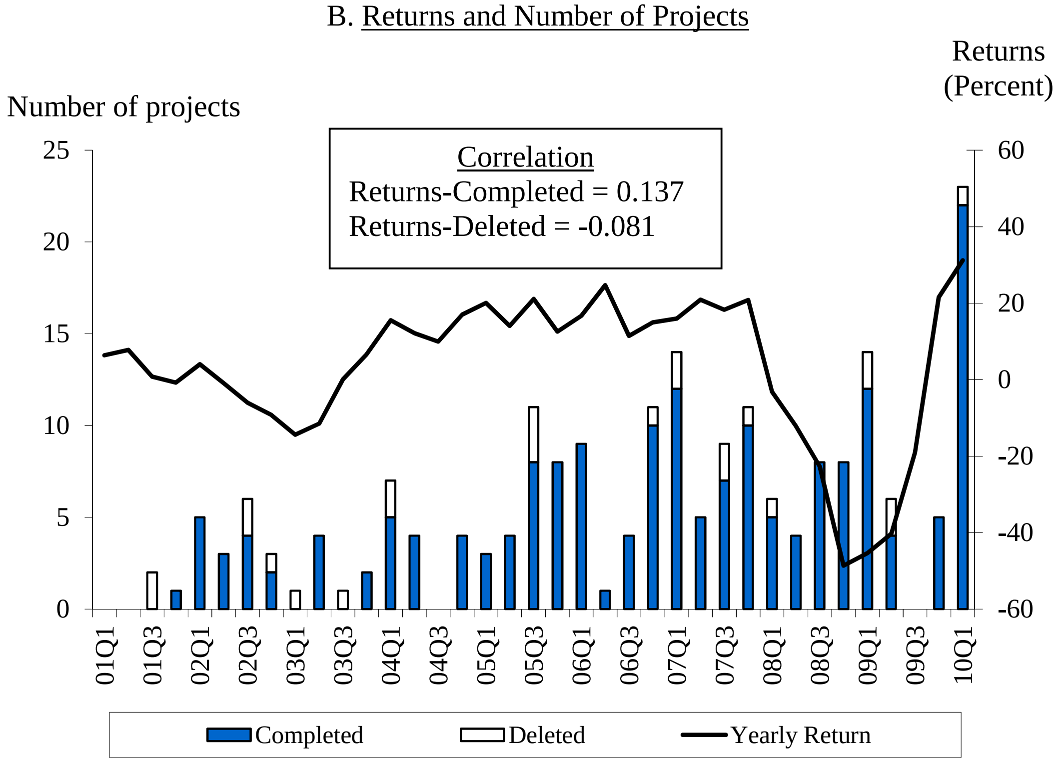
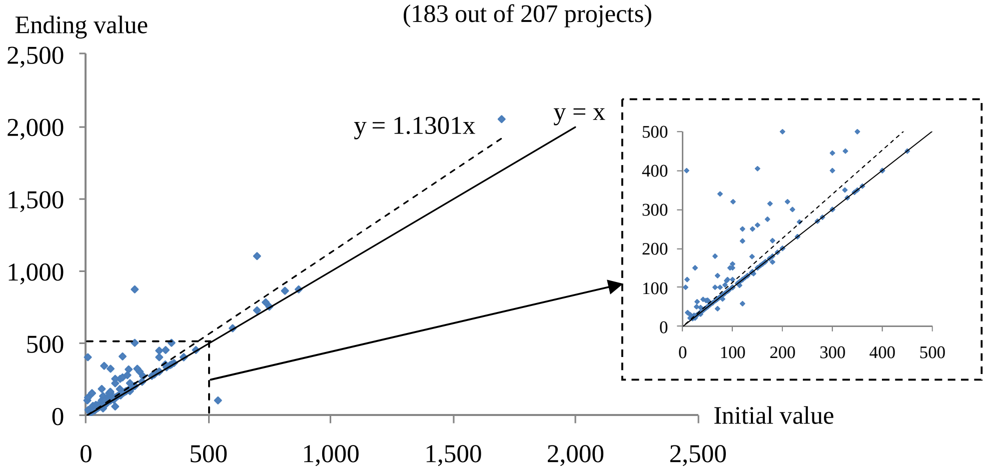
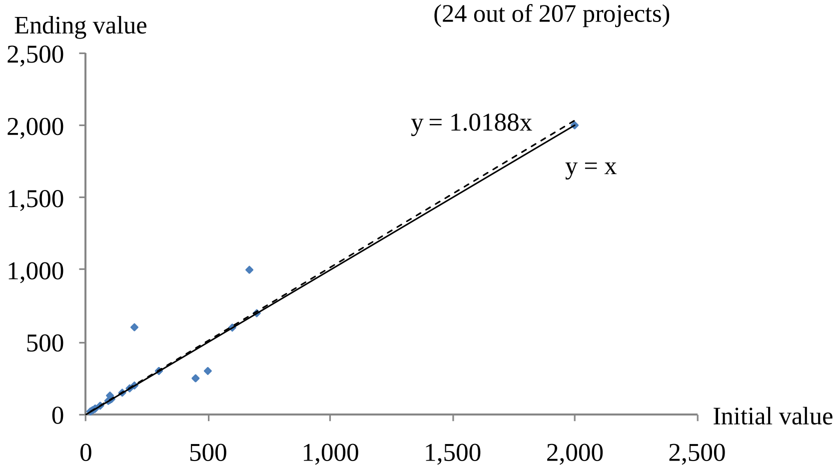


FIGURE 4
COST ESCALATION OF PROJECTS
($ million)

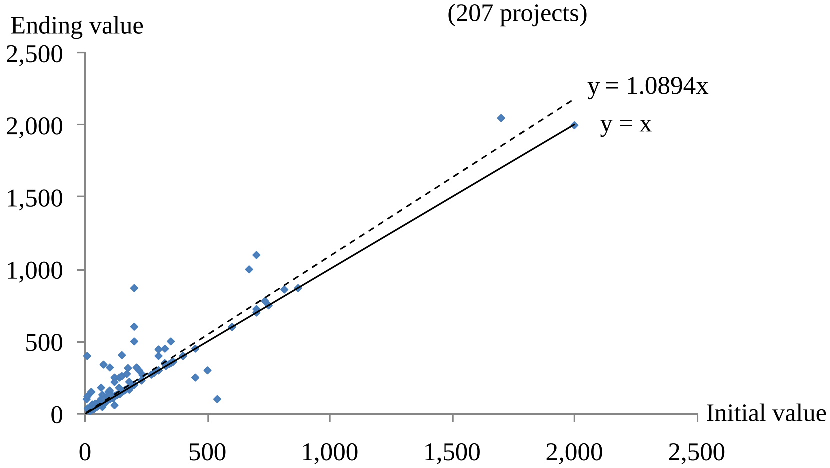
A. Successful Projects
(183 out of 207 projects)



B. Unsuccessful Projects
(24 out of 207 projects)



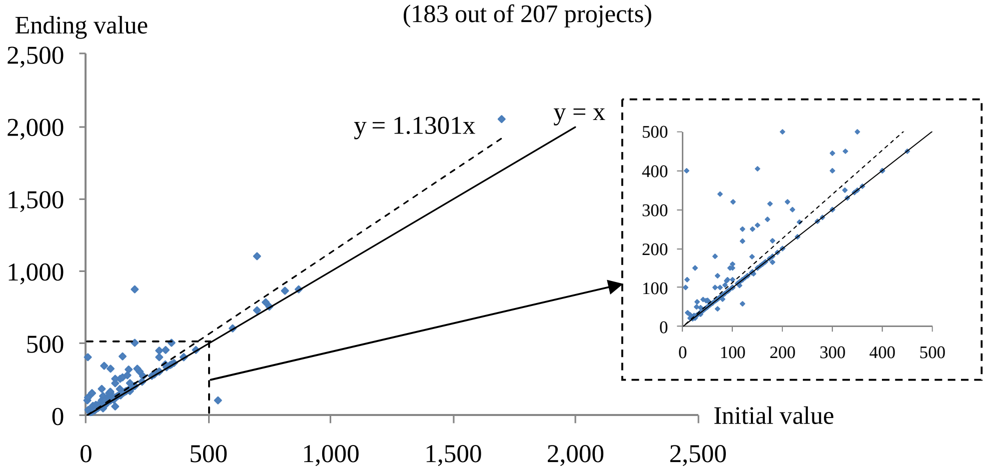
C. Successful and Unsuccessful Projects
(207 projects)



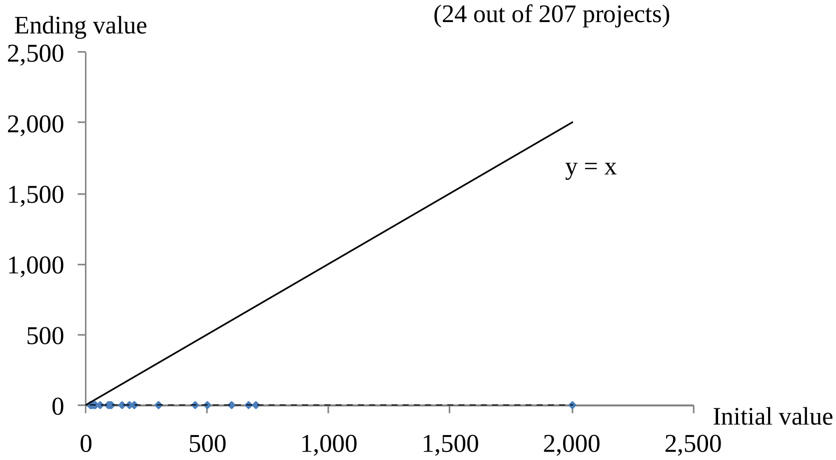
Note: The broken lines are the least-squares regression lines constrained to pass through the origin.

FIGURE 5
HOW MUCH SPENDING ACTUALLY OCCURS?
($ million)

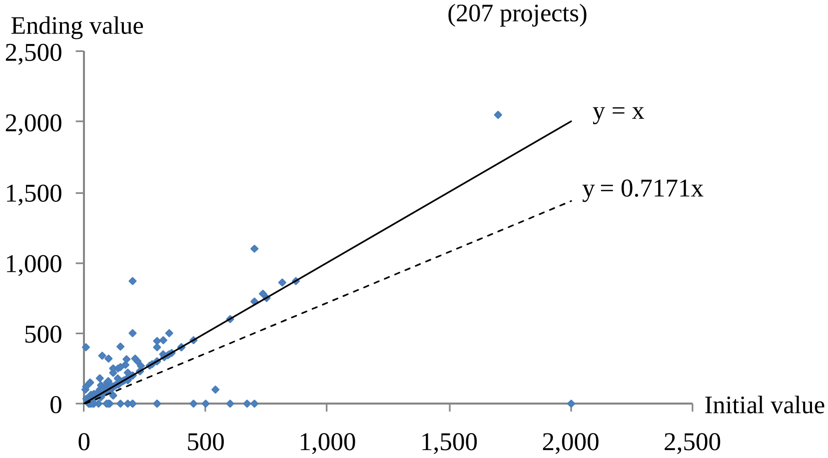
A. Successful Projects
(183 out of 207 projects)



B. Unsuccessful Projects
(24 out of 207 projects)



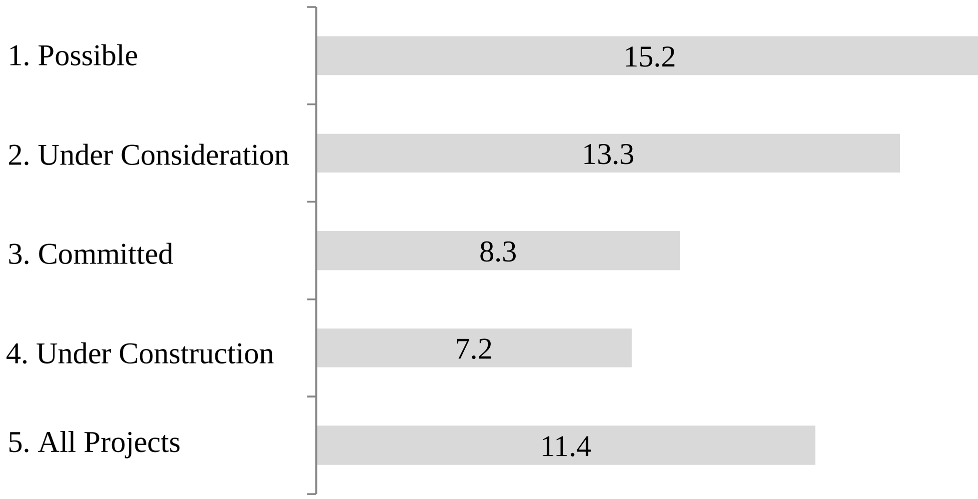
C. Successful and Unsuccessful Projects
(207 projects)



Notes:
1. The broken lines are the least-squares regression lines constrained to pass through the origin.
2. Panel A here coincides with the same panel of Figure 4.
3. Unsuccessful projects are set to have an ending cost of $0 as these costs were never realised.

FIGURE 6
AGE OF PROJECTS
(Number of quarters; value-weighted averages)

A. Completed Projects



B. Deleted Projects

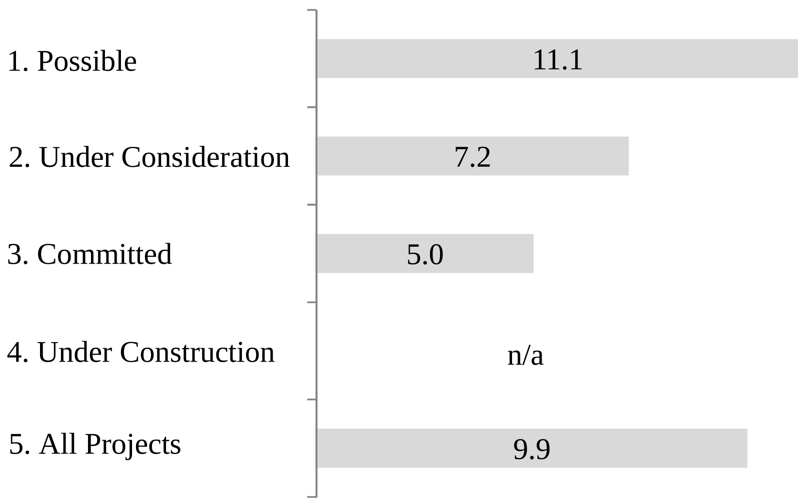
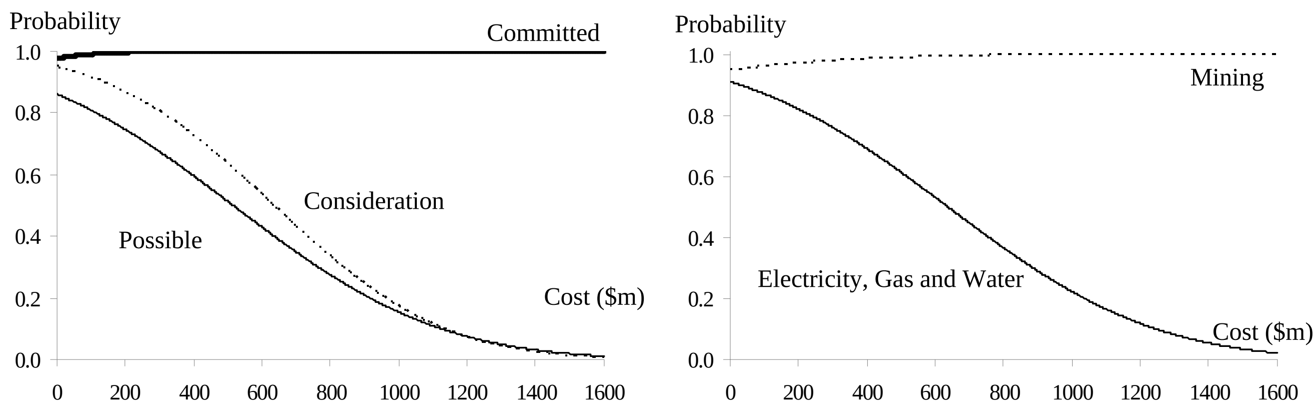


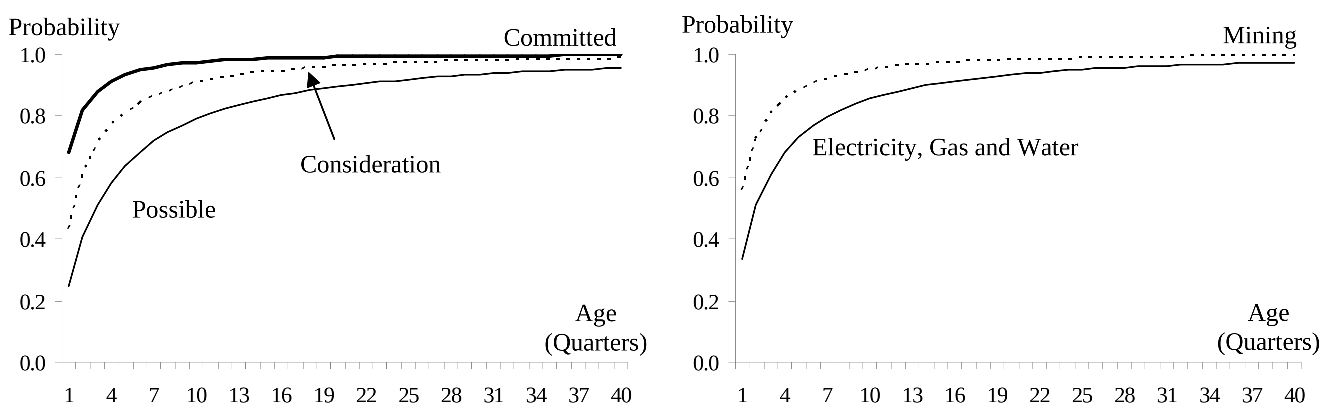
FIGURE 7
PROBABILITY OF PROJECT COMPLETION

I. <u>Starting State</u> **II. <u>Industry</u>**

A. Value



B. Age



C. Stock Market Returns

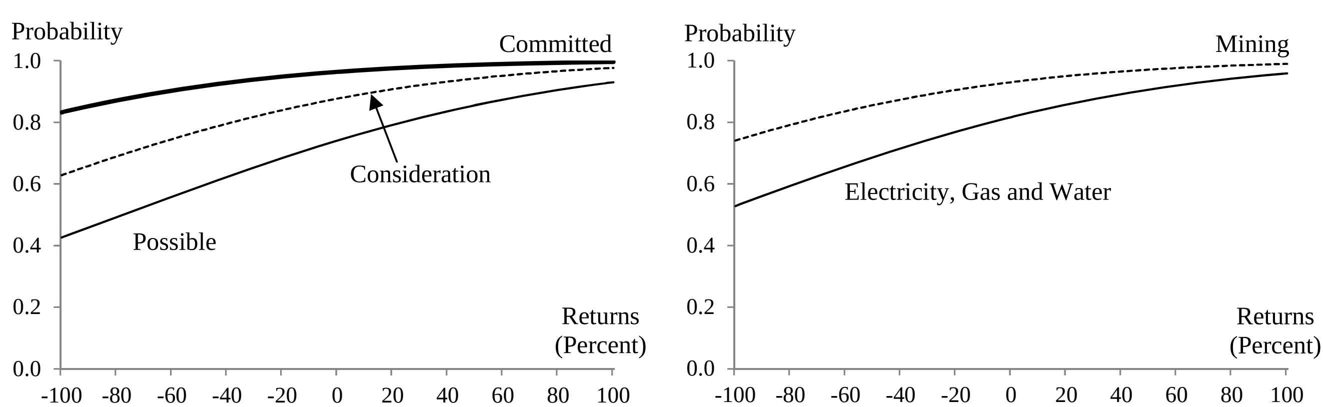
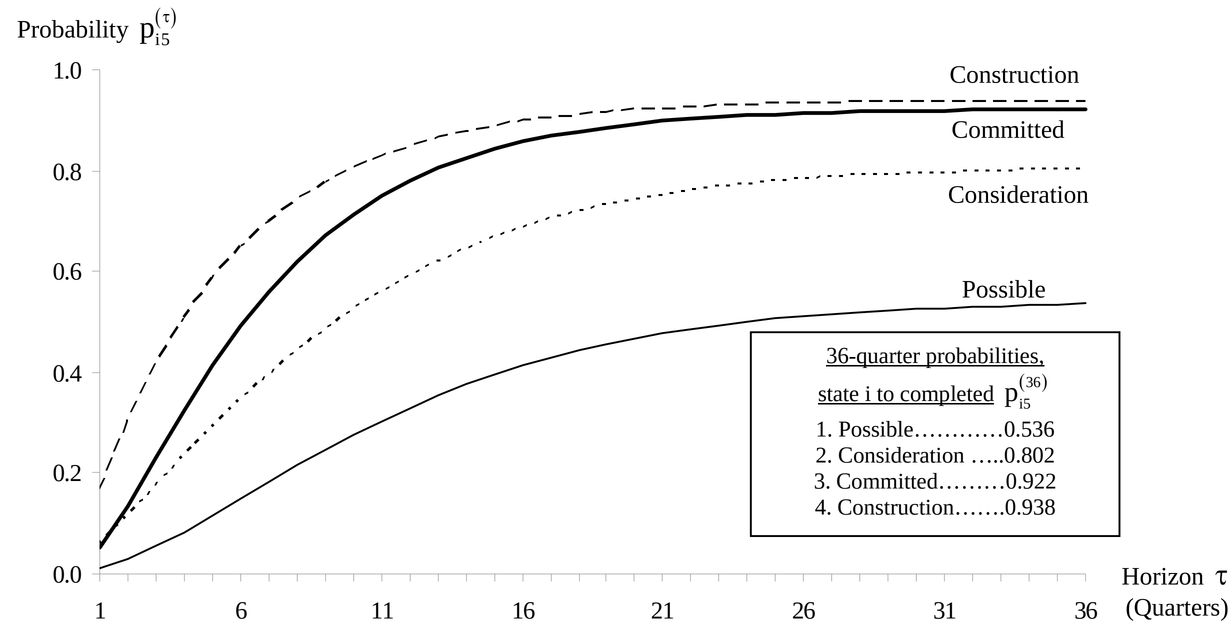


FIGURE 8
MULTIPERIOD TRANSITION PROBABILITIES

A. From state i to completed



B. From state i to deleted

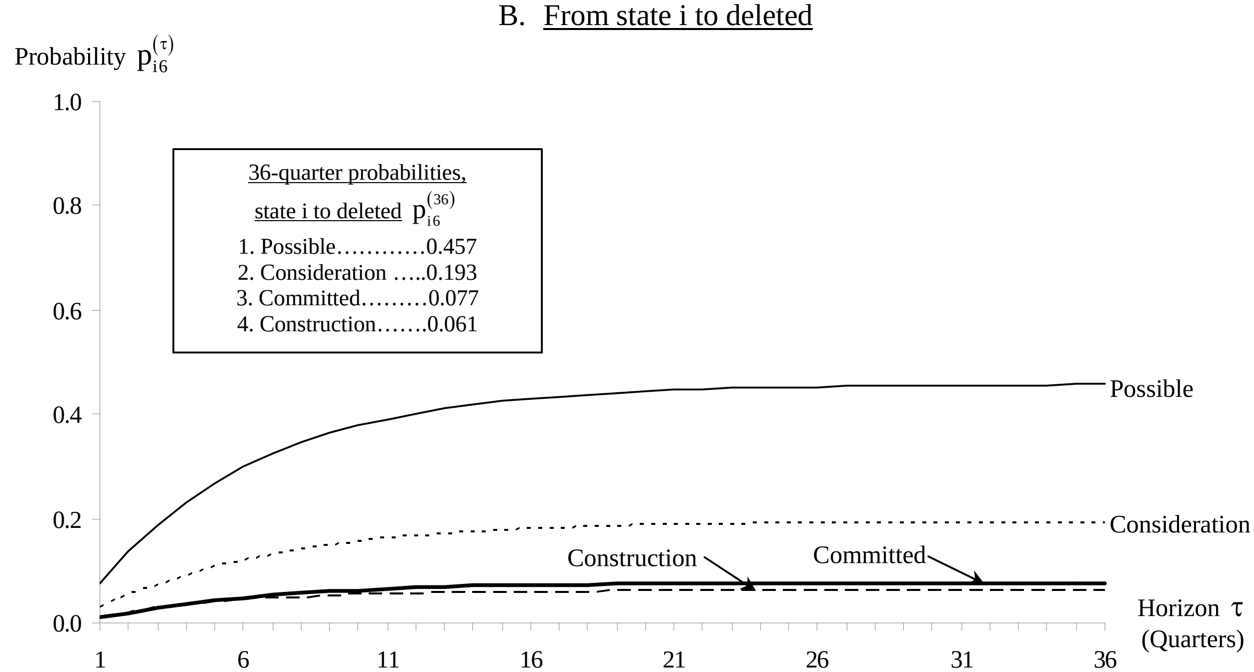


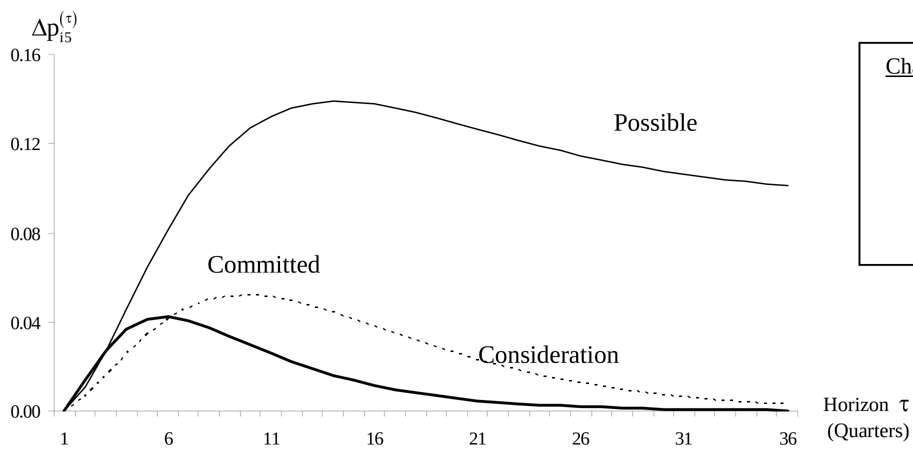
FIGURE 9
SPEEDING UP INVESTMENT PROJECT PIPELINE

A. Two transition matrices

State i in period t	*First matrix* State j in period t+1						*Second matrix* State j in period t+1					
	1	2	3	4	5	6	1	2	3	4	5	6
1.Possible	0.807	0.055	0	0.064	0	0.074	0.742	0	0	0.129	0	0.074
2. Consideration	0	0.819	0	0.123	0.058	0	0	0.758	0	0.184	0.058	0
3. Committed	0	0	0.635	0.313	0.052	0	0	0	0.513	0.434	0	0
4. Construction	0	0	0	0.834	0.166	0	0	0	0	0.834	0.166	0
5. Completed	0	0	0	0	1	0	0	0	0	0	1	0
6. Deleted	0	0	0	0	0	1	0	0	0	0	0	1

B. Changes in multi-period probabilities

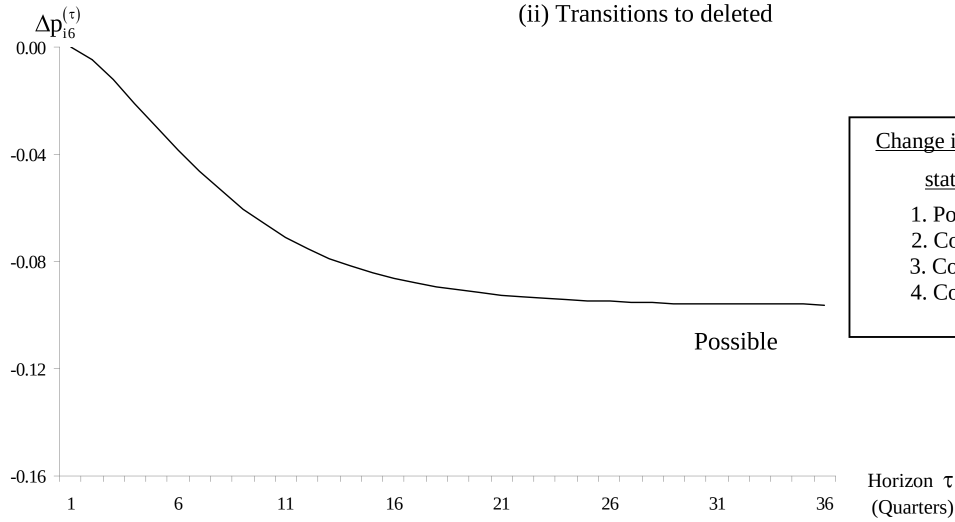
(i) Transitions to completed



Change in 36-quarter probabilities, state i to completed $\Delta p_{i5}^{(36)}$

1. Possible…………0.101
2. Consideration …..0.003
3. Committed………0.000
4. Construction…….0.000

(ii) Transitions to deleted



Change in 36-quarter probabilities, state i to deleted $\Delta p_{i6}^{(36)}$

1. Possible…………-0.096
2. Consideration ..….0.000
3. Committed……..…0.000
4. Construction…..…0.000

FIGURE 10
SPEEDING UP AND THE DISTRIBUTION OF PROJECTS

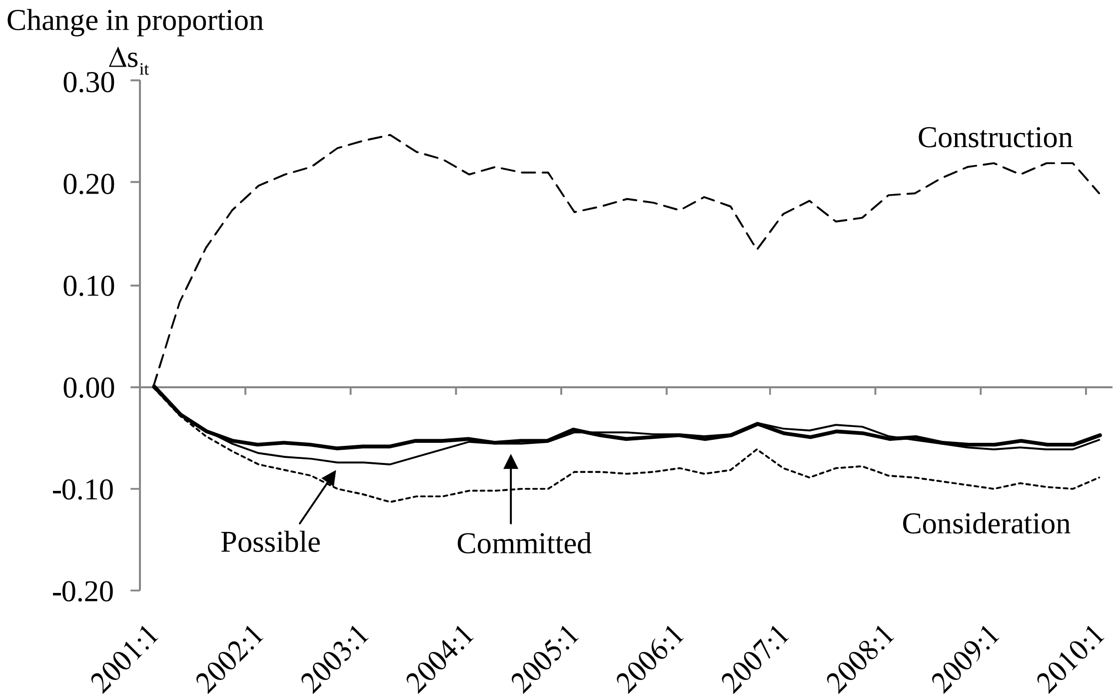
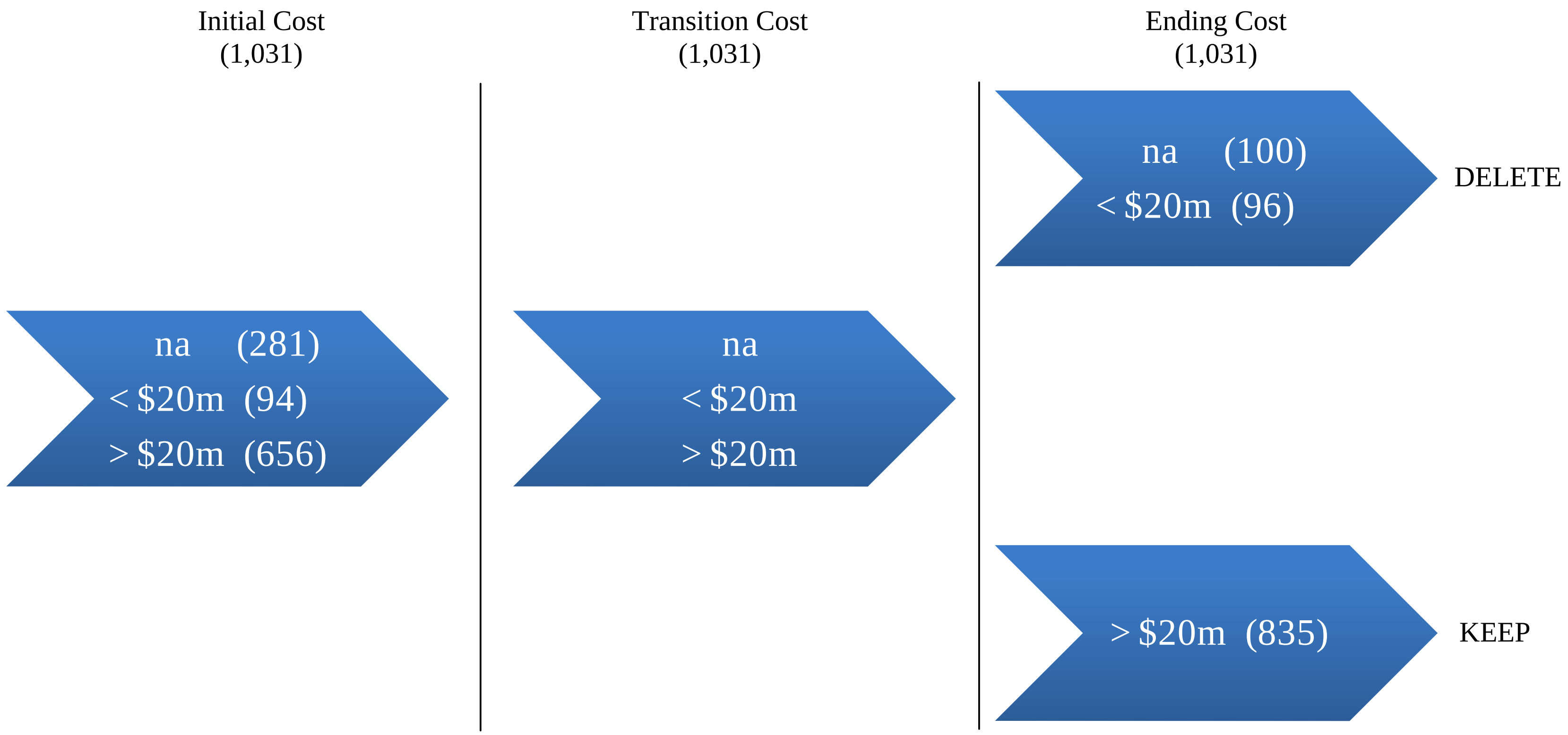


FIGURE A1.1

CONSOLIDATING "NA" PROJECTS

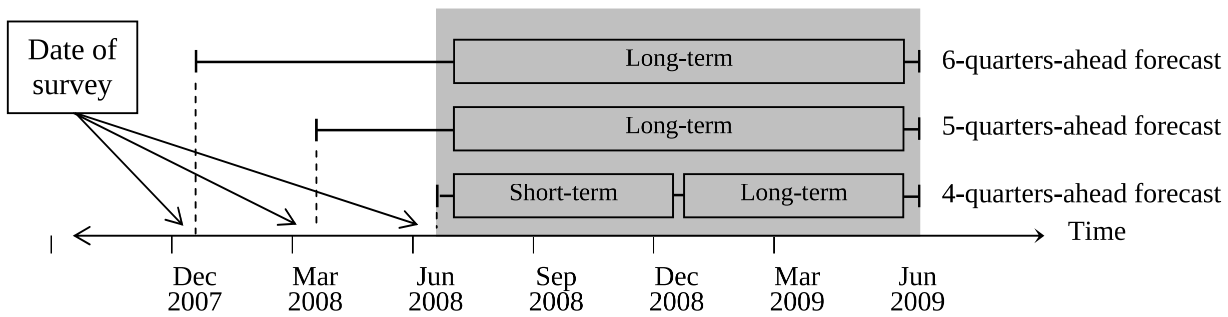


Note: Number of projects in parentheses.

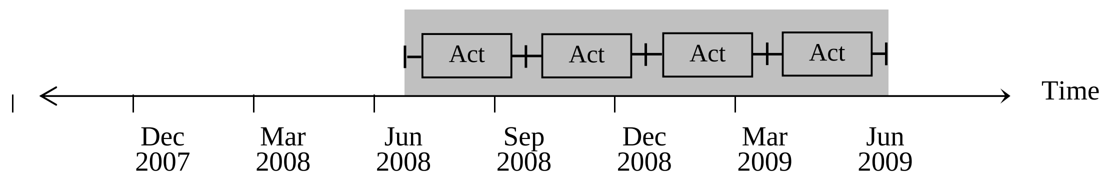
FIGURE A2.1

ABS CAPITAL EXPENDITURE SURVEY

A. Expected Expenditures for 2008/09

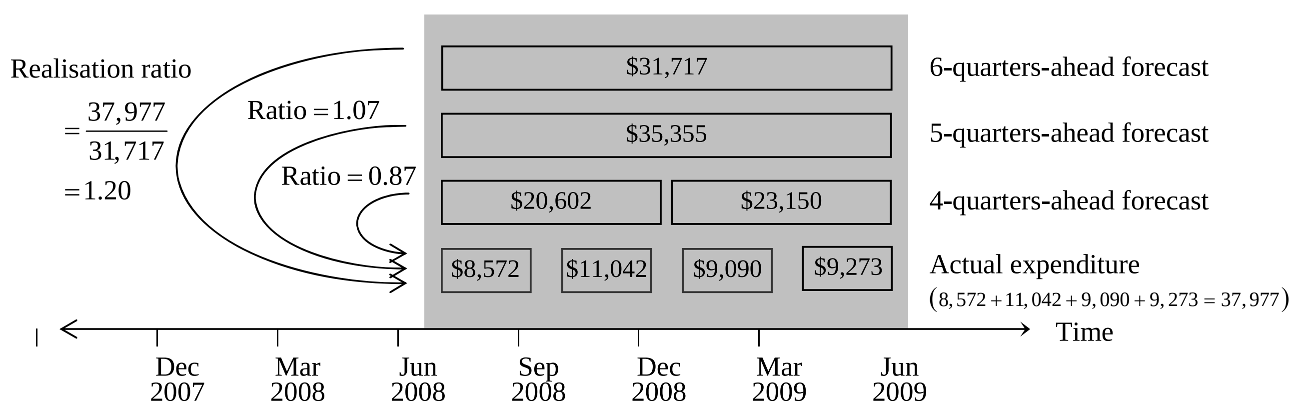


B. Actual Expenditures for 2008/09



C. Comparison of Actual and Expected, 2008/09, Mining Industry

($ million)



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