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UNDERSTANDING NEW RESOURCE PROJECTS

by

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Abstract

The surge in new resource projects has been a prominent feature of the recent strong performance of the Australian economy, with mining and energy investment accounting for almost one-half of all private investment. Although the current round of resource investment has now peaked, as resource cycles tend to repeat themselves, there is an ongoing need to carefully understand the available information sources. We use a specially developed panel of matched projects from three widely followed, but under-researched, sources to analyse cost inflation, the biases, the degree of independence and timeliness of each source. This information is of use to policy makers who have to closely monitor these developments, analysts following the resources sector, and project proponents wanting to know something about the typical cost profile of a project.

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1. Introduction

High commodity prices over the last decade or so have led to an unprecedented resources boom in Australia. This has stimulated a large-scale program of investments in new resource prospects that, in part at least, helped Australia avoid recession and perform better than most other high-income countries. As a result, analysts of the Australian economy now give considerable prominence to information on resource investment plans. As some resource projects are very large, the nature of their cost is of considerable relevant to public policy regarding infrastructure. A recent inquiry by the Australian Productivity Commission into public infrastructure has highlighted the inadequacy of presently available project data to systematically explain the source and nature of cost pressures, hampering accurate cost projections and optimal investment decisions (Productivity Commission, 2014). Internationally, there is considerable evidence of serious problems with investment in "megaprojects" as they suffer from widespread over optimism, cost overruns and delays (Flyvbjerg, 2009, 2014). Flyvbjerg (2009, 2014) goes so far as to describe the situation as one where "the worst projects get built".

This paper helps to deepen the understanding of project costs by identifying the strengths and weaknesses of three data sources of Australia resource projects that have tended to be under used in research in the past. The three sources are: The WA Department of State Development's Prospect Magazine, Deloitte Access Economics' Investment Monitor subscription database and the ABARES/BREE Mining Projects database.[1] Using a unique database in which projects are matched across these sources, we analyse the quality and usefulness of these data.

The structure of the paper is as follows. The next section describes the process of matching projects across the three sources. The matched data mean there are three readings on the cost of each project through time, from which preliminary estimates of the biases are obtained. Section 3 uses these rich data to construct a hedonic index of cost escalation that is not contaminated by the entry and exit of radically different projects, each with their own inflation rate. The hedonic model also leads to more refined estimates of biases in the three sources. Later sections deal with understanding the pattern of information flows regarding cost escalation and an analysis of the degree to which sources rely on each other. The

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[1] Details of the ABARES/BREE source are as follows. This is the Bureau of Resources and Energy Economics' publication "Resources and Energy Major Projects". Before July 2011, this publication was the Australian Bureau of Agricultural and Resource Economics and Sciences' "Minerals and Energy Major Development Projects". For brevity, the ABARES/BREE publications will be referred to as BREE.

estimates of the cost of a project made before its conclusion can be considered as a forecast of the final cost, and the quality of these forecasts is investigated towards the end of the paper. The paper concludes with an overall assessment of the three sources.

2. Matching Projects

To qualify for inclusion in our matched database, a project has to have at least one period of capital expenditure reported contemporaneously in all three sources. Projects that had triplicate matches in some periods but not others are included only for the matching periods.[2] The included projects are usually those that attract more attention from the various stakeholders, that is, the larger ones. The period covered is September 2006 to September 2012. Table 2.1, which summarises the matched data, clearly shows this as the mean project size (as measured by cost, termed “capex” in the table) is of the order of $A3.5b (second last row of the table). In total, 354 triplets of projects are matched and Table 2.1 gives the number per period.

The last three columns of Table 2.1 compare the cost in each of the three sources in the form of deviations from the overall mean. The second last element of the column for Prospect (column 10) reveals that according this source, the size of projects is lower, on average, by more than $100m than the overall mean. On the basis of a t-test, this difference is significant (see the last entry of this column). The bias is in the opposite direction for BREE projects, which are larger, on average, by about $100m (also significant). The Investment Monitor (IM) data are approximately unbiased. As the projects are matched exactly, these differences cannot be attributed to differing coverage of the three sources. Of course, in the context of a project costing $3.5b, a $100m error is less than 3 percent, so the economic significance is modest.

The second last row of Table 2.1 also shows that the dispersion, as measured by the standard deviation, of projects in IM and BREE are very similar, while that of Prospect is somewhat lower. The correlations among the three sources are high (at least 0.98, as indicated in the notes to the table), which is to be expected as the same projects are involved and, most likely, each source looks at its two neighbours. More will be said about this later. Figure 2.1 provides a visual comparison of the data by giving the three pairwise contrasts. The clustering of observations around the 45-degree lines illustrates the substantial agreement across sources. But still for the BREE/Prospect contrast in the south-east quadrant, there is a noticeable tendency for the points to lie below the 45-degree line, reflecting the underpricing

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[2] Refer to the Appendix for further discussion of the data.

in Prospect and overpricing in BREE. The high root mean square errors (RMSEs) of each quadrant, which are of the order of 30 percent, show a reasonably large degree of cross-source variance. In summary, although project values are highly correlated, there is still a significant difference between Prospect and BREE.

3. Hedonic Costing

Next, we use the matched data to estimate a hedonic model of the form

$$\log v_{it}^{s} = \gamma^{s} + \lambda_{i} + \theta_{t} + \varepsilon_{it}^{s}, \quad s = 1, 2, 3;\ i = 1, \ldots, N_{t};\ t = 1, \ldots, 13.$$

Here, v_{it}^{s} denotes capex from source s (s =1, 2, 3, representing Prospect, IM and BREE, respectively) in period t (t = 1,...,13) for project i (i = 1,..., N_t). This capex depends on source effects, γ^{s}, that allow for the biases in the three publications; projects effects, λ_i, to control for projects that differ in nature and scale; time effects, θ_t, to capture cost escalation (time is measured in half-yearly intervals, from September 2006 to September 2012); and random factors as measured by the disturbance term ε_{it}^{s}. The project effects allow for projects with different idiosyncrasies entering and dropping out of the system. The estimates of the time effects provide an index of cost escalation that measures "pure" inflation that in no way reflects extraneous influences. Similarly, estimated source biases are insulated from compositional issues.

The estimates of the hedonic model are given in Table 3.1. Across all projects, the annual rates of cost escalation in column 2 are highly significant, but there are some noticeable year-to-year fluctuations. Over the whole period, project cost escalation averages about 13 percent p.a., which is much larger than CPI inflation over the same period.[3] According to the estimated source effects (column 2), the costs of projects in Prospect are understated by about 5 percent, those in BREE overstated by 4 percent (and both estimates are significant), while for IM the bias is positive but insignificantly different from zero. These results broadly agree with those of Figure 2.1.

We also split the 74 projects into three equal sized groups (25, 25, 24) based on their average starting cost. The year-to-year cost escalation for small projects (column 3) is largely insignificant but on average costs increase by 8 percent p.a., which is significant. The majority of cost escalations for large and mega projects (columns 4 and 5) are statistically

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[3] The average logarithmic difference $(\times 100)$ of the CPI from September 2006 to September 2012 is 2.8% p.a. Source: ABS Cat No. 64010.0.

significant with the average change around 13 percent p.a. and 16 percent p.a., respectively. Prospect also continues to understate costs and BREE continues to overstate for large and mega projects. The source effects are the most extreme for large projects, where Prospect understates costs by 9.3 percent and IM and BREE overstate by 5.7 percent and 3.6 percent, respectively. For small projects, none of the source effects is significant.

Lastly, we repeat the analysis for the projects based on the industry (LNG, Iron Ore or Others) they belong to in columns 6 to 8 of Table 3.1. Apart from the year-to-year fluctuations, LNG and Iron Ore projects have an average cost escalation of about 15 percent p.a., while costs rise by 8 percent for those in Other industries, all of which are significant. The source bias of IM continues to be bracketed by Prospect and BREE for both the LNG and Iron Ore industries, whilst the source biases are insignificant for Other industries. The degree of underestimation in Prospect is more substantial for Iron Ore projects compared to LNG (–9 percent vs. –5.5 percent); likewise, BREE overstates costs slightly more for Iron Ore projects (6.3 percent) as compared to LNG projects (5.5 percent).

These hedonic results provide some insight into the pressures faced by the resources sector during the recent boom: If, on average, the cost of a project rises by, say, 15 percent p.a., after six years the cumulative escalation is almost 150 percent. Cost escalations are prevalent for all types of projects on average, but are substantially greater the larger ones, which tend to be in the LNG and Iron Ore industries. This is consistent with evidence presented by Flyvberg (2014) that initial project costs are substantially understated. Regarding source biases, project costs in Prospect are understated, BREE overstates them and IM is usually bracketed between the other two.

4. Modelling Information Flows

The three sources of capex data refer to the same projects, but in many instances report different values. Over time, it might be expected that the values converge through a Darwinian process of “good information driving out bad”. Suppose, for example, that source 2 initially has more accurate data on a certain project than source 1. Then, the “updating” process could be direct in the form of source 1 using previously published data by source 2 with a lag, which we can write as $2 \to 1$. This situation would also occur when source 2 responds rapidly to new information on the project, while 1 responds only slowly. Although there is no overt copying of one source by another, as it is observationally equivalent, the process can still be described as $2 \to 1$. The process could also be indirect involving a third source of the form $2 \to 3 \to 1$, a sequence that might extend over a longer period. For other projects, the reverse situation may apply with source 1 being more accurate than 2, so when all projects are considered together, there would be a two-way flow of information. In this section, we use a VAR model to measure this type of information exchange. This approach considers flows in all directions and sheds some light on which sources tend to excel in publishing new information.

Let $g_{it}^{s} = \log\left(v_{it}^{s} / v_{i,t-1}^{s}\right)$ be the revision, or growth rate, in the projected capex v_{it}^{s} for project i from period t-1 to t according to source s. The 3×1 vector of growth rates for project i, $\left[g_{it}^{1}, g_{it}^{2}, g_{it}^{3}\right]'$, is taken to be a first-order vector autoregressive process, the s^{th} member of which is

$$(4.1) \qquad g_{it}^{s} = \alpha_{i}^{s} + \sum_{r=1}^{3} \beta_{i}^{sr} g_{i,t-1}^{r} + \varepsilon_{it}^{s},$$

where α_{i}^{s} and β_{i}^{sr} are coefficients and ε_{it}^{s} is a disturbance term. The intercept α_{i}^{s} measures the role of other sources of cost escalation that occur independent of the past; these can be called "autonomous" cost increases. The own-coefficient β_{i}^{ss} refers to the degree to which current inflation depends on its own past history. The size of the cross-coefficient β_{i}^{sr}, for $s \neq r$, measures the direct flow of information from source r to s over 1 period. Equation (4.1) for $s = 1, 2, 3$ is the VAR model for project i.

As there is insufficient time-series data to estimate model (4.1) for each of the 74 distinct projects, we pool the data by taking the coefficients to be the same over projects to estimate

$$g_{it}^{s} = \alpha^{s} + \sum_{r=1}^{3} \beta^{sr} g_{i,t-1}^{r} + \varepsilon_{it}^{s}.$$

for $s = 1, 2, 3$. Panel A of Table 4.1 uses that matched data to estimate this model.[4] Looking at the first row that refers to <u>Prospect</u>, the estimate of the intercept is 0.050, which means that autonomous inflation according to this source is about 5 percent per half year (and significant). Next, the estimate of the own autoregressive coefficient, β^{11}, is -0.043. The negative sign means that higher inflation last period tends to be followed by lower inflation in this period, other things remaining unchanged. Thus, rather than inflation inertia, there is some degree of mean reversion in the level of capex. However, this coefficient is relatively small and not significantly different from zero. The estimated cross-lag coefficient β^{13} of

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[4] See Clements et al. (2014) for further details.

0.115 implies that about 12 percent of past growth in costs in BREE passes through into current growth in costs reported in Prospect. This estimate is significant and considerably larger than that for IM→Prospect $\left(\hat{\beta}^{12}\right)$. Thus, there is a more substantial flow of information from BREE to Prospect, than from IM. The estimates of the coefficients of the two other equations have a similar interpretation.

The F-statistics in column 8 of the table test the hypothesis of all the three lagged source coefficients are jointly zero. The null is rejected in the case of both IM and BREE, but not for Prospect. The last column tests if in each case, the two alternate sources play no role. BREE has a lower F-value than IM, suggesting the possibility that BREE is informed less by the other sources than is IM, and may rely more on its own research to revise its data. Further results below would also seem to point to this conclusion.

As discussed in the App, there are slight asynchronies in the dates of the publication of the three sources that may in part explain the result of Table 4.1 that BREE appears to be more influenced by IM than vice versa (that is, $\hat{\beta}^{32} > \hat{\beta}^{23}$).

The insignificant F-value for Prospect in the last column of panel A of Table 4.1 means that other sources play no role in contributing to this publication. Taken in isolation, the interpretation of this result is ambiguous. It could be that Prospect is the "market leader" in disseminating new information and does not need to absorb information from the other sources. Alternatively, it could be that they do not go to the trouble of "learning" from the other sources. From the second and third rows of columns 3-5 of Table 4.1, both IM and BREE appear to take on less information from Prospect than from the other sources $\left(\hat{\beta}_{21} < \hat{\beta}_{23}, \hat{\beta}_{31} < \hat{\beta}_{32}\right)$; this would seem to point to Prospect not being the market leader. Coupled with Prospect's systematic bias noted above, the indications are that Prospect does not seem to lead in information dissemination, but is somewhat divorced from the system as a whole. This conclusion is reinforced by the extremes of the cross-effects coefficients: In absolute terms, the smallest is for IM → Prospect $\left(\hat{\beta}^{12} = 0.017\right)$, while the largest is IM → BREE $\left(\hat{\beta}^{32} = 0.210\right)$. That is, IM plays a minor role in the revisions to data published in Prospect, but a major one regarding BREE, pointing to the apparent "insulation" of Prospect.[5]

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[5] Panel B of Table 4.1 shows the results when the intercepts are omitted from the VAR model. This has the effect of (i) decreasing (in absolute value) the own-lag coefficients, so now there is not as much mean reversion; and (ii) increasing most of the cross coefficients. But as these changes are not huge and as the general pattern

5. Bilateral and Multilateral Information Balances

The interactions among pairs of sources in the VAR model are bidirectional. For example, from panel A of Table 4.1, information from IM in the past is associated with revisions to BREE $\left(\hat{\beta}^{32}=0.210\right)$, while there is also a reciprocal flow from BREE to IM $\left(\hat{\beta}^{23}=0.101\right)$. The difference between these two gross flows is the net flow of $\hat{\beta}^{32}-\hat{\beta}^{23}=0.210-0.101=0.109$, which can be interpreted as saying that if costs in both sources grow by the same rate in the previous period, BREE will receive about 10 percent more information from IM than it gives in return. The flow of information is measured by that part of revision to costs in one source that can be attributed to past growth in another source, all other factors remaining unchanged. If the 3×3 matrix of estimated coefficients of the lagged terms, $\hat{\boldsymbol{\beta}}=\left[\hat{\beta}^{sr}\right]$, is symmetric, then the reciprocal trade flows are exactly equal, net flows are zero and no source is a net sender to or receiver of information from the others. Accordingly, the degree of asymmetry of $\hat{\boldsymbol{\beta}}$ provides a measure of the bilateral information flows. It is convenient to formulate asymmetry with the skew symmetric matrix $\boldsymbol{\Gamma}=\hat{\boldsymbol{\beta}}-\hat{\boldsymbol{\beta}}'$. The elements of the upper triangle of this matrix, $\gamma^{sr}=\hat{\beta}^{sr}-\hat{\beta}^{rs}, s<r$, give the signs of the net flows from source r to s, s < r = 1, 2, 3. The elements in the lower triangle are the net flows from r to s, $\gamma^{sr}=\hat{\beta}^{sr}-\hat{\beta}^{rs}, s>r$, which are the negative of those in the upper triangle, so $\gamma^{sr}=-\gamma^{rs}$. In words, if s receives information from r $\left(\gamma^{sr}>0\right)$, then obviously r sends it to s $\left(\gamma^{rs}=-\gamma^{sr}<0\right)$. As a source can neither receive or send a net flow to itself, $\gamma^{ss}=\hat{\beta}^{ss}-\hat{\beta}^{ss}=0$. The benchmark case is when $\boldsymbol{\Gamma}$ contains all zero elements, as then the original coefficient matrix $\hat{\boldsymbol{\beta}}$ is symmetric and the bilateral trades are balanced.

Panel C of Table 5.1 gives the $\boldsymbol{\Gamma}$ matrix associated with the estimates of panel A of Table 4.1 (the other two panels contain intermediate steps). The lower triangle contains the three independent measures of net flows; as these are all nonzero, bilateral trade is unbalanced. For the pairs IM/Prospect and BREE/IM, the net flows are positive, so more information is received by the former source than sent back in return. The reverse is true for

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remains more or less the same, in what follows we use the estimates of the model for the case in which the intercepts are included.

BREE/Prospect. But as these measures have relatively large standard errors, not too much reliance can be placed on these results.

Suppose each source revises upwards in the previous period their cost data for project i; if the revisions are equiproportional, then $g^1_{i,t-1} = g^2_{i,t-1} = g^3_{i,t-1} = g^*_{i,t-1}$. Other things remaining unchanged, the current-period revision of source s is then $g^*_{i,t-1} \cdot \Sigma^3_{r=1}\hat{\beta}^{sr}$. Thus, the sum of the coefficients in the row for source s is proportional to its response to a "uniform" message from the three sources. The corresponding information supplied by s to the others as the reciprocal flow is $g^*_{i,t-1} \cdot \Sigma^3_{r=1}\hat{\beta}^{rs}$, implying that the net effect is $g^*_{i,t-1} \cdot \left(\Sigma^3_{r=1}\hat{\beta}^{sr} - \Sigma^3_{r=1}\hat{\beta}^{rs}\right) = g^*_{i,t-1} \cdot \Sigma^3_{r=1}\gamma^{sr}$. When $\Sigma^3_{r=1}\gamma^{sr} > 0$, source s receives more information from the others than it provides, so can be described as a net importer, and vice versa. In other words, the sign of γ^{sr} denotes the bilateral information trade balance, while that of $\Sigma^3_{r=1}\gamma^{sr}$ denotes the multilateral balance. By construction, $\Sigma^3_{s=1}\Sigma^3_{r=1}\gamma^{sr} = 0$, so world trade is balanced. The multilateral balances are contained in the last column of panel C of Table 5.1 and as can be seen, Prospect is a small exporter of information, IM is a larger exporter and BREE is an importer. In this sense, IM would seem to be the largest contributor to the flow of new information. But due to the high standard errors, again caution should be exercised with this specific result. Further analysis of the speed of information flows using impulse response functions and a vector error correction model suggests that IM and BREE respond faster to new information than Prospect. For details, see the Appendix.[6]

6. Predicting Future Costs

This section examines the ability of the estimated capital expenditure in each source to predict the subsequent actual cost of projects.

As before, for source s, the estimated capex of project i at time t is v^s_{it}. If construction of the project is completed at time T_i, this estimated cost is to be compared with the final cost denoted by v^s_{i,T_i}; this final, or actual, cost is observed $T_i - t = h$ periods in the future from t. The estimated cost can also be formulated in terms of the forecast horizon h as v^s_{i,T_i-h}.

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[6] Another metric of the quality of information is its timeliness, as measured by the frequency and nature of cost revisions. We find that BREE is updated substantially more frequently than the other two sources; however, IM adds more unique information in its updates. For details, see the Appendix.

If there are N_h projects having horizon h, then the logarithmic mean forecast error at h and the corresponding standard deviation are

$$B_h^s = \frac{1}{N_h}\sum_{i=1}^{N_h}\left(\log v_{i,T_i}^s - \log v_{i,T_i-h}^s\right), \qquad SD_h^s = \sqrt{\frac{1}{N_h}\sum_{i=1}^{N_h}\left(\log v_{i,T_i}^s - \log v_{i,T_i-h}^s - B_h\right)^2}.$$

These measures, for each source, are used as the basis for the fan charts of panels A, B and C of Figure 6.1.[7] For each source, the mean errors are mostly positive, indicating a bias to underestimate costs.[8] The bias, however, declines with the horizon from about 5-10 percent for a two-year horizon to -2 to 1 percent for six months out. The error bands also shrink noticeably with the horizon; for h = 4, for example, the two-standard-error band is about ± 10 percent, while for h = 1, it is smaller by a factor of almost 10. As to a first approximation these patterns apply to all three sources, they provide little basis for choosing between them. Panel D of Figure 6.1 will be discussed subsequently.

Rather than taking each source by itself as a predictor, we now consider a composite forecast made up of all three together. We start with a regression of actual on estimated capex for source s and horizon h:

$$\text{(6.1)} \qquad \log v_{i,T_i}^s = \alpha_0^s + \alpha_1^s \log v_{i,T_i-h}^s + \varepsilon_i^s, \quad i = 1,\ldots,N_h,$$

where ε_i^s is a random disturbance. The forecasts are said to be unbiased if the intercept $\alpha_0^s = 0$ and efficient if the slope coefficient $\alpha_1^s = 1$ (Mincer and Zarnowitz, 1969). Averaging both sides of this equation over sources gives

$$\text{(6.2)} \qquad \log v_{i,T_i} = \beta_0 + \sum_{s=1}^{3}\beta_1^s \log v_{i,T_i-h}^s + \varepsilon_i, \quad i = 1,\ldots,N_h,$$

where $\log v_{i,T_i} = (1/3)\Sigma_{s=1}^3 \log v_{i,T_i}^s$ is averaged actual cost, $\beta_0 = (1/3)\Sigma_{s=1}^3 \alpha_0^s$ is the averaged intercept, $\beta_1^s = \alpha_1^s/3$ is one-third of the slope coefficient in equation (6.1), $s = 1,2,3,$ and $\varepsilon_i = (1/3)\Sigma_{s=1}^3 \varepsilon_i^s$ is the averaged disturbance.[9] The term $\Sigma_{s=1}^3 \beta_1^s \log v_{i,T_i-h}^s$ on the right of equation (6.2) can regarded as a composite forecast; unbiasedness and efficiency of this composite requires $\beta_0 = 0,\ \Sigma_{s=1}^3 \beta_1^s = 1.$

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[7] For details of the data used in this section, see Clements et al. (2014).

[8] The tendency to underestimate project costs has been noted by others. See, e. g., Flyvbjerg et al. (2009, 2014).

[9] In most cases, "actual" capex differs by source, probably because sources update their data at different speeds. Taking the average reduces the random components of the "actuals"; and, of course, when actual is the same in each source (which occurs for some projects), the average is the common value. It is worthwhile noting that there does not seem to be any particular tendency for poor prediction to be associated with projects with diverse actuals.

Table 6.1 gives the estimates of equation (6.2) for four horizons and several features should be noted. First, the estimates of the intercepts for all four horizons are positive and three are insignificant. This indicates the forecasts when combined in this manner are approximately unbiased and agrees with Figure 6.1, where the error bands mostly span the zero line. Second, in all but one out of the twelve cases, the estimated slope coefficients are positive, so each source usually makes a positive contribution to the composite forecast. Third, as column 6 shows that the sums of the slope coefficients are insignificantly different from unity, it can be concluded that the composite forecast is also efficient. Finally, from columns 10 and 11, there is no strong evidence against the hypothesis of equal slope coefficients, so that the three sources can be equally weighted to form the composite.

Based on these results, we set the intercept in equation (6.2) to zero and the slope coefficients to 1/3. Thus, the composite becomes the unweighted mean of the three sources:

$$(6.3) \qquad \log v_{i,T_i} = \log v_{i,T_i-h} + \xi_i , \text{ with } \log v_{i,T_i-h} = \sum_{s=1}^{3} (1/3) \log v^{s}_{i,T_i-h}, \quad i = 1,\ldots,N_h,$$

where ξ_i is the forecast error. Panel D of Figure 6.1 contains the corresponding fan chart and it can be seen that the averaging procedure decreases the width of the error bands noticeably – by at least 40 percent in seven of the twelve cases. In other words, averaging leads to a considerable increase in forecast precision. Columns 11-13 of Table 6.2 confirms that model (6.3) performs reasonably satisfactorily: For a two-year horizon, the mean error is about 8 percent and the RMSE is 18 percent, while for six months these fall to near zero and slightly less than 3 percent, respectively.[10]

7. Summary and Conclusions

The resources sector (mining and energy) has been a prominent contributor to Australia's recent strong economic performance. As estimates of future investment in resource projects are carefully monitored as an indicator of the likely future course of the Australian economy, it is surprising that there is little research assessing the quality of this information. In this paper, we examined carefully three such sources: The Western Australian Department of State Development's Prospect Magazine, Deloitte Access Economics' Investment Monitor subscription database and the ABARES/BREE Mining Projects database (which, for simplicity, we refer to as just "BREE").

The results of the paper provide guidance regarding how the sources should be assessed and ranked. Table 7.1 provides a convenient summary of the key results. From panel

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[10] Table 6.2 also contains the corresponding error statistics for each of the three sources.

A, there are significant differences in the estimates of capital expenditure in the three sources, with those in Prospect the cheapest, on average, and those in BREE the most expensive. Panel B shows that the bias in Prospect is about -5.4 percent, while that for BREE is 3.6 percent. While modest, these are significantly different from zero. The Investment Monitor (IM) is approximately unbiased. IM also distinguishes itself as being the largest net exporter of information (row 8 of the table).

There are some additional important features of the three sources that should also be mentioned: BREE presents some difficulties in tracking projects over time as it does not assign a unique number to each project and also has the problem of referring to the same project by different names at different times. Prospect and BREE are provided free of charge by government, whereas IM costs $1,210 for four issues (or $616 for a single issue). Another feature is timeliness and coverage: Prospect is published biannually and deals with major projects in the state of WA (the location of the majority of projects); and IM and BREE are quarterly and report Australian projects. Finally, as discussed in Clements et al. (2014), IM attracts more media attention than BREE (and Prospect, which has a very low media presence), but BREE is a more recent product that is growing rapidly (in terms of citations).

Taken as a whole, the above considerations mean that IM is most likely the preferred source. This conclusion is reinforced by the finding that the updates to the IM data contribute more unique information relative to the other two sources (see the Appendix for details). Thus, in this sense, it is true that "you get what you pay for".

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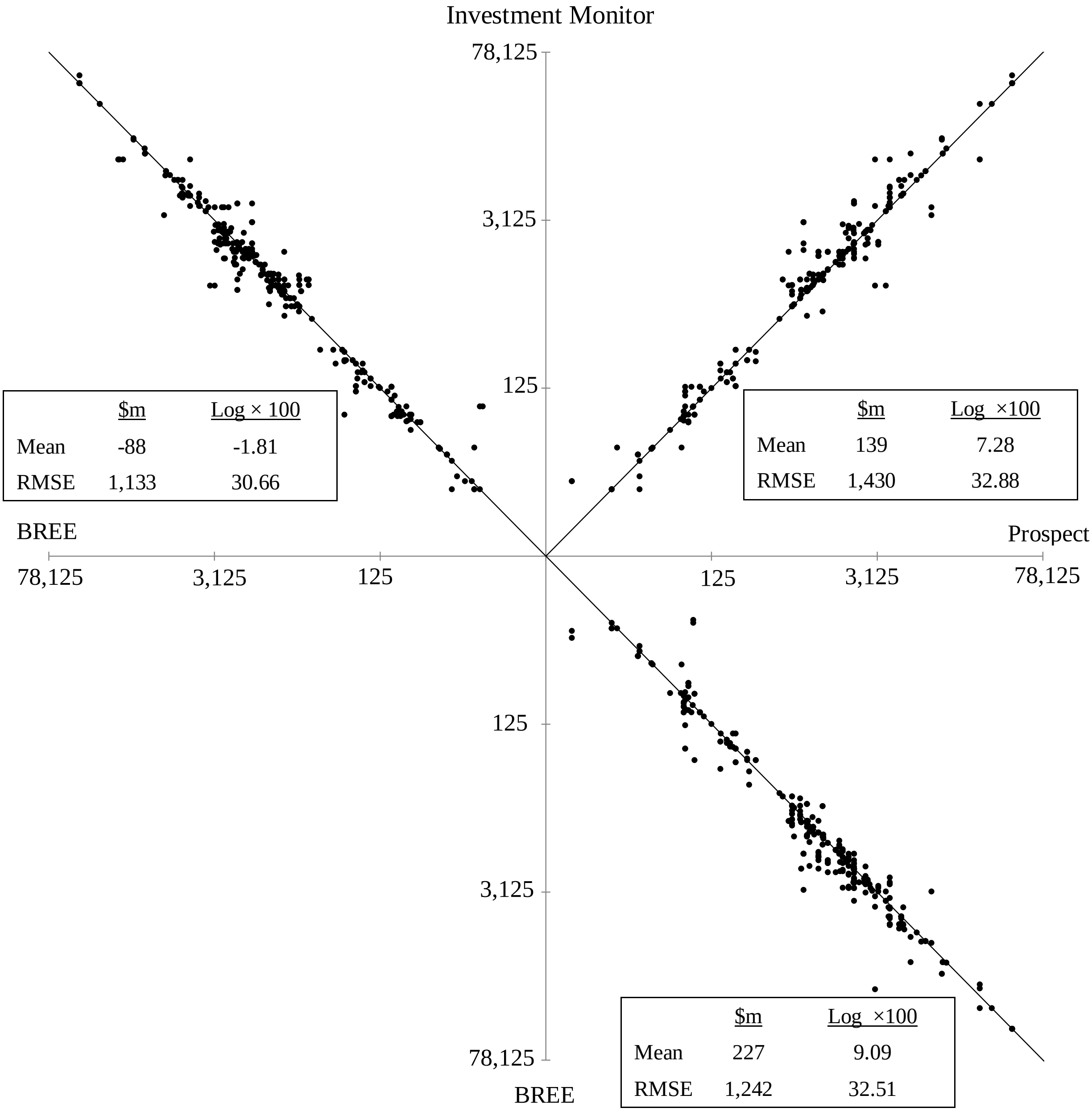
Figure 2.1 Three-way comparison of capex, matched projects

($ million)



	$m	Log × 100
Mean	-88	-1.81
RMSE	1,133	30.66

	$m	Log ×100
Mean	139	7.28
RMSE	1,430	32.88

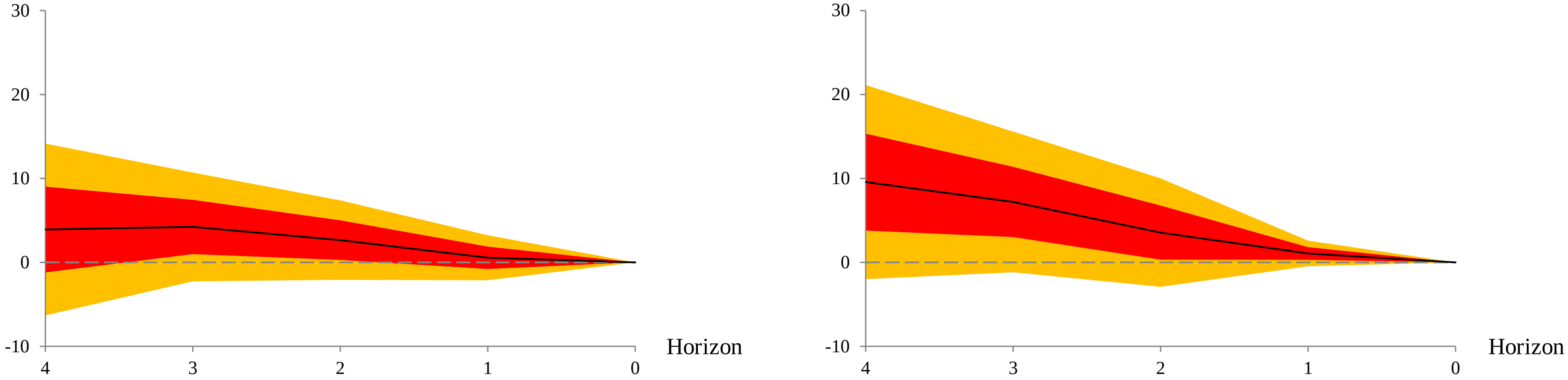
	$m	Log ×100
Mean	227	9.09
RMSE	1,242	32.51

Notes:

1. The rays from the origin are 45-degree lines, along which capex from pairs of sources coincide.
2. The boxes contain the error statistics. The mean is the average difference between capex according to the source on the vertical axis minus that for the horizontal. Because the number of observations in each period is not the same in Table 2.1, the mean errors in this figure are not completely consistent with those of that table, but the differences are small. The RMSE is the root-mean-squared error.

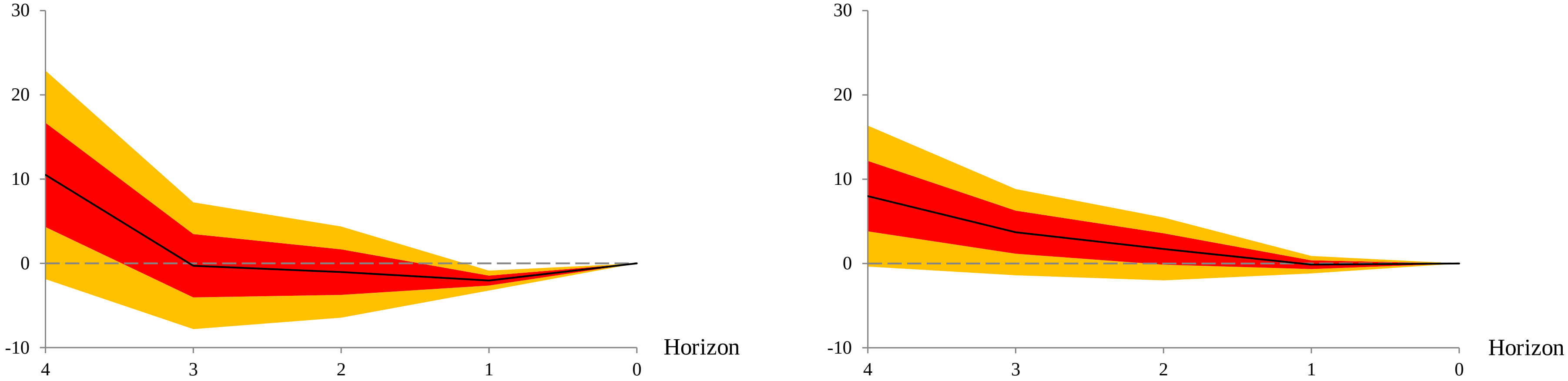
Figure 6.1 Capex forecast errors

(Logarithmic ratios ×100)



A. Prospect

B. Investment Monitor



C. BREE

D. Unweighted mean

Note: The solid back line is the average forecast error; a positive value implies actual exceeds forecast. The dark and light shaded areas below and above the solid black line represent the one- and two-standard error bands, respectively. The horizon is measured in terms of six-monthly intervals.

Table 2.1 Capex, matched projects

Date	Number of projects	Prospect		Investment Monitor		BREE		Grand mean	Difference from grand mean		
		Mean	SD	Mean	SD	Mean	SD		Prospect	Investment Monitor	BREE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sept 06	40	1,464	2,232	1,589	2,657	1,590	2,707	1,548	-84	41	42
Mar 07	41	1,549	2,196	1,719	2,692	1,712	2,673	1,660	-111	59	52
Sept 07	39	1,258	1,601	1,427	2,118	1,499	2,238	1,394	-137	32	104
Mar 08	34	1,237	1,948	1,291	1,937	1,346	2,077	1,291	-55	0	55
Sept 08	31	1,488	2,457	1,418	2,097	1,654	2,527	1,520	-32	-102	134
Mar 09	28	1,733	2,397	1,967	2,434	2,077	2,625	1,926	-193	42	151
Sept 09	28	3,610	8,112	3740	8,076	3,751	8,114	3,700	-90	39	51
Mar 10	24	4,200	8,656	4,979	10,071	5,126	9,222	4,768	-569	211	357
Sept 10	21	5,560	10,024	5,061	9,292	5,661	9,757	5,428	133	-366	234
Mar 11	20	5,130	10,189	4,860	9,341	5,126	9,788	5,039	91	-179	87
Sept 11	18	5,471	10,695	5,894	11,334	5,918	11,320	5,761	-290	133	157
Mar 12	15	5,100	10,588	5,550	10,527	5,444	10,539	5,365	-265	185	79
Sept 12	15	7,209	12,231	7,437	12,210	7,166	12,166	7,271	-62	167	-105
Average	27	3,462	6,410	3,610	6,522	3,698	6,596	3,590	-128	20	108
t-value									2.86	0.42	3.17

Note: Except for the first two columns and the last row, all entries are in $Am. SD denotes standard deviation. The correlations between the sources are as follows: Prospect-IM = 0.977, Prospect-BREE = 0.983 and IM-BREE = 0.986.

Table 3.1 Hedonic costing of projects, matched projects

$$\log v_{it}^{s} = \gamma^{s} + \lambda_{i} + \theta_{t} + \varepsilon_{it}^{s}$$

Variable	All	Projects distinguished by size and industry					
		Size			Industry		
		Small	Large	Mega	LNG	Iron Ore	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cost escalation $(\theta_t - \theta_{t-2}) \times 100$							
Sept 06	- -	- -	- -	- -	- -	- -	- -
Sept 07	10.30 (3.43)	3.72 (6.05)	5.37 (5.33)	23.30 (6.28)	21.92 (6.65)	11.33 (7.16)	5.14 (4.45)
Sept 08	11.13 (3.58)	3.40 (5.80)	14.67 (5.40)	22.01 (7.78)	31.78 (8.86)	8.12 (6.37)	10.58 (4.72)
Sept 09	14.69 (3.86)	5.22 (8.23)	14.77 (5.55)	14.36 (7.36)	11.00 (8.23)	12.00 (6.24)	13.15 (6.06)
Sept 10	14.50 (4.32)	11.09 (11.14)	19.27 (6.56)	8.72 (6.49)	10.57 (7.49)	9.54 (6.94)	17.12 (7.89)
Sept 11	15.75 (4.80)	9.42 (11.16)	16.81 (7.16)	16.41 (7.68)	10.16 (7.43)	33.04 (8.00)	-0.89 (8.89)
Sept 12	11.34 (5.23)	17.38 (16.41)	7.45 (7.95)	12.56 (7.56)	9.17 (8.43)	17.30 (8.16)	3.18 (10.26)
Average	12.95 (0.88)	8.37 (2.52)	13.05 (1.32)	16.23 (1.44)	15.77 (1.60)	15.22 (1.52)	8.05 (1.53)
Source effects $\gamma^s \times 100$							
Prospect	-5.46 (1.06)	-2.01 (2.04)	-9.28 (1.60)	-2.81 (1.84)	-5.53 (2.03)	-8.96 (1.81)	-1.93 (1.57)
IM	1.83 (1.06)	-0.60 (2.04)	5.70 (1.60)	-1.76 (1.84)	0.01 (2.03)	2.70 (1.81)	1.93 (1.57)
BREE	3.63 (1.06)	2.61 (2.04)	3.58 (1.60)	4.56 (1.84)	5.53 (2.03)	6.26 (1.81)	0.00 (1.57)
Project effects included							
SEE	0.244	0.237	0.245	0.234	0.217	0.262	0.228
R-Squared	0.999	0.997	0.999	0.999	0.999	0.999	0.999
No. of Observations	1,062	270	468	324	225	417	420

Notes:

1. Standard errors are in parentheses.
2. As the data are semi-annual, cost escalation measured by $\theta_t - \theta_{t-2}$ is in terms of a change over the year. Only September years are shown.
3. For project size, the sample is split into three equal sized categories (small, large and mega) based on the average of their earliest matched cost across the three sources. The cost ranges are: Small, less than $470 million; Large, greater than Small but less than $1,740 million; and Mega, greater than Large and up to $13.5 billion.
4. For details of size and industry classification, as well as a listing of the data, see the Appendix.

Table 4.1 Estimates of VAR model of information flows, matched projects, semi-annual, 2006-2012

$$g_{it}^{s} = \alpha^{s} + \sum_{r=1}^{3} \beta^{sr} g_{i,t-1}^{r} + \text{dummies} + \varepsilon_{it}^{s}$$

Dependent variable g_{it}^{s}	Intercept	Independent variables, lagged values, $g_{i,t-1}^{r}$			R^2	SEE	F-tests, $H_0: \beta^{sr} = 0$ for	
		Prospect	IM	BREE			$r = 1, 2, 3$	$r = 1, 2, 3;$ $r \neq s$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			A. Intercepts included					
Prospect	0.050 (0.014)	-0.043 (0.057)	0.017 (0.074)	0.115 (0.059)	0.37	0.198	1.43	2.07
IM	0.038 (0.012)	0.089 (0.050)	-0.072 (0.065)	0.101 (0.052)	0.25	0.174	2.83	4.10
BREE	0.041 (0.017)	0.056 (0.068)	0.210 (0.088)	-0.190 (0.070)	0.12	0.235	3.97	3.43
			B. Intercepts supressed					
Prospect	-	-0.009 (0.058)	0.070 (0.075)	0.145 (0.060)	0.34	0.204	2.74	3.94
IM	-	0.115 (0.051)	-0.032 (0.065)	0.123 (0.052)	0.22	0.178	4.46	6.59
BREE	-	0.084 (0.068)	0.253 (0.087)	-0.166 (0.070)	0.10	0.237	4.54	5.60

Notes:

1. The dummies deal with transition from the last observation on one project to the first observation of the next. For details, see Clements et al. (2014).
2. Standard errors in parenthesis.
3. The model of panel A has an AIC value of -0.703; panel B AIC = -0.635. These are insignificantly different (p = 0.97).

Table 5.1 Relative information flows

Source (1)	Prospect (2)	IM (3)	BREE (4)	Row sum (5)
A. Coefficient matrix $\left[\hat{\beta}^{sr} \times 100\right]$				
Prospect	–4.3 (5.7)	1.7 (7.4)	11.5 (5.9)	
IM	8.9 (5.0)	–7.2 (6.5)	10.1 (7.0)	
BREE	5.6 (6.8)	21.0 (8.8)	–19.0 (7.0)	
B. Transpose $\left[\hat{\beta}^{rs} \times 100\right]$				
Prospect	–4.3 (5.7)	8.9 (5.0)	5.6 (6.8)	
IM	1.7 (7.4)	–7.2 (6.5)	21.0 (8.8)	
BREE	11.5 (5.9)	10.1 (7.0)	–19.0 (7.0)	
C. Net information flows $\mathbf{\Gamma} = \left(\hat{\beta}^{sr} - \hat{\beta}^{rs}\right) \times 100$				
Prospect	0	–7.1 (9.0)	6.0 (9.0)	–1.1 (12.2)
IM	7.1 (9.0)	0	–10.9 (10.2)	–3.8 (13.3)
BREE	–6.0 (9.0)	10.9 (10.2)	0	4.9 (13.1)
Total	1.1 (12.2)	3.8 (13.3)	–4.9 (13.1)	0.0

Notes:

1. Panel A is from Table 4.1.
2. In panel C the elements of the matrix refer to the bilateral information balances. A positive element indicates that the row source receives more information from the column source than it sends in return; vice versa for a negative element. The row sums refer to the multilateral balances. A positive row sum indicates the source receives more information from the others than it sends in return; vice versa for a negative row sum.
3. Standard errors in parentheses.

Table 6.1 Combining forecasts of capex costs

$$\log v_{i,T_i} = \beta_0 + \sum_{s=1}^{3} \beta_1^s \log v^s_{i,T_i-h} + \varepsilon_i , \quad i = 1, \ldots, N_h ,$$

Forecast horizon (6-month periods)	Intercept β_0	β_1^s, coefficients of forecast from			Sum $\sum_{s=1}^{3}\beta_1^s$	SEE ×100	R^2	Number of projects	Equal coefficients, $\beta_1^s = \beta_1$ $s = 1, 2, 3$	
		Prospect	IM	BREE					Probability	Restricted estimate β
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
4	0.657 (0.535)	0.494 (0.443)	0.815 (0.783)	-0.385 (0.792)	0.924 (0.072)	17.15	0.959	14	0.681	0.314 (0.019)
3	0.116 (0.225)	0.113 (0.191)	0.286 (0.191)	0.587 (0.263)	0.986 (0.030)	12.08	0.986	20	0.524	0.326 (0.010)
2	0.178 (0.087)	0.287 (0.115)	0.263 (0.119)	0.425 (0.056)	0.975 (0.013)	9.35	0.997	26	0.246	0.328 (0.004)
1	0.037 (0.024)	0.337 (0.027)	0.317 (0.026)	0.339 (0.015)	0.994 (0.004)	2.76	1.000	28	0.812	0.331 (0.001)

Notes: Standard errors are in parentheses. SEE is the standard error of estimate. Column 10 contains p-values for F-statistics of $H_0 : \beta_1^s = \beta_1 , s = 1, 2, 3$.

Table 6.2 The accuracy of capex forecasts

Forecast horizon (6-month periods)	Forecast errors (Logarithmic ratios ×100)												Number of projects
	Prospect			IM			BREE			Unweighted mean			
	Mean	SD	RMSE	Mean	SD	RMSE	Mean	SD	RMSE	Mean	SD	RMSE	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
4	3.91	19.15	19.54	9.56	21.62	23.64	10.50	23.15	25.42	7.99	15.64	17.56	14
3	4.22	14.48	15.09	7.20	18.74	20.08	-0.28	16.82	16.82	3.71	11.43	12.02	20
2	2.65	12.07	12.36	3.55	16.47	16.85	-1.04	13.79	13.83	1.72	9.50	9.66	26
1	0.55	7.09	7.11	1.06	4.04	4.18	-2.05	3.13	3.74	-0.14	2.74	2.74	28

Table 7.1 Summary comparison of three sources of capex data

Criterion	Data source			Origin	Comments
	Prospect	Investment Monitor	BREE		
(1)	(2)	(3)	(4)	(5)	(6)
A. Summary statistics					
1. Mean ($m)	3,462	3,610	3,698	Table 2.1	Projects in Prospect significantly cheaper; BREE significantly more expensive; substantial dispersion, but sources highly correlated.
2. Standard deviation	6,410	6,522	6,596		
3. t-value (from mean)	2.86	0.42	3.17		
B. Source bias					
4. Source bias (%)	-5.46	1.83	3.63	Table 3.1	Constant-quality biases consistent with panel A results.
5. H_0 : Bias = 0 (t-value)	-5.15	1.72	3.33		
C. Information flows					
6. H_0 : All sources in past = 0 (F-value)	1.43	2.83	3.97	Table 4.1	IM and BREE consumers of information from other sources.
7. H_0 : Cross sources in past = 0 (F-value)	2.07	4.10	3.43		
8. Multilateral information balance (elasticity)	-0.011	-0.038	0.049	Table 5.1	IM net information exporter, BREE net importer

Appendix to
UNDERSTANDING NEW RESOURCE PROJECTS

The appendix presents the underlying data and some additional results as well as elaborating further some of the findings in the text of the paper.

A1. The Data

The data come from three sources, Prospect, IM and BREE, and projects included in this data set appear in each of the three sources. Projects were individually matched by hand and the Microsoft Excel "Fuzzy Lookup" plugin used as a cross check. The matching process was time consuming as it involved, for example, identifying cases in which the same project was referred to by different names and the use of the same project number to refer to different projects. The sample period starts in March 2006 and finishes in September 2012. These data are semiannual, so there are 13 time-wise observations. The 354 matched triplets ($3 \times 354 = 1{,}062$ observations in total) are listed in Table A1.1, along with cost and industry identifiers used in the hedonics in Section 3. For full details of the data, refer to Clements et al. (2014).

As discussed in Clements et al. (2014), there are slight asynchronies in the dates of the publication of the three sources. The March (September) issues of IM and Prospect are matched with April (October) issues of BREE. Accordingly, the data from BREE are more up-to-date by one month, relative to the other two sources. In the context of the VAR model, in essence this means that current capex growth for IM is related to the BREE lagged value that is only five months before, not six. This lag is seven months when the current value for BREE is related to the previous values of IM and Prospect. Thus, BREE has more time to "learn" from the publication of data from IM (seven months) than IM has regarding BREE (five months). This timing asymmetry may in part explain the result of Table 4.1 that BREE appears to be more influenced by IM than vice versa (that is, $\hat{\beta}^{32} > \hat{\beta}^{23}$).

A2. The Transmission of New Information

Section 4 used a VAR approach to model the transmission of information across the three sources. To analyse the dynamic response of the system to the receipt of new information, we now consider the associated impulse response functions (IRFs). Column 3 of Table A2.1 gives the results for a shock to each variable equal to one standard error of estimate for the corresponding equation.[11] By construction, the own-effects in period one are

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[11] We consider the IRFs for two periods only (that is, one year), as they are effectively zero thereafter.

equal to the shock, while the period-one cross-effects are zero as it takes at least six months for any information transmission to take place. The two-period own-effects for Prospect and IM are small and insignificant, but this effect is larger and significant for BREE; these effects reflect the relative size of the estimated own-lag coefficients $\hat{\beta}^{ss}$ and the SEEs of Table 4.1.

Next, consider the cross-effects in column 3 of Table A2.1 for period two. Two values here are at least twice the corresponding standard errors:

IM to BREE = 0.024 (0.012) BREE to IM = 0.037 (0.015),

where the figures in parentheses are standard errors. Thus, we now see that BREE provides more information to IM than it receives in return. This is opposite to the result discussed above based on the direct, one-period effects as measured by the $\boldsymbol{\Gamma}$ matrix. This apparent contradiction can be explained as follows. The discussion in Sections 4 and 5 dealt with the proportion of information that flows from one source to another. Thus, as $\hat{\beta}^{32} > \hat{\beta}^{23}$, a ten-percent inflation shock in IM contributes more to BREE than a similar shock in BREE contributes to IM. But according to the SEEs in column 7 of panel A of Table 4.1, the BREE data contain a greater amount of unexplained variation, relative to the others. As the shock for each source that underlies the IRFs of column 3 of Table A2.1 is just this SEE, the shock for BREE is larger than that for the other two sources, which explains the above result. In other words, BREE incorporates a greater proportion of a *given* innovation from IM than vice versa, but BREE also contributes more innovations than IM.

The above IRFs trace out the trajectory of cost inflation following a given shock to the residual of one equation. The results, however, cannot be completely ascribed to an independent shock to the equation in question as the residuals are correlated across equations. The issue can be dealt with by the Cholesky orthogonalisation of the residuals. We use the ordering of variables: Prospect > IM > BREE. BREE is last in the ordering due to its one-month publication lag mentioned in Section 4 (and discussed in more detail in Clements et al., 2014). Similarly, as Prospect tends to publish slightly ahead of IM (see Clements et al., 2014, for details), Prospect is ordered first. Column 4 of Table A2.1 gives the IRFs associated with the Cholesky factorisation. For the own-effects, these results are quite similar to those of column 3. The cross-effects are also similar, except now three period-one effects are relatively large:

IM to Prospect 0.026 (0.010), BREE to Prospect 0.064 (0.014), BREE to IM 0.041 (0.013).

Thus, BREE is now quite sensitive to the other two sources: Following a one-standard-deviation shock of the transformed residuals of Prospect, after a six-month lag, inflation, as measured by BREE, increases by about six percent, while it increases by four percent following a similar shock from IM. This result, which is different from before (when these effects were all zero), highlights the role of new information that is common to the three sources. This information hits all sources simultaneously in the form of correlated shocks.[12]

An error correction model is an alternative approach to analysing the speed at which information travels to each source dynamics. If the three sources of capex $\left(\log v_{it}^{r},\ r=1,2,3\right)$ are cointegrated, then the linear combination $\mu + \Sigma_{r=1}^{3}\beta^{r}\log v_{i,t-1}^{r}$ is stationary and can be treated as a deviation from equilibrium that is common for each source in a VEC model:

$$g_{it}^{s} = \alpha^{s}\left(\mu + \sum_{r=1}^{3}\beta^{r}\log v_{i,t-1}^{r}\right) + c^{s} + \sum_{r=1}^{3}\gamma^{sr}g_{i,t-1}^{r} + \varepsilon_{it}^{s},\quad s=1,2,3,$$

where, for source s, α^{s} is the speed of adjustment, c^{s} is an intercept, ε_{it}^{s} is a disturbance and the γ^{sr}'s are parameters that deal with any autocorrelation. The adjustment coefficients are the key parameters for our purpose and their estimates with the matched data are

Prospect -0.074 (0.031), IM -0.138 (0.027), BREE 0.138 (0.035),

where standard errors are in parentheses. Thus, IM and BREE revise their data at about the same speed, while Prospect is much slower. For further details, see Clements et al. (2014).

A3. Sources' Resources

Another way of assessing the quality of the three data sources might be to compare the resources devoted to each -- the more resources, the better the product. The problem is that resource inputs are not directly observable. But it may be possible to measure this indirectly by the number of instances in which the capex costs are changed, on the basis that more changes may reflect greater collection of more new information, more recording activity and/or more resources devoted to maintaining and updating the database. In this

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[12] The second-period lags of the column 4 IRFs accord more closely with those of column 3. Three further sensitivities of the results can also be noted. (i) When the VAR intercepts are supressed, the corresponding IRFs are in columns 5 and 6 of Table A2.1. In general, these are similar to those with the intercepts included. (ii) We also experimented with second- and fourth-order VARs, but the results, in terms of the value of the AIC, are no better. This is not unexpected as it is unlikely that information should take longer than six months to move directly between sources. (iii) Interchanging Prospect and IM in the Cholesky ordering has little effect on the results. See Clements et al. (2014) for details.

section we investigate this issue by examining the extent to which old and outdated capex projections remain on the books.

Figure A3.1 depicts the incidence of capex updates. Of the 282 triplets, in 92 cases there is no change in any source. These cases are represented by that part of the rectangle that lies outside the three circles. The area of each circle is proportional to the number of cases when the data in the respective source are revised. The tendency for BREE to update more frequently is immediately apparent. Moreover, as indicated by the "non-overlapping" area in its circle, BREE has more than twice as many unique revisions as do the other sources combined (84 vs. 11 + 26 = 37).

Do we know that more frequently revised data are of higher quality? Rather than additional information, could updates simply add more noise, so there might be a distinction between the nominal and effective quality? While iron-clad guarantees of quality cannot be provided, two points can be made in this regard. First, suppose one source were producing "information" of dubious value. Presumably, this would be apparent to the other two, who would tend not to place reliance on the "noise producer". But as indicated in Sections 4 and 5, there are substantial two-way flows of information across sources over time, which points to valuable information.

The second point relates to the coincidence of revisions. In Table A3.1 we test the hypothesis that revisions of each source are independent of that of their counterparts. The large χ^2-statistics for BREE and <u>Prospect</u> mean that independence is rejected, so that these are dependent on the other sources. By contrast, the small χ^2-value for <u>IM</u> indicates it revises more independently of the other two sources. This can be interpreted as saying the revisions to <u>IM</u> are less redundant, or more unique, than those of the other two sources, even though BREE revises more frequently.[13]

<u>Reference</u>

Clements, K. W. and J. Si and T. Simpson (2014). "Understanding New Resource Projects." Economics Discussion Paper 14.17, UWA Business School. http://www.business.uwa.edu.au/__data/assets/pdf_file/0005/2530058/14.17-Understanding-New-Resource-Projects.pdf

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[13] As discussed in Clements et al. (2014), there are a modest number of missing observations for which zero cost escalation is assumed. As most of these pertain to BREE, this would bias the revision frequency count and the contingency-table test of independence in favour of <u>IM</u> and <u>Prospect</u>. We judge this to be of minor importance, however.

Figure A3.1 Revision frequency
(282 triplets)

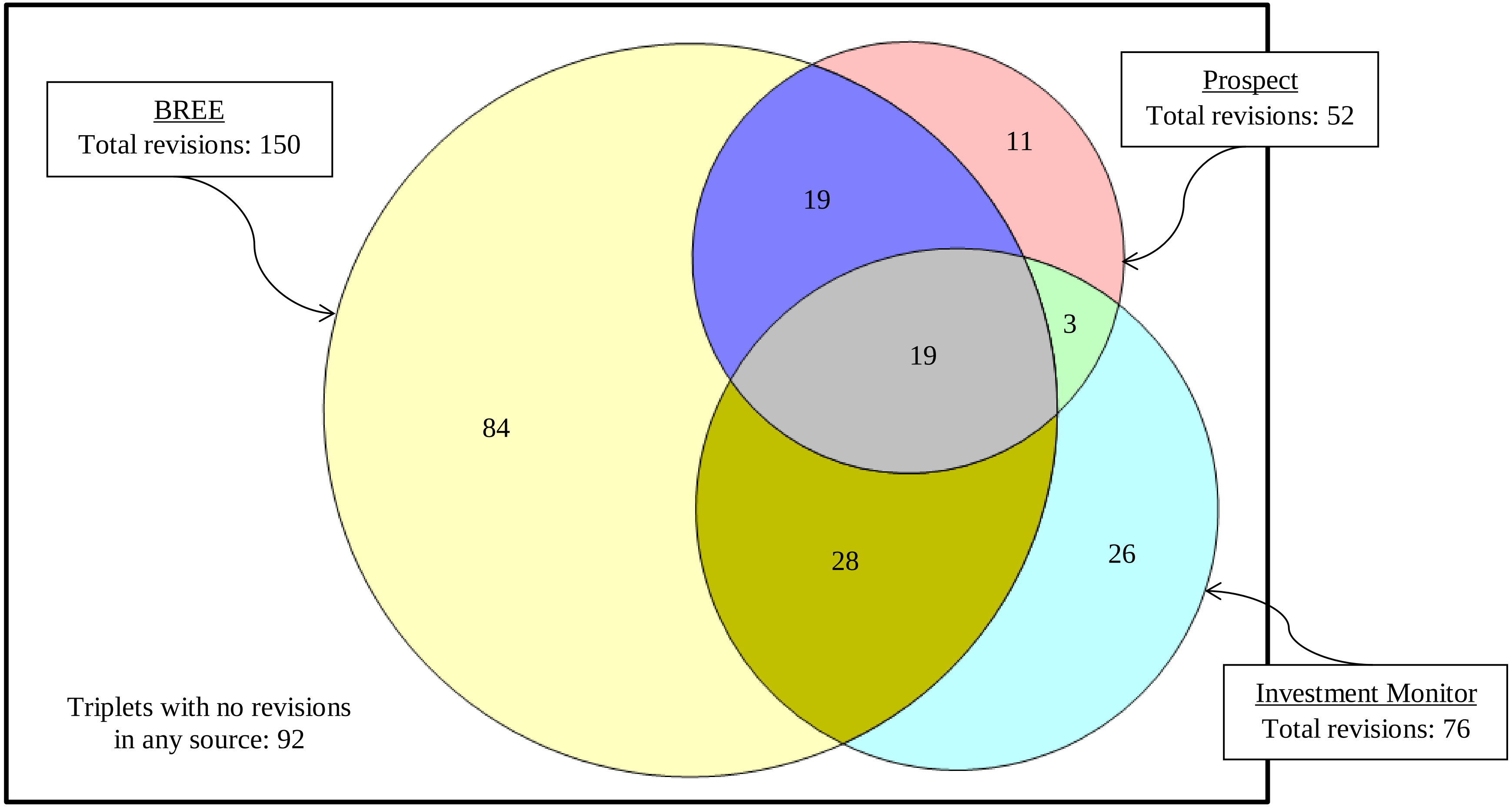

Table A1.1 Matched triplets of projects, by project size

Row no. (1)	Year/ Quarter (2)	Project (3)	Industry (4)	Cost ($m) PR (5)	IM (6)	BR (7)
		A. Small				
1.	2006 Q3	Halls Creek — Panton Sill — Platinum Project	Other	80	65	61
2.	2007 Q1	Halls Creek — Panton Sill — Platinum Project	Other	80	65	61
3.	2007 Q3	Halls Creek — Panton Sill — Platinum Project	Other	80	65	57
4.	2008 Q1	Halls Creek — Panton Sill — Platinum Project	Other	80	65	57
5.	2008 Q3	Halls Creek — Panton Sill — Platinum Project	Other	80	65	57
6.	2006 Q3	Jangardup South — Mineral Sands Mine	Other	40	40	40
7.	2007 Q1	Jangardup South — Mineral Sands Mine	Other	70	40	40
8.	2007 Q3	Kemerton — Titanium Dioxide Pigment Plant Expansion	Other	470	470	470
9.	2008 Q3	Kwinana — Titanium Dioxide Pigment Plant Expansion	Other	100	100	100
10.	2009 Q1	Kwinana — Titanium Dioxide Pigment Plant Expansion	Other	100	100	100
11.	2009 Q3	Kwinana — Titanium Dioxide Pigment Plant Expansion	Other	100	100	100
12.	2006 Q3	Mt Weld — Rare Earths Operations	Other	80	66	75
13.	2007 Q1	Mt Weld — Rare Earths Operations	Other	80	75	96
14.	2007 Q3	Mt Weld — Rare Earths Operations	Other	90	75	250
15.	2008 Q1	Mt Weld — Rare Earths Operations	Other	90	75	70
16.	2008 Q3	Mt Weld — Rare Earths Operations	Other	90	75	70
17.	2006 Q3	Sunrise Dam — Gold Mine — Underground Development	Other	87	87	87
18.	2006 Q3	North Eastern Goldfields - Jaguar - Base Metals Mine	Other	56	56	69
19.	2007 Q1	North Eastern Goldfields - Jaguar - Base Metals Mine	Other	69	69	69
20.	2006 Q3	Kimberley – Koolan Island Western Australia- Iron Ore Mine	Iron Ore	125	125	125
21.	2006 Q3	Exmouth - Exmouth Solar Salt Project	Other	200	130	200
22.	2007 Q3	Exmouth - Exmouth Solar Salt Project	Other	200	130	150
23.	2008 Q1	Exmouth - Exmouth Solar Salt Project	Other	200	130	200
24.	2008 Q3	Exmouth - Exmouth Solar Salt Project	Other	200	130	200
25.	2009 Q1	Exmouth - Exmouth Solar Salt Project	Other	200	200	200
26.	2009 Q3	Exmouth - Exmouth Solar Salt Project	Other	200	200	200
27.	2006 Q3	Pilbara - Nickel Mine	Other	30	35	34
28.	2007 Q1	Pilbara - Nickel Mine	Other	30	35	34
29.	2007 Q3	Pilbara - Nickel Mine	Other	30	35	34
30.	2008 Q1	Pilbara - Nickel Mine	Other	30	35	34
31.	2008 Q3	Pilbara - Nickel Mine	Other	30	35	34
32.	2006 Q3	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	75	128	128
33.	2007 Q1	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	85	128	100
34.	2007 Q3	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	100	128	100
35.	2008 Q1	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	100	128	100
36.	2008 Q3	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	100	128	100
37.	2009 Q1	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	100	128	100
38.	2009 Q3	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	100	128	100
39.	2010 Q1	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	169	140	169
40.	2010 Q3	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	169	140	169
41.	2011 Q1	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	169	169	169
42.	2011 Q3	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	169	169	180
43.	2012 Q1	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	180	169	180
44.	2012 Q3	Shark Bay / Coburn - Heavy Mineral Sands Mine	Other	180	169	193
45.	2006 Q3	North Eastern Goldfields - Yakabindie - Nickel Mine	Other	20	40	20
46.	2006 Q3	Kwinana - Ammonium Nitrate Plant & Expansions	Other	200	260	260
47.	2007 Q1	Kwinana - Ammonium Nitrate Plant & Expansions	Other	200	260	260
48.	2007 Q3	Kwinana - Ammonium Nitrate Plant & Expansions	Other	260	260	310
49.	2008 Q1	Kwinana - Ammonium Nitrate Plant & Expansions	Other	260	260	400
50.	2006 Q3	Keysbrook - Heavy Mineral Sands Mine	Other	31	31	31
51.	2007 Q1	Keysbrook - Heavy Mineral Sands Mine	Other	31	18	31
52.	2007 Q3	Keysbrook - Heavy Mineral Sands Mine	Other	18	18	18
53.	2008 Q1	Keysbrook - Heavy Mineral Sands Mine	Other	18	18	20
54.	2008 Q3	Keysbrook - Heavy Mineral Sands Mine	Other	18	18	20
55.	2009 Q1	Keysbrook - Heavy Mineral Sands Mine	Other	18	18	20
56.	2006 Q3	Windimurra - Vanadium Pentoxide mine and processing plant	Other	149	175	175
57.	2007 Q1	Windimurra - Vanadium Pentoxide mine and processing plant	Other	149	200	175
58.	2007 Q3	Windimurra - Vanadium Pentoxide mine and processing plant	Other	149	200	296
59.	2008 Q1	Windimurra - Vanadium Pentoxide mine and processing plant	Other	296	209	250
60.	2008 Q3	Windimurra - Vanadium Pentoxide mine and processing plant	Other	296	250	250
61.	2007 Q1	Midwest Region - Karara Hematite Project	Iron Ore	75	88	75
62.	2007 Q3	Midwest Region - Karara Hematite Project	Iron Ore	75	108	94
63.	2008 Q1	Mid West Region - Mungada Hematite Mine	Iron Ore	75	117	200
64.	2008 Q3	Mid West Region - Mungada Hematite Mine	Iron Ore	75	117	200
65.	2009 Q1	Mid West Region - Mungada Hematite Mine	Iron Ore	108	117	108
66.	2006 Q3	Waroona - Heavy Mineral Sands Mine	Other	39	39	39
67.	2007 Q1	Waroona - Heavy Mineral Sands Mine	Other	39	39	39
68.	2006 Q3	Lennard Shelf (Pillara) - (Plant Expansion) Zinc/Lead Mine	Other	31	23	28
69.	2007 Q1	Gwindinup - Heavy Mineral Sands Mine	Other	88	88	18
70.	2007 Q3	Gwindinup - Heavy Mineral Sands Mine	Other	88	88	17
71.	2007 Q1	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	67	73
72.	2007 Q3	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	73	84

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Table A1.1 Matched triplets of projects, by project size (continued)

Row no. (1)	Year/ Quarter (2)	Project (3)	Industry (4)	Cost ($m) PR (5)	IM (6)	BR (7)
73.	2008 Q1	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	73	100
74.	2008 Q3	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	73	100
75.	2009 Q1	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	73	100
76.	2009 Q3	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	73	100
77.	2010 Q3	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	73	89
78.	2011 Q1	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	80	82
79.	2011 Q3	Mid West Region - Extension Hill Hematite Mine	Iron Ore	73	80	90
80.	2007 Q3	Pilbara - Pardoo Hematite DSO Mine	Iron Ore	8	21	21
81.	2008 Q1	Pilbara - Pardoo Hematite DSO Mine	Iron Ore	8	21	24
82.	2007 Q3	Pilbara - Panorama Copper/Zinc mine	Other	250	213	213
83.	2008 Q1	Pilbara - Panorama Copper/Zinc mine	Other	250	213	213
84.	2008 Q3	Pilbara - Panorama Copper/Zinc mine	Other	250	213	242
85.	2009 Q3	Ravensthorpe – Mt Cattlin Tantalum and Lithium Mine	Other	75	75	68
86.	2010 Q1	Great Southern Region - Mount Cattlin Lithium Project, Ravensthorpe	Other	75	75	79
87.	2010 Q3	Ravensthrpe - Ravensthrope Nickel Operation	Other	150	150	150
88.	2011 Q1	Ravensthrpe - Ravensthrope Nickel Operation	Other	190	150	150
89.	2011 Q3	Ravensthrpe - Ravensthrope Nickel Operation	Other	190	150	194
90.	2012 Q3	Mt Windarra - Windarra Nickel	Other	250	213	250
		B. Large				
91.	2006 Q3	Wagerup/Willowdale — Alumina Refinery/Bauxite Mine Expansion Train 3	Other	1,500	1,700	1,500
92.	2007 Q1	Wagerup/Willowdale — Alumina Refinery/Bauxite Mine Expansion Train 3	Other	1,500	1,700	1,500
93.	2007 Q3	Wagerup/Willowdale — Alumina Refinery/Bauxite Mine Expansion Train 3	Other	1,500	1,700	1,500
94.	2008 Q1	Wagerup/Willowdale — Alumina Refinery/Bauxite Mine Expansion Train 3	Other	1,500	1,700	1,500
95.	2006 Q3	Hope Downs — Iron Ore Mine	Iron Ore	1,500	1,330	1,310
96.	2007 Q1	Hope Downs — Iron Ore Mine	Iron Ore	1,500	1,330	1,270
97.	2007 Q3	Hope Downs — Iron Ore Mine	Iron Ore	1,500	1,330	1,170
98.	2010 Q3	Carnarvon Offshore Basin - Macedon - Gas Field	LNG	1,000	1,570	1,700
99.	2011 Q1	Carnarvon Offshore Basin - Macedon - Gas Field	LNG	1,000	1,570	1,550
100.	2011 Q3	Carnarvon Offshore Basin - Macedon - Gas Field	LNG	1,000	1,570	1,450
101.	2012 Q1	Carnarvon Offshore Basin - Macedon - Gas Field	LNG	1,000	1,570	1,470
102.	2012 Q3	Carnarvon Offshore Basin - Macedon - Gas Field	LNG	1,500	1,570	1,470
103.	2006 Q3	Burrup Peninsula — Ammonia Urea Plant	Other	900	1,000	900
104.	2007 Q1	Burrup Peninsula — Ammonia Urea Plant	Other	900	1,000	900
105.	2007 Q3	Burrup Peninsula — Ammonia Urea Plant	Other	900	1,000	900
106.	2008 Q1	Burrup Peninsula — Ammonia Urea Plant	Other	900	1,000	900
107.	2008 Q3	Burrup Peninsula — Ammonia Urea Plant	Other	900	1,000	900
108.	2009 Q1	Burrup Peninsula — Ammonia Urea Plant	Other	900	900	900
109.	2006 Q3	Worsley/Boddington - Alumina Re?nery Expansion to 4.4Mt/a	Other	900	1,100	900
110.	2007 Q1	Worsley/Boddington - Alumina Re?nery Expansion to 4.4Mt/a	Other	900	1,100	900
111.	2007 Q3	Worsley/Boddington - Alumina Re?nery Expansion to 4.4Mt/a	Other	900	1,100	900
112.	2008 Q1	Worsley/Boddington - Alumina Re?nery Expansion to 4.4Mt/a	Other	2,000	1,500	2,540
113.	2008 Q3	Worsley/Boddington - Alumina Re?nery Expansion to 4.4Mt/a	Other	2,500	1,500	2,600
114.	2009 Q1	Boddington - Alumina Refinery Expansion	Other	2,500	2,500	3,160
115.	2009 Q3	Boddington - Alumina Refinery Expansion	Other	2,500	2,500	2,700
116.	2010 Q1	Boddington - Alumina Refinery Expansion	Other	2,500	2,500	2,500
117.	2010 Q3	Boddington - Alumina Refinery Expansion	Other	2,500	2,500	2,400
118.	2011 Q1	Boddington - Alumina Refinery Expansion	Other	2,500	2,500	2,300
119.	2006 Q3	Yandicoogina - Iron Ore Mine EXPANSION	Iron Ore	700	700	710
120.	2006 Q3	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	500	800
121.	2007 Q1	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	800	800
122.	2007 Q3	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	800	579
123.	2008 Q1	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	800	579
124.	2008 Q3	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	800	579
125.	2009 Q1	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	800	800
126.	2009 Q3	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	800	800
127.	2010 Q1	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	800	1,000	800
128.	2010 Q3	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	1,000	1,000	800
129.	2011 Q1	Midwest Region - Weld Range - Iron Ore Mine - Midwest Region	Iron Ore	1,000	1,000	2,000
130.	2006 Q3	Goongarrie - Kalgoorlie Nickel Proj. - Mine (laterite ore) & Hydrometallurgi	Other	1,400	1,400	1,400
131.	2007 Q1	Goongarrie - Kalgoorlie Nickel Proj. - Mine (laterite ore) & Hydrometallurgi	Other	1,400	1,400	1,400
132.	2007 Q3	Goongarrie - Kalgoorlie Nickel Proj. - Mine (laterite ore) & Hydrometallurgi	Other	1,400	1,400	1,400
133.	2008 Q1	Goongarrie - Kalgoorlie Nickel Proj. - Mine (laterite ore) & Hydrometallurgi	Other	1,400	1,400	1,400
134.	2008 Q3	Goongarrie - Kalgoorlie Nickel Proj. - Mine (laterite ore) & Hydrometallurgi	Other	1,400	1,400	1,400
135.	2009 Q1	Goongarrie - Kalgoorlie Nickel Proj. - Mine (laterite ore) & Hydrometallurgi	Other	1,400	1,400	2,140
136.	2007 Q1	Cape Lambert - Capacity Expansion and Stockyard Rationalisation	Iron Ore	1,100	1,100	1,120
137.	2007 Q3	Cape Lambert - Capacity Expansion and Stockyard Rationalisation	Iron Ore	1,100	1,120	1,040
138.	2008 Q1	Pilbara - Cape Lambert Port Expansion	Iron Ore	1,100	1,120	1,090
139.	2008 Q3	Cape Lambert - Cape Lambert Port Expansion	Iron Ore	1,100	986	1,120
140.	2006 Q3	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	750	820
141.	2007 Q1	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	820	820
142.	2007 Q3	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	820	820
143.	2008 Q1	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	820	820
144.	2008 Q3	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	820	820

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Table A1.1 Matched triplets of projects, by project size (continued)

Row no. (1)	Year/ Quarter (2)	Project (3)	Industry (4)	Cost ($m)		
				PR (5)	IM (6)	BR (7)
145.	2009 Q1	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	820	820
146.	2009 Q3	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	820	2,000
147.	2010 Q1	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	715	820	2,000
148.	2011 Q1	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	2,000	2,000	2,500
149.	2011 Q3	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	2,000	2,000	2,900
150.	2012 Q1	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	2,000	2,000	2,900
151.	2012 Q3	Mid West Region - Extension Hill Magnetite Mine	Iron Ore	2,000	2,000	2,900
152.	2006 Q3	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	560	1,700	803
153.	2007 Q1	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	560	893	803
154.	2007 Q3	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	893	893	744
155.	2008 Q1	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	893	893	964
156.	2008 Q3	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	839	1,119	987
157.	2009 Q1	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	839	1,119	1,200
158.	2009 Q3	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	839	1,119	1,900
159.	2010 Q1	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	1,600	1,700	1,800
160.	2011 Q3	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	2,570	2,570	2,600
161.	2012 Q1	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	2,750	2,570	2,900
162.	2012 Q3	Great Southern Region - Southdown Magnetite - Iron Ore Project	Iron Ore	1,600	2,880	2,880
163.	2006 Q3	Argyle – Underground Diamond Mine	Other	1,200	1,200	1,220
164.	2007 Q1	Argyle – Underground Diamond Mine	Other	1,200	1,220	1,220
165.	2007 Q3	Argyle – Underground Diamond Mine	Other	1,200	1,220	1,800
166.	2008 Q1	Argyle – Underground Diamond Mine	Other	1,200	1,700	1,700
167.	2008 Q3	Kimberley - Argyle - Argyle Diamond Mine	Other	1,200	1,700	1,760
168.	2009 Q1	Kimberley - Argyle - Argyle Diamond Mine	Other	1,200	1,700	2,140
169.	2009 Q3	Kimberley - Argyle - Argyle Diamond Mine	Other	1,200	1,700	1,800
170.	2010 Q1	East Kimberley - Argyle Diamond Mine (and Underground Expansion)	Other	1,200	1,700	1,700
171.	2007 Q1	Mid West Region - Karara Magnetite Mine	Iron Ore	1,000	1,100	1,000
172.	2007 Q3	Mid West Region - Karara Magnetite Mine	Iron Ore	1,000	1,700	1,600
173.	2008 Q1	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,000	1,700	1,600
174.	2008 Q3	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,000	1,700	1,600
175.	2009 Q1	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,700	1,700	1,700
176.	2009 Q3	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,800	1,800	1,700
177.	2010 Q1	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,800	1,800	1,900
178.	2010 Q3	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,975	1,970	2,000
179.	2011 Q1	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,975	2,700	2,600
180.	2011 Q3	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,975	2,700	2,600
181.	2012 Q1	Mid West Region - Mt Karara Magnetite Mine	Iron Ore	1,975	2,570	2,600
182.	2006 Q3	Pilbara - Spinifex Ridge Mo/Cu mine	Other	622	622	622
183.	2007 Q1	Pilbara - Spinifex Ridge Mo/Cu mine	Other	622	622	622
184.	2007 Q3	Pilbara - Spinifex Ridge Mo/Cu mine	Other	622	622	1,080
185.	2008 Q1	Pilbara - Spinifex Ridge Mo/Cu mine	Other	1,084	1,100	1,080
186.	2008 Q3	Pilbara - Spinifex Ridge Mo/Cu mine	Other	1,084	1,100	1,260
187.	2009 Q1	Pilbara - Spinifex Ridge Mo/Cu mine	Other	1,084	1,084	1,260
188.	2009 Q3	Pilbara - Spinifex Ridge Mo/Cu mine	Other	1,084	1,084	604
189.	2010 Q1	Pilbara - Spinifex Ridge Mo/Cu mine	Other	1,084	542	604
190.	2006 Q3	Angel (Carnarvon Offshore Basin) - Gas Field	LNG	1,600	1,500	1,600
191.	2007 Q1	Angel (Carnarvon Offshore Basin) - Gas Field	LNG	1,600	1,600	1,600
192.	2007 Q3	Angel (Carnarvon Offshore Basin) - Gas Field	LNG	1,600	1,600	1,430
193.	2008 Q1	Angel (Carnarvon Offshore Basin) - Gas Field	LNG	1,600	1,600	1,380
194.	2006 Q3	Stybarrow (Carnarvon Offshore Basin) - Oil Field	LNG	815	810	803
195.	2007 Q1	Stybarrow (Carnarvon Offshore Basin) - Oil Field	LNG	815	810	803
196.	2007 Q3	Stybarrow (Carnarvon Offshore Basin) - Oil Field	LNG	860	860	905
197.	2008 Q3	Tom Price - Brockman 4 Iron Ore Mine	Iron Ore	1,521	1,500	1,760
198.	2009 Q1	Pilbara - Brockman Syncline 4 Iron Ore Mine	Iron Ore	1,521	1,520	2,100
199.	2009 Q3	Pilbara - Brockman Syncline 4 Iron Ore Mine	Iron Ore	2,000	1,520	1,800
200.	2010 Q1	Pilbara - Brockman Syncline 4 Iron Ore Mine	Iron Ore	2,000	1,638	1,700
201.	2006 Q3	vincent (Carnarvon Offshore Basin) - Oil Field	LNG	1,000	1,000	1,000
202.	2007 Q1	vincent (Carnarvon Offshore Basin) - Oil Field	LNG	1,000	1,000	1,000
203.	2007 Q3	vincent (Carnarvon Offshore Basin) - Oil Field	LNG	1,000	1,000	1,000
204.	2008 Q1	vincent (Carnarvon Offshore Basin) - Oil Field	LNG	1,000	1,000	1,000
205.	2007 Q1	Jack Hills	Iron Ore	1,700	1,760	1,760
206.	2007 Q3	Jack Hills	Iron Ore	750	1,760	3,000
207.	2008 Q1	Jack Hills	Iron Ore	750	3,000	1,500
208.	2008 Q3	Jack Hills	Iron Ore	750	3,000	1,500
209.	2009 Q1	Jack Hills	Iron Ore	750	3,000	1,500
210.	2009 Q3	Jack Hills	Iron Ore	750	3,000	1,500
211.	2010 Q1	Jack Hills	Iron Ore	750	2,000	1,500
212.	2010 Q3	Jack Hills	Iron Ore	2,000	2,000	1,500
213.	2011 Q1	Jack Hills	Iron Ore	2,000	4,300	1,500
214.	2011 Q3	Jack Hills	Iron Ore	2,000	4,300	2,000
215.	2012 Q1	Jack Hills	Iron Ore	2,000	4,300	2,000
216.	2007 Q1	Pilbara - Dampier Port Expansion	Iron Ore	920	940	1,040
217.	2008 Q1	van Gogh (Carnarvon Offshore Basin) - Oil Field	LNG	600	600	700

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Table A1.1 Matched triplets of projects, by project size (continued)

Row no. (1)	Year/ Quarter (2)	Project (3)	Industry (4)	Cost ($m)		
				PR (5)	IM (6)	BR (7)
218.	2008 Q3	Carnarvon Offshore Basin - van Gogh – Oil Field	LNG	600	600	700
219.	2009 Q1	Carnarvon Offshore Basin - van Gogh – Oil Field	LNG	600	600	780
220.	2009 Q3	Carnarvon Offshore Basin - van Gogh – Oil Field	LNG	600	600	658
221.	2008 Q1	Pilbara - Devil Creek Development Project	LNG	600	750	842
222.	2008 Q3	Pilbara - Devil Creek Development Project	LNG	600	800	875
223.	2009 Q1	Pilbara - Devil Creek Development Project	LNG	800	800	1,060
224.	2009 Q3	Pilbara - Devil Creek Development Project	LNG	800	850	896
225.	2010 Q1	Pilbara - Devil Creek Development Project	LNG	800	850	845
226.	2010 Q3	Pilbara - Devil Creek Development Project	LNG	800	850	1,080
227.	2011 Q1	Pilbara - Devil Creek Development Project	LNG	800	850	1,080
228.	2011 Q3	Pilbara - Devil Creek Development Project	LNG	800	850	1,050
229.	2009 Q1	Goldfields - Tropicana Gold project	Other	500	1,000	500
230.	2009 Q3	Goldfields - Tropicana Gold project	Other	500	1,000	500
231.	2010 Q1	Kalgoorlie (330kms North East) - Tropicana Gold Project	Other	700	1,000	520
232.	2010 Q3	Kalgoorlie (330kms North East) - Tropicana Gold Project	Other	700	1,000	600
233.	2011 Q1	Kalgoorlie (330kms North East) - Tropicana Gold Project	Other	700	700	725
234.	2011 Q3	Kalgoorlie (330kms North East) - Tropicana Gold Project	Other	700	700	665
235.	2012 Q1	Kalgoorlie (330kms North East) - Tropicana Gold Project	Other	700	700	715
236.	2012 Q3	Kalgoorlie (330kms North East) - Tropicana Gold Project	Other	700	700	775
237.	2009 Q1	Burrup Peninsula - Burrup Ammonium Nitrate Plant	Other	600	900	500
238.	2009 Q3	Burrup Peninsula - Burrup Ammonium Nitrate Plant	Other	600	900	500
239.	2010 Q1	Burrup Industrial Estate Site D - Burrup Nitrates ammonium nitrate plant	Other	600	900	600
240.	2010 Q3	Burrup Industrial Estate Site D - Burrup Nitrates ammonium nitrate plant	Other	600	900	600
241.	2011 Q1	Burrup Industrial Estate Site D - Burrup Nitrates ammonium nitrate plant	Other	600	600	600
242.	2011 Q3	Burrup Industrial Estate Site D - Burrup Nitrates ammonium nitrate plant	Other	600	600	600
243.	2012 Q1	Burrup Industrial Estate Site D - Burrup Nitrates ammonium nitrate plant	Other	600	600	600
244.	2012 Q3	Burrup Industrial Estate Site D - Burrup Nitrates ammonium nitrate plant	Other	600	600	775
245.	2012 Q1	Pilbara - Hope Downs 4 Iron Ore Mine	Iron Ore	1,600	1,330	2,100
246.	2012 Q3	Pilbara - Hope Downs 4 Iron Ore Mine	Iron Ore	1,600	1,330	2,040
		C. Mega				
247.	2006 Q3	Boddington — Gold Mine (Wandoo Expansion)	Other	2,000	2,000	2,000
248.	2007 Q1	Boddington — Gold Mine (Wandoo Expansion)	Other	2,000	2,000	2,000
249.	2007 Q3	Boddington — Gold Mine (Wandoo Expansion)	Other	2,000	2,000	2,000
250.	2008 Q1	Boddington — Gold Mine (Wandoo Expansion)	Other	2,000	2,000	2,400
251.	2008 Q3	Boddington — Gold Mine (Wandoo Expansion)	Other	2,000	2,000	2,900
252.	2009 Q1	Boddington — Gold Mine (Wandoo Expansion)	Other	2,000	4,500	3,700
253.	2006 Q3	Fortescue (Cape Preston) — Mine and HBI Plant	Iron Ore	2,000	1,800	2,000
254.	2007 Q1	Fortescue (Cape Preston) — Mine and HBI Plant	Iron Ore	2,000	2,000	2,630
255.	2006 Q3	Ravensthorpe - Lateritic Nickel Mine and Hydro-metallurgical Process. Plant	Other	1,800	2,680	2,250
256.	2007 Q1	Ravensthorpe - Lateritic Nickel Mine and Hydro-metallurgical Process. Plant	Other	1,800	2,800	2,900
257.	2007 Q3	Ravensthorpe - Lateritic Nickel Mine and Hydro-metallurgical Process. Plant	Other	2,200	2,900	2,600
258.	2006 Q3	Gorgon (Carnarvon Offshore Basin) —Gas and Condensate Field	LNG	11,000	14,600	15,000
259.	2007 Q1	Barrow Island (Carnarvon Offshore Basin) - Gorgon LNG	LNG	11,000	15,000	15,000
260.	2009 Q3	Carnarvon Offshore Basin - Barrow Island -Gorgon LNG	LNG	43,000	43,000	43,000
261.	2010 Q1	Carnarvon Offshore Basin - Barrow Island -Gorgon LNG	LNG	43,000	50,000	43,000
262.	2010 Q3	Carnarvon Offshore Basin - Barrow Island -Gorgon LNG	LNG	43,000	43,000	43,000
263.	2011 Q1	Carnarvon Offshore Basin - Barrow Island -Gorgon LNG	LNG	43,000	43,000	43,000
264.	2011 Q3	Carnarvon Offshore Basin - Barrow Island -Gorgon LNG	LNG	43,000	43,000	43,000
265.	2012 Q1	Carnarvon Offshore Basin - Barrow Island -Gorgon LNG	LNG	43,000	43,000	43,000
266.	2012 Q3	Carnarvon Offshore Basin - Barrow Island -Gorgon LNG	LNG	43,000	43,000	43,000
267.	2006 Q3	North West Shelf — Project Expansion:5th LNG Train	LNG	2,000	2,425	2,425
268.	2007 Q1	North West Shelf — Project Expansion:5th LNG Train	LNG	2,425	2,425	2,425
269.	2007 Q3	North West Shelf — Project Expansion:5th LNG Train	LNG	2,425	2,425	2,600
270.	2008 Q1	North West Shelf — Project Expansion:5th LNG Train	LNG	2,425	2,425	2,600
271.	2006 Q3	Pilbara - Iron Ore Mine, Rail and Port Development	Iron Ore	2,500	1,950	1,920
272.	2007 Q1	Pilbara - Iron Ore Mine, Rail and Port Development	Iron Ore	3,200	1,950	2,780
273.	2007 Q3	Pilbara - Iron Ore Mine, Rail and Port Development	Iron Ore	3,200	2,056	2,880
274.	2008 Q1	Pilbara - Iron Ore Mine, Rail and Port Development	Iron Ore	3,200	2,056	3,100
275.	2006 Q3	Pilbara - Rapid Growth Project 3	Iron Ore	2,000	1,700	2,050
276.	2007 Q1	Pilbara - Rapid Growth Project 3	Iron Ore	2,000	2,050	2,010
277.	2007 Q3	Pilbara - Rapid Growth Project 3	Iron Ore	2,000	2,050	1,820
278.	2006 Q3	Onslow - LNG Plant	LNG	5,000	5,000	5,000
279.	2007 Q1	Onslow - LNG Plant	LNG	5,000	5,000	5,000
280.	2006 Q3	Carnarvon Basin - Pluto LNG	LNG	5,000	5,000	5,000
281.	2007 Q1	Carnarvon Basin - Pluto LNG	LNG	5,000	6,000	5,000
282.	2007 Q3	Carnarvon Basin - Pluto LNG	LNG	6,000	11,200	12,000
283.	2008 Q1	Carnarvon Basin - Pluto LNG	LNG	11,200	11,200	12,000
284.	2008 Q3	Carnarvon Basin - Pluto LNG	LNG	11,200	11,200	12,000
285.	2009 Q1	Carnarvon Basin - Pluto LNG	LNG	11,200	11,200	12,000
286.	2009 Q3	Carnarvon Basin - Pluto LNG	LNG	11,200	11,200	12,000
287.	2010 Q1	Carnarvon Basin - Pluto LNG	LNG	12,000	12,320	12,100
288.	2010 Q3	Carnarvon Basin - Pluto LNG	LNG	12,000	12,320	12,100
289.	2006 Q3	Pilbara - Rapid Growth Project 4	Iron Ore	1,800	1,800	2,200

(continued on next page)

Table A1.1 Matched triplets of projects, by project size (continued)

Row no. (1)	Year/ Quarter (2)	Project (3)	Industry (4)	Cost ($m)		
				PR (5)	IM (6)	BR (7)
290.	2007 Q1	Pilbara - Rapid Growth Project 4	Iron Ore	1,800	2,200	2,820
291.	2007 Q3	Pilbara - Rapid Growth Project 4	Iron Ore	2,600	2,200	2,550
292.	2008 Q1	Pilbara - Rapid Growth Project 4	Iron Ore	2,600	2,200	2,470
293.	2008 Q3	Pilbara - Rapid Growth Project 4	Iron Ore	2,600	2,000	2,520
294.	2009 Q1	Pilbara - Rapid Growth Project 4	Iron Ore	2,840	2,840	3,060
295.	2009 Q3	Pilbara - Rapid Growth Project 4	Iron Ore	2,597	2,597	2,600
296.	2007 Q3	Pyrenees Development (Carnarvon Offshore Basin)- Oil Fields	LNG	2,000	2,000	2,020
297.	2008 Q1	Pyrenees Development (Carnarvon Offshore Basin)- Oil Fields	LNG	2,000	2,000	1,930
298.	2008 Q3	Carnarvon Offshore Basin - Pyrenees – Oil Fields	LNG	2,000	2,000	2,180
299.	2009 Q1	Carnarvon Offshore Basin - Pyrenees – Oil Fields	LNG	2,000	2,000	2,400
300.	2009 Q3	Carnarvon Offshore Basin - Pyrenees – Oil Fields	LNG	2,000	2,000	2,000
301.	2006 Q3	Browse Basin - Ichthys (Browse Offshore Basin)	LNG	8,000	8,000	8,000
302.	2007 Q1	Browse Basin - Ichthys (Browse Offshore Basin)	LNG	8,000	8,000	8,000
303.	2007 Q3	Browse Basin - Ichthys (Browse Offshore Basin)	LNG	8,000	8,000	8,000
304.	2008 Q3	Pilbara - West Pilbara Iron Ore Project	Iron Ore	3,000	4,100	4,150
305.	2009 Q1	Pilbara - West Pilbara Iron Ore Project	Iron Ore	3,900	4,100	5,000
306.	2009 Q3	Pilbara - West Pilbara Iron Ore Project	Iron Ore	3,900	4,100	4,200
307.	2010 Q1	Pilbara - West Pilbara Iron Ore Project	Iron Ore	4,000	4,810	4,200
308.	2010 Q3	Pilbara - West Pilbara Iron Ore Project	Iron Ore	4,000	4,810	5,800
309.	2011 Q1	Pilbara - West Pilbara Iron Ore Project	Iron Ore	4,000	4,810	5,800
310.	2011 Q3	Pilbara - West Pilbara Iron Ore Project	Iron Ore	4,000	4,810	5,800
311.	2012 Q1	Pilbara - West Pilbara Iron Ore Project	Iron Ore	4,000	5,800	5,800
312.	2012 Q3	Pilbara - West Pilbara Iron Ore Project	Iron Ore	6,000	7,400	7,400
313.	2009 Q3	pilbara - Sino Iron pellet project	Iron Ore	5,200	5,200	4,200
314.	2010 Q1	pilbara - Sino Iron pellet project	Iron Ore	5,200	5,200	5,900
315.	2010 Q3	pilbara - Sino Iron pellet project	Iron Ore	5,200	5,200	5,800
316.	2008 Q3	Pilbara - Rapid Growth Project 5	Iron Ore	9,000	3,440	8,300
317.	2009 Q1	Pilbara - Rapid Growth Project 5	Iron Ore	7,365	7,365	8,100
318.	2009 Q3	Pilbara - Rapid Growth Project 5	Iron Ore	6,740	6,740	6,800
319.	2010 Q1	Pilbara - Rapid Growth Project 5	Iron Ore	5,300	6,740	6,400
320.	2010 Q3	Pilbara - Rapid Growth Project 5	Iron Ore	4,800	6,740	6,300
321.	2011 Q1	Pilbara - Rapid Growth Project 5	Iron Ore	4,800	6,740	5,800
322.	2009 Q1	Cape Preston - Magnetite Iron Ore Mine	Iron Ore	2,700	2,600	2,700
323.	2009 Q3	Cape Preston Balmoral South -Australasian Resources	Iron Ore	2,700	2,600	2,700
324.	2010 Q1	Pilbara - Cape Preston - Balmoral South Iron Ore Project	Iron Ore	2,700	2,600	2,700
325.	2010 Q1	Pilbara - Wheatstone LNG Development	LNG	3,000	10,000	20,200
326.	2010 Q3	Pilbara - Wheatstone LNG Development	LNG	23,000	10,000	19,800
327.	2011 Q1	Pilbara - Wheatstone LNG Development	LNG	23,000	10,000	18,400
328.	2011 Q3	Pilbara - Wheatstone LNG Development	LNG	23,000	29,000	29,000
329.	2012 Q3	Pilbara - Wheatstone LNG Development	LNG	29,000	29,000	29,000
330.	2011 Q3	Pilbara - Cape Lambert Iron Ore Project	Iron Ore	3,700	3,700	3,700
331.	2012 Q1	Pilbara - Cape Lambert Iron Ore Project	Iron Ore	3,700	3,700	3,700
332.	2012 Q3	Pilbara - Cape Lambert Iron Ore Project	Iron Ore	3,700	3,700	3,700
333.	2009 Q3	Carnarvon Offshore Basin - North Rankin Redevelopment	LNG	5,000	5,000	6,100
334.	2010 Q1	Carnarvon Offshore Basin - North Rankin Redevelopment	LNG	5,000	5,000	5,800
335.	2010 Q3	Carnarvon Offshore Basin - North Rankin Redevelopment	LNG	5,000	5,000	5,700
336.	2011 Q1	Carnarvon Offshore Basin - North Rankin Redevelopment	LNG	5,000	5,000	5,200
337.	2011 Q3	Carnarvon Offshore Basin - North Rankin Redevelopment	LNG	5,000	5,000	5,000
338.	2012 Q1	Carnarvon Offshore Basin - North Rankin Redevelopment	LNG	5,000	5,000	5,100
339.	2012 Q3	Carnarvon Offshore Basin - North Rankin Redevelopment	LNG	5,000	5,000	5,000
340.	2009 Q3	Oakajee - Oakajee Industrial Estate & Port Project	Iron Ore	4,000	4,000	3,500
341.	2010 Q1	Oakajee - Oakajee Industrial Estate & Port Project	Iron Ore	4,000	4,370	4,300
342.	2010 Q3	Oakajee - Oakajee Industrial Estate & Port Project	Iron Ore	4,000	4,370	4,300
343.	2011 Q1	Oakajee - Oakajee Industrial Estate & Port Project	Iron Ore	4,000	5,239	5,200
344.	2012 Q1	Oakajee - Oakajee Industrial Estate & Port Project	Iron Ore	4,000	5,940	5,900
345.	2012 Q3	Oakajee - Oakajee Industrial Estate & Port Project	Iron Ore	4,000	10,000	5,000
346.	2010 Q1	Wanaea/Cossack (Carnarvon Offshore Basin) -Oil and Gas Fields	LNG	1,800	1,800	1,700
347.	2010 Q3	Wanaea/Cossack (Carnarvon Offshore Basin) -Oil and Gas Fields	LNG	1,800	1,800	1,600
348.	2011 Q1	Wanaea/Cossack (Carnarvon Offshore Basin) -Oil and Gas Fields	LNG	1,800	1,800	1,500
349.	2011 Q3	Pilbara - Cape Lambert Port B Expansion	Iron Ore	3,700	890	3,100
350.	2010 Q3	Port Wallcott - Cape Lambert Expansion	Iron Ore	3,000	890	3,400
351.	2011 Q1	Solomon - Pilbara - Solomon Hub Stage 1	Iron Ore	4,000	4,000	2,370
352.	2011 Q3	Solomon - Pilbara - Solomon Hub Stage 1	Iron Ore	4,000	4,000	2,600
353.	2012 Q1	Solomon - Pilbara - Solomon Hub Stage 1	Iron Ore	4,000	4,000	2,700
354.	2012 Q3	Solomon - Pilbara - Solomon Hub Stage 1	Iron Ore	9,000	4,000	3,100

Notes:

1. PR, IM and BR are abbreviations for the Prospect, Investment Monitor and ABARE/BREE databases, respectively.
2. Q1 and Q3 in column 2 refer to the March and September quarters where the matched data recorded.

Table A2.1 Impulse response functions

Sources s to r	Period	Intercepts included		Intercepts supressed	
		Response of s to unfactorised 1 SD shock in r	Response of s to factorised 1 SD shock in r	Response of s to unfactorised 1 SD shock in r	Response of s to factorised 1 SD shock in r
(1)	(2)	(3)	(4)	(5)	(6)
PR to PR	1	0.198 (0.008)	0.198 (0.008)	0.204 (0.009)	0.204 (0.009)
	2	-0.009 (0.011)	-0.001 (0.011)	-0.002 (0.012)	0.011 (0.012)
PR to IM	1	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
	2	0.003 (0.013)	0.008 (0.013)	0.012 (0.013)	0.019 (0.013)
PR to BR	1	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
	2	0.027 (0.014)	0.026 (0.013)	0.034 (0.014)	0.032 (0.013)
IM to PR	1	0.000 (0.000)	0.026 (0.010)	0.000 (0.000)	0.033 (0.011)
	2	0.018 (0.010)	0.022 (0.010)	0.023 (0.010)	0.031 (0.010)
IM to IM	1	0.174 (0.007)	0.172 (0.007)	0.178 (0.007)	0.174 (0.007)
	2	-0.013 (0.011)	-0.008 (0.011)	-0.006 (0.012)	0.000 (0.011)
IM to BR	1	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
	2	0.024 (0.012)	0.022 (0.011)	0.029 (0.012)	0.027 (0.012)
BR to PR	1	0.000 (0.000)	0.064 (0.014)	0.000 (0.000)	0.072 (0.014)
	2	0.011 (0.013)	0.004 (0.014)	0.017 (0.014)	0.014 (0.014)
BR to IM	1	0.000 (0.000)	0.041 (0.013)	0.000 (0.000)	0.044 (0.013)
	2	0.037 (0.015)	0.028 (0.015)	0.045 (0.016)	0.037 (0.015)
BR to BR	1	0.235 (0.010)	0.222 (0.009)	0.237 (0.010)	0.222 (0.009)
	2	-0.045 (0.016)	-0.042 (0.016)	-0.039 (0.017)	-0.037 (0.016)

Notes:
The factorisation columns correspond to the Cholesky factorisation of the covariance matrix with ordering Prospect > Investment Monitor > BREE. PR, IM and BR are abbreviations for Prospect, Investment Monitor and BREE, respectively. Standard errors are in parentheses.

Table A3.1 Are capex revisions independent?

Other sources	Prospect			Investment Monitor			BREE		
	Update	No Update	Total	Update	No Update	Total	Update	No Update	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A. Observed (number)									
Update	41	138	179	50	114	164	66	40	106
No Update	11	92	103	26	92	118	84	92	176
Total	52	230	282	76	206	282	150	132	282
B. Observed (%)									
Update	14.54	48.94	63.48	17.73	40.43	58.16	23.40	14.18	37.59
No Update	3.90	32.62	36.52	9.22	32.62	41.84	29.79	32.62	62.41
Total	18.44	81.56	100.00	26.95	73.05	100.00	53.19	46.81	100.00
C. Expected (%)									
Update	11.70	51.77	63.48	15.67	42.48	58.16	19.99	17.59	37.59
No Update	6.74	29.79	36.52	11.28	30.57	41.84	33.20	29.21	62.41
Total	18.44	81.56	100.00	26.95	73.05	100.00	53.19	46.81	100.00
D. Squared deviations									
Update	1.94	0.44	2.38	0.82	0.30	1.12	1.79	2.00	3.79
No Update	3.37	0.76	4.13	1.13	0.42	1.54	1.06	1.22	2.28
Total	5.31	1.20	6.51	1.94	0.72	2.66	2.85	3.22	6.07

Notes:

The χ^2 -test statistics in panel D are 6.51, 2.66 and 6.07 for Prospect, Investment Monitor and BREE, respectively. These are formed from the rounded expectations recorded in panel B. The χ^2 -statistics implied by the unrounded expectations are 6.50, 2.49, and 5.61 (same order).