Australian School of Business Research Paper No. 2012 ECON 35

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May 1, 2012

Abstract

We study the implications of vertical integration on innovation performance using firm-level data on Australian manufacturing. We use the data to distinguish between low-cost-oriented and innovation-oriented outsourcing. Outsourcing without innovation lowers costs at the expense of damaging the future chances of innovation, while innovation-oriented outsourcing leads to higher costs but increases the likelihood of future innovation. For firms that innovate and outsource, the probability of future innovation is 54 per cent compared to 15 per cent for those who outsource without innovating. Comparing across firms that innovate, simultaneously outsourcing increases the probability of future innovation by 4 per cent. Innovation-oriented outsourcing is accompanied by firms shifting focus to research and marketing of new products. Our results offer strong support that outsourcing may be used not just as a cost-cutting strategy, but as part of comprehensive firm strategy to innovate and improve.

Keywords: Outsourcing, Innovation, Firm Performance, Business Strategy.

JEL Codes: D22, L21, L24, L6.

1 Introduction

Outsourcing in mainstream economics is often modeled as a cost-reducing venture that helps firms reduce fixed costs by reducing the number of managers (Grossman & Helpman, 2002)

or replace employees with cheaper contractors (Dube & Kaplan, 2010). Understandably, the least efficient firms are the ones most benefiting from this type of outsourcing. However, the range of firms observed in practice that opt for outsourcing is broader than can be explained by cost-oriented outsourcing. In this paper, we consider the relationship between outsourcing and innovation. It turns out that whether or not firms innovate at the same time as they outsource is crucial for understanding future firm performance in innovation, employment creation and wages.

By simultaneously examining innovation and outsourcing, we are able to identify in the data a clear distinction between low-cost-oriented outsourcing and innovation-oriented outsourcing. This distinction is also made by Bengtsson et al. (2009). They use a small, cross-sectional sample of Swedish engineering firms who outsource manufacturing and ask these firms about their reasons for outsourcing. In our case, we consider a much larger and broader panel sample of firms, and a much wider range of variables, from all manufacturing sectors. Although we do not have any information on why firms outsource, we see a clear effect on firm performance which emerges in the data and which is consistent with there being two types of outsourcing. For firms that outsource, those that simultaneously innovate are 40 per cent more likely to innovate in the next period relative to firms that outsource but without innovating.

For our study, we rely on firm-level data from Australian manufacturing. Our data is unique in that it is a panel of firm-level observations which include information about outsourcing and innovation activity across all sections of manufacturing. Furthermore, it provides us with details of expenditures on innovative activities enabling us to investigate the details of the innovation process for firms that innovate. Importantly, we can separate out low-cost-outsourcing from innovation-oriented outsourcing because during the time frame of our data, most outsourced jobs were service jobs, such as maintenance and janitorial jobs, that could only be outsourced to domestic suppliers. Benson & Ieronimo (1996), using different data which covers the same time period as our study, show that offshore outsourcing of jobs was very infrequent during this period.

Our findings show two very different types of outsourcing. Outsourcing in the absence of product innovation leads to lower wages, higher profits, but also a lower probability of future

product innovation. We brand these firms as seeking low-cost oriented outsourcing. Yet, we find that when a firm introduces a new product (product innovation) and outsources at around the same time, the likelihood of further product innovations in the years that follow is about 4.4% higher than firms which introduced a new product but did not outsource. These firms also experience about a 6% rise in their total wage bill relative to firms that introduce product innovation with no simultaneous outsourcing. We interpret this wage rise as firms replacing their lower skilled workers, whose jobs are being sent out, with higher skilled professionals and researchers in a bid to increase research activity and innovate more frequently. It is this second group of firms that embodies innovation-oriented outsourcing.

To further understand innovation-oriented outsourcing, we also look at the breakdown of expenditure on product innovation and observe how outsourcing shifts the focus to different activities related to product innovation. Our data provides expenditure, specifically relating to innovation, on research and development (R&D), patenting, marketing, retooling of manufacturing and training of staff. Our empirical results show that firms engaged in innovation-oriented outsourcing experience an intensity shift in the year after innovation to R&D and marketing of the new product. Looking at a two year window tells us that the same firm also shifts focus from retooling of manufacturing in the first year to the training of staff in the second year. This time line could be interpreted as an attempt to adapt manufacturing processes for the production of a new product, then to prepare staff for functioning in the new manufacturing environment.

Our findings support the predictions made by Acemoglu et al. (2003). They argue that vertical integration can eliminate transaction costs associated with conflict of interest and the holdup problem. However, it overburdens management, thus managers are compelled to focus on production more than innovation. Outsourcing, on the other hand, frees up management, and can be used to shift the emphasis to innovation. Our results can be interpreted as support for this type of mechanism. It is important to note that we do not directly observe in our data which types of jobs are contracted out. But, based upon Benson & Ieronimo (1996), we believe that most of the jobs contracted out by the innovative firms have been service jobs.

The rest of the paper is composed as follows: The next section reviews the relevant literature. Section 3 describes our data. Section 4 models the role of simultaneous innovation

and outsourcing in the future performance of firms. Section 5 looks at the different elements of expenditure on innovation, such as research, patenting and training. We document how innovating and outsourcing firms focus on certain aspects of innovation. We conclude in the last section.

2 Literature

Discussion of outsourcing in the economics literature is mostly in the context of cost reduction. Only a few papers have looked at innovation-oriented outsourcing and even these few works emphasize the impact of off-shoring on innovation and do not consider doemstic outsourcing. The outsourcing which will be the focus of this paper is almost entirely domestic rather than off-shoring.

Glass & Saggi (2001) develop a model where outsourcing to a low wage country reduces costs of production and causes wages at home (especially those of researchers) to fall. Since production costs are lower (due to the off-shoring) and innovation is cheaper (due to lower wages at home), firms find incentives to invest more in innovation and come up with better and newer products more often. On the empirical side, Criscuolo et al. (2005) show that offshore outsourcing among UK firms has opened new and more diverse feedback lines to the firm, thus helping firms refine their current innovations and come up with newer products more frequently.

The approach of Acemoglu et al. (2003) is more relevant for our study. They argue that vertical integration overburdens management. In their model, firms focus on production instead of innovation because management resources are limited. Outsourcing frees up management from overseeing production, so that managers now find it optimal to focus on innovation. In their setting, outsourcing creates a holdup problem; the supplier will underprovide relative to the optimum under vertical integration. Under such circumstance, firms in a more productive country will select outsourcing/off-shoring, innovate more rapidly and distance themselves from the developing world. Again, the focus here is on off-shoring as the vehicle for outsourcing, which is different than our focus.

Another line of research has focused on the outsourcing of innovation. The outsourcing of R&D and innovation is not the focus of this paper. Aghion & Tirole (1994), Quinn (2000)

and Lai & Riezmann (2009) provide a starting point for readers interested in this line or research.

The paper by Bengtsson et al. (2009) is closest to our study in examining the distinction between low-cost-oriented outsourcing and innovation-oriented outsourcing. We adopt their terminology but our approach is a departure from theirs. We focus on the entire manufacturing sector as opposed to one industry; our sample is over 4,000 firm-years whereas theirs is less than 150; our data includes a much richer set of control variables including continuous measures of sales, employment and wages. We also have detailed data on expenditures related to innovation. They focus on subjective responses to questions about reasons for outsourcing which we do not have. Rather, we look at the relationship between outsourcing and other business activities. Finally, while their data is cross-sectional, we use a panel data set over 4 years which allows us to study a much richer set of dynamic relationships between outsourcing and firm performance. There are some management case studies which have focused on the distinction between low-cost-oriented outsourcing and innovation-oriented outsourcing; see Bengtsson et al. (2009) for references.

Görg and Hanley (2011) show that outsourcing services makes firms more 'innovative' (in the sense of increasing their expenditure on research and development) and distinguish between international and domestic outsourcing. They show that international services outsourcing has a stronger effect on increasing research and development expenditure than domestic outsourcing. Our paper provides one possible explanation for their results. If the mix of low-cost-oriented and innovation-oriented outsourcing is different for international and domestic outsourcing, then our results indicate that it is not surprising to find a difference between the amount of innovation that results from these two types of outsourcing.

3 Data

The Business Longitudinal Survey (BLS) was conducted by the Australia Bureau of Statistics (ABS) during the fiscal years 1994–95 to 1997–98.[1] Four waves of data are available to researchers in a Confidentialised Unit Record File (CURF) in which several measures are

[1]The fiscal year in Australia is from beginning July to end of June the following year, hence the use of two-year combinations.

taken to protect the confidentiality of individual firms, such as adding small amounts of noise to numerical values and suppressing extreme observations. The most important step taken is that all firms with more than 200 full-time employees are excluded from the CURF to render it more difficult for data users to identify individual firms. The results in this paper should thus strictly be considered as being only applicable to small and medium-size enterprises, but such businesses comprise 99% of all manufacturing firms.[2] The data are a unique source of detailed information on Australian firms from a wide array of industries such as manufacturing, mining, construction and services.[3]

The first wave in 1994–95 covers about 13,000 firms which are randomly selected from the Australian Business Register stratified by industry and business size. Sample weights were derived such that industry/size sample cells matched population totals (Will & Wilson, 2001). In the continuing (panel) phase of the survey about half of the 13,000 firms were followed. Firms from the first wave were stratified by innovation status, exporting status and growth. Those firms that were identified as innovators, exporters and those with high employment or sales growth were over-sampled for the panel. In all subsequent years (after the first year) a small sample of new firms was added to the survey (Breunig & Wong, 2008). In wave 2 and later, weights were re-calculated for each wave to account for the post wave 1 stratification and sample attrition. In all of our descriptive statistics and regressions reported below, we use the original weights, adjusted for non-response by the ABS, from 1994–1995 in order that our estimates may be interpreted as representative of the population of firms at that point in time.

The sample we use for analysis is restricted to the manufacturing sector (ANZSIC 2x). Some manufacturing firms are coded as ANZSIC 20 (unknown manufacturing). For these firms, we use the industry codes reported for the following years to identify the subdivision. In those cases where we could not find any identifying information, we assigned firms to Miscellaneous Manufacturing (ANZSIC 29). As a result, ANZSIC 29 is better described as a mix of manufacturing firms and is set as the control group in our regressions. Below, we consider the dynamic behavior of firms over a three-year time window and we therefore use

[2]The ABS Business Counts (Cat.No.8165.0 at `http://www.abs.gov.au`) show that only about 1% of manufacturing firms in Australia have more than 200 employees.

[3]For full information on the population frame, sampling strategy, survey and available data items, see the Technical Manual, ABS Catalogue Number 8141.0.15.001 at `http://www.abs.gov.au`.

the balanced panel of firms that are available in all four years of the survey. We only use firms that reported nonzero sales and employment in all years because we are unable to distinguish between continuing businesses that fail to respond and exiters.

In the first three years of the data, the BLS asks firms whether, in the last twelve months, they contracted out jobs that used to be performed by the firm's own employees ($OUTS$). We believe that this variable excludes new activities which are added through outsourcing. We further believe, subject to recall window problems, that this excludes jobs that were contracted out in previous years. Some confirmation of this is provided in Table 3(a)–we observe that about 80% of firms reporting contracting out in one year do not report any contracting out the following year. The question about contracting out was not asked in 1997–98.

In addition, the BLS informs us about the number of employees, sales, value of exports, and the number of locations. Employment numbers are reported for the last pay period in the month of June every year, hence, we average over two consecutive years to find an annual calendar year estimate. The BLS also reports a few items relating to operational costs, such as the total wage bill, the cost of inputs, the cost of rentals and leasing of equipment, and other operational costs. For the empirical applications, the cost of production is set to the sum of expenditures on the purchases of inputs, rental and leasing expenses, and other operation costs. Our results suggest that the cost of contracted out jobs is captured in 'other operation costs'. Sales, wages, and costs are deflated to 1995 dollars using the ABS reported Consumer Price Index (CPI) values.[4] We construct a firm-level average wage by dividing the total wage bill by the number of employees.

Regarding innovation, the BLS provides a variety of detailed information. Firms indicated if they introduced a substantially new or improved product over the year ($PINV$). This variable is Boolean in nature. Firms also report their total expenditure on R&D (RD). In addition, if a firm had a product innovation ($PINV = 1$), then the firm reports itemized expenditures specific to the different aspects of the new product. These reported items, all of which are specific items relating to the new innovation, are expenditures on R&D, patenting and license acquisition, training of staff, retooling of manufacturing processes and marketing expenses. This level of detail for innovation expenses is available in every year except in

[4]Cat.No.6401.0 at `http://www.abs.gov.au` provides CPI figures for Australia.

ANZSIC	Description	Number of Firms	Contracting Out		
			1994–95	1995–96	1996–97
21	Food, Beverages and Tobacco	150	8.7%	4.7%	7.3%
22	Textile, Clothing, Footwear and Leather	118	9.3%	9.3%	11.0%
23	Wood and Paper Products	75	8.0%	6.7%	6.7%
24	Printing, Publishing and Recorded Media	107	14.0%	12.2%	5.6%
25	Petroleum, Coal, and Chemical Products	176	5.7%	8.5%	6.3%
26	Non-metallic Mineral Products	68	7.4%	8.8%	4.4%
27	Metal Products	192	12.0%	4.7%	6.8%
28	Machinery and Equipment	369	13.8%	8.6%	6.8%
29	Miscellaneous Manufacturing	194	11.3%	10.3%	9.3%
2x	All Divisions	1,449	10.8%	8.1%	7.3%

Table 1: Contracting out activity by manufacturing sector in the analysis sample.

1995–96.

Table 1 reports the composition of manufacturing in the balanced panel and the level of contracting out activity. Table 2 reports the level of innovation activity by manufacturing subdivision. Both tables point to some cross-industry differences. The number of innovations also falls over the years within our sample. One explanation for this may be that firms do not necessarily innovate products in successive years, but rather benefit from the rents of innovation for some period of time before innovating again. As a result, the number of firms in our sample with an incentive to innovate gets smaller by the year.

Table 3 looks at the fraction of firms that engage in contracting out and innovation activity. Part (a) presents the relationship between outsourcing in consecutive years. As mentioned above, this part seems to indicate that the outsourcing question is primarily capturing incremental outsourcing. Part (b) looks at contemporaneous outsourcing and innovation activity. About 4% of the sample has reported both innovation and contracting out in the same year. However, only about 14% of all the firms that innovated also outsourced in the same year. Firms that innovate at one point in time are more likely to innovate the following period than firms which do not innovate. Perhaps more surprisingly, outsourcing is also positively correlated over time within firms.

ANZSIC	Description	Number of Firms	Innovation 1994–95	1995–96	1996–97
21	Food, Beverages and Tobacco	150	38.7%	34.7%	20.0%
22	Textile, Clothing, Footwear and Leather	118	31.4%	23.7%	11.9%
23	Wood and Paper Products	76	13.3%	13.3%	8.0%
24	Printing, Publishing and Recorded Media	107	29.9%	21.5%	11.2%
25	Petroleum, Coal, and Chemical Products	177	48.9%	42.6%	32.4%
26	Non-metallic Mineral Products	68	38.2%	35.3%	20.6%
27	Metal Products	192	34.4%	24.5%	17.2%
28	Machinery and Equipment	371	45.3%	33.9%	25.5%
29	Miscellaneous Manufacturing	195	41.0%	30.4%	20.6%
2x	All Divisions	1,449	38.7%	30.6%	20.7%

Table 2: Innovation activity by manufacturing sector in the analysis sample.

	$OUTS_{t+1}$	
$OUTS_t$	No	Yes
No	2,459 (84.8%)	164 (5.7%)
Yes	216 (7.5%)	59 (2.0%)
n=2898		

(a)

	$PINV_t$	
$OUTS_t$	No	Yes
No	2,831 (65.1%)	1,136 (26.1%)
Yes	212 (4.9%)	168 (3.9%)
n=4347		

(b)

Table 3: The composition of firms by outsourcing and innovation activities.
(a) The intertemporal link between outsourcing activities (1994-95 through 1995-96)
(b) Simultaneous innovation and outsource (1994–95 through 1996–97)

4 Outsourcing and Innovation

A first look at the data reveals that firms which outsource in one period are more likely to innovate in the following period. In our data, pooled across the four waves, 32 per cent of firms that outsource in one period innovate in the next period whereas only 23 per cent of those firms that do not outsource at time t report an innovation at time $t+1$. This simple dichotomy is mis-leading however. If we look further at those firms which outsource in period t and divide them into firms which simultaneously innovate at time t and those that do not innovate at time t, we find that outsourcing combined with innovation is a strong predictor of future innovation whereas outsourcing in the absence of innovation is a strong *negative* predictor of future innovation. Of those firms that innovate and outsource in the same period,

fully 54 per cent of them innovate in the following period. Those firms that outsource in one period but do not innovate in the same period have only a 15.1 per cent probability of innovating in the next period. Firms that *do not* outsource in period t are actually more likely to innovate at time $t+1$ than firms that outsource in the absence of innovation.

This basic empirical fact, which we document for the first time in a broad sample of manufacturing firms, forms the basis for the investigation that we undertake in this paper. Given that we have panel data which contains detailed information on outsourcing and innovation, we can examine the relationship between the two in a novel way. What is the relationship between past outsourcing and future innovation? What is the relationship between past and future innovation? How do past outsourcing and innovation interact with one another in their relationship with future innovation?

We begin our investigation with a model of the probability of a firm innovating which depends upon past innovation and outsourcing. The model allows for outsourcing and innovation in the two prior periods (as well as their interactions) to affect the probability of innovating. Given that firms can innovate in either period $t-1$ or t and that they can outsource in either period $t-1$ or t (including the possibility of outsourcing and/or innovating in both periods), this allows us to examine the probability of innovation for 16 different 'types' of firms where type is defined as the outsourcing/innovation path over the previous two periods.[5] We estimate the following probit model:

$$
\begin{aligned}
&Prob[PINV_{j,t+1}=1|t,t-1] = \\
&\quad \Phi\Big(\alpha_0 + \alpha_1 PINV_{j,t} + \alpha_2 PINV_{j,t-1} + \alpha_3 PINV_{j,t}PINV_{j,t-1} \\
&\quad + \alpha_4 OUTS_{j,t} + \alpha_5 OUTS_{j,t-1} + \alpha_6 OUTS_{j,t}OUTS_{j,t-1} \\
&\quad + \alpha_7 OUTS_{j,t}PINV_{j,t} + \alpha_8 OUTS_{j,t-1}\times PINV_{j,t-1} \\
&\quad + \alpha_9 OUTS_{j,t}PINV_{j,t-1} + \alpha_{10} OUTS_{j,t-1}PINV_{j,t} + Z_{j,t}\beta\Big),
\end{aligned}
\tag{1}
$$

in which $Z_{j,t}$ is a vector of observable controls for firm j in time t. The controls include the log of employment size (EMP), the log of average wages ($WAGES$), export and R&D inten-

[5]The length of the panel and the fact that outsourcing was not included in 1997–98 prevents us from looking at longer lags.

Variable	Mean	Std.Dev.	1st Decile	Median	9th Decile
EMP	15.2	25.3	2.0	6.0	36.0
$SALES$(\$000)	2525.7	7297.1	97.1	572.5	5400.0
$WAGES$(\$000)	24.8	15.4	4.7	24.4	42.8
$COST$(\$000)	488.0	1005.9	13.0	156.0	1156.0
$RDINT$	0.021	0.386	0	0	0.012
$EXPINT$	0.045	0.189	0	0	0.105

Table 4: Sample statistics for key control variables. Pooled sample of 1,449 firms averaged over 1994–1997 from the balanced panel of the BLS.

	EMP	$SALES$	$WAGES$	$PURCHAS$	$RDINT$
$SALES$	0.758				
$WAGES$	0.288	0.310			
$PURCHAS$	0.723	0.984	0.294		
$RDINT$	-0.017	-0.013	-0.025	-0.012	
$EXPINT$	0.125	0.140	0.105	0.154	0.127

Table 5: Correlation coefficients for key variables. Pooled sample of 1,449 firms averaged over 1994–1997 from the balanced panel of the BLS.

sities ($EXPINT$ and $RDINT$), and whether the firm is multi-location ($MULTI$).[6] Export (R&D) intensity is defined as the value of exports (research and development expenditure) divided by the value of sales using nominal values. The estimates also include controls for year, age of the business, and industry effects. The dummies that absorb the age effects are formed as bins of 0–1, 2–4, 5–9, 10–19, 20+. Table 4 shows sample statistics for the control variables. In particular, we note that more than half the firms in the data are not spending on R&D or exporting at all. Table 5 reports the correlation between key variables. As one would expect, most variables have a positive relationship with size, stated in employment or real sales, but the intensity of R&D drops with size.

In addition to examining the propensity to innovate, we examine a variety of other performance measures including change in wages and change in employment. We compute change in performance in log terms, or

$$\Delta X_{t+1} = \log(X_{t+1}) - \log(X_t), \tag{2}$$

[6] A small number of firms report zero wages in some years, and most of them have only one or two personnel. We regard these jobs as self-employment, and to include those firms, we use $\log(1 + WAGES)$, in which $WAGES$ is the average real wage per employee.

in which X is the quantity of interest, for instance, sales or employment.

We then estimate a flexible equation relating past innovation and outsourcing to current performance changes as

$$\begin{aligned}\Delta X_{t+1} = & \\ & \alpha_0 + \alpha_1 PINV_{j,t} + \alpha_2 PINV_{j,t-1} + \alpha_3 PINV_{j,t} PINV_{j,t-1} \\ & + \alpha_4 OUTS_{j,t} + \alpha_5 OUTS_{j,t-1} + \alpha_6 OUTS_{j,t} OUTS_{j,t-1} \\ & + \alpha_7 OUTS_{j,t} PINV_{j,t} + \alpha_8 OUTS_{j,t-1} \times PINV_{j,t-1} \\ & + \alpha_9 OUTS_{j,t} PINV_{j,t-1} + \alpha_{10} OUTS_{j,t-1} PINV_{j,t} + Z_{j,t}\beta + \epsilon_{j,t+1},\end{aligned} \tag{3}$$

where the control variables are the same as those used in equation (1) above.

Table 6 summarizes the regression results from equations (1) and (3).[7] The rows in the table are sorted by the predicted probability of innovating from the estimates of equation (1). First we note that outsourcing at time $t-1$ has little effect on innovation at time $t+1$ once we consider outsourcing behavior at time t and innovation at both times $t-1$ and t. A very clear pattern emerges when we look at these last three items. Firms that outsource at time t and do not innovate at either time $t-1$ nor at time t are least likely to innovate at time $t+1$ (the rows labeled 1 and 2 in Table 6). Firms that innovate at both time periods and outsource at time t are the most likely to innovate at time $t+1$ (the last two labeled rows of Table 6). The remaining intermediate groups are almost perfectly sorted on these three variables in the following order, by increasing probability to innovate at time $t+1$:

- Firms that do not outsource at time t and do not innovate at time $t-1$ nor at time t (rows 3 and 4)
- Firms that outsource at time t and innovate at time $t-1$ but do not innovate at time t (rows 5 and 6)
- Firms that innovate at time $t-1$ but neither innovate nor outsource at time t (rows 7 and 8)
- Firms that innovate at time t but not at time $t-1$ (rows 9 through 12)

[7] The coefficient estimates which produce this table are available upon request from the authors.

Row Label	Outsource $t-1$	Outsource t	Innovate $t-1$	Innovate t	Number of Firm–years	Probability of Innovating in $t+1$	% Change in Wage t to $t+1$	% Change in Employment t to $t+1$
1		•			71	4.0%	-2.3%	-8.8%
2	•	•			26	4.8%	1.4%	2.3%
3					1,440	6.5%	4.1%	-0.1%
4	•				98	8.8%	-6.1%	2.9%
5	•	•	•		7	8.9%	-5.4%	0.1%
6		•	•		27	11.8%	-2.6%	-3.2%
7	•		•		54	13.1%	-2.6%	-3.2%
8			•		432	15.0%	14.3%	2.7%
9				•	218	19.7%	2.1%	-0.5%
	Sample Size and Predicted Mean				2,898	22.2%	3.5%	-0.9%
10		•		•	21	25.4%	11.4%	-3.9%
11	•			•	12	26.6%	-3.3%	4.6%
12	•	•		•	8	30.7%	20.0%	9.3%
13	•		•	•	52	41.5%	-2.4%	-0.8%
14			•	•	369	42.5%	9.6%	1.8%
15	•	•	•	•	18	49.7%	10.4%	6.6%
16		•	•	•	45	53.2%	8.5%	1.2%
	# Firm-years					2,898		

Table 6: The predicted values of the dependent by the type of outsourcing and innovation activities in t and $t-1$. Bullets indicate that the action took place at the given time. The results are sorted from the lowest probability of innovation to the highest. $t = 1995-96, 1996-97$.

- Firms that innovate both at time $t-1$ and time t but do not outsource at time t (rows 13 and 14)

Other things that are clear from the table are that 'super-innovators' who innovate in both previous periods are most likely to innovate at time $t+1$. Innovation dominates in determining future innovation and innovation only at time t results in higher probability of innovation at time $t+1$ than innovation only at time $t-1$. Outsourcing is less important than innovation in explaining future innovation, but the overall pattern is clear: outsourcing at time t in partnership with innovation at time t is related positively to future innovation whereas outsourcing at time t without innovating at time t is related negatively to future innovation.

When we look at column 7 which estimates equation (3) for wages, we see two clear patterns. Firms that outsource at time t without innovating report lower wages (or in one case, small positive wage growth below the mean wage growth in the data). Firms that outsource at time t and simultaneously innovate, report higher wages in $t+1$, ranging from 8.5% to 20% higher, well above average wage growth in the sample. This is consistent with a story about there being two very different types of outsourcing. Low-cost-oriented outsourcing which is not accompanied by innovation and which is undertaken to reduce costs results in lower wages. Innovation-oriented outsourcing outsources low cost jobs and replaces them with higher cost jobs that are focused on further innovation or on making the most of the innovation which has occurred. This results in a higher wage bill.

Looking at changes in employment in column 8, the results are slightly more varied. Simultaneously outsourcing and innovating at time t appears to lead to higher employment, though the increase is smaller than the increase in wages, consistent with a story of replacing lower-paid outsourced workers with higher-paid workers who can pursue innovation. The largest decreases in employment come from firms that outsource in time t with no innovation at time t. There does seem to be some role for outsourcing at time $t-1$ for this variable, as those firms that outsourced at time $t-1$ generally seem to have higher change in employment at time $t+1$ irrespective of outsourcing and innovation at other time periods. While this latter results holds for most categories, it does not hold for all and the effects are numerically small.

If we only look at contemporaneous effects, there is a clear ordering in the predicted probability of future innovation, from least to most likely:

- Outsourcing at time t
- Neither outsourcing nor innovating at time t
- Innovating at time t
- Innovating and outsourcing at time t

Since these contemporaneous effects are stronger than the lagged effects, we also estimate a restricted model of the probability of innovation at time $t+1$ as

$$Prob[PINV_{j,t+1} = 1|t] = \Phi\Bigg(\alpha_0 + \alpha_1 PINV_{j,t} + \alpha_2 OUTS_{j,t} + \alpha_3 OUTS_{j,t} PINV_{j,t} + Z_{j,t}\beta\Bigg), \tag{4}$$

where control variables are still defined as for equation (1). Equations for changes in wages and employment are estimated as in equation (3) but without terms involving time period $t-1$. For a more detailed look at the effects of simultaneous innovation and outsourcing on firm performance, we additionally estimate this reduced form of equation (3) for changes in sales and operational costs as independent variables. A further advantage of this approach of only using one lag is that it allows us to estimate over a larger sample.

Results from equation (4) are summarized in Table 7. First, we observe the intertemporal link between innovation activities, so that firms that innovated at time t are much more likely to come up with an innovation in $t+1$. The estimated effect of average wages is especially interesting since it shows that firms paying higher wages per employee, supposedly to professional and skilled workers, are more likely to innovate.

The results show that firms that outsource at time t but do not innovate at the same time are saving on wages, increasing their sales, and decreasing their employment. This pattern is consistent with low-cost-oriented outsourcing. The same firm also experiences an increase in its operational costs, which we explain as the value of the contracted out service being added to the operational costs. Low-cost-oriented outsourcing, however, is damaging the future

Variable	Dependent Variables				
	$PINV_{t+1}$	$\Delta Sales_{t+1}$	ΔEMP_{t+1}	$\Delta WAGE_{t+1}$	$\Delta COST_{t+1}$
Controls					
$\log(EMP_t)$	0.042***	-0.003*	-0.030***	0.010***	-0.000
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
$\log(1+WAGES_t)$	0.015***	-0.014***	0.031***	-0.213***	0.012***
	(0.002)	(0.002)	(0.001)	(0.006)	(0.003)
$EXPINT_t$	0.065***	0.262***	-0.007	0.089***	0.011
	(0.006)	(0.028)	(0.005)	(0.009)	(0.009)
$RDINT_t$	-0.019***	0.115***	-0.020***	0.016***	0.131***
	(0.004)	(0.002)	(0.003)	(0.001)	(0.003)
$MULTI_t$	-0.023***	0.017***	-0.017***	0.003	-0.004
	(0.004)	(0.004)	(0.003)	(0.006)	(0.005)
$OUTS_t$	-0.036***	0.036***	-0.016**	-0.046***	0.055***
	(0.007)	(0.006)	(0.005)	(0.008)	(0.007)
$PINV_t$	0.276***	0.054***	0.026***	0.016**	0.045***
	(0.005)	(0.004)	(0.002)	(0.005)	(0.005)
$OUTS_tPINV_t$	0.076***	-0.032**	-0.002	0.104***	-0.006
	(0.014)	(0.011)	(0.008)	(0.013)	(0.014)
R^2		0.074	0.058	0.093	0.034
Log-Likelihood	-22340.6	-22546.3	4144.5	-36027.5	-37900.1
# Firm–years			4,347		

Table 7: The marginal effects of innovation and contracting out on firms' future performance. The numbers in parenthesis are robust standard errors. Year, age, and industry dummies are also included but not reported. *** and ** denote 1% and 5% significance levels. $t = 1994-95$ to $1996-97$.

chances of innovation, hence, this practice turns out to be a short-sighted strategy which increases profits for now at the cost of hurting the long-term competitiveness of the firm.

On the other hand, for those firms that both innovate and outsource at time t, we find lower sales at time $t+1$ relative to time t. These firms are also paying higher wages per employee. This is consistent with firms incurring higher costs and sacrificing future sales to improve their future innovation capability and to position themselves for future success.

The main patterns described earlier in the four bullet points are also clearly visible in Table 8 of predicted values. Again, low-cost-oriented outsourcing shows very different implications for firm innovation, wages and employment than innovation-oriented outsourcing.

Outsource t	Innovate t	Number of Firm–years	Probability of Innovating in $t+1$	% Change in Wage t to $t+1$	% Change in Employment t to $t+1$
•		1,136	7.2%	0.1%	0.1%
		2,831	10.0%	4.7%	1.8%
Sample Size and Predicted Mean		4,347	24.8%	2.9%	0.7%
	•	212	37.4%	6.3%	4.4%
•	•	168	41.8%	12.1%	2.6%
# Firm–years		4,347			

Table 8: The predicted values of the dependent by the type of outsourcing and innovation activities in t. Bullets indicate that the action took place at the given time. The results are sorted from the lowest probability of innovation to the highest. Using years $t = 1994-95$ to $1996-97$.

5 Outsourcing and the Type of Innovation Activity

To improve our understanding of innovation-oriented outsourcing, we examine how expenditure components of innovation activity are affected by outsourcing. In our data, firms who indicate that they have made a product innovation are asked specifically about expenditure for innovation. This expenditure is categorized in five mutually exclusive ways: research and development (R&D), training, patenting/licensing, retooling and marketing. We also consider how innovation-oriented outsourcing relates to overall firm R&D expenditure by considering the R&D intensity variable, $RDINT$, defined in Section 4 above. We calculate $W_{ij,t}$ as the fraction of expenditure on component $E_{ij,t}$ out of total innovation-related expenditure

$$W_{ij,t} = \frac{E_{ij,t}}{\sum_{i=1}^{5} E_{ij,t}} \tag{5}$$

Table 9 reports the sample statistics for the fraction of expenditures on the different elements of innovation conditional on those firm-years where a firm reports a product innovation and non-zero expenditure on innovation. Importantly, the prevalence of zeros in the table shows that many firms only focus on certain aspects of innovation activity. In particular, research and development, retooling and marketing seem to be regarded by Australian firms as the more relevant factors for the success of an innovation. In the second-last row of the table, we also present summary information about R&D intensity for this subset of firms.

Fraction	Mean	Std.Dev.	1st Decile	Median	9th Decile
R&D	0.480	0.366	0	0.500	1
Training	0.068	0.172	0	0	0.177
Patenting	0.018	0.090	0	0	0.022
Retooling	0.291	0.329	0	0.167	0.893
Marketing	0.143	0.236	0	0.006	0.667
$RDINT$	0.132	1.025	0	0.012	0.142
# Firm-years			844		

Table 9: The fraction of expenditure pertaining to the different elements of product innovation. The last row is about the R&D intensity in firms. The sample is the pooled sample of firm-years form the balanced panel of the BLS conditional on firm-year having had a product innovation.

To proceed, we model each of these fractions as

$$W_{ij,t} = \alpha_0 + \alpha_1 PINV_{j,t} + \alpha_2 OUTS_{j,t} + \alpha_3 PINV_{j,t} OUTS_{j,t} + Z_{j,t}\beta + \epsilon_{j,t}. \qquad (6)$$

By construction, the left-hand side of (6) is bounded between zero and one. We estimate this equation over all firms, including those who don't innovate and who thus report zero expenditure on innovation-related activity. The fractions in these cases are set to zero, hence, a large concentration of zeros exists for $W_{ij,t}$. We specify (6) in terms of contemporaneous innovation and outsourcing only, based upon the results of Section 4.

We apply the method of Papke & Wooldridge (1996) to estimate the coefficients in (6). In this approach, the left-hand side of (6) is treated as a probability and the coefficients are estimated by the application of a maximum likelihood estimator to a logit function of the right-hand side. Table 10 reports the estimated coefficients. The results of the previous section show that outsourcing by itself is targeted at reducing costs and not innovation. Accordingly, Table 10 shows that firms that only outsource and do not innovate are spending less on all the elements of innovation. It goes without saying that firms that innovate a product are spending more on each element of innovation. What is interesting, however, is that firms that innovate and outsource at the same time seem to be focused on certain elements of innovation, namely, research and development and marketing. This observation is strengthened by the fact that firms clearly allocate expenditure to R&D and marketing in innovating a new product (Table 9). Outsourcing is helping these firms to focus on research

	Expenditure Component				
Variables	R&D	Training	Patent	Tooling	Marketing
$Log(EMP_t)$	0.173***	-0.420***	-0.403***	-0.056*	0.010
	(0.022)	(0.042)	(0.073)	(0.023)	(0.025)
$Log(1+WAGES_t)$	-0.034	0.081	0.694***	0.100***	-0.014
	(0.030)	(0.045)	(0.079)	(0.030)	(0.033)
$EXPINT_t$	0.585***	-2.720***	-0.283	-0.356***	0.415***
	(0.094)	(0.261)	(0.211)	(0.101)	(0.086)
$RDINT_t$	5.105***	-5.766***	-0.254***	-2.551***	-3.811***
	(0.658)	(0.725)	(0.059)	(0.418)	(0.466)
$MULTI_t$	-0.061	0.788***	-0.301*	-0.119*	-0.019
	(0.046)	(0.086)	(0.145)	(0.054)	(0.061)
$OUTS_t$	-0.373***	-0.099***	-0.415***	-0.453***	-0.407***
	(0.014)	(0.027)	(0.041)	(0.016)	(0.021)
$PINV_t$	40.330***	27.104***	25.319***	27.880***	33.578***
	(0.030)	(0.037)	(0.097)	(0.027)	(0.030)
$OUTS_tPINV_t$	0.724***	-1.153***	-0.347**	0.371***	0.607***
	(0.052)	(0.104)	(0.133)	(0.055)	(0.060)
Log-Likelihood	-4382.9	-1561.2	-612.5	-3950.9	-2632.4
# Firm–years			2,898		

Table 10: The influence of outsourcing and innovation on different expenditure components of innovation. The numbers in parenthesis are robust standard errors. ***, **, and * denote 1%, 5%, and 10% significance levels. $t = 1994-95, 1996-97$.

and marketing. Besides, these firms are also concentrating more expenditure on the retooling of their production. One can interpret this in the light of the paper by Acemoglu et al. (2003) that firms undertake this re-focusing of activity when the burden of having to manage peripheral jobs not related to research and marketing activities is reduced by contracting them out.

It is interesting to know whether past outsourcing and innovation affects expenditure on innovation in the current period. To explore this question, we estimate the following model

$$W_{ij,t} = \alpha_0 + \alpha_1 PINV_{j,t-1} + \alpha_2 OUTS_{j,t-1} + \alpha_3 PINV_{j,t-1} OUTS_{j,t-1} + Z_{j,t}\beta + \epsilon_{j,t}. \quad (7)$$

The method we apply for estimation is again the one proposed by Papke & Wooldridge (1996). Table 11 reports coefficient estimates from this model. Note that the sample of firm-years used to generate the results in Tables 10 and 11 do not fully overlap because the

	Expenditure Component				
Variables	R&D	Training	Patent	Tooling	Marketing
$Log(EMP_t)$	0.587***	0.463***	0.572***	0.181***	0.304***
	(0.021)	(0.039)	(0.072)	(0.023)	(0.029)
$Log(1+WAGES_t)$	0.438***	0.301***	0.183**	0.243***	0.307***
	(0.044)	(0.042)	(0.064)	(0.035)	(0.051)
$EXPINT_t$	1.037***	-3.792***	-2.983***	0.337**	1.045***
	(0.092)	(0.375)	(0.596)	(0.115)	(0.101)
$RDINT_t$	28.252***	-0.004	0.266***	-0.051**	-0.352**
	(1.926)	(0.042)	(0.045)	(0.016)	(0.122)
$MULTI_t$	-0.156**	-0.269**	0.244	-0.042	-0.067
	(0.056)	(0.103)	(0.162)	(0.066)	(0.077)
$OUTS_{t-1}$	-0.329*	-1.744***	1.016***	-0.498**	-0.413*
	(0.140)	(0.333)	(0.210)	(0.191)	(0.198)
$PINV_{t-1}$	1.209***	0.539***	0.743***	1.315***	1.151***
	(0.045)	(0.072)	(0.158)	(0.051)	(0.058)
$OUTS_{t-1}PINV_{t-1}$	0.595***	2.364***	-0.433	0.183	0.886***
	(0.167)	(0.362)	(0.321)	(0.210)	(0.227)
Log-Likelihood	-6208.2	-1645.3	-787.7	-5020.3	-3007.4
# Firm–years			2,898		

Table 11: The influence of lagged outsourcing and lagged innovation on different expenditure components of innovation. The numbers in parenthesis are robust standard errors. ***, **, and * denote 1%, 5%, and 10% significance levels. $t = 1996-97, 1997-98$.

details of innovation expenditures are missing in 1995–96.

We think the explanation for the different results in Tables 10 and 11 arises from firms that innovate in consecutive periods. These innovations may be incremental steps related to the same overall innovation. We thus interpret these results as indicating that firms continue to focus on research and marketing for the innovated products even one year after outsourcing took place. However, focus has shifted from retooling production to the training of staff in the second year. The shift seems to be indicative of a trend relating to the previous year innovation, so that firms invest in retooling the production and then spend to train their staff to work in the new environment.

Most importantly, from Tables 10 and 11 we learn that firms which simultaneously innovate and outsource behave differently in their expenditure allocations than firms which innovate without outsourcing. This seems to be indicative of these firms using outsourcing as

part of their innovation strategy. Interestingly they focus more on research and development and marketing and less on patenting and licensing.

6 Conclusion

Outsourcing can be targeted at saving costs, reducing wages or downsizing. Alternatively, outsourcing could be used to free up resources to shift a firm's focus from one activity to another or to pursue activities such as innovation or research and development. In the latter case, there is less concern in saving total costs and more concern in improving the firm's research and innovation environment. Consequently, a firm which outsources janitorial jobs, for example, might be observed to have a higher wage bill after outsourcing if these jobs have been replaced with higher-paid professional and research staff or if performance incentives for existing staff to engage in more innovative endeavors are increased.

This paper presents a range of results that uncover a distinction in the data between outsourcing to reduce cost and outsourcing to boost innovation. Based on these results, we interpret outsourcing by innovative firms as an attempt to reduce the scope of peripheral jobs undertaken in-house to shift managerial resources to oversee innovation. Moreover, we observe a shift to more intensive research and development, retooling and marketing on the part of these innovation-oriented outsourcing firms that is consistent with this story. A similar conclusion is reached by looking at the higher overall wage bill that innovation-oriented outsourcing firms have. In line with the theoretical predictions of Acemoglu et al. (2003), these firms experience an accelerating rate of innovation and may perhaps be able to distance themselves from the horde.

We find that firms which outsource without innovating are the worst of all performers in terms of future innovation probability. This may be consistent with low-cost-oriented outsourcing being a sign of trouble for the firm. It may be a strategy to keep the firm alive rather than to improve firm performance.

Finally, our key empirical observation that the best performers in terms of future innovation are those that combine innovation with outsourcing whereas the worst performers are those who outsource without innovating has an important implication for future economic research. Researchers who treat all outsourcing firms as homogeneous, either in theoretical

or empirical research, risk missing important features of economic behavior and the data it generates. We would argue for a richer view of outsourcing and a clear distinction between outsourcing to cut costs and outsourcing as one aspect of the strategy of an innovative firm trying to stay ahead of the pack.

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