Venture Capital and Private Equity investment and the innovation of Australian firms

1. Introduction

The success of the venture capital (VC) and private equity (PE) sector is regarded as important for economic growth and innovation. Both theoretical and empirical research in the U.S and Europe is consistent with the proposition that VC/PE funds are value-added investors [Gompers and Lerner (1999, 2001), Lerner (1999, 2002a, b), Kortum and Lerner (2000), Hege, et al (2003), Gompers et al (2005)].

In contrast to other financial intermediaries, the PE fund takes an active role in the development of the investee firm. In addition to providing funding, PE managers serve their investee firms through coaching and guidance, networking for strategic alliances, and attracting further capital [Bygrave and Timmons (1992)]. Hellmann and Puri (2002) empirically confirm that the in-kind services of PE managers are of economic significance, through a reduction in time to bring a product to market and by professionalizing the start-up company to achieve organizational milestones such as building a management team.

In addition, VC/PE investors are typically geographically proximate to their investees, and among the most sophisticated of financial intermediaries at mitigating informational asymmetries and agency costs in financial contracting [Sahlman (1990), Gompers (1997), Bergman and Hege (1998), Trester (1998), Gompers and Lerner (1999, 2000, 2001), Kirilenko (2001), Schmidt (2003)].

VC/PE investors are also frequent participants in the capital markets as a method of exiting from their investments [Lerner (1994)]. Empirical observations suggest that they choose the exit channel strategically and build up reputation primarily through successful IPOs [Gompers (1996)]. VC/PE investors tend to hold significant ownership and board positions [Barry et al. (1990)], and continue to be involved in the firm after going public [Megginson and Weiss (1991)] and thus may provide access to capital even in the post-IPO period. Finally, VC/PE investors tend to put effective management structures in place, which assist in superior long run performance [Brav and Gompers (1997)].

In addition, many policymakers have a perception that private equity organisations have influenced the rising leadership of U.S firms in high-technology industries. Kortum and Lerner (2000) demonstrate that venture funding has a strong positive impact on innovation in the U.S. On average, a dollar of venture capital appears to be three to four times more potent in stimulating patenting than a dollar of traditional corporate R&D.

A host of subsequent papers have tested the main results of Kortum and Lerner (2000) in a variety of different environments, with ambiguous results. Hellman and Puri (2000) suggest that venture capital may not stimulate innovation via incentives and monitoring, but via screening of firms. Engel and Keilbach (2007) find that German VCs seems to be more focused on bringing existing innovations to the markets rather than on fostering new ones. Caselli et al (2009) reach a similar conclusion for Italian

IPOs. Caselli et al (2009) find that the role of venture capital in Italy does not seem to promote innovation but appears to be mainly concerned with the growth of sales. The propensity to innovate is a fundamental requirement for passing the screening phase of the venture capitalists' selection process, but it seems that the entry of venture capital into the company does not promote continued innovation.

Jeng and Wells (2000) and Balboa and Marti (2001) analyse the determinants of venture capital across countries and find that innovation is not a significant determinant, while the IPO opportunity represents the strongest driver of venture capital investment. However, Popov and Roosenboom (2009) analyse the effect of private equity investment on innovation across 18 European countries over the period 1991-2004. Their results imply that while private equity investment accounts for 8% of aggregate (private equity plus R&D) industrial spending, PE accounts for as much as 12% of industrial innovation.

Further, Shiri and Trabelsi (2009) show that the presence of venture capitalists enhances the innovation intensity in French firms and that innovation is an indicator that attracts venture capitalist. In addition, Lerner et al. (2008) suggest that the effect of venture capital on innovation goes beyond "cherry-picking". In a U.S firm-level sample they find that receiving venture capital funding is associated with a significant reduction in the time to bring a product to the market. Their evidence suggests that, controlling for the characteristics of the firm at the time of the venture capitalist's involvement, firms pursue more influential innovations as measured by the number of patent citations in the years after venture capital investment took place. Further U.S evidence is provided by Mollica and Zingales (2007), who find that VC investments

have a significant positive effect both on the production of patents and on the creation of new businesses. A one standard deviation increase in the VC investment per capita generates an increase in the number of patents between 4 and 15%. An increase of 10% in the volume of VC investment increases the total number of new business by 2.5%.

The Australian VC/PE market differs to the U.S market. It has a legal and institutional structure similar to most common law countries where VC/PE markets have been the subject of much study (including Canada, the U.K and the U.S), but is a relatively younger market. Investment in Australia PE funds has increased 348% in the last decade (Australian Bureau of Statistics), yet accounts for only 0.58% of GDP compared to 1.8% of GDP in more mature markets such as the US [Probitas Partners (2009)]. Australia only accounts for 1% of the global PE market but is a significant part of the fastest growing region, representing around 14% of regional funds [Probitas Partners (2009)]. VC/PE markets are influenced by many factors including a country's legal and institutional structure, liquidity and stock market performance, investor sophistication and ability to provide value-added assistance to entrepreneurial firms. Recent studies have demonstrated international differences in financial contracts, syndication, and exits.[1]

However, there has been little research on innovation in Australia. Gans and Hayes (2008) evaluate Australia's innovative capacity over 1975 -2006. They show that during the 1980s, Australia moved from a classic imitator economy to a second-tier innovator. Australia's innovation index rose slightly from 1998 and in recent years

[1] On exits see Barry et al. (1990), Megginson and Weiss (1991), Cumming and MacIntosh (2003) and Das et al. (2003).

has moved within a fairly flat band, with a noticeable increase in 2006. They argue that the drivers of innovative capacity in Australia suggest that the key reason for the surge after several years of stagnation is a revival in the growth of R&D expenditure and changes in technological specialization.[2] Further, on a firm level, Bosworth and Rodgers (2001) and Feeny and Rodgers (2003) find some evidence that R&D and patent activity is positively linked to market value for Australian listed firms.

The purpose of this paper is to examine the impact of the impact of venture capital and private equity managers on the innovation of Australian firms. Firms at the time of listing on the stock exchange are analysed as information on private firms is scarce. A wide range of innovation measures are examined including number of patents, trademarks and designs, R&D expenditure and patent and trademark citation.

2. Data and Methodolgy

The sample covers the period December 1994 to February 2006. The initial sample consists of 551 IPOs and includes 471 non-VC/PE backed IPOs and 80 VC/PE backed IPOs. The VC/PE backed firms and their details are obtained from the data provided by the Australian Venture Capital and Private Equity Association (AVCAL) and shareholder information in prospectuses. IPO prospectuses were obtained from the Connect 4 and Finanalysis database. Firm characteristics (size, age, cash flow to sales, ROE, number of employees, R&D expenditure, R&D grants) were hand collected from the prospectus. Patent, trademarks and design counts were sourced

[2] However, these changes are driven by the performance of a single strong company.

from the databases held by IP Australia. Patent citations were sourced from the European Patent office.

The use of patent applications as an output measure of innovative behavior has often been criticised. Patents are primarily legal titles that protect the output of an innovation process from being copied. Hence firms can be expected to apply for a patent if they believe that this is a meaningful way of protecting their intellectual property. However firms might use other strategies to protect their innovations, such as secrecy or speed of innovation. Thus, Engel and Keilbach (2007) argue that not all innovative output can be expected to be patented. First, not all innovations are patentable such as innovations in the service sector. Second, even if an innovation is patentable, a firm might choose not to apply for a patent because the duration of the procedure is too long relative to the duration of the innovation cycle. And third, a firm might not apply because it must disclose at least some of the knowledge that is imbedded in the innovation (see Griliches (1990) for an extended discussion of this topic).

Nevertheless, using patent applications is still the dominant approach to measuring innovative output (e.g. Kortum and Lerner, 2000) since it is the most detailed and best documented data on innovative output available. Thus, innovative activities can be measured using inputs, which relate to the process of discovering new products and processes and outputs, which relate to the outcomes of these inputs. R&D expenditure is used as a measure of innovative input and the standard measure of innovative outputs (patents) is extended in this study to include trademarks and designs. The proxies for the level of innovation used in this study include the number of patents

[Gans and Stern (2003)], the number of trademarks, designs and patents (total innovation), the number of patents to R&D [Kortum and Lerner (2000)], the number of patents to firm size, R&D to firm size [Bosworth and Rodgers (2001)], total innovation to R&D and total innovation to firm size [Feeny and Rodgers (2003)].

The impact of VC/PE funding on the innovation of newly listed firms is first analysed using regression methodology. A count data methodology (negative binomial regressions) is used to estimate the determinants of innovation where the number of patents and the number of trademarks, designs and patents (total innovation) are the innovation measures [see Rock et al (2000)]. OLS regressions are used for the additional proxies. The total innovation to R&D and the number of patents to R&D measures are standardised by the natural logarithm of the sum of one and the variable's value as they are not normally distributed. The determinants of firm's technological innovation include the probability of VC/PE backing, firm size (total assets), return on equity (net profit after tax /book value of equity) and firm age (the number of years between IPO and the founding year in the prospectus).

However, Lee and Masulis (2009) argue that there is a VC selection effect. Venture financing is the outcome of an endogenous choice between VCs and the entrepreneur. This endogenous choice is reflected in the non-random distribution of IPO characteristics such as industry clustering, geographical concentrations (in the US market), offering year clustering (IPO waves) in the VC-backed and non VC-backed IPO samples. It is likely that VC/PE ownership and a firm's level of innovation are related to each other. VC firms might choose to invest in innovative firms but VC/PE backed firms may also be more innovative than non-VC backed firms due to the

active role of VC/PE managers. If this is an important VC investment criterion, then results would be biased without controls for the VC selection effect.

To control for endogeneity, a two-stage procedure is used. In the first stage, VC/PE backing is modelled using an OLS (probit) model. In the second stage, the models for innovation are estimated using the predicted values from the first stage instead of actual values to examine the relationship between VC investment and firm innovation.

In the first stage, a dummy variable for VC/PE funding or percentage ownership of the VC/PE investor is used as the independent variable. Peters (2010) shows that Australian VC firms are more likely to fund deals that have received grant funding and have generated revenue. Thus, a dummy variable that is equal to one if a firm has received an R&D grant before listing and the cash flow to sales ratio are used. Lee and Masulis (2009) argue that VC-backed IPOs are likely to be younger, be smaller in size and have higher market to book ratios. Therefore, in the first stage probit regression, we include firm age (the number of years between IPO and the founding year in the prospectus), firm size (market value of equity before listing) and the market to book ratio. The cash flow to sales ratio also controls for differences in firm performance. Unlike the mature US market, geographic location is not a determinant of funding in the smaller Australian VC/PE market. As in Lee and Masulis (2009), time variation and industry clustering is controlled for by including year and industry fixed effects. Technology and telecommunications and the health sector account for 42.5% of the VC/PE backed IPOs.

In the second stage, the determinants of firm's technological innovation include the probability of VC/PE backing (from the first stage), firm size (total assets), return on equity (net profit after tax /book value of equity) and firm age. For robustness, a 3SLS system with simultaneous equations is also estimated.

Table 1 provides summary statistics for the sample.

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VC/PE backed IPOs makeup 15% of the sample, of which 9.3% are VC backed and 5.2% PE backed, compared to 34% for U.S. IPOs in Bakers and Gompers (2003). A large proportion of IPOs (40%) in the sample period listed in the 1999-2000 hot market. The second largest group of listings occurred in 2004 (14%). A similar pattern holds for both VC/PE backed and non-VC/PE backed IPOs. 41% of VC/PE backed and 40% of non-VC/PE backed IPOs listed in the 1999-2000 hot market. VC/PE backed IPOs account for 21% of the market value of IPOs issued over the sample period.

The whole sample has operated prior to the IPO for 11 years on average, and the median is 5 years. Australian IPOs are relatively small with an average pre listing market capitalization of $80.5 million and a median of $22.3 million. The average firm has positive operating cash flows ($3.8M) but 57% of firms have negative operating cash flows and the median firm has negative operating cash flows of -$0.37 before listing. Technology and telecommunication firms account for 24% and health sector firms 18% of the sample.

The average number of patents held for the sample is 1.2. However, only 15% of firms hold patents before listing and they hold an average number of 9 patents. This compares to 4.5% of listed Australian firms that held patent applications in 1996 in Bosworth and Rodgers (2001). Similarly, the average number of trademarks and designs held by the sample firms is 4.2 and 0.2 respectively. . However, 55% of firms hold trademarks and these firms hold an average of 7.7 trademarks and 3% of firms hold registered designs where the average for these firms is 7. This compares to 17.6% and 2.1% of listed Australian firms that held trademark and design applications in 1996 in Bosworth and Rodgers (2001).

For firms holding patents and trademarks, the patents are cited on average 2.6 times before listing and trademarks 0.3 times. The average total innovation measured by the number of patents, trademarks and designs is 5.53 for the whole sample and 59% of firms hold at least one measure. 10% of firms hold R&D grants with an average value of $2.1M and 40% and 58% of these firms hold patents and trademarks. The average patent to R&D ratio is 2.43 for the whole sample and 14.5 for those firms that hold patents. The average total innovation measure to R&D ratio is 5.11 for the whole sample and 8.33 for those firms that hold a patent, trademark and/or design.

Table 2 examines the differences in firm, ownership and IPO characteristics between VC/PE backed firms and non-VC/PE backed firms

<Insert Table 2 here>

VC/PE and non-VC/PE backed firms have similar firm characteristics, with the median VC/PE backed firm being larger than non-VC/PE backed firms (total assets and pre market size). The similar age and size of VC/PE and non-VC/PE backed firms is consistent with prior Australian evidence in da Silva Rosa et al (2003) and Owen and Suchard (2009). The results suggest that Australian venture capitalists do not take firms public at an earlier stage that non-VC-backed firms, which is in contrast to the U.S [Megginson and Weiss (1991), Gompers and Lerner (2000), Lee and Wahal (2004) and Krishnan et al (2008)]. The similar size of VC/PE and non-VC/PE backed firms is inconsistent with US markets where Lee and Masulis (2009) find that non-VC backed IPO issuers are larger in terms of total assets than VC backed companies. However, this may reflect the size of the US market in general and the maturity of the US VC/PE market.

A higher percentage of VC/PE backed firms hold R&D grants (21%) than non-VC/PE firms (8%) and the average and median dollar value of the grant is higher for VC/PE backed firms. In terms of innovation measures, 20% of VC/PE backed firms hold patents, compared to 15% of non-VC/PE backed firms and a similar percentage of firms have R&D expense (40%).

In terms of innovation input, non-VC/PE firms have higher levels of relative R&D expense. However, in terms of innovation output, VC/PE backed firms hold a higher number of patents, trademarks and designs at listing. This result is similar to Italian IPOs, where venture funded firms have a larger number of patents than non- venture funded [Caselli et al (2009)]. However, when total innovation is scaled by R&D expense, non-VC/PE firms have higher innovation levels per dollar of R&D. Further,

VC/PE investors own on average 32% of the firm pre IPO and invest on average $6.98 M in investee firms. Investment in 29% of the VC backed firms is syndicated with an average of 2 co-investors.

3. Results

The regression results of the determinants of the level of innovation in newly listed firms are shown in Table 3. Innovation is proxied using number of patents, trademarks and designs (total innovation), total innovation scaled by R&D or firm size and R&D scaled by firm size, as only 15% of the sample hold a patent at listing.

<Insert Table 3 here>

The results are not consistent across innovation measures. VC/PE backing is significantly positive when total innovation is used a measure of innovation levels, but is insignificant for the other measures. Age is also significantly positive across two of the specifications suggesting that older firms at IPO are associated with higher levels of innovation. However, venture financing is the outcome of an endogenous choice between VCs and the entrepreneur. This endogenous choice is reflected in the non random distribution of IPO characteristics such as industry clustering, geographical concentrations (in the US market), offering year clustering (IPO waves) in the VC-backed and non VC-backed IPO samples. Thus, to assess the relationship between VC/PE investment and the innovation of Australia firms, a two stage approach is used to control for edogeneity. Innovation is proxied using number of patents, trademarks and designs (total innovation), total innovation scaled by R&D or

firm size and R&D scaled by firm size, as only 15% of the sample hold a patent at listing.[3] The results are shown in Table 4.

<Insert Table 4 here>

The first stage results suggest that the level of innovation in a firm is not related to the likelihood of receiving VC/PE funding. Consistent with Peters (2010), firms with R&D grants are more likely to be funded. Further, firms with positive cash flows, smaller size and younger firms at IPO are more likely to be VC/PE backed. The age results are consistent with US evidence in Lee and Masulis (2009).

The second stage results suggest that VC/PE backed IPOs are associated with higher levels of innovation than non-VC/PE backed IPOs. This relationship holds across all measures of innovation. Higher innovation levels are also associated with older IPO firms (except for the specification where innovation is measured by total innovation/size). For robustness, the simultaneous equation results are shown in Table 5. The models include two dummy variables for the IPO hot market periods of 1999-2000 and 2004-2005. The results are similar to the two stage model in that VC/PE backed IPOs are associated with higher levels of innovation than non-VC/PE backed IPOs. Further VC/PE funding is not related to the level of innovation but firms with R&D grants are more likely to receive funding.

<Insert Table 5 here>

[3] However, the results are robust to using the number of patents/size or patents/R&D as the innovation measure.

The results are in contrast to most European evidence that finds that innovation is associated with receiving VC/PE funding but that VC/PE funding does not impact the levels of innovation. However, the results are similar to US evidence [Lerner et al. (2008), Mollica and Zingales (2007)]which suggests that there is a relationship between VC/PE investment and the level of firm innovation. The results suggest that although Australian VC/PE markets are at a similar stage of maturity to European markets, Australian VC/PE investors contribute to firm innovation, unlike most of their European counterparts.

4. Conclusion

The evidence on the relationship between VC/PE investors and the innovation of firms is mixed. U.S evidence suggests that VC/PE investment impacts the level of firm innovation. However, there is contrasting evidence in Europe, which suggests that innovative firms are more likely to receive VC/PE funding and that VC/PE investors do not influence further innovation. The purpose of this paper is to examine the impact of the impact of venture capital and private equity managers on the innovation of Australian firms.

The Australian VC/PE market differs to the U.S market as it has a legal and institutional structure similar to most common law countries where VC/PE markets have been the subject of much study, but is a relatively younger market. Firms at the time of listing on the stock exchange are analysed. As venture financing is the outcome of an endogenous choice between VCs and the entrepreneur, a two stage procedure is used. A number of measures of innovation including number of patents,

trademarks and designs, R&D expenditure and patent and trademark citation are examined.

The results suggest that VC/PE backed IPOs are associated with higher levels of innovation than non-VC/PE backed IPOs. Further VC/PE funding is not related to the level of innovation but firms with R&D grants are more likely to receive funding. The results suggest that although Australian VC/PE markets are at a similar stage of maturity to European markets, Australian VC/PE investors contribute to firm innovation, similar to VC/PE investors in the more mature U.S market.

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Table 1
Summary statistics for 551 Australian IPOs between 1994 and 2006

	Mean	Median	Stdev	Minimum	Max	No
A. Firm characteristics:						
Age	11.13	5.28	15.81	0.01	122.48	541
Size	80.45	22.28	306.38	0.20	5740.85	541
ROE	0.13	0.04	0.55	-0.80	8.09	522
CF/sales	-4.40	0.00	24.25	-419.00	2.21	547
Total assets	100.52	18.91	449.73	0.46	6760.10	550
Book to Market	0.46	0.38	0.33	0.01	2.63	541
Number of employees	464.49	130	1059.49	4	9700	226
B. Innovation measures						
No patents	1.16	0	6.202327	0	119	524
No trademarks	4.23	1	16.24	0	278	551
No designs	0.19	0	1.894965	0	28	551
Total innovation	5.53	1	18.21	0	286	551
No patent citations	0.42	0	4.115362	0	81	524
No trademark citations	0.15	0	0.78	0	10	551
$ R&D grants	1.93	0	1.08	0	15.00	548
R&D expense	0.71	0	3.03	0	36.15	456
Total innovation /size	0.21	0.04	0.47	0	4.77	535
Total innovation /R&D	5.11	0	34.23	0	598.98	456
Patent/size	0.05	0	0.18	0	1.37	535
Patent/R&D	2.42	0	28.74	0	598.98	456
R&D/ Total assets	2.56	0	17.12	0	299.49	456

Age = the difference between the IPO year and the founding year in the IPO prospectus
Size = number of pre-IPO shares, multiplied by the offer price.
ROE = Net Profit After Tax /Book Value of Equity for year end before listing
CF/sales = Operating Cash Flow/Sales for year end before listing
Total assets = post-issue (pro forma) book value of total assets
Book to Market = post-issue (pro forma) book value of equity divided by the first-day's market value of equity
Number of employees = total number of employees disclosed in prospectus
No patents = number of patents held at listing date
No trademarks = number of trademarks held at listing date
No designs = number of designs held at listing date
Total innovation = no patents + no trademarks + no designs
No patent citations = number of citations of patents held at listing date
No trademark citations = number of citations of trademarks held at listing date
$ R&D grants = Dollar value of research and development grants held at listing
R&D expense = total research and development expenses disclosed in income statements in prospectus over 1-3 years
Total innovation /size= no patents + no trademarks + no designs/ number of pre-IPO shares, multiplied by the offer price.
Total innovation /R&D= no patents + no trademarks + no designs/ total research and development expenses
Patent/size= number of patents held at listing date / number of pre-IPO shares, multiplied by the offer price.
Patent/R&D = number of patents held at listing date/ total research and development expenses
R&D /total assets = research and development expenses / total assets

Table 2
Differences in the characteristics of 80 Australian VC/PE backed and 471 non-VC/PE backed IPOs between 1994 and 2006

	non-VC/PE backed (mean)	VC/PE backed (mean)	t-test	MW test
A. Firm characteristics:				
Age	10.78	13.46	-1.14	-1.15
Size	72.96	130.82	-1.48	-4.57[a]
ROE	0.13	0.14	-0.12	-0.11
CF/sales	-3.31	-10.77	1.29	0.02
Total assets	100.40	101.20	-0.03	-2.51[b]
Book to Market	0.46	0.42	0.84	0.13
Number of employees	451.90	524.80	-0.34	0.62
B. Innovation:				
No patents	0.84	3.07	-1.35	-1.48
No trademarks	3.20	10.31	-1.80[c]	-1.00
No designs	0.16	0.39	-0.88	-1.38
Total innovation	4.16	13.58	-2.14[b]	-0.92
No patent citations	0.34	0.88	-0.95	-1.42
No trademark citations	0.12	0.34	-1.50	-1.72[c]
$ R&D grants	0.12	0.60	-2.47[b]	-3.87[a]
R&D expense	0.65	1.08	-0.79	-0.41
Total innovation /size	0.21	0.22	-0.16	-1.42
Total innovation /R&D	5.80	1.44	2.22[b]	-0.54
Patent/size	0.05	0.08	-1.22	-1.46
Patent/R&D	2.69	0.95	1.05	-1.11
R&D/ Total assets	2.90	0.72	2.21 [b]	0.54

[a], [b], and [c] indicate significance at 1%, 5%, and 10%, respectively.
Age = the difference between the IPO year and the founding year in the IPO prospectus
Size = number of pre-IPO shares, multiplied by the offer price.
ROE = Net Profit After Tax /Book Value of Equity for year end before listing
CF/sales = Operating Cash Flow/Sales for year end before listing
Total assets = post-issue (pro forma) book value of total assets
Book to Market = post-issue (pro forma) book value of equity divided by the first-day's market value of equity
Number of employees = total number of employees disclosed in prospectus
No patents = number of patents held at listing date
No trademarks = number of trademarks held at listing date
No designs = number of designs held at listing date
Total innovation = no patents + no trademarks + no designs
No patent citations = number of citations of patents held at listing date
No trademark citations = number of citations of trademarks held at listing date
$ R&D grants = Dollar value of research and development grants held at listing
R&D expense = total research and development expenses disclosed in income statements in prospectus over 1-3 years
Total innovation /size= no patents + no trademarks + no designs/ number of pre-IPO shares, multiplied by the offer price.
Total innovation /R&D= no patents + no trademarks + no designs/ total research and development expenses
Patent/size= number of patents held at listing date / number of pre-IPO shares, multiplied by the offer price.
Patent/R&D = number of patents held at listing date/ total research and development expenses
R&D /total assets = research and development expenses / total assets

Table 3
VC/PE backing and innovation for 80 Australian VC/PE backed and 471 non-VC/PE backed IPOs between 1994 and 2006

	Negative binomial regression	OLS regressions		
	Total innovation	Total innovation /R&D	Total innovation /size	R&D/ size
VCPE	0.65	-0.01	-0.01	0.01
	(2.64)[a]	(-0.01)	(-0.28)	(0.31)
Size	0.11	-0.08		
	(1.76)[c]	(-2.04)[b]		
ROE	-0.13	-0.13	-0.07	-0.02
	(-1.07)	(-1.42)	(-1.77)[c]	(-1.23)
Book to Market	-0.53	-0.05	-0.01	0.00
	(-2.14)[b]	(-0.30)	(-0.07)	(0.18)
Age	0.33	0.13	0.01	0.01
	(4.78)[a]	(3.19)[a]	(0.07)	(1.45)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
N	520	432	516	432
R^2		0.12	0.04	0.08
Chi^2	119.18			

[a], [b], and [c] indicate significance at 1%, 5%, and 10%, respectively

VCPE = a dummy variable equal to 1 if the IPO is VC/PE backed
Size = ln (total assets)
ROE = Net Profit After Tax /Book Value of Equity for year end before listing
Book to Market = post-issue (pro forma) book value of equity divided by the first-day's market value of equity
Age = ln (the difference between the IPO year and the founding year in the IPO prospectus)
Total innovation = no patents + no trademarks + no designs
Total innovation /R&D= no patents + no trademarks + no designs/ research and development expenses disclosed in income statements in prospectus over 1-3 years
Total innovation /size= no patents + no trademarks + no designs/ number of pre-IPO shares, multiplied by the offer price.
R&D /size= research and development expenses / total assets

Table 4

VC/PE backing and innovation for 80 Australian VC/PE backed and 471 non-VC/PE backed IPOs between 1994 and 2006

This table presents the 2 stage least squares regression results. In the first stage, VC/PE backing is estimated using probit regression. In the second stage, the fitted values of VC/PE backing from the first stage regression are replaced for actual VC/PE backing variable. The dependent variable in the second stage regression is the measure of innovation. Negative binomial regressions are used for the number of total innovation measures. OLS regression is used for the scaled innovation measures. The regressions include industry and year fixed effects.

	1st stage	2nd stage			
	Probit model	Negative binomial regression	OLS regressions		
	VCPE dummy	Total innovation	Total innovation /R&D	Total innovation /size	R&D /TA
Innovation	0.03				
	(0.50)				
Pred VCPE		3.43	3.19	1.35	0.22
		(2.53)[b]	(3.96)[a]	(3.03)[a]	(1.88)[c]
Size	-0.10	0.21	-0.02		
	(-2.49)[b]	(3.06)[a]	(-0.53)		
ROE		-0.09	-0.10	-0.05	-0.01
		(-0.71)	(-1.19)	(-1.58)	(-1.18)
CFSales	0.08				
	(2.06)[b]				
R&D grant	0.71				
	(3.10)[a]				
Book to Market		-0.57	-0.02	0.03	0.01
		(-2.29)[b]	(-0.15)	(0.30)	(0.33)
Age	-0.10	0.38	0.18	0.02	0.01
	(-1.79)[c]	(5.37)[a]	(4.42)[a]	(1.53)	(2.84)[a]
Year fixed effects	No	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
N	536	517	430	512	430
R^2			0.16	0.08	0.10
Chi^2	227.66	117.23			

[a], [b], and [c] indicate significance at 1%, 5%, and 10%, respectively.

Innovation = ln(1+Total innovation) = ln (1 + no patents + no trademarks + no designs)

Pred VCPE = the fitted values of VC/PE backing from the first stage regression

Size = ln (total assets)

ROE = Net Profit After Tax /Book Value of Equity for year end before listing

CF/sales = Operating Cash Flow/Sales for year end before listing

Book to Market = post-issue (pro forma) book value of equity divided by the first-day's market value of equity

Age = ln (the difference between the IPO year and the founding year in the IPO prospectus)

Total innovation = no patents + no trademarks + no designs

Total innovation /R&D= no patents + no trademarks + no designs/ research and development expenses

Total innovation /size= no patents + no trademarks + no designs/ number of pre-IPO shares, multiplied by the offer price.

R&D /size= research and development expenses / total assets

Table 5

Simultaneous equations model for VC/PE backing and innovation for 80 Australian VC/PE backed and 471 non-VC/PE backed IPOs between 1994 and 2006

This table presents the 3 stage least squares regression results The VCPE dummy is a dichotomous variable and innovation is a continuous variable.

	Model 1		Model 2		Model 3	
	VCPE dummy	Total innovation / R&D	VCPE dummy	Innovation	VCPE dummy	R&D/ TA
Total innovation /R&D	-0.45					
	(-0.75)					
Innovation			0.63			
			(1.15)			
R&D/ TA					4.21	
					(0.28)	
VCPE		0.49		0.59		0.02
		(2.21)[b]		(2.22)[b]		(1.99)[b]
Size	0.24	-0.21	0.15	-0.04	0.28	
	(3.08)[a]	(-2.80)[a]	(1.83)[c]	(-0.58)	(3.83)[a]	
ROE		-0.12		-0.01		-0.02
		(-1.05)		(-0.09)		(-1.65)[c]
CFSales	-0.10		-0.03		-0.06	
	(-1.85)[c]		(-0.39)		(-0.48)	
R&D grant	0.91		0.53		0.33	
	(2.01)[b]		(1.87)[c]		(0.29)	
Book to Market		0.06		-0.25		0.01
		(0.26)		(-1.12)		(0.65)
Age	0.08	0.11	-0.08	0.14	0.01	0.01
	(0.91)	(2.13)[b]	(-0.73)	(2.77)[a]	(0.04)	(0.88)
Hotmkt1		-0.15		-0.25		-0.01
		(-0.81)		(-1.29)		(-0.33)
Hotmkt2		-0.48		-0.37		0.01
		(-2.27)[b]		(-1.63)		(0.25)
Intercept	-1.94	1.43	-2.18	2.04	-2.05	0.02
	(-5.34)[a]	(2.69)[a]	(-5.31)[a]	(3.55)[a]	(-6.08)[a]	(0.87)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	430		517		430	

[a], [b], and [c] indicate significance at 1%, 5%, and 10%, respectively.

Innovation = ln(1+Total innovation) = ln (1 + no patents + no trademarks + no designs)

VCPE = a dummy variable equal to 1 if the IPO is VC/PE backed

Size = ln (total assets)

ROE = Net Profit After Tax /Book Value of Equity for year end before listing

CF/sales = Operating Cash Flow/Sales for year end before listing

Book to Market = post-issue (pro forma) book value of equity divided by the first-day's market value of equity

Age = ln (the difference between the IPO year and the founding year in the IPO prospectus)

Hotmkt1 = a dummy variable equal to 1 if the IPO listed in 1999-2000

Hotmkt2 = a dummy variable equal to 1 if the IPO listed in 2004-2005

Total innovation = no patents + no trademarks + no designs

Total innovation /R&D= no patents + no trademarks + no designs/ research and development expenses

R&D /size= research and development expenses / total assets