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Mark Humphery-Jenner

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Stimulating Venture Activity Through Government Investment in Venture Funds

Mark Humphery-Jenner*

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Abstract
Innovation and R&D are important to economic growth. One argued way to encourage innovation is through government support for venture funds. This might be especially important in countries that lack a developed venture capital (VC) sector. However, some papers have suggested that this government backing might 'crowd out' purely private sector funds and might undermine innovation creation. Thus, I examine the use of a scheme in Australia (the Innovation Investment Fund (IIF) scheme). I focus on Australia because unlike many low innovation countries, it has strong legal foundations, enabling a cleaner look at the impact of government backing. I argue that Australia's scheme is well structured. I then show that while Australia has relatively low levels of VC and innovation compared with other countries, its VC activity scaled by GDP has grown following the inception of the IIF scheme, particularly increasing after 2001. The policy implication is that properly structured government support for VC funds can stimulate innovation and VC activity.

Keywords: Innovation Investment Funds, government investment, venture capital.

1. INTRODUCTION

Innovation and research can encourage economic and social development.[1] The government can increase innovation by directly investing in research. However,

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[1] See for, example, Fei and Ranis, 1963; Arup, 1990; Bagchi-Sen and Ghosh, 2005.

public expenditure may be sub-optimal due to a lack of resources (McGinnis et al., 2002) and the latent inefficiencies of a government bureaucracy (Sakakibara, 1997). An alternative way to stimulate innovation is to provide grants and subsidies to private organisations that undertake research, and to venture funds that might invest in that research. Such schemes have existed in Australia, and to a lesser extent in the United Kingdom, the United States and parts of Europe. The utility of these grants and subsidies is the focus of this article.

Venture capital (VC) is an important driver of innovation. Venture capital funding has stimulated economic growth in the United States. It is also an important determinant of start-up financing (Nofsinger and Wang, 2011) and a catalyst for improving corporate governance (Suchard, 2009). However, these benefits rely on there being a strong domestic VC sector, with foreign funds being less able to nurture start-ups due to problems of geographical distance and informational symmetry (Dai et al., 2011; Wang and Wang, 2011a, 2011b). This poses a problem in smaller markets, such as Australia, where there is a lack of trained venture capitalists (VCs) and the small market might make it prohibitively risky and costly for professionals to start a VC fund. Some governments have attempted to resolve this by either establishing their own venture funds or backing existing VC funds.

Support for VCs and innovation can come from the government. In the United States, government funding accounts for around 20-25% of all money invested in venture-stage technology firms (Auerswald and Branscomb, 2003). There are some government-funding policies in continental Europe. However, they are sporadic, with a dearth of public funding existing in some countries, such as Belgium (Bozkaya and Van Pottelsberghe de la Potterie, 2008). The issue is then how the government can appropriately fund venture investment and innovation.

Governments can try to stimulate innovation by establishing their own VC funds. There are two problems with establishing a government-run venture fund. First, it tends to 'crowd out' private venture involvement (Wallsten, 2000; Cumming and MacIntosh, 2006). This is a problem because it discourages the growth of private sector venture capital by depriving it of some profitable investments. Second, it can lead the government to attempt to 'pick winners'. This is a problem because, compared with private sector VCs, government administrators generally lack performance-based compensation and are usually less financially exposed to failed investments. This can induce government departments to invest inefficiently while depriving private sector VCs of investment opportunities.

An alternative to establishing a government venture fund is to incentivise and fund private sector VCs. Australia has adopted such a scheme. An issue with assessing such schemes is that many of them exist in high-innovation countries (e.g., the US and UK). This makes it difficult to determine whether any VC activity is due to the scheme or to the stimulatory effect of latent innovation.[2] However, most low-

[2] Some prior studies suggest that the latent level of innovation in an economy might stimulate VC activity: Engel and Keilbach (2007); Shiri and Trabelsi (2009).

innovation countries with such systems of grants or government backing (e.g., Turkey) score relatively poorly on established measures of sovereign risk and governance, making it difficult to know if a failed scheme is due to the chilling effect of poor governance or to the scheme being ineffective. A workaround is to examine Australia, a low-innovation country with strong legal mechanisms and an otherwise well-developed financial market.

Australia is an ideal market in which to examine the impact of a government innovation scheme. Australia is a low-innovation country; it has historically ranked in the bottom half of all OECD countries in terms of R&D/innovation (Department of Industry Tourism and Resources, 2003) and its innovation output is below that of countries such as Denmark, Finland, Germany, and Norway (Gans and Stern, 2003; Gans and Hayes, 2010). However, Australia has well-developed (non-VC) financial markets[3] and scores relatively highly on most measures of sovereign risk and governance, including the ICRG sovereign risk index and the World Bank governance scores.[4]

The Australian government has adopted a scheme of subsidies and grants through the Innovation Investment Fund (IIF) programme. The enabling legislation is the Industry Research and Development Act 1986 (Cth). The regulator is the Department of Innovation, Industry, Science and Research (DIISR). Under the IIF programme, the government provides capital to VC funds to invest in start-up companies. The government takes no ownership stake in the fund or the portfolio company and does not have a claim on the returns. There have been three Rounds of IIF funding. The government promulgated the first IIF scheme in 1997. The IIF programme has proceeded in three investment Rounds, each Round opening in 1998, 2001 and 2007. The most recent tranche of the current Round closed in 2010 (Carr, 2010). For each Round, funds can apply for government funding, and the funds would commence investment in the years after receiving approval. Thus, in each Round, any actual investment would occur several years after the Round opens for investment. This scheme provides an environment in which to examine the impact of government backing of VC funds.

The issue is to find an appropriate funding policy. I focus on Australia's venture policy. Thus, the purpose of this article is twofold. First, the article analyses whether the text of the IIF scheme contains provisions are likely to create value. This involves an analysis of whether the scheme contains appropriate criteria for selecting VC funds in which to invest. Second, the article empirically tests whether the IIF scheme has so far increased the amount of VC investment.

The results show that the text of the IIF scheme is justified. First, the IIF scheme's provisions ensure that the government invests in VC funds with the rele-

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[3] For example, Australia has well-developed trading mechanisms that encourage high-frequency trading and liquid equities markets (Humphery-Jenner, 2011).

[4] The ICRG risk index contains subscription data. The World Bank data are available from: <http://info.worldbank.org/governance/wgi/index.asp>.

vant level of experience, expertise and record of success. Second, the data show (a) that there has been less VC activity in Australia than in other countries, but that (b) the IIF scheme has encouraged VC in Australia to follow a similar trend to that in other countries, and that the scheme has increased the level of VC investment in Australia compared with that in other countries (after 2001, when the first Round of IIF-backed funds had begun investing). While the third Round of investment is still in progress and a complete evaluation is not possible, these results indicate that government stimulus is desirable.

This analysis makes a key contribution to the literature. The article shows that an effective way to encourage innovation is through a series of government grants designed to direct VC investment into innovative areas. This is the first article to examine the impact of the IIF scheme on the aggregate level of venture activity and to compare the level of venture activity with that in other countries. This is also the first article to evaluate the text of the IIF scheme. The implication for Australia is that the IIF scheme is justified and that the government can continue to pursue this as a way to create value in the VC industry. The implication for other countries is that governments can pursue a scheme of matching private sector funding in order to encourage innovation.

This paper also supports prior literature on effective government regulation. Previous literature has highlighted that government incentives and subsidies are ways to stimulate value-creating activity (Balch, 1980; Grabosky, 1995). The literature has also argued that 'command-control' type regulation might not be effective (Aalders and Wilthagen, 2002). I support these arguments by showing that incentives are an effective way of stimulating venture activity.

This article is related to prior literature on regulation and VC/PE funds. The literature broadly shows that public policy is important to venture capital; however, it has not examined the impact of government investment on aggregate venture activity. Some literature suggests that government policy in general influences innovation and R&D (see Jenkins et al., 2006; Kirejczyk, 2009; Zeegers, 2009) and the performance of hedge funds (Cumming and Dai, 2010a, 2010b) or the performance of VC/PE funds (Cumming, 2011). Important factors include bankruptcy laws (Armour and Cumming, 2008), IT investment (Cumming and Johan, 2010a) and tax law (Keuschnigg and Nielsen, 2003). Furthermore, laws influence institutional investor participation in VC/PE investment (Cumming and Johan, 2007). Cumming (2007) and Cumming and Johan (2009) suggest that government-backed seed and pre-seed funds perform well, but they do not dissect the text of the relevant legislation and do not analyse the impact of government intervention on the aggregate level of venture activity. Overall, while the literature shows that public policy is important to venture capital, it has not examined the impact of a key mechanism – direct investment – on venture capital activity.

The balance of the paper proceeds as follows. Section 2 details the IIF scheme, with a particular emphasis on the content of the current (Round Three) programme. Section 3 examines whether the key provisions in the scheme are justified and are

likely to encourage value-creating innovation. Section 4 tests whether there is empirical support for the IIF scheme by comparing the level of VC investment in Australia with that in other countries. Section 5 concludes that the IIF scheme is justified and does encourage investment in the VC sector.

2. WHAT ARE THE REFORMS?

The Innovation Investment Fund (IIF) scheme involves the government contributing funds to enable VC mangers to invest in start-ups. It has proceeded in several Rounds (or programmes). The government does not take an ownership stake in either the start-up or the VC fund and has no claim on the returns. Thus, this is not a co-investment scheme. The IIF programme has proceeded in three investment Rounds, in 1998, 2001 and 2007. The government invested AUDm 221 in Rounds One and Two and intends to invest up to AUDm 200 in Round Three. The private sector matched the government funding up to a maximum of two to one in Rounds One and Two, and must match the government at least one to one in Round Three.

The enabling legislation is the Industry Research and Development Act 1986 (Cth). Each IIF Round has a separate legislative instrument (collectively called 'IIF scheme').[5] The current provisions are in the third Round of IIF funding and are contained in the 'Innovation Investment Fund Program Round Three Direction No. 1 of 2006'.

Each IIF Round contains similar provisions. The presently relevant similarities are twofold. First, Clause 5 of all IIF programmes requires the administrator to consider the policy objectives of the IIF programme.[6] Second, all three IIF programmes contain a set of guidelines with which to assess funds that apply for IIF funding. Each of the IIF programmes contains different requirements. The main difference is that the Round One and Round Two requirements are more specific than the Round Three requirements.[7]

The Third Round IIF programme contains 20 clauses. Clauses 1-4 pertain to preliminary matters and interpretation. Clauses 5-7 impose the requirement that the IIF Board consider applications for IIF funding. Clause 5 requires that the IIF Board consider particular policy objectives when assessing an application. Clauses 6 and 7

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[5] Round One is under: *R&D Start Program, Policies and Practices of the IR&D Board in Relation to the Innovation Investment Fund (IIF) Program Direction No. 1 of 1997*. Round Two is under: *Policies and Practices of the IR&D Board in Relation to the Innovation Investment Fund Program Round Two Direction No. 1 of 1999*. Round Three is under: *Innovation Investment Fund Program Round Three Direction No. 1 of 2006*.

[6] This is stated in Clause 5 of all three programmes.

[7] The main example is the requirement that the VC fund exhibit expertise; for example, Clause 15 of the Round One and Round Two programmes lists specific types of expertise, whereas Clause 9 of the Round Three programme allows the regulator to consider expertise broadly.

stipulate the consideration procedure. Clause 8 requires that the IIF Board assess applications subject to the exceptions in Clause 7. Clause 9 non-exhaustively details the factors that the IIF Board must consider when assessing the merit of an application. Clauses 10-20 contain other matters that are not presently relevant, including how a fund can change its structure after it receives funding.

The key clauses are Clause 5, 8 and 9. It is useful to enumerate them in full:

Board to have regard to certain policy objectives

5. The Board must have regard to the following policy objectives in giving effect to these directions:
   (a) to develop fund managers with experience in the early stage venture capital industry;
   (b) by addressing capital and management constraints, to encourage the development of new companies which are commercialising research and development;
   (c) to establish in the medium term a 'revolving' or self funding scheme; and
   (d) to develop a self-sustaining Australian early stage, venture capital market.

Assessment of applications

8. Subject to clause 7, the Board must assess each eligible application on its merit according to the extent to which the application meets the merit criteria (as set out in clause 9 below).

Merit criteria

9. The technical merit of eligible applications must, amongst other things, be assessed against the following criteria:
   (a) whether the proposed applicant has effective strategies to contribute to the training and developing of Australian based staff in all aspects of making venture capital investments in early stage companies;
   (b) the proposed size of the fund and ratio of privately sourced capital to Commonwealth program capital (subject to the Commonwealth program capital not exceeding a 1:1 ratio to the privately sourced capital and the Commonwealth program capital being no more than $20 million);
   (c) the level and structure of management fees proposed;
   (d) the applicant's capacity and experience in early stage equity investing giving particular attention to realising returns from investments, sourcing investment opportunities and managing an investment portfolio;
   (e) whether the applicant has a balanced management team including relevantly qualified and skilled personnel;
   (f) whether the applicant has an understanding of, and experience in, dealing with issues related to Australian and international investments, products, services and markets; and
   (g) whether the applicant has a demonstrated willingness to operate within the intent of the IIF program.

The clauses yield four common themes. First, the IIF provisions emphasises expertise. Clause 5(a) states that developing expertise within the VC industry is a key policy goal. Clause 9(a) operationalises this. Clauses 9(d), (e) and (f) indicate that the IIF Board should consider the fund's existing expertise.

Second, fees are a factor. Clause 9(c) requires that the IIF Board consider the fee structure. In this context, the fee typically comprises: (1) a flat fund-management fee that is a percentage of the funds under management; and (2) a percentage 'bonus' that arises if and when the fund exceeds a certain threshold return or internal rate of return (IRR) (Korteweg and Sorensen, 2009; Phalippou and Gottschalg, 2009).

Third, a prior performance track record is important (Clause 9(d)); however, it is not determinative as Clauses 10 and 11 explicitly allow the IIF Board to give preference to 'new' managers without a track record.

Fourth, some form of past or present diversification across geographies and industries is desirable. Clause 9(f) suggests that the IIF Board consider the applicant's international experience and also suggests that the IIF Board consider experience across 'products, services and markets'. This implies that the government will focus on the fund manager having a diverse set of experiences. The provisions do not require that the VC manager's present fund operates in a diverse set of industries.

The following sections analyse whether the content of the IIF provisions is justified (section 3) and whether the IIF scheme has stimulated VC investment in Australia (section 4).

3. IS THE IIF SCHEME A JUSTIFIED RESPONSE?

The first key issue is whether the particular provisions of the IIF scheme will achieve their policy purpose of stimulating value-creating innovation. I focus on the provisions in the third Round of IIF funding. The analysis proceeds by examining the four key themes in Clauses 5-9: expertise, fees, experience and diversification.[8]

Expertise: The IIF provisions emphasise the creation and utilisation of expertise in the VC industry. This has two inter-related aspects: (1) developing VC expertise; and (2) exploiting connections with other VCs. This is likely to create value.

The evidence suggests that this past experience enables VC managers to create value: Hochberg, Ljungqvist and Lu (2007) show (a) that better-connected VCs generate higher returns (and thus corporate value) and are more successful at exiting

[8] I note that there are some relevant factors that are not in Clauses 5-9. These include the contractual relationship between the VC and the portfolio company, which can influence the company's performance (Bienz and Hirsch, 2012; Repullo and Suarez, 2004). However, the government cannot control all such contracts, and thus it appears unrealistic to expect it to legislate on them.

investments, and (b) that the companies in which connected VCs invest are more likely to avoid bankruptcy. They suggest that this may be because connections allow VC managers to share technical knowledge and to form investment syndicates. Humphery-Jenner (2012) confirms this result, finding a positive relationship between a fund's IRR and its connections (e.g., number of professionals who have sat on other boards or have run other companies in the Execucomp universe). Demiroglu and James (2010) show that VC/PE reputation (and connections, by proxy) makes it easier to raise capital and to do so on better terms. Overall, this implies that connections facilitate value creation and may benefit innovation creation. Furthermore, by emphasising the development of VC expertise, the scheme should encourage the long-term development of the VC industry.

Fees: The IIF scheme highlights the importance of fees. The provisions are 'vague' in that they do not specify the precise form or level of fees.[9] VC fees typically involve a fixed fee (paid on capital under management) and a percentage of the fund's returns over a particular threshold (Korteweg and Sorensen, 2009; Phalippou and Gottschalg, 2009; Metrick and Yasuda, 2010). The fixed fee is typically between 1.5%-2% of funds under management. The performance bonus (called 'carry') is typically around 20% or the excess return.

Three factors are important: (a) the overall level of fees; (b) the structure of the fees; and (c) the heterogeneity of fees between funds. First, the overall level of fees is important. High fee levels reduce overall investment returns (Phalippou and Gottschalg, 2009; Humphery-Jenner, 2012) and thus implicitly reduce value of innovation. Second, Phalippou and Gottschalg (2009) show that fixed fees reduce returns by twice as much as do incentive fees. To an extent, this is obvious: higher fees mean less money for portfolio companies. However, a more surreptitious impact is on investment behaviour: high fixed fees reduce the need to rely on a performance bonus. If the company is borderline for reaching the bonus threshold, the ability to simply rely on fixed management fees might deter risky/innovative investments, thereby reducing the fund's ability to drive innovation.

Together, these results imply that the focus on fees in Clause 9(c) is justified. Fees can harm returns, but are necessary to encourage VCs to invest in companies. The vagueness of the provisions allows the regulator to adapt the Clause to the circumstances of the particular VC fund under consideration (following Eskridge, 1987; Eskridge and Frickey, 1990; Graham, 2002). This allows the government to encourage value creation while limiting the capacity of VC managers to extract rents while still enabling them to earn an adequate return for their effort.

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[9] It is vague in the technical sense that the words are capable of myriad meanings, thereby mandating that the court consider the purpose of the statute when interpreting it (following Graham, 2001, 2002; Coxon, 2009; Humphery-Jenner, 2009; Tsen-Ta Lee, 2010; Sainsbury, 2011).

Prior performance and experience: The IIF provisions suggest that prior performance is an important but non-determinative factor. This is justified. Where there is some evidence of VC/PE performance persistence (Kaplan and Schoar, 2005), the performance/experience relationship is nuanced; experience can, but need not, increase returns.

First, Metrick and Yasuda (2010) suggest that prior performance increases revenues (but mainly for buyout funds, not VC funds). The main explanation is that prior performance enables managers to create larger funds and to benefit from increased revenues per partner. Furthermore, Phalippou (2010) indicates that this relationship between performance and fund size exists mainly if the fund's backers are 'unskilled'. The implication is that skilled backers look at a range of factors when investing, whereas unskilled factors just consider raw prior returns. Overall, this suggests that prior performance need not mean higher future performance.

Second, Shepherd, Zacharakis and Baron (2003) suggest a quadratic relationship between returns and experience. That is, 'excess' experience may reduce returns. The hypothesis is that excess experience may make VCs narrow-sighted and thus reduce their ability to find new and innovative sources of profit. Arguably, a way to ameliorate this is to require VC managers to have functioned in a diverse range of industries and to encourage knowledge transfers between new and established VC professionals.

The IIF provisions should capture the nuanced relationship between prior performance and future performance. The IIF scheme contains provisions that should allow experience to generate value. The IIF provisions do encourage diversification (Clause 9(f) on diverse geographic experience) and the interaction of established VC professionals with the training of new VC professionals (Clauses 9(a) and (e) read together). The IIF scheme also allows the regulator to favour 'new' VC managers (see Clauses 10 and 11). Overall, this suggests that the IIF scheme's approach to prior performance and experience should create value.

Diversification: The IIF scheme suggests that diverse experiences are desirable but does not mandate diversification in the present fund. This approach is justified.

Industry and geographic diversification can create value. The rationale is that broad industry experiences enable VC professionals to generate new knowledge synergies (Rind, 1981; Siegel et al., 1988; Hurry et al., 1992; Sapienza et al., 2004). For example, skills gained by managing a retailer would provide a manager with insights to use when advising a supplier. The gains particularly arise when there is vertical diversification along a production chain, for this best enables knowledge sharing (Lin and Lee, 2009). Here, the skills gained from one industry are more directly applicable to another industry, enabling easier transportation of skills and experience. However, diversification does not always increase value. Instead, specialisation can create value because (a) it enables the VC manager to remain focused, and (b) it increases the chances that the portfolio companies face similar problems and thus are more likely to benefit from each other's experiences (Norton and Tenenbaum, 1993).

The IIF scheme takes a flexible approach. It indicates that diverse experiences are beneficial (see Clause 9(f)) but does not mandate diversification in the current portfolio. This appears to best balance the benefits and disbenefits of diversification.

It is significant to note the aspects that the legislation does not emphasise. Importantly, the legislation does not favour large funds. This is important because the literature shows that large funds tend to devote less attention to each investment and create less value (Cumming, 2006; Cumming and Dai, 2011; Humphery-Jenner, 2012). Cumming and Dai (2011) suggest that this could be because large fund size causes funds to spread staff too thinly across investments (the 'limited attention' problem). Humphery-Jenner (2012) argues that large funds are simply less skilled at managing venture companies due to the limited attention problem and are less able to screen for quality ventures due to the size than relatively smaller and more specialised VCs.[10] Furthermore, Humphery-Jenner (2012) contends that large funds have a comparative advantage in managing larger companies (doing buyouts) rather than investing in smaller companies, so they will generally only invest in smaller companies if they lack profitable opportunities in the buyout space, thereby inducing the 'money chasing deals' problem, raised in Gompers and Lerner (1998).

Overall: The overall conclusion is that the provisions of the IIF scheme are justified. They focus on choosing to invest in funds that have expertise, experience and a track record of success. These types of funds should make value-creating innovation investments. The issue is then whether the IIF scheme has encouraged VC investment.

4. IS THERE EMPIRICAL SUPPORT FOR THE IIF SCHEME?

The second issue is whether there is empirical support for the IIF reforms. The empirical goal is to determine whether the IIF scheme has increased the level of VC investment. This involves a comparison of VC investment in Australia with VC investment in other developed nations (e.g. Canada, the United States and the United Kingdom).

4.1 Empirical approach and data

The empirical approach is similar in spirit to a difference-in-difference test.[11] The IIF scheme is successful if it increases the amount of VC investment in Australia compared with that in other countries. It is important to compare the level of VC

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[10] Specifically, the hypothesis is that small VCs have funding constraints, so have access to a smaller set of investments. This decreases the number of investments needing analysis, reducing screening time and enabling small funds to cherry-pick profitable small companies. Large funds have a larger set of investments. This delays large funds from analysing smaller companies. This delay could cause large funds to cede a first-mover advantage to small funds.

[11] See, for example, the approaches in Cumming et al., 2011.

investment in Australia with that in other countries in order to address the concern that VC investment has increased (or decreased) for extraneous market-related reasons.

To make the approach concrete, there are two samples: Australia, and other countries. One sample (Australia) is exposed to the treatment (the IIF programme), the other countries are not. The treatment date is not precise. There are three Rounds of funding: Round One commences in 1998, Round Two commences in 2001 and Round Three, which commences in 2007 and involves three tranches. However, VC funds do not invest the money immediately and do not invest their money all at once. Instead, they have spread the funding from each Round over time.[12] Thus, the goal is to examine whether there has been an upward trend in the level of VC investment in Australia versus that in other countries.

Data on VC deals come from Thomson VentureXpert. The sample comprises deals from Australia, the UK, the US and Canada. Australia is the sample of interest. The UK, the US and Canada are comparison samples. The deal must post-date 1980 and the portfolio company must have been founded after 1980. The post-1980 restriction is because VentureXpert data are unreliable before 1980 (Humphery-Jenner, 2012). The paper only considers start-up or venture deals, and only focuses on high-tech deals because Clause 5 explicitly contemplates technology transfer and R&D, which is lacking in non-tech and non-start-up deals. Additional data on the GDP and market capitalisation for Australia, the UK, the US and Canada come from the World Bank. The paper uses the GDP and market capitalisation data to standardise the level of VC investment by the size of the economy.[13]

The focus is on portfolio companies (rather than VC funds). This is because the focus is on the outputs of the VC industry. The sample contains 338 portfolio companies from Australia, compared with 17,139 from the United States, 1,762 from the United Kingdom and 1,278 from Canada. Table 1 contains the industries in which the portfolio companies operate. The figures indicate that Australian VC deals tend to focus more on healthcare and biotech and less on computers and electronics than in other countries. Thus, it is unsurprising that recipients of IIF funding focus on healthcare and biotech.[14]

4.2 **Analysis**

This section analyses the change in VC investment. To summarise, VC investment is lower in Australia than in other countries, but it does follow a similar trend to other countries and has increased since 2001 (i.e., in the few years since the IIF programme began). This implies that government stimulus is desirable and that the IIF programme has so far been effective. I present several sets of results.

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[12] The government explicitly envisages an investment horizon of 10 years, see AusIndustry, 2010.

[13] This is important because Australia's economy is smaller than that of Canada, the UK and the US, and thus, comparing the raw amount of investment might be misleading.

[14] For details on grant recipients, see Carr, 2010.

Table 1: VC investment by industry segment and country

This table contains the number of unique portfolio companies in each industry. Panel A contains the raw number of companies. Panel B contains the proportion of companies in each industry. The data are from Thomson VentureXpert.

Industry	All countries	Aus	US	UK	Can
Panel A: Number of companies					
Biotechnology	1,661	47	148	135	147
Communications and media	3,589	61	282	199	207
Computer-related	10,471	141	899	660	682
Medical/health/life science	3,126	64	300	149	154
Semiconductors & electrical	1,670	25	133	135	138
Total		338	1,762	1,278	1,328
Panel B: Proportion of companies					
Biotechnology	8.1%	13.9%	8.4%	10.6%	11.1%
Communications and media	17.5%	18.0%	16.0%	15.6%	15.6%
Computer-related	51.0%	41.7%	51.0%	51.6%	51.4%
Medical/health/life science	15.2%	18.9%	17.0%	11.7%	11.6%
Semiconductors & electrical	8.1%	7.4%	7.5%	10.6%	10.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

First, I look at the raw number of companies that subsequently receive VC backing. Table 2 contains the number of portfolio companies in each country by company founding year. Note, these do not per se plot the actual amount of VC investment or the date of the VC investment (merely when the innovative company was founded). I make several observations.

The key observations are that (1) Australia has fewer VC deals than the other three countries, and (2) the ratio of Australian VC to non-Australian VC appears stable over time. The historical dearth of VC investment in Australia is unsurprising given that Australia has historically under-invested in VC in general. For example, the OECD ranks Australia's innovation output as below that of countries such as Denmark, Finland, Germany and Norway (Gans and Stern, 2003; Gans and Hayes, 2010). Australia has historically ranked in the bottom half of all OECD countries in terms of R&D/innovation (Department of Industry Tourism and Resources, 2003). This general dearth of innovation could feed into the historically low levels of VC activity, given the importance of regional innovation to attracting VC funds.[15]

Another interesting observation in Table 2 is that between 1999 and 2001, more companies (which subsequently received VC investment) were founded. This coincides with the opening of the IIF scheme (with tenders being called for in 1998). This also quadrates with prior findings that VC activity increased during the tech

[15] This follows the observations in Engel and Keilbach, 2007, who suggest that VCs are more concerned with commercialising existing innovations than with developing new ones.

boom, for example (Cumming and MacIntosh, 2006; Coakley et al., 2007; Cumming and Johan, 2009). Note that these results are only illustrative because they do not show the level of investment (as opposed to when the company was founded).

Table 2: VC investment by company founding year

This table contains the number of unique companies that receive VC funding, broken down by the year in which the company was founded. Note that the company need not receive funding immediately. Each company can only appear once in this table. Columns 1-4 show the number of companies founded in each country that receive VC funding. Column 5 divides the number of companies from Australia (Column 1) by the sum of Columns 2-4. The data are from Thomson VentureXpert.

	Companies founded in year *t* that subsequently receive VC funding				
Year *t*	Aus	US	UK	Can	Aus /(US+UK+Can)
	(1)	(2)	(3)	(4)	(5)
1980	1	193	10	16	0.46%
1981	2	280	12	11	0.66%
1982	5	296	13	14	1.55%
1983	6	392	22	19	1.39%
1984	6	336	28	34	1.51%
1985	12	317	19	23	3.34%
1986	13	322	21	42	3.38%
1987	14	366	22	24	3.40%
1988	2	317	17	25	0.56%
1989	5	381	35	31	1.12%
1990	9	297	35	32	2.47%
1991	8	279	38	36	2.27%
1992	9	345	41	35	2.14%
1993	5	387	41	47	1.05%
1994	11	456	50	61	1.94%
1995	15	640	85	70	1.89%
1996	22	794	104	76	2.26%
1997	21	892	110	97	1.91%
1998	19	1144	119	79	1.42%
1999	33	1929	206	114	1.47%
2000	29	1364	197	106	1.74%
2001	23	657	104	73	2.76%
2002	11	645	82	54	1.41%
2003	13	655	64	40	1.71%
2004	11	682	66	35	1.40%
2005	12	728	59	28	1.47%
2006	11	732	68	13	1.35%
2007	5	655	50	21	0.69%
2008	2	378	24	17	0.48%
2009	3	205	12	4	1.36%
2010	0	75	8	1	0.00%
Total	338	17139	1762	1278	1.68%

Second, I examine VC funding by year. I analyse how many companies received VC funding, and the dollar amount of this funding. These results are in Table 3. The important observation from this is that Australia appears to have fewer deals but the number and value of deals follows a similar trend to that in other countries. This is despite Australia under-investing in other areas of innovation per se. This means that even though Australia has under-invested in innovation overall, the VC sector has kept pace with trends in other markets.

To focus on the results in detail: Table 3 shows the number and value of VC deals by year. Columns 1-4 contain the number of VC deals. Columns 5-9 show the value of VC deals. Here, a company can appear multiple times if it receives funding in multiple years. Australia has fewer deals and they are worth less. Figures 1 and 2 illustrate the number of deals and the value of deals by country. They highlight that (a) Australia has fewer deals that are worth less (unsurprising given that Australia is a smaller country), but (b) the number and value of deals in Australia follow a similar patter to that in the other three countries. Together, these results suggest that (a) government investment in the VC industry is desirable because there is less VC investment in Australia,[16] and (b) the IIF scheme has been beneficial by indicating that the scheme has placed VC in Australia in a similar situation to that in other countries despite Australia's historical lack of innovation.

Next, I focus on how VC investment has changed over time compared with the state of the economy. The goal is to control for the possibility that VC investment has increased (in any given country) simply as a function of GDP increasing. To do this, I examine the amount of VC investment scaled by GDP or market capitalisation.

I show (in Table 4) that VC investment increased in Australia after 2001 compared with other countries. This coincides with the scheme opening in 1998, with investments occurring several years after). Table 4 shows the USDm value of VC in each country scaled by the country's market capitalisation and GDP. The important result is the difference between VC/market capitalisation and VC/GDP for (a) Australia, and (b) the other countries. The key finding is that after 2001, Australia's ratios increased over time.

I graphically illustrate these results in Figure 3. Figure 3 plots the differences in VC/market capitalisation and VC/GDP. It shows that while Australia's ratios are lower than those in other countries, it is also true that (a) since 2001 the difference has decreased, and (b) the difference is relatively small in magnitude (the ratio differing by less than 1% in absolute value). This provides further support for the IIF scheme.

The summary of the findings is as follows. First, there has been less VC in Australia than in other countries. This was especially the case prior to 2001. This reflects the general dearth of innovation and R&D in Australia when compared with other countries. Second, the level of VC in Australia follows similar trends to that in other countries. This provides some support for the effectiveness of the IIF scheme.

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[16] Note that these figures do not scale the level of VC activity by the size of the economy.

It shows that while Australia has under-invested in innovation, it has kept pace with other countries in terms of VC activity. Third, the amount of VC activity scaled by has increased in Australia compared with that of other countries since 2001. The 2001 marker is important since this relates to the few years after the inception of Round One of the IIF Scheme. This suggests that the IFF scheme might have inspired additional VC investment.

Table 3: VC investment by year

This table analyses the amount of VC investment by year and by country. Columns 1-4 show the number of companies that receive VC funding in each year. A company can receive funding in multiple years. Columns 5-8 show the total dollar amount of VC funding by year (converted at the prevailing USD exchange rate). The data are from Thomson VentureXpert.

	Number of companies receiving VC funding				Total amount of VC funding (USDm)			
Year	Aus	US	UK	Can	Aus	US	UK	Can
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980		302	1	2		487.0	0.8	3.9
1981		543	1	5		1026.3	0.1	18.2
1982		751	5	2		1439.3	6.8	0.5
1983		998	10	2		2680.6	17.7	1.4
1984		1100	10	4		2762.2	21.6	15.4
1985	1	1049	13	2	0.3	2557.1	20.3	16.5
1986	1	1074	11	7	2.0	2946.7	20.0	25.3
1987	3	1190	12	9	2.1	2970.3	10.9	23.9
1988		1084	12	5		3283.4	33.3	8.1
1989	2	1096	17	5	1.2	3148.4	23.3	15.3
1990		922	14	6		2359.5	19.8	2.8
1991		822	11	67		1765.3	91.7	62.9
1992	3	1006	20	74	4.1	3629.5	57.4	283.8
1993	7	852	12	88	13.5	2995.0	106.7	168.4
1994	6	947	13	107	9.7	3845.6	44.0	144.5
1995	8	1368	16	132	13.0	5883.7	63.7	276.9
1996	12	1949	42	242	34.5	9731.3	252.3	457.4
1997	15	2311	52	368	42.2	13332.7	349.7	697.5
1998	26	2832	87	394	68.6	21411.9	563.8	827.2
1999	70	4171	198	401	183.1	52311.3	1486.1	1536.9
2000	122	6009	535	620	541.4	101082.8	5708.2	3054.5
2001	130	3624	399	491	487.8	38321.5	2543.8	2380.8
2002	103	2594	203	376	303.4	23304.3	1639.4	1325.0
2003	80	2385	167	333	171.3	20652.6	1069.7	1226.2
2004	66	2531	156	315	121.2	24430.7	1368.6	1379.4
2005	73	2602	191	299	235.6	25838.3	1154.1	1287.5
2006	56	2919	241	312	176.7	32164.1	2409.4	1769.4
2007	43	3132	210	302	117.8	31654.6	2233.9	3952.2
2008	38	3156	216	318	183.1	34714.6	2064.4	2277.6
2009	34	2248	164	193	81.4	25244.6	1513.9	952.4

Figure 1
This figure shows the number of companies that receive VC investment each year. Note that a company can receive VC investment in multiple years.

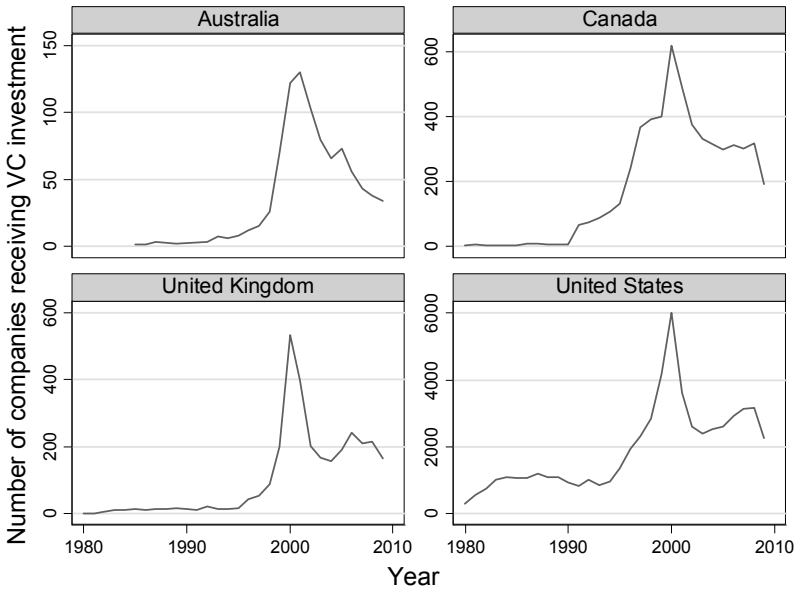


Figure 2: USDm invested by year
This figure shows the total amount invested each year, converted to USDm.

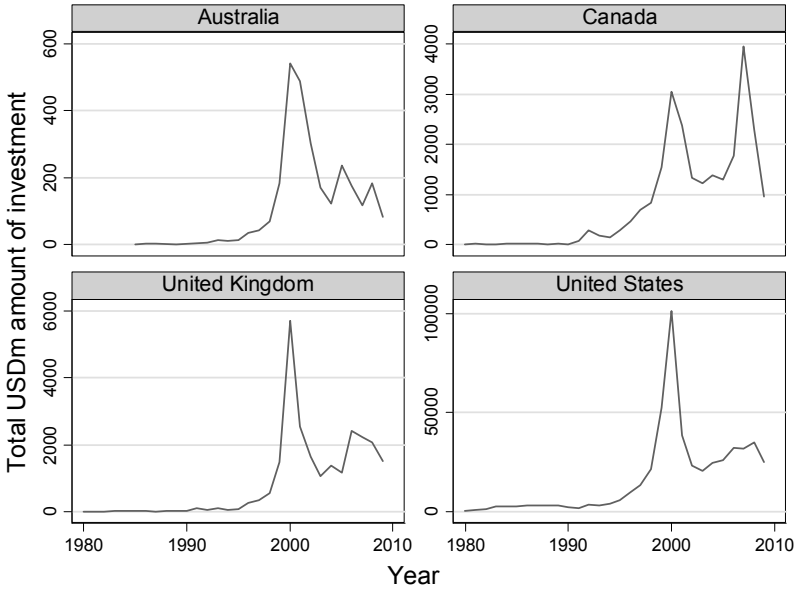


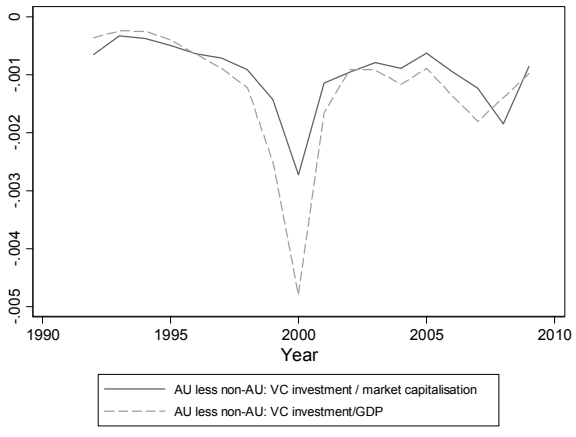
Table 4

This table analyses the amount of VC in Australia versus the average amount of VC in the US, the UK and Canada. Columns 1-3 show the ratio of VC investment to GDP. Columns 4-6 show the ratio of VC investment to market capitalisation.

	VC investments / GDP			VC investments / market capitalisation		
Year	AU	Non-AU	AU less non-AU	AU	Non-AU	AU less non-AU
	(1)	(2)	(3)	(4)	(5)	(6)
1992	0.001%	0.037%	-0.036%	0.003%	0.068%	-0.065%
1993	0.004%	0.029%	-0.024%	0.007%	0.040%	-0.033%
1994	0.003%	0.028%	-0.025%	0.004%	0.042%	-0.037%
1995	0.004%	0.044%	-0.041%	0.005%	0.055%	-0.050%
1996	0.009%	0.073%	-0.065%	0.011%	0.074%	-0.063%
1997	0.010%	0.099%	-0.089%	0.014%	0.086%	-0.072%
1998	0.017%	0.139%	-0.122%	0.021%	0.112%	-0.091%
1999	0.047%	0.298%	-0.251%	0.043%	0.186%	-0.143%
2000	0.130%	0.609%	-0.480%	0.145%	0.418%	-0.273%
2001	0.128%	0.294%	-0.166%	0.130%	0.244%	-0.114%
2002	0.076%	0.167%	-0.091%	0.080%	0.176%	-0.096%
2003	0.037%	0.128%	-0.092%	0.029%	0.108%	-0.079%
2004	0.020%	0.136%	-0.116%	0.016%	0.105%	-0.089%
2005	0.034%	0.123%	-0.089%	0.029%	0.092%	-0.063%
2006	0.024%	0.160%	-0.136%	0.016%	0.111%	-0.095%
2007	0.014%	0.194%	-0.180%	0.009%	0.132%	-0.123%
2008	0.018%	0.157%	-0.139%	0.027%	0.212%	-0.185%
2009	0.009%	0.107%	-0.098%	0.006%	0.093%	-0.086%

Figure 3

This figure shows the difference between VC investment in Australia and average VC investment in the UK, the US and Canada. The solid line is the difference between (a) the average dollar VC investment/market capitalisation in the US, Canada and the UK, and (b) the value of VC investment/ market capitalisation in Australia. Similarly, the dashed line indicates the difference in VC investment/GDP between the average (a) in the US, Canada and the UK, and (b) in Australia. The data for the graph are in Table 4.



The implications are twofold. First, because Australia has less VC than other countries, further stimulus of the VC industry is desirable. Second, the IIF scheme has been at least partially successful because (a) the Australian VC sector has followed similar trends to those of other countries, and (b) the amount of VC (scaled by GDP or market capitalisation) has increased in Australia compared with that in other countries.

5. CONCLUSION

Governments often wish to stimulate innovation and R&D. One way to achieve this is by backing venture capital (VC) funds to invest in innovative start-ups. However, there is some argument that this could crowd out non-government-backed VC (Cumming and MacIntosh, 2006). Furthermore, not all schemes are well structured (Cumming and Johan, 2010b). An additional issue is that most schemes exist in high-innovation countries (e.g., the UK), which makes it difficult to know if changes in VC are due to the scheme or to the stimulatory effect of the latent level of innovation.

This paper examines the Australian Innovation Investment Fund (IIF) scheme. The IIF scheme involves the government matching VC companies' investments in start-up companies. This article (a) analyses whether the government's criteria for selecting in which VC funds to invest are justified, and (b) empirically tests whether the IIF scheme has been beneficial.

The article shows that the text of the IIF scheme is justified and that it has created value. Specifically, the paper suggests that it is justified and beneficial for governments to focus on experienced fund managers who have relevant expertise and a track record of success. The empirical results show that while the IIF programme is not yet complete, the IIF scheme has been beneficial so far. Despite Australia having a relatively low level of innovation by world standards, Australia's VC investment has at least kept pace with that of other countries. Furthermore, compared with other countries, the level of VC scaled by GDP has actually increased in Australia since 2001. This is especially important as Australia first opened the scheme for tenders in 1998 (with investments occurring at the earliest three years thereafter). Read together, these results suggest that Australia's IIF scheme has been a valuable addition to the venture environment.

This paper's findings have policy implications for Australia and for other countries. For Australia, it implies that the government should continue to pursue the IIF scheme, for (a) it has been beneficial so far, but (b) VC investment in Australia still lags behind that in other countries. It is especially important to maintain this support during market downturns, when a dearth of funding opportunities might hamper the VC sector. For other countries, it implies that governments can stimulate innovation by pursuing a scheme of investing in VC funds in order to encourage private sector innovation. The most direct implication is for continental Europe. Some countries face a similar situation to that in Australia: limited innovation but

strong legal regulation and economic development schemes such as the IIF would be most directly portable to such regions. Overall, the results support government involvement in the VC sector and suggest that appropriately structured schemes can encourage innovation.

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