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ECONOMIC GROWTH AND INNOVATION

Can Venture Capital Foster Innovation in Canada? Yes, but Certain Types of Venture Capital Are Better Than Others

by
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- Canada's problem with lagging productivity growth has led policymakers to focus on boosting innovation, in part by supporting Canadian venture capital funding for business.
- But which types of venture capital (VC) funds are most effective in spurring innovation? This study examines that question in the Canadian context by examining the records of VC funding in generating new patent applications for the period 1996-2008.
- Overall, Canadian VC funding spurs innovation more effectively on a dollar-for-dollar basis than investment in research and development (R&D).
- The type of VC fund also matters. Private and institutional VC funds consistently foster innovation; corporate and government VC funds do reasonably well in promoting innovation; but retail, bank and other VC dollars perform poorly on that score.

As Canadian policymakers wrestle with chronically weak Canadian productivity growth, attention has turned to the role that the venture capital (VC) ecosystem plays in fostering innovation. The 2012 Federal budget reflected this focus by earmarking $400 million to support a market for the kind of early-stage risk capital that venture capital funds provide, and without which

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entrepreneurial start-ups often have limited or no access to capital. This study examines which types of VC best serve the goal of promoting innovation.[1] Empirical studies of US data support the idea that venture capital is critical to fostering innovation. One dollar of venture capital may yield proportionately as many successful patent applications as three dollars of research and development (R&D) spending (Kortum and Lerner 2000). This may reflect the stronger equity-building incentives that drive entrepreneurs and the venture capitalists that back them.

To apply US data and conclusions to Canada would be problematic, however, because the structure of the Canadian VC market is different. The US market is dominated by private VC firms, which often are actively involved in adding value to companies in their portfolio as directors, advisors, and managers, and bring critical managerial skills and networks of connections to growing businesses. By comparison, in Canada, investment by US-style private VC funds accounts for a smaller share of the total, ranging anywhere from 9 percent to 20 percent per year (see Figure 1).[2]

Focusing on the Canadian context, this study examines the relationship between VC funds and innovation, as measured by patent applications, for the years 1996 to 2008. The analysis includes foreign and domestic VC funds active in the four Canadian provinces with significant VC markets. The goal is to determine which types of VC funds best promote innovation (see Box 1).

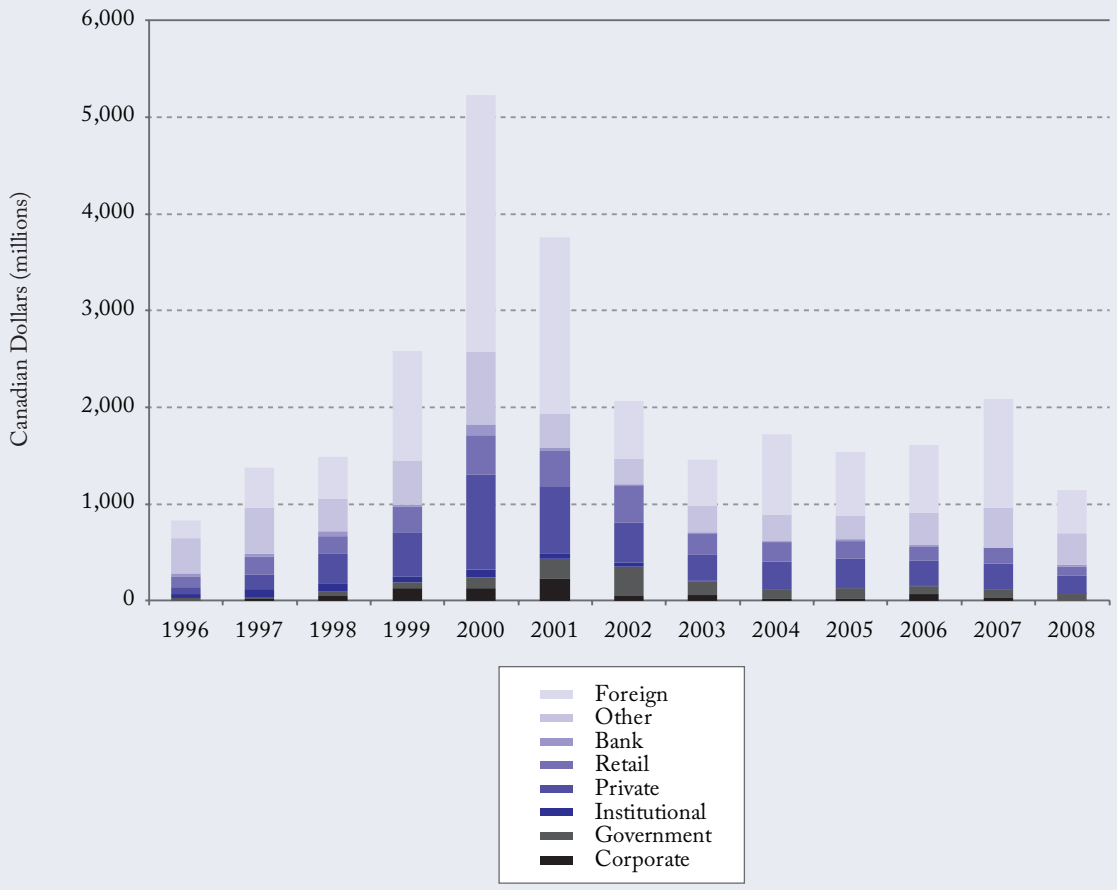
Box 1: Venture Capital (VC) Sources: Domestic VC Funds by Type

- Corporate: VC dollars from corporations that have a basket for venture investments (e.g., Rogers Ventures);
- Government: VC dollars from pools that are 100 percent government (taxpayer) backed (e.g., Business Development Bank of Canada);
- Institutional: VC dollars from institutions such as endowments, foundations or pension funds (e.g., OMERS Ventures);
- Retail: VC dollars from funds established with the benefit of government tax credits to individuals (e.g., labour-sponsored funds);
- Private: VC dollars from private funds structured on limited partnerships and related vehicles;
- Bank: VC dollars from investment banks and other financial institutions; and
- Other: VC dollars from any sources that do not fit into the above categories.

1 While this study examines which type of VC best promotes innovation once the decision has already been made to support a VC ecosystem, future government decisions on whether to allocate more money to VC or change tax rules in this area should be based on an argument that a market failure exists in VC thus requiring government intervention – a broader question that is outside the scope of this paper. In addition, while I recognize that there are various other important policy aims to consider in the context of VC and R&D spending, for clarity the focus of this paper is solely on fostering innovation as measured by patent applications.

2 This E-Brief analysis (and all references to Canada herein) is limited to the four major provinces with large, active VC markets: Ontario, Quebec, Alberta and British Columbia. These four provinces constitute 95 percent of the VC dollars disbursed in Canada for the time period examined: 1996-2008.

Figure 1: Venture Capital Investments in Canada by Fund Type, 1996-2008



Source: Author's calculations from Thomson Reuters.

The analysis in this E-Brief confirms that venture capital in Canada is strongly linked to innovation, as measured quantitatively by new patent applications. However, not all VC funds are equally strong performers. The data suggest that – perhaps because domestic firms are more involved during the earlier innovation stages of a start-up's lifecycle – Canadian VC funds are more closely linked than foreign funds, on a dollar-for-dollar basis, to innovation in Canadian companies. Furthermore, among domestic VC funds, private and institutional funds are the best at fostering innovation, while corporate and government funds are helpful, if slightly less effective. However, bank, retail – primarily labour-sponsored funds – and other forms of VC show no positive link.

On balance, this suggests that Canadian policymakers are correct to focus on venture capital as a critical component in promoting innovation, but they should focus less on the overall size of the VC market in Canada and more on promoting the right kinds of VC funding, with innovation outcomes as an important criteria.

Recent Trends in the Canadian Venture Capital Market

The Canadian VC market has experienced significant challenges over the last 15 years, as venture capital investment as a share of overall economic activity has steadily declined since 2000. Whereas in the US venture

capital investments have constituted roughly 0.20 percent of GDP over the last 10 years, such investments in Canada, as a percentage of GDP, have dropped to less than half of that.

Besides being proportionally smaller than the US market, the Canadian VC market is dominated by non-private firms. In addition to the government entities – the Business Development Bank of Canada (BDC) and Export Development Canada (EDC) – the provinces and the federal government began aggressively encouraging the Labour-Sponsored Investment Fund (LSIF) program in the 1980s and 1990s. LSIFs attract retail investors – rather than the institutions and high-net worth investors that traditionally back private funds – who receive tax incentives to invest in funds that in turn are intended to invest in small businesses and start-ups.[3]

Although a handful of funds have recorded winning performances, the LSIF program has received much criticism owing to design flaws, including the tax preferences that can allow funds with poor returns to survive, concerns over governance related to labour's mandated board role in LSIFs, and the potential for high fees or poorly conceived fund structures, or time limits that can push the deployment of capital into suboptimal investment opportunities (Cumming 2007). Overall, government-sponsored venture capital, of which LSIF-backed companies are a major component, underperform private VC-backed companies in achieving public policy aims, including value creation, innovation and competition (Brander, Egan and Hellmann 2008). Rather than supporting the creation of a robust private VC space, evidence suggests the LSIF program crowds out private capital and potentially reduces the overall level of VC activity (Cumming and MacIntosh 2006; and Cumming 2007).

Not all VC Promotes Innovation Equally

My analysis uses two methods to evaluate the link between VC investments and innovation: (i) a possible linkage between VC funding and patent applications, and (ii) another that attempts to measure the potency of VC in stimulating patentable research in comparison to R&D. Each method looks at new patent filings (the dependent variable) as a function of R&D spend and VC invested (the explanatory variables) for a given province and time. I examine annual and quarterly data, with the latter using time lags of zero to four quarters due to a possible delay between a company receiving funding and then innovating and filing for a new patent.

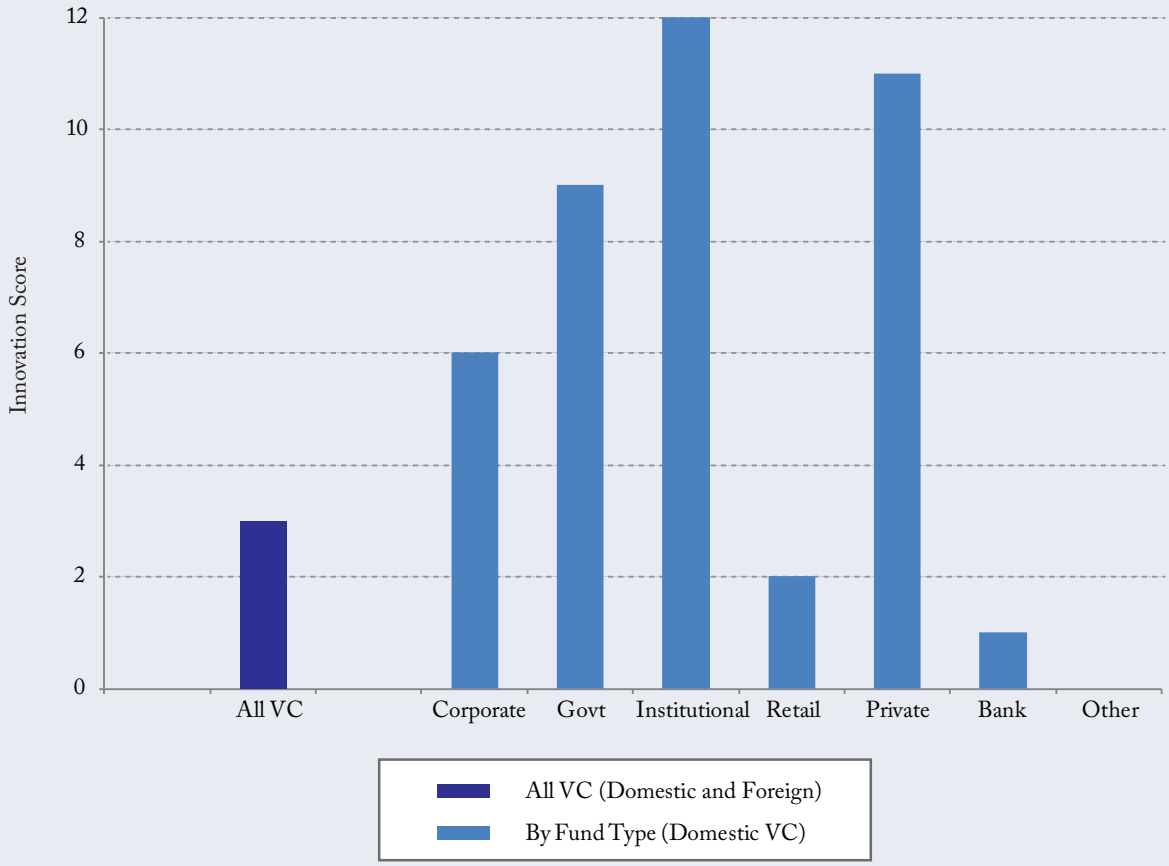
The aim is to answer this question: Which types of VC clearly show a consistently strong and significantly positive link to innovation and which types do not? Accordingly, each VC type receives a score for each of 12 tests I use. (There are two different models with six variations on each model. See Appendix A.) Scores range from plus one for a significant and positive relationship, to minus one for a significant and negative relationship, and zero if no significant link exists. The maximum possible score is therefore 12.

VC funding overall scores a disappointing three – though the underlying components tell different stories (Figure 2). Domestic VC is more closely related to innovative activity than foreign VC, but this may be due to inherent differences between domestic and foreign VC (see Appendix B). For Canadian VCs, private and institutional score the highest at 11 and 12, respectively.[4] Government VC funding scores well with nine and corporate ends up with six, thus showing a link to innovation in roughly half of the specifications. Retail, bank

3 BDC and EDC are Crown corporations. BDC describes itself as Canada's development bank and has a stated mission of promoting entrepreneurship by providing tailored financing, venture capital and consulting services to entrepreneurs. EDC is Canada's export credit agency.

4 It is worth noting that the institutional category, which consists primarily of endowments, foundations and pension funds, is rather small – just one-tenth the total dollar size of private VC during the period examined. The overall composition of Canadian VC by type over the period examined is corporate 5.6 percent, government 8.6 percent, institutional 3.1 percent, private 29.9 percent, retail 18.9 percent, bank 2.3 percent, and other 31.6 percent.

Figure 2: Total Innovation Score (Out of 12)



Sources: Author's calculations from Statistics Canada, Thomson Reuters, and Canadian Intellectual Property Office.

and other all score from zero to two, showing little or no significant impact on fostering innovation in Canada.

Private VC money, in this analysis, promotes innovation considerably better than business R&D on a dollar-for-dollar basis.[5] Using the same approach here as Kortum and Lerner (2000), which concluded that VC potency relative to R&D is seven in the US, this analysis indicates that private Canadian VC potency is six – suggesting that Canadian VC funds may also be considerably more efficient in promoting innovation than is R&D spending.[6]

5 Although Lerner and Kortum (2000) using US data found that VC and R&D are highly substitutable, I note that the latter may serve other policy aims beyond creating new patent applications. Hence, while this study shows that private VC dollars exhibit a stronger link to patent applications than R&D funding it should not be interpreted as a conclusion in favour of redirecting public funding from supporting R&D funding to supporting private VC firms.

6 Private VC ranged from 4.4 to 7.5 times more potent across the six regressions comparing its relative potency in promoting new patent filings – the link was significant at the 1 percent level in the six specifications (see table 2 in Appendix A). I use measures of private Canadian VC in the empirical analysis because the US market is predominantly private, allowing for a valid comparison to US results. Looking at all VC in Canada or domestic Canadian VC overall the potency figures are considerably lower, ranging anywhere from 0-3, only some of which are statistically significant.

Implications for Policymakers

My analysis suggests that governments are right to assume that a link exists between a healthy venture capital system and innovation in Canada. But if governments are to continue to intervene in order to promote such an ecosystem, an effective strategy should take into account the following:

Not all VC is created equal. Rather than simply measuring success by the aggregate amount of venture capital activity, greater emphasis should be placed on promoting the right kinds of VC funding, in the interest of seeing a boost in innovation.

Private, institutional and government VC should be encouraged. Institutional and government venture capital activities show a clear capacity to promote innovation. But a potentially large opportunity remains in seeing private VC firms thrive, because they boost innovation by providing not only critical funding, but also knowledge and oversight to entrepreneurial start-ups. Many private firms in Canada have had a hard time raising funds, owing to poor returns in the past, possibly because of the crowding out effect of other types of VC, including the LSIFs (Cumming 2007). The Ontario Venture Capital Fund (OVCF) could be a step in the right direction.[7]

If government money is to be spent, spend it wisely. Providing tax relief to LSIFs has been, overall, a disappointing use of taxpayers' money. Such funds have been shown in multiple studies, including this one, to do a poor job of achieving public policy aims. Given that subsidizing such firms potentially crowds out private venture capital (Cumming 2007), doing nothing at all would arguably be better than subsidizing LSIFs. If government money must be spent, an emphasis should be placed on promoting private or institutional VC spending or, failing that, allocating capital to arms-length government institutions such as BDC and EDC – which better promote innovation.

7 The OVCF is a fund of funds, backed by the Government of Ontario and various institutional investors, which seeks to generate attractive investment returns by investing in Ontario-based and Ontario-focused private venture capital firms.

Appendix A: An Empirical Look at the Link between VC and Innovation

Venture capital is generally defined as early-stage equity or equity-linked investments in young, privately-held high potential growth companies. These mainly equity private investments are made with the goal of generating a high investment return through an eventual realization event such as an initial public offering or sale of the company to a strategic or financial acquirer. Besides providing growth capital, venture capital firms generally tend to take a role managing entrepreneurial companies at an early stage, in doing so adding skills, know-how, expertise, and networks of connections.

The data set for venture capital disbursements comes from Thomson Reuters' VCReporter database. Thomson Reuters' data is the standard data source for economic analyses concerning private equity and venture capital.

The categories of VC measure total venture capital dollars invested in a given period in each of the four designated provinces (Ontario, Quebec, Alberta, British Columbia) broken down by VC fund location and type:

- All venture capital: All VC investment dollars (from all types of firms, domestic and foreign).

All VC is split into two broad geographical categories:

- Foreign VC: All VC investment dollars originating from VC firms anywhere outside Canada; and
- Domestic VC: All VC investment dollars originating from Canadian VC firms.

Domestic VC further breaks down into the following types of Canadian funds:[8]

- Corporate: VC dollars from corporations that have a basket for venture investments (e.g., Rogers Ventures);
- Government: VC dollars from pools that are 100 percent government (taxpayer) backed (e.g., Business Development Bank of Canada);
- Institutional: VC dollars from institutions such as endowments, foundations or pension funds (e.g., OMERS Ventures);
- Retail: VC dollars from funds established with the benefit of government tax credits to individuals (e.g., labour-sponsored funds);
- Private: VC dollars from private funds structured on limited partnerships and related vehicles;
- Bank: VC dollars from investment banks and other financial institutions; and
- Other: VC dollars from any sources that do not fit into the above categories.

Assessing the link between venture capital and innovation

For the supply of venture capital dollars to be a useful lever with which to support innovation, it must show a

8 The original Thomson Reuters VCReporter dataset included more categories, many of which exist primarily for other jurisdictions and are not relevant in Canada. For the purposes of clarity some categories from the original VCReporter dataset were rolled up into existing categories as follows: "Other" is comprised of the original Other category from the VC reporter dataset as well as Angel, Business/Community Development Programs, Individuals, US Small Business Investment Company (SBIC) Program, Secondary Purchases, Evergreen and Fund of Funds, "Institutional" is comprised of Endowment/Foundation/Pension Funds and University, and "Bank" includes Investment Affiliates, Investment Banks, and Other Banking/Financial institutions.

meaningful causal impact on the creation of new patents, which is used herein as a quantitative proxy for the level of innovation.

Two models are run to assess this relationship. The first model, with subscripts p and t indicating province and year observations, is:

$$\ln (P_{pt}) = \gamma(R_{pt}) + \delta(VC1_{pt}) + \eta(VC2_{pt}) + u_{pt}$$

which captures the basic impact of a change in one dollar of a given type of VC on new patent filings in a given province and year, controlling for R&D.[9] The dependent variable *P* is the log of new patent filings as a function of venture capital *VC* and R&D spend *R.* This model is straightforward and captures the relationship between the disbursement of different types of VC and new patent filings.

The second model is based on a past study that compared the potency of VC in spurring patenting activity relative to R&D (Kortum and Lerner 2000), yielding the oft-cited result that one dollar of VC leads to the same level of patent creation as three dollars of R&D spending. The second model is as follows:

$$P_{pt} = (R_{pt} + b(VC_{pt}))^{\alpha} + u_{pt}$$

which simplifies by linear approximation to

$$\ln (P_{pt}) = \alpha \ln(R_{pt}) + \alpha\, b(VC_{pt}/R_{pt}) + u_{pt}$$

where *VC* and *R* are taken as perfectly substitutable means of financing innovative efforts. In this model b measures the potency of venture capital, defined as the impact on patenting of a dollar of venture capital relative to a dollar of R&D.[10]

The two specifications above are run using annual and quarterly data. The quarterly approach includes lags ranging from 0 to 4 quarters under the assumption that the causal link between one dollar of VC being invested in a company and a patent filing related to the innovation funded by that dollar may take up to a year to play out.

The coefficients in Table 1 are not all comparable; the basic regressions are untransformed, for example, whereas the Kortum-Lerner approach uses logs. It is unwise to read too much into individual coefficients given the multiple assumptions in the models outlined above as well as the limitations in this data set, like any other.

9 Because it is impossible to separate R&D dollars spent by VC-backed from those spent by non-VC backed companies, aggregate provincial R&D figures indirectly include some VC funding (for those R&D amounts spent by VC-backed companies). The inability of the data to allow for a clean division is not ideal, though the risk of multicollinearity is reduced given that the magnitudes of spending in each differ enormously. Each type of VC comprises at most a few percent of R&D in a given province and time period, and all VC in aggregate generally comprises around 10 percent of R&D on average across the time period of this analysis.

This model was also run in log form, however the non-log form yielded superior r-squared values and was deemed to be a more useful comparison. Comparing $1 of a given type of VC to, say, $1 of R&D is a more intuitive approach than comparing a percentage change of one to a percentage change of another, particularly as the underlying figures varied widely in magnitude with R&D always being a far larger figure. In addition, standard errors were clustered on province to address any presence of heteroskedascity.

10 See Kortum and Lerner (2000) for a more full explanation of the model, assumptions and equilibrium conditions. The specification included herein is an adjusted version where fixed effects are run for provinces rather than industries.

Table 1: Effect of VC Investments on New Patent Filings, 1996-2008

	Coefficients Across All Specifications[a]												
	Basic						Kortum-Lerner						Score[b]
Period:	Annual	Quarterly					Annual	Quarterly					
Lags:	0	0	1	2	3	4	0	0	1	2	3	4	
All VC	0.079	0.073	0.074	0.088**	0.055	0.081*	0.806*	0.429*	0.420*	0.933***	0.563*	0.845**	3
Foreign	-0.039	-0.044	0.081	-0.028	0.0202	-0.041	-0.0466	0.0397	0.109	0.777*	0.179	0.392	0
Domestic	0.263	0.228*	0.175	0.245**	0.131	0.233**	2.610***	1.946***	1.800***	2.672***	2.253***	2.980***	8
Corporate	0.012	0.651	-0.276	0.232	0.115	0.109	15.07**	12.28***	7.788**	12.28***	9.128**	12.33**	6
Government	0.365***	0.430*	0.172*	0.399**	0.115	0.354**	19.29**	9.262**	8.066**	18.37***	12.28**	13.36**	9
Institutional	2.351**	1.462**	1.935***	1.690***	2.296***	2.332***	22.54***	10.04**	13.66***	15.41***	20.41***	22.57***	12
Retail	-0.137	-0.011	-0.073	0.182**	-0.371**	0.221***	1.820	1.695	1.205	7.919**	-0.995	6.339	2
Private	0.769**	0.378**	0.462***	0.288**	0.205**	0.189	7.457***	4.925***	4.377***	5.944***	5.132***	6.815***	11
Bank	-0.281	-0.621	-1.817	0.343	0.664	0.704**	3.529	-1.249	0.550	1.334	4.813	7.393	1
Other	-0.309	0.086	-0.197	0.106	0.041	0.174	1.091	0.703	0.958	1.627	1.661	2.507*	0
Specifications	3	3	3	3	3	3	10	10	10	10	10	10	
R-squared (high)	0.985	0.958	0.958	0.954	0.955	0.955	0.460	0.218	0.118	0.198	0.169	0.193	
R-squared (low)	0.974	0.950	0.949	0.948	0.946	0.947	0.214	0.127	0.125	0.091	0.094	0.084	
Observations	48	192	192	192	192	192	48	192	192	192	192	192	

*** p<0.01, ** p<0.05, * p<0.1

a Note that unlike traditional regression results tables, each column above does not represent one individual regression. Per the models outlined earlier, multiple regressions (summed up in the 'Specifications' row across the bottom) are run per column to evaluate each different type of VC.

b The Score column at the far right indicates the 'Innovation Score' and is calculated by tallying across all 12 columns where a positive or negative coefficient significant at the 1% or 5% level is scored a +1 or -1, respectively.

Sources: Author's calculations from Statistics Canada, Thomson Reuters, Canadian Intellectual Property Office.

Nonetheless, even focusing on the directional link rather than specific coefficients, a clear pattern emerges in which relatively consistent coefficients within a given method suggest a strong causal link in Canada between the disbursement of certain types of VC dollars and new patent filings.

A closer look at the *b* values in the second model allows a comparison of VC's innovation potency vis-à-vis R&D in Canada to that in the US (see Table 2). Kortum and Lerner tested various specifications before arriving at a figure of 3.1 for US VC potency by averaging across their different specifications. In that study the same linear specification employed here revealed US VC potency as higher (7.26) whereas in the analysis here private VC

Table 2: Private VC Potency vs R&D	
Period/Lag	***b* Value**
Annual	7.457***
Quarterly (0 lags)	4.925***
Quarterly (1 lag)	4.377***
Quarterly (2 lags)	5.944***
Quarterly (3 lags)	5.132***
Quarterly (4 lags)	6.815***
Average	5.8

*** p<0.01
Sources: Author's calculations from Statistics Canada, Thomson Reuters, Canadian Intellectual Property Office.

potency ranged from 4.4 to 7.5 times across the six specifications for an average of 5.8 overall. While I caution against putting too much faith in precise figures or coefficients in such an analysis, this result – significant in all six specifications at the 1 percent level – certainly suggests that private Canadian VC firms are, much like their counterparts south of the border, better at promoting innovation than R&D on a dollar-for-dollar basis.

Appendix B: Caveats about the Results

Innovation is not the only metric worth considering. Various other policy aims should be considered, many of which are harder to measure quantitatively. Foreign VC or bank VC, for example, may bring useful connections and business know-how that are not captured in patenting rates.

Patent filings are an imperfect proxy for innovation. Patent data exclude such things as trade secrets, for example, suggesting that some forms of innovation are not captured in the data. In addition, if certain categories of VCs are focused more on industries that patent less (e.g., software or ecommerce), such an effect could cause a downward bias on the innovation score – though there is nothing clear to suggest that this might be the case.

CIPO versus USPTO data. This study uses Canadian Intellectual Property Office (CIPO) data, though a useful area for further study would be to include US Patent and Trademark Office (USPTO) data – just in case a start-up's investor base has an effect on where it files patent applications first. However, if any such effect exists it probably causes only a small downward bias on foreign VC results, leaving the comparison among Canadian VCs unchanged.

Demonstrating causality. A limitation of the approach employed herein is that it is hard to clearly distinguish causality from correlation (i.e., VC disbursements and patent filings could both be driven by a third, difficult-to-measure variable: the arrival of technological opportunities). Kortum and Lerner (2000) used an instrumental variable approach supported by a unique 1979 spike in US VC funding to demonstrate causality rather than correlation in new patent creation, suggesting strongly that a similar relationship likely holds in Canada – even if it cannot be replicated due to limitations in Canadian data. In addition, even without a concrete causal link my results still demonstrate clearly that certain types of VC show a stronger link to innovation than others – even if that link simply means that certain VCs are better at finding and financing innovation than actually causing it.

Small firms may simply innovate better. One limitation in the results comparing VC to R&D is that VC dollars are skewed toward small, high-growth firms, whereas R&D is often carried out by large firms. Given the possible agency problems that exist in such large firms they may innovate less efficiently per dollar spent than small firms. As such, the fact that a dollar of VC fosters innovation better than a dollar of R&D may say little about VC versus R&D per se and more about the need to finance small, high-growth firms (both through a VC ecosystem and via R&D incentives to small firms).

Later stage funding may see less new patent filings. Funds that generally invest at a later stage may see less new patent creation – as companies have often already moved from the innovation to the commercialization phase. Foreign VCs active in Canada typically invest in later funding rounds that are two to three times larger than the average funding round of a Canadian VC firm – probably due to a reluctance to travel outside of their homes in large tech hubs to cross geographical distances, borders and incur various transaction costs unless a fairly large investment is on the cards. This may result in some downward bias to the results for the foreign VC category, though it would not affect the comparisons between Canadian VC fund types.

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