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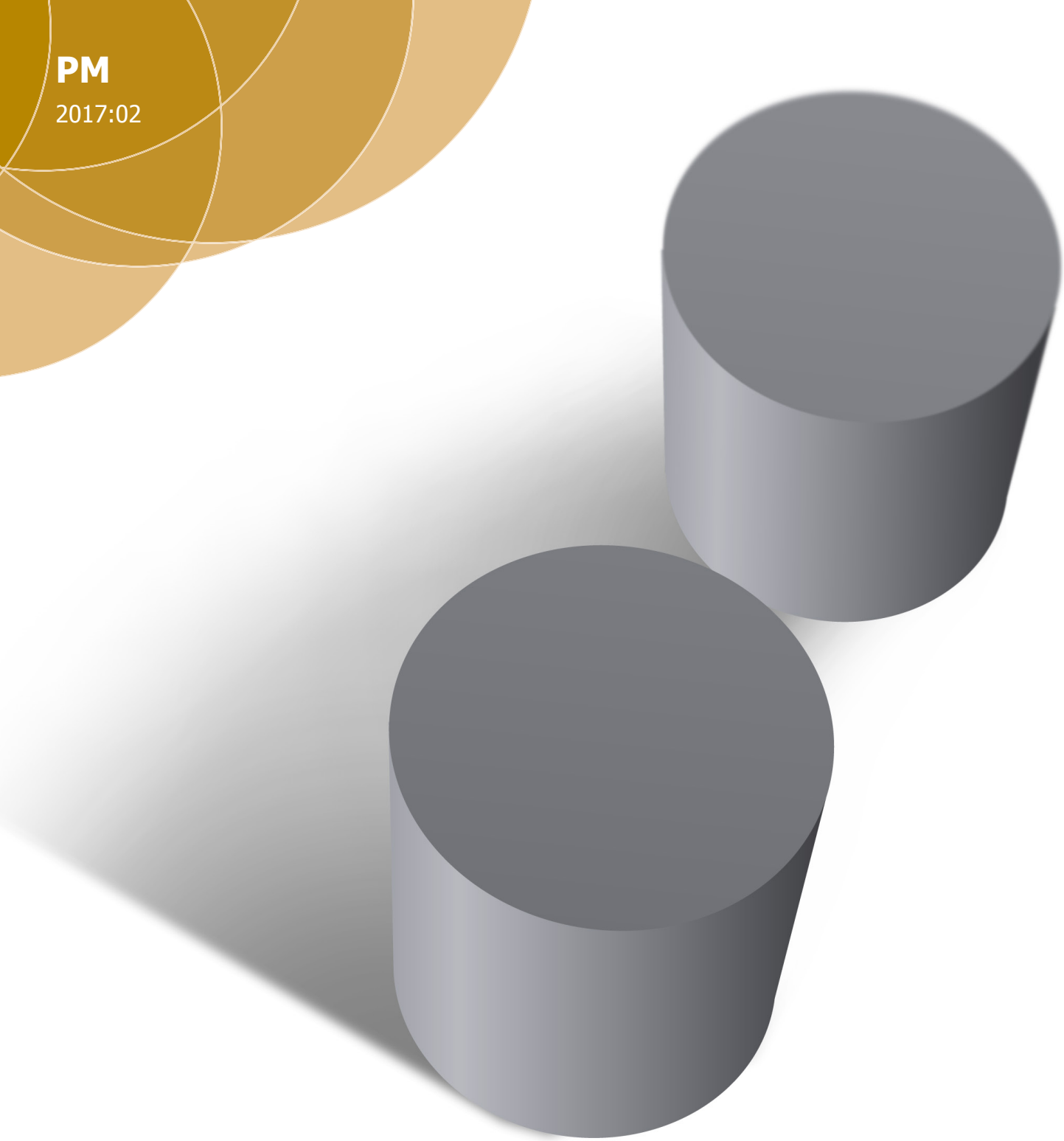

Firms´responses to private- and government sponsored Venture Capital

This report analyses actual outcomes of government and private venture capital investments (venture capital, VC) and effects on employment, turnover and investments in real capital in portfolio companies in Sweden. It also examines whether the effects differ between government and private VC.

tillväxtanalys

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Myndigheten för tillväxtpolitiska utvärderingar och analyser
Studentplan 3, 831 40 Östersund
Telefon: 010 447 44 00
Fax: 010 447 44 01
E-post: info@tillvaxtanalys.se
www.tillvaxtanalys.se

För ytterligare information kontakta: Patrik Gustavsson Tingvall, Björn Falkenhall
Telefon: 010 447 44 15, 010 447 44 33
E-post: patrik.tingvall@tillvaxtanalys.se, bjorn.falkenhall@tillvaxtanalys.se

Förord

Det politiska intresset för att främja företagande, entreprenörskap och ekonomisk tillväxt är stort liksom kapitalförsörjningens betydelse i detta sammanhang. Intresset från samhällets sida att underlätta små- och medelstora företags finansieringssituation är dock långtifrån nytt.

I denna rapport analyseras faktiskt utfall av statliga och privata riskkapitalinvesteringar (venture capital, VC) och reala effekter på sysselsättning, omsättning och investeringar i realkapital i portföljföretagen. Vidare undersöks om effekterna skiljer sig åt mellan statligt och privat VC, och vilka bolag och faser som de statliga aktörerna investerar i jämfört med de privata aktörerna.

Resultaten visar inga dramatiska skillnader mellan statliga och privata VC-investerare vad gäller tillväxteffekter, även om det finns vissa tendenser till en starkare tillväxteffekt via det privata riskkapitalet. Vidare skiljer sig inte de statliga VC-bolagen från privata investerare vad gäller deras benägenhet att investera i de tidigaste faserna. Ett något överraskande resultat då det är bristen på riskkapital i de tidigaste faserna som ofta används som argument för att rättfärdiga statens roll som aktör på VC-marknaden. De statliga VC-bolagen verkar även vara mer benägna att hålla kvar vid, och fortsätta investera i, stagnerade företag som inte tar fart och växer.

Rapporten är författad av Patrik Gustavsson Tingvall, professor i nationalekonomi vid Södertörns högskola, analytiker vid Tillväxtanalys och forskare vid Ratio, Näringslivets forskningsinstitut, och Daniel Halvarsson, fil. Dr i nationalekonomi och forskare vid Ratio samt Erik Engberg, master i nationalekonomi och forskningsassistent vid Ratio.

En kortare version av rapporten ingår även som ett kapitel i boken Tillväxtfakta 2016: Perspektiv på kapitalförsörjning – en antologi om företagens finansiering och statens roll.

Östersund, mars 2017

Björn Falkenhall
T.f. avdelningschef, Entreprenörskap och näringsliv
Tillväxtanalys

Foreword

There is major political interest in promoting enterprise, entrepreneurship and economic growth, and the same goes for the significance of capital provision in this context However, interest on the part of society in facilitating small and medium-sized companies' financing situation is far from new.

This report analyses actual outcomes of government and private venture capital investments (venture capital, VC) and real effects on employment, turnover and investments in real capital in portfolio companies. It also examines whether the effects differ between government and private VC, and which companies and phases the public actors invest in compared with the private actors.

The results do not demonstrate any dramatic differences between public and private VC investors in terms of growth effects, even though there are some tendencies towards a stronger growth effect via private venture capital. Further, the public VC companies do not differ from private investors when it comes to their propensity to invest in the earliest phases. A somewhat surprising result as it is the lack of venture capital in the earliest phases which is often used as an argument to justify the government's role as an actor in the VC market. The public VC companies also seem to be more disposed to stay the course with, and continue to invest in, stagnant companies which do not take off and grow.

The report was written by Patrik Gustavsson Tingvall, Professor in Economics at Södertörn University, analyst at Growth Analysis and researcher at the Ratio Research Institute, and Daniel Halvarsson, PhD. in economics and researcher at Ratio, as well as Erik Engberg, MSc in economics and researcher assistant at Ratio.

A shorter version of the report is also included as a chapter in the book Growth Analysis, (2016), Perspectives on capital provision - an anthology about company financing and the government's role".

Östersund, March 2017

Björn Falkenhall, director
Entrepreneurship and Enterprise
Growth Analysis

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Sammanfattning

Den svenska staten har verkat på riskkapitalmarknaden sedan tidigt 70-tal och den fråga vi ställer i denna rapport är: hur effektiv är staten som riskkapitalist? Mer precist ska vi i denna rapport granska och analysera senare års statliga riskkapitalsatsningar för att se vilka effekter de har gett upphov till. Vi börjar dock med en kort tillbakablick. Den första statliga riskkapitalfonden, Svetab, bildades 1970 och följdes därefter av Företagskapital, 1973. Efter en försiktig start på 70-talet tillkom under 1980-talet bland annat sex regionala investmentbolag, och i mitten av 1990-talet bedömdes det att staten varit aktiv tillräckligt länge för att en utvärdering av statens riskkapitalsatsningar skulle vara möjlig (Riksdagens revisorer, 1996). Utfallet från denna analys var inte alltigenom positiv. Endast några få av de statliga riskkapitalbolagen (även kallat venture capital eller VC-bolag) hade lyckats investera i hållbara företag och Riksdagens revisorer uppskattade kostnaden per anställd till närmare 200 000 kronor (Tillväxtanalys, 2010). En förklaring till de svaga resultaten ansågs vara att de statliga riskkapitalbolagen både sökte lönsamma investeringar samtidigt som statens riskkapitalinsatser även sågs som ett sysselsättningspolitiskt instrument där investeringarna hade funktionen av sysselsättningsuppehållande karaktär. Det pekades även på att de statliga VC-bolagen i många fall saknade kompetens av lednings- och styrelsearbete i små företag. Det har även diskuterats huruvida ett överutbud av kapital (via investerare som pensionsfonderna, Industrifonden, teknikbrostiftelserna m.fl.) kan ha bidragit till IT-bubblan under 90-talet (Tillväxtanalys, 2010).

Flyttar vi oss framåt i tiden till idag är det Almi Invest, Industrifonden, Inlandsinnovation, och Fouriertransform som är de största statliga aktörerna på riskkapitalmarknaden. Utöver dessa finns det ett antal kvasi-statliga aktörer i Sverige så som Karolinska Development och Stockholm Innovation and Growth. Den statliga VC-verksamheten står dock inför omfattande förändringar. Till följd av regeringens proposition (2015/16:110) håller ett nytt statligt VC-bolag, Saminvest, på att bildas under hösten 2016.

Sedan 2011 har en stor del av den svenska debatten i denna fråga cirkulerat kring vilken roll de statliga VC-bolagen har att spela, och hur de ska styra sina investeringar. Nyckeln till denna debatt går till stor del att spåra till Svensson (2011). Svensson (2011) genomlyser den svenska riskkapitalmarknaden och kommer med ett antal rekommendationer om hur de statliga VC-bolagen (GVC) bör styra sina placeringar. Det centrala budskapet från Svensson (2011) är, i linje med Lerner (2002), att i den mån staten intervenerar på VC-marknaden bör den fokusera på de tidiga faserna (*seed och early-stage*), då det är troligast att det föreligger ett marknadsmisslyckande (underfinansiering) i dessa faser. Vidare förespråkar Svensson (2011) även så kallade fond-i-fond lösningar där statliga VC-investerare drar nytta av privata investerares kompetens och förmåga att välja investeringar.

Sedan Svensson (2011) har det statliga VC-kapitalet analyserats av Riksrevisionen (2014), SOU (2015:64), och nu senast i propositionen (2015/16:110). I samtliga fall trycks det på, i linje med Svensson (2011), att i den mån staten ska agera på VC-marknaden bör fokus ligga på tidiga skeenden samt att så kallade fond-i-fond lösningar i allmänhet ses som något positivt. Dessa rekommendationer har inte helt undgått kritik. Almi Företagspartner (2015) pekade bl.a. på att det finns en inneboende konflikt mellan att det statliga kapitalet skall fånga upp företag som den privata VC-marknaden tenderar att missa genom att gå in i

tidiga skeenden och ta en högre risk än det privata kapitalet, samtidigt som samfinansieringslösningar (statligt och privat VC) rekommenderas.

Som vi ser så har de senaste årens VC-debatt handlat om var, när, och hur staten skall intervenera, snarare än hur lyckosam staten har varit på riskkapitalmarknaden. Det finns sålunda ett behov av en analys över hur de statliga VC-bolagen de-facto investerat och vilka resultat som har uppnåtts. Med detta som bakgrund genomlyser denna rapport följande frågeställningar:

- Går det att spåra några reala effekter av VC-investeringarna på
    - Sysselsättning
    - Investeringar i realkapital
    - Omsättningstillväxt
- Skiljer sig eventuella effekter åt mellan statligt VC och privat VC?
- I vilka typer av bolag investerar staten?
- Håller statliga investerare fast vid sina investeringsobjekt i större utsträckning än privata investerare?

Innan vi går in på resultaten från de analyser som gjorts i denna rapport vill vi först kort belysa de grundläggande argumenten, och motargumenten, för att staten skall agera på riskkapitalmarknaden. Vi kommer även att belysa några metodaspekter som en analys av kausala effekter har att brottas med, och hur vi har gått tillväga för att lösa denna problematik.

De grundläggande antagandena om varför staten har en kompletterande roll att spela på riskkapitalmarknaden bygger på att det finns någon form av marknadsmisslyckanden som leder till att marknadslösningen inte tillhandahåller tillräckligt med kapital, ett så kallat "funding gap". Detta *gap*, eller brist på riskkapital, är särskilt kännbart för små och medelstora företag med litet eget kapital och kort eller obefintlig historik. Mer precist så tyngs kapitalmarknaderna av *asymmetrisk information*, vilket innebär att den som söker finansiering vet mer om sin produkt eller tjänst än den som ska finansiera den (Akerlof, 1970). Detta leder till svårigheter att bedöma risken för finansiären, vilket i sin tur leder till att finansiären håller tillbaka kapital, eller om det gäller lån, höjer låneräntan. Det centrala är dock att den privata marknaden genererar ett underskott av kapital utifrån ett samhällsekonomiskt perspektiv (Svensson 2006; Svensson 2011) och att den privata marknaden särskilt underfinansierar små, nystartade företag med liten säkerhet och att staten därför ska rikta in sig på detta segment. Utöver misslyckandet på kapitalmarknaden brukar det pekas på att innovativa företag och FoU-projekt ger upphov till en större samhällsnytta än den nytta som det uppfinnande företaget och/eller dess investerare får. Detta gör att utan statliga insatser leder marknadslösningen till för lite FoU och färre innovationer än det samhällsekonomiskt optimala. Sammantaget leder dessa argument till att statligt riskkapital bör riktas mot små och nystartade, gärna innovativa företag, med hög skalbarhet.

På samma sätt som det finns argument för statlig intervention finns det argument som vänder sig emot statlig intervention på VC-marknaden. Styrkan i en marknadsekonomi är att den på ett effektivt sätt förmedlar och samordnar kunskap från alla individer till att göra extremt komplicerade varor och tjänster. I en känd essä beskriver Leonard E. Read hur en individ ensam inte ens kan konstruera en så pass enkel vara som en blyertspenna. Poängen som görs är att marknaden samordnar information på ett sätt som en enskild planerare

omöjligen kan göra på egen hand. Det är därför svårt att teoretiskt motivera varför staten skulle vara bättre på att identifiera potentiellt lönsamma investeringar och företag än den privata marknaden. De privata riskkapitalbolagen lägger stora resurser på att identifiera individer och företag som har potential och som är värda att satsa på. Givet att dessa företag lyckas väl i sitt arbete minskar utrymmet för statlig intervention. Vidare leder detta till att de företag som inte fått privat finansiering även är företag som inte heller bör få finansiering då de inte är långsiktigt konkurrenskraftiga. Informationsproblemet handlar inte bara om svårigheten med "picking winners" utan även om att politiken kan ha svårigheter med att hantera asymmetrisk information och externa effekter. Som diskuterats av t.ex. Baumol (2002) har politiken normalt sett, inte ens i princip, tillgång till sådan information som marknader anses sakna. Med detta som bakgrund finns en risk att statliga interventioner inte ger önskat utfall och därmed riskerar slöseri med skattemedel (Lerner 2009).

Utöver dessa argument mot statlig intervention pekas även på att delar av den politik som bedrivs, inte alltid syftar till att korrigera marknadsmisslyckanden samt är förenad med olyckliga bieffekter. Några exempel på detta är den kritik som framfördes av Riksdagens revisorer (1996) när de pekade på att statligt riskkapital även sågs som ett sysselsättnings-politiskt instrument. Riskkapitalet användes, med andra ord, delvis som konstgjord andning för icke lönsamma företag. Det bör även pekas på att statligt riskkapital finansieras via skatteintäkter och därför kan bidra till ökade skattekilar. Slutligen finns det farhågor om att det statliga riskkapitalet kan tränga ut privata investerare (”crowding out”). Internationell forskning har gett blandade resultat vad gäller *crowding out* i olika kontexter; vissa studier fann bevis för att statligt VC trängde undan privata investeringar, andra gjorde det inte.

Som vi sett av ovanstående diskussion framstår det statliga ingripandet på riskkapital-marknaden ibland som önskvärt och ibland som något negativt som bör undvikas. Med detta som bakgrund blir det viktigt att på ett så exakt sätt som möjligt både mäta effekten av de statliga insatserna och förstå de mekanismer som driver VC-marknaden. Med en detaljerad utvärdering kan vi både skapa oss en uppfattning om vad vi får för pengarna, vad som fungerar, och vad som fungerar mindre bra. Därmed kan en lärandeprocess ta vid där man i nästa steg kan lära sig av tidigare erfarenheter.

Utvärderingar handlar ytterst om att undersöka huruvida insatserna uppnått de avsedda målen. I utvärderingslitteraturen pekas på flera kritiska aspekter såsom mål och åter-koppling. Vi kommer här att kort diskutera problematiken med att skatta ett kontrafaktiskt utfall, eller mer specifikt, vad som hade hänt om ett företag inte fått statligt riskkapital?

För att identifiera en effekt räcker det inte att upptäcka en förändring, utan denna förändring måste också kunna *härledas till själva åtgärden*. För att ta reda på effekten av åtgärden skulle vi behöva jämföra förändringen efter stödet med vad som skulle varit utfallet utan stödet. Ett syfte med en effektutvärdering är alltså att undersöka orsaks-samband utifrån en kontrafaktisk analys. För att nå detta mål kan vi försöka skapa en kontrollgrupp med företag som inte fått behandling (tagit emot riskkapital), men som i övrigt är så lika de företag som fått riskkapital som möjligt. En stor fördel av att analysera svenska företag är att vi har tillgång till detaljerade data som gör det möjligt att följa vad som händer med företagen över tid. I denna rapport har vi med hjälp av registerdata över samtliga svenska företag tillsammans med information om statliga och privata VC-investerare använt oss av så kallad Coarsened Exact Matching (CEM) för att skapa en kontrollgrupp av företag som ej erhållit VC (se metodkapitlet för detaljer).

När vi studerar den svenska riskkapitalmarknaden ser vi att investeringar i företag som enbart får statliga VC-investeringar (GVC-investeringar) utgör sju procent av totalt investerat riskkapital medan 55 procent utgörs av investeringar i företag som enbart får privata VC-investeringar. De återstående 38 procenten utgörs av investeringar där både staten och privata investerare går in i samma bolag.[1] Ser vi till utvecklingen under perioden 2007–2014 har de årliga beloppen av statliga VC-investeringar fluktuerat, ungefärligen från 200 miljoner kr till 1 miljard kr. En närmare granskning visar att till skillnad från det privata riskkapitalet, som huvudsakligen utvecklats negativt under perioden 2008–2013 (med undantag för en viss uppgång 2014), har det statliga riskkapitalet ökat i omfattning. Det vill säga, volymen av privat och statligt VC har i princip utvecklats i motsatt riktning. Jämför vi sedan de enskilda investeringarnas storlek uppgår en genomsnittlig statlig VC-investering till ca 5 miljoner kr medan motsvarade summa bland de privata bolagen är närmare 30 miljoner kr. De privata VC-bolagen går sålunda typiskt sett in med större belopp än staten.

Som framgick av diskussionen ovan har det upprepade gånger påpekats att staten bör fokusera på företag i tidiga skeenden. När vi ser till våra data blir bilden något annorlunda. Delar vi upp de olika investeringsfaserna, från tidig till senare fas (seed-, start-up och senare VC fas) ser vi att både de statliga och privata riskkapitalbolagen allokerat drygt två procent av totalt kapital, (eller uttryckt i antal utbetalningar, cirka 7,5 procent av alla transaktioner) till seed-finansiering. Oavsett vilket mått vi använder oss av ligger den privata andelen något högre än de statliga VC-bolagen. Dock är den generella bilden att allokeringen av VC-kapital till företag i olika faser ser likartad ut för privata och statliga VC-bolag. Det vill säga, det finns inget som tyder på att de statliga VC-bolagen, i högre utsträckning än privata VC-investerare, specialiserat sig på finansiering i de allra tidigaste faserna av företagens livscykel. Vi vill dock reservera oss för att även om beloppen i sig är exakta är inte skiljelinjen mellan statligt och icke statligt VC alltid tydlig; med en annan indelning skulle andelarna kunna se något annorlunda ut. Trots dessa förbehåll kan det tyckas förvånande att staten, som till stor del rättfärdigar sin närvaro på VC-marknaden genom målet att fånga upp företag i tidiga skeenden, inte tycks vara mer aktiv i de tidiga faserna än de privata VC-investerarna. En liknande kritik mot statliga VC-investerare framfördes av Riksrevisionen (2014) i sin rapport "*Statens insatser för riskkapital-försörjning – i senaste laget*".

Ser vi till resultaten från den ekonometriska analysen finns det några intressanta observationer att ta fasta på. För det första, ser vi till försäljningsutvecklingen hos företag som får någon form av VC så tar den fart ca två-tre år efter injektionen, och dessa företags försäljning växer då snabbare än likande företag som inte fått VC. För det andra, när det gäller sysselsättningen hos företag som fått VC växer de inte snabbare än likande företag som inte fått VC, snarare finns det en tendens till att dessa företag håller tillbaka på nyanställningar. Däremot kan vi se tendenser att VC har en positiv effekt på (reala) investeringar i maskiner, inventarier och byggnader. Till detta kan vi även addera en ökad effektivisering i företag som erhållit VC. Detta kan tolkas som att insatsen av finansiellt kapital tillsammans med den rådgivning som följer med en VC-investerare leder till en ökad kostnadseffektivitet.

[1]Vad gäller GVC-data finns det ett bortfall i ALMI-data medan täckningen av Industrifondens och Fouriertransform är nästan 100 % (jämfört med deras årsredovisningar). På grund av att ALMI gör cirka 1/3 av sina saminvesteringar tillsammans med affärsänglar (som inte syns i vårt dataset) underskattas sannolikt andelen mixad/samfinansierat VC.

I den internationella litteraturen som jämfört effekterna av statligt och privat riskkapital är det typiska resultatet att man finner något svagare tillväxteffekter av statligt riskkapital än av privat. I denna studie finner vi dock inga starka bevis för att effekterna av statligt och privat VC skulle skilja sig nämnvärt åt. Skillnader finns, men de är ofta för små för att betraktas som signifikanta; i de fall de uppträder är det dock privat riskkapital som genererar en starkare tillväxt. En djupare jämförelse mellan privat och statligt riskkapital visar att statliga investerare är mer benägna att hålla fast vid, och fortsätta investera i stagnerande företag som inte tar fart.

Sammanfattningsvis finner vi inga dramatiska skillnader mellan statliga och privata VC-investerare vad gäller tillväxteffekter, även om det finns tendenser till en starkare tillväxteffekt via det privata riskkapitalet. Vi har även sett att de statliga VC-bolagen inte skiljer sig från privata investerare i deras benägenhet att investera i de tidigaste faserna. Om något så ligger de privata investerarna något tyngre i den så kallade seedfinansieringen än de statliga VC-bolagen. Med tanke på att det är bristen på riskkapital i de tidigaste faserna som till stor del rättfärdigar statens roll som aktör på VC-marknaden kan detta ses som något överraskande. Till sist har vi sett tecken på att statliga VC-bolag kan vara mer benägna att hålla kvar vid, och fortsätta investera i, stagnerade företag som inte tar fart och växer.

Summary

The Swedish government has been an active player on the venture capital (VC) market since the early 1970s and its influence has been steadily increasing. Given the increased participation of governmental VC (GVC) funds in the VC market, one might presume that they have an excellent record of accomplishment and that there is a well-identified market failure for these actors to fill. Is that really the case? In this report, we discuss the function of the VC market along with the arguments both for and against GVC interventions. We also highlight the Swedish GVC experience and the Swedish GVC policy discussion.

Two conclusions can be drawn from the current Swedish debate. First, we do not really know to what extent there is a private market funding gap that motivates GVC interventions. Second, despite the long existence of GVC interventions, little is known about their real effects and performance. The focus of this report is to shed light on the performance and the effects of Swedish private and public venture capital (PVC and GVC).

One important motive for state intervention in the VC market is that the market solution is likely to generate an undersupply of financial capital. This funding gap is expected to be most severe for young innovative ventures with little (if any) cash flow and/or no collateral to pledge for credit (Lerner, 2002). The funding gap is partly a consequence of an entrepreneur's unwillingness to fully disclose her strategy, innovation technology, and business operations. From the investors' point of view, the difficulty in gathering information constitutes a significant hurdle in the form of a transaction cost. This causes market mechanisms to malfunction, leading to problems of adverse selection and moral hazard (Lerner, 2002; Akerlof, 1970).

Although VC firms are especially well equipped to resolve the principal-agent problem, there are reasons to believe that the market solution falls short in supplying capital. In addition to the problem of asymmetric information, private VC firms prefer relatively large investments and view investments in the earliest stages as too risky, essentially ignoring struggling new ventures. This leaves room for GVC interventions targeting firms in the early start-up phase. It has also been argued that GVC can catalyze the development of a VC market and start-up ecosystem.[2] Despite the potential benefits of GVC interventions, a series of arguments can be raised against GVC involvement. One major allegation is that GVC can crowd out PVC investments; another is that because of GVC investors' political nature, they lack the incentives or ability to operate businesses efficiently.

In tandem with an increased presence of GVC in many countries, our knowledge of GVC's relative performance as compared to PVC has increased and resulted in a number of stylized facts that help to navigate in the difficult and sometimes contradictory theoretical landscape.

One lesson learned from previous empirical literature is that on average, GVC-funded firms tend to develop less strongly compared to firms funded by either PVC or mixed financing (both GVC and PVC). Because GVC should theoretically make investments that

[2]In addition, GVC injections can be motivated by the fact that innovation's social returns are larger than its private returns.

are less profitable than PVC investments, this is to be expected and may not be sufficient to conclude that GVC is not doing its job.

Turning to Sweden, after a slow start in the 1970s, the Swedish GVC market expanded considerably in the 1980s because of the creation of six regional GVC funds. These funds were scrutinized by the Parliamentary Audit Office (Riksdagens revisorer, 1996), which considered most of the early GVC investments to be failures and argued that the GVC funds lacked both knowledge and the appropriate skills either to counsel boards or to guide managers. The GVC funds are further criticized for being an instrument for employment policy.

More recently, the Swedish discussion has addressed how GVCs funds should invest, not what they have achieved. This discussion was triggered by Svensson (2011), who surveyed the Swedish GVC market. His primary recommendations were that GVC funds should focus on early-stage financing and fund-of-funds solutions in which they cooperate with private investors and take advantage of their competence. Since Svensson (2011), follow-up studies performed by the National Audit Office (Riksrevisionen, 2014) and a government-commissioned inquiry (SOU 2015:64) have made similar recommendations. However, as noted by the public small business loans program, Almi Företagspartner (2015), there can be a conflict between GVC's focus on high-risk seed financing (which lacks private actors) and co-investments between PVC and GVC investors. Following parliament's approval of the government's formal proposal (Prop. 2015/16:110) in June 2016, a major reorganization of Swedish GVC is underway. These reforms have taken some of the previous studies' recommendations to heart, including the creation of a fund-of-funds structure.

Instead of adding to the discussion of what GVC funds should do, this report looks in the rear-view mirror to determine what GVC funds have achieved so that any future policy initiative to restructure the GVC market will be well informed of the merits and limitations of GVC as a policy instrument.

The results from this study can be summarized in four points:

1. The results from this study suggest that both private and public VC investments boost sales two to three years after the investment. These increased sales are largely driven by increased efficiency and investments in physical capital, while there is no evidence of any employment effects.
2. The real impact of governmental and private VC on firm growth is similar, though private VC tends to have larger growth effects.
3. We find evidence suggesting that Swedish GVC funds are more likely than private investors both to hold on to and continue to invest in stagnating, non-growing firms.
4. There are no signs that GVC investors are more focused on seed financing and start-up financing than private investors.

1 Introduction

Young, innovative firms play a critical role as important sources of job creation (Puri & Zarutskie, 2012), productivity growth (Chen et al, 2013), and new innovations (Kortum and Lerner, 2000; Cumming and Johan, 2016). Despite their importance, many new ventures find it difficult to raise enough external capital (Hall and Mairesse, 2008). Because of asymmetric information between entrepreneurs and investors along with insufficient internal cash flow or lack of collateral, investing in these firms is viewed as very risky, making traditional financiers (e.g., bank loans) reluctant to provide funding. Instead, many young, innovative firms therefore rely on venture capital (VC) to finance their businesses (Colombo and Grilli 2010; Chemmanur et al. 2011; Puri and Zarutskie 2012; Croce et al. 2013).[3]

VC firms invest directly in the equity of the target firm with the purpose of increasing its value (Hellmann & Puri, 2002) and later selling it, often through an initial public offering (IPO) or an acquisition by a larger company. In the interim period, VC exerts a lasting effect on the backed companies that includes higher employment and sales growth (Davila et al., 2003; Bertoni et al., 2011), higher productivity growth (Chemmanur et al., 2011; Croce et al, 2013), a higher likelihood of going public (IPO) (Puri and Zarutskie, 2012) and generation of patents (Brander et al., 2010), compared to other similar firms not receiving any VC.

The benefits of an active VC market can also be observed at the country level (Buera et al., 2011). For example, it has been argued that the higher R&D spending in the US (2.6% of GDP) compared to in the EU (2% of GDP) is a reflection of the relatively small pan-European VC market (European Commission, 2010; p.22).[4] Even within the EU, there are large differences between countries and the sizes of their respective VC markets (Groh and Lieser, 2010). This heterogeneity can be partially explained by the chicken-egg paradox of developing VC markets. The paradox states that the lack of VC depends on the lack of innovative ventures, and vice versa. Both for this reason and because of private investors' inability to incorporate positive externalities stemming from innovative activities, the supply of private VC can be lower than what is socially optimal.

To close the European-US VC-gap, in 1998 the European Commission implemented the Risk Capital Action Plan (European Commission, 1998), which sought to stimulate stock market openness, increase the flexibility of labor markets, and provide a set of tax incentives. Further initiatives are currently being taken by governments around Europe in line with the Europe 2020 agenda to make *"an efficient European venture capital market a reality"* (European Commission, 2010, p.22). These efforts have led to a unique situation with an increased number of European government-sponsored VC investors (GVCs). To be precise, according to the European Venture Capital Association (EVCA), 38% of the

[3]VC is supplemented in the earliest stages by other sources of financing, including business angels (wealthy individuals buying shares in early-stage ventures, also known as "informal VC"), crowdfunding and the entrepreneur's friends and family.

[4] According to Puri and Zarutskie (2012), firms that at some point received VC represented 5.3%-7.3% of US employment in 2001-2005. Kortum and Lerner (2000) argue that 8% of "industrial innovations" during 1983-1992 in the United States can be attributed to VC-backed firms.

total VC raised in Europe in 2013 came from government-controlled bodies (EVCA, 2014).

GVCs are VC companies that are either partly financed or entirely owned by the government. They enter the VC market directly by increasing the supply of VC in industries in which the flow of private VC investments is thin. As a supply-side intervention (Colombo et al., 2016), GVCs should be distinguished both from other programs that indirectly seek to increase the supply of private VC and from other government subsidies or grants that target the same group of firms (Grilli and Murtinu, 2014), but do not provide the same incentive and monitoring schemes.

The increased presence of GVCs has triggered a spirited academic debate on the role of GVCs and the appropriateness of their investments, along with a growing literature that aims to evaluate GVC performance against both PVC and its own objectives. This literature (discussed in chapter 3) has tended to find that firms backed by GVC do not develop as strongly as those backed by PVC or Mixed VC (MVC, private and governmental co-investments) as measured by several metrics including exits, patents, growth and productivity.

The theoretical case for GVC intervention is the strongest for the earliest stages of a firm's life cycle (the *seed* and *start-up* stages). In other words, private investors are reluctant to invest in early stages (Colombo et al., 2016; Svensson, 2011), giving rise to a funding gap (OECD, 2006). Contrary to what could be expected from a theoretical point of view, Svensson (2011) finds that in the Swedish market, a large share of GVC was invested in later stages. In a more recent study, the Swedish National Audit Office reached the same conclusion (Riksrevisionen, 2014). It also pointed to several inefficiencies in the Swedish system, with multiple GVCs that have different profiles and an unclear division of labor. Although the Swedish government is currently enacting a GVC reform (SOU, 2015:64; Prop., 2015/16:110), there is a lack of evidence about the impact of GVC investments and how they perform compared to PVC.

To bridge the knowledge gap about the impact of GVC investments and how they compare to private investors, we analyze the growth effects experienced by firms that have received VC. By using detailed firm-level data, we can distinguish not only between firms that receive PVC and GVC but also between firms that receive both, i.e., so-called mixed (MVC) VC financing. The results of this study can be summarized as follows:

During the period 2008-2014, GVC investments have been occupying an increasing share of the Swedish VC market. However, there are no indications that GVC is more focused than PVC on early-stage financing. Therefore, there is no evidence that the Swedish GVC market specializes in bridging the seed-funding gap. A similar critique has also been made by the National Audit Office in the report "Statens insatser för riskkapitalförsörjning – I senaste laget" (Riskrevisionen, 2014).

The econometric evidence from this study does not suggest that PVC and GVC exhibit dramatic differences in terms of their real effects on sales, investment and employment. However, there are indications that GVC investors are more prone than PVC investors to hold on to, and continue to invest in stagnating non-growing firms.

Analyzing the real effects of VC, we find no signs of more rapid employment growth in firms that receive VC than in similar firms that do not receive VC. However, firms that receive VC increase their capital stock and sales increase two-three years after the VC injection. Therefore, receiving VC seems to be associated with streamlining firms through

increasing investments, holding back on the hiring of new staff, and increased efficiency and sales. Thus, not only does VC seem to help to finance real investments but also the managerial aspect of VC involvement makes these firms more efficient and increases their competitiveness.

The remaining chapters of the paper are structured as follows: Chapter 2 provides an overview of the literature on GVC. Chapter 3 gives a theoretical background on the role of PVC and GVC. Chapter 4 presents and thoroughly describes the data and Chapter 5 discusses the empirical framework and the matching methodology. The empirical results are presented in chapter 6. Chapter 7 provides a summary and conclusion.

2 The theory of government-sponsored venture capital

Government intervention in financial markets can be motivated by the existence of capital market failures that give rise to a funding gap. This failure is often attributed to the asymmetry of information between the entrepreneur and the investor. To protect business secrets, entrepreneurs are unwilling to disclose certain information concerning technology or business operations. However, if there is a lack of information, investors are confronted by a significant hurdle in the form of a transaction cost that can lead to problems of adverse selection and moral hazard (Lerner, 2002; Akerlof, 1970). As a result, traditional investors are often reluctant to provide funds or extend credit to innovative start-ups.[5]

Conversely, VCs are especially well equipped to resolve the principal-agent problem through a regimen of screening, contracting and monitoring techniques (Kaplan & Strömberg, 2001). Screening refers to an evaluation of the entrepreneur before an investment is made. Contracting refers to providing incentives for the entrepreneur to maximize performance, such as an agreement to match the investment with his or her own funds, and monitoring refers to supervising the entrepreneur after investing, which often involves taking a seat on the board and overseeing the financial performance.

Although PVC investors can bridge some of the funding gap, there are reasons to believe that their effort is insufficient. Young PVC markets are one example of this situation. Such markets are associated with the chicken-egg paradox (Gilson, 2003), which holds that the VC shortage is caused by the lack of innovative firms, which in turn could be caused by a lack of VC (Grilli and Murtinu, 2014). As a result, the total amount of PVC is inadequate to fully remedy the shortage of financial capital demanded by young, innovative firms. If the lack of VC depends on too few innovative start-ups, government can intervene to catalyze the development of an active VC market. According to Lerner (2010), the externalities generated by GVC investment are particularly powerful in an undeveloped market because such investment helps to build the institutional framework needed. Once the institutions needed for the VC market have been established, the positive externalities caused by GVC diminish (Guerini and Quas, 2016). One such example is Israel's VC industry, which during the 1990s became one of the largest VC industries in absolute terms (second only to the U.S.) and the largest in relative terms (in terms of VC expressed as a percentage of GNP), was triggered by a government-targeted program—the Yozma program. Yozma has been credited with helping to unleash the potential of the Israeli start-up ecosystem, which has since gained international renown (Avnimelech and Teubal, 2006; Lerner, 2010). The "GVC as catalyst" argument could also be applied to particular industries or regions of a country.

A lack of VC funds could also occur in developed markets, where the dearth is the most prominent for younger ventures with little (if any) cash flow or collateral to pledge for credit (Lerner, 2002). It is well known that a large share of start-ups fail (Daunfeldt and

[5]Cooter and Schäfer (2012) discuss the double-trust dilemma known as "Solomon's knot". On the one hand, investors are unwilling to provide funding unless the entrepreneur fully discloses information about his innovation. On the other hand, the entrepreneur is not willing to disclose all information to the investor, who could then steal the idea for himself.

Halvarsson, 2014). Because PVCs spend considerable resources on screening, supervising and coaching, their high fixed cost for each investment combined with the high risk of failure makes seed and early stage financing less attractive. Many PVCs also manage large funds and therefore prefer larger investments, making the costs associated with seed and early-stage financing unjustifiable (Svensson, 2011). Furthermore, the time horizon until the potential return from the investment in a start-up tends to be longer for investments in earlier stages, which also makes these investments less attractive. The persistence of a financing gap for the very youngest firms thus motivates GVC intervention to help provide a continuous financing ladder (sometimes referred to as the financing *chain*) throughout a start-up's life cycle.

GVC investment can also be motivated based on the "social returns" that accrue from innovations, which are larger than the private returns. Seen from this perspective, GVC is an instrument for the government to increase innovations to socially optimal levels. Finally, there is an argument that GVC should play a counter-cyclical role to PVC, smoothening macroeconomic fluctuations (Gompers and Lerner, 2003; Robinson and Sensoy, 2013; Lerner & Watson, 2008).

Despite the inefficient market solution that is alleged to characterize VC markets, there are several criticisms related to the appropriateness of GVC increasing the supply of VC funds. A major critique of GVC intervention is that it can displace or *crowd out* PVC investment. Because GVCs spend public funds, crowding out would at best only replace private investments, which is merely wasteful. However, this use of public money could be directly harmful if it distorts the PVC, leading to less total VC in the market.

More generally, GVCs can be criticized on the same grounds as government corporations generally, i.e., their inefficiency. Government tends to be less efficient compared to a private business that has strong performance incentives (Colombo et al., 2016). Applied to GVC, inefficiency can arise both because GVCs are not as handsomely rewarded as their private counterparts and because they do not face the same downside in case of failure. Furthermore, after making their investment, GVC managers may be less concerned about monitoring their portfolio firms to ensure that the funds are used as efficiently as demanded by private investors. Moreover, GVC might also devote less effort to minimizing bureaucracy and making their own organization efficient. Finally, GVC managers could simply be less competent at picking and coaching start-ups than their private sector counterparts.

In addition to efficiency-related issues, there is also a risk of corruption and cronyism associated with GVCs. Without adequate supervision, individuals may abuse their control of public funds to benefit themselves or their cronies instead of working for the common good. Lerner (2009, 2010) documents a series of examples of incompetence, wasted resources and corruption associated with GVC programs. On the political side, Florida and Smith (1993) argue that GVC can be a way for politicians to compensate for failures in other policy areas and that introducing a political failure makes the outcome worse than the initial situation.

3 The empirical literature

The empirical VC literature can be classified into a few broad topics. Of the studies that examine the performance of VC-backed companies, we distinguish between studies that investigate the effects of general VC from studies that look at the effects of PVC, GVC and MVC investments separately.

3.1 Productivity and firm growth

In examining productivity growth among a sample of VC-backed US firms, Chemmanur et al. (2011) find that VC-backed firms that have already received their first VC investment were more productive than similar firms that have not received an investment. The authors interpreted this finding as evidence of a selection or "screening effect". The VC-backed firms were also observed to experience higher productivity growth for up to four years after the initial investment, which the authors interpreted as evidence that the "value added" services provided by VCs helped make the firms more productive. Croce et al. (2013), studying European firms, also found evidence of higher productivity growth of the VC-backed firms but no evidence for a screening effect. When comparing the productivity effects of GVC and PVC on 515 Belgian companies, Alperovych et al. (2015) find that companies backed solely by GVC experienced significant *reductions* in productivity after receiving GVC, whereas companies that received PVC investments experienced significant productivity gains.

Positive productivity shocks can boost labor demand, resulting in employment growth, which is a key policy variable. Indeed, a series of papers investigate the relationship between VC and growth in sales and employment. Early studies in this vein of research focus on the American Small Business Investment Research program and include, e.g., Audretsch et al (2002); Gans and Stern (2003); Wallsten (2000). Lerner (1999) studied employment and sales growth of 900 high-technology firms that participated in the program during 1985-1995. Although the program was not strictly structured as GVC but instead as a research grant, Lerner finds that the firms participating in the program grew faster than a control group of similar firms outside of the program. He also noted that this effect only held for companies that were based in areas with substantial VC activity. Later studies on the relationship between firm growth and VC include Bertoni et al. (2011), who found evidence for sales growth among 537 Italian "new technology-based firms" following VC investments. In a similar vein, Davila et al. (2003) analyzed short-term employment growth among 500 VC-backed firms in Silicon Valley. Whereas firms experienced significant employment growth prior to receiving VC investment, those authors also found that growth continued to accelerate in the ensuing months.

Looking at the growth effects from PVC and GVC individually, there appear to be some differences. In a recent study, Grilli and Murtinu (2014) found no evidence for sales growth among GVC-backed firms, whereas MVC- and PVC-backed firms experienced significant sales growth following an investment. There was, however, no evidence for significant employment growth from any type of VC investment (PVC, GVC, or mixed).

3.2 Exits and patenting

The primary means through which VCs can realize a successful investment is by selling their shares in the company either to another investor or through an IPO, what's known as

"exiting" the investment. From the perspective of the VC company, therefore, an alternative and perhaps more direct way to gauge a targeted company's performance is to look at exit rates and survival rates. If the company fails, there are no returns for the VCs to reap. In a study of more than 10,000 US firms that received VC, Puri and Zarutskie (2012) observe that during the first years after receiving VC capital, VC-recipient firms were less likely to fail compared a control group of non-VC-recipient firms. As time went by, however, that difference disappeared.

Using cross-country data on exit and VC investments in Canada, the US, Europe and several Asian countries, Brander et al. (2015) investigated the exit performance of GVC- and PVC-backed firms, finding that companies backed by PVC had a significantly higher probability of a successful exit than companies backed by GVC. When controlling for the amount of capital invested, however, all differences disappeared. Similar results have also been reached by Cumming et al. (2014a) for a sample of European companies. Guerini and Quas (2016) provide evidence that initial GVC investment helps ventures get PVC investment later on, and that such firms are successful as measured by exits, which supports the hypothesis of GVC helping to catalyze PVC investment and fill an early-stage PVC gap.

A few papers have used patents as a measure of innovation in VC-backed companies. The general finding is captured by Brander et al. (2010) and Bertoni and Tykova (2015): PVC-backed firms were more likely than GVC-backed firms to produce patents.

3.3 Crowding out

With an established presence of GVCs, the interplay between PVCs and GVCs leads to the question of whether GVCs are crowding out PVCs. Although the results are mixed, most studies seem to find evidence for a crowding-out effect (i.e., GVC replacing PVC) from GVC rather than a crowding-in effect (i.e., more PVC). An early study by Leleux and Surlemont (2003) investigated the relationship between GVC and PVC in a European context, finding that PVC and GVC largely developed independently from each other. However, a more recent study by Brander et al., (2015) finds evidence that the presence of GVC was crowding *in* PVC. Analyzing a different sample of VC-backed firms in Canada, the US and numerous European countries, Cumming and Macintosh (2006) and Armour and Cumming (2006) instead found evidence that GVC was crowding out PVC. Cozzarin et al. (2015) found that GVCs crowded out PVC in the home market and that, in response, PVC chose to reallocate its investments to neighboring countries. An interpretation of these mixed results could be that the risk for crowding out PVC depends on how GVC is carried out, and/or on the context in which it is done. For example, if GVC competes with PVC for investments, and offers investment terms that PVC cannot compete with (e.g., more lenient contracts, bigger investments for smaller shares), then there is clearly a risk that entrepreneurs will opt for GVC even though PVC is available. However, if GVC takes care not to compete with PVC, then the risk of crowding out can be significantly reduced.

3.4 The Swedish GVC debate

The Swedish government has been an active player in the VC market since the early 1970s, and since 2010, its influence on the VC market has steadily increased. An early analysis of the Swedish GVC market has been undertaken by the Parliamentary Audit Office (Riksdagens revisorer, 1996). The results of that study are not entirely optimistic. It stated that most GVC investments had been failures and that the GVCs lacked knowledge and skills in board work and management. Riksdagens revisorer (1996) estimated the cost

of each new job created by GVC to 200,000 SEK (approximately 20,000 Euros). GVC was also criticized as a tool for employment policies. That is, GVC investments were used to maintain employment in otherwise non-competitive firms. Concerns were also raised that the risk of an over-supply of VC could have contributed to the IT-bubble in the 1990s (Tillväxtanalys, 2010)

More recently, the Swedish discussion has centered on what GVCs should do, not what they have achieved. It can be said that this discussion was triggered by Svensson (2011), who analyzed the Swedish GVC market. In line with the theoretical leitmotif, which is emphasized by Lerner (2002), Svensson argued that GVC is mostly justified for small, risky, early-stage ventures, for which the supply of private financing is likely to be insufficient. However, his examination of GVCs in Sweden reveals that they did not invest accordingly; instead, that too much GVC was invested during later stages. Svensson therefore recommended GVCs to focus more on the early investment stages and increase coordination with private investors.

In 2014, a second evaluation of Swedish GVC was undertaken by the Swedish National Audit Office (Riksrevisionen, 2014). Riksrevisionen's views are largely in line with those of Svensson (2011). In addition to recommending an increased focus of GVCs on early-stage financing, Riksrevisionen argued that overall, the Swedish GVC system was inefficient. There were multiple GVCs with different profiles and the division of labor among them was unclear. After the 2014 Riksrevisionen report, an investigation of Swedish GVC policy was commissioned by the newly elected Swedish government in early 2015 and presented that same year (SOU 2015:64). The SOU argued that although when making an international comparison, Swedish ventures' access to financing was good, there was a funding gap in the earliest start-up stages. The SOU also proposed the creation of a fund-of-funds structure, which would help set up VC funds co-financed by public and private funds ("hybrid funds"), but that would be managed by private VC teams. The report also argued in favor of shuttering the region- and sector-specific GVCs, Fourier transform (manufacturing) and Inlandsinnovation (Northern Sweden). In addition, it was suggested that Almi loans targeting SMEs be expanded to complement VC funding. In its official response to the SOU, Almi (Almi Företagspartner, 2015) supported most of the proposals by the SOU, but highlighted not only the conflict between GVC in taking more risk than PVC and having expectations of a return but also that GVCs' high-risk profile would complicate the scope of private-public co-investments. Many of the SOU's key proposals were accepted by the government and included in a formal proposal presented to parliament in March 2016 (Prop. 2016/16:110). Parliament approved the proposal in June of 2016, and as a consequence a new fund-of-funds structure dubbed Saminvest is being set up during fall 2016.

4 Data and description

This section provides a descriptive overview of the database of GVC and PVC investments managed by the Swedish Agency for Growth Policy Analysis (Myndigheten för tillväxt-politiska utvärderingar och analyser). The VC dataset includes information on approximately 700 Swedish entrepreneurial firms that received VC from 2007–2013. The database includes all forms of *private equity* investment, including buyouts and growth capital. Here we focus on private equity invested in the early stages, i.e., *venture capital*. Following Invest Europe's classification of investment stages, VC investment was defined to include the categories "seed", "start-up" and "later-stage venture", but not "growth capital". GVC is defined as the six VC firms wholly funded and operated by the government that we observe in our sample. It does not include quasi-governmental VCs such as public pension funds.

Data on VC comes from two sources. Data on private equity investments is provided by the Swedish Venture Capital Association (SVCA). On behalf of its European parent organization, Invest Europe (formerly EVCA), SVCA asks its members to submit information about all their investments; each observation in the dataset represents one transaction from an investor to a receiving company. Data contain information on the private equity firm making the investment, the entrepreneurial firm receiving the investment, and the transaction itself, such as the amount of money invested and the date. The period covered is 2007–2014. The data do not include equity investments made by private individuals, so-called *business angels* (sometimes referred to as "informal venture capital").

Data on firms' input and output are provided by Statistics Sweden (SCB) and cover all Swedish firms. Firm-level data complement VC data with information on production, sales, employment, value added, investments, physical capital, profits, industry affiliation, educational attainment of the labor force, geographic location, etc., spanning the period 2007-2013. All firm-level datasets are merged using unique individual firm-year ID codes.

4.1 VC investments in Sweden, 2007–2014

Figure 1 presents the total amounts of GVC and PVC invested in Sweden from 2007–2014. As shown in the figure, there was a sustained included in PVC investments in Sweden starting from the global financial crisis in 2008 until 2013. During the same period, the amount of GVC investment increased substantially.

Figure 1 Total yearly VC investment in Sweden, GVC and PVC (SVCA)

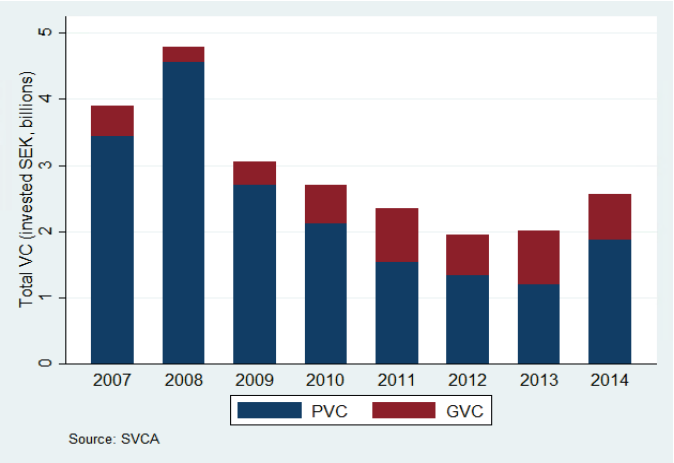
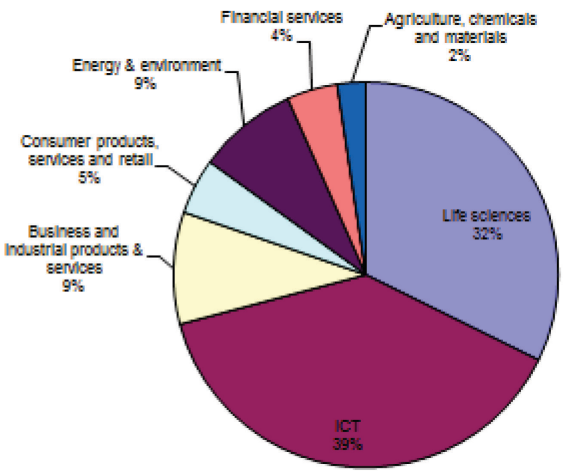


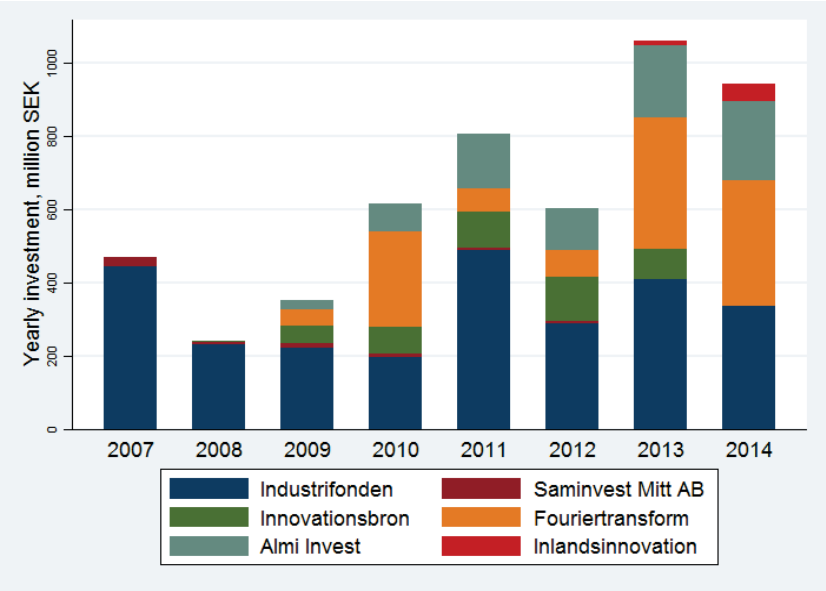
Figure 2 shows the distribution of VC among various sectors. As shown in figure 2, ICT is the single biggest sector for VC, followed by life sciences; together, those sectors account for 72% of invested VC. *Energy and environment* and *Business and industrial products and services* account for just under 10% each. The remaining 10% is divided between *Consumer goods, services and retail*, *Financial services* and *Agriculture, chemicals and materials*.

Figure 2 Total VC investments by sector (SVCA data)



The set of GVC investors consists of GVCs that are wholly funded and operated by the government ("*direct* GVC"). The data includes six GVC companies: Almi Invest, Industrifonden, Inlandsinnovation, Fouriertransform, Innovationsbron and Saminvest Mitt AB. Data does not include publicly owned pension funds such as the 6th AP Fund and VCs that are independently run but funded partially with public funds, such as the VC/incubator Stockholm Innovation and Growth (what is known as a "hybrid" public-private VC). Figure 3 depicts investments from each of the six GVC firms, based on the SVCA data.

Figure 3 Yearly total GVC investment, by GVC firm



As shown in figure 3, Industrifonden has consistently been the largest GVC investor. Almi Invest and Fouriertransform were both founded in 2009, followed by Inlandsinnovation in 2010. Almi Invest established several regional "co-investment funds", which were supposed to co-invest with private investors in early stage ventures. Almi Invest has steadily increased its investment since then, absorbing two smaller GVCs in 2013: Saminvest Mitt (a small regional GVC based in Östersund) and Innovationsbron (focused on early-stage investment). Fouriertransform was created as part of a rescue package for the troubled auto industry to provide urgent support to struggling companies. Its mandate was later expanded to include other manufacturing industries. Inlandsinnovation focuses on Northern Sweden.

Table 1 Overview of GVC investments

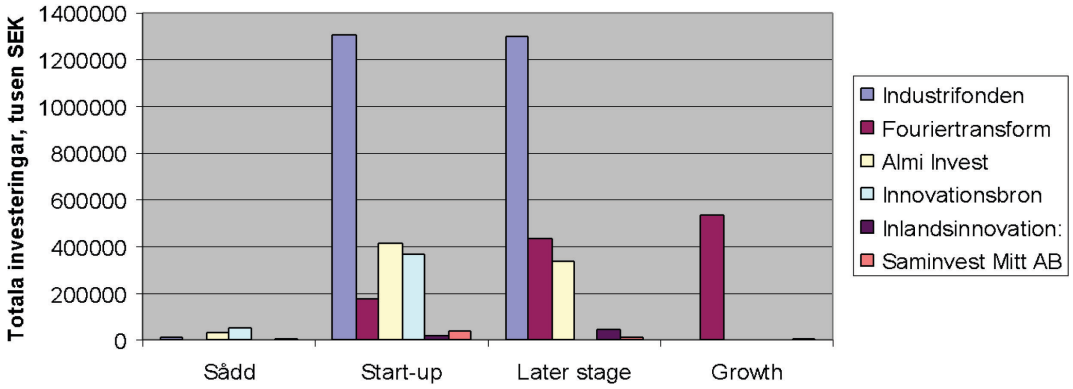
GVC investor	Total investment*	No. of firms	Obs.	Average tranche*
Industrifonden	2,618,252	123	473	5,535
Fouriertransform	1,146,176	24	46	24,917
Almi Invest	783,024	390	599	1,307
Innovationsbron	420,708	485	485	867
Inlandsinnovation	86,904	9	10	8,690
Saminvest Mitt AB	65,422	31	46	1,422

**Thousand SEK.*

Table 1 presents a detailed view of the GVC investments and figure 4 shows a breakdown of total investments for each VC investment stage: seed, start-up and later-stage (expansion). In the *seed* stage, the company is just getting started: the entrepreneur might be in the process of setting up the company, researching his business plan, etc. The *startup* stage is when the company has begun to develop its product and is preparing to launch it commercially. In the *expansion* (or *later-stage*) phase, the company has completed its product launch and is focused on expanding. Among governmental investors, Fourier transform stands out as focusing more on later-stage investment (including growth capital)

and investing a larger sum in each company, reflecting its unique mandate to support mature, struggling companies, whereas all the other GVCs focus on earlier stages. Whereas Almi Invest and Industrifonden appear to be focused on roughly the same investment stages, Industrifonden generally invests considerably larger sums that Almi in its portfolio companies.

Figure 4 Total GVC investments by GVC firm and investment stage



Although not part of the main analysis, some types of equity investment focus on investment in more mature companies, but do not involve buyouts. These include *growth capital* and *turn-arounds*. Growth capital is provided when a private equity firm acquires a minority stake in a relatively mature company that needs an infusion of capital. These companies typically have not previously received VC. Spotify and Klarna are examples of companies that have received growth capital in the last few years to finance their global growth and that did receive VC in earlier stages. A turn-around is an investment in a struggling, relatively mature firm. In this situation, the investors buy shares at a low price, hoping that their infusion of capital and management expertise can help the company recover and increase in value. This report focuses on VC, not growth capital and turnarounds.

4.2 Companies receiving VC

Our data include 699 companies receiving VC. As shown in table 2, a majority of these companies (55 percent) were financed either partially or entirely by GVC. However, according to Tillväxtanalys (2016), Almi Invest makes nearly all of its investments with private investors and business angels. Further, Tillväxtanalys (2016) states that 35 percent of Almi's co-investments are with business angels, which are not present in our data. For this reason, the share of "GVC only" companies is likely to be overestimated, while the share of "GVC and PVC" companies is underestimated.

Looking at the size of PVC and GVC investments, the broad pattern is that companies backed by GVC tend to receive less VC per company than companies backed by PVC (or GVC+PVC). Companies backed by GVC and PVC tend to receive slightly more VC than companies backed by PVC only.

Table 2 Companies in each category of public and/or private VC backing

Type of VC	Number of firms	Share of firms	Total VC invested*	Avg. VC per company*
GVC only	237	33.9%	1,200,647	5,066
PVC only	317	45.4%	9,483,392	29,916
GVC and PVC	145	20.7%	6,525,215	45,001
Total	699	100%	17,209,374	24,620

*Note: *Thousand SEK*

Table 3 provides descriptive statistics of VC investments in the three investment stages: seed, start-up and later-stage. As shown in table 3, the average size of the VC investment roughly doubles at each stage. An interesting finding is that even though GVC purportedly focuses on the earliest stages of financing, PVC and GVC investors allocate their investments in a similar manner. Both private and governmental VCs allocate approximately two percent of their investment budgets to seed funding, with private investors allocating a slightly higher seed share (2.2 percent GVC-seed vs. 2.7 percent PVC-seed). Looking at the number of investments (tranches), a similar picture emerges, with 7.7 percent of the private tranches and a slightly lower share of GVC tranches, 7.5 percent, allocated to seed funding. Looking at subsequent stages, (start-up and later-stage) the same picture remains. There is no evidence that the state is more specialized in funding the earliest investment stages compared to private investors. Considering that one of the primary justifications for GVCs is the assumption of a PVC funding gap in the earliest stages, one might assume that GVCs should be more focused on seed and start-up funding. A similar critique was made by Riksrevisionen (2014) in the report, "*Statens insatser för riskkapitalförsörjning – I senaste laget*".

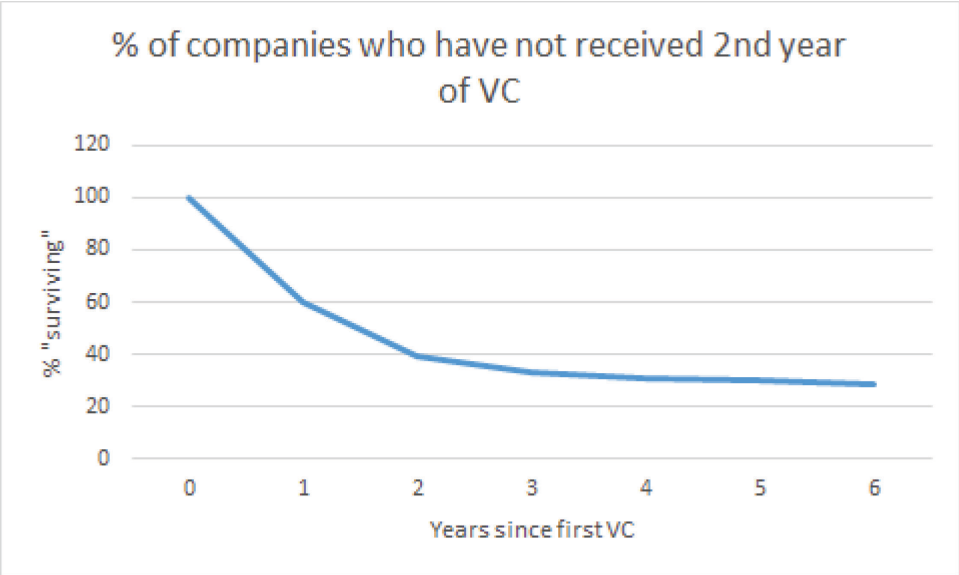
Table 3 Investments by investment stage, thousand SEK.

	Median	Mean	Stdv.	Obs (%)
All VC				
Seed	929	1,771	3,443	325 (7.6%)
Start-up	1,349	4,073	9,747	2,612 (61.4%)
Later stage	2,989	7,720	15,235	1,315 (30.9%)
GVC				
Seed	445	737 [2,2%]	967	123 (7.5%)
Start-up	898	2,013 [51,4]	4,003	1,055 (64.4%)
Later stage	1,778	4,179 [46,4]	7,735	458 (28.0%)
PVC				
Seed	1,339	2,401 [2,7%]	4,183	202 (7.7%)
Start-up	2,221	5,469 [49,4%]	11,989	1,557 (59.5%)
Later stage	4,114	9,612 [47,8%]	17,722	857 (32.8%)

Notes: These are the figures for the entire SVCA dataset for 2007-2014, including unmatched firms. Share of total number of tranches within parenthesis (,). Share of total VC within brackets [.].

Most firms that receive VC investment receive VC more than once. Figure 5 illustrates how many companies receive VC in more than one year. Approximately 40% of companies that received VC receive another injection in the year after, and after five years, approximately 3/4 of all firms have received at least one more VC injection.

Figure 5 Survival graph for companies receiving second year of VC



Looking at the number of tranches received, in table 4 we see that in a given year, 60 percent of all firms (that received VC) receive one tranche only. That is, given that a firm has received VC in a given year, 40 percent of those firms receive more than one injection. The maximum number of tranches received by a single firm in one year is ten, and over the period of observation, the maximum number of tranches received by a single firm is 47. Thus, it is common practice in the VC industry for VCs to pay out their investments in pieces ("tranches") as the entrepreneur attains predetermined goals. This is a method used by VCs to maintain control over the entrepreneur and mitigate moral hazard ("monitoring"). Furthermore, many companies receive capital from several VCs.

Table 4 Number of transactions per year, per company

Number of tranches in a year	Number of observations	Share of total
1	826	0.6051
2	313	0.2293
3	134	0.0982
4	42	0.0308
5	19	0.0139
6	16	0.0117
7	5	0.0037
8	3	0.0022
9	4	0.0029
10	1	0.0007
12	1	0.0007
16	1	0.0007

The VC industry focuses on relatively young and small firms. It is therefore interesting to analyze the distribution of firms' size when they receive their first VC investment. As shown in table 5, the median firm had three employees when receiving the first VC-injection and 16% of the companies had one employee only. We may also note that no firm

with more than 221 employees received seed, early-stage, or later-stage VC (typically, larger firms are more prone to become targets of leveraged buyouts or growth capital).

Table 5 Distribution of company size (number of employees) in year of the first VC investment

Percentile:	Min	0.01	0.05	0.1	0.25	0.5	0.75	0.9	0.95	0.99	Max
Size:	1	1	1	1	2	3	8	21	44	86	221

Table 6 shows the companies' age in the year when they received their first VC investment. Most were just a few years old; the median age was 3 years.

Table 6 Distribution of company age (years) in year of first VC investment

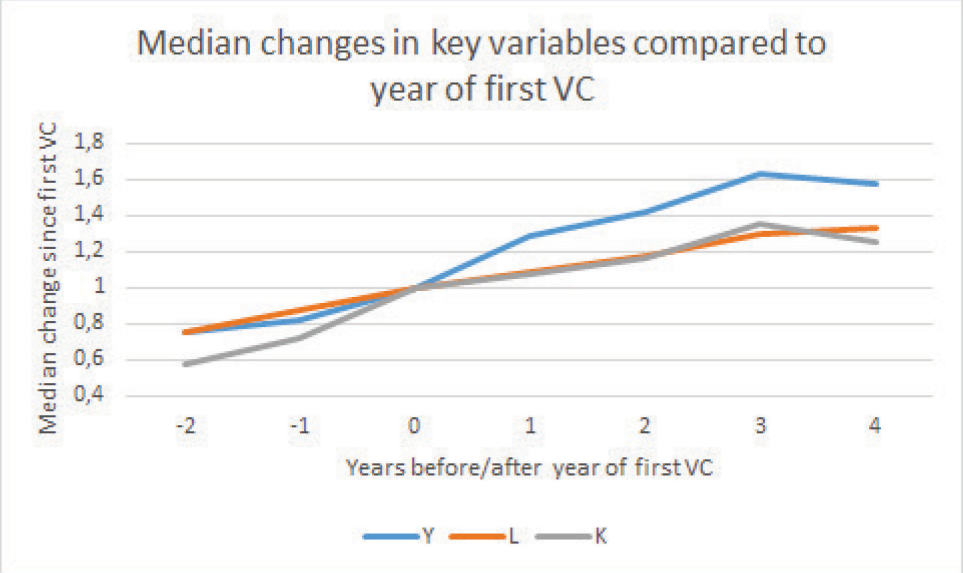
Age* at first VC:	0	1	2	3	4	5	6	7	8	9
Number of firms:	145	117	88	186	70	55	30	29	18	9
Percent	19.41	15.66	11.78	24.90	9.37	7.36	4.02	3.88	2.41	1.20
Cumulative percentage	19.41	35.07	46.85	71.75	81.12	88.49	92.50	96.39	98.80	100

**Company birth is defined as the year when the company is formally incorporated, and therefore appears in our data.*

It is well known that firms tend to grow relatively fast during the first 5-7 years of their existence, and the growth rate then flattens out as they reach their minimum efficient scale (Daunfelt and Halvarsson, 2014). Therefore, given that the VC industry targets small and young firms, one could expect these firms to grow over time even without receiving VC: growth is simply a natural part in their phase of the firm life cycle. In figure 6, we depict the growth of employment, capital and sales in the years before and after firms receive their first VC investment.

The medians of all variables (number of employees, capital stock, and sales) are lower in the years before the first VC investment compared to the year of first VC and higher in the years after. Capital stock seems to take a great leap in the year of first VC (compared to t-1) and then grows more slowly in the years that follow, suggesting that the first VC investment tends to be followed by immediate and significant capital investment. Employment growth appears to stagnate after three years.

Figure 6 Growth of Capital (K), employment (L) and sales (Y), before and after the first VC investment.



In table 7, we tabulate some key characteristics of firms receiving VC, the control group, and the entire population of Swedish firms.

Table 7 Descriptive statistics

Variable		VC-backed companies	Control group	All Swedish companies
Sales (revenues)	Mean	20,119	38,428.5	17,835.4
	Median	3,399	5,289	1,967
Capital assets (K)	Mean	47,733	262,547	35,236
	Median	8,318	4,086	1,537
No. employees (L)	Mean	14.5	19.6	10.1
	Median	5	5	2
Share skilled labor	Mean	56.2	54.3	14.5
	Median	60	57.9	0
Gross investments	Mean	1,559	2,328	1,094
	Median	92.6	15.7	0
Equity/sales	Mean	73.8	371.1	10.56
	Median	0.62	0.22	0.21
Total debt	Mean	19,736	139,161	20,197.6
	Median	3,413	2,162	801
Gross profit/sales	Mean	-29.9	-5.9	-0.61
	Median	-0.35	0.06	0.06
Value added (VA)	Mean	5,228	16,782	6,664
	Median	658	2,401	939
Return to capital (r)	Mean	-4.58	17.5	10.1
	Median	-0.06	1.73	1.20
Average wage (w)	Mean	387	365	239
	Median	350	331	234

Notes: Numbers based on merged firm VC and register data. All variables are denoted in thousands of SEK, unless stated otherwise. For all variables except for the share of high-skilled workers and the return on capital, the numbers of observations are the same: 4,263 for the treated group, 7,290 for the control group, and 2,137,815 for the entire population of Swedish companies.

5 Empirical framework

Analyzing the impact of VC investment on firms is challenging for reasons that go beyond the data requirements. The selection and screening performed by VC firms suggests that companies that receive VC might be different from companies that do not receive VC. In line with previous studies, we therefore resort to matching methods to create a control group of non-treated firms that is as similar as possible to the VC-treated firms. In addition, we aim to estimate the direct impact of VC on firm sales, to capture indirect effects in which VC impacts sales through employment and investment, and to analyze these sub-channels.

5.1 CEM matching

Firms receiving VC are not selected randomly. As noted in a previous section, VCs engage in screening activities where the target firms' profitability, growth and survival potential are analyzed. Therefore, directly comparing the performance of VC companies with firms that do not receive VC can be misleading. To manage this problem, our main strategy is to opt for a matching method that seeks to pair every VC-backed firm with a similar non-VC-backed firm. For a recent application of matching methods in the VC literature, see Croce et al. (2013), Cumming et al. (2014), and Grilli and Murtinu (2014).

We use a matching technique known as coarsened exact matching (CEM) (Iacus et al., 2011, 2012). Compared to the propensity score matching (PSM) technique, CEM has some useful properties (Iacus et al., 2011, 2012; Blackwell et al., 2009; King and Nielsen, 2016). Most importantly, the CEM estimator satisfies the property of *monotonic imbalance bounding*, which means that total balance can be improved by improving the balance of a single covariate. When using PSM, there is no way of knowing whether the total balance in the matching has been improved by improving the balance of a single covariate or by adding and removing additional covariates. The key difference between CEM and PSM, therefore, is that CEM allows for a systematic way of working with different matching variables to increase balance, whereas PSM only *"works when it works, and when it does not work, it does not work (and when it does not work, keep working at it)"* (Ho, et al., 2007, p.219). A further property of CEM that is conducive to finding a suitable control group is that it is robust to the presence of measurement error (Blackwell et al., 2009).

For each of the treated firms, we match using firm properties one year before the treatment, (t-1), with t being the year a firm receives VC. The matching results are presented in table 8. Our matching is based on the following variables (for the sales and capital equations): equity/debt, employment, employment growth, profit ratio, 2-digit industry code, and the share of high-skilled workers. Accounting for profit rate and amount of equity in the company, our matching model is slightly more extensive than that used by e.g., Paglia and Harjoto (2014), who account for 2-digit industry code, annual net sales, number of employees, and state of location. Because it is not advisable to match on the dependent variable, when considering the employment regression we replace employment and employment growth with sales and sales growth. The set of possible control firms consists of all Swedish firms. We perform a so-called 1-to-1 match that associates each VC firm with one control firm. This makes the post-matching parametric analysis simpler because we do not have to adjust for differences in number of observations between the control and treated groups using weights in the regression analysis.

The matching results are presented in table 8, in which the first two columns report the imbalance between the treatment and control group, and in parentheses (.), the imbalance between treated and all non-treated firms. As noted by Iacus et al. (2011, 2012), the value of the imbalance test is subordinate to the change in imbalance as given by matching. As shown in table 8, matching reduces the imbalance for all variables, suggesting that matching leads to a control group that is more similar to the treatment group than the collection of all non-treated firms. In columns 3-5 of the table, we proceed and present average values for the matching variables for the three groups: all firms, the control group and the treatment group. Again, we see that for all the variables but employment and sales, the absolute difference in averages between the treated firms and the control group is smaller for the control group than for all non-treated firms. That is, overall, matching leads to improved similarity between the treatment group and the control group, though the two groups do not end up with identical values. Finally, the bottom row reports the overall imbalance between the treatment and control groups.

Table 8 Matching results using 1-1 coarsened exact matching

	Matching imbalance		**Mean values**		
	Sales equation	Employment equation	Mean (treated)	Mean (controls) [(A)]	Mean (all firms)
Employment	0.09 (0.32)		14.50	19.64	10.14
Employment growth	0.09 (0.44)		0.12	0.04	0.01
Profit ratio	0.04 (0.72)	0.03 (0.72)	-29.86	-4.94	-0.61
Skill share	0.04 (0.69)	0.00 (0.69)	56.22	54.29	14.46
Sni-2 (industry code)	0.05 (0.67)	0.04 (0.67)	57.03	56.27	53.21
(Equity/debt)	0.15 (0.20)	0.14 (0.20)	3.51	2.54	.2.46
Sales		0.03 (0.12)	20,119	38,428	17,835
Sales growth		0.09 (0.44)	0.20	0.03	-0.01
Overall L1 dist.	0.55	0.58			

Note: Matching imbalance, univariate L1 distance between treated and control group, imbalance between treated and all other firms within parenthesis (.). [(A)] *Control group averages from the sales equation matching.*

5.2 Estimation of sales, employment, and capital

Our econometric analysis investigates the impact of VC on sales, employment and physical capital. For the analysis of the direct impact of VC on sales, we build on Liu and Yoon (2000), Griliches and Mairesse, (1997) and Frankel and Romer (1999) and estimate an augmented production-function-based model. The estimated model is formulated as follows:

$$\ln(ln(Y)_{it} = B_1 ln(L)_{it} + B_2 ln(K)_{it} + \sum_h^H B_{3h}\,(H)_{hit} + B_4\, ln(Debt)_{it} + B_5(equity)_{it} + B_6(\pi)_{it} + \sum_{t+s}^T B_{7s}\,(VC)_{it+s} + B_8(T)_i + v_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where Y_{it} is sales in firm i at time t, L is the number of employees, K is the capital stock, H is the share of the labor force with secondary, short tertiary and longer tertiary education, *Debt* is total debt, *equity* is the equity ratio equity/sales, π is the profit ratio, T is a

balancing indicator taking the value of one for all years for treated firms and zero for non-treated firms, v_i represents firm-fixed effects, γ_t is a period dummy and $\varepsilon_{it}$is the error term. The term $\sum_{t+s}^{T}(VC)_{it+s}$ refers to a set of dummy variables that capture the instantaneous (s=0) and the post-treatment effect (s=1,…,T) of VC on firm sales. Using a matched control group, this model represents a standard conditional matched difference-in-differences (DiD) model. In the analysis, the model will be elaborated to consider impact lags, endogeneity, and indirect effects.

As shown in equation 1, sales are a function of capital and labor (K, L). These variables can also be affected by a VC injection. We therefore complement equation (1) with estimations of the impact of VC on employment and capital, which comprise factor demand. When estimating the impact of VC on factor demand (K and L), we draw on the labor demand literature in which labor and capital are both considered factors of production. Demand for these factors (K and L) can be derived from the cost function, $C_i(w_i, r_i, y_i: i = K, L)$,which is a function of factor prices, i.e., wages (w_i), interest (r_i) and output (y_i). Assuming no adjustment costs, labor demand can be described with the following log-linear function (Hijzen and Swaim, 2008):

$$ln(L)_{i,t} = \alpha_i + \beta_r\, ln(r)_{i,t} + \beta_w\, ln(w)_{i,t} + \beta_y \ln(Y)_{i,t} + v_i + \gamma_t + \epsilon_{i,t} \quad (2).$$

where L is the number of employees, w and r represent factor prices and Y is value added. Following the common assumption of adjustment costs suggests the inclusion of the lagged dependent variable on the right-hand side of the equation, yielding the following general expression for factor demand (Cahuc and Cylberg, 2004):

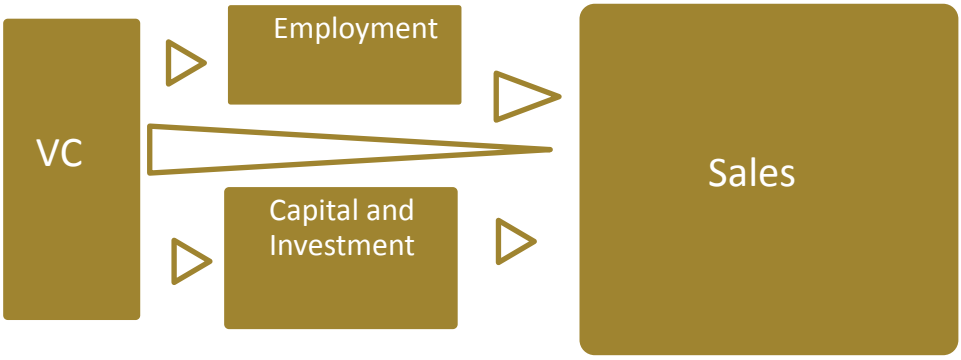
$$\ln(V_F)_{i,t} = \alpha_i + \beta_v \ln(V_F)_{i,t-1} + \beta_r \ln(r)_{i,t} + \beta_w\, ln(w)_{i,t} + \beta_y \ln(Y)_{i,t} + \sum_h^H B_{3h}\,(H)_{hit} + B_4 \ln(Debt)_{it} + B_5(equity)_{it} + B_6(\pi)_{it} + \sum_{t+s}^{T} B_{7s}\,(VC)_{it+s} + B_8(T)_i + v_i + \gamma_t + \varepsilon_{it} \quad (3).$$

with F= $\{L, K\}$. In equation (3), we present the full demand model in equation (2) fitted with treatment variables and additional control variables following the specification of equation (1). The inclusion of a lagged dependent variable imposes an endogeneity problem. To manage this problem, we apply a dynamic panel data estimator. Instead of using the difference-system-GMM estimator (Arrelano and Bond, 1991; Blundell and Bond, 1995) that relies on proper identification of an instrument matrix and the absence of a second-order autocorrelation in the residual term, we apply the Han and Philips (2010) dynamic panel data estimator. The estimator relies on (long) differencing and is not burdened by the problem of (weak) moment conditions. Because our panel is short, similar to the previous GMM-estimators, the differencing approach has good short panel properties.

As shown in equations (1) and (3), VC does not only have a direct impact on sales but also feeds into sales through investment (capital stock) and employment. For these reasons, when analyzing the impact of VC on sales, results from the production function based on the model in equation (1) might not fully capture the impact of VC on sales. We therefore combine the factor demand equations in equation (3) for capital and employment with the sales equation in a structural equation system. This allows us to analyze both the direct

impact of VC on sales and the total impact of VC, where indirect effects, transmitted through changes in the capital stock and employment are included. The structure of the system is depicted in figure 7 and formally shown in (4-6).

Figure 7 Direct and indirect effects of VC on sales



We may note that the structural equation system, (4), is based on a simplified version of factor demand in which we assume no adjustment costs and replace firm-fixed effects with two-digit industry dummies. The structural system can therefore be described as follows:

$$ln(Y)_{it} = B_1 \ln(L)_{it} + B_2 \ln(K)_{it} + \sum_{h}^{H} B_{3h}\,(H)_{hit} + B_4 \ln(Debt)_{it} + B_5 (equity)_{it} + B_6 (\pi)_{it} + B_7 (T)_i + \sum_{t+s}^{T} B_{8s}\,(VC)_{it+s} + v_j + \gamma_t + \varepsilon_{it} \quad (4)$$

$$ln(L)_{i,t} = \alpha_i + \beta_r \ln(r)_{i,t} + \beta_w\, ln(w)_{i,t} + \beta_y \ln(Y)_{i,t} + \sum_{t+s}^{T} B_{1s}\,(VC)_{it+s} + B_2 (T)_i + v_j + \gamma_t + \epsilon_{i,t} \quad (5)$$

$$ln(K)_{i,t} = \alpha_i + \beta_r\, ln(r)_{i,t} + \beta_w\, ln(w)_{i,t} + \beta_y \ln(Y)_{i,t} + \sum_{t+s}^{T} B_{1s}\,(VC)_{it+s} + B_2 (T)_i + v_j + \gamma_t + \epsilon_{i,t} \quad (6)$$

where *j* is industry fixed effects at the two-digit level. For details on structural equation models (SEM), see (Acock, 2013; Kline, R.B., 2010; Matsueda, 2012). In addition to using a matched control group, we will analyze the impact of VC using fixed-effect estimations of the treatment group only. This strategy seeks to identify trend-breaks instead of comparing the development of two groups of firms. For details, see Tillväxtanalys (2014, 2015).

6 Results

To investigate the impact of VC on firm sales, which is our primary outcome variable, we develop the analysis in several steps. Beginning with the *direct* effect of VC investments, we use a standard fixed effect panel data estimator. Next, we turn to the *total* effect of VC on sales where we to the direct effect add indirect effects that work through employment and investments. To analyze the total effect, we use a structural equation estimator (SEM). Finally, we take a closer look at the impact of VC investments on the sub-channels, employment and investment, respectively. In each of the steps, we present separate results for firms that receive PVC only, GVC only, and firms that receive both PVC and GVC, referred to as mixed VC (MVC).

In the analysis, we follow the impact of VC (treatment effect) over time both from the time it "arrives" ($t = 0$) at the company and for the t= $1, \ldots, 4$ years after receiving the VC investment.[6] For each step, we present results from looking at both sales of the group of treated firms only to determine whether the trend in sales displays a break before and after VC investments, and the differences in sales for the group of treated firms compared to the control group of matched firms not receiving VC.

6.1 The direct impact of venture capital on firm sales

We begin the analysis to see how the three types of VC investment directly impact firm sales. Table 9 shows the results when we restrict the sample to only include firms that received VC investment at some time during the period. The results are estimated using fixed effects at the firm level. By restricting the sample to firms that receive VC at some point in the period, a significant treatment effect (B_{7s}) means that firm sales were different during the s year following the VC investments compared to the years before receiving the investments. The analysis therefore traces structural breaks in firm sales when or after receiving VC.

Starting with firms receiving PVC only (column 1 in table 9), there is no evidence of increased sales after receiving PVC. Instead, we detect a negative impact on sales the same year that the VC is received ($t = 0$). One possible explanation for the contemporary drop in sales is increased investments. If VC is used for a large investment, there might be an immediate negative impact on sales.

Moving on to firms receiving GVC only, we find a somewhat different pattern. First, we do not see a dip in sales at the time of the VC investment and there is a tendency toward positive post-treatment effects on sales. Specifically, we find in period (t+1), (t+2), and (t+4), there is evidence of a significant positive impact on sales with the largest coefficient of 0.42 suggesting a sales increase of 52 percent, four years after receiving GVC.[7] Thus, in the years after receiving GVC, sales seem to take off.

Approximately 20 percent of the firms in our sample receive both public and private VC. According to e.g., Brander et al, 2015, Bertoni and Tykova, 2015,and Grilli and Murtinu, (2014), firms that receive both GVC and PVC tend to perform about as well as firms

[6]Due to sample size issues in the post-treatment period, we limit the analysis to a maximum of four years after the firm received VC.
[7] $(e^{0.42} -1)*100 = 0.52$

receiving PVC only and better than firms receiving GVC only. This could be attributable to the advantages of being backed by a more diverse group of investors (Colombo et al, 2014), or receiving a greater amount of VC (Brander et al, 2015). However, the results in column 3 of table 9 do not suggest any significant effects of mixed VC on firm sales except in (t+4). In other words, four years after the VC investment, there is a tendency for MVC-backed firms to grow faster than they would have had they not received VC.

Finally, in columns 4-5 in table 9 we separate manufacturing sector firms from service sector firms and analyze the evolution of sales after receiving VC. In this step, we do not separate PVC from GVC. In other words, when comparing the manufacturing sector with the service sector we merge all types of VC.

Starting with the manufacturing sector, the results in table 9 suggest no significant effects of VC on firm sales either during or after receiving VC. For the service sector, however, we find an initial dip in sales the same year as the VC investment is made; this dip is followed by a positive post-treatment effect that becomes significant three-four years after the capital injection. As shown in table 9, the post-treatment effect peaks four years after receiving capital with an estimated sales increase of 35 percent.[8] Thus, for many firms it seems as though the positive effect of VC on sales comes with a delay. This delay might be connected to investments in capital or labor. We will return to the issue of dynamics and indirect effects in the next section.

Moving on to the control variables, capital and labor appear with positive and significant signs. Firms' labor composition is captured by three skill-intensity variables measuring the share of labor in each group, taking the share of low-skilled labor (primary education) as a reference. The general impression throughout the analysis is that the skill composition is uncorrelated with firm sales.

VC is one of many sources of funding for investments and the need for VC is therefore related to the firm's financial strength. It is therefore interesting to analyze other measures of financial capacity such as equity, debt and profits. The results in table 9 suggest that there is little evidence of a systematic relation between equity per unit of sales and firm size. Looking at the elasticity of debt with respect to sales, the estimated elasticity is smaller than one, suggesting that in relation to sales, the relative size of total debt decreases as firms grow larger, i.e., a relatively low debt ratio among larger firms that receive VC.

[8] $(e^{0.32} -1)*100 = 0.35$.

Table 9 Dependent variable, firm sales. Fixed effect models, treated firms only

	1. PVC	**2.GVC**	**3. Mixed VC**	**4. Service sector** [(A)]	**5. Manu. sector** [(A)]
***ln*(K)**	0.1904 (0.062)***	0.0972 (0.074)	0.0918 (0.076)	0.1645 (0.047)***	0.0022 (0.065)
***ln*(L)**	0.5998 (0.080)***	0.6618 (0.074)***	0.4797 (0.078)***	0.5540 (0.058)***	0.8176 (0.088)***
Md-skill	7.6e-05 (0.003)	-0.0052 (0.003)*	0.0080 (0.007)	5.8e-05 (0.003)	0.0037 (0.004)
Hi-skill short	-0.0052 (0.003)	-0.0069 (0.003)**	0.0045 (0.008)	-0.0057 (0.003)	0.0024 (0.005)
Hi-skill long	-0.0033 (0.003)	-0.0083 (0.003)***	.00323 (0.007)	-0.0037 (0.003)	0.0013 (0.005)
***ln*(Tot. debt)**	0.2794 (0.056)***	0.2015 (0.069)***	0.3595 (0.063)***	0.2707 (0.044)***	0.3447 (0.047)***
Equity/sales	1.3e-05 (0.0001)	0.0004 (0.0004)	0.0009 (0.0002)***	1.6e-05 (0.0002)	0.0010 (0.0002)***
Profit/sales	0.0012 (0.0001)***	0.0060 (0.002)***	0.0031 (0.0006)***	0.0014 (0.0003)***	0.0034 (0.0007)***
Period dummies **Firm dummies**	yes yes	yes yes	yes yes	yes yes	yes yes
VC (t)	-0.1909 (0.094)**	-0.0605 (0.085)	-0.1141 (0.131)	-0.1551 (0.063)**	-0.0616 (0.097)
VC (t+1)	-0.0078 (0.116)	0.1988 (0.113)*	-0.0201 (0.151)	0.0484 (0.079)	0.0899 (0.108)
VC (t+2)	-0.0612 (0.1349)	0.2911 (0.152)*	0.0729 (0.154)	0.1445 (0.092)	0.0417 (0.143)
VC (t+3)	-0.0236 (0.161)	0.2900 (0.177)	0.2003 (0.160)	0.2013 (0.114)*	0.2410 (0.167)
VC (t+4)	-0.0247 (0.197)	0.4204 (0.210)**	0.3476 (0.204)*	0.3030 (0.147)**	0.1431 (0.227)
R^2-within	0.51	0.52	0.50	0.46	0.59
Obs.	1,945	1,124	945	3,173	841

*Notes: *, **,and *** indicate significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors clustered at the firm level.* [(A)] *For the manufacturing and service sectors, the analysis covers all firms receiving any type of VC.*

The analysis in table 9 involves identifying structural breaks. One complication of this analysis is that the treatment effects hinge on changes over time and variation within firms during the period of treatment. We therefore proceed in table 10 by introducing a reference group. The reference group in columns 1-3 consists of CEM-matched "twin" firms that, based on observable characteristics, are as similar as possible to the firms receiving VC but do not receive any type of VC.[9] Special attention is paid to analyzing whether firms receiving GVC evolve differently from those receiving PVC. Therefore, in column 4 we

[9]To ease the comparison across different treatment groups, treated firms are compared against the same reference group.

use firms receiving PVC only or GVC only. Merging these groups into the same model allows us to directly analyze how the impact of GVC differs from that of PVC.

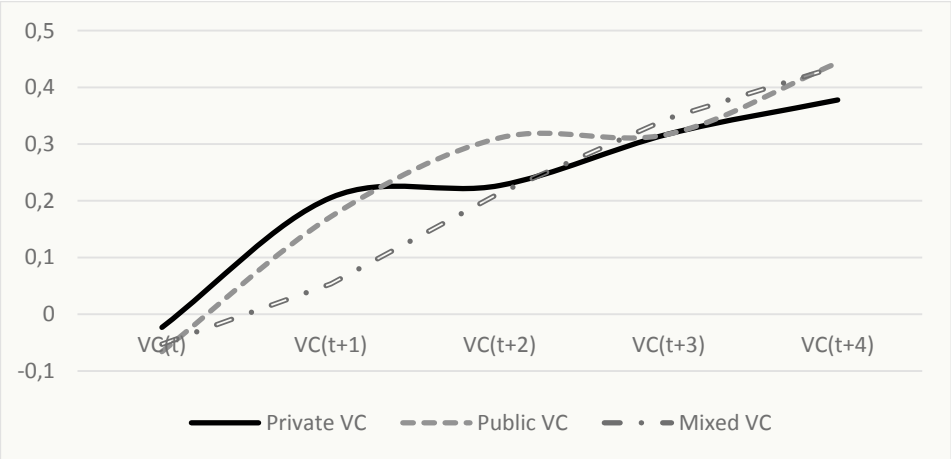
Table 10 Dependent variable, firm sales. Fixed-effect models. Matched non-treated firms included.

	1. PVC	**2. GVC**	**3. Mixed VC**	**4. PVC vs. GVC.** [(A)]	
	Estimation 1-3. CEM-matched data			PVC	GVC
VC (t)	-0.0232 (0.062)	-0.0660 (0.072)	-0.0529 (0.117)	-0.1261 (0.072)*	0.2117 (0.081)***
VC (t+1)	0.2056 (0.073)***	0.1721 (0.081)**	0.0534 (0.137)	0.0921 (0.089)	-0.0386 (0.104)
VC (t+2)	0.2270 (0.074)***	0.3110 (0.117)***	0.2138 (0.122)*	0.0803 (0.100)	0.065 (0.146)
VC (t+3)	0.3179 (0.088)***	0.3176 (0.142)**	0.3455 (0.143)**	0.1537 (0.123)	-0.0086 (0.211)
VC (t+4)	0.3778 (0.115)***	0.4434 (0.147)***	0.4369 (0.153)***	0.1891 (0.158)	0.1163 (0.180)
Full set of controls	yes	yes	yes	yes	
R^2-within	0.40	0.48	0.41	0.49	
Obs.	8,761	7,933	7,754	3,069	

*Note: *, ** and *** indicate significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors clustered at the firm level. For control variables, see table 9. [(A)] Estimations in column 4 are based on firms receiving GVC only and firms receiving PVC only.*

A comparison of treated firms with firms not receiving VC clarifies the tendencies observed in table 9. First, using a matched sample of treated firms we see in table 10 that sales do not take off in the same year that VC is received. Moving to the post-treatment period, we note in columns 1-3 that sales among firms receiving (any form of) VC grow faster than sales among the control group of firms not receiving VC. The growth pattern for firms receiving different types of VC is depicted in figure 8 below.

Figure 8 Sales development. Firms receiving VC vs. controls not receiving VC.



Note: Figure is based on results in table 10 columns 1-3.

As shown in figure 8, sales grow faster for VC-receiving firms than for the non-VC-receiving control group. Among firms receiving VC, there are some minor differences. First, although firms receiving only private or public VC have a quicker take-off compared

to MVC-backed firms, after three years, they all (PVC-, GVC- and MVC-backed firms) grow at roughly the same rate. Thus, from figure 8 it is difficult to say that one type of VC outperforms another type of VC. In other words, in most cases there are no significant differences in how different types of VC impact sales, although the timing of the growth pattern is somewhat different depending on who made the VC investment.

In column 4, we change the comparison group and directly compare firms receiving private VC with firms receiving GVC. As indicated by figure 8, there are no large differences between these groups. Specifically, for the post-treatment period there is no evidence of a significant difference between these two groups, whereas during the year of receiving VC, there is a tendency of more rapid growth in sales among firms receiving GVC compared to those receiving PVC.

6.2 Including indirect effects of venture capital on firm sales

As discussed above, the impact of VC on firms' sales might be misleading if VC impacts sales not only directly but also indirectly through investment and employment. To address this issue, we estimate a structural equation system (SEM) from which the direct and indirect effects of VC can be disentangled, as specified in equations (4) through (6). The full set of structural equation results comparing the direct and total effects of VC on sales are presented in Table A 1 in the Appendix. To ease the presentation, the treatment effects are summarized below in table 11 and further depicted in figure 9. The table presents the direct and total effects. In the case that the direct effect differs from the total effect, we can attribute the change to the indirect effect of VC that goes through changes in employment and investments in physical capital.

Table 11 Structural equation estimations of the direct and total effects of VC on firm sales.

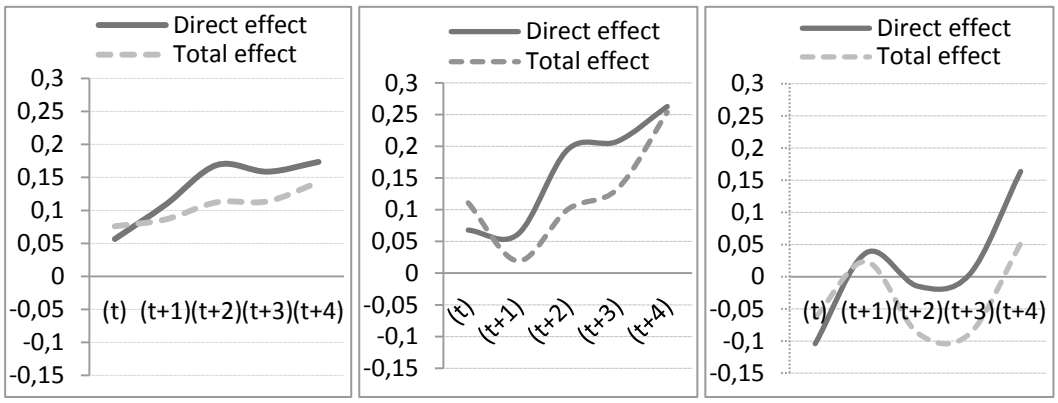
	PVC		**GVC**		**MVC**	
	Direct effect	*Total effect*	*Direct effect*	*Total effect*	*Direct effect*	*Total effect*
VC (t)	0.0566 (0.048)	0.0759 (0.044)*	0.0679 (0.046)	0.1108 (0.043)***	-0.10413 (0.066)	-0.0635 (0.061)
VC (t+1)	0.1088 (0.046)**	0.0864 (0.042)**	0.0615 (0.060)	0.0192 (0.060)	0.0374 (0.078)	0.0233 (0.077)
VC (t+2)	0.1687 (0.057)***	0.1123 (0.057)**	0.1948 (0.099)**	0.1005 (0.087)	-0.0149 (0.124)	-0.0880 (0.116)
VC (t+3)	0.1587 (0.062)***	0.1138 (0.057)**	0.2078 (0.105)**	0.1329 (0.092)	0.0031 (0.110)	-0.0891 (0.093)
VC (t+4)	0.1735 (0.089)*	0.1427 (0.080)*	0.2628 (0.165)	0.2536 (0.127)**	0.1636 (0.113)	0.0515 (0.089)
Obs.	6,415		6,171		2,341	

Note: Full set of estimates from the structural equation system available in Table A1.

Starting with the significance of the total effect of VC, we note in table 11 that there are no significant treatment effects for MVC, whereas firms backed by PVC show a positive treatment effect in both the treatment year and all post-treatment periods. GVC takes an intermediate position with a significant total effect both in the treatment year and four years after the VC injection.

Comparing the total and direct effects of VC, in figure 9 we see that the direct effect of VC typically is larger than the total effect for all years but the treatment year. This result holds for all types of VC: private, public and mixed. One might argue that the low total effect is attributable to missed dynamics in the estimates of table 11, in which the post-treatment effect is analyzed period-by-period. In other words, if investment and employment effects differ in their dynamic patterns, then the results can be misleading, at least to an extent. Both as a robustness test and to increase the comparability of the direct and total effects of VC, we therefore proceed with a simplified dynamics in which we replace the period dummies with a treatment dummy (*treat*) covering the treatment year and all post-treatment years. Therefore, the treatment dummy signals the average effect of VC over all observed treatment and post-treatment years. The average treatment effect is displayed in table 12, in which estimations are based on the same model as those in Table A 1.

Figure 9 Sales and direct and indirect effects of VC on treated vs. matched control group (SEM estimations).[10]



(a) PVC (b) GVC (c) MVC

Table 12 confirms the patterns detected in figure 9 and can be summarized in three bullet points:
(i) The impact of PVC seems to be larger than that of GVC (but not significantly larger);
(ii) There is little evidence of a significant effect of MVC on sales; and
(iii) When evaluating the over-all-periods effect, the average direct effect of VC on sales is larger than the total effect.

The absence of positive indirect effects leads to the question of how VC impacts investments and labor demand. According to the sales equations in table 9, the coefficient of labor is larger than that of capital. Therefore, one immediate conclusion is that the indirect effect of VC going through employment has a larger impact on sales than the indirect effect originating from capital investments. Therefore, we continue by taking a deeper look at the relationships between VC, labor demand and investments.

[10]*Note: Based on estimates from Table A1, columns 1-3. Total effects of VC: Private VC significantly different from zero at (t), (t+1), (t+2), (t+4); Public VC at (t), (t+4); Mixed VC not significant different from zero in any period.*

Table 12 Robustness test. Dependent variable, firm sales. SEM-system, matched firms.

Group of comparison	**Variable**	**Direct effect**		**Total effect**	
Estimation 1. PVC	VC treatment incl. post treat	0.1115 (0.036)***		0.0900 (0.033)***	
Estimation 2. GVC	VC treatment incl. post treat	0.0999 (0.040)**		0.0873 (0.037)**	
Estimation 3.MVC	VC treatment incl. post treat	-0.0366 (0.059)		-0.0399 (0.053)	
		Direct effect		Total effect	
		Private VC	Public VC	Private VC	Public VC
Estimation 4. PVC vs. GVC	VC treatment incl. post treat	0.0532 (0.040)	0.0245 (0.043)	0.0874 (0.039)**	0.0438 (0.039)

*Note: *, **, and *** indicate significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors. For control variables, see Table 9. Estimation 1, PVC-backed firms vs. non-treated matched control group. Estimation 2, GVC-backed firms vs. non-treated matched control group. Estimation 3, MVC-backed firms vs. non-treated matched control group. Estimation 4, private VC firms vs. public VC firms*

6.3 Effects of VC on investment

In table 13 we analyze the impact of various types of VC on investment. We follow the set-up from the CEM specification and analyze how firm capital stocks are affected by VC. Following Hall et al. (2001), we apply a dynamic model specification. The regressions analyzed in table 13 are performed using the Han-Philips Fixed Effects Dynamic Panel Data estimator.[11] In line with subsequent labor demand estimations, the estimated model is based on a standard labor demand model (or more generally, demand for factors of production) with adjustment costs (Cahuc and Zylberberg, 2004; Hijzen and Swaim, 2008).

[11] Han, et al. (2014).

Table 13 Dep. Var., ln(capital stock). Han-Philips Dynamic Panel Data estimations.

	1. Private VC	2. Public VC	3. Mixed VC	4. Private vs. Public VC [(A)]	
	Estimation 1-3. CEM-matched data				
***ln*(K)(t-1)**	0.6373 (0.059)***	0.6452 (0.064)***	0.6469 (0.065)***	0.6499 (0.057)***	
***ln*(VA)**	0.0544 (0.32)*	0.0196 (0.034)	0.0519 (0.033)	0.0320 (0.029)	
***ln*(w)**	0.0343 (0.048)	0.0192 (0.053)	0.0273 (0.053)	0.0140 (0.045)	
***ln*(r)**	0.0441 (0.063)	0.0520 (0.067)	0.0694 (0.068)	0.0417 (0.059)	
Md-skill	0.0041 (0.002)*	0.0022 (0.002)	0.0028 (0.002)	0.0032 (0.002)	
Hi-skill short	0.0065 (0.003)***	0.0035 (0.003)	0.0040 (0.003)	0.0055 (0.002)**	
Hi-skill long	0.0038 (0.002)	0.0016 (0.002)	0.0011 (0.002)	0.0037 (0.002)*	
ln(tot. Debt)	0.3438 (0.027)***	0.3563 (0.027)***	0.3481 (0.027)***	0.3526 (0.025)***	
Equity/sales	0.0034 (0.002)**	0.0026 (0.002)*	0.0027 (0.002)*	0.0037 (0.001)**	
Profit/sales	-0.1231 (0.050)**	-0.1006 (0.051)**	-0.1020 (0.50)**	-0.1332 (0.048)***	
Period dummies **Company dummies**	yes yes	yes yes	yes yes	yes yes	
				Private	Public
VC (t)	0.1737 (0.120)	0.2737 (0.138)**	0.3206 (0.165)*	0.1612 (0.120)	0.2661 (0.139)*
VC (t+1)	0.2825 (0.155)*	0.2588 (0.194)	0.4754 (0.204)**	0.2667 (0.155)*	0.2471 (0.195)
VC (t+2)	0.3295 (0.187)*	0.1527 (0.268)	0.4707 (0.260)*	0.2969 (0.188)	0.1432 (0.270)
VC (t+3)	0.3072 (0.229)	0.3217 (0.389)	0.3481 (0.350)	0.2668 (0.230)	0.3182 (0.392)
VC (t+4)	-0.1078 (0.267)	0.7455 (0.556)	0.5938 (0.522)	-0.1538 (0.269)	0.7290 (0.560)
Buse R^2	0.0610	0.0602	0.0618	0.0625	

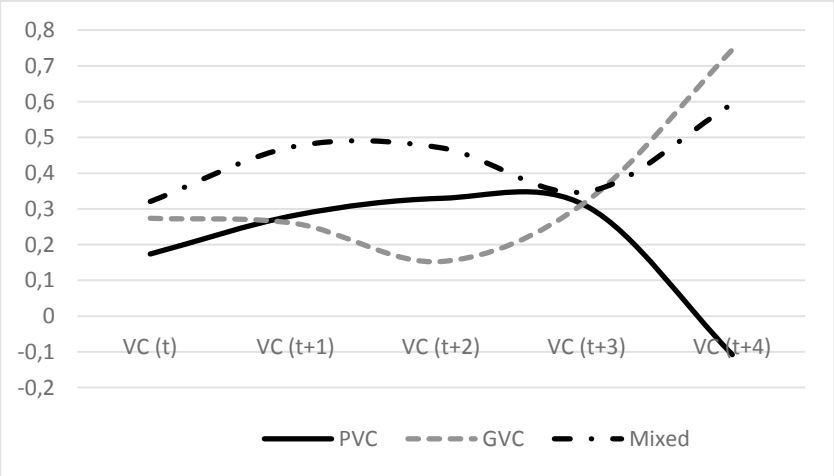
*Notes: *, **, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.*
[(A)] Estimations in column 4 are based on firms receiving public VC only and firms receiving private VC only. In column 4, we therefore directly compare firms receiving private VC only with firms receiving public VC only.

The results in table 13 are depicted in figure 10. From figure 10, columns 1-3, we note that, when significant, VC typically has a positive and significant impact on investment either at the year of the VC injection or one-two years after VC has been received. After three years, no significant investment effect remains. Considering that VC often is intended to

finance investments, these results are expected. We may also note that it is difficult to say that one type of VC outperforms other types of VC. That is, considering the variations in the estimates, it is difficult to say that one type of investor (PVC, GVC, or MVC) has larger investment effects than the others. If anything, this could indicate that all VC investors have similar target functions, (make sure the firm can do needed investments). In column 4, we directly compare GVC against PVC. The results in column 4 verify the findings from columns 1-2; it is difficult to say that one type of VC outperforms the other. When studying figure 10, one can keep in mind that the seemingly divergent developments observed three-four years after the VC injection mostly consist of noise and the estimates at t+3 and t+4 are all insignificant.

Turning to the control variables, we see that investments are positively related both to debt and to equity, suggesting that investments are partially financed by loans and own capital. The results suggest that profits go down when investments are made. Considering that the implementation of a new investment can lead to a reallocation of resources from directly productive activities to investment activities, these results may be expected. Looking at the skill composition, on average we find little evidence for a systematic relation between firm skill composition and investments. Moving to factor prices, we find, as expected, a positive relation between investments and labor cost, whereas the positive relation with return on capital is less expected. Finally, we note a positive relation between capital and value added along with evidence of persistence in investment patterns.

Figure 10 Capital stock growth. Firms receiving VC vs. CEM-matched control group. Han-Philips dynamic panel data estimations.



Note: Based on table 13 columns 1-3.

6.3.1 Robustness of the investment analysis

To test the robustness of the investment analysis, in table 14 we re-estimate the investment regression from table 13 using a fixed-effects (FE) model with no transition dynamics.

Using an FE-model, the overall size and significance of the estimates increases and the pattern for the first three treatment periods remains similar. That is, using a fixed-effect model, we have significant investment effects for all types of investors (PVC, GVC and MVC) both during the treatment year and for the two subsequent years. Again, for the first three years, the patterns look similar for all three types of VC investments and in the last two periods they split up; however, so does the variance and uncertainty of the estimates.

Combining results from table 13 and table 14, we conclude that the size of the investment results are not fully stable with respect to choice of model and estimator, but there is evidence for a positive and significant (physical capital) investment effect from VC at the treatment year and during the two subsequent years. After three-four years, the investment effect seems to wear off or becomes less significant. Finally there is no strong evidence for one type of VC (PVC, GVC or MVC) giving rise to larger and more significant capital investments than the others. Considering that financing investments is one of the most common motivations behind raising VC, a positive investment effect is anticipated.

Figure 11 Capital stock growth. Firms receiving VC vs. CEM-matched control group. FE-model estimations.

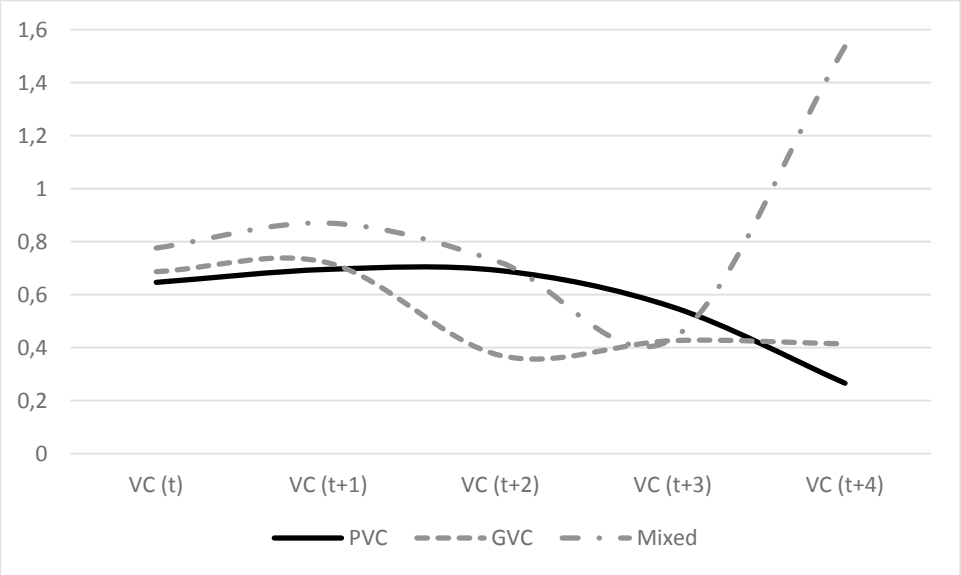


Table 14 Dependent variable, *ln*(K). Fixed-effect estimations.

	1. Private VC	**2. Public VC**	**3. Mixed VC**	**4. Private vs. Public VC** [(A)]	
	Estimation 1-3. CEM-matched data			PVC and GVC firms	
				PVC	GVC
VC (t)	0.6462 (0.120)***	0.6866 (0.141)***	0.7758 (0.146)***	0.6277 (0.119)***	0.6671 (0.141)***
VC (t+1)	0.6954 (0.126)***	0.7196 (0.144)***	0.8698 (0.180)***	0.6672 (0.127)***	0.6813 (0.142)***
VC (t+2)	0.6904 (0.131)***	0.3702 (0.206)*	0.7211 (0.030) **	0.6547 (0.130)***	0.3367 (0.205)*
VC (t+3)	0.5528 (0.177)***	0.4263 (0.257)*	0.4340 (0.389)	0.5137 (0.177)**	0.3875 (0.256)
VC (t+4)	0.2656 (0.222)	0.4140 (0.361)	1.5366 (0.224)***	0.2277 (0.222)	0.3409 (0.360)
Full set of controls	yes	yes	yes	yes	
R^2	0.5038	0.4944	0.5010	0.5031	

Notes: Robust standard errors clustered at the firm level. For control variables, see table 13. No lagged dependent variable in table 14. [(A)] *Estimations in column 4 are based on firms receiving public VC only and firms receiving private VC only.*

6.4 Employment

From a policy perspective, increased employment is a desired effect of GVC investments. In addition, together with physical capital, employment is a channel for the indirect effects of VC on sales.

Table 15 Dependent variable, log of employment. Han-Philips Dynamic Panel Data estimations.

	1. Private VC	**2. Public VC**	**3. Mixed VC**	**4. Private vs. Public VC** [(A)]	
	Estimation 1-3. CEM-matched data				
***ln*(L)(t-1)**	0.7423 0.046)***	0.6643 (0.047)***	0.6489 (0.048)***	0.9181 (0.083)***	
***ln*(VA)**	0.5827 (0.011)***	0.6316 (0.011)***	0.6200 (0.011)***	0.7143 (0.026)***	
***ln*(w)**	-0.5135 (0.012)***	-0.5556 (0.013)***	-0.5381 (0.013)***	-0.6141 (0.031)***	
***ln*(r)**	-0.0480 (0.003)***	-0.0503 (0.003)***	-0.0524 (0.003)***	-0.0550 (0.008)***	
md-skill	-0.0003 (0.0005)	-0.0004 (0.0005)	-0.0002 (0.0005)	-0.0006 (0.002)	
Hi-skill short	-0.0009 (0.0006)	-0.0010 (0.0006)*	-0.0010 (0.0006)*	-0.0020 (0.002)	
Hi-skill long	-0.0009 (0.0005)*	-0.0010 (0.0005)*	-0.0011 (0.0005)*	-0.0025 (0.002)	
Profit/sales	-0.0169 (0.004)***	-0.0166 (0.004)***	-0.0154 (0.004)***	-0.2972 (0.038)***	
Period dummies	yes	yes	yes	yes	
Industry dummies	yes	yes	yes	yes	
				Private	Public
VC (t)	-0.0092 (0.034)	0.0541 (0.037)	0.1034 (0.058)*	-0.0095 (0.042)	0.0403 (0.045)
VC (t+1)	-0.0291 (0.046)	-0.0127 (0.052)	0.0766 (0.071)	-0.0346 (0.058)	-0.0275 (0.066)
VC (t+2)	0.0035 (0.055)	-0.0940 (0.073)	-0.1504 (0.080)*	-0.0006 (0.077)	-0.1122 (0.098)
VC (t+3)	-0.0092 (0.066)	-0.0081 (0.089)	-0.1336 (0.094)	-0.0133 (0.104)	-0.0289 (0.128)
VC (t+4)	-0.0228 (0.078)	0.0175 (0.113)	-0.0902 (0.129)	-0.0083 (0.136)	-0.0048 (0.164)
Buse R^2	0.43	0.47	0.45	0.50	
Obs.	5,080	4,851	4,659	1,177	

*Notes: Notes: *, ** and *** indicate significance at the 10, 5, and 1 percent levels, respectively.*
[(A)] Estimations in column 4 are based on firms receiving public VC only and firms receiving private VC only. In column 4, we therefore directly compare firms receiving private VC only with firms receiving public VC only.

We therefore specifically analyze employment effects of VC investments. The employment regressions analyzed in table 15 are performed using the Han-Philips Fixed Effects Dynamic Panel Data estimator.[12] The estimated model is based on a standard labor demand model with adjustment costs (Cahuc and Zylberberg, 2004; Hijzen and Swaim, 2008).

The results from the employment regressions can be summarized as there being no significant effects of VC on employment. The only exception is for mixed VC, for which we have a positive employment effect at the treatment year and a negative employment effect two years after the VC injection. Considering both that these results go in opposite directions and the overall lack of a significant effect on employment, the results suggest that VC does not primarily boost employment. In addition, most point estimates suggest a negative, non-significant employment effect.

These results lead to two conclusions. First, as noted in table 10 and table 11, there is a tendency for the total effect of VC on firms' sales to be lower than the direct effect, suggesting a negative indirect effect of VC working through investment and employment. It is therefore likely that the generally lower total effect of VC (compared to the direct effect) can be explained by a drift toward negative employment effects. Second, the drift toward a positive investment effect of VC and a non-positive employment effect suggests that VC can be considered a trigger for increased efficiency, where capital investments are made at the same time as potential surplus labor is released or employment held back. For private investors, the lack of a positive employment effect from private VC is unproblematic. The primary goal of private investors is return on investment, something that can be achieved without employment growth. For GVC, however, employment is often a desired outcome, which can cause a conflict of interest when public investors want to achieve both increased competitiveness and employment.[13]

6.5 Robustness

6.5.1 By stage

It is well known that small, young and innovation-driven firms can find it difficult to raise capital in early stages. GVCs are often justified as a bridge filling the seed and early-stage capital gap.

If GVC is biased toward seed- and early-stage financing (i.e., high-risk firms), then it might be inappropriate to directly compare the performance of PVC with that of GVC. To tackle this comparability issue, we proceed and compare the effects of GVC and PVC at the same investment stage. The stages analyzed are: (i) seed, (ii) start-up, and (iii) later-stage investments. Seed-stage firms are defined as firms that receive seed capital during the period of observation. However, some of these firms will subsequently receive VC for later stages. Accordingly, in subsequent years early-stage firms are allowed to receive later-stage capital, and so on. In other words, in the stage classification, firms are allowed to move upward from their starting point.

[12] Han, et al. (2014).

[13] As a robustness test, employment regressions are estimated using both the Arellano and Bond (1991) estimator and the Blundell and Bond (1998) system GMM estimator with similar results; no employment effects from VC. Results available on request.

Table 16 displays results by investment stage for different types of VC versus a matched control group of firms not receiving VC. The results in table 16 reflect the average treatment effect over the treatment year and all observed post-treatment years. The results can be summarized in five points.

1. Starting with non-significant results, we note no significant VC effects on sales for firms that receive both private and public VC (MVC-backed firms). The non-significance of mixed VC holds for all investment stages.
2. GVC is the only type of VC for which we find a positive effect of seed capital on sales.
3. PVC outperforms other types of VC in start-up stage financing.
4. For later-stage financing, we note a positive estimate for GVC, although this (positive) result only holds when including indirect effects.
5. For seed and start-up financing, the total effect of VC is lower than the direct effect. Thus, considering the investment stage does not alter earlier results suggesting an overall negative indirect (combined capital and employment) effect on sales.[14]

Table 16 Private, public and mixed VC vs. matched control group. SEM-estimations, by investment stage. Dependent variable, firm sales.

	Direct effect			**Total effect**		
	Private VC	Public VC	Mixed VC	Private. VC	Public VC	Mixed VC
Seed capital	0.1953 (0.121)	1.3399 (0.216)***	0.1060 (0.111)	0.1258 (0.101)	0.0837 (0.173)	0.0467 (0.056)
Early stage	0.3249 (0.057)***	0.0832 (0.055)	0.0094 (0.102)	0.2787 (0.050)***	0.0358 (0.054)	0.0722 (0.087)
Later stage	-0.0056 (0.044)	0.1000 (0.058)*	0.0937(A) (0.289)	0.0030 (0.042)	0.1473 (0.055)***	n.a.
Full set of controls	yes	yes	yes	yes	yes	yes

*Notes: *,** and *** indicate significance at the 10, 5, and 1 percent levels, respectively. For control variables, see Table 9. (A) Fixed-effect estimation results.*

6.5.2 By VC spells, investment size and lags

Investing capital in a firm is associated with a high level of engagement from the investor. If the firm exits, the investment is lost. Therefore, it can be rational for an investor to follow up an initial investment. As shown in table 17, approximately one-third (31 percent) of the firms in our data receive one tranche of VC only, the mean number of tranches received is 3.8 and the maximum number of tranches received by a single firm over the period 2007–2013 is 47.

[14] Results in Table 16 are SEM estimation with a simplified labor-demand specification assuming no adjustment costs in labor and capital.

Table 17 Number of VC tranches

No. of tranches	Percent	Cumulative
1	31	31
2	21	52
3-5	28	80
6-10	15	95
11-47 (max)	5	100

Note: Data spanning the period 2007-2013.

As noted above, on the one hand, repeated investments can be considered a quality indicator; the firm succeeds in attracting multiple VC investments. At the same time, repeated VC injections can also signal problems raising internal capital and the investor's protection of investments sunk in the firm. Thus, the question of whether multiple tranches signal firm growth or financing problems is to some extent an empirical question. In addition to the signal value of repeated tranches, the impact of the later tranches can interact with lagged effects from earlier tranches.

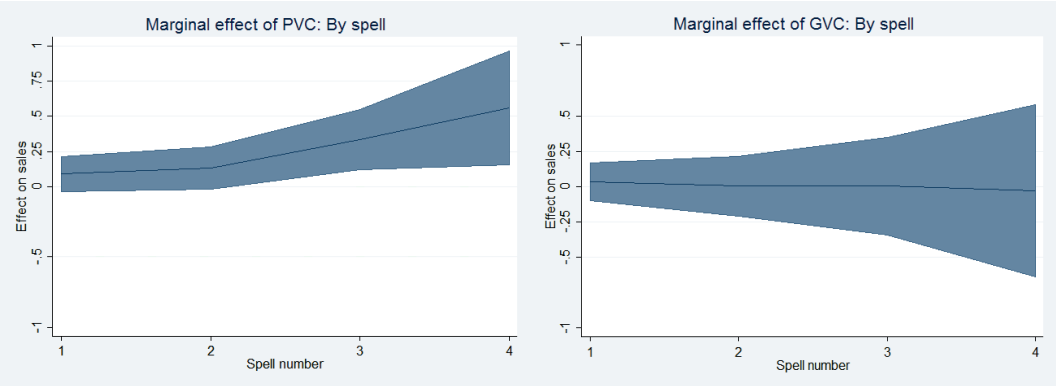
To analyze whether the impact of VC changes over time, in table 18 we analyze the impact of VC by separating the analysis by yearly VC spells. In other words, we estimate how the treatment effect evolves for each subsequent VC-injection. To ease readability of the results, the marginal effect of each subsequent VC spell is depicted in figure 12. The results suggest an increased impact from each subsequent VC spell of private and mixed VC. The increased effect can be partially attributable to remaining post-treatment effects from previous VC injections but also be a signal of fast growth. GVC is the only type of VC for which we cannot detect an increasing effect on sales from each subsequent VC spell. To some extent, these results are in line with Buzzachi et al. (2013), who show that European VC firms with a higher level of public funding tend to support start-ups for a longer time after the initial investment, even when the return on the investment is mediocre (whereas private investors would withdraw support).

Table 18 The impact of VC on sales. CEM-matched control group. By VC spell. FE-estimations.

	All firms	**Private VC**	**Public VC**
VC Spell 1	0.0382 (0.046)	0.0899 (0.064)	0.0347 (0.067)
VC Spell 2	0.0249 (0.068)	0.1333 (0.076)*	0.0029 (0.108)
VC Spell 3	0.1791 (0.086)**	0.3351 (0.109)***	0.0025 (0.176)
VC Spell 4	0.3413 (0.141)**	0.5587 (0.206)***	-0.0302 (0.311)
Full set of controls	yes	yes	yes

*Notes: *,** and *** indicate significance at the 10, 5, and 1 percent levels, respectively.*
For control variables, see Table 9. Because of a lack of observations for higher-order spells, the analysis is restricted to a maximum of four years spell count.

Figure 12 The impact of VC on sales per yearly VC spell.



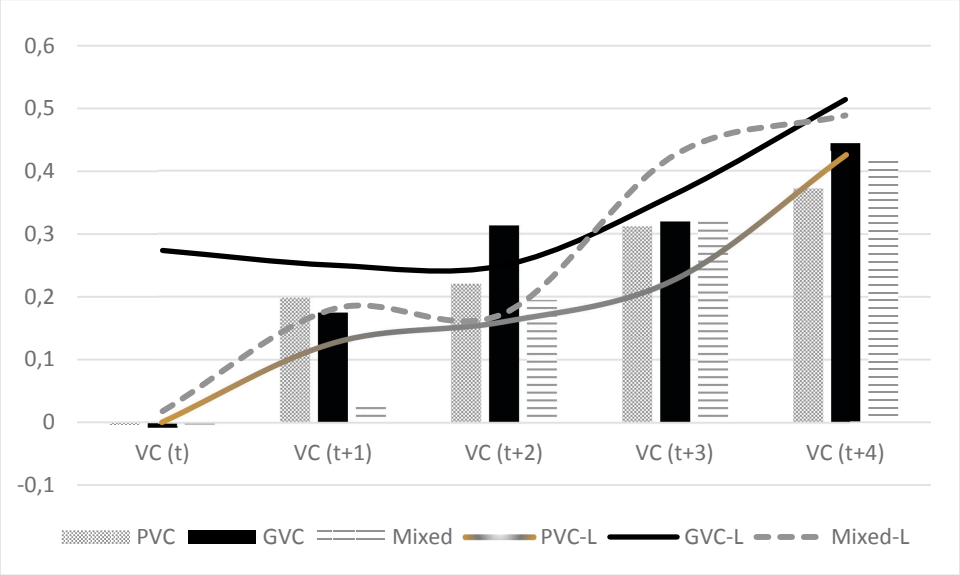
Note: Based on estimates from Table 6.10.

We also test the robustness of the results to how VC impacts sales by replacing the VC(t) dummy with the log of the actual annual amount of VC received and lagging the covariates. These results are depicted in figure 13 and displayed Table A2 in the Appendix. The results from the robustness check can be summarized as follows. First, replacing the VC(t) dummy with the size of the investment does not alter the results found in table 10. If anything, there is a slight increase in the post treatment dummies, whereas the insignificance of VC at the treatment year remains. There is, however, a positive drift in the estimates of the contemporary effect of VC from negative and insignificant to positive and insignificant.

One reason that the results seem to be robust with respect to the use of a VC dummy or the actual amount of capital invested could be how VC works. Typically, a VC investor adjusts the size of the investment according to the firm's needs. In other words, the size of the VC investment is—to some extent—endogenous. Therefore, what matters is that a VC investment is made, not the size of that investment.

Finally, applying lagged covariates is a common way to tackle potential endogeneity and impact lags. Given strong exogeneity, lagged covariates can solve endogeneity problems. This technique is especially useful when valid (contemporary) instruments are lacking (Hendry, 1995). As shown in figure 13, using lagged covariates does not alter either the estimated impact or the dynamic pattern of VC on firm sales, with the exception of GVC, which now returns a stronger and more positive impact for the year of investment. In other words, the dynamic pattern of the impact of VC on firm sales is similar when using the investment dummy (figure 8, table 10) as when using the (log) sum of the investment with lagged or contemporary covariates (Figure 13, Table A 2). Thus, changing the model specification does not upset the results in table 10.

Figure 13 Impact of VC on sales using the (log) monetary size of VC investment. Lagged and contemporaneous covariates.



Note: Figure based on estimates from Table A2. FE-estimation. Columns display estimated effects of VC using contemporaneous covariates. Lines are based on estimations using lagged covariates.

7 Conclusions and policy recommendations

The Swedish government has been an active player on the VC market since the early 1970s and since 2010, its influence on the VC market has been steadily increasing. Given the increased role of GVC funds, one might presume that they have a proven record of accomplishment and that a well-identified market failure motivates their role. But is this really the case? In this report, we discuss the function of the VC market and the motives for GVC interventions. The focus, however, is on the econometric analysis in which we compare the performance of and effects on Swedish firms that receive PVC or GVC.

It should be noted that VC is merely one source used to finance young and innovative firms. Alternative sources for these firms include, e.g., crowd funding, loans, grants, and business angels. Despite the existence of several funding alternatives, it is recognized that the market tends to undersupply financial capital for these firms, causing a so-called funding gap.

In short, the state's motivations for intervening in the VC market are that normally, the entrepreneur is unwilling to fully disclose her strategy, innovation technology, and business operations. From the investors' perspective, difficulty gathering information constitutes a significant hurdle in the form of a transaction cost. This causes market mechanisms to malfunction, leading to problems of adverse selection and moral hazard (Lerner, 2002; Akerlof, 1970), which are most striking for young ventures with little if any cash flow or no collateral to pledge for credit (Lerner, 2002). Although VC companies are especially well equipped to resolve the principal-agent problem, there are reasons to believe that their effort is inadequate. As a result, the total amount of PVC might not be sufficient to fully remedy the dearth of financial capital.

It has also been noted that private VC firms prefer larger investments and are more shortsighted than GVC funds. In addition to the capital market argument, GVC injections can also be motivated by the fact that innovation's "social returns" are greater than its private returns, thus suggesting that GVC should target innovative start-ups (Lerner, 2002). Finally, it is argued that GVC can catalyze the development of an immature VC market and an ecosystem for startups.

A major critique of GVC interventions is that they can displace or *crowd out* PVC investment. GVC funds have also been criticized for their inefficiency, incompetence and lack of incentives, and for being a way for politicians to compensate for failures in other policy areas. There is also a risk for corruption and cronyism associated with GVC. However, an international outlook shows that GVC is present in many countries (including Sweden and many other EU member states) in which is seems to be increasing its influence in the VC market.

With respect to the effects of VC and the consequences of GVC, evidence from international studies is fairly consistent: GVC-funded firms seem to develop less strongly compared to firms funded by either PVC or mixed financing (both GVC and PVC). Because GVC should in, theory, make investments that are not as profitable as those made by PVC investors, this suggests that a lower return cannot directly been taken as GVC investeor not are not doing their job. That is, the role of GVC is to make investments that PVC is not willing to make because although they are socially desirable, they are not

profitable enough as these investments have a lower expected return, a higher risk of failure and longer time horizons.

After a tentative start in the 1970s, the Swedish GVC market expanded in the 1980s with the creation of six regional GVC funds. Riksdagens revisorer (1996) conducted an early evaluation of the Swedish GVC experience that judged most GVC investments (at the time) as failures. GVC funds were found to lack sufficient knowledge and the appropriate skills to provide the firms in which they invested with governance and management advice. They estimated the cost of each new job created by GVC at 200,000 SEK (approximately 20,000 EUR). GVC funds were also criticized for being a tool for employment policies. In other words, GVC investments were used to maintain employment in otherwise non-competitive firms. Concerns were also raised that the supply of GVC may have contributed to the IT-bubble in the 1990s (Tillväxtanalys, 2010).

The more recent Swedish discussion has addressed how GVC funds should invest—i.e., in which types of firms, at what stage, and whether they should seek co-investments with private VC actors. To summarize this discussion, which was triggered by Svensson (2011) and followed up in Riksrevisionen (2014), SOU (2015:64), and the recent government proposition (2015/16:110), the main recommendations are as follows:

(i) GVCs should focus on early-stage financing, that is, seed and so-called early stage VC; and
(ii) fund-of-fund solutions, in which GVC takes advantage of the competence of PVC, are recommended. However, as noted by Almi Företagspartner (2015), there can be a conflict between GVC funds focusing on high-risk investments, seed financing (where private actors do not enter) and co-investments between PVC and GVC.

With its focus on what GVC funds have achieved rather than what they should do, this report bridges a current knowledge gap on GVC performance. The results from this study can be summarized in a few bullet points.

- The results from this study do not suggest any dramatic differences in real effects on sales, investment and employment between firms that have received PVC- and those that have received GVC investments. If anything, and in line with the international literature, PVC tends to slightly outperform GVC.
- The real effects of VC investments in Sweden (PVC and GVC) are as follows:
    - There are no signs that employment increases more rapidly in firms that receive VC than in similar firms that do not receive VC.
    - Firms that receive VC increase their capital stock.
      Thus, VC boosts investments.
    - There is evidence of increased efficiency and sales in firms that receive VC compared to similar firms that do not receive VC.
      The impact on sales appears two to three years after the VC injection.
    - Thus, receiving VC seems to be associated with streamlining the firm through increased investments, with no matching employment, leading to increased effeiency and sales.
- There are indications that GVC investors are more prone than PVC investors to hold on to, and continue to invest in stagnating, non-growing firms.

- From 2007–2013, there was a steady increase in the total amount of GVC investments from approximately 200 million SEK per year to slightly more than 1 billion SEK in 2013. At the same time, the amount of total PVC investments decreased from almost 7 billion SEK in 2008 to less than 2 billion SEK in 2013. Overall, GVC accounted for 24% of the total VC invested in Sweden during the period.
- Contrary to the theoretical motivation for GVC intervention where GVC investments should be targeting early stages of firm develpment, PVC investors allocate about the same share of total VC investments in seed financing (slightly above 2 percent of total VC capital) and GVC investors. This can indicate that GVC is not very successful in filling the seed-funding gap. Similar critique was raised by Riksrevisionen (2014) in the report, "*Statens insatser för riskkapitalförsörjning – I senaste laget*".

Based on these observations we raise three noteworthy discussion points.

First. A fundamental motive for the existence of GVC is to fill the funding gap, which is expected to be especially severe for young firms in the earliest stage of their life cycle. It is therefore tempting to recommend that GVC increase its focus on seed investments. There is however one fundamental problem with this recommendation, namely that we do not know to what extent there is a seed-funding gap in Sweden. To the best of our knowledge, no such analyses have been undertaken during the last ten years. This issue should be further analyzed.

Second. There are indications that GVC investors are more prone to hold on to stagnating firms than private VC investors. Here, we ask whether there are any motives for this or if it is the result of political directives or a consequence of lower pressure to yield a positive return on investment. In Riksdagens revisorer's (1994) analysis, GVC investments were criticized for being directed towards maintaining employment in less competitive firms located in remote areas. Can this be part of the answer?

Third. Considering that there is no robust evidence that GVC has a significantly lower growth effect than PVC, this finding can both be considered an indication that GVC investors are doing a good job or of that they are not taking greater risks than PVC investors.

It is our hope that these insights can help in the development of Swedish GVC going forward, notably in the implementation of the forthcoming fund-of-funds, *Saminvest,* and in the continued management of the other remaining GVC funds, Industrifonden and Almi Invest.

Appendix

Table A 1 Part 1. SEM-estimations. Dep. var. Sales, matched firms.

Sales	**Private VC CEM-matched**		**Public VC CEM-matched**		**Mixed VC CEM-matched**	
***ln*(K)**	0.1753 (0.011)***		0.1773 (0.011)***		0.1785 (0.012)***	
***ln*(L)**	0.5950 (0.011)***		0.5959 (0.011)***		0.5837 (0.012)***	
Md-skill	0.0017 (0.0005)***		0.0017 (0.0005)***		0.0017 (0.0005)***	
Hi-skill short	4.3e-05 (0.0005)		4.6e-05 (0.0005)		7.6e-05 (0.0005)	
Hi-skill long	-0.0002 (0.0004)		-0.0003 (0.0004)		-0.0004 (0.0004)	
***ln*(tot.Debt)**	0.2596 (0.013)***		0.2558 (0.013)***		0.2624 (0.014)***	
Equity/sales	-0.0058 (0.001)***		-0.0073 (0.002)***		-0.0077 (0.002)***	
Profit/sales	0.1036 (0.058)*		0.1645 (0.069)**		0.1825 (0.074)**	
Period dum.	yes		yes		yes	
Ind. dum.	yes		yes		yes	
	Direct effect	*Total effect*	*Direct effect*	*Total effect*	*Direct effect*	*Total effect*
VC (t)	0.0566 (0.048)	0.0759 (0.044)*	0.0679 (0.046)	0.1108 (0.043)***	-0.10413 (0.066)	-0.0635 (0.061)
VC (t+1)	0.1088 (0.046)**	0.0864 (0.042)**	0.0615 (0.060)	0.0192 (0.060)	0.0374 (0.078)	0.0233 (0.077)
VC (t+2)	0.1687 (0.057)***	0.1123 (0.057)**	0.1948 (0.099)**	0.1005 (0.087)	-0.0149 (0.124)	-0.0880 (0.116)
VC (t+3)	0.1587 (0.062)***	0.1138 (0.057)**	0.2078 (0.105)**	0.1329 (0.092)	0.0031 (0.110)	-0.0891 (0.093)
VC (t+4)	0.1735 (0.089)*	0.1427 (0.080)*	0.2628 (0.165)	0.2536 (0.127)**	0.1636 (0.113)	0.0515 (0.089)
Obs.	6 415		6 171		2 341	

*Notes: *, **, *** indicate significance at the 10, 5, 1 percent level respectively. Industry dummies at the 2-digit level. Robust standard errors in parenthesis ().*

Table A 2 Dependent variable, firm sales. Fixed effect models. Matched non-treated firms included. Treatment variable with the size of the VC investment.

	1. PVC	**2. GVC**	**3. MVC**	**4. PVC**	**5. GVC**	**6. MVC**
	Contemporary control variables			Lagged control variables		
VC (t)	-0.0043 (0.007)	-0.0086 (0.009)	-0.0105 (0.0142)	0.0007 (0.010)	0.2738 (0.094)***	0.0177 (0.017)
VC (t+1)	0.1983 (0.072)***	0.1748 (0.0792)**	0.0327 (0.134)	0.1263 (0.089)	0.2503 (0.163)	0.1805 (0.169)
VC (t+2)	0.2204 (0.074)***	0.3129 (0.1159)***	0.1947 (0.121)	0.1602 (0.091)*	0.2503 (0.163)	0.1736 (0.145)
VC (t+3)	0.3115 (0.087)***	0.3194 (0.141)**	0.3269 (0.142)**	0.2273 (0.099)**	0.3633 (0.129)***	0.4259 (0.163)***
VC (t+4)	0.3717 (0.114)***	0.4448 (0.146)***	0.4207 (0.151)***	0.4250 (0.122)***	0.5143 (0.174)***	0.4890 (0.209)**
Full set of controls	yes	yes	yes	yes	yes	yes

*Notes: *, **, ***, indicate significance at the 10, 5, 1 percent level respectively.*
Robust standard errors clustered at the firm level. For control variables, see Table 6.1. CEM-matched control group. This table replicates Table 10 with the VC(t) dummy replaced with the log of VC investment. Estimation 4-6 use lagged covariates.

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Myndigheten för tillväxtpolitiska utvärderingar och analyser

Tillväxtanalys är en analysmyndighet under Näringsdepartementet. På uppdrag av regeringen utvärderar och analyserar vi svensk tillväxtpolitik.

Vi arbetar för att stärka den svenska konkurrenskraften och skapa förutsättningar för fler jobb i fler och växande företag i alla delar av landet. Det gör vi genom att ge regeringen kvalificerade kunskapsunderlag och rekommendationer för att utveckla, ompröva och effektivisera statens arbete för hållbar tillväxt och näringslivsutveckling.

Sakkunniga medarbetare, unika databaser och utvecklade samarbeten på nationell och internationell nivå är viktiga tillgångar i vårt arbete. Myndighetens primära målgrupper är regeringen, riksdagen och andra myndigheter inom vårt kunskapsområde. I våra utvärderingar och analyser har vi en oberoende ställning.

Vi är cirka 35 anställda och finns i Östersund (huvudkontor) och Stockholm.

Våra publikationer
Vi publicerar rapporter i tre olika serier på vår hemsida:

Rapportserien – Tillväxtanalys huvudsakliga kanal för publikationer.
I rapportserien ingår även myndighetens faktasammanställningar.

Statistikserien – Löpande statistikproduktion

PM – Metodresonemang, delrapporter och underlagsrapporter är exempel på publikationer i serien.

Tillväxtanalys Studentplan 3, 831 40 Östersund
Telefon: 010 447 44 00 | info@tillvaxtanalys.se | www.tillvaxtanalys.se