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Venture Capital Policies in the Netherlands

LESSONS FROM THE LITERATURE AND BENCHMARK COUNTRIES

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1. Setting the Scene

1.1 Motivation and Research Questions

Why, in the midst of financial and economic crises, would we care about venture capitalism?

There are at least three reasons. Firstly, governments are increasingly interested in innovation to foster long-run and sustainable economic growth. For instance, the European Council adopted the Lisbon Agenda in 2000, which treated innovation as the crucial driver of economic growth. The focus on innovation becomes even stronger now economies experience severe and long-lasting recessions. Venture capitalism is traditionally associated with innovation, as will be explained below, which explains the potential importance of venture capital to policy-makers.

Secondly, some of the nowadays largest, most visible and influential companies have in the past received venture capital. Microsoft, Compaq, Intel, Google, Apple, and many other companies received venture capital at some point in their development and are now the envy of many countries. Such companies have driven innovation and have achieved extremely rapid and significant growth, which is particularly interesting against the already sketched background of economic stagnation.

Thirdly, recent developments may have created a funding or equity gap. The recent financial crisis and its consequences induced and forced banks to take less risk, for instance through the Basel III Accords. Similarly, pension funds allocate less capital to long-term and relatively risky investments. Maarsen and Engelenburg (2012) indicate that in the Netherlands pension funds and banks supplied 12% and 17% of the risk-bearing capital of venture capital funds before the recent crises, but that these percentages shrank to 2% afterwards. De Swaan et al. (2011) indicate that venture capitalism may play an important role in financing SMEs now banks are less and less likely to fulfil this role, but that new policy initiatives are necessary to achieve this.[1]

The question that is raised is what role venture capital (VC) can, could, and did play in facilitating innovation and economic growth by providing the necessary capital to young and growing firms. This question raises a number of other questions. Is a thriving VC market desirable for society? If so, does it need the government to intervene and facilitate its development, or should the whims of the market be respected? If some sort of intervention is required, then what kind?

This leads us to the research questions that this Thesis will endeavour to answer. The main research question is investigated by decomposing it into four subquestions, which in turn are decomposed in several subquestions. The most important questions are presented in Figure 1.1. The corresponding parts of the Thesis are indicated between brackets.

[1] Former Finance Minister Jan Kees de Jager recently confirmed these considerations (Schoemakers, 2012). See also Elsevier (2012) and Duffhues and Camdzic (2011).

- Should the Dutch government actively support the emergence and development of venture capital markets, and if so, how? (Chapter 4)
    - Does a public interest exist that legitimises government intervention in VC markets?
        - What does economic theory predict with regard to positive externalities? (Subsection 1.3.1)
        - Can we empirically relate increased venture capitalism to positive externalities? (Subsection 1.3.2)
        - Might countries have an equal interest in and ability to create thriving VC markets? Why (not)? (Subsection 1.3.1 and Section 3.2)
    - What do public policies that successfully foster VC markets look like?
        - What market failures should public policy address according to theory? (Sections 2.1 and 2.2)
        - What are the right instruments to do so? (Section 2.2)
        - What do empirical evidence and historic examples tell us? (Section 2.2)
        - What are important environmental factors that affect and limit the success of public policies? (Section 3.2)
    - What is the situation in the Netherlands, and how did we get there?
        - How large is the Dutch VC market, and how has it developed comparatively and historically? (Section 1.4)
        - What are important environmental factors for the Netherlands? (Section 3.2)
        - Did the Dutch government have an active policy towards VC, and if so, what was it like? (Section 2.3)
        - Do recent Dutch policies accord with recommendations from the literature? (Section 2.3)
    - How effective have Dutch VC policies been, and how may this be improved?
        - How can we (not) measure the effect of public VC policies? (Subsection 1.3.2 and Chapter 3)
        - Has Dutch VC policy been efficient and effective? (Subsection 3.3.4)
        - How can the effectiveness be improved? (Subsection 3.3.5)

Figure 1.1: The most important research questions and subquestions.

This Thesis proceeds as follows. Chapter 1 continues to set the scene. It briefly describes what venture capitalism is and elaborates on why governments have a stake in fostering it. It describes how VC markets have developed, zooming in on relevant developments for the Netherlands.

Chapter 2 reviews the academic literature to explain when and how governments should intervene in order to foster VC markets. The relevant market failures are described, as well as other factors that may foster or impede the development of VC markets. The policy landscape is explored by describing the range of possible instruments, and their effectiveness according to the empirical literature. National VC policies are reviewed, after which historic and more recent Dutch VC policy efforts are described and subsequently assessed in light of the obtained insights from the literature.

Chapter 3 investigates the effectiveness of Dutch VC policy quantitatively. It starts by outlining that doing so is troubled by inherent methodological difficulties, but also by a lack of data, which implies that traditional methods of scoring government policy fail to work. It then introduces an alternative method, data envelopment analysis, for assessing the effectiveness of VC policies. Finally, lessons for Dutch VC policies are derived by studying the countries that achieved higher VC investments despite a similar set of

environmental obstacles.

Thus, Chapter 1 introduces; Chapter 2 derives lessons from the literature; Chapter 3 derives lessons from benchmark countries; and Chapter 4 concludes.

1.2 What is Venture Capitalism?

This section will describe the main characteristics of venture capitalism.[2] Eisinger (1991, p. 64) defines venture capitalism as "… equity investment in small, often new, growth-oriented businesses, typically at the gestation or seed, start-up, and early expansion stages", and Tykvová, Borell, and Kroencke (2012, p. 15) indicate that VC "is typically defined as the investment of long-term, unquoted, risk equity finance by professional investors in young firms." Venture capitalism thus refers to the financing of enterprises that are particularly risky. Often, these enterprises are young and starting up, and have a high profit and growth potential, but are surrounded by uncertainty and hence risk. For VC-backed firms it is typical that the likelihood of both loss of investment and of substantial profits are larger than for non-VC firms. In other words, their returns are volatile.[3]

The venture capital cycle starts with an individual or a group of individuals, the (potential) *investee*, having an idea with potential commercial value, that needs further development and that is eventually to be put into practice. This idea can be a new business model, a technical or technological breakthrough – basically anything that is new and potentially profit-generating. The problem for potential investees is that, often, it is only this: an idea. This idea is "untested in the market",[4] and future profits are thus highly uncertain and anything but guaranteed.

Potential investees often do not have enough capital to explore the feasibility of their idea and to set up a firm, especially since during the first years no or insignificant revenues can be generated. This is referred to as the 'valley of death'; a first period of negative cash flows that is needed to be able to generate positive cash flows in the future, during which firms may fail and go bankrupt because of insufficient capital. This explains why they are in need of (additional) external financing in the first place.[5]

Additionally, potential investees do not (yet) possess tangible assets and thus have problems providing collateral[6] and have a lacking track record.[7] Therefore, potential investees "rarely have access to conventional financing of any sort"[8] since lenders such as banks tend to demand collateral to limit their exposure and minimise the risk they take. Potential investees often have to resort to equity capital, and more specifically, to venture capital.

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[2] For the interested reader, Gompers and Lerner (2001, pp. 146-152) provide a historical account on the development of the VC industry.

[3] Hall (2002).

[4] Eisinger (1991, p. 64).

[5] It is for this reason that Puri and Zarutski (2008, p. 30) state that "a primary role played by VC is to keep firms alive in the early part of their lifecycles and give them a chance to grow."

[6] Thompson (1989) and Gompers and Lerner (2001).

[7] E.g. see Croce, Martí, and Murtinu (2012), and Berger and Udell (1998).

[8] Eisinger (1991, p. 64). See also Gompers and Lerner (2001).

The first thing to do for potential investees is to convince venture capitalists of their idea. Since they cannot require collateral, they want to be convinced of the profit potential before providing capital. The idea has to be pitched, based on which venture capitalists decide whether or not they will invest in the idea.

If the pitch turns out to be successful and venture capitalists decide to invest in the idea, then the investees receive funds called *venture capital* (VC). Depending on the stage of the development and marketing of the idea, this capital can be used to further develop the idea, to finalise the product or service, and/or to set up the firm. During later stages, when a firm has been set up and has generated some initial revenues, the investees and venture capitalists might agree that a larger potential exists, and that the firm should be expanded, perhaps again incurring some negative cash flows, in order to generate even larger revenues later on.

Venture capital investments can be distinguished by the stage in which the firm that received the investments is located. *Seed* investments refer to capital that is provided for the creation, exploration, and development of ideas during the earliest stages. *Start-up* investments are used to set up a firm by for instance hiring people, building or renting necessary real estate, and running a marketing campaign. They are used to prepare a company for actually going into business and to facilitate the future generation of revenues. *Expansion* investments are used to expand a company in order to generate even larger revenues later on. *Later stage* investments are aimed at reaching the status of market leader and are often done in preparation of going public or a trade sale.[9] The distinction between expansion and later stage investments is often especially blurred. For potential investees it is important to realise for what stage they require funding, since different stages need different amounts of capital and are associated with different kinds of risks.

Obtaining venture capital is often accompanied by an exchange of equity shares; in return for providing capital, venture capitalists become owners of a share of the firm. They gain an important say in the management of the firm, which reduces some share of the risk they face, since they can exert influence on the firm's policies and since information gaps are reduced.[10]

Venture capitalists are therefore more than just investors. Venture capitalists are often experienced in bringing novel ideas to the market ('marketing innovations'). They have the necessary expertise on how to position a new product or service, and how to close profitable and necessary contracts, which is typically missing in the VC receiving firms.[11] Saxenian and Sabel (2008) emphasise the importance of the networks venture capitalists have. Timmons and Bygrave (1986, p. 161) stipulate the importance of the "very early involvement by venture capitalists in nurturing budding innovators and technology, and thereby bird-dogging and accelerating the emergence of highly innovative technologies".[12] Lerner et al. (2011, p. 8) add that venture capitalists are invaluable by "helping the company to raise more finance, reviewing and helping

[9] See Box 2 in Bottazzi and Da Rin (2002, p. 237).

[10] Gompers and Lerner (2001).

[11] See Teece (1986), Gorman and Sahlman (1989), Sapienza (1992), and Casamatta (2003).

[12] See also Hellmann and Puri (2002), Pinch and Sunley (2009), and Sahlman (1990).

to formulate business strategy, filling in the management team and introducing them to potential customers and suppliers." Venture capitalists are therefore crucial, because having (the ability to come up with) a great idea is not a guarantee whatsoever that this idea will eventually be brought to the market and be of any value to society.[13]

Venture capitalists try to seek out those innovative opportunities of which they can facilitate the development and marketing within a timeframe of maximally, say, ten years.[14] When the job is done, and the idea has been developed and brought to the market through an often newly created firm, which has expanded over time and earned considerable revenues that convinced the market of its competitiveness and profitability, the time comes for venture capitalists to earn their profit. The company is sold, and investments are earned back, preferably with a (big) positive return. This act is called the *exit*. It marks the end of the venture capital process and completes the circle, since funds can now be used for new VC investments. The most profitable and well-known exit route is an initial public offering (IPO).[15]

1.3 Venture Capitalism: Why Care?

Governments should only play an active role in VC markets if *both* of the following two statements are true: (1) the utilisation of VC leads to positive externalities; (2) VC markets need the government (for instance to address market failures) in order to do so; moreover, government failures are not bigger than the market failures they address, nor are the costs of intervention higher than the societal benefits derived from it. The rest of this section will focus on the first statement and review if and how venture capitalism may actually lead to positive externalities for society; Chapter 2 will focus on the second statement.

1.3.1 Theoretical considerations

The most frequently sounded reason why VC is important is that it fosters innovation. VC enables bright minds to develop and market their ideas where they would not have been able to do so otherwise, because they could not dispose of the required capital and because they lack managerial, marketing, and networking expertise. This has already been discussed at greater length in Section 1.2.

Innovation is often considered to be 'intrinsically good' and thus desirable. For instance, Greenhalgh and Rogers (2010, p. 4) acknowledge this when they define innovation

> as the application of new ideas to the products, processes, or other aspects of the activities of a firm *that lead to increased 'value.'* This 'value' is defined in a broad way to include higher value added for the firm and also benefits to consumers or other firms." (my italics)

Greenhalgh and Rogers (2010, p. 4) distinguish between *product innovation*, being the introduction of a new

[13] Although the book narrates about a technological breakthrough that many regard as fictional and that, until now, remains unproven at best, Smit (2004) provides an interesting view on how a major technological breakthrough is brought to the market, more specifically also on the numerous difficulties that come with it, and on the expertise that is needed to cope with these difficulties. See also Sapienza (1996), Croce, Martí, and Murtinu (2012), Keuschnigg (2004), and Kanniainen and Keuschnigg (2004).

[14] See Murray et al. (2012, p. 2).

[15] Gompers and Lerner (2001) and Muscarella et al. (1990).

product, or a significant qualitative change in an existing product, and *process innovation*, being the introduction of a new process for making or delivering goods and services. Numerous examples show that VC can stimulate both types of innovations.[16]

Let us now, briefly, look at how innovation can lead to positive externalities a bit more precisely. Some theories hold that innovation is indispensable to achieving long-term, sustainable economic growth, in a systematic way. In neoclassical growth models (and so-called endogenous growth models) the state of the technology co-determines the rate of growth. Howitt (2007, p. 2) points to Solow (1956) and Swan (1956) when he states that according to the neoclassical growth model "technological change has a profound influence on our well-being" and that "the economy's long-run growth rate is determined exclusively by the rate of technological progress." Innovation can be seen as the mechanism through which technological knowledge advances, which is perceived as a rather gradual process.[17]

Joseph Schumpeter, one of the most famous early writers on innovation, had a view on innovation different from neoclassical economists. Schumpeter (1942) coined the term *creative destruction*, which Howitt (2007, p. 6) defines as "the process whereby each innovation creates some new technological knowledge that advances our material possibilities, while rendering obsolete some of the technological knowledge that was created by previous innovations." This view on innovation differs from neoclassical views in that it emphasises its disruptive and painful nature; every new innovation creates new opportunities, but in time its use is bound to be destroyed by future innovations.[18]

Whether inclined to follow ideas categorised as Schumpeterian, neoclassical or otherwise, most agree that innovations lead to increased productivity. Significant productivity improvements come, almost by definition, in the shape of innovations. These are often process innovations, and the easiest imaginable examples come from the manufacturing sector (e.g. conveyor belts that can move quicker). Product innovations, however, can also lead to massive increases in productivity. It has happened many times that a product turned out to be of incredible productive use to the general public, even though this was not the central motivation behind its invention. This process, where the knowledge and practice of an innovation spreads, improving efficiency and productivity, is called *diffusion*.[19] One may take computers, which are now ingrained in almost every daily activity, as a simple example.[20] Innovations as momentous as the computer jointly with a virtually unlimited number of less notable innovations mean that people can do whatever they do more efficiently, thus raising productivity levels.[21]

According to the above, efficient VC markets can stimulate innovation, which in turn fuels sustainable long-term economic growth. VC may add to economic growth because enabling the creation of new businesses

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[16] See e.g. European Commission (1995).

[17] Mankiw, Romer, and Weil (1992) provide an augmentation of the neoclassical growth model, by including the accumulation of human and physical capital, to explain international variation in living standards, and to show that countries are indeed converging with respect to their economic growth levels.

[18] See also Cantner, Gaffard, and Nesta (2009).

[19] See Rogers (2003) and Ten Raa (2009a).

[20] This example is quite appropriate, given that "[v]enture capital was of vital importance to the personal computer industry" (Florida & Kenney, 1988, p. 129).

[21] See also Gordon (2000), Davenport (1993), and Roberts (2002).

can lead to the creation of employment.[22] In the first stages VC creates employment for venture capitalists and for the owners and first employees of the VC receiving firm. Keuschnigg (2004, p. 239), moreover, notes that VC-backed firms "generate more employment than other start-ups".[23] Additional employment will be created in particular when firms turn out to be successful and grow enormously. One may think, for instance, about the employment that the rise of the Internet created. Job titles like web designer and e-marketer obviously did not exist prior, nor did firms that provide Internet security (such as Symantec Corporation) or online social media (such as Facebook and LinkedIn). Of course, following Schumpeter's concept of creative destruction, jobs created because of certain innovations come to a certain extent at the expense of other jobs. The aggregate effect of innovation on employment is, however, predominantly deemed positive.

European Commission (1995, p. 9) explains that both product and process innovations may lead to increased employment:

> The relationship between innovation and employment is complex. In principle, technological progress generates new wealth. Product innovations lead to an increase in effective demand which encourages an increase in investment and employment. Process innovations, for their part, contribute to an increase in productivity of the factors of production by increasing production and/or lowering costs. In the course of time, the result is another increase in purchasing power, which promotes increased demand and, here again, employment.

Although the influence of innovation on the aggregated employment of all countries may be disputed,[24] it is hard to do so on a local level against a background of globalising economies and reduced trade barriers. If a certain country innovates and sees its productivity increase relative to other countries, then its competitiveness improves. Among other effects this strengthens the trade position, which will induce (the relative level of) exports to increase. This, in turn, has an effect on employment in sectors that produce to export, but also a less observable effect since certain sectors might now not be relocated to regions in other countries. Thus it is not only true that innovation leads to increased employment; *not* innovating leads to decreased employment.[25]

Since VC is associated with innovation, which in turn is associated with both increased employment and productivity, VC and innovation must necessarily also be associated with economic growth, since this can be seen as the product of the number of workers and their productivity. It is for this reason that Grossman and Helpman (1994, p. 23) can argue "that purposive, profit-seeking investments in knowledge play a critical role in the long-run growth process".[26] Wasmer and Weil (2004, p. 944) "build a simple macroeconomic model of credit and labor market imperfections which sheds light, in a tractable way, on the interaction between macroeconomic activity and finance." They investigate the role finance can play "in an environment in which new entrepreneurs have no wealth of their own, and must raise funds on imperfect

[22] See Gompers and Lerner (2001), and Wasmer and Weil (2004) for a formal model.

[23] See also the more recent Keuschnigg (2010), and Smolny (1998).

[24] See e.g. Roberts (2011).

[25] See e.g. Cooke (2001) and Lerner et al. (2011).

[26] See also Keuschnigg (2004), Canton et al. (2005), and Lerner et al. (2011).

credit market before they enter the labor market to search for workers" (pp. 944-945), and particularly what this entails for job creation and destruction. Their model assumes that new entrepreneurs use existing technologies, but "assuming that new entrepreneurs, instead of using an existing technology, are the engine of technological innovation" would lead to the conclusion that "finance would become an essential input into long-run growth." This corresponds quite accurately to the situation potential VC-receiving firms face, and although Wasmer and Weil (2004) do not indicate a specific role for VC, it becomes clear how VC can act as the oil in 'the engine of technological innovation', thus stimulating long-run growth. Keuschnigg (2004) also models credit market imperfections. He focuses on incentive problems, by including VC in a dynamic general equilibrium model of innovation, and concludes that growth can indeed be stimulated significantly, provided that the right government policies are implemented that acknowledge the incentives of venture capitalists and VC receivers.

Hippeau (2009) argues that VC is particularly important when economic recovery is desired after periods of recession, because "big companies are jettisoning employees at a furious pace [and] are not going to be hiring any time soon. When the economy picks up, they'll find ways to stay lean." An important "source of new jobs [...] will come from start-ups and existing small businesses", which leads him to the conclusion that economies "need more venture capital."

Perhaps the most important aspect of innovations is that they are crucial to increasing living standards. The list of innovations that eventually improved the quality of life is practically endless. Think, for instance, of the introduction and improvement of plumbing and the development of antibiotics and immunisations. The increase in productivity levels means that people can direct their attention to activities that have a larger incremental impact on their happiness, for instance by taking time off for leisure or education.[27] VC focuses on relatively small economic units, frequently consisting of a single individual, which is important given that almost all major advances of civilisation were the result of individuals' efforts.[28] People are able to live longer and they live the years of their lives comparatively in better health, in greater comfort, and hence in higher quality. Looking ahead, Metcalfe (2006, p. 12) thus recognises that innovations are "the key to further advances in our standards of life".[29]

Not everyone is convinced of the societal benefits of VC; the literature describes adverse effects of VC as well. Some doubt whether innovations have raised living standards as much as others think they have. Gordon (2000), for instance, doubts that the Internet actually contributed much (if anything at all) to productivity growth and increased living standards. Others emphasise that innovations may indeed have led to increased growth, but that some benefit more from this than others. Several authors have suggested that factors like globalisation and increased complexity can drive the demand for highly educated and skilled workers up relative to their lower educated and unskilled counterparts.[30] Bound and Johnson (1992,

[27] The average hours worked per week has decreased in most countries during the past decades, even though economies (also on a per capita basis) generally kept growing. The Netherlands is a frontrunner in this, having one of the lowest averages hours worked per week in the entire world (OECD, 2012).

[28] Friedman (1962).

[29] Metcalfe (2006) specifically emphasises the importance of innovations in the tertiary sector. See also Hsu (1998) and Cincera, Czarnitzki, and Thorwarth (2009).

[30] See e.g. Lemieux (2006).

p. 34) hint at the importance of innovation when they state that "[t]echnological change [...] accounted for some of the major changes in the wage structure" and that "[t]here is a great deal of anecdotal evidence that production processes have changed significantly over the past decade in a manner that favors more relative to less educated workers".[31] Howitt (2007, p. 12) points at a specific influence of innovations when he states that "the recent wave of information technology innovations has been especially rewarding for people with the mobility, adaptability, and creativity to profit from rapid change." This way, "the adaptable — who are already likely to be in the upper end of the wage distribution — find their wages rising relative to other workers."[32]

Friedman (1962, p. 4) counters such reasoning by stating "that experimentation [which is related to innovation] can bring tomorrow's laggards above today's mean," which means that even though relative inequality, in monetary terms, may indeed become stronger, everyone improves in an absolute sense. Some inequality might even be *necessary*; if successful innovations would not lead to significant benefits for the innovators, this would greatly reduce the incentives for creative minds to take the risks that are associated with innovating.[33]

Hall (2002, p. 17) doubts whether venture capitalism can always be the solution for innovative firms to find funding:

> The VC solution to the problem of financing innovation has its limits: First, it does tend to focus only on a few sectors at a time, and to make investment with a minimum size that is too large for startups in some fields. Second, good performance of the VC sector requires a thick market in small and new firm stocks (such as NASDAQ or EASDAQ) in order to provide an exit strategy for early stage investors.

A final critical argument regarding the importance of VC is provided by authors who agree that innovation is indeed important, but emphasise that VC is not the only source of innovation. Florida and Kenney (1988, p. 119), for instance, argue that there are also costs associated with VC, since they can "cause disruption of established research organizations and the establishment of strong incentives for 'breakthroughs' as opposed to other types of innovation." In this respect and in the context of this Thesis, it should be reminded that the Netherlands boasts many and significant research centres that are already important innovators, such as those of DSM and Philips.[34] Even if this Thesis would find a holy grail of VC policy, the effects of its potential implementation on existing innovation centres should be studied carefully.[35]

It is worth noting that the literature that is reviewed above almost without exception refers to a general or universal role of VC. Conclusions about mechanisms and effects of VC investments, even when obtained after doing *case studies*, almost always have a universal claim; that is, they are deemed to hold *across countries*. Gompers and Lerner (1999b, p. 36) seem to acknowledge this when they indicate that "if venture capital organizations spur technological innovation in the United States, it is not evident that the model

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[31] See also Acemoglu (2002) and Aghion (2002).

[32] Howitt (2007, p. 12). See also Aghion, Howitt, and Violante (2002).

[33] On the importance of incentives for innovation, see for instance Scotchmer (2006) and Alberts (2009).

[34] Van der Poel, Seip, and Snoei (2010), for instance, indicate that during the years 2003-2007 Philips filed 30% of all filed patents, and together with NXP, Unilever, Shell, and DSM even about 46%.

[35] Gompers and Lerner (2001) also raise this concern.

can be seamlessly transferred abroad." It is thus remarkable that, as far as I am aware, the literature rarely investigates how VC can play *different roles across countries*.[36] Below, I pose and discuss two main reasons why VC may be of different importance, desirability, and feasibility across countries. What follows is that the interest in developing efficient VC markets may vary widely across countries corresponding to the different roles they (could) play.

Section 1.2 described the main mechanisms and characteristics of VC markets, and showed that a great deal of venture capitalism takes place in and via equity markets, which makes the familiarity with such markets and the comfortability with market transactions important. If entrepreneurs do not feel comfortable accepting capital from venture capitalists, perhaps because of a lack of trust (after all, venture capitalists take a stake in their project), then they will not easily engage in venture capitalism. This holds also for venture capitalists; if they perceive that financial markets will not allow them to close the contracts they desire (for instance to cope with incentive problems and information asymmetries) or to earn significant positive returns on their investments because the stock market is not active (or liquid) enough (and thus exiting via IPOs is difficult), then they will not easily provide VC to young firms.[37]

Considering the following quote from the summary findings of Demirgüç-Kunt and Levine (1999), it seems that the degree to which a region is 'market-based' or 'bank-based' conveys information about the potential role VC might play:

> In bank-based systems banks play a leading role in mobilizing savings, allocating capital, overseeing the investment decisions of corporate managers, and providing risk management vehicles. In market-based systems securities markets share center stage with banks in getting society's savings to firms, exerting corporate control, and easing risk management.

As explained, young firms might have problems obtaining capital because of a lack of collateral, and information and incentives problems. This is particularly severe because young firms do not have a track record that could give credibility to good intentions. In bank-based systems individuals and firms have longer and closer relationships with banks; bank officials often fulfil advisory and managerial roles similar to those of venture capitalists, although nowadays this is less and less the case. This should overcome at least part of the information asymmetries and trust problems, and it is thus conceivable that in bank-based systems there is less need and demand for VC. This reasoning seems to be corroborated by observing that, indeed, VC markets are well-developed and influential particularly in the U.S. and the U.K., which are often classified as being (relatively) market-based. They are less developed in Germany, which is classified as bank-based, and moderately developed in the Netherlands, which is often seen as some kind of hybrid.[38]

The second reason is to a certain extent related to the first reason described above. VC is particularly important for innovations that have a 'breakthrough' nature. Such innovations are typically radical, come as a surprise, and destroy existing production bases. Incremental innovations, on the other hand, are less

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[36] Bottazzi and Da Rin (2002, p. 19) for instance document "important differences between the type of firms listed on the Neuer Markt and on the Nouveau Marché". Differences between these countries and, for instance, the U.S. and the U.K. can only be expected to be even larger.

[37] See Hall (2002) and Black and Gilson (1998).

[38] See Levine (2002). On Germany's bank-based system, see Vitols (2004).

radical, often the result of targeted R&D (of existing companies), and enhance rather than render useless existing production bases.[39]

Hall and Soskice (2001) pioneered a field that because of the success of their work is now called *varieties of capitalism*. They distinguish between two main types of economies: liberal market economies (LMEs) and coordinated market economies (CMEs). LMEs are more likely to successfully sprout radical innovations, whereas incremental innovations are better stimulated in CMEs. LMEs emphasise short-term tenures, in which workers change jobs quicker and thus focus less on firm- or product-specific knowledge (which would induce incremental innovations). Hall and Soskice (2001, p. 40) argue that

> the institutional framework of liberal market economies is highly supportive of radical innovation. Labor markets with few restriction on layoffs and high rates of labor mobility mean that companies interested in developing an entirely new product line can hire in personnel with the requisite expertise, knowing they can release them if the project proves unprofitable. Extensive equity markets with dispersed shareholders and few restrictions on mergers or acquisitions allow firms seeking access to new or radically different technologies to do so by acquiring other companies with relative ease, and *the presence of venture capital allows scientists and engineers to bring their own ideas to market*. (my italics)

Hall and Soskice (2001) thus find that CMEs are more supportive of incremental innovation. The institutional framework that supports the one, seems disruptive of the other. This institutional framework interacts with and is a part of the culture present in the relevant country. Anglo-Saxon countries have economies that closely resemble a LME, and its citizens are less risk-averse than those of CMEs. A certain country might not have a strong desire or use for a large and influential VC market because its citizens have a different mindset: one that, to mention just a single aspect, is relatively risk-averse. The European Commission recognised in 1999 that "[c]ulture is the main barrier to the development of risk capital markets" and that "[d]eveloping a less risk-averse culture [...] is key to Europe's economic growth and job creation".[40] For the European Commission preserving national cultures might not be an important goal – they are even seen as *barriers* – but most national politicians will certainly have deviating views on this.

Hall and Soskice (2001) do not just focus on innovation; their focus is on the (nationwide) competitive advantages that result from institutional frameworks. This is important for those arguing in favour of creating a Dutch equivalent of Silicon Valley. Creating an environment that would maximally stimulate VC could very well erode the competitive advantage of other sectors and thereby decrease competitiveness of the country as a whole. The methodology for and discussion of the empirical work in next sections should take this into account. Countries that are relatively more bank-based and aim predominantly at incremental innovations are expected to have smaller and less active VC markets, and to have less interest in creating them.

Figure 1.2 depicts this section's findings. Although some dispute it, VC is generally believed to foster rising living standards, economic growth, increased productivity levels, and increased employment, either directly or via innovation. The extent to which a country is market-based or a CME (or LME), in addition to other

[39] See e.g. Hurmelinna-Laukkanen, Sainio, and Jauhiainen (2008), Cromer, Clay, and Craig (2011), and Hellmann and Puri (2000; 2002).

[40] European Commission (1999, pp. 9-10).

environmental factors that will be explained later on, affects these channels of influence, and can thus be seen as moderating variables. The next section will survey the empirical literature, to see whether the displayed arrows in Figure 1.2 have been found to be significant.

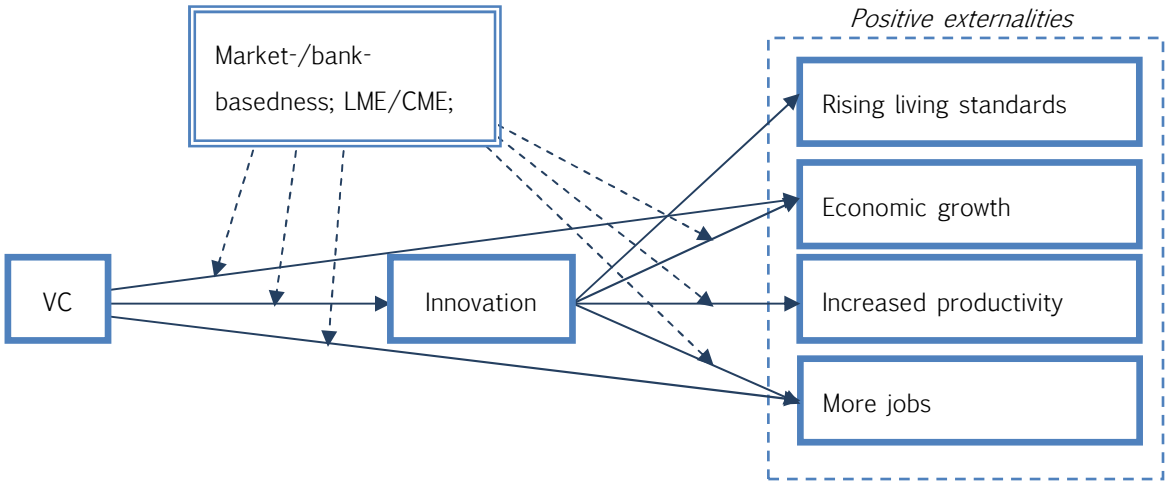

Figure 1.2: Venture capitalism may result in positive externalities.

1.3.2 Empirical evidence

This subsection will consult the existing literature with regard to the theoretical considerations of Subsection 1.3.1: can we find empirical evidence to corroborate them?

Convincingly and conclusively relating VC empirically via innovation to economic growth is troubled by several causality problems. Firstly, it might be the case that innovations propel VC investments. Successful innovations create a market for VC because they create incentives and technological opportunities. Therefore, a positive correlation observed between VC investments and innovation might be the result of reversed causality. Secondly, it could be the case that more innovative firms more often resort to VC. This would mean that correlation is just that – correlation, not causation.[41] Thirdly, venture capitalists might not so much create value as they screen out the best projects.[42] Observed extra economic growth created by firms using VC might therefore be the result of a selection bias; these firms might have created this growth without VC as well. Fourthly, and perhaps most notably, there are reversed causality problems between economic growth and VC investments (and also innovation). In prosperous times of substantial economic growth retained earnings build up. Firms and individuals see their profits and savings increase, which may find their way to venture capitalists, thereby stimulating VC investments.[43] Also, a growing economy offers more opportunities for an entrepreneur to bring a new product or service to the market. This way, a growing economy fuels VC investments, and not necessarily vice versa.

Another reason, not often mentioned in the literature, that explains why despite a crucial importance it may still be difficult to quantify the effects of VC and innovation, is that the effects of these innovations do not have a known, estimable distribution. They cannot be predicted and neither occur nor develop in a

[41] Gompers and Lerner (2001).

[42] See e.g. Kaplan and Strömberg (2001) and Croce, Martí, and Murtinu (2012).

[43] See e.g. Lanser and Van der Wiel (2011).

regular manner. They present themselves as shocks, which moreover have a disruptive nature. It may be the case that 1.000 innovations or VC investments are useless, but that the 1.001st changes the world for the better. Methods like regression and Granger-causality analysis, which I will use later on, must assume certain time lag lengths, which may fail to find a significant influence because the relevant lag length may vary from one case to another.

Kortum and Lerner (2000) investigate the effect of VC on innovations by looking at twenty U.S. economic sectors for the period 1983-1992. They conclude that increases in VC activity lead to higher patenting rates and that VC spurred about 8% of all industrial innovations.[44] Mann and Sager (2007) reach a similar conclusion, considering VC investments in U.S. software firms. Keilbach and Engel (2005), using data on VC investments and patent applications, find that young German firms that are funded by VC have higher growth rates and apply for more patents than otherwise comparable firms, although the latter effect seems to happen *before* the actual VC deal is struck. Bygrave and Timmons (1992) emphasise that VC is a vital element of entrepreneurship, and that this has been particularly important for the semiconductor, computer, and biotechnology industries. Hellmann (2000) indicates that VC played a crucial role in the creation of innovative, young firms in Silicon Valley. Freear and Wetzel Jr (1990, p. 77) investigated "284 technology-based firms founded in New England [in the U.S.] between 1975 and 1986," eventually confirming the importance of venture capital for new technology-based firms.

A dissonant chord in the otherwise seemingly unequivocal literature is sounded by Stuck and Weingarten (2005, p. 50), who "examined 1303 electronic high-tech initial public offerings for a 10-year period ending in 2002" and found that innovation was (surprisingly) low and uncorrelated with VC funding. They provide four reasons. Firstly, the life cycles of venture funds are too short to foster true innovation. Secondly, venture capitalists are predominantly business people, who generally lack affinity with engineering and technology, and are thus unable to recognise breakthrough innovations of a technical nature. Thirdly, venture capitalists like 'serial entrepreneurs'; they prefer entrepreneurs who successfully applied for funding on earlier occasions. However, such entrepreneurs often provide variations on existing ('fashionable') innovations, as opposed to breakthrough ('unproven') innovations. Fourthly, venture capitalists "sync investments to business cycles." They opportunistically spend during economic upturns, while after crises and during recessions "even [venture capitalists] sitting on piles of cash have been afraid to invest".[45]

Popov and Roosenboom (2009a, p. 5) acknowledge that the evidence on the positive effect of VC on innovations consisted, until then, on anecdotal evidence and case studies, which is why they "provide the first empirical estimation" of "the contribution of private equity and venture capital finance to innovation outside the US." They look at patent applications and grants using panel data across 21 countries and between 1991 and 2004, eliminating the variation caused by government-financed research and development (R&D), human capital, GDP, and patent protection, and find that "a 1% increase in private equity investment increases the number of USPTO patents by between 0.04% and 0.05%".[46] Popov and

[44] Interestingly, research conducted by Kortum and Lerner (1998, p. 36) some years earlier led to the conclusion "that venture capital accounts for 15% of industrial innovations" – hence nearly double as much.

[45] Citations are from Stuck and Weingarten (2005, p. 55).

[46] Popov and Roosenboom (2009a, p. 5).

Roosenboom (2009a, p. 6) admit that their data does not permit them to isolate the effect of venture capital, because they have to use a proxy of private equity investments. The main component other than VC consists of buyouts, which have developed markedly different, especially during the recent crises years,[47] which greatly reduces the strength of their conclusions. Still, Lerner et al. (2011) state that "[t]here is an emerging consensus that venture capital is a key component of the innovation process."

The link between VC and productivity growth is investigated by several authors, who sometimes take productivity levels to be a proxy of innovation. The results are ambiguous. For instance, Tang and Chyi (2008) note that increased VC led to productivity growth in the Taiwanese industry, whereas Hirukawa and Ueda (2008) find that at an industry level VC investments do not improve the productive efficiency.

The empirical literature on the effects of innovations on economic growth is wide and deep, and generally confirms that innovation is a crucial ingredient of sustainable economic growth. With regard to manufacturing sectors in 17 OECD countries during the years 1981-1997, Ulku (2007, p. 513) for example reports that "the rate of innovation has a positive effect on the growth rate of output in all sectors except for the drugs and medical sector." Donselaar (2011) confirmed the importance of innovation, and R&D expenditures in particular. For 20 OECD countries and the years 1970-2006, he relates innovation to total factor productivity, which is argued to be a main determinant of sustained economic growth.

Gompers and Lerner (2001) indicate that it is difficult to conduct empirical tests that enable researchers to establish that causality is at work between VC on the one hand, and innovation and employment growth on the other - and not just (spurious) correlation. The empirical evidence on a link between VC and employment growth seems inconclusive. For instance, the section that Lerner et al. (2011) devote to the empirical backing of this link only contains three empirical works. Furthermore, for two out of these three works no reference is provided, and only one (Puri & Zarutski, 2008), actually empirically investigates this link. Lerner et al. (2011, p. 9) claim that this study "found that despite the extremely small proportion of VC-backed firms (0.1 per cent of all new firms created between 1981 and 2001) they accounted for nearly 10 per cent of employment in the US in the late 1990s and early 2000s." Closer scrutiny of this article, however, reveals a less clear picture, since Puri and Zarutski (2008, p. 12) themselves state that "casual empiricism suggests that VC finances firms that will rapidly grow and that will eventually become large players in certain industries." Presumably, they sum all employees of all firms that at some point received some amount of VC. They do not claim that VC actually created this (additional?) employment. Such a sum results, at best, in a rather large estimate, and leaves issues such as the screening abilities of venture capitalists and counterfactuals[48] unaddressed.

Contrary to what Keuschnigg (2004) predicts, Bottazzi and Da Rin (2002, p. 232) find, based on collected data on over 500 European VC-backed firms, that VC-backed firms "do not grow and create jobs faster than non venture-backed companies." Samila and Sorenson (2011), however, using data on U.S. metropolitan areas, find that increased VC investments does lead to additional firm start-ups, employment,

[47] See Eurostat (2012b).

[48] If these firms, for some reason, would not have received VC, would that mean that the entire mentioned 10% would have remained unemployed?

and aggregate income, and Meriküll (2010) obtains similar findings for Estonia

Wasmer and Weil (2000), who use data of 16 OECD countries for the years 1986-1995, calculate short-run and long-run effects of a one standard deviation increase in VC capital as a percentage of GDP on employment figures. Wasmer and Weil (2000, p. 34) determine the short-term effect to be 0.25% of the labour force, and find that the long-run effect "ranges in, say, 0.9 to 2.5 percent of the labour force". Their methodology seems to avoid most problems regarding causality (by taking lagged values) and the screening hypothesis (by taking measures of VC as percentages of GDP), and is thus convincing. Updating results using a larger and more recent dataset may strengthen their conclusions, since the data they use for estimation consists of only 140 observations, and since VC was not an important source of financing for 15 out of 16 of the investigated countries during 1986-1995.[49]

Given the lack of (recent) empirical evidence on the link between VC (and innovation) on the one hand, and employment growth on the other, it is surprising that a great number of authors assumes that a causal relationship is significantly operative, often based on some existing consensus or qualitative judgment. To take one example, Belke, Fehn, and Foster (2001, p. 19) firstly judge that the "ability of a country to encourage and sustain technological innovation by entrepreneurial firms is one of the main sources of economic and employment growth", and subsequently that "[e]conomic intuition suggests that venture capitalists have to play a key role in this respect." The empirical evidence does not convincingly corroborate this. It indicates that economic growth is positively correlated to innovation (and in certain occasions to VC investments). But economic growth can be decomposed into two components: the number of workers and the average production per worker. It seems that an increase in (only) the latter component explains how innovations (and VC) influence economic growth.

Not much empirical work exists on the effects that increased VC might have on existing R&D centres. Even though some tension might exist between VC and 'more traditional' ways of R&D, according to some empirical evidence this may be justified. For instance, Kortum and Lerner (1998, p. 3) "suggest that a dollar of venture capital could be up to ten times more effective in stimulating patenting than a dollar of traditional corporate R&D."

As far as not already addressed, Hirukawa and Ueda (2011) confirm the causality problems between venture capital investments and innovations. Using both total factor productivity growth and patent counts as measures of innovation, they find that innovation generates new VC investments, and not so much the other way around. Van Pottelsberghe de la Potterie and Romain (2004) also find that the number of (triadic) patents positively and significantly affects VC intensity. Geronikolaou and Papachristou (2012) use a panel dataset on European countries and annual patent applications at the European Patent Office as a proxy for innovation. They find that causality runs from patents to VC, and not the other way around.

With regard to the causality ambiguities relating to firms receiving VC and their performance (that is, whether VC truly adds value or whether the impact can be explained for instance by the screening abilities of venture capitalists), Bygrave and Timmons (1992) corroborate their theoretical considerations and

[49] See Figure A.1.10 (p. 107). See also Achleitner and Klöckner (2005).

empirical findings of a few years earlier[50] with the conclusion that the added value of VC investments to the economy largely stems from venture capitalists' expertise. Balboa, Martí, and Zieling (2006) reach the same conclusion, using data on 250 Spanish firms that received VC between 1993 and 1999.[51] Croce, Martí, and Murtinu (2012) find evidence for added value by venture capitalists, since they find that although productivity growth was similar before receiving VC, afterwards VC-backed firms' productivity grew faster. Baum and Silverman (2004, p. 431), looking at Canadian firms, find that causality runs both ways, since "VCs are attracted to firms that have technology that can lead to strong future performance but that are teetering on the edge of short-term failure."

Jingdong and Junmin (2011) use data on large and medium-sized industrial firms located in the Hubei province of China for the years 1990-2008. Cointegration and Granger-causality tests indicate that innovation stimulates firm growth *and* vice versa, where the latter effect is estimated to be the strongest. These conclusions may not be easily generalised, however, due to the specificity of their data sample.

Since the results are largely ambiguous and highly dependent on the choice of variables and of countries or sectors, I decided to replicate and update some results. Since my results are not very different from what is to be found in the reviewed literature, I have reported these empirical investigations in the Appendix (see Section A.1). Using dynamic panel data regressions, initial results excluding control variables result in significant coefficients for the explanatory variables. The significance, however, largely disappears when control variables are included.

The attempt to quantify positive externalities of VC like additional employment and economic growth serves two purposes. Firstly, it fills a gap in the literature, as indicated above. Secondly, the purpose of this Thesis is to assess the effectiveness, the *potential* effectiveness, and the legitimation of (Dutch) VC policy. The most powerful way would be to determine the realised and potential societal return on investment in VC policies. Ideally, the effects of VC policies on outcome variables like the mentioned public goods should be established – and quantified. Unfortunately, as is reported in Section A.1, I was unable to quantify (significant) relations between VC and the public goods – let alone between public VC policies and the public goods. This means that scoring Dutch VC policy in such a way, as Lanser and Van der Wiel (2011) and Stuiveling and Van Schoten (2011) similarly concluded for the broader category of innovation policy, is currently impossible. Section 3.1 will elaborate on this.

What I could do, however, is to try to find out whether the companies that received VC contributed to innovation at all. Kortum and Lerner (1998), for instance, indicate that patents are decent indicators of innovation. Thus, if VC-backed companies file for (and are granted) a large number of patents, this may indicate that VC indeed fosters innovation.[52]

From the Nederlandse Vereniging van Participatiemaatschappijen (NVP) I received a historic dataset with companies that at some point received VC. From the NL Octrooicentrum, a branch of Agentschap NL (itself

[50] Timmons and Bygrave (1986).

[51] See Peneder (2010) for similar results with regard to Austrian firms.

[52] Of course, issues such as the one of additionality persist; it might have been the case that these companies would have filed for patents also if they had not received VC.

a branch of the Ministry of Economic Affairs), I received a dataset with all companies that applied for a patent at the European Patent Office. A problem that presents itself is that a company listed in one of the datasets may be listed under a different name in the other.[53] For instance, to mention one issue, the datasets on patent data comprise companies of which the names have suffixes like "B.V.", "b.v.", "bv", or a not suffix at all (they might even be listed under the name of the CEO), despite the fact that they all have the same legal form. It is therefore difficult to match the two datasets.

With a simple programme I decapitalised the names in both datasets, and removed spaces and punctuations. I then matched the datasets, taking into account the dates at which VC was received. The results are presented in Figure 1.3. For instance, the value of 24 of the year 2007 means that, from 2007 onwards, 24 patent were filed by the companies that received VC in 2007. These numbers are (potentially grave) underestimations, because I was only able to link those companies who were named (almost) identically in both datasets.

The decline from 2007 onwards has two main causes. Firstly, as Section 1.4 will show, VC activity decreased after the onset of the crises. But secondly, it takes time to file for patents. A company that received VC in 2011 may only be ready to file for a patent in 2014. Eurostat metadata indicates that EPO data are 'quite definitive' after 3 to 4 years after the end of the reference period.

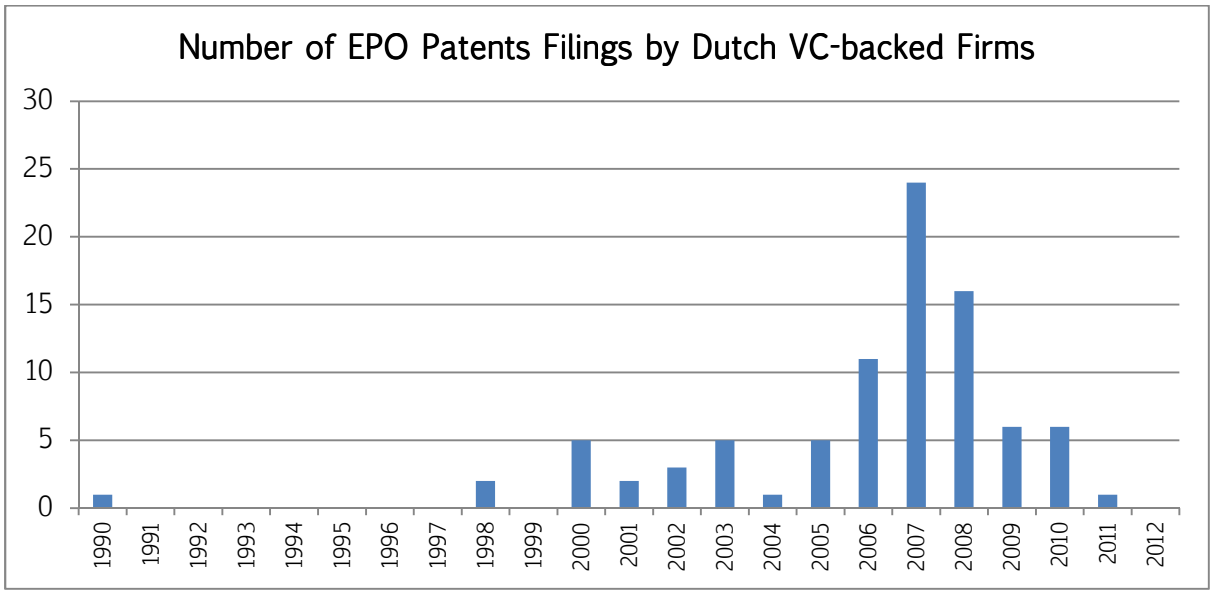

Figure 1.3: The graph shows the number of times a Dutch VC-backed company filed for a patent at the European Patent Office (EPO).

In any case, it seems that VC does foster innovation. Figure 1.5 and Table 1.2 in Section 1.4 will show that in 2007, 219 firms received a total of about €320 million in VC in the Netherlands. On average, one might say that about 11% of the firms receiving VC would file for a patent, and that a patent was filed for every €13 million of VC investments.

[53] See e.g. Thoma et al. (2010) and Eurostat (2011) on such problems and on methods of name harmonisation that address them.

1.4 VC Markets: Data, Definitions, and Developments

This section will firstly discuss the definitions of and data on VC investments, divestments, and fundraising, which will be used in the remainder of this Thesis. This section will *not* provide an exhaustive descriptive account of the development of European and Dutch VC markets for the past decades.[54] Rather, this section will present some general developments, and some developments that are either not (or in my opinion insufficiently) described in the literature, or that may have a particular significance for (future) government policy. Moreover, it will try to describe the development of the Dutch VC market against a European background.

1.4.1 Data and definitions

Yearly data on VC investments is retrieved from Eurostat databases. In 2007 practices with regard to data collection and definitions changed, and accordingly two databases are available. Eurostat (2012a) contains figures pertaining to *Early Stage* (ES) *Investments*, *Expansion and Replacement* (ER) *Investments*, *Buyouts*, and *Total Investments* (the sum of the first three figures), for the years 1989-2006 for 20 European countries.[55] A second database, Eurostat (2012b), contains the figures *Seed, Start-up, Early Stage*, *Later Stage, Expansion*, *Buyout*, *Growth, Rescue and Turnaround*, *Replacement*, and *Total* investments for the years 2007 up to and including 2011, for 22 European countries.[56] The indicators of venture capital investment intensity include millions of euro, percentage of GDP, number of investments, and number of companies.

Eurostat (2010) indicates that the data is provided by the European Private Equity and Venture Capital Association (EVCA) and that:

> [v]enture capital investment data are broken down into two investment stages:
>
> - **Early stage** (seed + start-up) and
>
> - **Expansion and replacement** (expansion and replacement capital).

These two stages can, in turn, be deconstructed into several components, which are available from 2007 onwards. Eurostat (2010) provides the following definitions:

> **Seed** is defined as financing provided to research, assess and develop an initial concept before a business has reached the start-up phase.
>
> **Start-up** is defined as financing provided for product development and initial marketing, manufacturing, and sales. Companies may be in the process of being set up or may have been in business for a short time, but have not sold their product commercially.
>
> **Expansion** is defined as financing provided for the growth and expansion of a company which is breaking

[54] To this end, reports from the Nederlandse Vereniging van Participatiemaatschappijen (NVP) can be consulted for the Dutch VC market, and from the European Private Equity and Venture Capital Association (EVCA) for the European market. For the Netherlands, see, in particular, the yearly reports called *Ondernemend Vermogen*, which are written on behalf of the NVP by PricewaterhouseCoopers.

[55] These countries are Belgium, the Czech Republic, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Hungary, the Netherlands, Austria, Poland, Portugal, Romania, Finland, Sweden, the United Kingdom, Norway, and Switzerland.

[56] The same countries as in footnote 55, plus Bulgaria and Luxembourg.

even or trading profitably. Capital may be used to finance increased production capacity, market or product development, and/or provide additional working capital. It includes bridge financing for the transition from private to public quoted company, and rescue/turnaround financing.

Replacement capital is defined as purchase of existing shares in a company from another private equity investment organisation or from another shareholder or shareholders. It includes refinancing of bank debt.

Buyout is defined as the purchase of a company or a controlling interest of a corporation's shares or product line or some business.

I can rely also on a richer dataset supplied by an analyst from the NVP. The dataset contains three main elements: fundraising, investments, and divestments. *Fundraising* refers to the capital that is collected from investors and that is subsequently available for investment. Investment definitions are already described above. *Divestments* refer to the 'exiting' of venture capitalists; the portfolio company's shares are sold so that venture capitalists can earn a profit. The NVP distinguishes between *industry* and *market* data. Industry data refers to investments done by Dutch venture capitalists, whereas market data refers to VC investment received by Dutch firms. Additionally, the NVP dataset provides quarterly data, although this data is less accurate because of a lower coverage rate.

To extend the 1989-2007 dataset to 2011, considering the Eurostat metadata and having consulted an analyst from the NVP, I take ES investments to equal the sum of seed and start-up investments, and ER investments to equal the sum of later stage and replacement investments. Total investments are then recalculated as the sum of ES and ER investments.[57]

1.4.2 Development of VC Markets in Europe and the Netherlands

Figure 1.4 shows the development of the amount of investments in the Dutch venture capital market. Venture capital was not an important financing source before 1994, never exceeding €200 million per year. Then, until 2000 and in the run-up to the Euro, the use of venture capital increased every year. VC investments in 2000 were more than *thirteen* times as high as in 1989. During 2000-2001 the dot-com bubble burst, which clearly depressed VC. Only in 2005 did levels reach those of 2000 again, only to decrease once more in the years after. Figure A.1.1, Figure A.1.2, and Figure A.1.3 (pp. 101-102) show that the depression following the dot-com bubble can be explained largely by a decrease of the number of VC investments. After the more recent crises the number of VC investments did not so much decline, but the average amount invested with each investment did.

ES investments increased until 2008, after which, following the onset of the recent crises, a decline set in. In 2011, total, ES, and ER investments only amounted to about 15%, 33%, and 9% of their 2000-levels. But even if 2011-levels are compared to the average levels of the entire preceding period (1989-2010), which thus includes both the boom and the bust of the dot-com bubble, total VC investments amounted to a

[57] I thus leave buyouts out of the calculation of total VC investments, since they are not VC investments; they are investments in *mature* companies. Bottazzi and Da Rin (2002, p. 239) make the same point, and Da Rin, Nicodano, and Sembenelli (2005, p. 16) prepare their data, which also comes from the EVCA, in a similar way. The Eurostat figures may overrate the volume of VC investments a bit, because they include replacement investments, which not necessarily always are typical VC investments.

meagre 44%. This can mainly be explained by depressed ER investments.

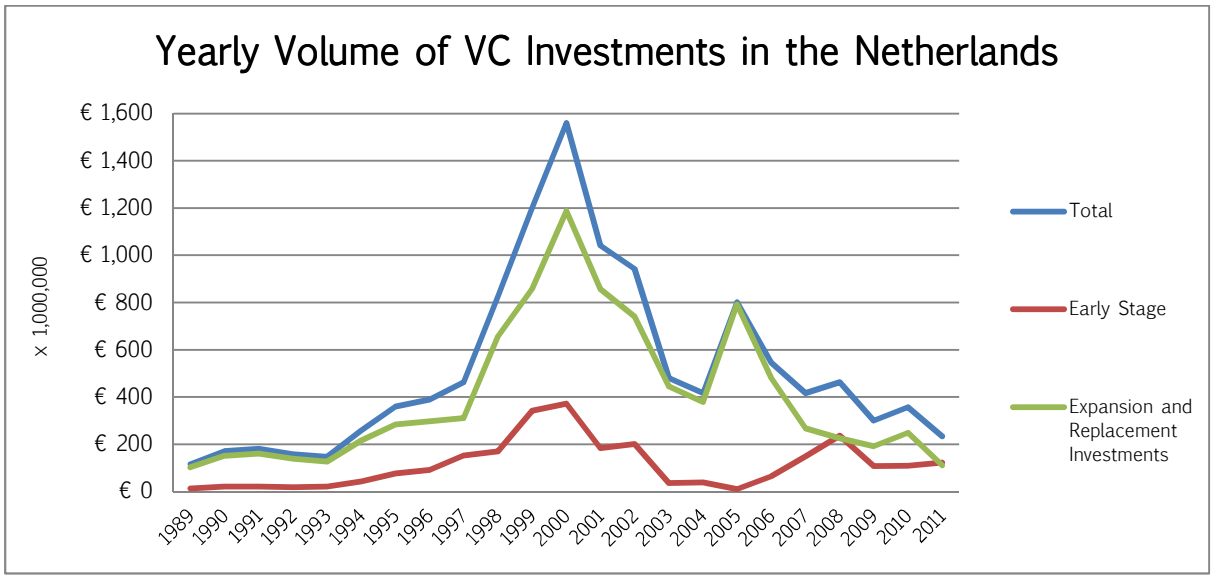

Figure 1.4: The graph shows the development of the Dutch venture capital market, and its two main components.

What strikes is that the different components of VC developed in distinctly different manners. From 1989 to 2000 both ES and ER were generally growing, but especially between 1997 and 2000 ER investments grew faster. Still, so far, a synchronisation seems discernible. This synchronisation disappears from 2003 onwards. ES investments hit rock bottom in 2005 at about €10 million, whereas ER investment were almost 80 times as high, at €792 million. In 2008 ES investments were *higher* than ER investments, which was the case again in 2011. Table 1.1 corroborates this further. It presents correlation figures for two growth measures of both VC investment components. At standard confidence levels they are not found to be correlated. This is surprising, because it might be expected that, to a certain extent, the different components move in a synchronised way.[58] Since apparently they do not, they might also be differently affected by environmental factors and have a need for different government intervention.

Correlations of VC Investment Growth Rates	
First Differences	*Percentage Changes*
35.11% (0.108)	-18.51% (0.409)

Table 1.1: Pearson product-moment correlation coefficients between growth measures of two different components of VC investments. Two-tailed *p*-values are shown between brackets.

Figure 1.5 shows the development of the total volume of investments received by Dutch firms, which may have been provided by foreign venture capitalists. The recent crises depressed VC investments, investments aimed at the start-up phase suffered less and later, and seed and later stage investments were depressed

[58] Firstly, they are both part of the larger market of VC, and secondly, investments in the early stage can spur firms to come into being, after which these firms may need expansion and replacement investments to keep growing.

more severely. Seed investments totalled €15.92 million in 2007, whereas for 2009 and 2010 *combined* they amounted to €6.44 million. Figure A.1.5 (p. 103) shows similar developments for VC investments made by Dutch venture capitalists.

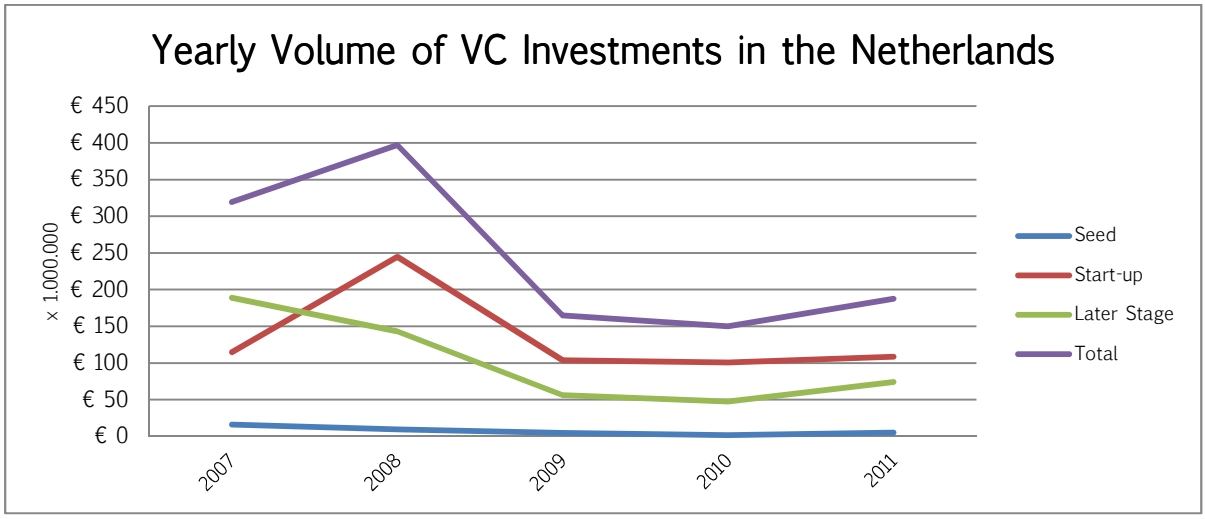

Figure 1.5: The yearly development of the total volume of VC investments received by Dutch firms.

Figure 1.4 seemed to convey that ES investments were not particularly affected by the recent crises; Figure 1.5 and Table 1.2 tell a different, more nuanced story by decomposing ES investments into seed and start-up investments. Firstly, the total volume of start-up investments dwarfs that of seed investments. Secondly, it is worth noting that seed investments were hit far more severely by the recent crises than start-up investments. In 2009 and 2010 only 4 and 3 Dutch firms, respectively, were allowed to further explore, assess, and work out (business) ideas and plans, which is worrisome.

Number of Investments and Recipient Firms											
		INDUSTRY					MARKET				
		2007	*2008*	*2009*	*2010*	*2011*	*2007*	*2008*	*2009*	*2010*	*2011*
# of investments	*Seed*	46	33	3	2	23	51	34	4	3	19
	Start-up	150	110	179	183	163	134	103	162	152	161
	Later Stage	77	60	80	66	66	65	59	78	73	63
# of firms	*Seed*	46	30	3	2	16	48	29	4	3	14
	Start-up	134	94	136	135	132	112	76	115	109	104
	Later Stage	70	49	69	53	48	59	41	61	44	36

Table 1.2: The table shows the number of VC investments by Dutch venture capitalists and the number of firms that received them ('Industry'), and the number of VC investments and the number of Dutch firms that received them ('Market').

Table 1.2 shows the number of VC investments and the number of firms receiving them per year. The numbers of start-up investments and firms receiving them seem not to have decreased dramatically. Depending on the taken perspective, they decreased by about 25% to 30% in 2008, but a year later 2007-levels were reached again. This holds for later stage investments as well. Seed investments seem to have suffered the hardest blow; in 2009 and 2010 only 3 and 2 investments, respectively, were made in as many firms by Dutch venture capitalists. It is hard to see how this could not strongly and negatively affect innovation, especially since in these years banks had to restrain the riskiness of their investments, and thus

could not participate in funding starting and growing (to-be) firms in the earliest stages as they could before. In 2011 improvement set in, with 14 Dutch firms receiving a total of 19 investments. It is remarkable that before the crises most firms received only one investment, whereas in 2011 a firm received on average 1.58 investments. This could indicate that venture capitalists have become a bit more careful, and would rather provide two smaller capital injections than one big one.

Section 1.1 mentioned that a belief exists that venture capitalism has suffered after the recent crises, and that governments need to step in. Table 1.2 nuances this. It shows that, apparently, investments in the start-up and later stage have not suffered so much, but seed investments have. This may indicate that if the Dutch government were to intervene, it should focus on the earliest stage of the VC cycle.

Let us now explore how the Dutch VC market developed compared to other European markets. To do so, the development of the size and intensity of venture capital markets will be investigated for every (European) country for which data was available. Here, we will consider the total volume of VC markets scaled by GDP levels, such that useful cross-country comparisons can be performed.[59] Three components will again be distinguished: early stage, expansion and replacement, and total investments, where the latter is the sum of the former two components.

Figure A.1.10 (p. 106) shows the development of the total volume of VC investments of 22 European countries and the aggregate EU15, and Table A.1.5 (p. 107) presents the corresponding first differences. It can be observed that until 2000 VC markets were growing steadily across all countries. The occurrence of the dot-com crisis is clearly visible, but the recent crises are even more obvious. Figure 1.6 is a simplified version of Figure A.1.10. The Netherlands was the absolute frontrunner with regard to VC intensity up to and including 2002. Then, the United Kingdom took over this role. During past years, Dutch VC markets were moderately active compared to other European countries.[60]

Figure 1.7 is a simplified version of Figure A.1.11 (p. 108) for the years 1995-2011. Before 1994 ES investments were not particularly sizable in the Netherlands, never climbing above 0.01% of GDP. The graphs show that from 1994 to 1998 the Netherlands was the clear frontrunner of investing in the early stage firms. During 1995, 1996, and 1997, ES investments as a percentage of GDP were at least *double* as high in the Netherlands as in any of the other countries. This classification had to be shared with Belgium and the U.K. during 1998, 1999, and 2000. After the burst of the dot-com bubble ES investment plummeted in all countries (even more so in the Netherlands) to rock bottom in 2005 when they amounted to only 0.002% of GDP. In recent years, save a peak at 0.04% in 2008, ES investment hovered around 0.2% of GDP, which is similar to the Belgian, French, British, and German levels, slightly below Scandinavian levels, and considerably above the Mediterranean countries' levels. In 2006, the U.K. experienced an exceptional surge in ES investments. After the recent crises hit, slight decreases in ES investments can be observed, with the notable exceptional increase in Luxembourg and decrease in the U.K.

[59] Following Eurostat (see http://ec.europa.eu/enterprise/policies/finance/data/enterprise-finance-index/access-to-finance-indicators/venture-capital/index_en.htm), GDP measured at current market prices will be used.

[60] Pierrakis (2010) describes trends for the U.K. that are similar to Dutch trends, such as lacking seed investments and fundraising.

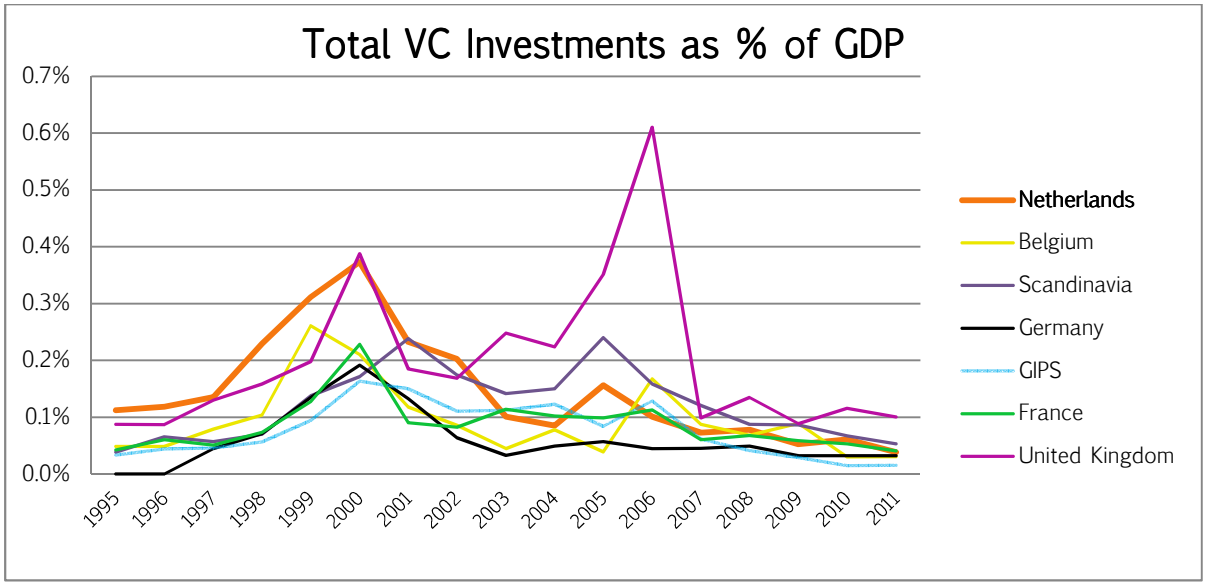

Figure 1.6: The development of the total VC investment volume, measured as a percentage of GDP. Scandinavia refers to Denmark, Sweden, Norway, and Finland, and GIPS to Greece, Italy, Portugal, and Spain.

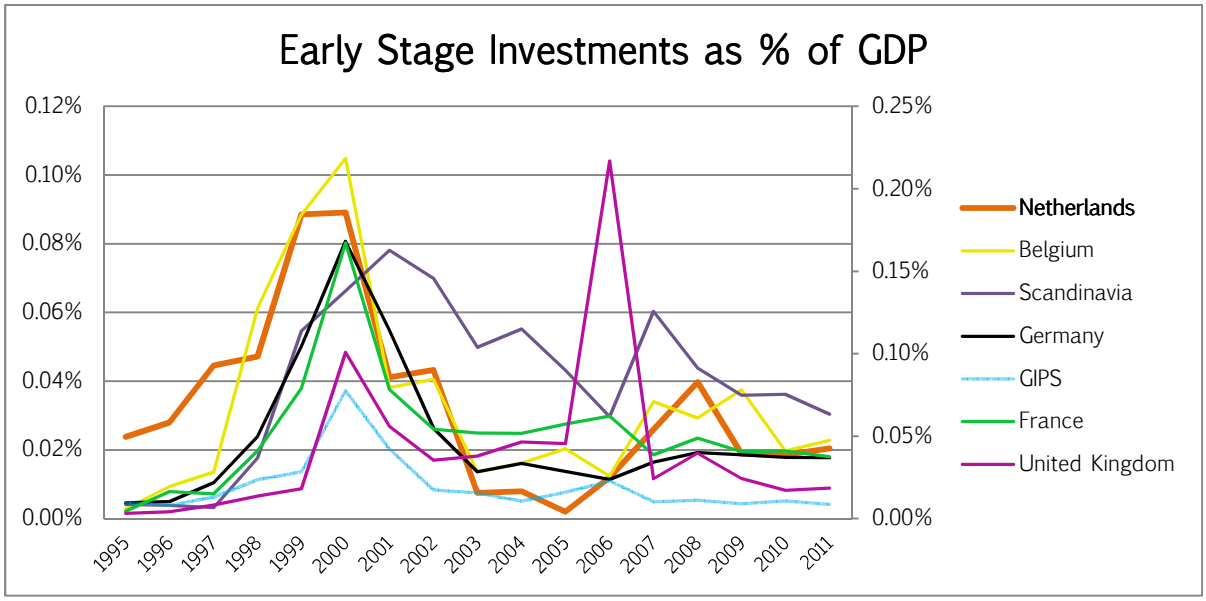

Figure 1.7: The development of the volume of early stage investments, measured as a percentage of GDP. For the United Kingdom the right vertical axis applies; for all the others the left axis.

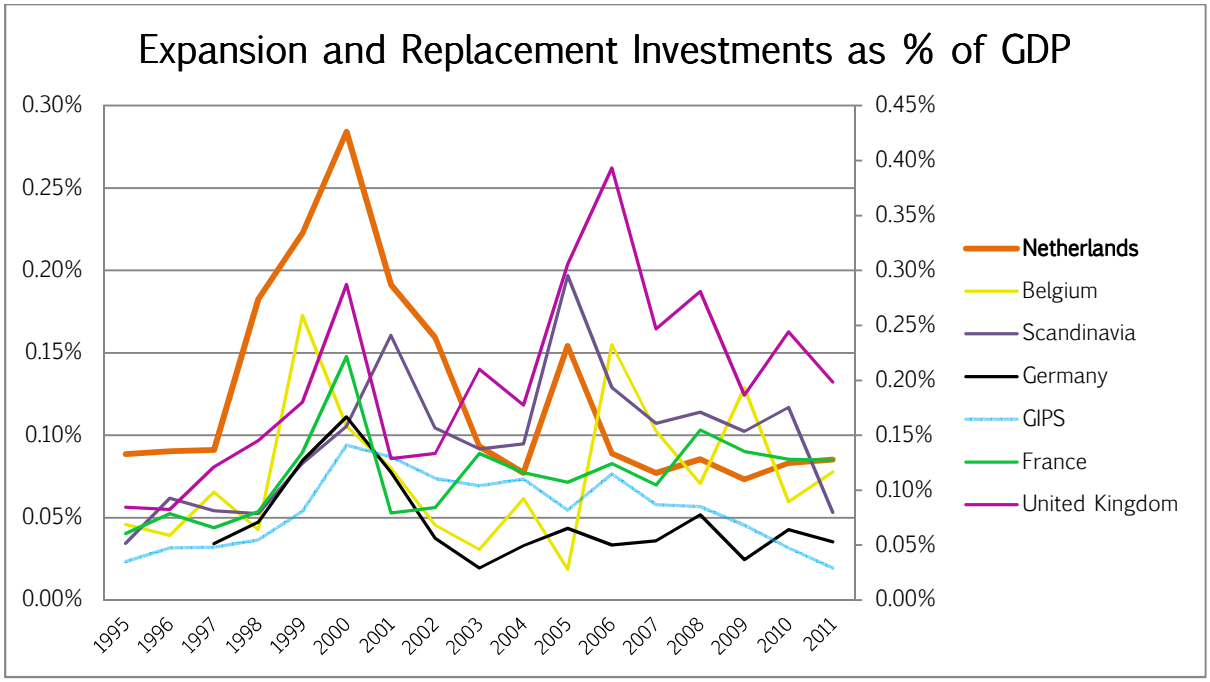

Figure 1.8: The development of the volume of expansion and replacement investments, measured as a percentage of GDP. For the United Kingdom the right vertical axis applies; for all the others the left axis.

Figure 1.8 is a simplified version of Figure A.1.12 (p. 109), for the period 1995-2011, and portrays the development of the total volume of ER investments, measured as a percentage of GDP. During the years 1995-2002 the total amount of ER investments was highest in the Netherlands and the U.K. As was the case with ES investments, afterwards Dutch ER investments declined relative to the other regions' levels. In recent years, the market has been dominated by the U.K. The Netherlands outperformed the GIPS countries and Germany, and the size of the Dutch market was similar to those of France, Belgium, and Scandinavia. In 2011 all countries had ER investment levels below 0.1% of GDP, except for the U.K. and Luxembourg.

The NVP dataset gives information on the distribution of investments over industrial sectors. Figure 1.9 shows that the most important sectors for VC seem to be the sectors of life sciences (33%), energy and environment (18%), computer and consumer electronics (17%), and communications (11%). Together, these sectors receive about 80% of all VC investments.

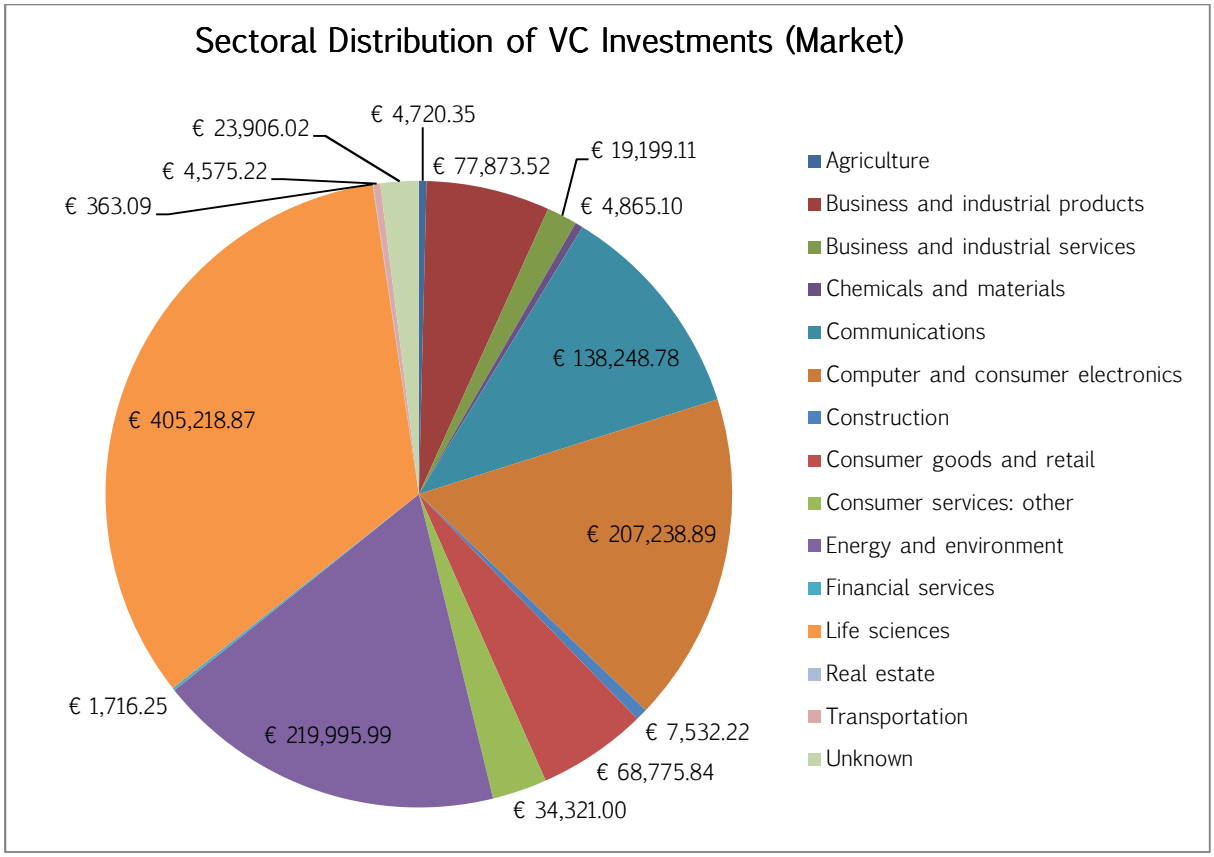

Figure 1.9: The sectoral distribution of VC investments in the Netherlands, based on volume, and according to the market perspective. The figures are cumulative with respect to the years 2007-2011, and are to be multiplied by 1,000.

Figure A.1.8 (p. 105) and Table A.1.6 (p. 110) show that the importance of these sectors, as measured by the total amount of VC investments they receive, has changed significantly over time. The life sciences sector became more important, receiving 20% of VC investments in 2007 and 63% in 2011, whereas the energy and environment sector has lost importance during recent years, as did the business and industrial products sector. These developments deserve attention from policy-makers.

Figure 1.10 shows that the amount of funds that were raised to be used as venture capital decreased massively after the onset of the recent crises. VC fundraising decreased nearly 90% from €765 million in 2007 to about €81 million in 2011. Figure A.1.4 in the Appendix shows a similar development for the development of the total amount of closing funds. In 2008, only one fund closed, which was an early stage fund worth €8 million. These developments are worrying, because if fundraising keeps faltering, investments eventually have to drop as well.[61]

Technically, divestments are not VC investments – they are not so much risky investments in (to-be) young and growing companies, as they are 'the way out' or 'exit' for venture capitalists. By divesting venture capitalists obtain profits and cut their links with the portfolio firm. The development of divestments is nonetheless important, because if venture capitalists perceive and experience that exiting profitably is more

[61] Block, Sandner, and De Vries (2010) also find that the recent financial crises induced a severe decline in funding. They argue that this led to a funding gap with regard to innovation.

difficult and less likely, it is reasonable to suspect that they might cut back on providing VC.[62]

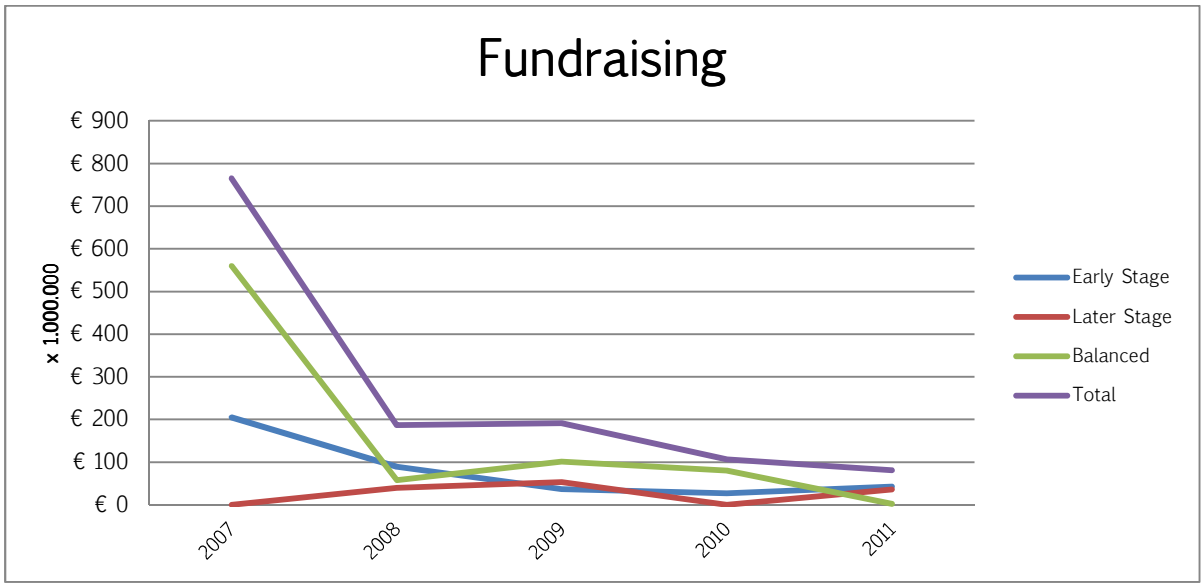

Figure 1.10: The graph shows the development of the amount of funds that were raised by venture capitalists. 'Balanced' refers to funds that are raised for both early and later stage investments.

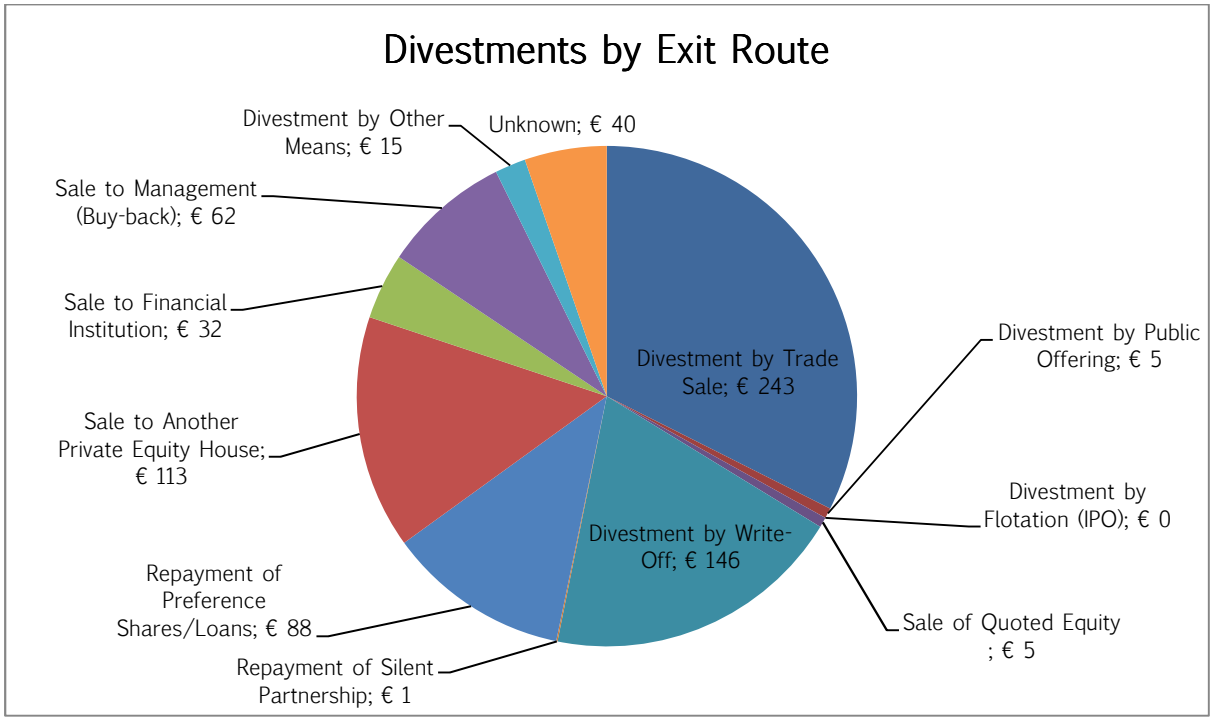

Figure 1.11: The distribution of VC divestments, based on volume, according to the market perspective, and by exit route. The figures are to be multiplied by 1,000,000.

Figure 1.11 shows that trade sales (32%), write-offs (19%), selling to another private equity house (15%), and repaying preference shares and loans (12%) are the most important exit routes used by Dutch venture capitalists. Remarkable is that during 2007-2011 *not a single IPO was used as an exit route*, even though

[62] De Swaan et al. (2011, p. 17), for instance, state that improved exit possibilities might stimulate early stage investments. They claim that informal investors that aided in their research emphasised that improving exit possibilities is crucial.

the literature emphasises the IPO as the most attractive exit route. Table A.1.7 (p. 111) provides more detailed figures on divestments by exit routes, including the number of divestments and the number of corresponding firms. Figure A.1.9 (p. 105) uses the data of Table A.1.7, and shows that in recent years the role of trade sales has gained importance. Write-offs, after a 2009-peak, has notably lost importance.

To summarise, some concluding observations may be drawn, which may be of interest to current and future government policy:

- Not a single IPO took place in the years 2007-2011 in the Netherlands, indicating that a liquid exit market may not be available for Dutch VC-backed companies.
- The Dutch, both regarding the total sum of VC investments and regarding their components, were frontrunners in the second half of the 1990s, but lost this position during the early 2000s.
- The components of VC investments developed in distinctly different ways, which means that they may also require different government interventions. Moreover, although all components suffered from recent financial and economic crises, the impact was highest on seed investments, which almost came to a complete standstill.
- After the recent crises, VC fundraising dried up almost completely.
- VC fundraising, investments, and divestments were depressed after the recent crises. Apparently, VC did not fill the gap left by banks in funding young, innovative companies; it even increased it.

These points all indicate that there is a role to be played by government policy.

2. Lessons from the Literature

Section 1.3 argued that VC can have desirable influences on national economies and societies by creating employment and long-term growth, positively impacting on productivity and thus on competitiveness, and raising living standards significantly and durably. This chapter will investigate whether there is a role for governments to shape VC markets actively (and if so, what kind of role), for two main reasons. Firstly, VC markets might already operate smoothly enough, and hence are not severely bothered by market failures and thus result in sufficiently high returns for private investors. Secondly, even if VC markets suffer from market failure(s), it might be the case that governments would fail even worse, or that remedying these market failures would be too expensive taking into account opportunity costs.

This chapter will investigate whether (recent) Dutch VC policies accord with the literature. Section 2.1 will describe relevant market failures and other reasons why VC markets may remain underdeveloped. Subsequently, Section 2.2 will explore the landscape of policy instruments, by deriving lessons from the theoretical and empirical literature. Section 2.3 will then describe the efforts of the Dutch government to foster venture capitalism, and discuss whether Dutch policy measures are in sync with what the literature recommends.

2.1 Reasons for Government Intervention: Market Failures and *Condiciones Sine Quibus Non*

Two main market failures are associated with venture capitalism. Firstly, since VC is often invested in potentially innovative products and services that could, as Section 1.3 argued, lead to positive externalities for society, underinvestment may be a problem if potential innovators cannot appropriate these societal gains. Here, the project may be 'profitable' from a societal (or public) perspective, but not from a private one. Secondly, it may be the case that projects are not funded even if they are privately profitable, for a multitude of information problems that will be addressed below. However, given the potential positive externalities for society, every factor that crucially impedes venture capitalism, and thus is a *condicio sine quibus non*, can to a certain extent be regarded as a market failure.

Thomas Hellmann is not alone in emphasising that many factors jointly enable a VC market to thrive. Figure 1 in Hellmann (2001, p. 114) provides a simplified oversight of the factors that, *together*, effectively stimulate venture capitalism. Firstly, a *liquid financial market* should provide exit opportunities for venture capitalists, since they will refuse to invest if they perceive that they cannot earn a decent profit. Secondly, *human capital*, being entrepreneurs, venture capitalists, and employees, should be present. Thirdly, *opportunities* should present themselves, which is related to, for example, technological developments and the presence of intellectual property rights. Fourthly, *supporting institutions* should provide the expertise of, for instance, lawyers and accountants. Fifthly, *government regulation* can affect the size and structure of the VC industry, especially through tax policies, regulation, and public support.

With a focus on Silicon Valley, Florida and Kenney (1988, p. 120) note that "fully blown venture capital-financed innovation generally takes place only in those areas which possess well developed technological infrastructures or what we refer to as 'social structures of innovation'".[63] They define these social structures of innovation to be

> integrative systems comprised of universities, technology-oriented enterprise, highly skilled labor, considerable public/private R&D expenditures, extensive networks of suppliers, manufacturers and vendors, support firms such as law firms and consultants specializing in high technology, strong entrepreneurial networks, and informal mechanisms for information exchange and technology transfer. (Florida & Kenney, 1988, p. 130)

Ronald J. Gilson zooms in on three aspects of the framework sketched by Hellmann. Gilson (2003, p. 1069) explains that a simultaneity problem must be resolved if a government wants to create a VC market, because "[t]hree central inputs are necessary to the engineering process: capital, specialized financial intermediaries, and entrepreneurs." He explains that "[t]he problem is that each of these inputs will emerge if the other two are present, but none will emerge in isolation of the others."[64]

Hellmann (2001), Florida and Kenney (1988), and Gilson (2003) are thus examples of authors who seem to emphasise that *condiciones sine quibus non* exist. The critical insight is that *all* mentioned factors must be present to a sufficient extent, because if one of them is lacking, an active and healthy VC market will not flourish.[65]

A consequence is that active VC markets might fail to develop for a multitude of reasons or 'market failures'. These market failures can be categorised according to *where* they occur (on the demand-side, on the supply-side, or in the environment in which demanders and suppliers interact) and *when* they occur (in the seed stage, start-up stage, or growth stage).

Section 1.3 has been devoted to what is perhaps the most prominent market failure associated with VC markets, which takes place on the demand-side: *positive externalities* for society. This results in a market failure if the innovator (i.e. the potentially VC-backed firm) cannot appropriate the societal return on its investments.[66] For instance, assuming away several kinds of uncertainty problems and other market failures, it might be the case that a certain VC investment of €1,000,000 would result in benefits to society that are somehow valued at (a present value of) €2,000,000, of which only €500,000 would come to the benefit of the innovator. The investment has a positive return for society, namely €1,000,000, but the innovator will not undertake it because otherwise he would face a *loss* of (€500,000 - €1,000,000 =) €500,000. This results in a suboptimal situation of underinvestment and 'an undersupply of innovations'.[67]

This market failure can be analysed in terms of *public goods*. A public good is a good that is non-rivalrous

[63] See also Dimov and Murray (2008).

[64] See also Reid and Nightingale (2011).

[65] A more recent work with a similar argument is Reid and Nightingale (2011, p. 12), who add that such indispensable factors should be present for a prolonged amount of time.

[66] Geroski (1995).

[67] Greenhalgh and Rogers (2010).

and non-excludable. A good is non-rivalrous if its consumption by someone does not reduce its availability to others, and non-excludable if, after its creation, people cannot be prevented from consuming or benefiting from it. Innovations, especially those pertaining to knowledge, are to a large extent public goods.

Problems on the supply-side entail that capital is not provided, sometimes despite good VC investment opportunities, and are issues of imperfect capital markets.[68] Such a situation, in which entrepreneurs and profitable innovations are present, but enough funding is not, is often referred to as a *funding gap*. Several possible causes for a funding gap exist. Greenhalgh and Rogers (2010, pp. 21-22) describe that *indivisibility* and *uncertainty* imply that competitive capital markets are not likely to provide the capital.[69] If capital markets would be efficient, capital would be provided if a project is sufficiently profitable, even if the volatility (or risk) is judged to be high, since portfolio diversification could mitigate this risk. But innovations are inherently uncertain – this is why VC-seekers often have to rely on venture capital in the first place – and the costs of finding out more about the innovator and his or her plans may be too high. Available risk capital may thus fail to find its way to profitable investments, which constitutes a market failure. Lindstrom and Olofsson (2001) find that the uncertainty problems are particularly acute in the early stages of development.

Part of this uncertainty stems from *information asymmetries*.[70] Not only the innovation itself (i.e. the product or the service) should be in order – the innovator is a source of uncertainty as well. Firstly, *adverse selection* may be an issue since it can be expected that among those seeking VC are those who know that their potential innovation is not as good as they convey it is.[71] Secondly, *moral hazard* looms, and occurs when the innovator misuses the capital that is provided by venture capitalists, for instance by driving fancy company cars for private purposes, instead of using the money to optimally develop the innovation. Keuschnigg and Nielsen (2004, p. 1012) note that "superior knowledge about the firm creates a possibility for opportunistic behavior that puts the investor's money at risk" and that this "is particularly severe in the case of young innovative firms."

Moral hazard also looms the other way around.[72] Arrow (1962) explains that selling knowledge is a tricky business because the most effective way to communicate the value of the information is to disclose it – but then it cannot be sold anymore. The ensuing literature, and Arrow himself, argue that *intellectual property rights* (IPRs) can work as a solution, but here comes the crux: inventors often need VC to develop their ideas to eventually file for a patent, not in the least because to most standards filing for patents cannot be considered inexpensive.[73] IPRs can thus be used to protect inventors *after* they deal with possible funding parties, but not before. As a matter of fact, the number of patents is actually used to measure the *output* of innovation policies and markets.

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[68] Hall (2002).

[69] See also European Commission (2000).

[70] See e.g. Gompers and Lerner (1999a) and Hall (2002).

[71] See European Commission (2000).

[72] This is markedly illustrated by the extremely mistrustful inventor Jan Sloot in Smit (2004). See also Keuschnigg and Nielsen (2004), Casamatta (2003) and Inderst and Müller (2004).

[73] See e.g. Reid and Nightingale (2011) and Tykvová, Borell, and Kroencke (2012).

Mason and Harrison (2002) seem to disagree with the severity of the funding gap on the supply-side (for the U.K.). They conclude that enough finance is available. Rather, they argue that business angels "do not see enough deals that meet their investment criteria" and that "the majority of the investment proposals that they receive are of poor quality" (p. 271). They argue that entrepreneurs who might actually have profitable projects do not understand how to get equity finance. Therefore, a need exists to "educate entrepreneurs on the advantages of equity financing", which "involves helping entrepreneurs to understand the expectations and requirements of investors and how to make their business plans into attractive investment opportunities".[74] The market failure could thus be a case of ignorance on the part of entrepreneurs. Dimov and Murray (2001, p. 2) moreover indicate that most studies investigating this gap are based on "large scale surveys measuring the verbalized attitudes of SMEs towards their financing environment", which have "severe methodological and empirical constraints." They point out that no uniform conclusions exist; they vary across countries and across types of (small) firms.

Hellmann (2001), as indicated above, and Black and Gilson (1998) note the importance of a liquid financial market. Jeng and Wells (2000, p. 286) corroborate this when they confirm "the value of having a well-functioning exit mechanism in the form of a strong IPO market." Thus, a market for VC might fail to develop, despite opportunities, suitable entrepreneurs and venture capitalists with available risk capital, because a well-developed financial (stock) market is absent.

As stressed in Subsection 1.3.1 and also articulated by the European Commission (1999), barriers to the development of risk capital (and thus also VC) markets may be cultural. A certain region may have a culture that is strongly risk-averse, which would impede venture capitalism, because VC investments are directed particularly towards young and *risky* firms. Also, a region might lack an 'entrepreneurial culture'. For example, scientists, after having discovered something with potential market value, might not know how to market their discoveries. However, I think it is difficult to describe such cultural barriers in terms of market failures.

Greenhalgh and Rogers (2010, p. 22) discuss another market failure that is different from the already noted ones in that it is not the problem that available capital does not reach potentially profitable projects. *Duplication* "concerns the fact that firms may compete head-to-head in the innovation process". In a patent race several parties invest in a similar field of innovation, where the winner, that is, the party that succeeds in developing the innovation first, takes all the returns. If this failure is severe, it might be desirable to internalise the effects, for instance by conducting research together.

Finally, a 'Catch-22' seems to exist; many authors, based both on theoretical and empirical grounds, argue that a geographical or concentration factor is present. VC investments are expected to be profitable and value-adding if the venture capitalist and the firm receiving VC are located in a region that is characterised by high VC-activity, because such a region likely has the necessary complementarities.[75] This relates closely to the social structures of innovation from Florida and Kenney (1988), mentioned earlier in this subsection.

[74] Mason and Harrison (2002, pp. 284-285).

[75] See e.g. Simmie (2005). Langeland (2007, pp. 1147-1148) specifically explores the innovation advantages of cities.

The Catch-22 is that accumulated experience and expertise are needed to foster VC investments,[76] but these are accumulated particularly through earlier VC investments. Logically, this seems to be equivalent to a statement like 'VC investments *do* not occur, because VC investments *did* not occur'. The question is thus how to start this cycle – how to jumpstart VC investments that will spur subsequent investments.[77]

This Catch-22 might be seen in a broader perspective, as Gilson (2003) seems to do. If several factors needed for an active VC market are absent, then a VC market will not thrive. But, importantly, there is no strong incentive for a separate factor to invest in developing itself, since it needs the presence of all the other factors. This is a simultaneity or coordination problem: each individual factor might be developed, but this will only happen if it is ensured that all other factors will be developed as well.

2.2 Instruments of Government Intervention: A Survey of the Theoretical and Empirical Literature

The previous section discussed the most prominent and relevant market failures and barriers to the development of VC markets. This section will focus on the instruments governments can use to address them. Moreover, this section will explore the literature for empirical evidence on the effectiveness of these instruments. A successful government policy is not only about the effectiveness of separate instruments; it is eventually about the effects and effectiveness of the entire mix of utilised instruments, which is why national policies are considered as well. The goal of this section is to derive lessons for Dutch VC policy, which will be applied in the next section.

Policy measures to cope with the problem of public goods come in many shapes. In the hypothetical example (without uncertainty) mentioned earlier in this chapter a government could tax its citizens for, say, €750,000 and transfer this capital to the innovator. This way, engaging in the investment would increase the (net present) wealth of the innovator by (€750,000 + €500,000 - €1,000,000 =) €250,000 and of society (excluding the innovator) by (€2,000,000 - €500,000 - €750,000 =) €750,000. The problem is, of course, uncertainty; innovations and their profitability are by nature unpredictable.[78] Such measures, where a government taxes or subsidises activities that result in negative respectively positive externalities, can be traced back to 1920 and Arthur Cecil Pigou, after whom *Pigo(u)vian taxes* are named.[79]

Keuschnigg and Nielsen (2002, p. 177) is "the first paper to investigate the consequences of tax policy for the quality of VC finance and the equilibrium level of start-up entrepreneurship." They derive conclusions from a general equilibrium framework model for several possible tax instruments. They find that

> capital income (capital gains) taxation strengthens incentives for advice but reduces the number of entrepreneurs while a wage tax holds opposite incentives. A uniform income tax is neutral on all margins,

[76] See e.g. Dimov and Murray (2008), who emphasise the importance of, among other aspects, the vintage year, size, and expertise of VC funds.

[77] See also Avnimelech, Rosiello, and Teubal (2010), who discuss this in terms of emerging clusters, and Martin, Sunley, and Turner (2001).

[78] See Arrow (1962).

[79] See Pigou (1932).

> distorting neither occupational choice nor incentives for advice. Progressive taxation, however, that uses a proportional (consumption based) income tax to pay for uniform per capita transfers, retards entrepreneurship and the expansion of innovative industries. Output and investment subsidies to start-up firms both stimulate entrepreneurial activity.

The strength of their conclusions may be troubled a bit by the assumptions they (have to) make for the model to work, but it is strong in that it considers multiple tax policy instruments that sometimes have opposing effects. Keuschnigg and Nielsen (2004, p. 1033) find that "the capital gains tax could indeed be a major impediment to the development of a high quality venture capital industry that significantly adds value to young innovative firms", and that lowering this tax results in improved incentives.[80] Poterba (1989) explains that lowering the capital gains rate increases VC investments by increasing the supply of funds and the supply of entrepreneurs. He finds that the latter effect is especially significant, because these "taxes have an important impact on the incentives of entrepreneurs and other employees of start-up firms who forego wage and salary income and accept compensation through corporate stock and options" (p. 47). He warns that encouraging VC investments by lowering the capital gains rate universally is blunt, because (at the time of his writing, but still so at the time of my writing) the vast majority of capital gains do not stem from VC investments. More recently, (e.g.) Gompers and Lerner (1999b) and Jeng and Wells (2000) confirm that lowering (capital gains) taxes increases VC investment activity. The persuasiveness of the arguments is large given that many countries have indeed lowered capital gains taxes. Da Rin, Nicodano, and Sembenelli (2005, pp. 10-11) note that reforms aimed at lowering the effective taxation have been introduced in, among other countries, the U.K., France, Germany, the Netherlands, and Spain.

IPRs, such as copyrights and patents, can be used to fight appropriability problems.[81] If an innovator receives IPRs for his or her innovation, than it is prohibited for everyone else to use or recreate this innovation for commercial ends if it would break the rules of the IPRs, unless explicit consent is given by the original innovator. A tension exists between full and everlasting IPRs, and no IPRs. Having no IPRs is inefficient because appropriability difficulties will arise, which remove powerful incentives to innovate. Everlasting IPRs are also detrimental, because the central idea of sustained economic growth fuelled by innovation is that knowledge and improved practices, at some point, become available to the whole of society. Additionally, it would put the innovator in a monopoly position, which could lead to inefficient outcomes.[82] Therefore, in practically every country a compromise can be found: IPRs that last a limited amount of time, which allow the innovators to earn returns on investments, but which ensure that in time the innovation becomes available for everyone to benefit from it.

Public production of innovation is a drastic measure to cope with incentive and externality problems. Public production refers to a situation in which researchers are publicly funded and are obliged to make their results available to the market almost instantaneously. Greenhalgh and Rogers (2010, p. 23) indicate that this is especially relevant for basic research, which is notably non-excludable and of which the effects on economic actors and society as a whole are particularly uncertain.

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[80] See also Keuschnigg (2004).

[81] Coase (1960) is the most-cited, early work arguing that IPRs could be used to deal with externalities.

[82] Greenhalgh and Rogers (2010, p. 27).

A less radical measure than public production is (facilitating) internalisation. With internalisation an attempt is made to internalise the externalities; that is, to align incentives by ensuring that externalities (largely) come to the benefit of the innovator.[83] Examples are research centres of companies, as well as joint ventures between scientists and companies. Adams and Marcu (2004, p. 22), after investigating 220 laboratories of 115 firms in the chemicals, machinery, electrical equipment, and motor vehicle industries, conclude that "[Research Joint Ventures] significantly increase innovation".[84]

If market failures result in too little available risk capital, then instead of fixing the market failures, it might be an option to compensate for them. Dimov and Murray (2008, pp. 148-149) note that "[g]overnment policy has generally addressed equity gap issues by creating and supporting new funds with a specialist focus on equity investment." Governments may compensate rather directly by using subsidies, loans, or participations. Less direct ways concern efforts to induce others to provide (more) VC, for instance through reduced taxes on income generated by innovative activities or by issuing guarantees.

A simple but potentially expensive policy measure is to provide capital in the form of subsidies. Lerner (1999) finds that the U.S. *Small Business Innovation Research (SBIR)* programme had a positive long-term effect because "SBIR awardees grew significantly faster than a matched set of firms over a ten-year period".[85] Subsidies may, however, not be ideal because governments do not possess the unique expertise of screening good projects and guiding good ideas towards a profitable enterprise, which traditional venture capitalists do possess. Moreover, providing loans might crowd out private investments.

A variation on subsidies comes in the shape of loans. They work the same as subsidies, except the receiving firms are required to pay back the received amount of capital. Loans, however, run the risk of *crowding out* private funders.[86] That is, it might be the case that firms receiving government subsidies or loans would otherwise have received private capital as well, albeit likely at less advantageous conditions. It might therefore be even less attractive for those possessing risk capital to enter the VC market. For instance, Brander, Egan, and Hellmann (2008) suggest that crowding out and less effective guidance explain that Canadian government-sponsored VC-backed firms underperform with regard to value-creation and innovation. Brander, Du, and Hellmann (2010), using international company-level data, find that modest government subsidies improve the performance of venture capitalists, but that large subsidies significantly depress performances. Contrary to Brander, Egan, and Hellmann (2008) they find that firms funded by government-sponsored venture capitalists create more patents.

Because of the aforementioned drawbacks, guarantees might be more appropriate than subsidies and loans. With guarantees, governments promise to compensate venture capitalists up to a certain amount or percentage for the loss they incurred in the case of a failed VC investment. The expertise of venture capitalists is thus retained, and incentives are kept better aligned, since venture capitalists will not be

[83] Internalisation is best known for dealing with *negative* externalities, and specifically pollution.

[84] See also Kogut (1991).

[85] Lerner (1999), however, does not seem to address important additionality questions, such as: Is the net present value of the value derived from the quicker growth of such companies indeed larger than that of the SBIR grants?

[86] Wallsten (2000) for instant provides evidence for crowding out effects in the case of the U.S. Small Business Innovation Research (SBIR) program.

guaranteed the total amount of the VC investment. An example from the Netherlands is the *(B)BMKB* (*Borgstelling MKB Kredieten*) programme, through which the government guarantees loans to firms that have problems securing financing from banks due to the lack of collateral, where more favourable conditions apply for starting and innovating companies.

A similar policy measure is for governments to take a stake in VC projects (or in funds that provide VC) using participations. Governments provide capital and receive ownership shares of VC receiving firms or of VC funds. This may be effective if a true funding gap exists when some venture capitalists are present who shy away from providing the total amount of capital a certain young firm requests.[87] A drawback is that someone has to decide in which projects to invest, which is an expertise of venture capitalists but not necessarily of government officials. This is why in many countries participations, shaped as co-investments, are kept below a maximal level, such that the expertise and incentives of venture capitalists are retained.

A non-financial way (i.e. a way in which the government does not directly pay for compensation) to compensate for market failures and address the funding gap is to persuade or require institutional investors like pension funds to invest (more) in the VC market. For the U.S., Gompers and Lerner (1999b, p. 35) find that the easing of pension fund restrictions – pension funds previously had to invest as a 'prudent man' – increased the number and total amount of VC investments significantly. Jeng and Wells (2000, p. 241) find that "[p]rivate pension fund levels are a significant determinant over time but not across countries."

With regard to the geographical argument that venture capitalism will only or particularly flourish if several complementary factors are present locally, Gompers and Lerner (1999b, p. 35) indicate that "[c]ountries that wish to promote venture capital activity may consider concentrating efforts rather than spreading resources uniformly around the country." Thus, in addition to picking the right policy measures, it is also important to implement them at the right place. Lerner (1999), for instance, found that the "positive effects of SBIR awards [in the U.S.] were confined to firms based in zip codes with substantial venture capital activity", thus indicating that subsidies (named 'grants') were only effective if they were awarded to firms located in a VC-intensive region. Pinch and Sunley (2009, p. 329), focusing on knowledge dissemination, acknowledge the location effects when they recognise "the importance of a dense cluster of both entrepreneurs and locally based VCs", following their study of the Southampton area in the U.K. Langeland (2007, p. 1143) notes similar conclusions for Norwegian cities, which "have specific innovation advantages which reduce transaction costs associated with venture capital investing."

The related 'Catch-22' issue is, as is widely applauded, solved by the Israeli government with the introduction of its *YOZMA* (Hebrew for 'initiative') programme. In addition to lowering capital gains rates,[88] the government provided $100 million for a so-called fund-of-funds, which is a fund that invests in VC-funds who in turn invest VC in innovative firms. The *YOZMA* programme appealed to investors, because the government would provide 40% funding for projects, but they could be bought out by private parties up to

[87] A successful example is the Israeli *YOZMA* program, which will be discussed later on.

[88] Additionally, Jeng and Wells (2000, p. 280) note that "the Israeli government enacted a temporary legislation allowing tax-free investing in Israeli venture capital funds by foreign venture funds".

five years after the initial investment. Gilson (2003) notes that the *YOZMA* programme was successful because it used the lesson from American experiences that incentives should be preserved or set right. Contributions from the *YOZMA* programme namely "increased [the] incentive [of private investors] to assure that the portfolio companies were carefully monitored" but "provided no guarantee against loss"; moreover, "[i]nvestment decisions were made by those who bore the investment's risk and return".[89] Gilder (2009) claims that (in 1999) Israeli economic growth was for (an almost literally unbelievable) 70% attributable to high-tech ventures.

The *YOZMA* programme can, however, not exclusively claim the credits for the successful jumpstart of the VC market in Israel. The programme played a role mostly on the supply-side – it incentivised (domestic and foreign) investors to supply VC. But another major explanatory development was present on the demand-side. Namely, before and during the *YOZMA* programme a massive stream of high-tech scientists entered Israel as immigrants, stimulating the demand for VC.[90] This does indicate that the *timing* of the *YOZMA* programme was right,[91] and that supply-side policies alone will not jumpstart a VC industry. Jeng and Wells (2000, p. 282) agree that the *YOZMA* programme should not be considered in isolation, because even though "the government has played an important role in nurturing the industry, Israel's strong equity markets, and cultural and institutional factors, have allowed venture capital to prosper." In any case, the *YOZMA* funds have been privatised and a high-tech industry is flourishing in Israel, being a fertile environment for venture capitalism – implying that the government could (and did) take a step back.

Mason and Harrison (2002) point out that many entrepreneurs that do have profitable innovative projects fail to get funding because they are uneducated about the demands of venture capitalists. Strommer and Lipper (2006, pp. 14-15) identify eight types of state-sponsored VC programmes that have been implemented by U.S. states, of which two seem to address such problems: 'Mobilizing Angel Networks' and 'Matchmaking Services'. Such programmes are aimed at educating entrepreneurs, and try to bring them into contact with venture capitalists. However, as they indicate in the end, "more study is needed to determine precisely what these programmes have accomplished" (p. 24). Collewaert, Manigart, and Aernoudt (2010) investigate whether the subsidisation of business angel networks (BANs) in Flanders is warranted. They find that it is strongly warranted, and indicate that "[e]ach euro of government subsidies spent on the Flemish BANs generated an estimated [staggering] €85.39 in value added" and "that each euro of government money spent on the BANs generated a direct return of €1.03 in taxes" (p. 126). They conclude that "clear evidence is found of BANs reducing information and financing problems of entrepreneurial companies" and that the effects are in fact additive.

With regard to cultural barriers that might impede venture capitalism, a report written under the auspices of the Dutch Bureau for Economic Policy Analysis (the CPB) calls for the provision of preconditions for entrepreneurship in academia. This way, "[p]rofessional guidance and technical assistance of scientists with

[89] Gilson (2003, pp. 1097-1098). Gilson calls the contributions from the *YOZMA* programme subsidies, but using the terminology adopted here they represent a type of participations.

[90] See Jeng and Wells (2000).

[91] See Avnimelech and Teubal (2003).

marketable inventions can help to commercialise public research".[92] Similarly, Bygrave and Timmons (1992) call for active government policy (from the U.S. government) to make national attitudes and culture more VC-friendly. Strommer and Lipper (2006, p. 15) describe 'Culture Bending Initiatives' that have been implemented in the U.S. states of North Carolina, California, and Pennsylvania. They report that such initiatives have successfully aspired entrepreneurs and helped "young people gain the courage to venture" (p. 20).

Irwin and Klenow (1996) describe a case where the duplication issue, as described (later) by Greenhalgh and Rogers (2010), was successfully dealt with by fourteen U.S. semiconductor producers by forming a joint researching venture called Sematech. They conclude that this means that government subsidies are not legitimised, because it did not lead to higher investments with spill-over effects, but predominantly to lower R&D expenditures. It is doubtful, however, how relevant duplication issues and adequate policy measures to fight them are for the VC market, since the innovations financed by VC are of a disruptive nature, and not so much a result of concentrated R&D expenditures as was the case with Sematech.

Government policies are not often easily recognised to have one of the above-mentioned shapes, because many combine several financial and non-financial measures. An invaluable supply of literature is provided by Ricardo Tejada and Günseli Baygan, who in 2003 investigated VC policies of the United Kingdom, Korea, Israel, Canada, Denmark, Sweden, the United States, Norway, Portugal, and Spain. These studies, and some supplementing ones, are reviewed in Section A.2 (p. 112 and further) in the Appendix.

Summarising, for most countries Baygan and Tejada recognise the problem that Tykvová, Borell, and Kroencke (2012, p. 11) describe as the "high fragmentation of the VC industry across national boundaries." Baygan and Tejada therefore recommend that the scope of stock markets should be increased by linking smaller stock exchanges, by liberalisation, and by creating common markets. They emphasise that governments can successfully jumpstart VC investing using all kinds of measures, including loans, participations, and guarantees,[93] but that strong government involvement risks crowding out private funding. Therefore, it is important to scale back or privatise government programmes as soon as possible, to ensure that incentives are kept aligned and to ensure that expertise is created and retained. For such reasons, tax incentives and leveraging private investments are preferred to subsidies and direct financial support, where subsidies have notable incentive distorting effects. For all countries they recommend or praise the reduction or removal of restrictions on institutional investors such as pension funds, which are or can be important suppliers of VC. Furthermore, simplicity and complementarity of government policies contribute to a better entrepreneurial (and hence VC-friendly) environment. Almost all countries succeed to a significant extent to stimulate expansionary, later stage VC investments, but largely fail to cater to smaller and starting companies.[94] Baygan and Tejada finally stipulate that many VC-markets suffer from cultural barriers such as risk-averse attitudes. They advise adapting such attitudes, but for logical reasons they do not offer concrete recommendations.

[92] Canton et al. (2005).

[93] See also Chapter 3 of EVCA (2010).

[94] Tykvová, Borell, and Kroencke (2012) confirm this.

More recently, Duruflé (2010), under the auspices of the Canadian venture capital and private equity association (CVCA), offers international comparisons of VC policies. He specifically looks into the policies of Australia, Canada, France, Germany, Israel, New Zealand, the United Kingdom, and the United States. Most conclusions do not significantly differ from those drawn by Baygan and Tejada seven years earlier. Moreover, countries seem to have followed policy directions as those formulated by Baygan and Tejada. Duruflé (2010) stipulates that governments should ensure that their VC policies are designed such that they can adapt to the relevant economic environment and that regulatory capture is avoided. Policy measures are increasingly indirect and 'arm's length' interventions. Instead of engaging in VC investing directly, governments invest in private funds, leverage private investments, or let an independently managed fund-of-funds invest in subsequent VC funds, hereby retaining and nurturing management expertise and preserving the right incentives. This way, several variants of co-investing have been implemented, with varying successes. Duruflé (2010) notes that except in the U.S. hardly any funds have been raised without government support. Tax incentives have been found to be effective, particularly in the United Kingdom, France, and Canada. Countries have adapted policies, for instance by removing fiscal barriers, to fuel the inflow of foreign VC. It has been recognised, as Baygan and Tejada indicated, that the demand-side (the entrepreneurial climate) needs to be improved, although policies aiming to do so have generally failed to do so to date.

What is new, is that Duruflé (2010, p. 15) indicates that co-investment funds, which have been implemented in Australia, France, Germany, Israel, New Zealand, and parts of Canada, are the most common countercyclical policy measure. Additionally, Duruflé (2010, p. 17) argues that the role of angel investors has increased,[95] because it has been recognised that "they not only provide funding (supply-side) but also experience, credibility, contacts and connections that improve the flow of high-quality firms available to the VC sector (demand-side)." This leads governments to back business angel networks, and provide and strengthen incentives by offering tax credits to and co-investing with business angels. Also, it has been recognised that European countries do not so much underperform in public and/or private R&D, but more so in the commercialisation of technological developments.

In a recent study, Tykvová, Borell, and Kroencke (2012) confirm most of the determined diagnoses described above. They emphasise that legal environments differ from country to country, which explains and reinforces the fragmentation of VC markets. This "hinders mobility of venture capitalists" and "results in markets that are too small for institutional investors" (p. 12). Also, they point out that double taxation is a problem, which should be taken care of to allow for cross-border venture capitalism. With regard to the climate for entrepreneurship, it is noted that insolvency treatments should be improved, so that serial entrepreneurship is enabled. Tykvová, Borell, and Kroencke (2012) corroborate that most of the VC-activity in Europe in some way depends on government funding, thus representing a significant equity gap. They praise the leveraging of private VC as opposed to just providing subsidies or loans. A lack of expertise is argued to be a problem, and hence it is recommended that policy measures should help to develop this, for instance through facilitating business incubators, coaching, and mentoring. They recommend forming

[95] See also Pierrakis and Mason (2008).

large funds-of-funds, with sufficient expertise. Also, large corporations should be involved more in policy initiatives, and obtaining IPRs should be made easier and cheaper.

EVCA (2010) corroborates most of the described findings, but disagrees with some others. Agreements pertain to the fragmented European stock market environment, the effectiveness but also the need for harmonisation of tax reliefs, the lack of venture capital expertise, the creation of funds-of-funds, the removal of barriers to cross-border VC investments, and making obtaining IPRs easier and cheaper. A notable disagreement emerges, since "EVCA believes that the lack of investment by private investors in venture capital is *not* a cultural issue or a reflection of the fact that European institutional investors might be overly risk adverse but rather a structural problem and can therefore be resolved" (p. 3).[96]

Lerner (2009) notes that government policies are of crucial importance. He stresses that government intervention has for instance been largely responsible for the success of Silicon Valley. The main message that Lerner seems to want to get across is that despite such successes significant government funds and efforts have been (needlessly) wasted. VC market policies were often half-hearted and uninformed, suffering from 'a lack of understanding for the entrepreneurial process' and 'poor design'. More concretely, Lerner emphasises that it is better to have a smaller number of VC projects if the alternative is a larger number of undercapitalised VC projects. Moreover, government policies should be (more) focused on the long term, and not expect a positive return too quickly, because it takes time to develop and market innovations.[97] Follow-up investments should be allowed and the "investment mandate cannot be too rigid with respect to how much one can invest in one specific case", because "[t]oo strict limitations on the allocation of capital to each portfolio company will reduce the fund's ability to follow up projects that often require substantial investment in the later stages".[98]

Finally, a last innovation in VC policies concerns crowdfunding, which "refers to the collective efforts of individuals who pool their resources through networking to support efforts initiated by other people or organizations".[99] Young entrepreneurs can advertise their ideas and specify the amount of capital they are looking for, practically always via the Internet. Individuals can then decide to invest a small amount in the project. In some cases investors obtain a share of the equity (until recently this was not allowed in the U.S.), and most of the times they are promised a share of (potential) future returns. Crowdfunding originated in the U.S., where it gained popularity after the onset of the recent crises. Greenwald (2012) notes that the impact is significant; by itself, the New York-based *Kickstarter* website, started only in 2009, raised about $100 million last year – equivalent to 10% of the total of U.S. seed investments.

Government policies with regard to crowdfunding are young or non-existing. In April 2012 President Obama signed into law the *Jumpstart Our Business Startups* (*JOBS*) *Act*, which is supposed to ease regulations for young companies to attract small amounts of capital from investors, and to allow private companies to sell equity shares to small investors. Although crowdfunding has also gained popularity in the past two years in

[96] My italics. I suppose the authors meant to refer to risk *averseness*.

[97] See also Tabarrok (2010).

[98] Grünfeld, Iversen, and Grimsby (2011, p. 5). See also Reed (2010, p. 83).

[99] Ross (2012, p. 65). See also Dell (2008).

the Netherlands, it is too soon to judge about its effectiveness and potential effects on the economy, and thus too soon to derive a 'lesson' from it.

Recent developments are nevertheless promising. Significant amounts are already collected by entrepreneurs via this medium and its mechanisms seem to suit the VC process quite well. Crowdfunding may be particularly successful because of the screening function of the individual investors. If a large number of investors decide to invest a small amount, it is very likely that the public will have an appetite for the product or service – if only because this large number of investors is part of the public. Furthermore, crowdfunding does not seem to need active government stimulation. Incentives are thus not distorted and a tight government budget is not an obstacle. It would be worthwhile to keep following developments, especially in the U.S., where a proper implementation of the *JOBS Act* is far from secured.

Some Lessons from the Literature for Public VC Policies	
Issue	*Lesson*
Incentives	The actors in the VC cycle should have the right incentives. Most importantly, the innovator and the venture capitalist should have a significant stake in the success of the project. The risk they face should not be taken away (entirely).
Crowding out of private investments	Governments should make sure that private investments are encouraged, not discouraged. Government funding should therefore not take over the funding role, but rather use methods of co-investing.
Nurturing and retaining expertise	The unique expertise of venture capitalists of bringing innovative products to the market and of screening projects should be used. Government officials should not take investment decisions. Where such expertise does not exist, it should be attracted and nurtured.
Market-orientation and cyclicality	Governments should adapt to the market (with a long-run perspective), and not shape or constrain it. Examples: do not constrain VC investments to a certain region; allow for follow-up investments; do not specify an exact volume of supplied funds; accept that cyclical behaviour is natural (but the best way to counteract it is to use co-investing).
Geographical concentration	Rather than trying to develop VC uniformly across the country, it may be considered to concentrate resources.
Simplicity	Government policies should be kept as simple as possible and the number of policies as small as possible.
Second-tier stock markets	To provide exit opportunities, it may be considered to (further investigate whether it is feasible to) create a (pan-European) second-tier stock market.
Attracting foreign capital	Government policies should acknowledge the importance of foreign sources of VC and should try to persuade them to invest in Dutch firms. This concerns but is not excluded to creating awareness, removing double taxation, and harmonising regulatory frameworks.
Crowdfunding	Closely follow developments and, if it is deemed desirable, act pro-actively in the promotion of crowdfunding, for instance through deregulation, enacting regulation to protect investors, or running an awareness campaign.

Table 2.1: The table shows some lessons for public VC policies that have been derived from the theoretical and empirical literature. This is not an exhaustive list.

All in all, the theoretical and empirical literature indicates that government policies and the instruments they comprise may be successful and effective if they take into account a number of lessons or issues. The most recent and relevant ones are listed in Table 2.1.

The next section will use these lessons, and check whether (recent) Dutch government policies to foster venture capitalism do indeed take them into account.

2.3 Dutch VC Policies

The previous two sections have derived a number of lessons from the literature. This section will investigate if in the case of Dutch VC policies these lessons have already been, or may still be, learned. To this end, an overview is given of Dutch VC instruments, after which it is checked whether they adhere to the lessons the literature prescribes.

Table 2.2 presents a chronology of Dutch policy measures, including the timeframe during which the programmes were active, and descriptions. I have chosen to present this chronology in a tabular form for the sake of clarity and brevity, since the number of relevant programmes is huge.

Policy Instruments that Impact on VC		
Policy instrument	*Years in which programme was active*	*Description*
Measures Specifically Aimed at Venture Capitalism		
SEED Capital Regeling (part of 'SME+ Innovation Fund')	2012 - present	Replaced the *Seed-Faciliteit*. Is aimed at fighting the equity gap, and focuses on innovative and creative starters and young firms. Investments are made in selected closed-end VC-funds, of which the capital will be doubled, who in turn invest in young innovative companies (early stage VC). Of income generated by investments, only 20% has to be paid to the SEED Capital fund, until the investment is earned back. Further income is then first used to pay back the SEED Capital investments, and of what remains 80% can be kept. Budget for 2012: ±€20 million.
Fund-of-Funds (part of 'SME+ Innovation Fund')	2012 - present	Budget for 2012-2015: ±€100 million from the Ministry of Economic Affairs, and the European Investment Fund will contribute 1/3 of the final fund capital. This fund-of-funds invests in funds that in turn provide later stage VC. This is to compensate for the smaller role banks and pension funds (have to) play due to stricter regulation.
Groeifaciliteit	2006 - present	Facility instituted to help firms that need VC capital for growth purposes. If selected, it offers a 50% guarantee on the VC investments by venture capitalists or banks, to a maximum of €2.5 million for subordinated loans from bank and of €12.5 million for equity provided by venture capitalists.
Business Angels Programma	2007 - present	The programme aims to educate business angels and to create awareness among potential investees. It tries to intensify existing business angel networks. Budget for 2010: €1.5 million.
Regionale Ontwikkelingsmaatschappijen	1996 - present	The *Regionale Ontwikkingsmaatschappijen* have revolving funds that can be used to provide VC. Four regional funds exist, which are the most important investors in young technically innovative companies. They invest about €70 million on a yearly basis.

SEED-Faciliteit (TechnoPartner)	Mid-2005 - 2011	Was aimed at fighting the equity gap, and focuses on innovative starters and young firms. Investments are made in selected closed-end VC-funds, of which the capital will be doubled, who in turn invest in young innovative companies. The budget was €24 million per year during the years 2007-2011.
Durfkapitaalregeling	2001-2011	Succeeded and replaced the *Tante Agaathregeling*. It applies when an external person (not e.g. a bank) provides a subordinated loan larger than €2,269. The loans are exempted from capital gains taxation for 8 years, to a maximum of €56,420. The supplier of the loan receives a reduction of his income tax, but this element will be phased out in 2014.
Tante Agaathregeling	1996 - 2000	In the beginning, it provided subordinated loans. From February 1997 onwards, also not-subordinated loans, in the shape of mortgages, were supplied.
INNOVATION MEASURES AFFECTING VENTURE CAPITALISM LESS DIRECTLY*		
Innovatie Prestatie Contracten (IPC)	June 2012 - present	€17 million is available to stimulate collaborative innovation in SMEs. It focuses on perennial projects.
Topconsortia voor Kennis en Innovatie (TKI)	2012 - present	In consortia pertaining to 9 selected 'top sectors', entrepreneurs and scientists collaborate, conduct basic research and investigate how innovations can be marketed. Budget for 2012: €90 million. From 2013 onwards, the government will contribute 25 eurocent for every euro private companies invest in *TKI*, and an extra 15 eurocent for every euro for the first €25,000 of every participant.
Research & Development Aftrek (RDA)	2012 - present	The *RDA* stimulates innovative companies fiscally. If a firm spends on R&D, then it can get income tax deductions for R&D costs that are not labour costs (since they fall under the *WBSO*). Budget for 2012 is €250 million, for 2013 €375 million, and for 2014 €500 million.
Innovatiebox	2010 - present	The *Innovatiebox* replaced the *Octrooibox* in January 2010, and aims to decrease the corporate income tax rate for incomes generated by R&D projects from 20% or 25% to 5%. The budget for 2012 is €625 million.
Microkredieten / Qredits	2009 - present	A programme to fix the market failure that financial intermediaries refuse to provide capita to profitable enterprises because of transaction costs. Qredits should fix this by scale economies. It provides loans up to €50,000 (until September 2011 the limit was €35,000), which bear competitive interest rates. It also involves coaching young entrepreneurs. The programme is funded jointly by the government and a consortium of banks.
Programma Groeiversneller	2009 - present	A programme partially funded by the Ministry of Economic Affairs to help firms with turnovers between €2 million and €20 million grow after the start-up phase, by opening companies up to networks and stimulating collaboration, and by intensive guidance. The budget for the entire programme is €6 million.
Garantie Ondernemingsfinanciering (GO)	2009 - present	Banks can request a government guarantee of 50% of large loans on behalf of firms, for a minimum of €1,5 million and a maximum of €50 million per firm. For 2010 and 2011 the cumulative budget was €1.5 billion. It was supposed to be a temporary measure, implemented against the background of the economic crisis, but for 2013 the budget will be increased to €1 billion.
Innovatiekredieten	July 2008 – present	Succeeded the *Uitdagerskredieten*. Invests in innovative projects with commercial potential (not only technically excelling projects), for a minimal amount of €150,000 and maximum amount of €5 million. The loans bear, depending on the estimated risks, 4%, 7%, or 10% interest. SMEs can finance 35% of innovative projects with *Innovatiekredieten*, and larger corporations 25%. Loan and interest have to be repaid in 10 years. If the project fails for technical reasons, then loan-repayments may be waived. Since start of 2012 part of the 'SME+ Innovation Fund'. Budget for 2012: €95

		million.
Besluit Bijstandsverlening Zelfstandigen	2004 - present	Provides financial assistance to entrepreneurs who rely on government income support in the shape of interest-bearing loans up to a maximum of €32,905.
Small Business Innovation Research (SBIR) programma	2004 - present	Government subsidies that finance the research for innovative solutions to societal issues. The government describes the issue in an official tender, after which parties can submit proposals. There then are 3 phase. In phase 1, some companies get a maximum of €50,000 to conduct a feasibility study in a maximum of 6 months. Phase 2 comprises R&D, and should result in a tested prototype within 2 years, financed by grants of maximally €450,000. In phase 3 the innovations are marketed, without government support.
Syntens	1998 - present	An organisation comprised of 15 centres, with a total of about 250 consultants, present in all major Dutch cities, which stimulate the innovativeness of SMEs. *Syntens* consultants specifically focus on the commercialisation of new knowledge. The organisation was established by merging two other organisations.
Eurostars	1998 - present	The Netherlands participates in this European initiative that subsidises researching performing project in which SMEs from at least two *Eurostars* countries participate. The goal is to stimulate market-oriented technological developments across countries. The participants should contribute at least 50% of the necessary capital, and a single participant cannot contribute more than 75%. The projects have a maximum duration of 4 years.
Wet Bevordering Speur- en Ontwikkelingswerk (WBSO)	1996 – present	The *WBSO* stimulates innovative companies fiscally. If workers of such companies work on R&D, then they are allowed to pay less wage taxes for these workers. This can be 50% less, but this can increase to 60% if the company is just starting up. These percentages will decrease in 2013 according to the plans of the recently appointed cabinet. Budget for 2012: €872 million.
(Besluit) Borgstelling MKB Kredieten (BMKB or, formerly, BBMKB)	1915 – present	Banks can request government guarantees for a share of the loans to SMEs, with less than 250 employees, and total turnover below €50 million or total assets below €43 million, which cannot provide collateral. The guarantees are larger for starting and innovative companies, and have a maximum of €1 million. Companies that are younger than 5 years, can receive a guarantee of 67.5% for a loan of maximally €266,667. Innovative companies can receive a 60% guarantee on a maximal loan of €1.5 million, provided that the banks also provides a loan to the value of at least 50% of the guaranteed loan. Budget for 2012: €1 billion (raised from €705 million in 2011).
Besluit Subsidies Investeringen Kennisinfrastructuur (Bsik)	2002 - 2011	Broad programme that supported 37 projects within for instance ICT, nanotechnology, biotechnology, sustainable system innovation, by providing subsidies summing up to a total of €802 million.
SZW Borgstellingsregeling	2009 and 2010	A pilot programme that provided loans (up to €35,000) to entrepreneurs who come from a situation of dependency on government income support and have trouble securing bank loans. It aimed to overcome the problem that for small loans, for regular credit suppliers the transaction costs are too high to make it worthwhile. Active in 5 municipalities. A predecessor ran from mid-2007 until mid-2008 in 3 of these 5 municipalities.
Octrooibox	2007 - 2009	Aimed to decrease the corporate income tax rate for incomes generated by patents (during 2007) and by patents and R&D projects (during 2008-2009) from 25.5% to 10%.
Uitdagerskredieten	February 2006 – June 2008	Came as a (late) successor to the *TOP* and *TOK*. Risk-bearing loans during the development phase of innovations, aimed at technically excelling projects.
Twinning Centres	1998 - 2003	Centres opened in Amsterdam, Eindhoven, Delft, Rotterdam, and Twente. The

		government invested in young ICT enterprises, and supported them with expertise and coaching. It was evaluated to have jumpstarted the sector of emerging ICT firms, after which it was disposed of.
Technische Ontwikkelingsprojecten (TOP)	2001 and 2002	About 1300 risk-bearing loans were given for the development of new processes, products, and services, summing up to a total value of about €1.8 billion, of which about 70% was retrieved. The *TOP* was a continuation of the *TOK*.
Technisch Ontwikkelingskrediet (TOK)	1954 - 2001	
Subsidieregeling Innovatie Stimulering (INSTIR)	1984 - 1995	Predecessor of the *WBSO*, which subsidised shares of labour costs that pertained to R&D research.

* A slightly outdated list of currently active research and innovation policy measures is presented in Appendix A of Mostert and Deuten (2011, pp. 22-25).

Table 2.2: Dutch policy measures to stimulate VC directly and less directly.

A discussion and evaluation of all these instruments falls outside the scope of this Thesis. The Netherlands has let relatively independent organisations execute the evaluation of government measures, and those interested can refer to such publications for evaluations of individual government instruments.[100] However, these individual measures themselves lack quality because they fail to assess the effectiveness of the instruments, according to Stuiveling and Van Schoten (2011); moreover, they do not assess the effect of the entire mix of utilised policy instruments. It is thus worthwhile to draw some broader observations, informed by the foregoing discussion of Sections 2.1 and 2.2. Based on the literature, are these measures expected to be effective? Are any measures notably missing?

It may firstly be noted that Dutch R&D and VC policies were quite advanced in the pre-2000 years, with the *Subsidieregeling Innovatie Stimulering*, the *Technisch Ontwikkelingskrediet*, the *Borgstelling MKB Kredieten*, the *Wet Bevordering Speur- en Ontwikkelingswerk*, the *Tante Agaathregeling*, and the *Twinning Centres* providing a balanced mix of tax incentives, guarantees, subsidies, and managerial coaching. This led Dimov and Murray (2001, p. 22) to conclude that Dutch government policies formed one of the most advanced national programmes because of the achieved complementarity among schemes. Figure 1.6 (p. 25) showed that venture capitalism was thriving in the Netherlands relative to other European countries until the time of writing of Dimov and Murray (2001), likely as a consequence of adequate government interventions, despite only one of these programmes (the *Tante Agaathregeling*) specifically targeting venture capitalism.

Table 2.2 indicates that during the early 2000s not much changed in the landscape of Dutch VC policy, contrary to many other countries, which according to the reviews of Baygan and Tejada implemented a multitude of policies specifically impacting venture capitalism. In 2002 the *Besluit Subsidies Investeringen Kennisinfrastructuur* was taken, subsidising innovative projects, and in 2004 the *Small Business Innovation Research* programme was instituted to fund innovative solutions to societal issues, also using subsidies. These programmes were not directly aimed at fostering venture capitalism, and may have even worked adversely in that they crowded out private VC investments. The risk-bearing loan policies were even

[100] For detailed evaluations of some of these instruments, please refer to Ter Beek et al. (2010) for an evaluation of the *Regionale Ontwikkelingsmaatschappijen*, to Carnegie Consult (2012) for an evaluation of the *Groeifaciliteit*, to Verhoeven, Van Stel, and Timmermans (2012) for an evaluation of the *WBSO*, to Bureau Bartels (2005) for an evaluation of the *Durfkapitaalregeling*, to Deuten et al. (2010) for an evaluation of the *SBIR programma*, and to Carnegie Consult (2011) for an evaluation of the *BMKB*.

stopped altogether, only to be restarted again in 2006.

From 2006 onwards, a flood of policy adaptations and implementations changed the face of the Dutch VC policy landscape. The *SEED-Faciliteit* was erected to fight the equity gap for innovative starters and young firms. The *Groeifaciliteit* was instituted to provide guarantees on private VC investments. These were the first two measures that, to use the Baygan and Tejada's terminology, leveraged private investments. The *Business Angels Programma* was the third government programme in a short while, directly stimulating venture capitalism.

In 2009 the flood became a tsunami: the *SZW Borgstellingsregeling*, *Innovatieprestatiecontracten*, *Topconsortia voor Kennis en Innovatie* (*TKI*), the *Research & Development Aftrek*, the *Innovatiebox*, *Microkredieten* (*Qredits*), the *Programma Groeiversneller*, and the *Garantie Ondernemingsfinanciering* are all programmes to improve the entrepreneurial environment and foster innovation. The latest 'innovation' in Dutch VC and innovation policy is the creation of the *SME+ Innovation Fund*, which comprises updated versions of the earlier initiated *Innovatiekredieten* and *SEED-Facility*, and a newly created *Fund-of-Funds*. The latter is a fund that invests in VC-funds providing later stage VC, and which is scheduled to be implemented at the time of writing.

Mostert and Deuten (2011) note that the most recent, significant policy change is the introduction of the *TKI*, which focuses on 9 'top sectors'. Next to that, the Ministry of Economic Affairs attempts to follow a more demand-driven policy, with fewer specific subsidies and more generic deregulation to free entrepreneurs of obstacles.[101] Könings and Balk (2011) indicate that these adaptations of used policy instruments represent a complex mindshift on the part of administrators, civil servants, executive organisations, supervisory authorities, the corporate world, and research institutions. They argue that the Dutch government strives to use the stick more than the carrot. These policy innovations coincide with an agenda of the Ministry of Education, Culture and Science, which emphasises the role of universities and the creation of knowledge clusters, informed by the concept of 'valorisation'.[102]

It is too early to evaluate these recently adapted or newly created programmes, also since Mostert and Deuten (2011, p. 14) indicate that "there is still limited information about the concrete implementation and impacts on current policy instruments", but it may be clear that although late relative to other European countries, the Dutch government recently gave innovation in a broad, and VC in a narrow, sense stronger attention, despite the need to implement severe cutbacks on its spending. It can be evaluated, however, if these recent programmes (and some of their less recent predecessors) accord with the recommendations found in the literature. I will consider the issues listed in Table 2.1.

INCENTIVES

Incentives of firms receiving VC and of venture capitalists should not be distorted. Regulatory capture should be avoided, and incentives should not weaken after the VC investment is done. Incentives may have been distorted in earlier years, as may have happened to a certain extent in the case of the *Besluit*

[101] See Ministry of Economic Affairs (2011).

[102] See Ministry of Education, Culture and Science (2011).

Subsidies Investeringen Kennisinfrastructuur, or left neutral, as seems to have been the case with the interest-bearing innovation loans. More recently, incentives have been taken into account more meticulously, and where possible and desirable even stimulated. The new *SEED Capital Regeling* doubles the capital of VC-funds, and ensures that most of the marginal profits accrue to the fund managers. The *Groeifaciliteit* offers guarantees on VC investments, but only up to 50%, which is similar to the arrangements of the *Garantie Ondernemingsfinanciering* and the *Innovatiekredieten*, which all require that the stake of the private investor is at least as large in absolute terms as the government's stake. Since the VC-fund managers in the case of the *SEED Capital Regeling*, and banks and venture capitalists in the case of the *Groeifaciliteit*, have an important stake in the success of the firm receiving the VC, they are powerfully incentivised to choose the right firms, and if possible to monitor and coach them. The to-be-created *Fund-of-Funds* is similarly designed.

The Dutch government also strengthens incentives where it is deemed desirable, especially in a wider innovation context. The *Durfkapitaalregeling* gives tax deductions for those providing subordinated loans. The *Innovatiebox* decreases the tax rate on income generated by R&D projects. The *WBSO* subsidises R&D labour costs and the *RDA* provides tax deductions to firms with non-labour R&D costs. These programmes avoid regulatory capture, because they are awarded *ex post*, or based on results.

Lastly, the incentives of government officials are taken into account, mostly by ensuring that funds are *revolving*. That means that the budget of the programme is to an important extent determined by the return on previous expenditures. For instance, the funds of the *Regionale Ontwikkelingsmaatschappijen*, which invest in young, technical firms, are revolving, since their future investments are constrained by the return on current investments. Although those who make the investment decisions may not experience incentives with regard to their own wallets, it is preferred to a situation in which they have to apply and fight for pieces of a limited cake of government subsidies every year, where the quality of taken investment decisions is disregarded.

CROWDING OUT OF PRIVATE INVESTMENTS

Crowding out is a problem when the government implements policies that discourage or even replace private investments. This may happen when loans are offered that have advantageous characteristics (e.g. with an interest rate significantly below the competitive market rate), with which private parties cannot compete. This may have been the case, to a limited extent, with the *Besluit Subsidies Investeringen Kennisinfrastructuur*, the *Innovatiekredieten*, and the *Innovatie Prestatie Contracten*, and perhaps to a larger extent with the *Regionale Ontwikkelingsmaatschappijen*, which are revolving but still do not take into account the risk of bankruptcy as heavily as otherwise similar private VC-funds do.[103] Crowding out is not a problem for other initiatives such as the *Microkredieten*, since these are loans offered at competitive rates.

The risk of crowding out, however, is generally limited. With its most recent policies, the Netherlands followed most other countries in leveraging private investments (also referred to as *co-investing*) instead of replacing them. Examples are the *SEED Capital Regeling*, the *Fund-of-Funds*, the *Groeifaciliteit*, and the

[103] Ter Beek et al. (2010) provide an evaluation of the *Regionale Ontwikkelingsmaatschappijen*, but remarkably do not even mention the possibility of crowding out private investments.

Garantie Ondernemingsfinanciering. They have in common that the government agrees to provide support, but only if the private sector participates to a significant extent as well. This may still result in the crowding out of private investment if the scope of these projects is too large or if the terms are too lenient. It is difficult to assess this, since it is difficult to observe counterfactuals. Generally, however, co-investing policies actively encourage private investments – definitely when compared to measures like preferential loans and grants.

NURTURING AND RETAINING EXPERTISE

The studies of Baygan and Tejada, and Tykvová, Borell, and Kroencke (2012) argued that a lack of entrepreneurial and VC-fund managing expertise is an important barrier to fostering venture capitalism. In earlier days, there was not much attention for creating this expertise. The first serious attempt may have been the *Twinning Centres*, which were conceived of in 1998 and provided expertise and coaching to young ICT enterprises, but which ended already in 2003.

More recently, attempts have been made to nurture relevant expertise. The *Business Angels Programma* endeavours to educates business angels and create awareness among potential investees. The *Programma Groeiversneller* provides intensive guiding of young companies to realise their growth potential. *Microkredieten* are provided alongside coaching of young entrepreneurs.

Perhaps the most important way in which expertise is nurtured is by co-investing. If VC were directly provided by the government, sidestepping private venture capitalists, experience would not be accumulated and private expertise would remain unused. Co-investing, however, retains the screening and coaching expertise of private VC-fund managers, and enables them to accumulate relevant experience.

MARKET-ORIENTATION AND CYCLICALITY

Duruflé (2010, p. 16) indicates that "there is now a growing consensus that government schemes should work with the market, not against it, and that investment objectives and constraints which come with a government investment programme should be designed accordingly." Recent Dutch government policies seem to largely satisfy this. Firstly, again, due to the structure of co-investing, which lets 'the market' decide about the investments. For instance, the *SEED Capital Regeling* and the *Fund-of-Funds* do not restrict investing to certain sectors. Secondly, because most programmes do not prescribe specific volumes to be lent, guaranteed, subsidised, or invested, but only specify a maximum (i.e. the budget). An exception may be the *Regionale Ontwikkelingsmaatschappijen*, since Duruflé (2010, p. 16) specifically mentions that geographical constraints may conflict with economic development purposes.

Adapting to the market does not appear to be seriously bothered by undercapitalisation for programmes like the *GO* and the *Groeifaciliteit*. The *SEED Capital Regeling*, however, with an annual budget of €20 million seems a bit small compared to similar arrangements in other countries.

VC markets are cyclical by their very nature,[104] which means that government policies will and should never

[104] See e.g. Ruis et al. (2009) and Van Pottelsberghe de la Potterie and Romain (2004).

take this away entirely.[105] Having stated that, Duruflé (2010) indicated that co-investments are the most countercyclical policy measures. Since the dominant way of stimulating VC investments directly in the Netherlands is and will be via co-investments, not much can be learned here.[106]

Geographical concentration

Gompers and Lerner (1999b) indicated that concentrating policy efforts is recommendable. Dutch policy measures have not been geographically concentrated,[107] which may be desirable in the particular case of investments constraints, as was mentioned above. Some VC policy measures, such as the participations of the *Regionale Ontwikkelingsmaatschappijen*, are part of a policy that explicitly attempts to reduce regional inequalities and thus spread resources across the country (and *away* from already successful areas). The example of the U.S. VC market shows that venture capitalism boomed not so much uniformly across the U.S., but that it did so in Silicon Valley, where multiple facilitating factors were and are present.[108]

Further evidence is provided by Reid and Nightingale (2011), who argue that social and economic policy should not be mixed and that funds should not be constrained by geographical regions. They base their conclusions in part on case studies of the Canadian *Labour-Sponsored Venture Capital Corporation* scheme and the English *Regional Venture Capital Funds*, and do not refrain from providing concise and to the point conclusions: "Do not constrain funds to regions, as regions are too small to provide sufficient deal flow for funds to specialise and learn how to effectively invest in particular sectors and technologies" (p. 33).

Dutch policies could thus improve if they take the geographical argument into account, by not specifically spreading out VC funds across the country. An advice seems to be given by Fortune (2012), indicating that the Eindhoven area was one of the seven areas in the world that qualifies as a potential 'next Silicon Valley'. It may thus be advisable to focus on creating a VC market specifically in the Eindhoven area, and more concretely, to remove the VC policies from the *Regionale Ontwikkelingsmaatschappijen*.

Simplicity

Tejada (2003a; 2003b) and Baygan (2003f) mention that the presence of a large number of similar government schemes may create confusion, which will reduce the schemes' efficiency. Ernst & Young (2012) agree, concluding that a simplified and streamlined innovation policy would be more effective. Looking at Dutch VC and innovation policy, before 2005 the policy landscape was rather orderly with well-delineated government programmes. This changed a bit during the crises years, when the flood of new policy measures arrived.

Currently, many programmes appear to have similar and overlapping purposes. For instance, the *Groeifaciliteit*, the *Garantie Ondernemingsfinanciering*, the *SEED Capital Regeling*, and the *BMKB* all leverage private investments in young and growing companies. For a firm it may be difficult to figure out in what

[105] It can be formulated even stronger: government policies that would eliminate cyclicality entirely can only be very costly and unhealthily distorting (see e.g. Lerner, 2009).

[106] Section 3.2, however, will elucidate on this, and indicate that the cyclicality of VC investments varies across the stages of the VC cycle.

[107] See e.g. Dimov and Murray (2001) and European Commission (2003).

[108] A similar observation can be obtained by considering London (Martin, 1989) or Scandinavian cities. For the U.S., Reid and Nightingale (2011, p. 35) consider the Boston area also as a success region for venture capitalism.

stage it exactly is, how to apply for these programmes, what their relative advantages are, that it is perhaps better served by contacting a business angel or applying for an *Innovatie-* or *Microkrediet*, and etcetera.[109] This may be contrasted with the Catalonian *Centre d'Innovació i Desenvolupament Empresarial*, which "functions as a 'one-stop shop' for start-up businesses and potential investors offering practical assistance at all phases of early business development".[110] Another contrasting example is the *Business Development Bank of Canada*, which comprises the *BDC Venture Capital Fund* (which leverages general VC investments), the *Seed Capital Funds* (which are independently managed partnerships with private partners targeting young innovative firms in the pre-start-up phase), *Subordinated Financing*, and *Management Programmes* (which offer business counselling and mentoring services).[111]

The recent institution of the *MKB+ Innovation Fund* simplified things somewhat, but confusion remains. Stuiveling and Van Schoten (2011) confirm this, finding that many (sub)departments of the Ministry of Economic Affairs were allowed to more or less follow their own innovation policy. They conclude that the number of measures stimulating innovation increased strongly, but that the coherence between measures and goals is missing, caused by lacking coordination.

If the development of a thriving VC market is deemed a truly important goal, then erecting an organisation as a one-stop shop may be advisable, to ensure that the landscape of policy measures is simplified and made more coherent. This organisation may or may not be independently managed. A funding-seeker may, figuratively speaking, enter the door of a one-stop shop, where it is first determined what the exact problems and wishes are, and subsequently what potential solutions could be. He or she is then referred to the specific programmes, which may include managerial support, financial assistance, and etcetera. Especially if the name of this umbrella organisation is chosen well, this may greatly increase awareness and understanding among potentially VC-backed entrepreneurs.

SECOND-TIER STOCK MARKETS

Dimov and Murray (2001, p. 7) stated that "the large number of European stock markets, with over 30 regulated markets and eighteen regulatory bodies [...] works against an optimal capital market structure." The studies by Baygan and Tejada assess how well second-tier stock markets have developed, and conclude for most European countries that they are non-existent or underdeveloped. Figure 1.11 (p. 28) showed that during the years 2007-2011 not a single IPO was used as a divestment route. The stock market situation is thus clearly far from optimal since it does not provide a liquid exit market.

A Dutch stock market would probably be too small and illiquid to smoothly facilitate IPOs of innovative, technical, and young firms. It is for this reason that in 1996-1997, following the example of the Nasdaq, the *Euro.nm* was created; a partnership of 'new markets' between the French *Nouveaux Marché*, the German *Neuer Markt*, the Belgian *Euro.nm*, the Dutch *Nieuwe Markt*, and the Italian *Nuovo Mercato*. Goergen et al. (2002, p. 20) explain that *Euro.nm* was, indeed, "launched in order to facilitate the financing of innovative

[109] This may partially explain why Carnegie Consult (2012) finds that the *Groeifaciliteit* is not fully utilised. The Ministry of Economic Affairs (2011) acknowledges the confusion.

[110] Tejada (2003a, p. 16).

[111] See Box 1 in Baygan (2003d).

companies with a high-growth potential", which "were the type of companies that continental European listing rules would have excluded earlier." Bottazzi and Da Rin (2000, Abstract) "conclude that Euro.nm is far from providing a pan-European stock market for innovative, high-growth companies." Two years later, however, Bottazzi and Da Rin (2002) document that "the opening of Euro.nm seems to have spurred also venture capital intensity at national level" (p. 17), and that "[t]he number of VC-backed start-ups clearly increases after the opening of Euro.nm" which is "a suggestive indication of the positive effect of Euro.nm on venture capital" (p. 34). Bottazzi and Da Rin (2002, p. 2) note that this partnership was dissolved in December 2000, and that the five exchanges continued to operate independently afterwards.

To my knowledge, ever since there has not been an attempt to create a pan-European index for young, innovative, and technical firms, nor has any proposal been put forward by Dutch government officials in this direction. Considering for instance Jeng and Wells (2000), who conclude that IPOs are the most important determinants of VC intensity, and accepting that the Dutch market is apparently unable to facilitate IPOs, it may be considered to propose the (re)establishment of a European stock index with the prospect of sufficient liquidity, preferably including more countries than just those that were part of the Euro.nm.[112] This may also be of interest to the next and final discussed issue: attracting foreign capital.

ATTRACTING FOREIGN CAPITAL[113]

As Subsection 1.4.2 showed, the amount of foreign VC capital being invested in the Netherlands is not abundant, so a future role for government policy might exist in this context. Baygan noted that a large share of the total amount of VC in Israel (2003c), Canada (2003d) and Sweden (2003f) came from foreign, often U.S., investors. Attracting foreign VC capital can be facilitated in various ways. The most important way is, probably, by establishing a common and liquid stock market, which could attract experienced and skilled venture capitalists.[114] It is to be expected that additional VC will find its way to the Netherlands when the infrastructure is clear and comparable across countries, because for instance the high number of patents signals that opportunities are present.[115]

The studies by Baygan and Tejada indicated that multi-rate tax policies are confusing. Tax transparency may be achieved by certain Dutch fund vehicles, but Reid and Nightingale (2011, p. 15), followed by the European Commission in recent press releases, argue that double taxation remains an issue, which significantly impedes cross-border venture capitalism. It may thus be advisable for the Dutch government to push for a harmonisation of venture capital tax regimes, or less radically, for mutual recognition.

Israel, for instance, is known for having attracted foreign VC by providing preferential tax treatments to foreign investors. Such (fiscal) policies do not exist in the Netherlands. Another approach would be to create awareness among foreign investors. To that end, one initiative that is undertaken at the moment is

[112] To stimulate venture capitalism and the creation of innovative new companies, Reid and Nightingale (2011, p. iii) specifically recommend the "creation of a liquid, unified European IPO market and the lowering of the hurdle for high-growth companies that aspire to list their stock on such markets should be a priority."

[113] On the importance and ways of attracting foreign VC, see Wright, Pruthi, and Lockett (2005) and Mäkelä and Maula (2008).

[114] De Swaan et al. (2011, p. 16) agree for the Dutch situation that such a stock exchange may create exit opportunities for venture capitalists and informal investors, which may provide SMEs access to risk capital markets.

[115] In an interview I conducted it was argued that it may particularly enlarge the visibility of European, young, technical, and innovative companies, and thus create awareness among foreign investors.

a mission to Silicon Valley. A member of the Ministry of Finance is at the Consulate General of the Netherlands in San Francisco, where he investigates how U.S. investors may be convinced to provide VC to Dutch entrepreneurs. This study may be intensified, and similar ones may be conducted for other countries.

CROWDFUNDING

At the time of writing, there have not been any policy initiatives with regard to crowdfunding. Future policy initiatives may focus foremost on creating awareness among entrepreneurs, but apart from that, and perhaps besides some (de)regulation, government intervention can and should be avoided. Promoting crowdfunding seems politically feasible. Firstly, because there is no real downside; governments need not increase their spending, nor are incentives distorted or private investments crowded out. And secondly, most political parties have already indicated to support crowdfunding, indicating that sufficient political support indeed exists. Crowdfunding seems particularly interesting and promising for the Netherlands recalling that, as Table 1.2 (p. 23) showed, seed investments have plummeted in recent years, sometimes almost drying up altogether.

The most important findings of this chapter will be summarised in the synthesis of Chapter 4. Chapter 3 will now continue by introducing a method to actually score government policies. Whereas this chapter looked for lessons that seem to hold universally and about which a consensus seems to exist, the next chapter will take a more differentiated approach. It will hold that government policies should aim to address and take into account the environmental factors that happen to be present. It will therefore look for lessons in the best practices of countries with environments similar to the Dutch one.

3. Lessons from Benchmark Countries

At the time of writing, about a year ago Da Rin, Hellmann, and Puri (2011, p. 99) concluded the following, which indicates why this chapter can contribute to the literature, and which therefore deserves quoting in full:

> Overall we note that the research on the role of government policies remains sparse. The results of a complementarity between government R&D spending and VC remind us of the importance of looking at the interactions among different government policies. We believe that the role of government in VC remains under-researched. There has been no systematic evaluation of the costs to government of supporting VC (e.g., what is the fiscal impact of reducing capital gains). There has also been little appreciation of the shape that government intervention should take (e.g., what is the best model of government-sponsored VC).

This chapter will not fill all gaps indicated in the quote,[116] but it will make a start. It will score countries on how well their VC policies dealt with environmental factors to stimulate venture capitalism, and correspondingly provide, as far as I am aware, a first-ever ranking of countries.

Section 3.1 will start by discussing the inherent difficulties of assessing the efficiency and effectiveness of innovation, and more specifically venture capital, policies. Section 3.2 will explain that environmental and to a certain extent exogenous factors exist that affect VC intensity. Moreover, it will determine which factors are most important, and it will quantify the effects of these environmental factors. This is informative by itself, but it serves also as a preparation to Section 3.3, which will use these environmental factors to determine which countries have most successfully dealt with them. Data envelopment analysis will be applied to investigate which countries have most successfully stimulated venture capitalism, taking into account the environmental factors present in those countries, and will correspondingly present a ranking of countries. Moreover, the analyses will indicate which countries' VC policy practices might contain lessons for the Netherlands, and will explore what these might be.

3.1 Problems of Scoring Public Policies

The most straightforward and powerful way to score public policy is as follows. Government policy may be considered successful *if the related societal benefits outweigh the corresponding costs*. Here, opportunity costs should be taken into account as well. This has to date remained infeasible because of both methodological difficulties and lacking data, as will be explained below.

Section 1.3 argued that VC may be desirable because it could lead to innovation and extra economic

[116] The quote indicates that it should be investigated what the best model of government-sponsored VC is. This chapter will hold that there is no such thing as a single, perfect policy; the appropriateness of VC policies depends on the environmental factors they aim to address.

growth. But, as the first paragraphs of Subsection 1.3.2 already explained, it is in the current state of the literature very difficult to conclusively quantify (and subsequently determine the societal benefit derived from) the *additional* innovation and economic growth caused by *additional* VC, mostly because a host of causality issues.

Even if it were possible, we would still need to quantify how government policy affected VC activity. The most promising method seems to be to take a firm-level approach,[117] following suggestions provided by Theeuwes et al. (2012). However, even Theeuwes et al. (2012), a working group that was tasked to provide methodologies for assessing the efficiency and effectiveness of instruments of the Ministry of Economic Affairs, indicated that it was unable to assess the quality of evaluations of the *SEED Capital Regeling*, in part because of lacking (firm-level) data. Since it has thus remained impossible to conclusively decide about the effectiveness of separate (VC) instruments, it seems even less possible to conclude about national policies that comprise several instruments.

Indeed, Lanser and Van der Wiel (2011) argue that measuring the effect of innovation policy is, at the moment of their writing, impossible for the Netherlands.[118] They quote Hall, Mairesse, and Mohnen (2009, p. 4), who

> caution the reader that the "return" to R&D is not an invariant parameter, but the outcome of a complex interaction between firm strategy, competitor strategy, and a stochastic macro-economic environment, much of which is unpredictable at the time a firm chooses its R&D program. Therefore, there is no reason to expect estimates of the *ex post* returns to be particularly stable over time or across sectors or countries. And in the case of social returns, they are not even tied to some kind of cost of capital.

Since such considerations also play a role in the case of VC policy, assessing the performance of (Dutch) government policy by calculating a societal return on investments is not (yet) possible. Another way to assess the effectiveness of VC policies would be to collect variables that measure governments' efforts (e.g. expenditures). Variations in VC market activities may then be explained by such variables using a variety of available methods, such as regression analysis.

Investigating the feasibility of such an approach, I distinguished five policy instruments that I think are the main, generic financial instruments in the case of public VC policy: tax incentives, loans, guarantees, subsidies, and participations. Only with the help of many specialists of the Ministry of Finance, the Ministry of Economic Affairs, the NVP, and the CPB, did I succeed in determining *proxies* of these figures for the Netherlands for the years 2007-2011. I would need to gather this data for many more countries (and, ideally, for multiple time periods) for the analyses to be powerful and meaningful. I contacted all equivalent Ministries and VC associations of the countries that are associated with the EVCA, but those who did reply indicated that this data was not readily available. It is perhaps also for this reason that a few months ago

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[117] In most methods, companies are divided in two groups which are otherwise comparable, except for that one group received government support whereas the other did not. Using various techniques, the different groups may then be compared in terms of survival rates, profits, employment creation, and etcetera.

[118] Stuiveling and Van Schoten (2011), a report containing similar conclusions that was written in association with the *Algemene Rekenkamer*, argue that it is impossible to score Dutch innovation policies between 2003 and 2010. One reason is that it is, at the time, impossible to measure innovation activity objectively, and another that executed evaluations of specific innovation instruments lack quality, mainly because they fail to assess the effectiveness of the instruments.

Tykvová, Borell, and Kroencke (2012, p. 14) called for the collection of reliable data on public policy programmes.

Having investigated the feasibility of several, more 'traditional' approaches without success, Section 3.3 will introduce a method to score VC policy that *can* be used. This method does not score policies *absolutely*, in that societal returns are calculated (which would still be ideal); it scores them *comparatively*. The question is therefore transformed from *Is Dutch VC policy effective?* into a question like *Is Dutch VC policy more effective than VC policies of other (comparable) countries?*

3.2 Determinants of VC Investments

Some look at Silicon Valley or the city of London for clues to improve venture capitalism in the Netherlands, but it may be the case that it thrives relatively well in certain regions because of exogenous factors. Changing such factors to stimulate venture capitalism may be impossible, very costly, or even detrimental if it would adversely affect other parts of the economy and society. It is beneficial to realise the potential of government policy, but it may be even more important to realise its limitations. Another way to frame the importance of this question is to recall that different counties might have different interests in developing VC markets.

3.2.1 A panel data approach

Several authors have already investigated the determinants of VC investments using a panel data approach, often using data from the EVCA and focusing on (Western) Europe. Examples are Jeng and Wells (2000), Schertler (2003), Romain and Van Pottelsberghe de la Potterie (2004), and Da Rin, Nicodano, and Sembenelli (2005). This section will update their results, foremost by including the years of the recent crises. The countries included in the analyses are Belgium, the Czech Republic, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Hungary, the Netherlands, Austria, Poland, Portugal, Romania, Finland, Sweden, the United Kingdom, Norway, and Switzerland, which are investigated for the years 1989-2011. The remaining part of this subsection will first present a list of relevant factors that can and will be included as explanatory variables in regression equations.

Jeng and Wells (2000) already noted that exogenous factors affect VC investments differently for different stages - they distinguish early stage and later stage investments. I will follow them by taking as dependent variables the total amount of VC investments ($Total_{i,t}$), Early Stage investments ($ES_{i,t}$), and Expansion and Replacement investments ($ER_{i,t}$), for country i and year t.[119]

Many authors suggest that a well-developed financial sector and stock market is crucial for a VC market to

[119] Subsection 1.4.2, and Table 1.2 in particular, showed the importance of decomposing ES investments further. Seed investments were gravely affected by the recent crises, which was less so for start-up investments. It is thus likely that the determinants of these components of ES investments are very different, and it is therefore recommended to investigate them. Unfortunately, the data that is fit for cross-country comparisons, is only available from 2007 onwards.

flourish.[120] For instance, venture capitalists will only invest if they think they can make a profit, for which (early) exiting possibilities must exist. Well-developed stock markets facilitate smooth exits, according to Jeng and Wells (2000), who conclude that IPOs are the most important determinants of VC intensity. IPOs are a doubtful indicator for VC investments in Europe, if only because, as Figure 1.11 showed, in the past years not a single IPO has occurred in the Netherlands. The total market capitalisation is a broader concept, which represents the total market value of all listed domestic firms, which can be included to investigate whether the size of stock markets influences the development of VC investments, and which is related to IPO-measures. The total market capitalisation as a share of GDP ($Market\_Cap_{i,t}$) is retrieved from databases of the World Bank for every country for every year.[121]

Gompers and Lerner (1999b) and Romain and Van Pottelsberghe de la Potterie (2004) suggest that interest rates are important determinants, because demand for VC might rise with interest rates, as VC alternatives become more attractive for innovators. Romain and Van Pottelsberghe de la Potterie (2004, pp. 4-5), however, point out that if "interest rates increase we can expect the fund providers to increase their return requirement", which would depress the supply of VC, and thus, for the interest rate, "the impact is either negative or positive depending on the difference between the demand price effect and the supply price effect." They moreover point out that short-term interest rates will affect demand and supply in a different way. One-year and ten-year national interest rates ($ST\_Interest_{i,t}$ and $LT\_Interest_{i,t}$) are therefore retrieved from OECD databases.

Da Rin, Nicodano, and Sembenelli (2005) and more forcefully The Economist (2012) emphasise that barriers of entrepreneurship may cause VC markets to fail to thrive. Big barriers to entrepreneurship are labour market rigidities.[122] The development of innovations is, by nature, uncertain, and as Hellmann (2001) argues, employees are required. Moreover, it might be the case that suddenly additional employees are needed, who in turn may be needed to work quite flexibly, or that employees have to be laid off - in any case, entrepreneurs desire flexibility to cope with the sudden developments that are inherent in the development of innovations. Therefore, developing innovations and thus the use of VC may be discouraged if employment protection is strong; that is, if it is difficult or expensive to lay off workers. Following Schertler (2003) I take indicators from the OECD that focus on employment protection.[123] The OECD provides employment protection indicators on a yearly basis for the years 1985-2008. These indicators ($Employ\_Prot_{i,t}$) are averages of other indicators that relate to lengths of notices periods, severance pays, definitions of justified or unfair dismissals, lengths of trial periods, compensations following unfair dismissals, and the maximum number of successive fixed-term contracts and cumulated duration of successive fixed-term contracts. I extrapolate the data for the years 2009, 2010, and 2011, by setting them equal to the 2008 value. This is imperfect, but not too harmful, because the indicators are relatively stable over time.

[120] See e.g. Becker and Hellmann (2003), Black and Gilson (1998), and Hall (2002).

[121] Cherif and Gazdar (2011) also take market capitalisation rates as a share of GDP to investigate VC investments.

[122] See Schertler (2003), Romain and Van Pottelsberghe de la Potterie (2004), and Jeng and Wells (2000).

[123] See OECD (1999).

Several macroeconomic factors can affect VC activity. A growing economy may sprout business ideas and increase savings, so that both demand and supply of VC can increase, whereas the converse holds for an economy in recession. This is referred to as cyclicality. Ruis et al. (2009) calculated that the cyclicality of VC is immense; based on a study of ten European countries they found that a decline in GDP growth of 1.5%, 2.5% and 4% would lead to a decrease of VC of 19.2%, 32.1%, and 51.3%, respectively. Section 1.4.2 seems to corroborate this, since it showed that VC intensity declined enormously after the onset of the recent crises. Therefore, similar to Jeng and Wells (2000), Romain and Van Pottelsberghe de la Potterie (2004), and Cherif and Gazdar (2011), I include percentage growth rates of GDP levels ($PC\_GDP_{i,t}$). I also include GDP per capita levels ($GDP\_Cap_{i,t}$), since I suspect that richer countries may have more means and a greater desire to develop VC markets. Finally, I also include GDP levels (at current market prices), because it might be the case that a country or its economy must be of a certain size before it can successfully support a thriving VC market. This is mostly relevant regarding IPOs bringing innovations to the market; this is easier when the market and the pool from investors to fish from are bigger. Additionally, big investment funds (which are not bound by national boundaries) seem to be attracted by bigger stock exchanges, because the opportunities, also for diversification, are bigger. Data on GDP and GDP per capita levels are retrieved from Eurostat databases.

VC can only be used if opportunities for innovative projects arise. Several authors try to include a measure of technological opportunities. For instance, Romain and Van Pottelsberghe de la Potterie (2004) include the number of patents and the growth rate of R&D investments. I therefore include the variable $Patent_{i,t}$, being the total number of patents filed at the European Patent Office (EPO) per inhabitant for every country and every year, respectively. As alternative patent measures I also retrieve the number of patents granted by the United States Patent and Trademark Office (USPTO) and the number of triadic patents.[124] Da Rin, Nicodano, and Sembenelli (2005) and Romain and Van Pottelsberghe de la Potterie (2004) include and compute R&D capital stock figures using a perpetual inventory method. However, whereas the former uses *public* R&D expenditures, the latter uses *business* R&D expenditures. I compromise by taking *total* R&D expenditures, retrieved from Eurostat databases.[125] I replicate Da Rin, Nicodano, and Sembenelli (2005)'s method of calculating the initial (1989) values and the same method both works use to calculate subsequent (1990 and further) values.[126] Calculated from the R&D data I include percentage growth rates of R&D expenditures ($PC\_RD_{i,t}$) as well.

As indicated in Section 2.2 a lower capital gains tax rate might lead to increased VC intensity. I use

[124] A triadic patent is a patent for a certain invention that has been filed at the EPO, USPTO, and the Japanese Patent Office (JPO). This is a measure of patents that are particularly valuable, because the corresponding inventions are apparently deemed to be valuable across countries.

[125] Some missing data is filled using linear interpolation.

[126] Initial values are calculated using the following equation:

$$CS\_RD_{i,1989} = \sum_{t=1981}^{1989} RD_{i,t}\,(1-\delta)^{1989-t}, \qquad \forall i$$

Subsequent values are calculated using the following equation:

$$CS\_RD_{i,t} = (1-\partial)CS\_RD_{i,t-1} + RD_{i,t}, \qquad \forall i\,, t \in \{1990, \ldots, 2011\}$$

The depreciation rate ∂ is taken to equal 15%, analogous to Da Rin, Nicodano, and Sembenelli (2005) and Romain and Van Pottelsberghe de la Potterie (2004).

corporate income tax rates as a proxy. This is a good proxy, in particular because some countries (like the Netherlands) do not have separate tax regimes for capital gains - for these countries the (hypothetical) capital gains tax rate equals the corporate income tax. Corporate income tax figures ($Corp\_Tax_{i,t}$) are retrieved from the OECD Tax Database.

Subsection 1.3.1 argued that cultural barriers might exist that discourage VC investing. It is difficult to find measures that proxy these cultural barriers. None of the mentioned articles included such measures or controlled for them. I include an indicator of market-basedness (or, equivalently, since it is the other end of the same scale, bank-basedness) from Levine (2002). The rationale is that cultural barriers might be difficult to measure, but that the same cultural phenomena prevent a country from being (or becoming) more market-based, would also impede venture capitalism. The addition might be of insignificant explanatory value if these indicators correlate too strongly with the total market capitalisation figures. The indicator ($Struc\_Aggr_{i,t}$) I include is an aggregate measure, based on three other indicators, that relate to the activity, size, and efficiency of stock markets relative to banks. They are aggregated by taking the first principal component.

Finally, the presence and size of pension funds may affect VC intensity. Such funds possess large amounts of capital on which a return needs to be earned, and which therefore may be used as VC capital.[127] From OECD databases for every country the total assets of funded pensions as a share of GDP ($Pension_{i,t}$) are downloaded. The data is generally available from 2001 onwards, which thus restricts the sample size considerably.

Variables relating to patents and the stock of R&D expenditures are normalised using population figures, following Da Rin, Nicodano, and Sembenelli (2005). Population figures have been retrieved from Eurostat databases.

3.2.2 Results and some interpretations

Table 3.1 presents correlation figures for the main variables. Countries with higher VC investments are countries that, on average, have weaker employment protection, higher R&D capital stocks, are relatively market-based, have larger private pensions, and higher short-term interest rates, which is all according to expectations. Table 3.1 reveals that performing regression analyses might be problematic, because several independent variables are significantly correlated.[128] For instance, $Struc\_Aggr_{i,t}$, $Market\_Cap_{i,t}$, and $Pension_{i,t}$ have positive correlations exceeding 0.59, which can be explained since they all measure to what extent a certain economy makes use of and has well-developed (stock) markets, albeit in differing ways. This also holds for $Patent_{i,t}$ and $CS\_RD_{i,t}$, which both measure the presence of technological opportunities. $GDP\_Cap_{i,t}$ seems problematic as well, given its high correlations with many other explanatory variables, most notably $CS\_RD_{i,t}$ (0.68). Such high correlations may indicate that they are, indeed, good indicators, but that they should not be included in regression analyses simultaneously.[129]

[127] See Black and Gilson (1998) and Jeng and Wells (2000).

[128] See e.g. Blalock Jr. (1963).

[129] Cincera, Czarnitzki, and Thorwarth (2009, p. 63) run into the same problem. They also decide to not include all determinants, despite

Correlations															
	$Total_{i,t}$	$ES_{i,t}$	$ER_{i,t}$	$GDP\_Cap_{i,t}$	$PC\_GDP_{i,t}$	$GDP_{i,t}$	$Employ\_Prot_{i}$	$Patent_{i,t}$	$PC\_RD_{i,t}$	$CS\_RD_{i,t}$	$Struc\_Aggr_{i}$	$Market\_Cap_{i,t}$	$Pension_{i,t}$	$Corp\_Tax_{i,t}$	$ST\_Interest_{i,t}$
$ES_{i,t}$	0.88														
$ER_{i,t}$	0.79	0.60													
$GDP\_Cap_{i,t}$	0.04	0.16	-0.05												
$PC\_GDP_{i,t}$	0.02	0.04	0.21	-0.18											
$GDP_{i,t}$	0.09	0.01	0.03	-0.15	0.10										
$Employ\_Prot_{i,t}$	-0.15	-0.15	-0.21	-0.05	-0.45	0.05									
$Patent_{i,t}$	0.13	0.05	0.27	-0.02	0.45	-0.03	-0.47								
$PC\_RD_{i,t}$	0.00	-0.08	-0.04	-0.23	-0.07	0.48	0.16	-0.24							
$CS\_RD_{i,t}$	0.16	0.18	0.37	-0.11	0.69	-0.07	-0.44	0.85	-0.25						
$Struc\_Aggr_{i}$	0.29	0.31	0.29	0.14	0.42	-0.02	-0.64	0.56	-0.27	0.51					
$Market\_Cap_{i,t}$	0.31	0.27	0.31	-0.06	0.28	0.14	-0.38	0.62	-0.11	0.47	0.69				
$Pension_{i,t}$	0.20	0.19	0.17	-0.02	0.17	0.01	-0.42	0.50	-0.18	0.29	0.59	0.66			
$Corp\_Tax_{i,t}$	0.12	0.11	-0.05	0.39	-0.46	0.06	0.40	-0.10	-0.06	-0.26	-0.21	-0.16	-0.22		
$ST\_Interest_{i,t}$	0.17	0.14	0.13	0.02	-0.08	0.24	0.03	-0.26	0.31	-0.26	-0.05	-0.17	-0.09	0.22	
$LT\_Interest_{i,t}$	0.02	-0.06	-0.04	-0.14	-0.36	0.03	0.24	-0.47	0.12	-0.49	-0.20	-0.40	-0.21	0.24	0.60

Table 3.1: Correlations of potential determinants of VC investments.

In order to cope with this problem I perform stepwise regression analyses that comprise two parts: forward selection and backward elimination. In the first part I start with an equation only incorporating a constant term and fixed effects as explanatory variables. I then calculate all *p*-values of the remaining explanatory variables, and enter the one with the lowest *p*-value into the equation, provided that this *p*-value is smaller than 0.1 and that the adjusted R^2 increases. This is repeated until no more variables can be added. In the second part, I delete the variable that has the highest *p*-value, provided that this *p*-value is larger than 0.1 and that deleting it increases the adjusted R^2. This is repeated until no further alterations are necessary. This process is done three times; one time for each of $Total_{i,t}$, $ES_{i,t}$, and $ER_{i,t}$. For $Total_{i,t}$ this process is reported in Table 3.2. It happened to be the case that backward elimination was not necessary in any of the three cases.

Table 3.3 presents the results of the regression analyses, which all pertain to fixed effects models. This choice for fixed effects stems from the desire to get rid of country-specific noise. The interest here is not (yet) in how efficient a certain country's VC policy is, but in what environmental factors drive VC investments across countries.

knowing that the ones not included may be relevant.

Regression Analyses*: Model Building					
Independent variables	Forward selection				
	(1)	(2)	(3)	(4)	(5)
	Dependent variable: $Total_{i,t}$				
$PC\_GDP_{i,t}$					0.00109
$Patent_{i,t}$		4.2415	5.66226	4.30437	4.58908
$PC\_RD_{i,t}$					
$CS\_RD_{i,t}$					
$Market\_Cap_{i,t}$	0.00086	0.00053	0.00048	0.00044	0.00037
$Corp\_Tax_{i,t}$			0.00152	0.00192	0.00194
$ST\_Interest_{i,t}$					
$LT\_Interest_{i,t}$				-0.00004	-0.00005
$GDP\_Cap_{i,t}$					
$Pension_{i,t}$					
$Struc\_Aggr_{i,t}$					
$Employ\_Prot_{i,t}$					
# Observations	396	376	365	351	348
Adjusted R^2	0.1954	0.2494	0.2862	0.3224	0.3491
R^2	0.2372	0.2937	0.3309	0.3701	0.3990

* The regression analyses are fixed effects models.

Table 3.2: Results of regression analyses to investigate the determinants of VC investments. Green and yellow backgrounds signify significance at the 1% and 5% level, respectively. Backward elimination was not necessary.

Estimation Results of Regression Analyses*			
	Dependent Variables		
Independent variables	$Total_{i,t}$	$ES_{i,t}$	$ER_{i,t}$
$PC\_GDP_{i,t}$	0.00109		0.00068
$Patent_{i,t}$	4.58908	2.02898	4.55718
$PC\_RD_{i,t}$			
$CS\_RD_{i,t}$			
$Market\_Cap_{i,t}$	0.00037	0.00015	
$Corp\_Tax_{i,t}$	0.00194	0.00053	0.00167
$ST\_Interest_{i,t}$			
$LT\_Interest_{i,t}$	-0.00005		-0.00004
$GDP\_Cap_{i,t}$			
$GDP_{i,t}$		1.67e-16	6.47e-16
$Pension_{i,t}$			
$Struc\_Aggr_{i}$			
$Employ\_Prot_{i,t}$			
# Observations	348	368	346
Adjusted R^2	0.3491	0.3632	0.4135
R^2	0.3990	0.4074	0.4593

* The regression analyses are fixed effects models.

Table 3.3: Results of regression analyses to investigate the determinants of VC investments are presented. Green, yellow, and red backgrounds signify significance at the 1%, 5%, and 10% level, respectively.

Two variables are significant in all three models. The number of filed patents is an important determinant, given that multiplying the estimated coefficient with the standard deviation results in a value of about 0.051% of GDP, indicating that the presence of technological opportunities significantly drives VC

investments. If the number of filed patents at the EPO per million inhabitants increases by 10, then the expected increase in total VC investments equals about, *ceteris paribus*, 0.0046% of GDP. For the Netherlands this would be an increase of about €28 million, or about €165.000 per patent.[130] The second variable is $Corp\_Tax_{i,t}$, which has an entirely surprising *positive* coefficient. Apparently VC investments have been higher in countries with higher corporate income tax rates.

The short-term interest rate does not have a clear effect, but the long-term interest rate does in the case of ER investments, perhaps because the amount of needed capital increases the further the innovation is in the VC cycle. This corroborates the idea that VC capital becomes more desirable when alternative sources becomes more expensive. The variable is economically significant as well; multiplying the estimated coefficient with the standard deviation results in a value of about -0.018% of GDP.

The presence of an active and liquid stock market is an important determinant of VC investments, especially of ES investments, given the significant estimate of the coefficient of $Market\_Cap_{i,t}$. This is corroborated by observing that even though they did not end up in the final equation, $Pension_{i,t}$ and $Struc\_Aggr_{i,t}$ are significant with the expected sign if they are included instead of $Market\_Cap_{i,t}$. This represents a very significant effect, for instance when we compare the Netherlands to the United Kingdom. During the years 2000-2010 the U.K. had an average market capitalisation of about 1.33 as a share of GP, and the Netherlands of about 0.98. The expected yearly total VC investments in the U.K. therefore were, *ceteris paribus*, 0.013% of GDP higher than in the Netherlands. It also shows the extreme vulnerability of the VC market with regard to the stock market. Market capitalisation rates in Europe decreased on average[131] by about 0.52% of GDP between 2006 and 2008, which according to the model corresponds to a decline of total VC investments of almost 0.02% of GDP.

The GDP growth rate is found to be a significant determinant.[132] VC investments thus seem to move cyclically with the business cycle, although the effects are nowhere near as large as in Ruis et al. (2009). It is estimated that if GDP growth were depressed by 1%, *ceteris paribus*, that the expected total amount of VC investments would decrease by about 0.001% of GDP. For the Netherlands in 2011, this would represent a decline of about 3%.

The growth of R&D expenditures does not seem to be an important determinant, nor do richer countries (i.e. those with a higher GDP per capita) seem to have more intense VC markets. It is worth mentioning that using alternative measures for the number of patents (the number of patents granted by the USPTO and the number of triadic patents) or for the measure of labour market rigidities does not significantly alter the results, nor does including trend terms or year dummies.

To end this section, let us have a look at where the Netherlands specifically stands with respect to the significant environmental variables. Table 3.4 shows the values of the environmental factors that were found to be significant in the regression analyses. The values pertain to the 18 countries for which no missing

[130] $CS\_RD_{i,t}$, the stock of R&D capital, has a similar effect when it is included instead of $Patent_{i,t}$.

[131] Based on the unweighted average.

[132] Lagged values of GDP growth have also been included, but they remained insignificant.

values were present for the relevant 2010 and 2011 data. In the columns 'Ranking' the place can be found that a country is in with regard to the corresponding factor. Number 1 refers to the country that has the most VC-friendly value, and number 18 to the one with the least VC-friendly value.

Environmental Factors – Recent Values										
COUNTRY	*GDP growth*		*GDP***		*Market capitalisation*		*Long-term interest*		*Number of filed patents*	
	Value	*Ranking*	*Value*	*Ranking*	*Value*	*Ranking*	*Value*	*Ranking*	*Value*	*Ranking*
Austria	5.00%	5	€ 300	11	0.20	13	3.32%	10	188	7
Belgium	3.85%	8	€ 369	9	0.45	10	4.18%	12	131	9
Czech Republic	3.95%	6	€ 156	17	0.18	15	3.71%	11	26	15
Denmark	1.68%	14	€ 239	12	0.54	6	2.73%	5	242	4
Finland	5.91%	4	€ 189	14	0.54	7	3.01%	6	218	5
France	3.06%	10	€ 1.990	2	0.57	5	3.32%	9	135	8
Germany	3.86%	7	€ 2.590	1	0.33	11	2.61%	3	266	3
Greece	-6.13%	18	€ 209	13	0.11	18	15.75%	18	7	18
Hungary	3.35%	9	€ 100	18	0.13	17	7.64%	15	20	16
Ireland	1.60%	15	€ 159	16	0.16	16	9.58%	16	79	11
Italy	1.71%	13	€ 1.580	4	0.20	14	5.42%	13	73	13
Netherlands	**2.25%**	**12**	**€ 601**	**6**	**0.71**	**3**	**2.99%**	**4**	**193**	**6**
Norway	11.01%	2	€ 347	10	0.45	9	3.14%	8	84	10
Portugal	-1.02%	17	€ 169	15	0.26	12	10.24%	17	10	17
Spain	1.38%	16	€ 1.070	5	0.69	4	5.44%	14	32	14
Sweden	10.76%	3	€ 387	8	0.87	2	2.61%	2	307	2
Switzerland	14.41%	1	€ 476	7	1.47	1	1.47%	1	379	1
United Kingdom	2.39%	11	€ 1.740	3	0.49	8	3.12%	7	77	12
AVERAGE*	2.19%		€ 704		0.46		5.01%		137	

* The averages are unweighted averages of the 18 countries listed in the first column.
** The GDP levels are in billions of 1999 euro's.

Table 3.4: The figures refer to the 2011-values of the mentioned environmental factors, except for the number of patents, which corresponds to 2010. The corporate income tax rate is excluded.

The Netherlands does not really score out of the ordinary with regard to GDP growth and size. The Netherlands scores decently with its number of filed patents, noting significantly more patents than the average. However, recalling the economic significance of the number of patents and observing the performance gap with Switzerland, Germany, and the Scandinavian countries, there may be scope for improvement. The score regarding the long-interest rate is quite favourable as well. The Netherlands, finally, scores highly with regard to rate of market capitalisation. The U.K., a known 'market-based country', is remarkable with a market capitalisation rate in 2011 only just above the average, even though in 2010 the rate was still 1.38 – representing a decline of about 64%.

It seems that the Netherlands does not have the most favourable VC environment, but there also do not seem to be any major barriers present that would obstruct the development of VC markets altogether.

3.3 Data Envelopment Analysis (DEA)

Before performing the benchmarking analyses using linear programming, Subsection 3.3.1 will briefly introduce the method of *data envelopment analysis* (DEA) and mention some recent applications of DEA in the field of innovation policies. Subsection 3.3.2 will explain why DEA is used in this Thesis, and elaborate on the method's strengths and advantages. Subsection 3.3.3 will mention some notable weaknesses of DEA in the case of this Thesis. Subsections 3.3.4 will present results and some interpretations, and Subsection 3.3.5 will try to derive lessons for Dutch VC policy from best practices present in other counties. The relevant mathematical foundations and a formal research methodology can be found in the Appendix to Chapter 3 (p. 115).

3.3.1 DEA: How does it work?

The central idea of DEA is that it assesses how efficient decision making units (DMUs) use inputs to produce outputs. I use Ten Raa (2009b) as a guide for my analyses, because it is clear and concise, and because it clarifies the insights DEA can provide.[133] I will also use it here to show why and how DEA can help scoring VC policies.

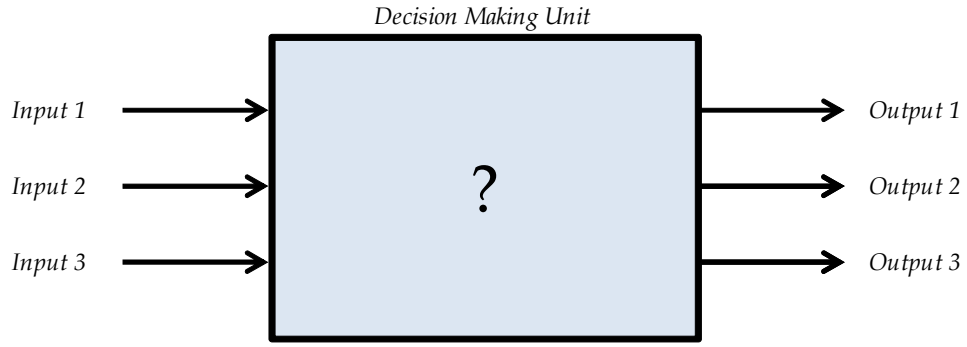

Figure 3.1: A representation of how DEA views DMUs.

Figure 3.1 shows that inputs enter a DMU, which then 'does something to and with these inputs', in turn resulting in certain outputs. The choice for 3 inputs and 3 outputs in Figure 3.1 is arbitrary. The question mark is put there, because DEA treats DMUs as *black boxes*. DEA is non-parametric; it does not assume any specific relation between inputs and outputs (i.e. it does not assume any specific production function), but it uses linear programming to determine which DMUs are efficient and which are not.

To see how, let us assume a simplified situation of four countries, with one input, x, that is deemed important for venture capitalism, and two outputs, y_{ES} and y_{LS}, which represent the total amounts of early stage and later stage VC investments. We can normalise these for every country, or DMU, by rescaling them in such a way that the inputs of every DMU are equal to 1. We can now plot them in a graph.

[133] Some other, usual references are Charnes, Cooper, and Rhodes (1978), Banker, Charnes, and Cooper (1984), and Ray (2004).

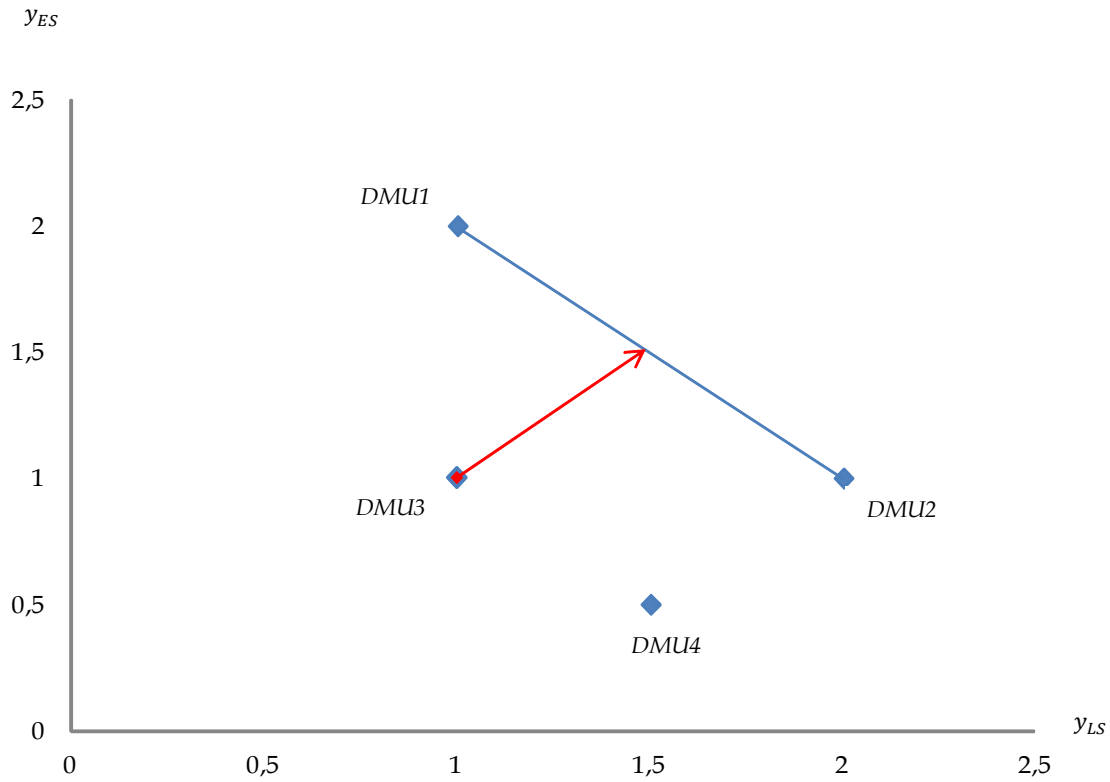

Figure 3.2: A graph showing four DMUs, with one input and two outputs, derived from Figure 3.2 of Ten Raa (2009b, p. 37).

In Figure 3.2 we see that using 1 unit of input x, DMU1 produces 2 units of y_{ES} and 1 unit of y_{LS}, DMU2 produces 1 unit of y_{ES} and 2 units of y_{LS}, DMU3 produces 1 unit of y_{ES} and 1 unit of y_{LS}, and DMU4 produces 0.5 unit of y_{ES} and 1.5 units of y_{LS}. Let us consider the case of DMU3. Intuition probably informs you that, in any case, DMU3 is not operating efficiently, because using the same amount of inputs, DMU1 and DMU2 succeed in producing more outputs.

DEA assumes that best practices can be copied. That is, DMU3 can improve its efficiency by copying the practices of DMU1 and DMU2, and moreover, that it can do so in a linear way. For instance, the red arrow indicates that by copying the practices of DMU1 and DMU2 with weights of ½, production could be increased to (1 ½, 1 ½), still using the same amount of inputs. This represents a 50% growth. Following Ten Raa (2009b), we can thus conclude that DMU3 operates inefficiently. More precisely, since it produces only about ($\frac{1}{1.5} \times 100\%$=) 67% of its potential output, DMU is only 67% efficient when it is compared to its benchmarks (DMU1 and DMU2).[134] Moreover, DEA points out that DMU4 is *not* a benchmark for DMU3, because copying its practices would mean trading off y_{ES} for y_{LS}. Qualitative judgments are then required to determine whether the new situation is preferred to the old.

Similarly, the efficiency rates of DMU1 and DMU2 would be 100%, since they are on the north-eastern frontier. Such efficiency rates can be calculated regardless of the number of inputs and outputs and the

[134] A similar analysis could determine how much DMU3 could reduce the usage of its inputs while keeping the same amount of output, by copying the practices of its benchmarks. This is called an input-oriented approach. The output-oriented approach is the one used here, for reasons that will be explained later on in this section.

number of benchmarks that happens to be present. How this is done exactly is explained in the Appendix to Chapter 3 (p. 115).

A recent and relevant application of this DEA technique is Cincera, Czarnitzki, and Thorwarth (2009), who recognise the problems mentioned in the previous section, and resort to using DEA for assessing the efficiency of government R&D policy.[135] With regard to inputs, they distinguish three categories of government expenditures: R&D expenditures in higher education, R&D expenditures in other government institutions, and government subsidies. The one output they consider is private R&D spending. For the Netherlands, for instance, they find an efficiency score of 1.147, which refers to an efficiency rate of about 87%, and that the relevant peers are Croatia, Japan, Luxembourg, and Switzerland.

Subsequently, they investigate the determinants of these efficiency scores. They perform Tobit regression analyses using some explanatory variables, such as the average GDP growth and an indicator of the legal structure and security of property rights.[136] Wang and Huang (2007) follow a similar approach, firstly applying DEA, followed by quantifying environmental effects using Tobit regressions. They, however, use different input and output variables, and do not report country-specific outcomes. It would perhaps have been ideal to perform an analysis similar to those referenced, but I am not able to do so, for the same reason as it is fairly impossible to calculate a societal return on VC policy: the inputs are not available.

Following Cincera, Czarnitzki, and Thorwarth (2009), I decide to take (the components of) VC investments as output variables, and not so much the economic or employment growth it may have created in turn. This choice is informed by the observation that the Dutch Ministry of Economic Affairs, as well as equivalent Ministries in other countries, explicitly state that the *direct goal* of its VC policy is to stimulate venture capital.[137] Efficient VC policy should thus result in high(er) VC investments. I take the components of VC investments (instead of their sum) because Subsection 1.4.2 showed that they have developed distinctly differently and that they are influenced by varying environmental factors in different ways. Taking the sum of all VC investments would be harmfully simplifying. Following Da Rin, Nicodano, and Sembenelli (2005), VC investments are scaled using population figures.

With regard to the inputs, I deviate from the approach taken by Cincera, Czarnitzki, and Thorwarth (2009). They take policy variables as inputs, calculate the efficiency rates, and then investigate how certain environmental conditions affect whatever takes place in the black box (i.e. the efficiency rates). I will do it the other way around; as inputs I take environmental factors that are present in certain countries, and I determine how efficiently these countries have transformed such factors into VC investments. I then investigate how policy measures have influenced these efficiency rates. This is depicted by Figure 3.3.

[135] They also used a different but related approach, *stochastic frontier analysis*.

[136] I will also use these two explanatory variables, as well as some additional ones.

[137] Similarly, the Barcelona European Council in 2002 agreed that R&D spending in the European Union should be as high as 3% of GDP.

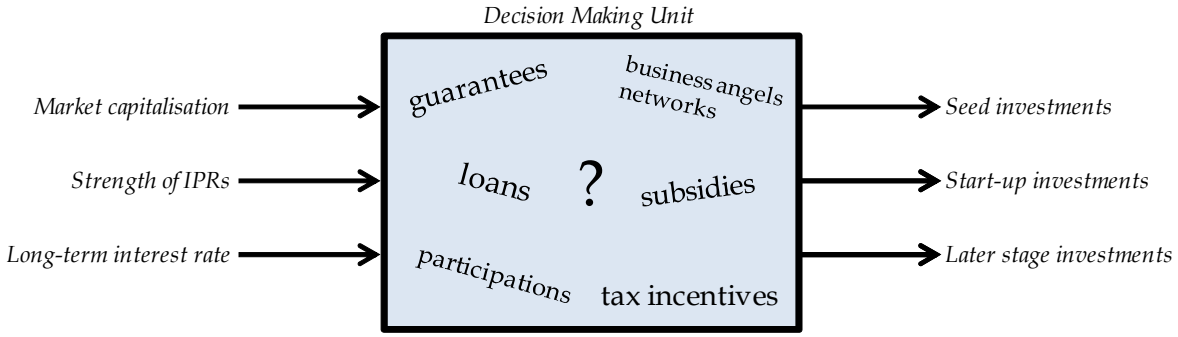

Figure 3.3: A representation of a DEA-model of VC policies.

Figure 3.3 shows three inputs: the market capitalisation rate, the strength of IPRs, and the long-term interest rate. The inclusion of the strength of IPRs is informed by the discussion in Chapter 3, which deemed it crucial to the development of a VC market. The used indicators are retrieved from Park (2008), which presents them for the years 1995, 2000, and 2005, and which vary from 1 (very weak IPRs) to 5 (very strong IPRs). I take the 2005-value as the input variable here. The market capitalisation rate and the long-term interest rate are included based on the results of Section 3.2 and have already been collected and computed. Following Wang and Huang (2007) and based on the results of Section 3.2, the R&D capital stock is included as well. Finally, based again on the Section 3.2 results and on Cincera, Czarnitzki, and Thorwarth (2009), I also include GDP growth rates.[138]

The data on the three VC components is only available from 2007 onwards. I will therefore investigate the years 2007-2011 first. I average the inputs and outputs for these five years, and subsequently perform the DEA. I use averages because some inputs and outputs may be quite volatile, especially considering that the 2007-2011 years were characterised by several (financial) crises, which reached countries at different moments and with different magnitudes.

A less detailed decomposition of VC investments, into early stage (ES) and expansion and replacement (ER) investment can be constructed from Eurostat databases, as has been explained in Subsection 1.4.1. It would therefore be possible to track the development of efficiency rates further back than 2007. For the strength of IPRs, indicators are available for 1995, 2000, and 2005. Linear inter- and extrapolation is used to obtain yearly indicators. For the other mentioned inputs, yearly data is available from 1996 onwards. Hence, it is possible to follow the development of efficiency rates based on the mentioned inputs and outputs during the years 1996-2011. I compute efficiency rates based on averages of three years.

3.3.2 Advantages and strengths

My approach has several advantages and strengths. First of all, it allows for straightforward and meaningful interpretations. Section 3.2 showed that certain environmental factors are important determinants of VC

[138] Except for the long-term interest rate, for every input it holds that the more it is available, present, or applicable, the higher VC investments are likely to be. This means that incorporating them in linear programming constraints is straightforward, as the Appendix to Chapter 3 (p. 108) illustrates. Table 3.3 shows that the coefficient of the long-term interest, if significant, is estimated to be negative. This means that the constraint should be adapted. I do so by transforming the average long-term interest rates into a score that linearly increases with decreasing rates, where the minimum observed interest rate gets a score of 5, and the maximum observed interest rate gets a score of 1. This indicator can vary along the same scale as the IPR indicator.

investments. My approach enables me to say something about *how well national VC markets have developed taking into account environmental factors*. This is important, because it is unrealistic to assume that a new Silicon Valley can (easily or swiftly) be created in the Netherlands (or anywhere else), since a multitude of conducive institutional and cultural factors that helped spur the success of Silicon Valley are absent or lacking in the Netherlands.

As Chapter 2 explained, government VC policy should be aimed at fixing or compensating for market failures. These market failures are represented here by the input variables. If a certain country performed better (that is, if VC investments have been higher) than in some other country, even though it had similar 'inputs' (that is, even though both countries were bothered by similar market failures), then its VC policy has been more effective. This is what Figure 3.3 tries to convey: countries have to deal with inputs (i.e. the environmental factors), using the instruments that are available to them (loans, subsidies, etc.), with the goal to maximise VC investments. The efficiency rates are therefore true performance rates.

Clearly, the goal should be to have efficient policies, so a strict assessment rule would be to conclude that every country that is not a benchmark has failed with regard to its VC policies. It seems more sensible to consider a boundary of about 75% or 80%, but such a boundary is by necessity arbitrary. The efficiency rates themselves, however, are not arbitrary; e.g. a country with a 90% efficiency rate performs better than one with a 50% efficiency rate. The efficiency rates can thus be used to rank countries. Other methods, like regression analyses, are not able to create such rankings. Moreover, in order to determine the efficiency rates DEA can consider *multiple* outputs. Other methods often fail to incorporate multiple output (or dependent) variables.

DEA enables one to score government VC policies by comparing them to how countries with similar input-sets have performed. But perhaps the most useful aspect of DEA is the following. If a country has performed inefficiently, then benchmarks *must* be present. These benchmarks can be identified. So, if the analyses point out that the benchmarks for the Netherlands are, say, Italy and Belgium, then apparently Italy and Belgium have used policy instruments better to deal with similar market failures as those present in the Netherlands. Thus, in order to improve its VC policy, Dutch government officials should consider taking a close look at the policy practices in Italy and Belgium. This is a feature of DEA that other methods, like regression analyses, do not have, and which is thus a reason why using it may generate new insights and contribute to the literature, since as far as I am aware it has not been used in the context of VC policies before, nor have environmental factors been used as inputs.

This provides part of the explanation why the output-oriented approach is justified. The inputs are hard to change, since they are exogenous factors. Applying an input-oriented approach, which tries to minimise the used inputs keeping output levels unchanged, would not make sense here, since these inputs cannot be changed easily anyway. An output-oriented approach is appropriate, because it leaves the inputs unchanged, and it investigates how output may be increased by adopting best practices. There is an additional reason why an output-oriented approach is appropriate, which is articulated by Cincera, Czarnitzki, and Thorwarth (2009, p. 28), who investigate the efficiency of R&D policies. They defend a

> focus on output-oriented measures of technical efficiency. In a revenue maximizing perspective, a reasonable justification to use the output oriented measure rests in the fact that the main objective of

R&D policies is to maximize private R&D activities (output) and not to minimize the funds (inputs) used to achieve this goal.

DEA provides shadow prices for the input variables. Shadow prices indicate what an increase in the input variables would mean for the output variables. It thus indicates which input variables are most valuable in marginal productivity terms. This is relevant regarding the approach taken here. Changing environmental factors is difficult and costly; one had therefore better be sure that changing (one of) them is worthwhile. Moreover, if there is one entity that can legitimately see environmental factors as input variables, it is the government.[139]

Lastly, DEA is *a method* to quantitatively assess the entire mix of VC policies. It comes with notable weaknesses and its results need to be interpreted with caution, but I am not familiar with any other quantitative method that succeeds in doing so.

3.3.3 Weaknesses

My approach also has notable weaknesses that should be kept in mind. Firstly, efficiency is determined only relative to the benchmark countries. It might be the case that these benchmark countries have inefficiencies as well, but since there is no country outperforming them within this model, DEA is not able to identify them.

Secondly, the results of DEA heavily depend on the choice of input (and output) variables. I use the results of Subsection 3.2.2 to justify the choice of input variables, which given the R^2-values of Table 3.3 (p. 61) seems justified. But, for instance, these regression analyses controlled for country-specific noise, which might to a certain extent have been caused by country-specific environmental factors. The DEA will not be able to control for these, and it is for this reason that conclusions as to which countries are relevant for VC policy lessons should be derived and interpreted with caution.[140]

Thirdly, since the input variables specifically do not take into account VC policy measures, the calculated efficiency rates might be too high for countries that have spent relatively much on such policies – no wonder a country is 'efficient' if a government decides to supply VC subsidies worth 10% of its GDP. This is an additional reason why conclusions should be derived and interpreted with caution, and why a prudential qualitative comparison of Dutch VC policy with that of its potential benchmarks should be made. In addition to the reasons mentioned in Section 3.1, it is therefore recommendable that data is collected on the efforts and costs of (national) VC policies, and subsequently harmonised. This way, inputs can be included that reflect countries' efforts to stimulate venture capitalism. This weakness is thus not a weakness of the method itself, but one of lacking data.

Fourthly and lastly, the results reported here pertain to DEA using constant returns to scale.[141] One

[139] In interviews I conducted for this Thesis, most interviewees even indicated that getting the environment right, which implies that environmental factors are to a certain extent seen as inputs, is even the *main* objective for governments in the case of venture capitalism.

[140] Although they do not mention it, this problem is also relevant for the analyses in, for instance, Cincera, Czarnitzki, and Thorwarth (2009). As a sensitivity analysis I replaced input variables by related determinants, as described in Section 3.2, which did not significantly alter the results for the Netherlands.

[141] Chapter 6 of Ten Raa (2009b) explains that the assumption of constant returns to scale can be adapted by assuming decreasing, increasing, or variable returns to scale. Incorporating this in the linear programming would boil down to adding restrictions that,

interpretation is that if twice as many inputs are available, then twice as much can be produced as outputs. This may be somewhat unrealistic, especially since some inputs take the character of *condiciones sine quibus non*.[142] This, once again, emphasises that conclusions should be drawn with caution.[143]

3.3.4 Results

Benchmarking (2007-2011): Results			
Country	*Efficiency*	*Peers**	*Potential Growth*
United Kingdom, Norway, Ireland, Switzerland, Denmark	100%		
Portugal	99.3%	United Kingdom (65%), Norway (35%)	0.7%
Sweden	91.8%	Denmark (48%), Norway (26%), Switzerland (26%)	9.0%
Finland	89.5%	Norway (75%), Ireland (38%)	11.8%
France	74.5%	United Kingdom (51%), Norway (49%)	34.2%
Spain	73.9%	United Kingdom (87%), Norway (13%)	35.4%
Belgium	64.9%	Norway (81%), United Kingdom (17%), Ireland (3%)	54.2%
Netherlands	64.2%	Norway (61%), United Kingdom (23%), Ireland (17%)	55.7%
Austria	62.8%	Norway (100%)	59.3%
Germany	51.2%	Norway (60%), Ireland (40%)	95.4%
Poland	48.0%	United Kingdom (62%), Norway (38%)	108.1%
Hungary	47.7%	United Kingdom (54%), Norway (46%)	109.9%
Greece	26.9%	Norway (98%), Ireland (2%)	271.8%
Italy	10.7%	Norway (65%), United Kingdom (22%), Ireland (13%)	838.3%
Czech Republic	8.6%	Norway (69%), United Kingdom (31%)	1067.7%

* The mentioned countries are the countries that, apparently, have successfully implemented VC policies that are relevant to the country in the first column. Percentages may not add up to unity because of rounding.

Table 3.5: Results of the benchmarking analyses for the years 2007-2011, pertaining to 3 outputs.

Table 3.5 presents the results of the DEA pertaining to the years 2007-2011. Firstly, it may be observed that the United Kingdom, Norway, Ireland, Switzerland, and Denmark apparently have efficient VC policies. Looking at the third column, it can be observed that Norway and the United Kingdom are the most

respectively, assume that the sum of weights with which best practices are copied is smaller than 1, either larger than 1 or equal to zero, or equal to 1. Using them does not result in significantly different results.

[142] See Subsection 3.1.1, from page 31 onwards.

[143] Figure 1 in Cincera, Czarnitzki, and Thorwarth (2009, p. 20) provides a schematic overview of the strengths and weaknesses of DEA and similar methods.

significant benchmarks. Looking at the data, the United Kingdom is a benchmark because it performed well despite a low GDP growth, and Norway because on average it had by far the highest seed investments as a share of GDP. This is interesting for the Netherlands, given that Table 1.2 (p. 23) indicated that in crisis years seed investing almost came to a complete standstill. On the bottom end of the table, the Czech Republic and Italy perform particularly poor, with potential growth rates exceeding 800%.

With regard to the Netherlands, Norway seems to be the most important benchmark. As mentioned, especially the high levels of Norwegian seed investments play a role here. Furthermore, the inputs of Norway are similar to the Dutch ones, although economic growth was notably higher in Norway. The United Kingdom and Ireland are benchmarks not because they had the highest VC investments in any of the components, but because they scored decently well despite low economic growth.

The latter conjecture is corroborated by the shadow price (of 0.1157, if GDP growth is measured in percentages) of the constraint that relates to economic growth, which indicates that if economic growth were to increase by 1%, this would further increase output by about 7.43%.[144] This once more emphasises the cyclicality of VC markets, and this time specifically for the Netherlands. The shadow price of the R&D capital stock is positive as well, indicating that (indeed) VC activity is restricted by the technological opportunities that present themselves. Perhaps equally important is the observation that the constraints that relate to the long-term interest rate, the market capitalisation rate, and the strength of IPRs are nonbinding (i.e. they have a zero shadow price). These last three factors, thus, do not seem to be the bottlenecks to further increase venture capitalism.

If the Netherland were able to perfectly copy the practices of Norway, the United Kingdom, and Ireland with the indicated intensities, staying within the boundaries drawn by the availability of inputs, it could increase start-up and later stage VC investment by more than 50%. The most striking result, however, is that seed investments would *triple*. Although such results should not be taken too literally, it clearly indicates that there is scope for improvement with regard to policies to allow for and stimulate increased seed investments. The overall efficiency rate is only 64.2%, which indicates that during 2007-2011 Dutch government policy to stimulate venture capitalism has been *inadequate* compared to its peers.

It is notable that the two most important benchmarks, the United Kingdom and Norway, are non-Euro countries. It cannot be excluded that the recent and current instability in the Eurozone has and had an effect on the decisions of venture capitalists, especially since VC investments take multiple years to earn a profit.

The next results pertain to the period 1996-2011. The input variables are the same as for the DEA that pertained to the 2007-2011 period. The used output variables are early stage (ES) and expansion and replacement (ER) VC investments. Despite some differences, it may first be observed from Table 3.6 that for the latter years (say, from 2006 onwards) similar countries (under)perform as was the case according to Table 3.5, which is reassuring with regard to the robustness of the results. Some efficiency rates may be notably and seemingly unexplainable high - for instance, if one considers the 100% efficiency for Greece

[144] $\left(\frac{0.1157}{1.5573}\right) \times 100\% \approx 7.43\%$.

(and to a lesser extent Hungary) for the period 2009-2011. This can be explained, however, by observing that during these years these countries had extremely unfavourable inputs (e.g. severely depressed economic growth, skyrocketing interest rates, and shrinking market capitalisation rates) which would prohibit even the slightest attempt to copy best practices, since input constraints would be violated immediately.[145]

Benchmarking (1996-2011): Efficiency Rates															
	1996-1998	*1997-1999*	*1998-2000*	*1999-2001*	*2000-2002*	*2001-2003*	*2002-2004*	*2003-2005*	*2004-2006*	*2005-2007*	*2006-2008*	*2007-2009*	*2008-2010*	*2009-2011*	***Average***
United Kingdom	100.0	100.0	100.0	96.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	***99.8***
Norway	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90.6	82.9	100.0	100.0	100.0	100.0	100.0	***98.1***
Sweden	59.1	84.2	95.2	100.0	100.0	100.0	100.0	93.8	100.0	88.2	92.1	100.0	100.0	100.0	***93.8***
Switzerland	100.0	100.0	82.0	61.8	47.7	57.7	100.0	100.0	63.6	83.1	70.9	100.0	100.0	100.0	***83.3***
Ireland	66.0	86.6	100.0	100.0	100.0	99.1	76.9	72.1	47.4	50.8	43.1	100.0	100.0	100.0	***81.6***
Denmark	28.2	31.7	51.4	84.6	100.0	100.0	100.0	100.0	100.0	100.0	70.9	63.5	88.7	100.0	***79.9***
Portugal	17.6	91.6	79.0	76.1	76.3	100.0	100.0	100.0	60.4	61.5	52.9	100.0	100.0	100.0	***79.7***
Netherlands	100.0	100.0	100.0	100.0	100.0	100.0	75.9	58.1	52.2	46.7	42.4	73.4	84.8	72.0	***79.0***
Spain	61.2	73.5	72.3	100.0	100.0	100.0	100.0	98.5	70.0	60.0	68.6	89.6	48.7	37.9	***77.2***
Finland	78.8	65.2	87.6	100.0	100.0	92.0	81.2	64.1	40.7	42.0	38.0	78.6	100.0	100.0	***76.3***
Belgium	100.0	100.0	100.0	100.0	100.0	55.1	47.4	30.8	38.6	42.5	71.1	98.8	87.2	77.2	***74.9***
Germany	100.0	100.0	100.0	100.0	92.4	48.6	43.5	43.4	31.8	31.6	36.2	52.2	47.0	46.3	***62.4***
Poland	79.6	98.0	100.0	100.0	86.6	64.5	100.0	58.5	33.6	24.3	18.4	26.3	29.0	17.6	***59.7***
Italy	64.2	46.1	55.4	60.3	69.4	79.4	67.3	40.7	38.9	35.6	38.5	49.9	61.6	55.3	***54.5***
France	62.5	56.7	67.9	63.4	66.6	48.4	52.4	41.4	35.5	32.9	37.1	64.5	69.9	63.1	***54.4***
Austria	43.0	50.6	76.6	93.3	86.7	66.8	64.0	38.6	31.6	21.5	21.8	27.5	46.9	50.9	***51.4***
Greece	53.6	56.6	100.0	100.0	96.5	71.7	28.2	10.1	3.3	2.9	4.3	7.1	8.5	100.0	***45.9***
Hungary	40.1	41.3	46.8	32.9	36.6	41.8	63.5	66.4	49.7	25.4	19.1	15.3	19.5	100.0	***42.7***
Czech Republic	17.4	23.9	68.8	69.4	67.1	24.7	15.3	4.5	3.0	1.8	1.7	4.1	9.4	16.4	***23.4***

* The presented averages are unweighted averages of the numbers in the same row, before it.

Table 3.6: Results of the benchmarking analyses for the years 1996-2011, pertaining to 3 outputs. All figures are percentages.

The countries that performed well throughout the entire period are the United Kingdom, Norway, and Sweden, in which evidently VC-favourable environments have been created. The Czech Republic is a notable underperformer scoring an average efficiency rate of only 23.4%. The VC policies of Germany, Poland, Italy, France, Austria, Greece, and Hungary also seem to have been largely unable to deal with the relevant environmental factors.

The Netherlands scores a 79% efficiency rate, which indicates that a decently VC-friendly climate was created for most of the time. Table 3.6 and (more clearly) Figure 3.4 show that VC policies were inadequate during 2007-2011 (thus corroborating the results of Table 3.5), but that in the beginning, during

[145] Although intuitively full efficiency rates in such cases may appear to be an undesirable result, they actually are not. If countries are characterised by extremely adverse conditions, then this may simply mean that no other countries are around that have similarly worse conditions. VC policies would have a negligible effect in such environments, and these countries thus have other things to worry about, such as retrieving the trust of markets (i.e. lower interest rates) by starting to grow economically again, which would relax at least two of the input constraints, and open up opportunities to copy best practices again.

the years 1996-2003, when the Netherlands was actually a benchmark country,[146] policies apparently were more effective. However, please bear in mind that these efficiency rates are *relative* – they are calculated with reference to benchmark countries. It may thus be the case that Dutch VC policies did not so much worsen but rather that VC policies of other countries improved. Recalling that the Dutch were frontrunners with regard to VC intensity during the years 1995-2002,[147] it may well be the case that the Netherlands actually served as a role model for other countries.

The relative performance of Dutch VC policy declined rapidly during the years 2004-2008. What strikes is that during these years the average relative performance (which one might expect to be constant) declined as well. This can be explained diverging performances: if certain benchmark countries start outperforming every other country, than the efficiency rates of the benchmarks will remain 100%, but the other rates will decrease, resulting in a decreased (unweighted) average relative efficiency. After the dot-com crisis, performances diverged. They converged again during the recent crises years.

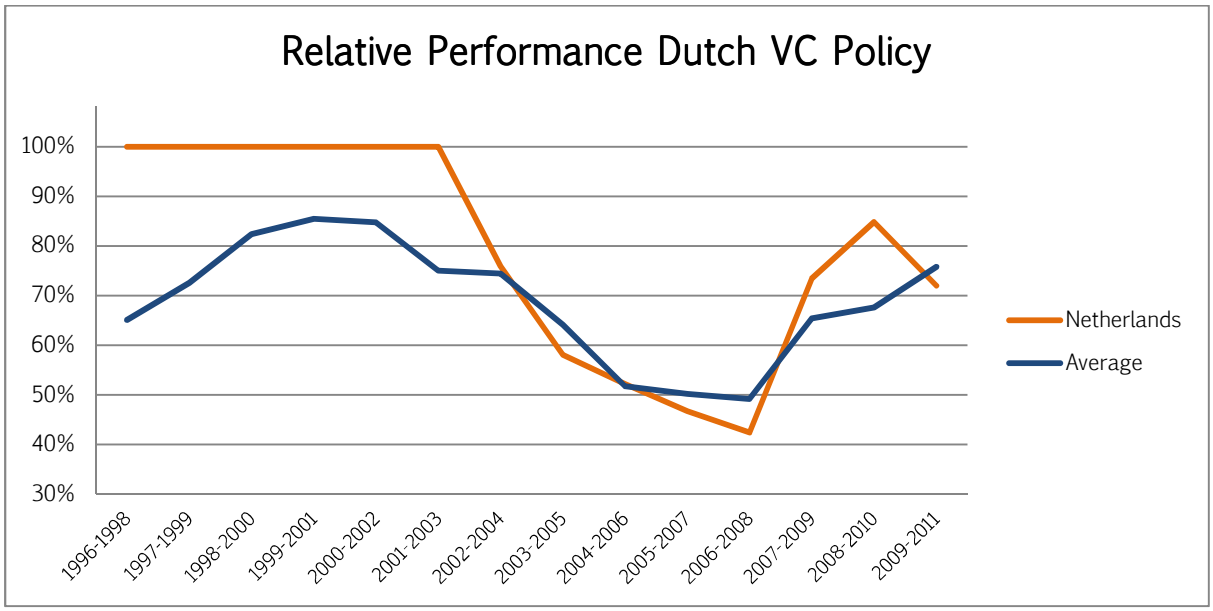

Figure 3.4: The graph presents the relative performance of Dutch VC policy as measured by the efficiency rate, and the unweighted average off all other countries' efficiency rates.

Figure A.3.1 (p. 120) presents Dutch government policy measures to stimulate VC directly or to make the environment more VC-friendly (e.g. by stimulating innovation). Although we must be careful with linking the results of Figure 3.4 to what Figure A.3.1 depicts, we cannot rule out that the relative underperformance of the years 2004-2008, can at least partially be explained by inactivity on the government's part. The articles of Baygan and Tejada, reviewed in Section A.2 (p. 112 and further), described that many countries implemented a series of VC policy initiatives in the early 2000s. According to Figure A.3.1, it was only in 2006 and 2007 that the Dutch government initiated a series of similar policy initiatives. Fund-of-funds, for instance, have been present for several years in Norway and the U.K., whereas the first one is only

[146] According to the DEA results, the countries that could have improved their policies by learning from Dutch practices include Poland, the Czech Republic, Denmark, Ireland, Spain, France, Italy, Sweden, and even the United Kingdom in the one year it was not a benchmark itself.

[147] See Figure 1.6 on p. 26.

scheduled to be implemented at the time of writing in the Netherlands.

The next section will delve deeper into the policies implemented in the two most important benchmarks of the Netherlands (Norway and the United Kingdom) to investigate what possible policy lessons may be, and how the Netherlands may regain the status of a (potential) role model.

3.3.5 Benchmark of the Netherlands: Norway

While exploring the literature on the second-most important two benchmarks, the U.K. and Ireland, it appeared that recommendations based on these explorations would be very similar to the recommendations formulated in Section 2.3. This should not come as a surprise, especially given the status of the U.K. as a leader in venture capitalism in Europe. Lessons from the U.K. and Ireland would include, for instance, that VC policies should not be used to fight regional economic backwardness, that the institution of second-tier stock markets would be recommendable, that co-investing is preferred to providing full subsidies, that fiscally stimulating innovation is worthwhile, and (especially in the case of Ireland) that public procurement may be effective.

This subsection will therefore focus on Norwegian government policies, because they might contain new lessons and because the DEA pointed out that it is the most important benchmark. This subsection does not aim to provide a full description of the Norwegian innovation and VC policies, but will rather highlight relevant developments and notable dissimilarities with Dutch practices. This section tries, so to say, to shed a light in the Norwegian black box.

Baygan (2003h), who assessed Norwegian VC policies about a decade ago, was predominantly negative, indicating that much remained to be improved, but that the Norwegian government was in the process of enacting and implementing various reforms. Nowadays, a first major difference between the execution and implementation of Dutch and Norwegian innovation policies is that in Norway responsibility resides in three separate, (quasi-) independent organisations, instead of within Ministries:

> Three agencies have the main responsibility for implementing national innovation and industry-oriented R&D policies: The Research Council of Norway, Innovation Norway[148] and SIVA - the Industrial Development Corporation of Norway. (Scordato, 2011, p. 3)

Moreover, the "[l]evel of cooperation between the three major research and innovation bodies Innovation Norway, RCN and SIVA was found to be well defined and fruitful", and as regards the RCN, it helped to "coordinate the national research effort by consolidating the number of programmes and designing programmes that tackle the needs of multiple ministries".[149] This is relevant, because Stuiveling and Van Schoten (2011) argue that although the responsibility of Dutch innovation policies from 2010 onwards resided entirely with the Minister of Economic Affairs, whereas previously several Ministries shared responsibility, coordination is still lacking. They particularly indicate that this lack of coordination resulted in departments following their own innovation policies, in a significantly increased number of subsidy programmes, and in scarcely any attention for environmental factors (which, as Section 3.2 pointed out,

[148] Innovation Norway is in fact part of the Norwegian Ministry of Trade and Industry.

[149] The first quote comes from Scordato (2011, p. 3), and the second from Arnold and Mahieu (2012, p. 11).

are very relevant). It may therefore be advisable to devise a more coherent national innovation strategy. This strategy should investigate what role governments policy should play and what part of these roles are already fulfilled by current programmes, eliminate unnecessarily overlapping of programmes, and where desirable create new programmes. More radically, it may be considered to outsource the implementation of innovation policies to a quasi-independent organisation with clearly specified goals.

Langeland (2007, p. 1153) indicates that the "geographical clustering of both venture capital firms and their investments in cities is [...] very clear." He describes that VC activities are particularly clustered in and around Oslo. The Norwegian capital contains 56% of the country's employment in computer services, the bulk of Norwegian financial firms, and 19 out of 21 main members of the NVCA – the Norwegian Venture Capital and Private Equity Association. Interviews with venture capitalists revealed

> that the reasons for this location pattern are first and foremost related to networking as a mix of proximity to investors, suppliers and competent labour, and to the socio-cultural factor understood as a milieu characterized by easy access to personal, face-to-face meetings; and a financial milieu and consultancy sector. This is all related to the innovation advantages of a city and the easy access to both fixed and relational assets. All venture capitalists emphasize the significance of being located in a large city, and in Norway Oslo seems to be particularly important. Geographical proximity and social relations are regarded as very important for getting early access to the deal flow. (Langeland, 2007, pp. 1153-1154)

A different pattern emerges for the Netherlands from Könings and Balk (2011), who provide a historical account of Dutch regional economic policies. Before the 1990s, government policies specifically aimed at spreading economic activity; for example, the *PTT Post* was transferred to Groningen and the new *DSM* was developed in Limburg. After 2004, innovation measures were also specifically used to develop economically backward regions. Könings and Balk (2011) mention that some results were the centre of excellence for sustainable water technology *Wetsus* in Leeuwarden, the logistical industry around Breda, the sensor technology industry between and in Groningen and Assen, and the *Health Valley* in Nijmegen. Regions that were not innovative were the ones receiving innovations grants. Könings and Balk (2011) argue that most projects appeared to be forced government initiatives. Recalling that, for instance, *Philips* is located in the Eindhoven area, and that most consultants and financial firms are located in Amsterdam, one can see that one advantage that the Norwegian VC market enjoyed compared to the Dutch one, is that relevant activities were more geographically clustered – although it should be kept in mind that Norway is much larger surface-wise and thus may have a greater interest in concentration policies. It may be advisable to take the geographical concentration argument into account, and at least refrain from deliberately spreading technologies across the country.

Another distinction becomes visible when policies regarding internationalisation are regarded. Rigby et al. (2012) is a very recent effort to evaluate the internationalisation efforts by the Research Council of Norway (RCN). The RCN has an 'Internationalisation Strategy', which "seeks to capitalize upon and realize the benefits for Norway of greater international cooperation in research" (p. 1). Used instruments to achieve this include the funding of joint, cross-border programmes, financial instruments establishing and strengthening long-term cooperation between Norwegian and foreign institutions, and reimbursing costs incurred by "Norwegian researchers, companies, and research institutions to participate more actively in international collaborative and competitive arenas" (p. 2). An important feature is the '*mainstreaming* of the

principle of internationalisation'; all programmes or initiatives the RCN supports must have targets for international collaboration. Rigby et al. (2012) contains a comparison with the Netherlands, where its equivalent would be the *Organisation for Scientific Research* (NWO). Despite some uncoordinated efforts to foster international research collaboration, such as opening up national programmes to international researchers, Rigby et al. (2012, p. 41) find that the "NOW does not have a dedicated internationalisation strategy nor a separate international department." Even more explicit is the following:

> There is no overarching internationalisation strategy in the Netherlands. The only strategy paper from a Dutch Ministry (Education, Culture and Science) dates from 2008 and is mostly focused on stimulating the individual Higher Education Institutions to become better at marketing themselves abroad and attracting students and researchers from abroad. Thus NWOs strategy is hardly steered by the ministries. (Rigby, et al., 2012, p. 41)

Scordato (2011, p. 5) adds that "Norway's scientific and technological cooperation with the USA and Canada has a long tradition", and that "bilateral research cooperation agreements have been signed with China, India, and Japan." Mostert and Deuten (2011) indicate that such (bilateral) agreements have not been part of Dutch innovation policy, but that the recently adopted 'top sectors' approach will investigate what role foreign policy could play. It may therefore be argued that the Norwegian VC market has benefited from closer links to other countries, created by the described internationalisation strategy. This could be part of the explanation why young and innovative Norwegian firms have been better able to attract foreign (and mostly U.S.) venture capital.[150]

A considerable Dutch measure generically stimulating innovation is the *WBSO*, with the Norwegian equivalent, of a smaller scope, being the *SkatteFUNN* scheme. Boekholt et al. (2001, p. 34) show that the Netherlands had extremely high tax incentives compared to other countries, which it still has. Norway, on the other hand, has more experiences with fund-of-funds and similar measures of co-investing with private parties. *Investinor*, for instance, is a government-funded investment company. It provides VC to companies in their (early) expansion stages. *Investinor* takes minority stakes in companies with an international growth potential, in sectors (like energy or maritime) of which the analysts have a deep knowledge. *Investinor* always syndicates its investments, thus engaging in co-investing, and controls a budget of about €460 million.[151]

Another example is *Argentum*, an investment company, created by the Norwegian Ministry of Trade and Industry in 2001. It invests in Nordic private equity and controls assets of about €1.3 billion. Via its *Nordic Private Equity Programme* (NPEP), *Argentum* invests in other private equity funds, who in turn invest in companies. Through its subsidiary *Argentum Secondary AS* (ASAS) investments are made in secondary markets since 2009, aiming to make the Nordic secondary market more liquid. Finally, *Argentum* co-invests with other private equity funds, preserving healthy incentives by requiring that the private equity funds invest at the same terms. *Argentum* states that it tries to invest countercyclically. The size of *Argentum* is

[150] Argentum (2012) indicates that the role of foreign private equity investors has been very significant. During 2011, Norwegian firms received over €1 billion in investments from foreign private equity funds, which represents more than 80% of the total. Additionally, over two-thirds of the exits concerned international investments in Norwegian firms.

[151] See the Investinor website: http://en.investinor.no/about-us.

considerable, which is why it cannot be ruled out that private investments are crowded out to a significant extent.[152]

Co-investment programmes also exist in the Netherlands, but investment vehicles like the NPEP and ASAS do not (yet). A fund-of-funds is scheduled to be created in the Netherlands at the time of writing, and based on the analysis here it can be expected to be successful. The size of this fund-of-funds (initially €150 million) is limited compared to its Norwegian equivalents.[153] Lessons from Norwegian (and other) experiences suggest to indeed let experienced fund managers with a proven track record make the investment decisions, and to refrain from incorporating social or regional development goals.

The data shows that Norway has noted by far the highest seed investments in the period 2007-2011. It is thus interesting to investigate the differences in policy practices with regard to this earliest stage of the VC cycle. Mr Johannesen from the Norwegian Ministry of Trade and Industry indicated that 15 seed capital funds have been established "to support and help Norwegian-based innovative young enterprises with a high-growth and international potential in the seed and start-up phases to grow by providing competence and capital." Six additional funds, which together will have about €400 million under management, may be established in upcoming years. The seed funds are independently run by managers who receive a market-based remuneration. The funds are not constrained to invest in certain industries, but they are allowed to specialise based on the specific expertise its investors and managers have. The funds' capital is provided for 50% by the Norwegian government, which is similar to the arrangements of the *SEED Capital Regeling* in the Netherlands. The major difference seems to be the scope. In the Netherlands, the *SEED Capital Regeling* and the *Microkredieten* are the programmes specifically targeting the earliest seed stage. Together they had about €150 million to provide in loans, guarantees, and equity capital. Only the proposed six new Norwegian seed capital funds would already have €400 million in management, which on a per capita basis is *more than 9 times as much* as the two aforementioned Dutch programmes. This may raise the issue of crowding out private investments and of a decrease in the overall quality of seed investments. The key question is therefore: what are the recorded or expected benefits and losses of the Norwegian seed capital funds?

This may provide part of the explanation of why seed investments have been so high in Norway. Another explanation can be found in the already discussed co-investment methods, including funds-of-funds. De Swaan et al. (2011) already indicated that the establishment of a fund-of-funds may be considered, because it would provide a more liquid and accessible exit market for seed investors. Although it is difficult to isolate the effect of their funds-of-funds, the Norwegian experience seems to indicate that this is well-informed advice.

It cannot be ignored that Norwegian VC policies, to a certain extent, have been more 'effective' because they had a larger scope. The Norwegian government has made considerably more efforts, both in financial and organisational terms, to stimulate venture capitalism. Whereas Dutch VC policies only started to be

[152] See the Argentum website: http://www.argentum.no/en/argentum/.

[153] Reid and Nightingale (2011, p. iv) specifically warn of undercapitalisation, since it "is vital to ensure schemes are large, as underfunded schemes guarantee failure". Lerner (2009) sounded similar warnings, and even from the outset it may thus be considered to expand the currently implemented fund-of-funds.

changed dramatically to adapt to 'new' insights in the late 2000s, Norwegian policies were already adapted in the early and mid-2000s, and their scale was increased during the recent crisis. This, however, cannot be the entire explanation. Scordato (2011) and Mostert and Deuten (2011) analyse innovation policies of Norway and the Netherlands, respectively, using the same framework. Comparing their results leads to the conclusion that both countries' governments spend about an equal amount per capita on innovation policies. Statistics from the OECD Science, Technology and Industry Scoreboard of 2011 indicate that the Dutch government spends even more than the Norwegian one on innovation (0.151% versus 0.136% of GDP).[154] This may be explained to a certain extent by the massive budget the *WBSO* takes up. Given the conclusion Reid and Nightingale (2011) draw that there "is limited evidence on the effectiveness of tax provisions (front or back end) in encouraging investors", it may be an option to use part of the *WBSO* budget for different measures. It should be kept in mind that VC is not the only source of innovation.

Norway also copes with the problem of illiquid second-tier stock markets, despite the efforts of *Argentum Secondary AS*. Argentum (2011) notes that since 2008 not a single firm that received private equity investments initiated an IPO. This might indicate, as Chapter 3 already suggested, that the establishment of a pan-European second-tier stock market may be considered, since even the benchmark countries should have an interest in it.

Finally, the recently initiated 'top sectors' approach by the Dutch government seems to be well-informed, as well as the more demand-driven focus within innovation policies, given that similar practices exist in Norway.[155] Differences can be found in the selected top sectors, which are explained by the countries' different comparative advantages. Public procurement is deemed to be successful in Norway, for instance through the industry and R&D grants given by *Innovation Norway*, which combines technological development with a market-driven and international approach. Innovation in the public sector is a major goal of this policy, where especially innovation in the healthcare sector receives attention.[156]

The most important results of this chapter will be integrated in the synthesis that Chapter 4 will offer.

[154] OECD (2011).

[155] See Izsak and Edler (2011) for the relevance of demand-side innovation policies, and how these are implemented in Norway and the Netherlands.

[156] See Scordato (2011).

4. Summary of Findings and Recommendations for Government Policy and Further Research

This chapter will synthesise the findings of the preceding chapters. It will summarise the case for (renewed or adapted) government intervention in VC markets, after which it will proceed to provide concrete policy recommendations, followed by brief justifications. Finally, it will list recommendations for further research.

4.1 Summary of Findings and Policy Recommendations

Venture capitalism is believed to be important to foster innovation, to stimulate long-term economic growth, and, eventually, to sustainably raise living standards. To date, attempts to quantify this importance have failed. This may be explained by methodological issues, lacking data, and the disruptive and unpredictable nature of innovations. However, its importance must also not be overstated; it is not the case that countries with increasing VC investments invariably experience a swift and conclusive increase in welfare. The anecdotal evidence and the theoretical reasoning, however, generally remain strong, so that it seems that governments should indeed have an interest in developing thriving VC markets.

The sketched development of the Dutch VC markets and its components gives rise to concern. Since the recent crises VC fundraising, investments, and divestments have been depressed. Seed investments and fundraising even came to an almost complete standstill, and not a single IPO was recorded between 2007 and 2011. Following economic crises and, in particular, stock market slumps, depressed VC activity is only to be expected. However, on average most other countries have observed fewer and less severe adverse developments. Moreover, the Dutch VC market has been overtaken by many European countries since 2003 (hence since before the onset of the recent crises) as regards its total size as a share of GDP, but also regarding each component. All of these developments, combined with the observation that banks have and had to become more prudent, call for adapting and adaptive government policy.

The majority of works studying venture capitalism emphasise the potential of and need for government intervention. Section 1.3 provided some theoretical foundations as to why VC markets may be more successful in some countries than in others. Section 3.2 provided proof in the shape of quantitative evidence; the variety of VC activity over time and across countries can to a large extent be explained by environmental factors, which can be adapted by government policy only with great effort, if at all. The potential of public policies thus has limits, and expectations should be set accordingly. Concretely: do not expect to create a new Silicon Valley and expect VC investments to move (very) cyclically.

Chapter 2, based on the literature, and Chapter 3, based on a comparison with countries that despite

having similar environments achieved higher VC investments, led to a number of insights. More to-the-point, they informed the following recommendations, which do not include 'traditional' recommendations (such as using co-investing rather than subsidies) but rather those that are not or less unequivocally mentioned in the literature, or that have not been fully incorporated in Dutch VC policies already:

- *Consider establishing a pan-European second-tier stock market*. This may improve exit opportunities by increasing liquidity and improving awareness, which would attract (larger) foreign VC venture capitalists. Given that this cannot be achieved unilaterally, that technological opportunities seem present, and that it may fall within the Single Market mandate of the European Commission, this should be advocated at a European level.
- *Do not mix goals of fostering venture capitalism with other, social and economic, goals*. Programmes that do combine them have been shown to be ineffective. Thus, do not restrict VC investments by region. Therefore, it is advisable to take the VC investments activities out of the *Regionale Ontwikkelingsmaatschappijen*, and to create a national fund (which may still have local offices and managers with regional expertise).
- *Induce environments to become and remain conducive of technological opportunities.* The demand-side is at least as important to the development of VC markets as the supply-side. If many projects are truly profitable and worthwhile, financing will tend to follow. This emphasises the importance of an environment that sprouts such projects, and in turn policies that encourage private R&D investments, patenting, and entrepreneurship.
- *Consider concentrating resources on VC rather than spreading them*. A radical policy would indeed concentrate resources, for instance through facilitating complementing factors to locate themselves in the Eindhoven area. A less radical policy would be to abolish the intentional spreading of resources, so that resources are allowed to concentrate on their own initiative. This could foster venture capitalism because a variety of factors is needed before it may flourish, and it is easier to achieve this at a local rather than at a national level.
- *With regard to innovation policies, strive for simplicity, coherence and internationalisation*. Currently, a relatively large number of programmes with overlapping goals is operative, which creates confusion. Consider creating a single organisation that is responsible for (the implementation of) VC or even innovation policies, preferably as a one-stop-shop. Improving coherence can increase effectiveness, by reducing overlap and increasing understanding. Internationalisation may comprise seeking bilateral agreements, which can be integrated in the recently launched 'top sectors' approach, and which can aid creating awareness among foreign venture capitalists.
- *Prevent undercapitalisation*. If it is decided that venture capitalism is stimulated, it should be done at a sufficient scale, with a significant intensity and a long-term perspective, allowing for follow-up investments. Small, short-lived funds are a waste of resources. The *SEED Capital Regeling* and the *Fund-of-funds* seem relatively small compared to successful foreign equivalents, and may thus be considered to be increased (or, alternatively, to be given part of the budget of, or be integrated with, for instance, the *Groeifaciliteit*).
- *Considering facilitating and creating awareness about crowdfunding*. While not requiring substantial government expenditures, crowdfunding may be particularly important to provide seed financing, since

seed investments have notably plummeted in the Netherlands in recent years.

- ***Decreasing the capital gains rate (further) may not be crucially important.*** Although a strong consensus seems to exist that decreasing the capital gains rate will stimulate venture capitalism, this Thesis finds no evidence for it. Other instruments may thus be more effective, and may thus be preferred.

4.2 Recommendations for Further Research

Several recommendations for further research can be formulated, mostly relating to harmonising and collecting data. This would fit well within evidence-based policy-making, as recently emphasised by Theeuwes et al. (2012).

The Dutch government does not possess an accurate oversight of the actual costs of its own VC policies, nor do many other countries with regard to their policies. It is recommendable to collect such data, for two main reasons. Firstly, in order to carry out instrument-specific evaluations, which investigate the efficiency and effectiveness of separate instruments following the suggestions of Theeuwes et al. (2012), it is necessary to know government efforts. Secondly, a host of research possibilities would open up if for a group of countries it was known how much they spent on, for instance, guarantees, loans, subsidies, tax incentives, and participations. Most notably, it would take away the major weakness of the DEA applied in Chapter 3, since effective countries might now actually just be spending a lot.

Subsequently, it would be worthwhile to plead for data harmonisation. This holds for government spending on VC policies, but also for patent datasets. If a dataset were created containing a list of companies of which you know how much government support they received, how many patents they filed (and how much were granted to them), how many workers they employ, etcetera, then this would greatly improve the possibility to conduct powerful statistical investigations into the positive externalities of venture capitalism and VC policies.

The results of this Thesis indicate that the VC policies of Norway, the U.K., and Ireland may contain best practices from which the Netherlands may learn. This Thesis already compared practices with these countries, and indeed tried to derive lessons from it, but it may be considered giving this some more elaborate and thorough attention.

Mostert and Deuten (2011) indicate that although some instrument-specific evaluations are available, no reports exist conclusively evaluating the effectiveness of innovation (or VC, for that matter) policies as a whole. Such research may include investigating what effect different instruments have on each other. A final recommendation would therefore be to undertake such research, despite difficulties as indicated by Lanser and Van der Wiel (2011) and Stuiveling and Van Schoten (2011). This Thesis may be used as a starting point.

Bibliography

Acemoglu, D. (2002). Technical Change, Inequality, and the Labor Market. *Journal of Economic Literature, 40*(1), 7-72.

Achleitner, A.-K., & Klöckner, O. (2005). Employment Contribution of Private Equity and Venture Capital in Europe. *CEFS Working Paper Series 2005-05*. Center for Entrepreneurial and Financial Studies, Technische Universität München.

Adams, J. D., & Griliches, Z. (1998). Research Productivity in a System of Universities. *Annales d'Économie et de Statistique, 49-50*.

Adams, J. D., & Marcu, M. (2004). R&D Sourcing, Joint Ventures and Innovation: A Multiple Indicators Approach. *NBER Working Papers 10474*. National Bureau of Economic Research, Inc.

Aghion, P. (2002). Schumpeterian Growth Theory and the Dynamics of Income Inequality. *Scholarly Articles 3350067*. Department of Economics, Harvard University.

Aghion, P., Howitt, P., & Violante, G. L. (2002). General Purpose Technology and Wage Inequality. *Journal of Economic Growth, 7*(4), 315-345.

Alberts, B. (2009). On Incentives for Innovation. *Science, 326*(5957), 1163.

Argentum. (2011). *Argentum Annual Norwegian Private Equity Market Report 2010.* Retrieved November 21, 2012, from http://www.argentum.no/en/Market-Analytics/Argentum-Analyses/Argentum-Annual-Analyses/Argentum-Norwegian-Annual-Report-2010/

Argentum. (2012). *Argentum Annual Norwegian Private Equity Market Report 2011.* Retrieved November 21, 2012, from http://www.argentum.no/en/Market-Analytics/Argentum-Analyses/Argentum-Annual-Analyses/Argentum-Annual-Norwegian-Report-2011/

Arnold, E., & Mahieu, B. (2012, August 31). A Good Council? *Evaluation of the Research Council of Norway*. Technopolis Group.

Arrow, K. (1962). Economic Welfare and the Allocation of Resources for Invention. In H. M. Groves, *The Rate and Direction of Inventive Activity: Economic and Social Factors* (pp. 609-626). National Bureau of Economic Research, Inc.

Avnimelech, G., & Teubal, M. (2003). Israel's Venture Capital Industry: Emergence, Operation, and Impact. In D. Çetindamar (Ed.), *The Growth of Venture Capital: A Cross-cultural Comparison* (pp. 207-240). Westport, Connecticut: Praeger.

Avnimelech, G., Rosiello, A., & Teubal, M. (2010). Evolutionary Interpretation of Venture Capital Policy in Israel, Germany, UK and Scotland. *Science and Public Policy, 37*(2), 101–112.

Balboa, M., Martí, J., & Zieling, N. (2006). Does Venture Capital really Improve Portfolio Companies Growth? Evidence from Growth Companies in Continental Europe. *EFMA 2006 Annual Conference*. Madrid, Spain: EFMA.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science, 30*(9), 1078-1092.

Baum, J. A., & Silverman, B. S. (2004). Picking Winners or Building them? Alliance, Intellectual, and Human Capital as Selection Criteria in Venture Financing and Performance of Biotechnology Start-ups. *Journal of Business Venturing, 19*(3), 411-436.

Baygan, G. (2003a). Venture Capital Policy Review: United Kingdom. *OECD Science, Technology and Industry Working Papers 2003/01*. OECD Publishing.

Baygan, G. (2003b). Venture Capital Policies in Korea. *OECD Science, Technology and Industry Working Papers 2003/2*. OECD Publishing.

Baygan, G. (2003c). Venture Capital Policies in Israel. *OECD Science, Technology and Industry Working Papers 2003/3*. OECD Publishing.

Baygan, G. (2003d). Venture Capital Policies in Canada. *OECD Science, Technology and Industry Working Papers 2003/4*. OECD Publishing.

Baygan, G. (2003e). Venture Capital Policies in Denmark. *OECD Science, Technology and Industry Working Papers 2003/10*. OECD Publishing.

Baygan, G. (2003f). Venture Capital Policies in Sweden. *OECD Science, Technology and Industry Working Papers 2003/11*. OECD Publishing.

Baygan, G. (2003g). Venture Capital Policy Review: United States. *OECD Science, Technology and Industry Working Papers 2003/12*. OECD Publishing.

Baygan, G. (2003h). Venture Capital Policy Review: Norway. *OECD Science, Technology and Industry Working Papers 2003/17*. OECD Publishing.

Becker, R., & Hellmann, T. (2003). The Genesis of Venture Capital - Lessons from the German Experience. *CESifo Working Paper Series 883*. CESifo Group Munich.

Belke, A., Fehn, R., & Foster, N. (2001). Venture Capital Investment and Labor Market Performance: A Panel Data Analysis. *Vienna Economics Papers 0112*. Department of Economics, University of Vienna.

Berger, A. N., & Udell, G. F. (1998). The Economics of Small Business Finance: The Roles of Private Equity and Debt Markets in the Financial Growth Cycle. *Journal of Banking and Finance, 22*(6-8), 613–673.

Besley, T. (2001). Political Institutions and Policy Competition. In G. Kochendorfer-Lucius, & B. Pleskovic (Eds.), *The Institutional Foundations of a Market Economy.* Villa Borsig Workshop Series 2000,.

Black, B. S., & Gilson, R. J. (1998). Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets. *Journal of Financial Economics, 47*(3), 243-277.

Blalock Jr., H. M. (1963). Correlated Independent Variables: The Problem of Multicollinearity. *Social Forces, 42*(2), 233-237.

Block, J., Sandner, P., & De Vries, G. (2010). Venture Capital and the Financial Crisis: An Empirical Study across Industries and Countries. *MPRA Paper 20287*. University Library of Munich, Germany.

Boekholt, P., Lankhuizen, M., Arnold, E., Clarke, J., Kuusisto, J., De Laat, B., et al. (2001, July). An International Review of Methods to Measure Relative Effectiveness of Technology Policy Instruments.

Bottazzi, L., & Da Rin, M. (2000). Euro.NM and the Financing of European Innovative Firms. *Working Papers 171*. Innocenzo Gasparini Institute for Economic Research, Bocconi University.

Bottazzi, L., & Da Rin, M. (2002). Venture Capital in Europe and the Financing of Innovative Companies. *Economic Policy, 17*(34), 229-270.

Bound, J., & Johnson, G. (1992). Changes in the Structure of Wages in the 1980's: An Evaluation of Alternative Explanations. *American Economic Review, 82*(3), 371-392.

Boyd, J. (2004). Measuring Social Impact: The Foundation of Social Return on Investment. London Business School.

Brander, J. A., Du, Q., & Hellmann, T. F. (2010). The Effects of Government-Sponsored Venture Capital: International Evidence. *NBER Working Paper No. 16521*. National Bureau of Economic Research, Inc.

Brander, J. A., Egan, E., & Hellmann, T. F. (2008). Government Sponsored versus Private Venture Capital: Canadian Evidence. *NBER Working Papers 01/2008*. National Bureau of Economic Research, Inc.

Bureau Bartels. (2005). Evaluatie van de Durfkapitaalregeling. Commissioned by the Ministry of Economic Affairs.

Bygrave, W. D., & Timmons, J. A. (1992). *Venture Capital at the Crossroads.* Harvard Business Review Press.

Cantner, U., Gaffard, J.-L., & Nesta, L. (Eds.). (2009). *Schumpeterian Perspectives on Innovation, Competition and Growth.* Springer.

Canton, E., Lanser, D., Noailly, J., Rensman, M., & Van de Ven, J. (2005). Crossing Borders: When Science Meets Industry. *CPB Document 98*. CPB Netherlands Bureau for Economic Policy Analysis.

Carnegie Consult. (2011). BMKB Beleidsevaluatie: 2005-2010. Ministry of Economic Affairs.

Carnegie Consult. (2012). Beleidsevaluatie Groeifaciliteit. Ministry of Economic Affairs, Agriculture and Innovation.

Casamatta, C. (2003). Financing and Advising: Optimal Financial Contracts with Venture Capitalists. *The*

Journal of Finance, 58(5), 2059-2085.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research, 2*(6), 429-444.

Cherif, M., & Gazdar, K. (2011). What Drives Venture Capital Investments in Europe? New Results from a Panel Data Analysis. *Journal of Applied Business and Economics, 12*(3), 122-139.

Cincera, M., Czarnitzki, D., & Thorwarth, S. (2009). Efficiency of Public Spending in Support of R&D Activities. *Economic Papers 376*. Directorate-General for Economic and Financial Affairs, European Commission.

Coase, R. H. (1960). The Problem of Social Cost. *Journal of Law and Economics, 3*(1), 1-44.

Collewaert, V., Manigart, S., & Aernoudt, R. (2010). Assessment of Government Funding of Business Angel Networks in Flanders. *Regional Studies, 44*(1), 119-130.

Comanor, W. S., & Scherer, F. M. (1969). Patent Statistics as a Measure of Technical Change. *Journal of Political Economy, 77*(3), 392-398.

Cooke, P. (2001). *Knowledge Economies: Clusters, Learning and Co-Operative Advantage.* New York: Routledge.

Croce, A., Martí, J., & Murtinu, S. (2012). The impact of venture capital on the productivity growth of European entrepreneurial firms: 'Screening' or 'value added' effect? *Journal of Business Venturing, Forthcoming. Available at SSRN: http://ssrn.com/abstract=1705225.*

Cromer, C. T., Clay, D., & Craig, J. B. (2011). A Study of Schumpterian (Radical) vs. Kirznerian (Incremental) Innovations in Knowledge Intensive Industries. *Journal of Strategic Innovation and Sustainability, 7*(1), 28-42.

Cutler, T. (2008, August 29). Venturous Australia - Building Strength in Innovation. Australia: Cutler & Company Pty Ltd.

Da Rin, M., Hellmann, T. F., & Puri, M. (2011). A Survey of Venture Capital Research. *NBER Working Papers 17523*. National Bureau of Economic Research, Inc.

Da Rin, M., Nicodano, G., & Sembenelli, A. (2005). Pulbic Policy and the Creation of Active Venture Capital Markets. *Working Paper Series No. 430*. European Central Bank.

Davenport, T. H. (1993). *Process Innovation: Reengineering Work through Information Technology.* Boston, Massachusetts: Harvard Business School Press.

De Swaan, T., Boot, A. W., Duffhues, P. J., Kuiper, J., Molenaar, T., Van de Poel, J. H., et al. (2011). *Naar een gezonde basis: bedrijfsfinanciering na de crisis.* The Hague: Ministry of Economic Affairs, Agriculture and Innovation.

Dell, K. (2008). Crowdfunding. *Time International, 172*(11), 41-42.

Demirgüç-Kunt, A., & Levine, R. (1999). Bank-based and Market-based Financial Systems: Cross-country Comparisons. *Policy Research Working Paper Series 2143*. The World Bank.

Deuten, J., Boekholt, P., Mostert, B., Nagle, M., Van der Veen, G., & Zuijdam, F. (2010, March 4). Eerste evaluatie Small Business Innovation Research (SBIR) Programma's in Nederland. Technopolis Group.

Dimov, D., & Murray, G. (2001). Literature Survey of Venture Capital Support. *Draft of Project IFISE (No. IPS029032PR)*. London Business School.

Dimov, D., & Murray, G. (2008). Determinants of the Incidence and Scale of Seed Capital Investments by Venture Capital Firms. *Small Business Economics, 30*(2), 127-152.

Donselaar, P. (2011, Novermber 10). Innovation and Productivity: The Solow Residual Disentangled. *Doctoral Thesis*. Erasmus University Rotterdam.

Duffhues, P., & Camdzic, B. (2011, December 6). *Waarom kredietunies de financiering van kleine bedrijven kunnen verlichten.* Retrieved September 7, 2012, from Mejudice: http://www.mejudice.nl/artikel/735/waarom-kredietunies-de-financiering-van-kleine-bedrijven-kunnen-verlichten

Duffhues, P., & Roosenboom, P. (2011). *Ondernemingsfinanciering nu en in de toekomst.* The Hague: Ministry of Economic Affairs, Agriculture and Innovation.

Duruflé, G. (2010). Government Involvement in the Venture Capital Industry: International Comparisons. Association Canadienne du Capital de Risque et d'Investissement (CVCA).

Eisinger, P. (1991). The State of State Venture Capitalism. *Economic Development Quarterly, 5*(1), 64-76.

Elsevier. (2012, March 7). *Minister De Jager: Banken moeten minder risico nemen.* Retrieved September 7, 2012, from http://www.elsevier.nl/web/Nieuws/Economie/332685/Minister-De-Jager-Banken-moeten-minder-risico-nemen.htm

Ernst & Young. (2012). The Power of Simplicity: . *Toward a Smarter and Streamlined Innovation Policy in the EU*. Ernst & Young.

European Commission. (1995, December). Green Paper on Innovation.

European Commission. (1999). Risk Capital Markets, a Key to Job Creation in Europe. From Fragmentation to Integration. *Euro Papers 32*. Brussels.

European Commission. (2000). The European Observatory for SMEs. Sixth Report.

European Commission. (2003). European Trend Chart on Innovation. *Thematic Report: Cluster Policies*.

European Commission. (2010). Innovation: Creating Knowledge and Jobs. *Studies and Reports, EUR 24431 EN*. Directorate L – Science, Economy and Society, Directorate-General for Research, European Commission.

Eurostat. (2010, May 31). *Eurostat Metadata: Venture Capital Investments.* Retrieved September 11, 2012, from http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/htec_vci_esms.htm

Eurostat. (2011). Patent Statistics at Eurostat: Methods for Regionalisation, Sector Allocation and Name Harmonisation. European Union.

Eurostat. (2012a, May 16). *Venture Capital Investment by aggregated stage of development (1989-2006) [htec_vci_stage1].* Retrieved September 10, 2012, from http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=htec_vci_stage1&lang=en

Eurostat. (2012b, August 23). *Venture Capital Investment by detailed stage of development (from 2007) [htec_vci_stage2].* Retrieved September 11, 2012, from http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=htec_vci_stage2&lang=en

Eurostat. (2012c, September 20). *GDP per capita - annual Data [nama_aux_gph].* Retrieved September 25, 2012, from http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

Eurostat. (2012d, March 20). *Access to Finance: Venture Capital*. Retrieved September 25, 2012, from http://ec.europa.eu/enterprise/policies/finance/data/enterprise-finance-index/access-to-finance-indicators/venture-capital/index_en.htm

Eurostat. (2012e, September 20). *Labour productivity - annual data [nama_aux_lp].* Retrieved September 25, 2012, from http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_aux_lp&lang=en

Eurostat. (2012f, July 12). *Employment growth and activity branches - annual averages [lfsi_grt_a].* Retrieved September 25, 2012, from http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

Eurostat. (2012g, September 25). *Unemployment rate, by sex (tps00180).* Retrieved September 25, 2012, from http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdec450&plugin=1

Eurostat. (2012h, August 13). *Annual data on employment in technology and knowledge-intensive sectors by NUTS 1 regions and level of education [htec_emp_risced].* Retrieved September 25, 2012, from http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

Eurostat. (2012i, August 13). *Annual data on employment in technology and knowledge-intensive sectors by NUTS 2 regions and level of education (from 2008, NACE Rev.2) [htec_emp_risced2].* Retrieved September 25, 2012, from http://appsso.eurostat.ec.europa.eu/nui/show.do

Eurostat. (2012j, May 2). *Economic statistics on high-tech industries and Knowledge Intensive Services at the national level (1995-2007, NACE Rev.1.1) [htec_eco_sbs].* Retrieved September 25, 2012, from http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=htec_eco_sbs&lang=en

Eurostat. (2012k, May 2). *Economic statistics on high-tech industries and Knowledge Intensive Services at the national level (from 2008, NACE Rev.2) [htec_eco_sbs2].* Retrieved September 25, 2012, from

http://appsso.eurostat.ec.europa.eu/nui/show.do

Eurostat. (2012l, March 6). *Total intramural R&D expenditure (GERD) by sectors of performance [rd_e_gerdtot].* Retrieved September 25, 2012, from http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

EVCA. (2010). Closing Gaps and Moving Up a Gear: The Next Stage of Venture Capital's Evolution in Europe. *EVCA Venture Capital White Paper*. Brussels: European Private Equity & Venture Capital Association (EVCA).

Florida, R. L., & Kenney, M. (1988). Venture Capital-Financed Innovation and Technological Change in the USA. *Research Policy, 17*(3), 119-137.

Folbre, N. (2009). Time Use and Living Standards. *Social Indicators Research, 93*(1), 77-83.

Fortune. (2012). 7 Best New Global Cities for Startups. Fortune Magazine.

Freear, J., & Wetzel Jr, W. E. (1990). Who Bankrolls High-tech Entrepreneurs? *Journal of Business Venturing, 5*(2), 77–89.

Friedman, M. (1962). *Capitalism and Freedom.* Chicago: Chicago University Press.

Georgescu-Roegen, N. (1951). The Aggregate Linear Production Function and it Applications to von Neumann's Economic Model. In T. Koopmans (Ed.), *Activity Analysis of Production and Allocation* (pp. 98-115). New York: Wiley.

Geronikolaou, G., & Papachristou, G. (2012, July). Venture Capital and Innovation in Europe. *Modern Economy, 3*(4), 454-459.

Geroski, P. A. (1995). Markets for Technology: Knowledge, Innovation and Appropriability. In P. L. Stoneman, *Handbook of the Economics of Innovation and Technical Change.* Oxford: Basil Blackwell.

Gilder, G. (2009). Silicon Israel - How Market Capitalism Saved the Jewish State. *City Journal, 19*(3).

Gilson, R. (2003). Engineering a Venture Capital Market: Lessons from the American Experience. *Stanford Law Review, 55*(4), 1067-1103.

Goergen, M., Khurshed, A., McCahery, J., & Renneboog, L. D. (2002). The Rise and Fall of the European New Markets: On the Short and Long-Run Performance of High-Tech Initial Public Offerings. *Discussion Paper 2002-101*. Center for Economic Research, Tilburg University.

Gompers, P. A., & Lerner, J. (1999b). What Drives Venture Capital Fundraising? *NBER Working Papers 6906*. National Bureau of Economic Research, Inc.

Gompers, P., & Lerner, J. (1999a). *The Venture Capital Cycle.* Cambridge, Massachusetts: MIT Press.

Gompers, P., & Lerner, J. (2001). The Venture Capital Revolution. *Journal of Economic Perspectives, 15*(2), 145-168.

Gordon, R. J. (2000). Does the "New Economy" Measure Up to the Great Inventions of the Past? *Journal of Economic Perspectives, American Economic Association, 14*(4), 49-74.

Gorman, M., & Sahlman, W. (1989). What Do Venture Capitalists Do? *Journal of Business Venturing, 4*(4), 231-248.

Goto, A., & Suzuki, K. (1989). R&D Capital, Rate of Return on R&D Investment and Spillover of R&D in Japanese Manufacturing Industries. *The Review of Economics and Statistics, 71*(4), 555-564.

Greenhalgh, C., & Rogers, M. (2010). *Innovation, Intellectual Property, and Economic Growth.* Princeton, New Jersey: Princeton University Press.

Greenwald, T. (2012). Crowdfunding. *Technology Review, 115*(3), 46.

Grossman, G. M., & Helpman, E. (1994). Endogenous Innovation in the Theory of Growth. *The Journal of Economic Perspectives, 8*(1), 23-44.

Grünfeld, L., Iversen, L., & Grimsby, G. (2011, October). The Need for Government Supported Capital Measures in the Market for Early Stage Risk Capital in Norway. *MENON-publication no. 18/2011*. MENON Business Economics.

Guellec, D., & Van Pottelsberghe de la Potterie, B. (2004). From R&D to Productivity Growth: Do the Institutional Settings and the Source of Funds of R&D Matter? *Oxford Bulletin of Economics and*

Statistics, 66(3), 353-378.

Hall, B. H. (2002). The Financing of Research and Development. *Oxford Review of Economic Policy, 18*(1), 35-51.

Hall, B. H., Mairesse, J., & Mohnen, P. (2009). Measuring the Returns to R&D. *NBER Working Papers 15622*. National Bureau of Economic Research, Inc.

Hall, P. A., & Soskice, D. (Eds.). (2001). *Varieties of Capitalism.* Oxford: Oxford University Press.

Hellmann, T. (2000). Venture Capitalists: The Coaches of Silicon Valley. In C.-M. Lee, W. F. Miller, M. G. Hancock, & H. S. Rowen (Eds.), *The Silicon Valley Edge: A Habitat for Innovation and Entrepreneurship*. Stanford: Stanford University Press.

Hellmann, T. (2001). Developing a Venture Capital Industry. In G. Kochendörfer-Lucius, & B. Pleskovic (Eds.), *The Institutional Foundations of a Market Economy.* Villa Borsig Workshop Series 2000, German Foundation for International Development.

Hellmann, T., & Puri, M. (2000). The Interaction between Product Market and Financing Strategy: The Role of Venture Capital. *Review of Financial Studies, Oxford University Press for Society for Financial Studies, 13*(4), 959-984.

Hellmann, T., & Puri, M. (2002). Venture Capital and the Professionalization of Start-Up Firms: Empirical Evidence. *Journal of Finance, American Finance Association, 57*(1), 169-197.

Hellmann, T., Lindsey, L., & Puri, M. (2004). Building Relationships Early: Banks in Venture Capital. *NBER Working Papers 10535*. National Bureau of Economic Research, Inc.

Hippeau, E. (2009, January 25). Retrieved September 18, 2012, from The Huffington Post: http://www.huffingtonpost.com/eric-hippeau/why-venture-capital-is-ke_b_160511.html

Hirukawa, M., & Ueda, M. (2008). Venture Capital and Industrial 'Innovation'. *CEPR Discussion Papers 7089*. Centre for Economic Policy Research.

Hirukawa, M., & Ueda, M. (2011). Venture Capital and Innovation: Which is First? *Pacific Economic Review, 16*(4), 421–465.

Howitt, P. (2007, April). Innovation, Competition and Growth: A Schumpeterian Perspective on Canada's Economy. *C.D. Howe Institute Commentary No. 246*. C.D. Howe Institute.

Hsu, R. C. (1998). Maintaining High Living Standards Through Innovation, Strong Patents. *Communications of the ACM, 41*(10), 27-28.

Hurmelinna-Laukkanen, P., Sainio, L.-M., & Jauhiainen, T. (2008). Appropriability Regime for Radical and Incremental Innovations. *R&D Management, 38*(3), 278-289.

Inderst, R., & Müller, H. M. (2004). The Effect of Capital Market Characteristics on the Value of Start-up Firms. *Journal of Financial Economics, 72*(2), 319-356.

Irwin, D. A., & Klenow, P. J. (1996). High Tech R&D Subsidies: Estimating the Effects of Sematech. *Journal of International Economics, 40*(3-4), 323-344.

Izsak, K., & Edler, J. (2011, October 26). Trends and Challenges in Demand-Side Innovation Policies in Europe. *Thematic Report 2011 under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011-2012)*. Technopolis Group.

Jaumotte, F., & Pain, N. (2005). Innovation in the Business Sector. *OECD Economics Department Working Paper No. 459*. OECD Publishing.

Jeng, L. A., & Wells, P. C. (2000). The Determinants of Venture Capital Funding: Evidence Across Countries. *Journal of Corporate Finance, 6*(3), 241-289.

Jingdong, Y., & Junmin, J. (2011). Relationship between Product Innovation and Firm Growth — Evidence from Large and Medium-sized Industrial Firms in Hubei of China. *6th International Conference on Product Innovation Management (ICPIM)*, (pp. 712-715). Wuhan, China.

Kanniainen, V., & Keuschnigg, C. (Eds.). (2004). *Venture Capital, Entrepreneurship, and Public Policy.* Cambridge and London: MIT Press.

Kaplan, S., & Strömberg, P. (2001). Venture Capitalists As Principals: Contracting, Screening, and Monitoring. *American Economic Review, 91*(2), 426-430.

Keilbach, M., & Engel, D. (2005). Firm Level Implications of Early Stage Venture Capital Investment - An Empiri cal Investigation. *Papers on Entrepreneurship, Growth and Public Policy 2005-22*. Entrepreneurship, Growth and Public Policy Group, Max Planck Institute of Economics.

Keuschnigg, C. (2004). Venture Capital Backed Growth. *Journal of Economic Growth, 9*(2), 239-261.

Keuschnigg, C. (2010). Public Policy, Venture Capital and Entrepreneurial Finance. In D. Cumming (Ed.), *Venture Capital: Investment Strategies, Structures, and Policies*. John Wiley and Sons.

Keuschnigg, C., & Nielsen, S. (2002). Tax Policy, Venture Capital, and Entrepreneurship. *Journal of Public Economics, 87*(1), 175–203.

Keuschnigg, C., & Nielsen, S. B. (2004). Start-ups, Venture Capitalists, and the Capital Gains Tax. *Journal of Public Economics, 88*(5), 1011-1042.

Kleijn, M., Faber, I., & Morley, P. (2010, October 18). Ambitie, niet geld, drijfveer innovatie. *Financieel Dagblad*.

Kogut, B. (1991). Joint Ventures and the Option to Expand and Acquire. *Management Science, 37*(1), 19-33.

Könings, M., & Balk, R. (2011, Januari 15). Trendrapport Economic & Innovatie: Van Subsidies naar Durfkapitaal. Lysias Consulting Group.

Kortum, S., & Lerner, J. (1998). Does Venture Capital Spur Innovation? *NBER Working Papers 6846*. National Bureau of Economic Research, Inc.

Kortum, S., & Lerner, J. (2000). Assessing the Contribution of Venture Capital to Innovation. *RAND Journal of Economics, 31*(4), 674-692.

Langeland, O. (2007). Financing Innovation: The Role of Norwegian Venture Capitalists in Financing Knowledge-intensive Enterprises. *European Planning Studies, 15*(9), 1143-1161.

Lanser, D., & Van der Wiel, H. (2011, May 16). Innovatiebeleid in Nederland: De (on)mogelijkheden van effectmeting. *CPB Achtergronddocument*. Centraal Planbureau (CPB).

Lemieux, T. (2006). Increasing Residual Wage Inequality: Composition Effects, Noisy Data, or Rising Demand for Skill? *American Economic Review, 96*(3), 461-498.

Lerner, J. (1999). The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program. *The Journal of Business, 72*(3), 285-318.

Lerner, J. (2009). *Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed – and What to Do About It*. Princeton: Princeton University Press.

Lerner, J., Pierrakis, Y., Collins, L., & Biosca, A. B. (2011). Atlantic Drift: Venture Capital Performance in the UK and the US. *Research Report: June 2011*. NESTA.

Levine, R. (2002). Bank-Based or Market-Based Financial Systems: Which Is Better? *Journal of Financial Intermediation, 11*(4), 398-428.

Lindstrom, G., & Olofsson, C. (2001). Early Stage Financing of NTBFs: An Analysis of Contributions from Support Actors. *Venture Capital: An International Journal of Entrepreneurial Finance, 3*(2), 151-168.

Maarsen, H., & Engelenburg, H. (2012, September 5). *Nieuw fonds voor techsector*. Retrieved September 13, 2012, from Het Financieele Dagblad: http://fd.nl/beleggen/697836-1209/nieuw-fonds-voor-techsector?visited=true

Mäkelä, M., & Maula, M. (2008). Attracting Cross-border Venture Capital: The Role of a Local Investor. *Entrepreneurship and Regional Development, 20*(3), 237-257.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A Contribution to the Empirics of Economic Growth. *The Quarterly Journal of Economics, 107*(2), 407-437.

Mann, R. J., & Sager, T. W. (2007). Patents, Venture Capital, and Software Start-ups. *Research Policy, 36*(2), 193-208.

Martin, R. (1989). The Growth and Geographical Anatomy of Venture Capitalism in the United Kingdom. *Regional Studies, 23*(5), 389-403.

Martin, R., Sunley, P., & Turner, D. (2001). Taking Risks in the Geographical Anatomy of Europe's Emerging Venture Capital Market. *ESRC Centre for Business Research - Working Papers wp202*. ESRC Centre for Business Research.

Mason, C. M., & Harrison, R. T. (2002). Barriers to Investment in the Informal Venture Capital Sector. *Entrepreneurship and Regional Development, 14*(3), 271-287.

Meriküll, J. (2010). The Impact of Innovation on Employment. *Eastern European Economics, 48*(2), 25-38.

Metcalfe, J. S. (2006). Innovation and the Conditions of Economic Progress. *Economic Analysis and Policy, 36*(1-2), 1-12.

Ministry of Economic Affairs, Agriculture and Innovation. (2011, February 4). To the Top - Towards a New Enterprise Policy. *Letter by Minister Verhagen about the Key Objectives of the Government's New Business Policy*.

Ministry of Education, Culture and Science. (2011, Augustus). Kwaliteit in Verscheidenheid: Strategische Agenda Hoger Onderwijs, Onderzoek en Wetenschap.

Mostert, B., & Deuten, J. (2011, December). Mini Country Report / The Netherlands. *Thematic Report 2011 under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011-2012)*. Technopolis Group.

Murray, G., Cowling, M., Liu, W., & Kalinowska-Beszczynska, O. (2012). Government Co-financed 'Hybrid' Venture Capital Programmes: Generalizing Developed Economy Experience and its Relevance to Emerging Nations. *Kauffman International Research and Policy Roundtable, Liverpool, 11-12 March 2012*. United Kingdom: University of Exeter Business School.

Muscarella, C., Peavy, J. W., Vetsuypens, M., & Barry, C. B. (1990). The Role of Venture Capital in the Creation of Public Companies: Evidence from the Going-Public Process. *Journal of Financial Economics, 27*(2), 447-471.

OECD. (1999). Employment Outlook 1999. Paris: Organisation for Economic Co-operation and Development.

OECD. (2011). OECD Science, Technology and Industry Scoreboard 2011: Innovation and Growth in Knowledge Economies. Directorate for Science, Technology and Industry, Organisation for Economic Co-operation and Development (OECD).

OECD. (2012). *Average annual hours actually worked per worker.* Retrieved September 19, 2012, from OECD.Stat: http://stats.oecd.org/Index.aspx?DatasetCode=ANHRS

Park, W. G. (2008). International Patent Protection: 1960–2005. *Research Policy, 37*(4), 761-766.

Peneder, M. R. (2010). The Impact of Venture Capital on Innovation Behaviour and Firm Growth. *Venture Capital: An International Journal of Entrepreneurial Finance, 12*(2), 83-107.

Pierrakis, Y. (2010, July). Venture Capital: Now and After the Dotcom Crash. *Research Report: July 2010*. National Endowment for Science, Technology and the Arts (NESTA).

Pierrakis, Y., & Mason, C. (2008). Shifting Sands: The Changing Nature of the Early-Stage Venture Capital Market in the UK. *Research Report*. National Endowment for Science, Technology and the Arts (NESTA).

Pigou, A. C. (1932). *The Economics of Welfare.* London: Macmillan.

Pinch, S., & Sunley, P. (2009). Understanding the Role of Venture Capitalists in Knowledge Dissemination in High-technology Agglomerations: A Case Study of the University of Southamption Spin-off Cluster. *Venture Capital: An International Journal of Entrepreneurial Finance, 11*(4), 311-333.

Popov, A., & Roosenboom, P. (2009a). Does Private Equity Investment Spur Innovation? Evidence from Europe. *Working Paper Series 1063*. European Central Bank.

Popov, A., & Roosenboom, P. (2009b). On the Real Effects of Private Equity Investment - Evidence from New Business Creation. *Working Paper Series 1078*. European Central Bank.

Poterba, J. M. (1989). Venture Capital and Capital Gains Taxation. In L. H. Summers (Ed.), *Tax Policy and the Economy* (3 ed., pp. 47- 67). Cambridge, Massachusetts: MIT Press.

Puri, M., & Zarutski, R. (2008). On the Lifecycle Dynamics of Venture-Capital- and Non-Venture-Capital-Financed Firms. *Working Papers 08-13*. Center for Economic Studies, U.S. Census Bureau.

PwC. (2011). *Monitor Financierbaarheid Nederland 2010.* PricewaterhouseCoopers. The Hague: Ministry of Economic Affairs, Agriculture and Innovation.

Ray, S. C. (2004). *Data Envelopment Analysis: Theory and Techniques for Economics and Operations*

Research. Cambridge, the United Kingdom: Cambridge University Press.

Reed, H. (2010). Reinventing Venture Capital: Towards a New Economic Settlement. London: Demos.

Reid, A., & Nightingale, P. (Eds.). (2011, October). The Role of Different Funding Models in Stimulating the Creation of Innovative New Companies. What is the Most Appropriate Model for Europe? *A Study for the European Research Area Board*.

Rigby, J., Cox, D., Cunningham, P., Edler, J., Gök, A., Shapira, P., et al. (2012, August 31). Evaluation of the Research Council of Norway. *Background Report No. 10. Internationalisation*. Technopolis Group and Manchester Institute of Innovation Research.

Roberts, E. B. (2002). *Innovation: Driving Product, Process, and Market Change.* San Francisco: Jossey-Bass.

Roberts, R. (2011, June 22). *Obama vs. ATMs: Why Technology Doesn't Destroy Jobs*. Retrieved September 20, 2012, from The Wall Street Journal: http://online.wsj.com/article/SB10001424052702304070104576399704275939640.html

Rogers, E. M. (2003). *Diffusion of Innovations* (5 ed.). New York: Free Press.

Romain, A., & Van Pottelsberghe de la Potterie, B. (2004). The Determinants of Venture Capital: A Panel Data Analysis of 16 OECD Countries. *Working Papers CEB 04-015.RS*. Universite Libre de Bruxelles.

Ross, C. (2012). Crowdfunding. *Bee Culture, 140*(11), 65-66.

Ruis, A., Van Stel, A., Tsamis, A., Verhoeven, W., & Whittle, M. (2009). Cyclicality of SME Finance: Literature Survey, Data Analysis and Econometric Analysis. EIM Business & Policy Research for the Directorate General Enterprise and Industry, European Commission.

Sahlman, W. A. (1990). The Structure and Governance of Venture-Capital Organizations. *Journal of Financial Economics, 27*(2), 473-521.

Samila, S., & Sorenson, O. (2011). Venture Capital, Entrepreneurship, and Economic Growth. *The Review of Economics and Statistics, 93*(1), 338-349.

Sapienza, H. J. (1992). When Do Venture Capitalists Add Value? *Journal of Business Venturing, 7*(1), 9-27.

Sapienza, H. J. (1996). Venture Capitalist Governance and Value Added in Four Countries. *Journal of Business Venturing, 11*(6), 439-469.

Saxenian, A., & Sabel, C. (2008). Venture Capital in the 'Periphery': The New Argonauts, Global Search, and Local Institution Building. *Economic Geography, 84*(4), 379-394.

Schertler, A. (2003). Driving Forces of Venture Capital Investments in Europe: A Dynamic Panel Data Analysis. *EIFC - Technology and Finance Working Papers 27*. Institute for New Technologies, United Nations University.

Schoemakers, I. (Ed.). (2012, 12 7). *Jan Kees de Jager: 'Durfkapitaal is nodig voor innovatie'.* Retrieved 1 7, 2013, from Management Scope: http://managementscope.nl/magazine/artikel/691-jan-kees-de-jager-durfkapitaal-innovatie

Scholes, L., Wright, M., & Burrows, A. (2002). Survey of the Economic and Social Impact of Venture Capital in Europe. *European Venture Capital Association Research Paper*. European Venture Capital Association.

Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy.* New York: Harper & Brothers.

Scordato, L. (2011, December). Mini Country Report / Norway. *Thematic Report 2011 under Specific Contract for the Integration of INNO Policy TrendChart with ERAWATCH (2011-2012)*.

Scotchmer, S. (2006). *Innovation and Incentives.* Cambridge, Massachusetts: MIT Press.

Simmie, J. (2005). Innovation and Space: A Critical Review of the Literature. *Regional Studies, 39*(6), 789-805.

Smit, E. (2004). *De Broncode.* Amsterdam: Uitgeverij Podium.

Smolny, W. (1998). Innovations, Prices and Employment. *The Journal of Industrial Economics, 46*(3), 359-381.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics, 70*(1), 65-94.

Strommer, S. P., & Lipper, G. (2006). Seed and Venture Capital: State Experiences and Options. The

National Association of Seed and Venture Funds.

Stuck, B., & Weingarten, M. (2005). How Venture Capital Thwarts Innovation. *IEEE Spectrum, 42*(4), 50-55.

Stuiveling, S. J., & Van Schoten, E. M. (2011). Innovatiebeleid. Algemene Rekenkamer.

Swan, T. W. (1956). Economic Growth and Capital Accumulation. *Economic Record, 32*(2), 334-361.

Tabarrok, A. (2010). Review of: Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed – and What to Do About It. *Economic Record, 86*(274), 458-459.

Tang, M.-C., & Chyi, Y.-L. (2008). Legal Environments, Venture Capital, and Total Factor Productivity Growth of Taiwanese Industry. *Contemporary Economic Policy, 26*(3), 468-481.

Teece, D. J. (1986). Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy. *Research Policy, 15*(6), 285-305.

Tejada, R. (2003a). Venture Capital Policy Review: Spain. *OECD Science, Technology and Industry Workings Papers 2003/18*. OECD Publishing.

Tejada, R. (2003b). Venture Capital Policy Review: Portugal. *OECD Science, Technology and Industry Working Papers 2003/19*. OECD Publishing.

Ten Raa, T. (2009a). Facets of Innovation and Stages of Development. *Trade and Development Review, 2*(1), 28-33.

Ten Raa, T. (2009b). *The Economics of Benchmarking: Measuring Performance for Competitive Advantage.* Palgrave Macmillan.

Ter Beek, H. M., Van Ommeren, C., Van der Meulen, G., Broer, J. T., Blikman, D., & De Porto, P. H. (2010). Evaluatie Regionale Ontwikkelingsmaatschappijen: Effectiviteit & Efficiëntie. *Eindrapport*. Decisio BV for Ministerie van Economische Zaken.

The Economist. (2012, July 28). *European Entrepreneurs: Les Misérables.* Retrieved October 4, 2012, from The Economist: http://www.economist.com/node/21559618

Theeuwes, J., Hassink, W., Van der Klaauw, B., Van Maasacker, M., Schaasberg, W., Straathof, B., et al. (2012, November). Durf te Meten: Eindrapport Expertwerkgroep Effectmeting. Expertwerkgroep Effectmeting.

Thoma, G., Torrisi, S., Gambardella, A., Guellec, D., Hall, B., & Harhoff, D. (2010, March). Harmonizing and Combining Large Datasets – An Application to Firm-Level Patent and Accounting Data. *NBER Working Paper No. 15851*. The National Bureau of Economic Research (NBER).

Thompson, C. (1989). The Geography of Venture Capital. *Progress in Human Geography, 13*(1), 62-98.

Timmons, J., & Bygrave, W. D. (1986). Venture Capital's Role in Financing Innovation for Eonomic Growth. *Journal of Business Venturing, 1*(2), 161-176.

Tykvová, T., Borell, M., & Kroencke, T.-A. (2012). Potential of Venture Capital in the European Union. Policy Department A: Economic and Scientific Policy, Directorate-General for Internal Policies, European Parliament.

Ulku, H. (2007). R&D, Innovation, and Growth: Evidence from Four Manufacturing Sectors in OECD Countries. *Oxford Economic Papers, 59*(3), 513-535.

Van der Poel, R., Seip, M., & Snoei, J. (2010, October 7). Octrooien in het MKB. NL Octrooicentrum.

Van Pottelsberghe de la Potterie, B., & Romain, A. (2004). The Determinants of Venture Capital: Additional Evidence. *Discussion Paper Series 1: Economic Studies 2004,19*. Volkswirtschaftliches Forschungszentrum der Deutschen Bundesbank.

Verbeek, M. (2008). *A Guide to Modern Econometrics* (3 ed.). Chichester, West Sussex, England: John Wiley and Sons Ltd.

Verhoeven, W. H., Van Stel, A. J., & Timmermans, N. G. (2012). Evaluatie WBSO 2006-2010: Effecten, Doelgroepbereik en Uitvoering. EIM for the Ministry of Economic Affairs, Agriculture and Innovation.

Vitols, S. (2004). Changes in Germany's Bank-Based Financial System: A Varieties of Capitalism Perspective. *Discussion Paper SP II 2004-03*. Wissenschaftszentrum Berlin.

Wallsten, S. J. (2000). The Effects of Government-Industry R&D Programs on Private R&D: The Case of the

Small Business Innovation Research Program. *RAND Journal of Economics, 31*(1), 82-100.

Wang, E. C., & Huang, W. (2007). Relative Efficiency of R&D Activities: A Cross-country Study Accounting for Environmental Factors in the DEA Approach. *Research Policy, 36*(2), 260–273.

Wasmer, E., & Weil, P. (2000). The Macroeconomics of Labor and Credit Market Imperfections. *IZA Discussion Papers 179*. Institute for the Study of Labor.

Wasmer, E., & Weil, P. (2004). The Macroeconomics of Labor and Credit Market Imperfections. *The American Economic Review, 94*(4), 944-963.

Wright, M., Pruthi, S., & Lockett, A. (2005). International Venture Capital Research: From Cross-Country Comparisons to Crossing Borders. *International Journal of Management Reviews, 7*(3), 135-165.

Appendix

A.1 – Appendix to Chapter 1

A.1.1 Quantifying the positive externalities of VC

Gompers and Lerner (2001) already indicated that it is difficult to conduct empirical tests that enable researchers to establish that causality is at work between VC on the one hand, and innovation and employment growth on the other.[157] This section will nevertheless give it a try, but expectations should be kept accordingly modest. The inherent difficulties of modelling the effects of increased VC investments on national welfare, which comprise but are not excluded to finding decent measures of innovation and wealth, a variety of causality issues, and the oversimplifying but necessary lag length choice, make that the chances of finding conclusive relations are doubtful.[158] If such difficulties would not complicate things enough already, the size of VC investments does; even though VC is hypothesised to be of *national* importance, in most European countries they add up to less than 0.1% of GDP. This implies that an inability to find conclusive effects need not mean that they do not exist, especially when considering the issue of reversed or circular causality.[159]

Additionally, the empirical investigations will try to assess the impact of *additional* VC investments and not so much the *average* effect of VC (which would likely have been easier established), because even if the average effect were found to be significant, this need not mean that governments should have a stake in increasing it even further. Thus, from the outset it should be clear that investigating the null hypothesis that additional VC investments are not important is troubled by a large risk of a Type II error.

Research methodology

Section 1.3 explained how VC may lead to positive externalities, and this is summarised by the depiction of Figure 1.2 (p. 14). VC arguably fosters innovation, which in turn stimulates economic growth, increases productivity levels, and raises the number of jobs available. Innovation, in this explanation, acts as a mediating variable. VC may also lead to economic growth and more jobs more directly, skipping the mediating variable of innovations. The degree to which a region is market- or bank-based, and to which it is a LME (or CME), may impact on how effective VC investments are, and may thus act as moderating variables. This is also true for R&D investments, because if (for instance) a certain market is already saturated with R&D capital it may be expected that the marginal effect of additional VC capital is rather low.[160] It may be noted that the 'public goods' (e.g. economic growth, increased productivity, and more jobs)

[157] See also Cutler (2008).

[158] See also Lanser and Van der Wiel (2011).

[159] Assume for instance that innovation stimulates economic growth, which in turn enables further innovation. If this is true, finding a one-way relation from innovation to economic growth may be difficult, even though for sustained economic growth (for which the circle has to be travelled many times) innovation may be indispensable.

[160] Kortum and Lerner (1998).

are interdependent; for instance, increased productivity could lead to economic growth, and in countries that have been more productive and have grown faster, more jobs have probably been created.

The data of VC investments consists of three figures: *Early Stage, Expansion and Replacement*, and *Total VC Investments*, where the latter equals the sum of the former two. It is available for 20 European countries[161] and for the years 1989-2011. For more information on how VC investment data is obtained and constructed, please refer to Subsection 1.4.1.

In Section 5 of their work, Kortum and Lerner (1998, pp. 16-31) investigate whether or not the amount of patents filings is a good proxy of innovation, because "[v]enture capital may spur patenting while having no impact on innovation" (p. 3). They conclude that patent filings are indeed to a large extent good proxies of innovation.[162] Two measures of innovation are available from databases of the European Patent Office (EPO) for the years 2002-2011 and for all 20 countries on a yearly basis: firstly, the number of patent *filings*, such as Kortum and Lerner (1998) use; secondly, the number of *granted* patents. Especially the latter seems to be a true proxy of innovation, since useless and unoriginal patent filings, which are not exactly innovative, are filtered out.

Logical proxies for economic growth are real GDP growth and real GDP per capita growth.[163] These are downloaded from Eurostat databases[164] and do not restrict the sample size. Following Eurostat (2012d) GDP measured at current market prices will be used. As a measure of productivity the real labour productivity in euro per hour worked is taken from Eurostat (2012e), which is available for the years 1995-2011. Measures for employment are the annual percentage change in total employed population and the unemployment rate, are retrieved from Eurostat (2012f) and Eurostat (2012g), and are available for the years 1992-2011 and 1989-2011, respectively.

Boyd (2004) introduces readers to the concept of *social return on investment*. To this end, Boyd (2004) notes that 'What Gets Measured, Gets Valued', which should direct researchers to incorporate those effects that can convincingly be related to the relevant investment. Looking at our example, even if VC investments were very effective, it would be difficult to establish a strong and conclusive influence on *national* employment and economic growth rates (or even living standards[165]). Other effects, such as banking and financial crises, global economic cycles, and many others, dwarf the effects of VC investments. In most European countries VC investments add up to less than 0.1% of GDP and in the entire dataset never exceed 1% of GDP. Such difficulties are further aggravated because it is unsure how swift the effects materialise.[166] For such reasons it seems a good idea to narrow the scope of the effects a bit down.

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[161] These countries are Belgium, the Czech Republic, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Hungary, the Netherlands, Austria, Poland, Portugal, Romania, Finland, Sweden, the United Kingdom, Norway, and Switzerland.

[162] One of the ways they check whether this is true or not is by refining their models by including R&D investments; I will include them as well. Comanor and Scherer (1969) investigate whether for pharmaceutical manufacturing companies the number of patents are good operational indexes of inventive and innovative activity and technical change. They find that they are, although "patents may be a better index of research input than output" (p. 398). See also Jaumotte and Pain (2005).

[163] See e.g. Metcalfe (2006).

[164] Eurostat (2012c).

[165] Explicit measures of (rising) living standards are not included in the analyses, although according to some the real GDP per capita level is a decent proxy of living standards. See Folbre (2009) for a discussion.

[166] Even if VC would lead to innovations, it is unsure how long it would take for these innovations to create (e.g.) extra employment – 1

Therefore, data is retrieved on knowledge-intensive and, even narrower, high-tech sectors, because innovations are likely to positively affect them. Data on the value added at factor cost of high-tech sectors is retrieved from Eurostat (2012j) for the years 1995-2007 and from Eurostat (2012k) for the years 2008 and 2009. From Eurostat (2012h) and Eurostat (2012i) data is retrieved on the percentage of total employment for both sectors, for the years 1994-2011.

Variables and Abbreviations	
Variable	*Description*
$Total_{i,t}$	Total amount of VC investments as a percentage of GDP for country *i* during year *t*
$FD\_Total_{i,t}$	Equals $Total_{i,t} - Total_{i,t-1}$
$AVG\_FD\_Total_{i,t}$	Equals $\frac{Total_{i,t-1}+Total_{i,t-2}+Total_{i,t-3}}{3} - Total_{i,t-4}$, an average of increases in total VC investments during years *t-1*, *t-2*, and *t-3*
$ES_{i,t}$	Total amount of early stage VC investments as a percentage of GDP for country *i* during year *t*
$FD\_ES_{i,t}$	Equals $ES_{i,t} - ES_{i,t-1}$
$ER_{i,t}$	Total amount of expansion and replacement investments as a percentage of GDP for country *i* during year *t*
$FD\_ER_{i,t}$	Equals $ER_{i,t} - ER_{i,t-1}$
$FPatent_{i,t}$	Total number of filed patents per inhabitant for country *i* during year *t*
$AVG\_FD\_FPatent_{i,t}$	Equals $\frac{FPatent_{i,t-1}+FPatent_{i,t-2}}{2} - FPatent_{i,t-3}$, an average of increases in the number of filed patents during years *t-1*, and *t-2*
$GPatent_{i,t}$	Total number of granted patents per inhabitant for country *i* during year *t*
$AVG\_FD\_GPatent_{i,t}$	Equals $(GPatent_{i,t-1} + GPatent_{i,t-2})/2\text{-}GPatent_{i,t-3}$, an average of increases in the number of granted patents during years *t-1*, and *t-2*
$GDP_{i,t}$	Real GDP at current market prices for country *i* during year *t*
$PC\_GDP_{i,t}$	Equals $(GDP_{i,t} - GDP_{i,t-1}) \ / GDP_{i,t-1} \times 100$
$GDPC_{i,t}$	Real GDP at current market prices per inhabitant for country *i* during year *t* as
$PC\_GDPC_{i,t}$	Equals $(PC\_GDPC_{i,t} - PC\_GDPC_{i,t-1}) \ / PC\_GDPC_{i,t-1} \times 100$
$Prod_{i,t}$	Labour productivity in country *i* during year *t* in € per hour worked
$FD\_Prod_{i,t}$	Equals $Prod_{i,t} - Prod_{i,t-1}$
$Employ_{i,t}$	Total number of workers in country *i* during year *t*
$PC\_Employ_{i,t}$	Equals $(Employ_{i,t} - Employ_{i,t-1}) / Employ_{i,t-1} \times 100$
$KIEmploy_{i,t}$	Total number of workers in knowledge-intensive sectors in country *i* during year *t*
$PC\_KIEmploy_{i,t}$	Equals $(KIEmploy_{i,t} - KIEmploy_{i,t-1}) / KIEmploy_{i,t-1} \times 100$
$HTEmploy_{i,t}$	Total number of workers in high-tech sectors in country *i* during year *t*
$PC\_HTEmploy_{i,t}$	Equals $(PC\_HTEmploy_{i,t} - PC\_HTEmploy_{i,t-1}) / PC\_HTEmploy_{i,t-1} \times 100$
$Unemploy_{i,t}$	Unemployment rate in country *i* during year *t*
$PC\_Unemploy_{i,t}$	Equals $(Unemploy_{i,t} - Unemploy_{i,t-1}) / PC\_Unemploy_{i,t-1} \times 100$
$HTValueA_{i,t}$	Total value added in high-tech sectors in country *i* during year *t*
$PC\_HTValueA_{i,t}$	Equals $(HTValueA_{i,t} - HTValueA_{i,t-1}) / HTValueA_{i,t-1} \times 100$
$RD_{i,t}$	Total expenditures on R&D in country *i* during year *t*
$FD\_RD_{i,t}$	Equals $\frac{RD_{i,t}+RD_{i,t-1}+RD_{i,t-2}}{3} - RD_{i,t-3}$, an average of increases in R&D expenditures during years *t*, *t-1*, and *t-2*
$AVG\_FD\_RD_{i,t}$	Average amount of R&D expenditures in country *i* during years *t-1*, *t-2*, and *t-3*

Table A.1.1: Used variables and their abbreviations.

Finally, to serve as control variables, the total amount of R&D expenditures as a percentage of GDP is downloaded from Eurostat (2012l) for the years 1990-2010. It is not necessary to gather data on the market-/bank-basedness or the degree to which countries are a LME or CME, as will be explained below.

year, 5 years, or perhaps 10 years? Or if innovative young firms develop into market leaders, and remembering the mechanisms of endogenous growth models, perhaps even longer? Probably, it goes gradually, and the created employment in a certain year is caused by innovations of *multiple* earlier years.

Regression Equations				
Tested relation	*Model*	VARIABLES		
		Dependent	*Explanatory*	*Control*
VC → Innovation	(1)	$FPatent_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(2)	$FPatent_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(3)	$FPatent_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(4)	$FPatent_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(5)	$GPatent_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(6)	$GPatent_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(7)	$GPatent_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(8)	$GPatent_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}, FD\_GDPC_{i,t}, GDPC_{i,t-1}$
	(9)	$FD\_Prod_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, Unemploy_{i,t}, Prod_{i,t-3}$
	(10)	$FD\_Prod_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, Unemploy_{i,t}, Prod_{i,t-3}$
	(11)	$FD\_Prod_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, FD\_GDPC_{i,t}, Unemploy_{i,t}, Prod_{i,t-3}$
	(12)	$FD\_Prod_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}, FD\_GDPC_{i,t}, Unemploy_{i,t}, Prod_{i,t-3}$
VC → Economic Growth	(13)	$PC\_GDP_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, GDPC_{i,t-1}$
	(14)	$PC\_GDP_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, GDPC_{i,t-1}$
	(15)	$PC\_GDP_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, GDPC_{i,t-1}$
	(16)	$PC\_GDP_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}, GDPC_{i,t-1}$
	(17)	$PC\_GDPC_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, GDPC_{i,t-1}$
	(18)	$PC\_GDPC_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, GDPC_{i,t-1}$
	(19)	$PC\_GDPC_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}, GDPC_{i,t-1}$
	(20)	$PC\_GDPC_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}, GDPC_{i,t-1}$
	(21)	$HTValueA_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(22)	$HTValueA_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(23)	$HTValueA_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(24)	$HTValueA_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}$
VC → Employment	(25)	$PC\_Employ_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(26)	$PC\_Employ_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(27)	$PC\_Employ_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(28)	$PC\_Employ_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}$
	(29)	$PC\_KIEmploy_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(30)	$PC\_KIEmploy_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(31)	$PC\_KIEmploy_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(32)	$PC\_KIEmploy_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}$
	(33)	$PC\_HTEmploy_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(34)	$PC\_HTEmploy_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(35)	$PC\_HTEmploy_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(36)	$PC\_HTEmploy_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}$
	(37)	$PC\_Unemploy_{i,t}$	$FD\_Total_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(38)	$PC\_Unemploy_{i,t}$	$FD\_ES_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(39)	$PC\_Unemploy_{i,t}$	$FD\_ER_{i,t-2}$	$Total_{i,t-3}, FD\_RD_{i,t-2}, RD_{i,t-3}$
	(40)	$PC\_Unemploy_{i,t}$	$AVG\_FD\_Total_{i,t}$	$Total_{i,t-3}, AVG\_FD\_RD_{i,t}, RD_{i,t-3}$
Innovation → Economic Growth	(41)	$PC\_GDP_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$FPatent_{i,t-3}, GDPC_{i,t-3}$
	(42)	$PC\_GDP_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GPatent_{i,t-3}, GDPC_{i,t-3}$
	(43)	$PC\_GDPC_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$FPatent_{i,t-3}, GDPC_{i,t-3}$
	(44)	$PC\_GDPC_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GPatent_{i,t-3}, GDPC_{i,t-3}$
	(45)	$PC\_HTValueA_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$FPatent_{i,t-3}, HTValueA_{i,t-3}$
	(46)	$PC\_HTValueA_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GPatent_{i,t-3}, HTValueA_{i,t-3}$
Inn. → Prod.	(47)	$FD\_Prod_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$FPatent_{i,t-2}, Prod_{i,t-3}, FD\_GDPC_{i,t}, Unemploy_{i,t}$
	(48)	$FD\_Prod_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GPatent_{i,t-2}, Prod_{i,t-3}, FD\_GDPC_{i,t}, Unemploy_{i,t}$
Innovation → Employment	(49)	$PC\_Employ_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$GDPC_{i,t-3}$
	(50)	$PC\_Employ_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GDPC_{i,t-3}$
	(51)	$PC\_KIEmploy_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$GDPC_{i,t-3}$
	(52)	$PC\_KIEmploy_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GDPC_{i,t-3}$
	(53)	$PC\_HTEmploy_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$GDPC_{i,t-3}$
	(54)	$PC\_HTEmploy_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GDPC_{i,t-3}$
	(55)	$PC\_Unemploy_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$GDPC_{i,t-3}$
	(56)	$PC\_Unemploy_{i,t}$	$AVG\_FD\_GPatent_{i,t}$	$GDPC_{i,t-3}$

Table A.1.2: An oversight of regression models to empirically investigate whether VC leads to positive externalities. All models are fixed effects regression models.

Table A.1.1 gives an oversight of all collected, and of subsequently calculated, variables. These variables are used in regression analyses. Table A.1.2 shows regression equations, by presenting the dependent, independent (i.e. explanatory), and control variables. In most regression equations causality issues are (tried to be) dealt with by considering first differences or percentage changes. This way it is investigated if a

change in explanatory variable x at time, say, $t-1$, leads to a change in dependent variable y at time t. By also including level-values of x at time $t-1$ it is prevented that the estimated coefficient of x only captures correlation.

This, however, raises another question: which lagged values to include? Here, I follow Wang and Huang (2007), who dealt with a similar question for R&D investments. They mention that Goto and Suzuki (1989), investigating Japanese manufacturing industries, found that the time until R&D innovations resulted in additional sales varied across industries, that Adams and Griliches (1998) took the lag length to be equal to 5 years with regard to the research output of U.S. universities, and that Guellec and Van Pottelsberghe de la Potterie (2004) found that the effect of business and public R&D capital stocks on multi-factor productivity had a lag length of 1 respectively 2 years. Wang and Huang (2007, p. 266), conclude that "a 3-year lag is most appropriate in the study when using aggregate data." Since I use aggregate data, I thus use lags of maximally three years, partly also because increasing the lag length much further would greatly reduce the number of observations that can be used for estimation.

It may be observed that no control variables with regard to the market-/bank-basedness or to the degree to which countries are a LME or CME are included. This is not necessary, because the choice of the dependent variables (percentage changes or first differences instead of levels) already largely takes care of it, given that the market-/bank-basedness and the degree to which countries are a LME or CME are not expected to change rapidly and significantly over time.[167] Additional control variables, which serve as dependent or explanatory variables in other equations, are considered based on consultations with Ministry experts. For instance, in models (9)-(12) and (47)-(48) that investigate the effects on productivity levels, the unemployment rate is included as a control variable, because increased unemployment levels may mean that especially the less productive workers have been laid off, which influences productivity levels. Finally, all regression equations are estimated using a fixed effects approach, removing as much of the country-specific noise as possible.[168]

Models (1) to (12) investigate whether increased VC investments lead to increased innovation, models (13)-(24) whether increased VC investments lead to economic growth, models (25)-(40) whether increased VC investments lead to improved employment indicators, models (41)-(46) whether increased innovation fuels economic growth, models (47) and (48) whether increased innovation spurs productivity, and finally, models (49)-(56) whether increased innovation improves employment indicators. These models relate closely to the arrows visible in Figure 1.2 (p. 14), basically from left to right and from top to bottom.

RESULTS

Firstly, let us look at Table A.1.3, which presents correlations of the main variables, and draw some observations. All correlations have the expected sign, except for the one of $ER_{i,t}$ and $GPatent_{i,t}$, which is slightly negative, and those of $Unemploy_{i,t}$ on the one hand, and $FPatent_{i,t}$ and $GPatent_{i,t}$ on the other, which are positive. It seems that economic growth ($HTValueA_{i,t}$, $GDPC_{i,t}$),

[167] Including them as moderating variables did not result in significantly different results.

[168] Verbeek (2008, p. 367) indicates that a fixed effects approach is most appropriate when countries are considered.

employment figures ($KIEmploy_{i,t}$, $HTEmploy_{i,t}$, $Unemploy_{i,t}$,), (potential) innovation-generating investments ($Total_{i,t}, ES_{i,t}$, $ER_{i,t}$, $RD_{i,t}$), patent figures ($FPatent_{i,t}, GPatent_{i,t}$), and productivity levels ($Prod_{i,t}$) move together. It thus seems that, for instance, richer countries spend more on VC and R&D as a percentage of GDP. What is perhaps notable, already, is that no strong positive correlation can be found between VC investment figures ($Total_{i,t}, ES_{i,t}$, $ER_{i,t}$) on the one hand and patent figures ($FPatent_{i,t}, GPatent_{i,t}$) on the other.

Correlations											
	$Total_{i,t}$	$ES_{i,t}$	$ER_{i,t}$	$FPatent_{i,t}$	$GPatent_{i,t}$	$GDPC_{i,t}$	$Prod_{i,t}$	$KIEmploy_{i,t}$	$HTEmploy_{i,t}$	$Unemploy_{i,t}$	$HTValueA_{i,t}$
$ES_{i,t}$	0.82										
$ER_{i,t}$	0.89	0.65									
$FPatent_{i,t}$	0.02	0.08	0.01								
$GPatent_{i,t}$	0.00	0.05	-0.02	0.98							
$GDPC_{i,t}$	0.27	0.36	0.28	0.23	0.19						
$Prod_{i,t}$	0.34	0.42	0.32	0.29	0.27	0.93					
$KIEmploy_{i,t}$	0.44	0.53	0.46	0.24	0.20	0.78	0.83				
$HTEmploy_{i,t}$	0.28	0.35	0.21	0.23	0.23	0.45	0.46	0.66			
$Unemploy_{i,t}$	-0.18	-0.21	-0.18	0.15	0.17	-0.41	-0.34	-0.30	-0.28		
$HTValueA_{i,t}$	0.34	0.36	0.30	0.12	0.11	0.21	0.22	0.46	0.85	-0.18	
$RD_{i,t}$	0.29	0.44	0.19	0.40	0.39	0.57	0.61	0.71	0.67	-0.18	0.46

Table A.1.3: Correlation figures of main variables. The figures are Pearson product-moment correlation coefficients.

However, a table of correlation figures like Table A.1.3 does not help to establish anything seriously useful about causality. Table A.1.4, however, presents the results of regression analyses that use lagged variables. Models (1)-(12) do not succeed in finding a significant positive link between changes in VC investments and changes in the number of filed or granted patents or in productivity.[169] Models (13)-(24) furthermore fail to find a significant relation between VC investments and innovation activity. Models (25), (28) and (40) find a positive link between VC investments and employment indicators. Interestingly, these indicators relate to national employment figures, whereas models (29)-(36) that take a narrower view result in insignificant estimates.

[169] Performing the regression analyses of models (1)-(12) without the control variables results in significant estimated coefficients. However, the significance transfers to the control variables when they are included.

Regression Analyses							
Model	Dependent variables	Independent Variables					
		$FD\_Total_{i,t-2}$	$FD\_ES_{i,t-2}$	$FD\_ER_{i,t-2}$	$AVG\_FD\_Total_{i,t}$	$AVG\_FD\_FPatent_{i,t}$	$AVG\_FD\_GPatent_{i,t}$
(1)	$FPatent_{i,t}$	-252.51					
(2)	$FPatent_{i,t}$		847.15				
(3)	$FPatent_{i,t}$			-339.20			
(4)	$FPatent_{i,t}$				-1346.45		
(5)	$GPatent_{i,t}$	-601.017					
(6)	$GPatent_{i,t}$		-1069.154				
(7)	$GPatent_{i,t}$			-763.3445			
(8)	$GPatent_{i,t}$				-381.12		
(9)	$FD\_Prod_{i,t}$	0.0722					
(10)	$FD\_Prod_{i,t}$		1.8432				
(11)	$FD\_Prod_{i,t}$			-0.3174			
(12)	$FD\_Prod_{i,t}$				-0.6846		
(13)	$PC\_GDP_{i,t}$	7.115					
(14)	$PC\_GDP_{i,t}$		-22.8924				
(15)	$PC\_GDP_{i,t}$			5.662			
(16)	$PC\_GDP_{i,t}$				-0.1031		
(17)	$PC\_GDPC_{i,t}$	5.542					
(18)	$PC\_GDPC_{i,t}$		-7.4479				
(19)	$PC\_GDPC_{i,t}$			1.081			
(20)	$PC\_GDPC_{i,t}$				2.1507		
(21)	$PC\_HTValueA_{i,t}$	-9.000					
(22)	$PC\_HTValueA_{i,t}$		-9.878				
(23)	$PC\_HTValueA_{i,t}$			-12.8223			
(24)	$PC\_HTValueA_{i,t}$				3.9421		
(25)	$PC\_Employ_{i,t}$	4.7283					
(26)	$PC\_Employ_{i,t}$		1.9030				
(27)	$PC\_Employ_{i,t}$			3.7780			
(28)	$PC\_Employ_{i,t}$				5.6948		
(29)	$PC\_KIEmploy_{i,t}$	-1.1034					
(30)	$PC\_KIEmploy_{i,t}$		-2.7689				
(31)	$PC\_KIEmploy_{i,t}$			1.0059			
(32)	$PC\_KIEmploy_{i,t}$				-0.0152		
(33)	$PC\_HTEmploy_{i,t}$	1.6535					
(34)	$PC\_HTEmploy_{i,t}$		-.2.8092				
(35)	$PC\_HTEmploy_{i,t}$			-9.738			
(36)	$PC\_HTEmploy_{i,t}$				9.7282		
(37)	$PC\_Unemploy_{i,t}$	-23.673					
(38)	$PC\_Unemploy_{i,t}$		14.0530				
(39)	$PC\_Unemploy_{i,t}$			-4.7058			
(40)	$PC\_Unemploy_{i,t}$				-59.4201		
(41)	$PC\_GDP_{i,t}$					-0.0039	
(42)	$PC\_GDP_{i,t}$						-0.00267
(43)	$PC\_GDPC_{i,t}$					-0.00358	
(44)	$PC\_GDPC_{i,t}$						-0.00329
(45)	$PC\_HTValueA_{i,t}$					-0.0051	
(46)	$PC\_HTValueA_{i,t}$						0.01257
(47)	$FD\_Prod_{i,t}$					-0.000336	
(48)	$FD\_Prod_{i,t}$						-0.000292
(49)	$PC\_Employ_{i,t}$					0.00021	
(50)	$PC\_Employ_{i,t}$						-0.0008
(51)	$PC\_KIEmploy_{i,t}$					0.00057	
(52)	$PC\_KIEmploy_{i,t}$						0.00064
(53)	$PC\_HTEmploy_{i,t}$					-0.00126	
(54)	$PC\_HTEmploy_{i,t}$						-0.00045
(55)	$PC\_Unemploy_{i,t}$					-0.00240	
(56)	$PC\_Unemploy_{i,t}$						0.00671

Table A.1.4: Results of the regression analyses. A green background indicates significance at the 1% level, yellow at the 5% level, and red at the 10% level.

Regarding the estimated effects of innovation on economic activity and productivity, the explanatory

variable that relates to granted patents ($AVG\_FD\_GPatent_{i,t}$) remains insignificant in all equations when control variables are included. The coefficient of the explanatory variable that relates to filed patents ($AVG\_FD\_FPatent_{i,t}$), interestingly, is estimated to be *negative* in the cases of GDP, GDP per capita, and productivity growth. Although this may be due to several unidentified causes, it could also be a clue to that increased innovative activity may have short-term costs before it can result in long-term gains. Finally, no significant relation is found between an increased amount of filed or granted patents, and employment indicators.

The results thus largely fail to find empirical evidence of the arrows depicted in Figure 1.2, which should not come as a surprise. On the other hand, it does indicate that the value and importance of venture capitalism and to a lesser extent innovation should not be overstated and taken for granted.

To corroborate the above, I have also conducted several Granger-causality tests. Although they generally found that the couples of variables, as mentioned in the third and fourth column of Table A.1.2, seem to positively affect each other, with causality running both ways, results were highly sensitive to the specification of the model (especially the choice of lag length). They thus resulted in inconclusive results.

These results have consequences for empirical research on the effectiveness and successfulness of VC policies. One way to investigate this is to calculate a societal return on investment; to calculate what the derived benefit (in monetary terms) is of the implemented VC policies. This is certainly not possible when it is not even possible to quantify the positive externalities of VC (and not even the changes therein that are arguably caused by VC policies[170]).

A.1.2 Development of VC Markets

Subsection 1.4.2 provided an overview of the development of the Dutch VC market, and of some developments that are particularly interesting from a policy perspective. This subsection will present and describe some other, perhaps less notable developments.

In Figure A.1.1 the development of the number of VC investments in the Netherlands is presented. Between 1989 and 2010 at least 271 investments have been provided every year to VC firms, with a maximum of 745 investments in 1999, at the peak of the dot-com bubble. Most investments concerned expansion and replacement investments. After the dot-com bubble burst the number of ES and ER investments decreased strongly.

The development of the number of firms that received VC investments in the Netherlands is presented in Figure A.1.2, and is, as expected, similar to the development of the number of VC investments. With respect to the number of firms that received VC investments, 1998, 1999, and 2000 can be considered as the booming years, during which more than 581 firms received VC investments every year. Over the entire period, an average of 357 firms received VC investments every year. Again, it seems that the dot-com bubble burst affected (the number of firms receiving) ES and ER investments, whereas the recent crises left these numbers relatively unaffected. Notable is that in recent, post-2006 years the number of VC receiving

[170] See Besley (2001).

firms is generally lower than in preceding years and that the number of ES investments receiving firms caught up with the number of ER investments receiving firms.

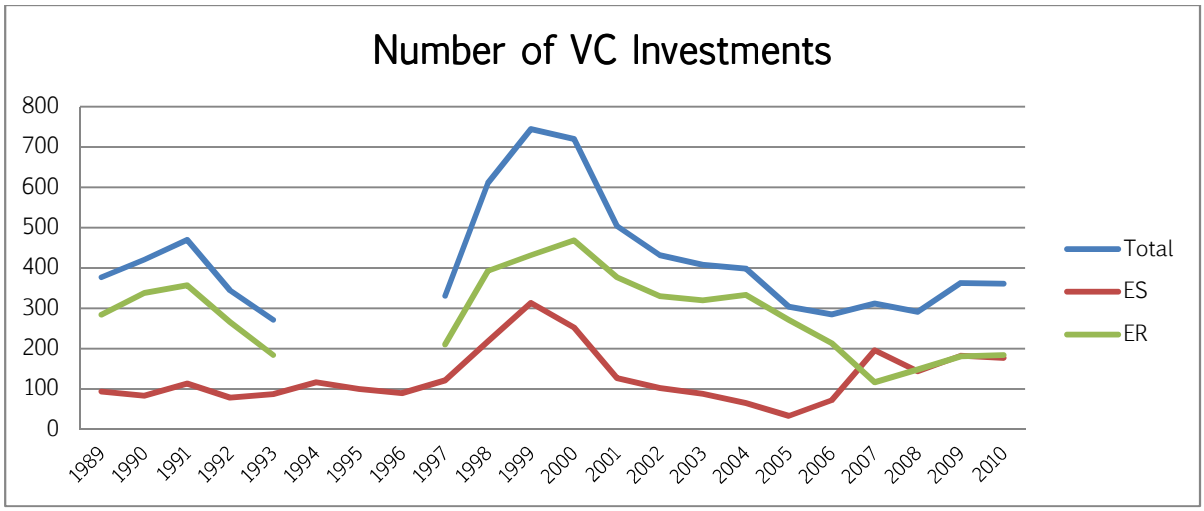

Figure A.1.1: The graph shows the development of the number of VC investments on the Dutch VC market, and of its three components. Data for ER investments is missing for 1994-1996, and no data is available for 2011.

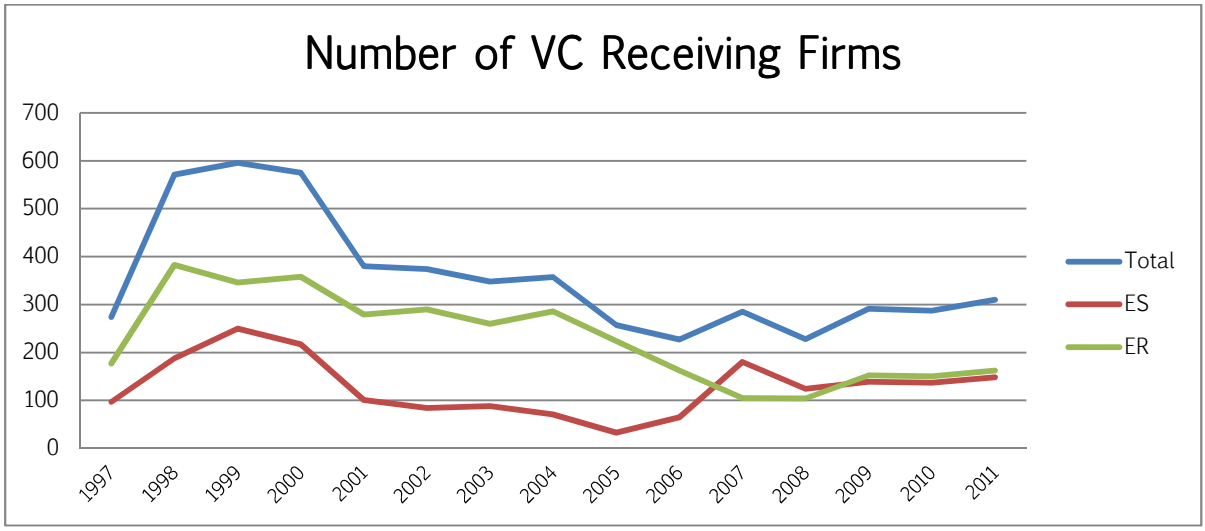

Figure A.1.2: The graph shows the development of the number of Dutch VC firms that received investments, and on its three components. Data is not available for years before 1997.

Figure 1.4 and Figure 1.5 show that the recent crises depressed the volume of VC investments in the Netherlands, but Figure A.1.1 and Figure A.1.2 show that the number of investments and of recipient firms did not decline dramatically. Therefore, Figure A.1.3 shows an interesting development. Over time, the average VC investments, and ER investments in particular, tended to grow considerably, although the recent crises halted these exceptional growth rates. Before 1994, when VC was not crucially important, investments averaged around €425,000. After 1997 average investments exceeded 1 million euro, until far into the recent crises. This could be a clue to that venture capitalists have recently grown bigger and become more interested in big absolute returns as opposed to relative returns.[171] Additionally, it could reflect that

[171] Even if a €1,000,- investment is expected to result in a 100% (i.e. €1,000,-) return, for a venture capitalist with a sufficiently large

investors have (or had to) become more risk averse during and after the recent crises.[172]

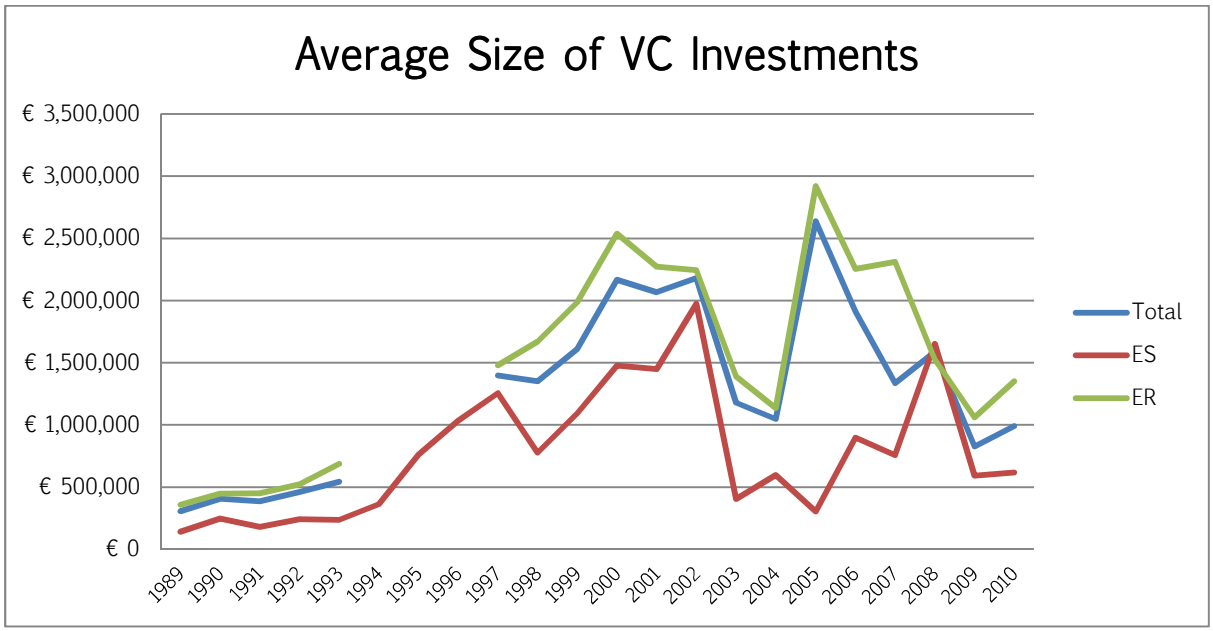

Figure A.1.3: The graph shows the development of the average size of VC investments in the Netherlands. Data is not available for ER investment for years 1994-1996.

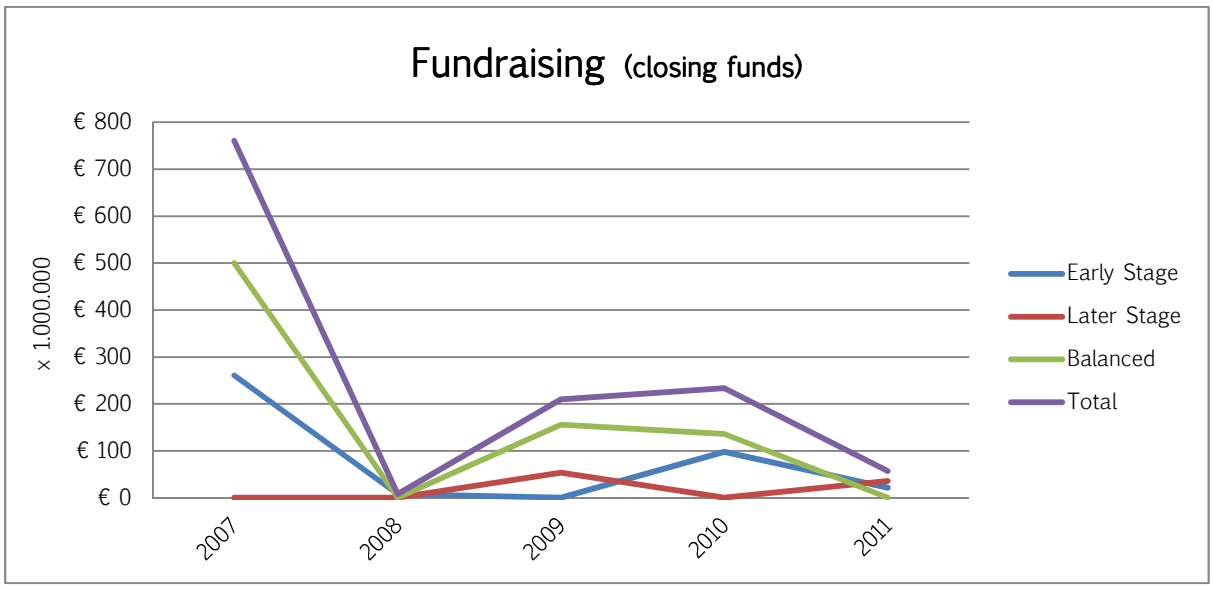

Figure A.1.4: The graph shows the development of the total volume of funds, that were raised by venture capitalists, and that were closed in the corresponding. 'Balanced' refers to funds that are raised for both early and later stage investments.

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budget, an investment of €1,000,000,- that is expected to yield 'only' 15% (i.e. €150,000,-) might be far more interesting. Dimov and Murray (2008, p. 147), for instance, find that with "regard to [...] the amount of capital available [...] we find a strong and consistent negative relationship with the likelihood, number, and proportion of seed investments." See also Kleijn, Faber, and Morley (2010).

[172] The conclusions remain unchanged if instead of the average investment, the average amount invested per firm is considered.

Figure 1.10 (p. 28) presented the development of raised funds. Figure A.1.4 shows a similar development for the development of the total amount of *closing* funds for the years 2007-2011. Contrary to the figures of Figure 1.10, capital of a fund closed in a certain year could have been raised, at least partially, in earlier years. Again, a massive decrease follows the recent crises. In 2008, only one fund closed, which was an early stage fund worth €8 million. These developments are worrying, because if fundraising does not recover, VC investments will eventually (have to) decrease as well.

Figure A.1.5 shows the development of the volume of investments by Dutch venture capitalists, which may have ended up at foreign firms. It can be observed that the recent crises depressed VC investments. Investments aimed at the start-up phase suffered less and later, whereas both seed and later stage investments were depressed more severely. Seed investments in 2007 totalled €14.28 million euro, whereas for 2009 and 2010 *combined* this amounted to only €2.73 million.

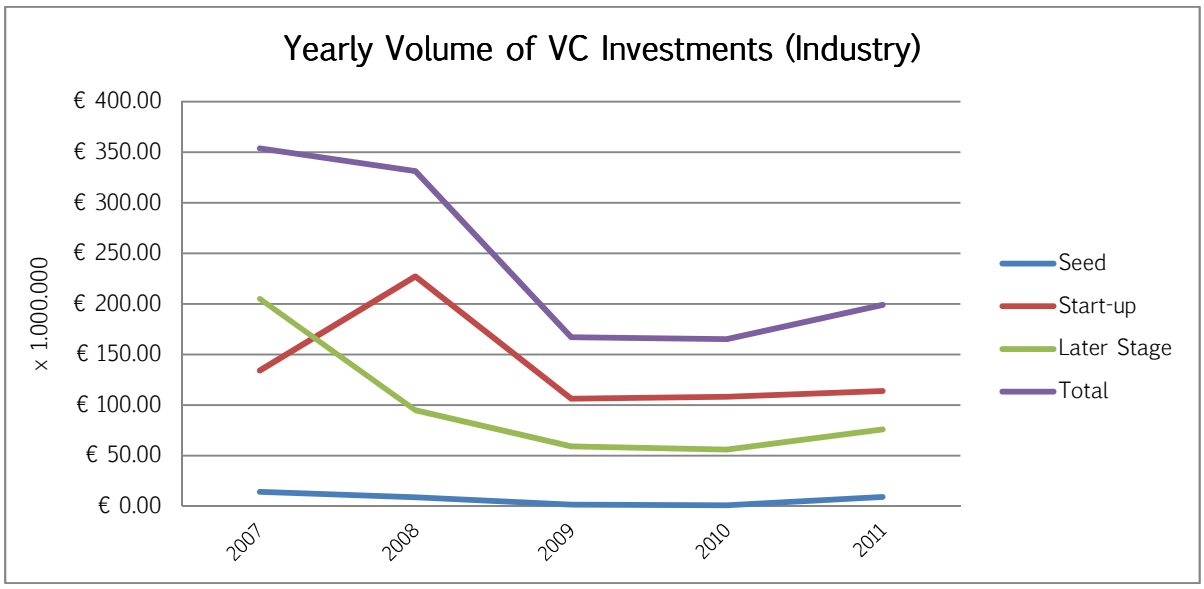

Figure A.1.5: The yearly development of the volume of VC investments by Dutch venture capitalists.

Figure A.1.6 is a more detailed version of Figure A.1.5, although its accuracy is less because of a lower coverage. It shows that start-up investments peaked in the second quarter of 2008,[173] after which all VC investment decreased. Afterwards, they remained quite constant, below pre-crises levels. Figure 1.5, Figure A.1.5, and Figure A.1.6 all show that seed investments are dwarfed by start-up and later stage investments. Figure A.1.7 is a more detailed version of Figure 1.5 (p. 23), although its accuracy is less because of a lower coverage. It portrays similar developments as Figure A.1.6. The last part of the graph is remarkable, with later stage investments climbing above €50 million for the first time since mid-2008, with total investments totalling €70 million, but with start-up investments decreasing 57% compared to the previous quarter.

[173] This could possibly be explained by an outlier; an exceptionally large investment that happened to occur that year. The data does not allow me to check for this.

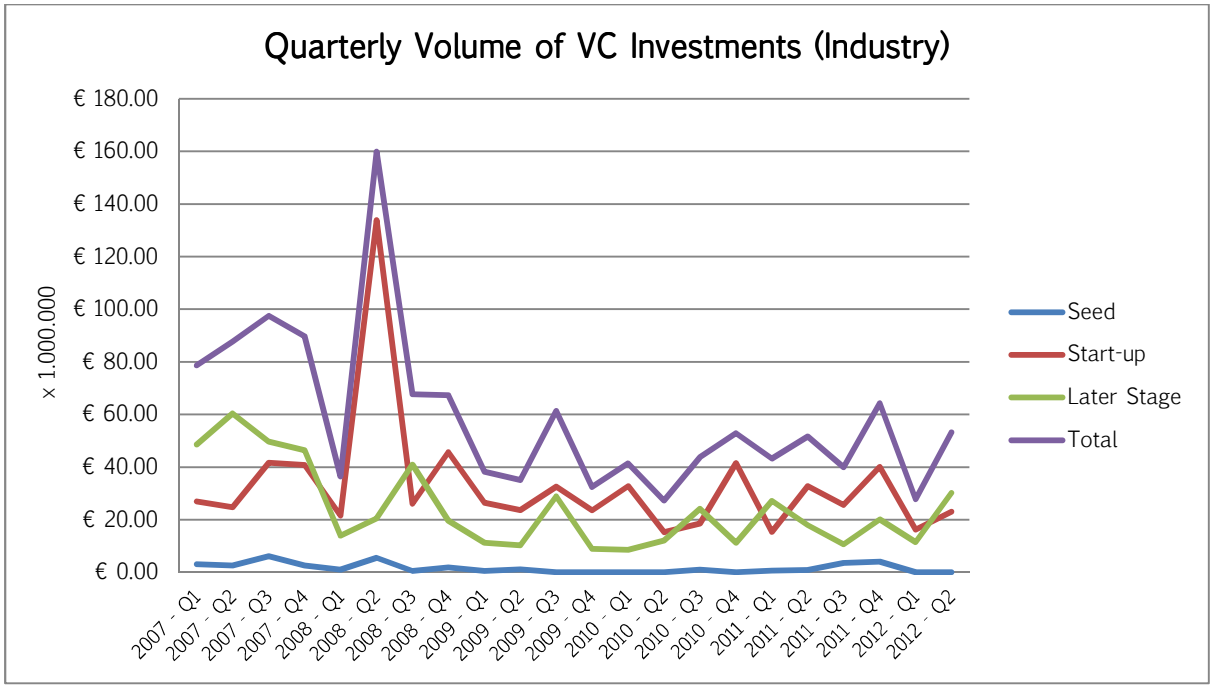

Figure A.1.6: The quarterly development of the volume of VC investments by Dutch venture capitalists.

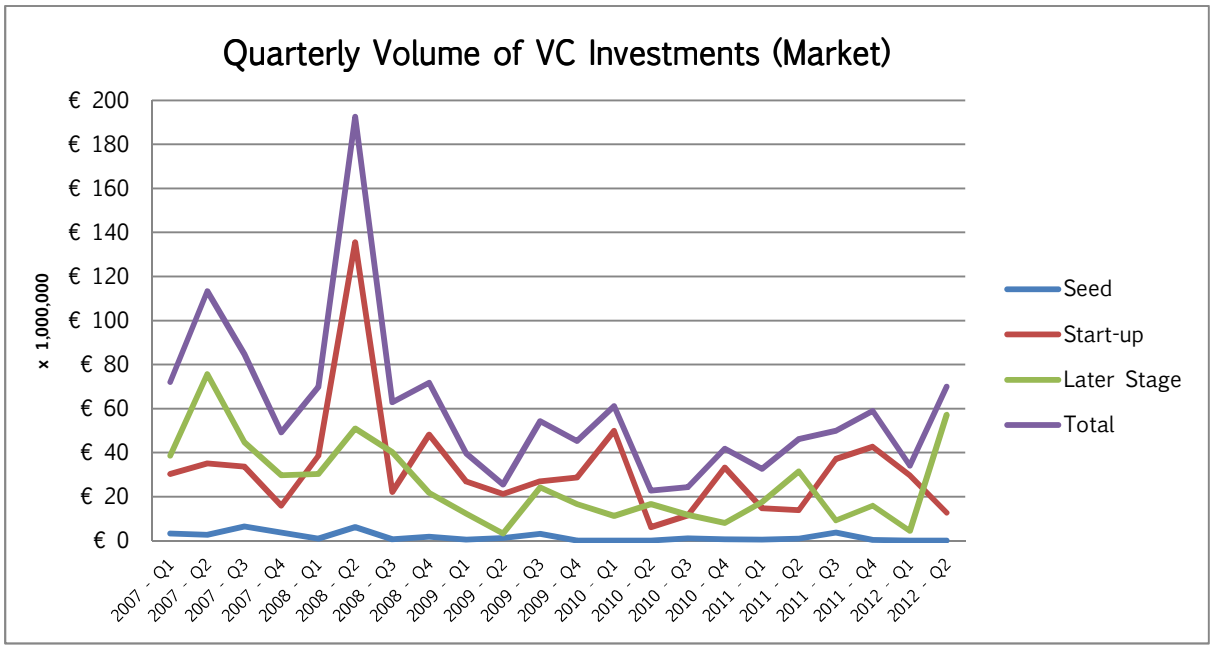

Figure A.1.7: The quarterly development of the total volume of VC investments received by Dutch firms.

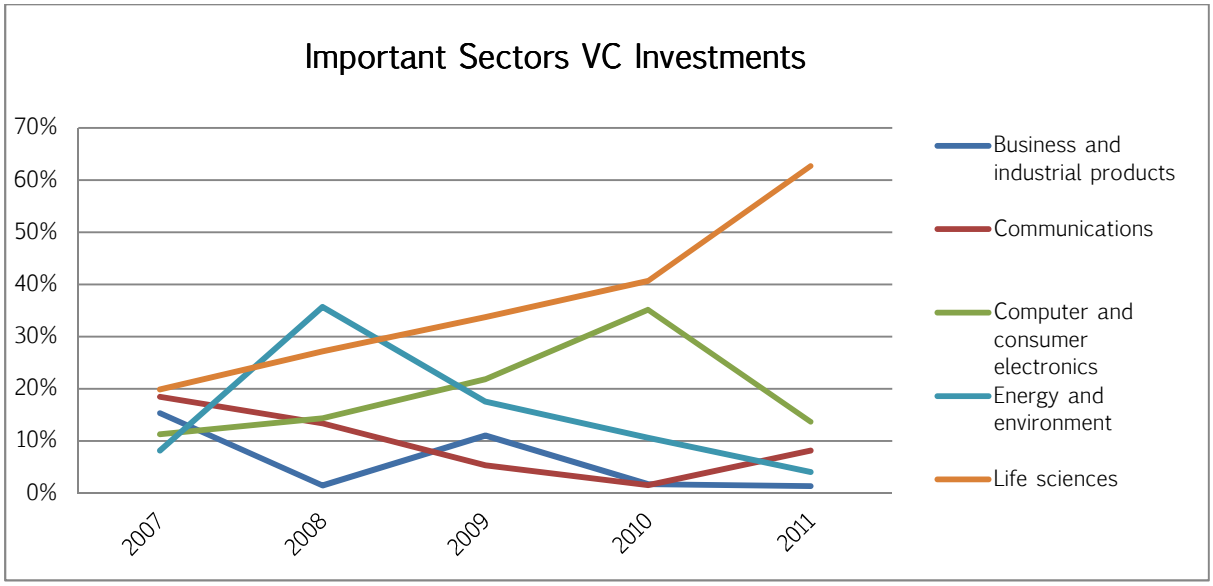

Figure A.1.8: The graph presents the development of the distribution of VC investments of some important sectors, based on volume, according to the market perspective, and presented as a percentage of the total volume of VC investments of the corresponding year.

Table A.1.7 (p. 111) provides more detailed figures on divestments by exit routes, including the number of divestments and the number of corresponding firms. Figure A.1.9 uses the data of Table A.1.7, and shows that in recent years the role of trade sales has gained importance. Write-offs, after a 2009-peak, has notably lost in importance.

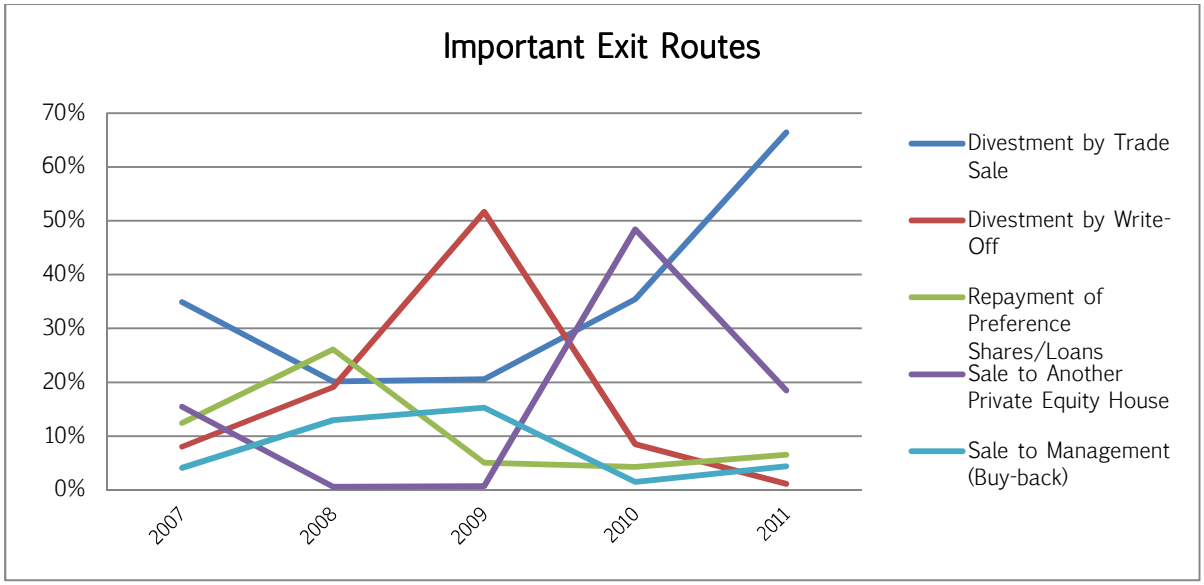

Figure A.1.9: The graph presents the development of the distribution of some important exit routes, based on volume, according to the market perspective, and presented as a percentage of the total volume of VC divestments of the corresponding year.

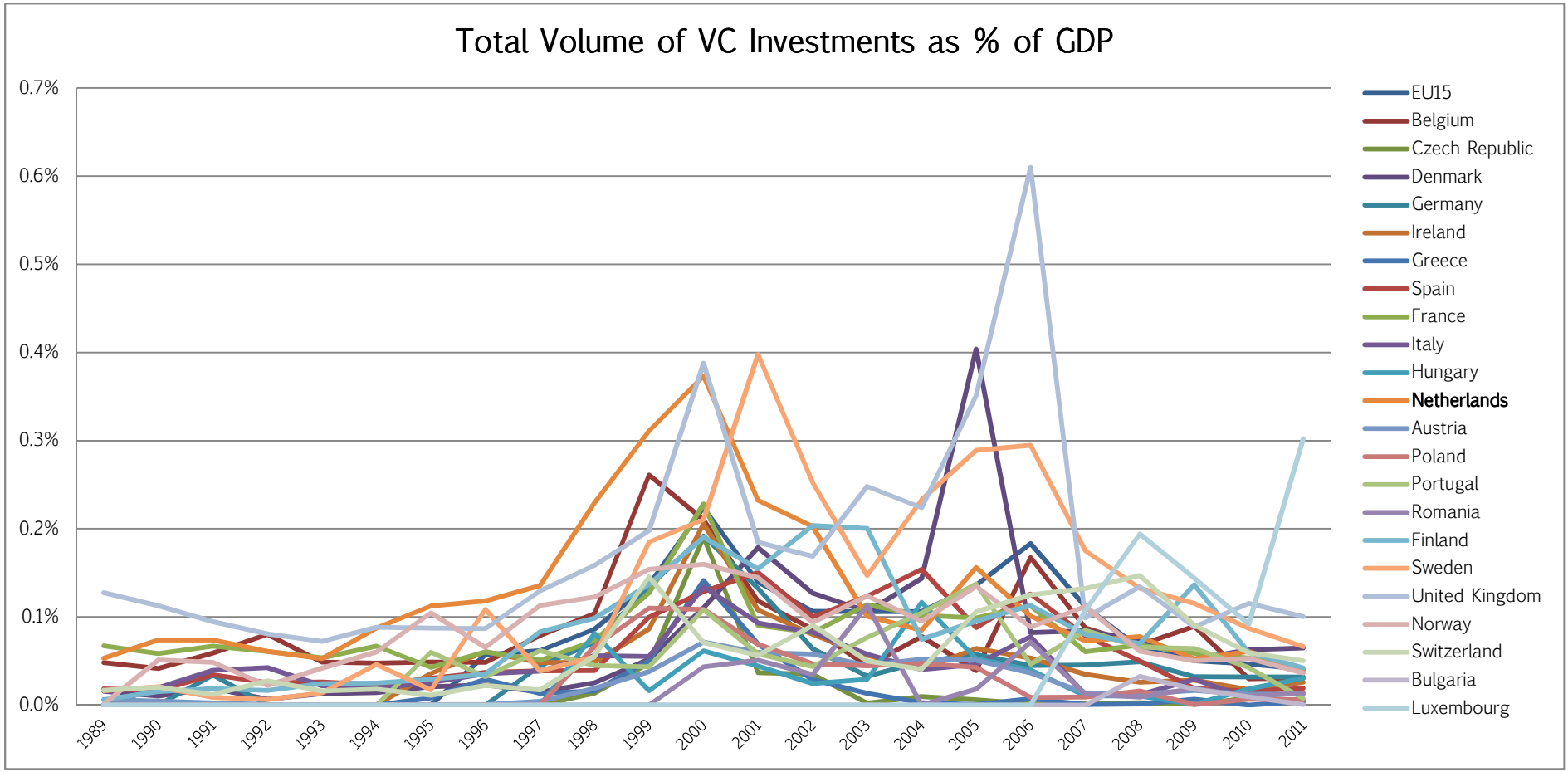

Figure A.1.10: Development of the total volume of VC investments, measured as a percentage of GDP.

First Differences of Total VC Investments																						
	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
EU15								2.80%	5.40%	11.70%	8.60%	-12.60%	2.80%	1.10%	6.30%	8.20%	19.20%	-3.30%	-15.60%	-24.50%	15.00%	1.80%
Belgium	-0.40%	1.30%	1.80%	-3.20%	0.40%	-0.30%	-0.10%	3.10%	3.20%	16.90%	-5.80%	-6.60%	-2.40%	-2.40%	-0.80%	-3.90%	23.10%	0.60%	-10.80%	11.50%	-17.20%	2.20%
Czech Republic										2.30%	13.90%	-15.40%	7.50%	-9.60%	0.60%	-0.10%	-1.00%	4.20%	-3.00%	2.00%	-1.80%	9.90%
Denmark	-0.60%	0.60%	-0.90%	0.20%	0.10%	0.80%	0.10%	-0.90%	1.10%	4.50%	8.70%	2.70%	-5.40%	8.90%	-1.90%	30.90%	-34.00%	35.70%	-31.10%	0.50%	-3.50%	-2.70%
Germany			-2.70%	-0.10%	0.80%	-0.90%	0.10%	5.70%	3.00%	5.80%	7.50%	-2.20%	-9.30%	-0.20%	5.60%	-5.00%	3.10%	18.30%	-4.80%	-18.50%	9.10%	-2.30%
Ireland							2.70%	-1.40%	3.00%	3.50%	9.60%	-8.90%	-4.20%	10.10%	-14.00%	2.50%	-0.50%	10.80%	-12.70%	-0.50%	-0.60%	0.20%
Greece							2.10%	-1.60%	0.20%	3.80%	8.70%	-7.00%	-4.20%	-1.40%	-1.20%	0.10%	0.30%	3.30%	5.90%	-8.20%	-1.30%	0.00%
Spain	-0.30%	1.50%	-0.80%	-0.10%	0.10%	0.80%	0.40%	1.30%	1.60%	5.70%	5.40%	-0.30%	-4.30%	3.80%	6.30%	5.90%	-0.70%	-2.40%	-11.50%	-6.00%	14.80%	-2.40%
France	-1.30%	1.70%	-0.70%	-1.00%	1.30%	-2.40%	-0.20%	3.10%	3.60%	7.10%	16.20%	-14.90%	15.40%	-10.60%	4.80%	10.90%	13.70%	8.00%	-20.10%	-25.80%	12.40%	15.70%
Italy		3.00%	-0.10%	-2.20%	0.10%	-0.10%	2.20%	0.60%	2.80%	7.20%	9.10%	-7.40%	2.80%	2.40%	-12.00%	4.60%	7.70%	-11.90%	9.50%	-11.10%	-3.50%	1.70%
Hungary										-6.50%	8.70%	14.00%	-21.90%	2.20%	7.00%	-6.40%	-1.30%	1.10%	-1.90%	17.70%	-16.30%	3.10%
Netherlands	1.80%	2.00%	-2.70%	-1.80%	3.50%	3.70%	-6.20%	13.90%	7.20%	14.90%	1.60%	-3.70%	-5.10%	-14.10%	10.90%	11.70%	-1.20%	16.90%	-32.50%	-15.40%	9.00%	11.60%
Austria	-0.20%	-0.20%	-0.20%	0.00%	0.00%	0.00%	0.00%	1.00%	1.60%	1.80%	3.30%	-0.90%	-0.20%	-1.60%	1.00%	-0.20%	0.30%	6.90%	-5.30%	-2.70%	-0.50%	-0.30%
Poland										5.00%	-0.80%	-3.80%	-1.50%	1.30%	-0.60%	-0.10%	4.50%	14.30%	-5.10%	-4.60%	-1.20%	4.40%
Portugal							-2.50%	2.60%	-1.70%	5.50%	4.40%	-6.30%	-3.20%	3.20%	2.70%	5.00%	-5.00%	1.70%	10.50%	-5.30%	-6.10%	9.80%
Romania												0.20%	-1.60%	7.80%	-7.40%	3.40%	2.60%	2.60%	-3.70%	-1.80%	-0.50%	-2.90%
Finland	0.80%	0.60%	-0.30%	0.80%	0.20%	0.50%	0.60%	6.40%	5.90%	4.00%	8.70%	-10.60%	13.30%	-1.50%	-15.60%	0.00%	1.40%	30.70%	-20.80%	-3.40%	0.90%	-1.20%
Sweden	4.00%	-3.70%	0.00%	1.00%	6.60%	-5.50%	14.90%	-3.60%	-6.80%	43.70%	33.10%	-5.20%	-25.50%	-18.60%	19.20%	45.00%	33.30%	-58.60%	22.90%	-55.00%	46.00%	-33.20%
United Kingdom	-7.50%	-3.40%	1.50%	-2.30%	5.80%	4.30%	1.30%	6.00%	17.80%	27.10%	0.90%	-40.60%	19.30%	21.30%	25.50%	21.10%	80.10%	-41.80%	-41.70%	-68.20%	55.70%	-1.50%
Norway	5.00%	-0.30%	-2.50%	1.80%	1.80%	4.50%	-3.90%	5.50%	0.10%	5.50%	-1.50%	-1.60%	-4.80%	4.00%	0.80%	2.70%	-0.40%	9.30%	-1.90%	-1.30%	8.10%	-10.60%
Switzerland	0.50%	-0.50%	1.50%	-1.00%	1.00%	-1.40%	3.20%	-2.90%	6.40%	8.50%	5.40%	-14.30%	2.00%	-2.70%	1.50%	2.70%	14.20%	0.10%	8.60%	-15.00%	17.10%	-22.40%
Bulgaria																			-8.50%	-2.40%	-0.50%	1.60%
Luxembourg																			81.90%	-72.40%	0.20%	30.50%

Table A.1.5: This table presents first differences of total VC investments for the countries for which data was available. The cells have been coloured on a scale from green to red, where green refers to an increase and red to a decrease of total VC investments.

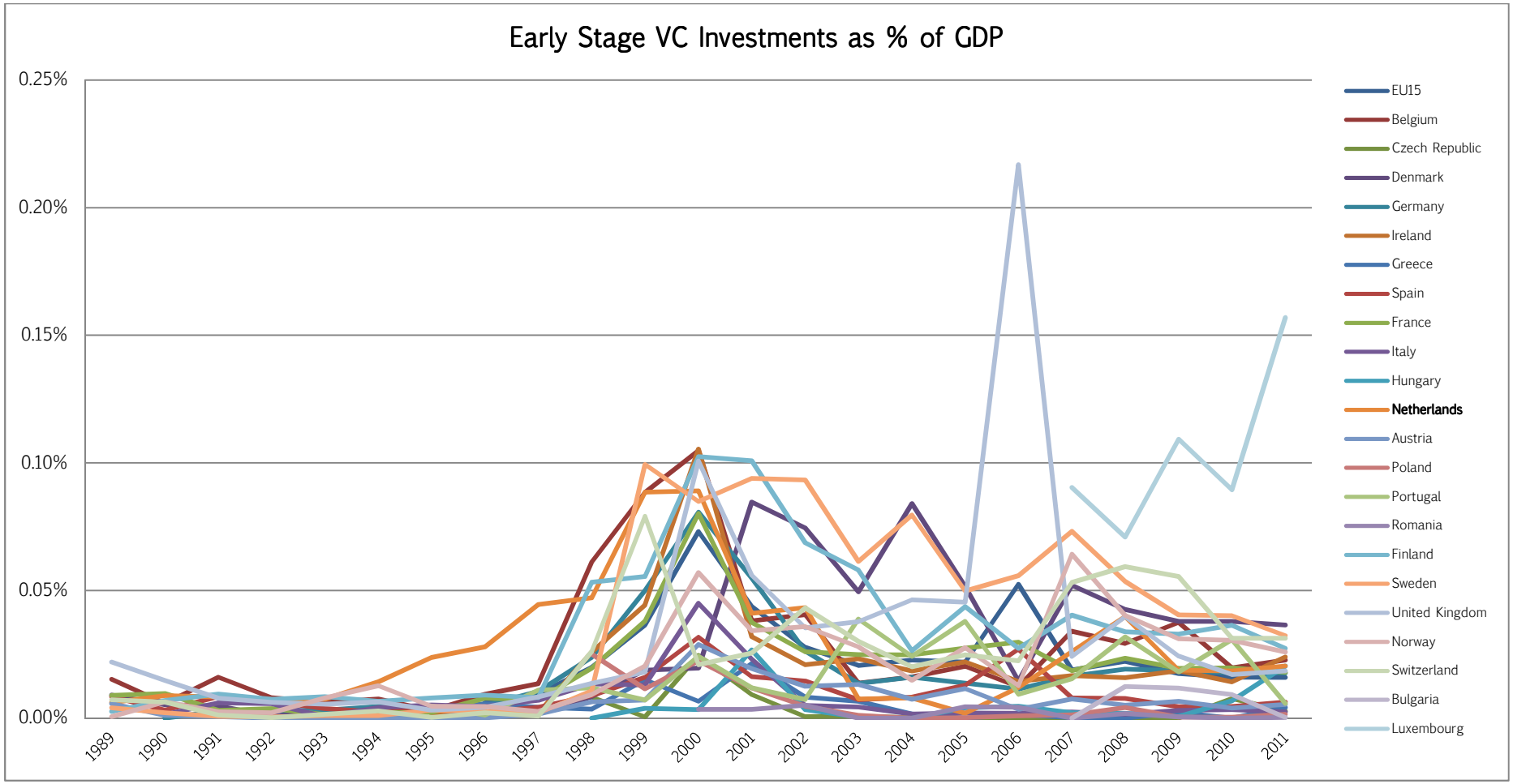

Figure A.1.11: The development of the volume of early stage investments, measured as a percentage of GDP.

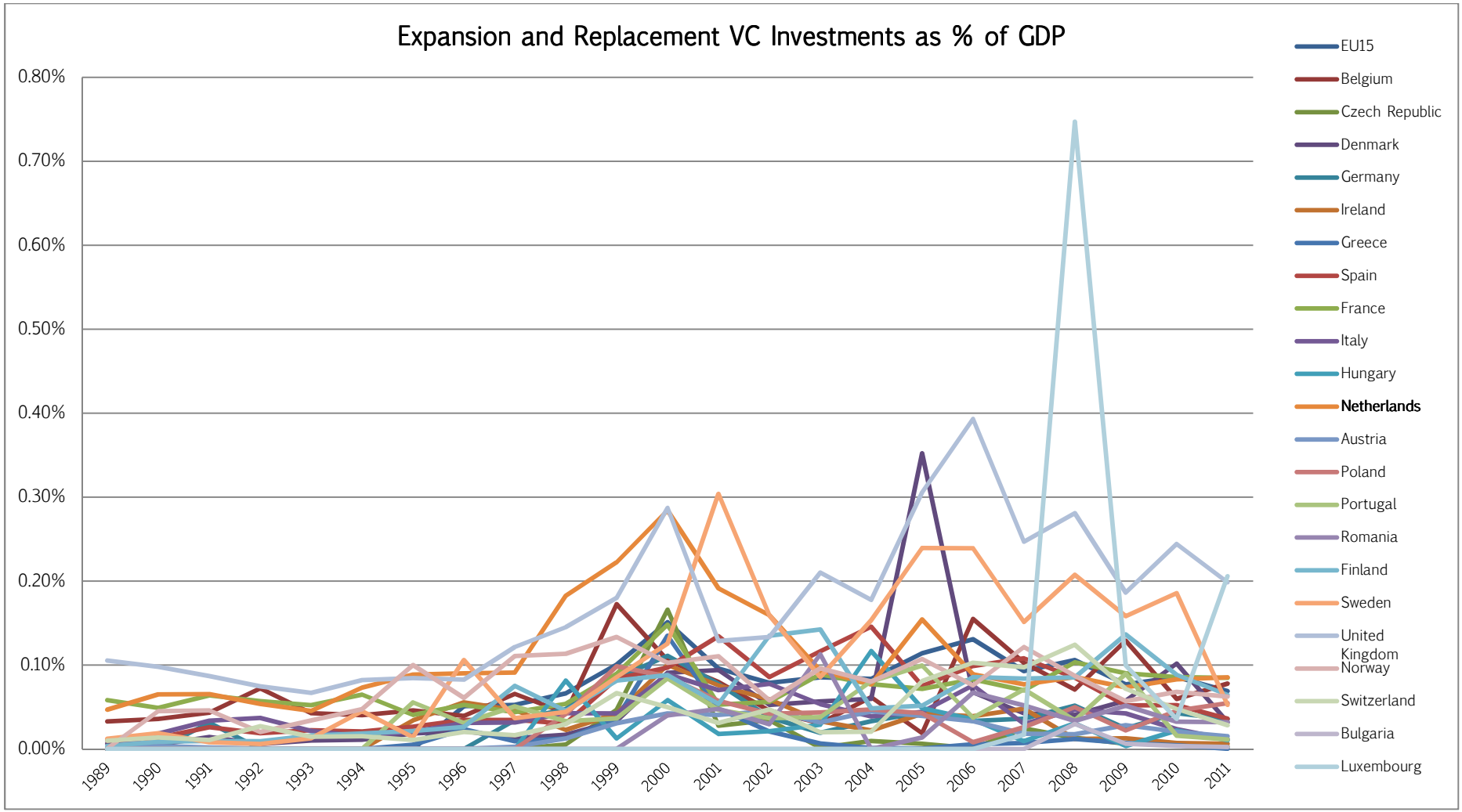

Figure A.1.12: The development of the volume of expansion and replacement investments, measured as a percentage of GDP.

Sectoral Distribution of VC Investments (Market)															
	Volume (x 1,000)					Number of Investments					Number of Firms				
	2007	*2008*	*2009*	*2010*	*2011*	*2007*	*2008*	*2009*	*2010*	*2011*	*2007*	*2008*	*2009*	*2010*	*2011*
Agriculture	€ 974.14	€ 2,500.00	€ 200.00	€ 304.55	€ 741.66	3	1	2	2	3	3	1	2	2	2
	€ 4,720.35					**11**					**10**				
Business and industrial products	€ 48,966.96	€ 5,691.61	€ 18,174.31	€ 2,540.64	€ 2,500.00	17	13	23	10	7	14	11	21	7	6
	€ 77,873.52					**70**					**59**				
Business and industrial services	€ 9,041.61	€ 2,520.06	€ 2,801.35	€ 3,072.16	€ 1,763.93	11	6	8	8	6	11	6	8	8	6
	€ 19,199.11					**39**					**39**				
Chemicals and materials	€ 490.19	€ 1,268.25	€ 1,473.05	€ 1,470.61	€ 163.00	3	3	5	6	2	3	3	5	6	2
	€ 4,865.10					**19**					**19**				
Communications	€ 58,913.20	€ 53,027.43	€ 8,778.62	€ 2,300.26	€ 15,229.27	35	35	20	17	32	31	35	19	16	27
	€ 138,248.78					**139**					**128**				
Computer and consumer electronics	€ 35,981.51	€ 56,970.36	€ 35,961.25	€ 52,665.92	€ 25,659.85	38	35	58	71	46	32	25	44	42	30
	€ 207,238.89					**248**					**173**				
Construction	€ 6,321.00	€ 850.00	€ 361.22	€ 0.00	€ 0.00	2	2	1	0	0	2	2	1	0	0
	€ 7,532.22					**5**					**5**				
Consumer goods and retail	€ 16,053.00	€ 23,476.00	€ 8,266.25	€ 5,624.17	€ 15,356.42	7	3	11	7	10	6	3	11	7	10
	€ 68,775.84					**38**					**37**				
Consumer services: other	€ 28,931.00	€ 850.00	€ 1,630.00	€ 2,885.00	€ 25.00	6	1	5	6	1	5	1	4	6	1
	€ 34,321.00					**19**					**17**				
Energy and environment	€ 25,921.36	€ 141,714.00	€ 28,892.66	€ 15,884.72	€ 7,583.25	12	26	18	12	13	12	14	13	10	9
	€ 219,995.99					**81**					**58**				
Financial services	€ 0.00	€ 18.00	€ 551.45	€ 1,146.80	€ 0.00	0	2	1	3	0	0	1	1	3	0
	€ 1,716.25					**6**					**5**				
Life sciences	€ 63,360.49	€ 107,707.89	€ 55,532.68	€ 60,956.81	€ 117,661.00	48	67	88	82	119	32	38	46	45	56
	€ 405,218.87					**404**					**217**				
Real estate	€ 0.00	€ 3.09	€ 10.00	€ 350.00	€ 0.00	0	1	1	1	0	0	1	1	1	0
	€ 363.09					**3**					**3**				
Transportation	€ 1,000.00	€ 400.00	€ 2,061.22	€ 164.00	€ 950.00	1	1	3	2	3	1	1	3	2	3
	€ 4,575.22					**10**					**10**				
Unknown	€ 23,346.02	€ 0.00	€ 0.00	€ 525.00	€ 35.00	67	0	0	1	1	67	0	0	1	1
	€ 23,906.02					**69**					**69**				
Total Venture Deals	€ 319,300.48	€ 396,996.69	€ 164,694.06	€ 149,890.64	€ 187,668.38	250	196	244	228	243	219	142	179	156	153
	€ 1,218,550.25					**1161**					**849**				

Table A.1.6: Sectoral distribution of VC investments in the Netherlands, according to the market perspective. Boldfaced figures are cumulative figures of the years 2007-2011. Source: NVP.

Divestments by Exit Routes - Market																
		Volume (x 1,000)					Number of Investments					Number of Firms				
		2007	*2008*	*2009*	*2010*	*2011*	*2007*	*2008*	*2009*	*2010*	*2011*	*2007*	*2008*	*2009*	*2010*	*2011*
Divestment by Trade Sale		€ 49,338.30	€ 38,253.03	€ 33,635.20	€ 50,482.86	€ 71,521.81	26	27	25	13	18	23	27	24	10	12
		€ 243,231.20					**109**					**96**				
Divestment by Public Offering	*IPO*	€ 0.00	€ 0.00	€ 0.00	€ 0.00	€ 0.00	0	0	0	0	0	0	0	0	0	0
		€ 0.00					**0**					**0**				
	Sale of Quoted Equity	€ 250.00	€ 1,723.00	€ 2,580.00	€ 0.00	€ 401.70	1	9	1	0	1	1	3	1	0	1
		€ 4,954.70					**12**					**6**				
Divestment by Write-Off		€ 11,349.25	€ 36,285.66	€ 84,599.41	€ 12,122.44	€ 1,240.00	17	6	27	18	6	17	6	24	17	6
		€ 145,596.76					**74**					**70**				
Repayment of Silent Partnership		€ 600.00	€ 0.00	€ 0.00	€ 0.00	€ 0.00	1	0	0	0	0	1	0	0	0	0
		€ 600.00					**1**					**1**				
Repayment of Preference Shares/Loans		€ 17,553.20	€ 49,587.23	€ 8,279.76	€ 6,051.84	€ 7,008.43	28	22	25	46	13	25	22	24	30	7
		€ 88,480.46					**134**					**108**				
Sale to Another Private Equity House		€ 21,893.74	€ 1,123.00	€ 1,186.00	€ 69,000.00	€ 19,898.00	4	1	2	1	7	4	1	2	1	4
		€ 113,100.74					**15**					**12**				
Sale to Financial Institution		€ 0.00	€ 31,666.02	€ 227.90	€ 0.00	€ 200.00	0	1	2	0	1	0	1	2	0	1
		€ 32,093.92					**4**					**4**				
Sale to Management (Buy-back)		€ 5,785.01	€ 24,554.00	€ 24,998.70	€ 2,148.00	€ 4,702.00	9	5	11	3	10	8	5	11	3	8
		€ 62,187.71					**38**					**35**				
Divestment by Other Means		€ 7,530.00	€ 6,714.00	€ 765.00	€ 0.00	€ 0.00	3	3	1	0	0	3	3	1	0	0
		€ 15,009.00					**7**					**7**				
Unknown		€ 27,112.67	€ 0.00	€ 7,371.14	€ 2,705.03	€ 2,683.00	30	0	3	5	1	30	0	3	1	1
		€ 39,871.84					**39**					**35**				
Total Venture Deals		€ 141,412.17	€ 189,905.94	€ 163,643.11	€ 142,510.17	€ 107,654.94	119	74	97	86	57	108	63	83	61	39
		€ 745,126.33					**433**					**354**				

Table A.1.7: Distribution of VC divestments, according to the market perspective. Boldfaced figures are cumulative figures of the years 2007-2011. Source: NVP.

A.2 – Appendix to Chapter 2: Evaluations of National VC Policies

During 2003 and under the auspices of the OECD Ricardo Tejada and Günseli Baygan investigated the VC policies of the United Kingdom, Korea, Israel, Canada, Denmark, Sweden, the United States, Norway, Portugal, and Spain. These studies will be reviewed here, at places supplemented by other sources

Baygan (2003a) evaluates VC policies in the United Kingdom, describing the broad range of policies present at that point in the U.K. The tax incentives are argued to be effective, and the efforts of supporting business angel networks are praised. It is noted that later stage VC-funding is well-developed, but that "relatively little funding is reaching small, technology-based companies" (p. 3). This is argued to be due to a lack of demand rather than to a lack of supply. The U.K. followed the U.S. in making it easier for institutional investors to invest in VC markets. Baygan recommends further liberalisation, which seen in the light of the recent crises and subsequent tightened regulations might not be that appropriate today. The U.K. implemented policies to leverage private investments through participations and guarantees, successfully keeping incentives aligned and retaining expertise. Baygan warns for the crowding out of private investments, and recommends that the scope of such programmes should be reduced when possible.

Baygan (2003b, p. 3) argues that the Korean government successfully jumpstarted venture capitalism "through direct infusion of equity capital, generous tax incentives and equity guarantees", but that the government presence in VC markets is too strong now. Banks should therefore be privatised and institutional investment liberalised, in order to expand the range of VC investors. Just like in the U.K., a stronger emphasis should be put on small corporations relative to large ones (most importantly the *chaebol*).

Baygan (2003c) considers Israel, and highlights the dependence on foreign capital; no less than 70% of Israelian VC is estimated to come from foreign sources. This was accommodated by equity guarantees and tax breaks for foreign investors, and the earlier discussed "hybrid public–private Yozma fund" through which "the government played a key role in helping build the largest venture capital industry (as a share of national GDP) in the world".[174] Baygan (2003c) praises the phasing out of the equity involvement of the Israeli government, and again emphasises that institutional investors should be allowed to invest in VC more intensely. She adds that domestic fundraising should be stimulated, for instance by offering the same tax incentives as foreign investors receive. Baygan (2003c, p. 13) concludes that the "Israeli venture capital infrastructure is strong." Compared to other countries' policy evaluations, it seems that the mix of tax incentives and focus on private investors has been successful, making full use of present technological opportunities. Foreign capital markets play a crucial role; much of the Israeli VC comes from abroad, and most VC-backed firms that get listed on a stock exchange, do so on a foreign stock market.

[174] Reed (2010, p. 82).

Baygan (2003d) describes that Canadian venture capitalism grew enormously during the 1990s, but that most of the VC investments was aimed at later stages, with start-ups being neglected. The Canadian VC market stands out because 80% of the investments went through so-called *Labour-Sponsored Venture Capital Corporations*, which were "created in 1984 on the basis of preferential tax provisions", are "provincially-based funds, sponsored by labour unions and supported by individual investors" and "generally make smaller investments in manufacturing activities" (p. 5). Later on, the *Business Development Bank of Canada* (BDB) developed several programmes to leverage private investing, which had success. Providing capital is often accompanied by taking positions on the boards of VC-receiving firms to provide managerial support. The BDB also offered "a range of business counselling and mentoring services" (p. 15). Independently managed seed capital funds were set up with private parties, which, contrary to the U.K. and Korea, led to investments reaching SMEs. Local initiatives appear to have been more effective than national ones, and at the time of writing a major share of VC comes from abroad, most notably from the U.S.

Whereas the U.K., Korea, Israel, and Canada evaluations were by and large success stories, the Danish evaluation of Baygan (2003e) is not. Baygan indicates that Denmark has a relatively low VC market intensity, despite risk capital being readily available and several schemes to encourage equity financing for young companies. Several explanations for lacking VC investments are offered: the absence of tax incentives, a lack of private equity investment culture and venture management expertise (traditionally, banks play a prominent role), an incomprehensible tax system with high rates, scant activity on stock markets and a lack of IPOs, and weak or nonexistent linkages between potential investors and investees.

Baygan (2003f) investigates Sweden and finds that its VC investments are mainly aimed at later stage venture and funded by foreign investors. Despite instituting tax incentives, liberalising pension funds' investment rules, deregulating stock exchanges, and booming stock markets, VC activity remained underdeveloped, for which a "lack of entrepreneurial demand, a dearth of equity-related management expertise as well as a confusing array of small-scale government schemes were at fault" (p. 5).

The undeniable success of the U.S. VC market, which sprouted Microsoft, Compaq, Sun Microsystems, Netscape, Intel, Google, and Apple, among thousands of other companies, continues to inspire. A clear example is Israel, which has been recording the highest VC per capita rates in past years and which explicitly states to have implemented U.S.-inspired VC policies. Baygan (2003g) agrees with Lerner (2009) that the U.S. government played a crucial role in jumpstarting venture capitalism. The *Small Business Investment Company* (SBIC) program, established already in 1958, can be considered as the catalyst of venture capitalism in the U.S and thus in the world. The government channelled capital into these privately owned and managed SBICs, which in turn invested in small and young firms thus directly increasing VC investments, but which also facilitated the "training [of] venture managers and set the grounds for the development of private funds" (p. 15). The seeding stage has gotten more attention recently, with "government technology programmes providing seed funding to small firms to commercialise their innovations, mostly from public research, notably the *Small Business Innovative Research* (SBIR) scheme and the *Small Business Technology Transfer* (STTR) program" (p. 15). Equity programmes were accompanied by introducing generous reductions in the capital gains rate and effective albeit costly fiscal measures at the state level. The U.S. policies were well-designed in that they retained incentives and nurtured expertise. The

rules governing institutional investors such as pension funds were relaxed, opening up pools of potential VC capital, further stimulating VC investments. Baygan (2003g, p. 19) notes that these programmes could work well also because of "well-functioning exit mechanisms, particularly in the form of initial public offerings (IPOs) on second-tier stock exchanges." Highlighting that the U.S. has a right cultural mindset for venture capitalism, she sums up that "[i]n addition to an entrepreneurial and risk-taking culture, US firms benefit from a continuum of finance provided by pension funds and corporations stimulated by liberal investing rules and fiscal incentives, active business angel networks, government funds, and well-functioning second-tier stock markets." Baygan (2003g) seems to note that the only major drawback of U.S. policies seems to be that they are procyclical; U.S. VC intensity may experience high peaks, but extreme market downturns prove to be fatal to the long-term survival of many small firms.

Baygan (2003h) assesses that Norway, at the time of writing, had an average VC intensity, which primarily consisted of expansion investments. She indicates that most of the VC is supplied by the government through its *SND Invest* fund, which although in the process of being privatised still crowds out private funding. Many factors explain why VC markets have failed to thrive. The demand for VC is simply low: few new business ideas and opportunities arise. The regulatory and fiscal environments are to blame as well, for instance regarding a substantial wealth tax and investment restrictions on institutional investors. A large second-tier stock market is absent, thus so are exit opportunities. Finally, the development of venture capitalism is impeded by a strong reliance of the economy on natural resources, and by a risk-averse culture. Baygan does report that various reforms are being enacted at the time of writing, aiming to fix the most acute problems of those mentioned above.

Tejada (2003a) reports that the Spanish VC market grew considerably despite only marginal government support. VC investments were funded largely from capital inflows from abroad and were aimed at mature, expanding companies, thus neglecting small technology start-ups. Public schemes mostly comprised participatory loan programmes. Tejada reports that risk-averse attitudes, a lack of entrepreneurship, and restrictions on institutional investors impede the growth of venture capitalism. Government-sponsored equity programmes are limited, but a *Nuevo Mercado* was launched in 2000 as a stock market for technology-based start-ups, with limited success. Business angel activity hardly exist, with the only business angel network, *Xarxas d'Inversors Privats*, instituted only a year earlier, but the Catalonian *Centre d'Innovació i Desenvolupament Empresarial* does provide consultative and financial support, working as a "one-stop shop" since it also makes equity investments (p. 16).

Tejada's (2003b) evaluation of Portugal's VC policies indicates that most VC activity aims to expand existing companies. Government policies are very dominant, with VC programmes historically having served as "investment vehicles for European structural funds",[175] which have crowded out private investments. Tejada thus recommends adapting policies to leverage private investments instead of just supplying VC, which has been set in progress. Although being generous, tax incentive programmes have been confusing because there is a multitude of different rates that apply, and instead of some significant equity programmes, too

[175] Tejada (2003b, p. 5).

many small ones exist, which adds to the confusion. Cultural barriers are responsible for a lack of entrepreneurial opportunities, which relates to the "bank-dominated economy and a family-dominated corporate world" (p. 12). Impediments to further developing venture capitalism include a risk-averse culture, the absence of a second-tier stock market and business angel networks, and, again, restrictions on institutional investors.

A.3 – Appendix to Chapter 3

A.3.1 Data envelopment analysis: Ten Raa (2009b)

This section will shortly describe the technique of benchmarking using DEA and linear programming, and is based primarily on Chapters 2 and 3 of Ten Raa (2009b). Before applying linear programming, let us for the sake of completeness briefly go through its mechanisms.

Linear programming aims to optimise a linear combination of variables (the *objective function*), subject to a number of constraints. 'Optimise' can refer to either 'maximise' or 'minimise', depending on the issue at hand. It can be shown that every maximisation problem can be transformed in an equivalent minimisation problem, so let us focus on maximisation problems only. An objective function has the shape $f(x_1, \dots, x_J) = c_1 x_1 + \cdots + c_J x_J$, for J variables. In matrix notation, this is given by $\mathbf{c}^T\mathbf{x}$.

There are I constraints that bound the set of feasible solutions, that have the shape $a_{i,1}x_1 + \cdots + a_{i,J}x_J \leq b_i$, where $i \in \{1, \dots, I\}$. The $\leq$-sign is harmless, as the next examples will show. The inequality $5x_1 - 3x_2 \geq 10$ is equivalent to $-5x_1 + 3x_2 \leq -10$, which does have the familiar shape. Similarly, the equality $5x_1 - 3x_2 = 10$ can be replaced by the two inequalies $5x_1 - 3x_2 \leq 10$ and $-5x_1 + 3x_2 \leq -10$. In matrix notation, these constraints are given by $\boldsymbol{A}\mathbf{x} \leq \mathbf{b}$.

Nonnegativity constraints are often introduced to prevent variables from attaining nonsensical values. In our example, it would not make any sense, for instance, if best practices are copied with a negative value. We thus impose that $x_j \geq 0$, for every j. These constraints can be manipulated so that they fit the format of a basic constraint: $-x_j \leq 0$. We can simplify further by using matrix notation:

$$\begin{bmatrix} -x_1 \leq 0 \\ \vdots \\ -x_J \leq 0 \end{bmatrix} \sim -1 \begin{bmatrix} x_1 \\ \vdots \\ x_J \end{bmatrix} \leq \mathbf{0} \sim \begin{bmatrix} -1 & 0 & \cdots & 0 & 0 \\ 0 & -1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & -1 & 0 \\ 0 & 0 & \cdots & 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_J \end{bmatrix} \leq \mathbf{0} \sim -\mathbf{I}\mathbf{x} \leq \mathbf{0}.$$

The constraints are thus now represented by $-\mathbf{I}\mathbf{x} \leq \mathbf{0}$, where $\mathbf{0}$ is a vector of zeros.

In the optimised situation (i.e. the solution) every constraint is either binding or nonbinding. Taking an example, in the solution the constraint $5x_1 + 2x_2 \leq 7$ may either be binding, when $5x_1 + 2x_2 = 7$, or nonbinding, when $5x_1 + 2x_2 < 7$. We add a slack variable, s_i, to every constraint to make it an equality: $a_{i,1}x_1 + \cdots + a_{i,I}x_J + s_i = b_i$, where $s_i \geq 0$. *Complementary slackness* refers to that exactly one of the two constraints must be binding; that is, either $a_{i,1}x_1 + \cdots + a_{i,I}x_J + s_i = b_i$ and $s_i > 0$, or $a_{i,1}x_1 + \cdots + a_{i,I}x_J + s_i < b_i$ and $s_i = 0$. This means that the product of the two slacks must be zero for every constraint: $s_i\left[b_i - (a_{i,1}x_1^* + \cdots + a_{i,J}x_j^*)\right] = 0$. The * in x_i^* signals that it is part of the solution.

The entire problem can now be presented as follows:

$\text{Maximise}_{x_1,\dots,x_J}\ Z = c_1x_1 + \cdots + c_Jx_J$,

Subject to: $\begin{bmatrix} 1 & -\mathbf{c}^T & 0 \\ 0 & \boldsymbol{A} & \mathbf{I} \end{bmatrix} \begin{bmatrix} Z \\ \mathbf{x} \\ \mathbf{s} \end{bmatrix} = \begin{bmatrix} 0 \\ \mathbf{b} \end{bmatrix}$, $-\mathbf{I}\mathbf{x} \leq \mathbf{0}$.

Every basic linear programming problem has a dual. This dual problem minimises $Y = b_1y_1 + \cdots + b_Jy_J = \mathbf{b}^T\mathbf{y}$, subject to $\boldsymbol{A}^T\mathbf{y} \geq \mathbf{c}$ (and $\mathbf{y} \geq 0$). The Strong Duality Theorem indicates that if the primal (i.e. the original) problem has a solution, $x^* = (x_1^*, \dots, x_J^*)$, then so does the dual problem; $y^* = (y_1^*, \dots, y_I^*)$. Moreover, the values of the objective functions of the primal and the dual problem coincide in the solution: $Z = Y$, or $\sum_{j=1}^{J} c_j\, x_j^* = \sum_{i=1}^{I} b_i\, y_i^*$, or even in matrix notation, $\mathbf{c}^T\mathbf{x}^* = \mathbf{b}^T\mathbf{y}^*$.

This is an important result, because we now see that if constraint i were to be relaxed by 1 unit (that is, if b_i increases by 1) that the value of the objective value of the original, primal problem, increases by (about) y_i^*. The solution $\mathbf{y}^*$ of the dual problem thus happens to be the vector of shadow prices of the constraints in the primal problem: y_i^* is the shadow price that relates to constraint i of the original problem, and indicates how much Z would (approximately) increase if constraint i were to be increased by 1 unit.

The dual and primal problems can be solved by the simplex algorithm, which moves along the vertices of possible solutions until the optimal solution is found, or by software that does the job for you. I follow Ten Raa (2009b)'s instructions, and use the Solver Add-in of Microsoft Excel.

Let us now look at the efficiency analysis. We assume that we have I decision making units (DMUs); with thus $i \in \{1,2,\dots,I\}$. Inputs are denoted by $input_k^i$ and outputs by $output_l^i$, where $k \in \{1,2,\dots,K\}$ and $l \in \{1,2,\dots,L\}$. There are thus K inputs and L outputs.

We now allow DMU1 to copy practices of other decision making units. More precisely, we allow DMU1 to do so with weights x_i, where i refers to DMUi. The inputs used by DMU1 are now equal to $x_1input_k^1 + x_2input_k^2 + \cdots + x_Iinput_k^I = \sum_{i=1}^{I} x_i input_k^i$, for every input k. Similarly, DMU1 now produces $x_1output_l^1 + x_2output_l^2 + \cdots + x_Ioutput_l^I = \sum_{i=1}^{I} x_i output_l^i$, for every output l. Note that DMU1 is allowed to 'copy its own practices'. Copying must happen with positive weights, which is why the following nonnegativity constraints are introduced: $x_i \geq 0$, for every i.

Of course, we must limit DMU1 to copy practices of others DMUs in such a way that it does not use more inputs than it has. Hence, we introduce the following constraints:

$\sum_{i=1}^{I} x_i input_k^i \leq input_k^1$, for every input k.

Similarly, we restrict DMU1 so that it can only end up in situations where it produces at least an equal amount of every output as it did before, so that copying practices will indeed result in an (Pareto) improved (or at least not worsened) efficiency. The following constraints take care of that:

$\sum_{i=1}^{I} x_i output_l^i \geq output_l^1$, for every output l.

To enable the maximisation of outputs given a certain set and amounts of inputs, an expansion factor e is introduced, and the output inequalities are adapted to $\sum_{i=1}^{I} x_i output_l^i \geq output_l^1 e$. The expansion factor

measures the potential growth of the outputs, and in the solution it equals the maximum of the minimum of the potential growth rates of outputs.[176] Of course, e cannot be allowed to attain values below 1. No constraints are needed to ensure this, because if copying practices of other DMUs would not lead to increased output, then x_1 would be set equal to 1. DMU1 would then stick to the old situation, in which case e would equal 1.

The last thing to do before we can solve the problem is to transform the above into a linear programming problem. We need to define the objective function, $f(x)$, and the restrictions in the shape $\boldsymbol{A}\mathbf{x} \leq \mathbf{b}$. The objective function is, simply, e.

The input constraints are already in the right shape: $\sum_{i=1}^{I} x_i input_k^i \leq input_k^1$. In matrix notation, this is equivalent to the following, where $INPUT$ is the matrix with (given) input data:

$$\begin{bmatrix} x_1 input_1^1 + x_2 input_1^2 + \cdots + x_I input_1^I \leq input_1^1 \\ x_1 input_2^1 + x_2 input_2^2 + \cdots + x_I input_2^I \leq input_2^1 \\ \vdots \\ x_1 input_{K-1}^1 + x_2 input_{K-1}^2 + \cdots + x_I input_{K-1}^I \leq input_{K-1}^1 \\ x_1 input_K^1 + x_2 input_K^2 + \cdots + x_I input_K^I \leq input_K^1 \end{bmatrix} \sim \begin{bmatrix} input_1^1 & input_1^2 & \cdots & input_1^{I-1} & input_1^I \\ input_2^1 & input_2^2 & \cdots & input_2^{I-1} & input_2^I \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ input_{K-1}^1 & input_{K-1}^2 & \cdots & input_{K-1}^{I-1} & input_{K-1}^I \\ input_K^1 & input_K^2 & \cdots & input_K^{I-1} & input_K^I \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_I \end{bmatrix} \leq$$

$$\begin{bmatrix} input_1^1 \\ input_2^1 \\ \vdots \\ input_K^1 \end{bmatrix} = INPUT \times \mathbf{x} \leq \begin{bmatrix} input_1^1 \\ input_2^1 \\ \vdots \\ input_K^1 \end{bmatrix}.$$

The output constraints can be transformed into $\sum_{i=1}^{I} -x_i output_l^i \leq -output_l^1 e$, and then into $-\sum_{i=1}^{I}\{x_i output_l^i\} + e \times output_l^1 \leq 0$. In matrix notation this is equivalent to the following, where $OUTPUT$ is the matrix with (given) output data:

$$\begin{bmatrix} -x_1 output_1^1 - x_2 output_1^2 - \cdots - x_I output_1^I + e \times output_1^I \leq 0 \\ -x_1 output_2^1 - x_2 output_2^2 - \cdots - x_I output_2^I + e \times output_2^I \leq 0 \\ \vdots \\ -x_1 output_{L-1}^1 - x_2 output_{L-1}^2 - \cdots - x_I output_{L-1}^I + e \times output_{L-1}^I \leq 0 \\ -x_1 output_L^1 - x_2 output_L^2 - \cdots - x_I output_L^I + e \times output_L^I \leq 0 \end{bmatrix} \sim$$

$$\begin{bmatrix} -output_1^1 & -output_1^2 & \cdots & -output_1^{I-1} & -output_1^I & output_1^1 \\ -output_2^1 & -output_2^2 & \cdots & -output_2^{I-1} & -output_2^I & output_2^1 \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ -output_{L-1}^1 & -output_{L-1}^2 & \cdots & -output_{L-1}^{I-1} & -output_{L-1}^I & output_{L-1}^1 \\ -output_L^1 & -output_L^2 & \cdots & -output_L^{I-1} & -output_L^I & output_L^1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{I-1} \\ x_I \\ e \end{bmatrix} \leq \begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix} \sim$$

$$OUTPUT \times \begin{bmatrix} \mathbf{x} \\ e \end{bmatrix} \leq \begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}.$$

The nonnegativity constraints can be transformed into $-x_i \leq 0$. In matrix notation:

$$\begin{bmatrix} -x_1 \leq 0 \\ \vdots \\ -x_I \leq 0 \end{bmatrix} \sim \begin{bmatrix} -1 & 0 & \cdots & 0 & 0 \\ 0 & -1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & -1 & 0 \\ 0 & 0 & \cdots & 0 & -1 \end{bmatrix} \times \mathbf{x} \leq \mathbf{0} \sim -\mathbf{I}\mathbf{x} \leq \mathbf{0}.$$

We can now integrate these three groups of constraints in one big group, where a $\mathbf{0}$ in the first matrix

[176] If, for instance, there are two outputs, and in the solution output 1 increases with 10% and output 2 with 20%, then e equals 1.1.

refers to a $1 \times I$ vector of zeros:

$$\begin{bmatrix} INPUT & \mathbf{0} \\ OUTPUT & \\ -\mathbf{I} & \mathbf{0} \end{bmatrix} \begin{bmatrix} \mathbf{x} \\ e \end{bmatrix} \leq \begin{bmatrix} input_1^1 \\ input_2^1 \\ \vdots \\ input_K^1 \\ 0 \\ \vdots \\ 0 \end{bmatrix}.$$

Now, we have defined an objective function and manipulated the constraints such that they can be presented in the basic shape $\boldsymbol{A}\mathbf{x} \leq \mathbf{b}$, with $\boldsymbol{A} = \begin{bmatrix} INPUT & \mathbf{0} \\ OUTPUT & \\ -\mathbf{I} & \mathbf{0} \end{bmatrix}$, $\mathbf{x} \Rightarrow \begin{bmatrix} \mathbf{x} \\ e \end{bmatrix}$, and $\mathbf{b} = [input_1^1 \quad input_2^1 \quad \dots \quad input_K^1 \quad 0 \quad \dots \quad 0]^T$. We are now set to solve the problem.

What remains is to define efficiency, or effectiveness. Ten Raa (2009b, p. 43) indicates that Georgescu-Roegen (1951) already hinted at a revenue/cost ratio, which is what we aim for.

Every linear programming problem has a dual, and so does the one we just determined. The solution of this dual problem results in shadow prices. Following Ten Raa (2009b, p. 38), the shadow prices of the inputs are denoted by w_k and of the outputs by p_l. The dual problem would be to minimise $\mathbf{b}^T\mathbf{y}$, subject to $\boldsymbol{A}^T\mathbf{y} \geq \mathbf{c}$ (and $\mathbf{y} \geq 0$). The vector $\mathbf{c}$ equals $[0 \quad \cdots \quad 0 \quad 1]^T$, and the vector $\mathbf{y}$ equals $[\mathbf{w} \quad \mathbf{p}]^T$.

One of the conditions we can derive from this problem is the price normalisation constraint: $p_1 output_1^1 + p_2 output_2^1 + \cdots + p_L output_L^1 = 1$. The other components are given by $p_1 output_1^i + p_2 output_2^i + \cdots + p_L output_L^i \leq w_1 input_1^i + w_2 input_2^i + \cdots + w_K input_K^i$. The latter components indicate that activities are either unprofitable or are not conducted at all.

Ten Raa (2009b, p. 41) argues that it is straightforward to define efficiency as the inverse of the expansion factor e. For instance, if for a DMU it is found that $e = 1.5$, then apparently it could increase production by 50%. In other words, currently it is operating at approximately ($\frac{100\%}{150\%} \times 100\% = {}^{1}/_{1.5} \times 100\% \approx$) 67% of its potential. Thus: $efficiency = 1/e$.

Ten Raa (2009b, p. 42) notes that the value of the bounds for DMU1 equals $\sum_{k=1}^{K} w_k input_k^1$. Using the price normalisation constraint and the objective function that equals e, the expansion factor e equals the ratio of shadow costs and revenues: $e = \frac{\sum_{k=1}^{K} w_k input_k^1}{\sum_{l=1}^{L} p_l output_l^1}$. What follows is that $efficiency = \frac{\sum_{l=1}^{L} p_l output_l^1}{\sum_{k=1}^{K} w_k input_k^1}$. "In words, the performance of a decision making unit is measured by the *revenue/cost ratio* at [shadow] prices".[177] The numerator here measures the minimal amount of required inputs. The denominator measures the actual amount of used inputs.

Chapter 5 in Ten Raa (2009b) describes a method of ranking DMUs by using uniform shadow prices across the DMUs. It is a spectacular method, because it describes how DMUs can be compared with weights that are independent of the specific DMUs. Much of the analysis rests on a thought experiment in which it is not only allowed to let DMUs copy best practices, but also to reallocate resources between them. This is

[177] Ten Raa (2009b, p. 43).

clearly not applicable to our case of environmental factors, which are specific to certain countries and that are difficult to change.

As an alternative, I use the efficiency scores as outlined above to rank countries with regard to how well they succeeded in creating active VC markets. This has the advantage of a straightforward interpretation: the countries are ranked according to how well they deal with environmental factors compared to how other countries with similar sets of inputs have performed. A weakness, however, must be acknowledged, which is the sole reason why Chapter 5 in Ten Raa (2009b) is so spectacular: the efficiency of a certain country depends on (potential) benchmarks. This means, for instance, that even an extremely inefficient DMU may be deemed *efficient* if it happens to be the case that no other country with similar inputs performed more efficiently. This weakness is addressed by taking a large number of countries and choosing those inputs of which Section 3.2 found that they can be found in most if not all countries.

A.3.2 Representation of Dutch innovation and VC programmes

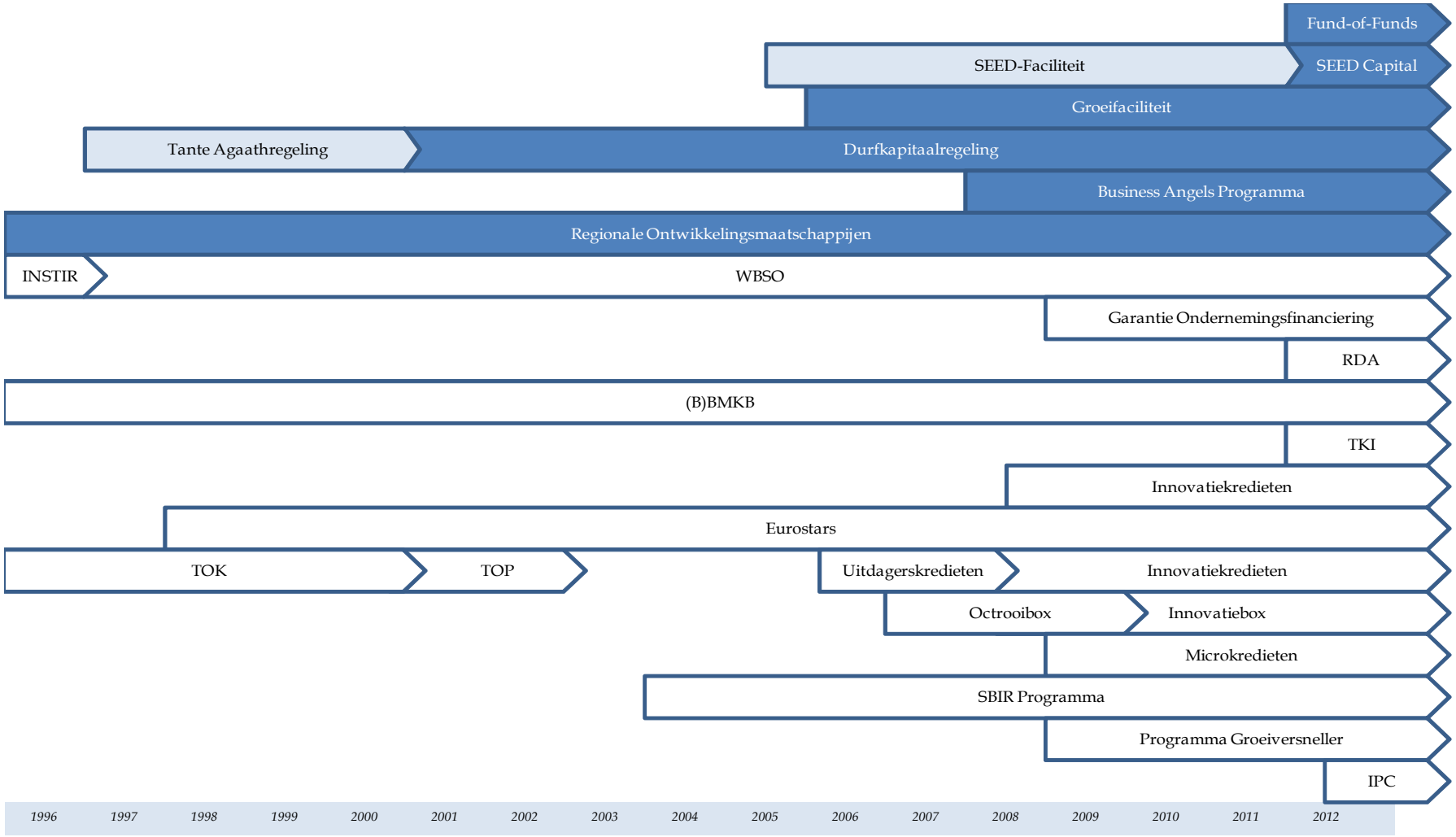

Figure A.3.1: The arrows represent policy measures that have been implemented, and that stimulate or have stimulated innovation broadly (white arrows), that have stimulated VC directly (light blue), or that still stimulate VC directly (dark blue). It contains the most important measures of Table 2.2.