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## Article

# Governmental venture capital: A social capital and principal-agent related examination for Belgium, The Netherlands, Luxembourg, Austria and Germany

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**Governmental venture capital – A social capital and principal-agent related examination for Belgium, The Netherlands, Luxembourg, Austria and Germany**

Christian Schlamp

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## Governmental venture capital – A social capital and principal-agent related examination for Belgium, The Netherlands, Luxembourg, Austria and Germany

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**Abstract:** The underlying research study was concerned with public venture capital which is grounded in the assumption of market failure and financing gaps (Güllmann 2000; Brettel 2005) and associated with the risk of crowding-out (Colombo et al. 2016). In order to expand the research perspective and to shed new light on the public investors, this project was concerned with their strategy, with their social networks, their syndication rationales, their monitoring and mentoring in turnaround situations and their exit routes between 2015 and 2017. 67 governmental investors in Belgium, The Netherlands, Luxembourg, Austria and Germany were invited to participate in a fully structured survey. In addition, secondary data sources were examined regarding the developments of the venture capital markets, of the crowdfunding markets and of the business angels' investments in the underlying countries between the phase of the financial crisis and the recent COVID-19 pandemic. The data was analysed by means of descriptive statistics and the survey results were finally validated by an additional validation study. The results, inter alia, showed that the public investors maintained comprehensive networks with different types of network partners and that social capital (Burt 1993; Lin 1999) played an important role for their business and not the provision of financings alone. Nevertheless, the results also showed that the network size did not matter for exit success on a statistically significant level and that the recent developments on the macro level called the public involvement in question.

**Key words:** Governmental venture capital, venture capital networks, syndication, monitoring and mentoring, social capital, technology financing, financial crisis, COVID-19 pandemic

## 1. The introduction

Technological start-ups play an important role (Hüther 2015) for the stimulation of economy's development in the Schumpeterian sense (Schumpeter 1985 and 1987). Nonetheless, their financing is limited due to prohibitive credit rates (Brettel 2005) which calls for alternative financing measures. At least for the moment, such alternatives, for example business angel financings seem rather small-scaled (EBAN 2019), the equity-crowdfunding markets in their infancy (Ziegler et al. 2018 and 2019) and the European venture capital market compared with the United Kingdom (Invest Europe 2019) and the United States (NVCA 2019) still expandable. Therefore, so-called governmental venture capitalists are mandated to support the financing of the technological start-ups (Colombo et al. 2016). The results regarding the capacities of the public investors to spur innovation, to nurture the portfolio companies effectively or to achieve successful exits differ and risks remain that the public involvement rather crowds-out than stimulates additional investment capital (Geyer and Heimer 2010; Bertoni and Tykvová 2015; Brandner et al. 2015; Colombo et al. 2016; Effenberg 2016). In that context of venture capital financing, networks play a pivotal role in the market too and earlier research has already shown that the venture capitalists maintain comprehensive networks (Aldinger 2005; Fiegler 2015). The social relationships are applied to support the portfolio companies (Aldinger 2005; Fiegler 2015), to protect the venture capital market and to sustain the bargaining power of the leading protagonists (Hochberg et al. 2010).

In order to shed new light on the subject of governmental venture capital, I combined a social capital and a principal-agent theoretical perspective and also considered micro- and macro-related developments. On the macro level, the underlying study was concerned with the development of the venture capital markets in Belgium, The Netherlands, Luxembourg, Austria and Germany between the period of the financial crisis and the recent pandemic. On the micro level, the examination was aimed to examine the strategy, the network compositions, the syndication rationales, the mentoring procedures in the case of portfolio company's underperformance and the exit routes of the governmental venture capitalists between 2015 and 2017. Finally, the study was also concerned with the examination of the relationship between network size and the number of successful exits expressed by initial public offerings and trade sales.

Reliable secondary data sources were considered regarding the progress of the venture capital markets, of the crowdfunding markets and of the business angels' investments in the underlying countries for the period between 2010 and 2020, in order to assess the appropriateness of the public involvement. In addition, a full survey of 67 governmental venture capitalists in the field of early-stage financings in Belgium, The Netherlands, Luxembourg, Austria and Germany was carried out by means of a fully structured questionnaire in 2018 and 2019. The main study results were then validated by means of a structured survey in 2019 and 2020. The secondary data sources were analysed in a longitudinal fashion and resulted in descriptive statistics which allowed for the assessment of the market's progress in comparison to the crowdfunding markets, the business angels' investments, but also the entrepreneurial activity in the underlying countries. The survey and the validation study results were analysed by means of descriptive statistics too.

Even though the underlying study delivered new insights regarding the governmental venture capitalists, the meaningfulness of the examination was limited due to the small response rate of the GVCs in Belgium, The Netherlands and the non-response of the Luxembourgish investor. In addition, the survey responses were partly incomplete and not suitable for a detailed examination.

The remainder of the article is structured as follows. Chapter two briefly summarises the literature, chapter three presents the research questions, chapter four the research methodology and chapter five the examination results. Chapter six is concerned with the discussion and the concluding remarks, chapter seven with the implications for theory and practice and finally, chapter eight with the limitations and recommendations for further research.

## 2. *The literature*

In the aftermath of the financial crisis, venture capital investments realised a sharp increase in Benelux, Austria and Germany. The total investments for venture capital financings were growing from approx. 995 million euros in 2010 to approx. 1,971 million euros in 2017 and thus, nearly doubled in their amount (Invest Europe 2019). This progress was accompanied from an increase of the business angels' investments from approx. 59.4 million euros in 2013 to approx. 130.1 million euros in 2017 alone (EBAN 2017 and 2019). An additional financing source for the financing of technological start-ups, so-called crowdfunding, also developed positively which was shown by a market's increase from approx. 1.5 billion euros in 2013 to 11.9 billion euros in 2017 in Europe (Ziegler et al. 2021). In 2018, 162 domestic and non-domestic crowdfunding-platforms were meanwhile active in Benelux, Austria and Germany (Ziegler et al. 2020). Nevertheless, the business angel markets, the crowdfunding markets and also the venture capital markets in the underlying countries seemed still expandable, compared to the market volumes in the United Kingdom and also the United States (EBAN 2017 and 2019; Invest Europe 2019; Ziegler et al. 2021; NVCA 2023).

In context to the venture capital market's development, governmental venture capital is provided in order to support young technological firms, to certify the investment readiness of an enterprise, to stimulate private sector investments, but also in order to support less developed regions or specific industry sectors, respectively (Colombo et al. 2016). The proportion of public funding from the total fundraising volume in Benelux, Austria and Germany was on average approx. 28% and with a share of 58.42% largest in Austria during the period of 2010 to 2017 (Invest Europe 2021). Due to the recent market developments, risks remain that the public funds are inefficient and might cause crowding-out effects rather than to stimulate additional private sector investments (Brettel 2005). Elsewhere, I already expressed concerns regarding possible crowding-out effects due to the significant expansion of the public funds in Germany (Schlamp 2022a), but also in Austria due to the unclear investment activity of the business angels (Schlamp 2022b).

In addition, the capabilities of the public investors are also less clear. Effenberg (2016) for example, reasons that their portfolio companies would receive less support and that the public investors would not have the required expert knowledge in order to satisfy the expected monitoring demand. Moreover, Effenberg (2016) concludes that the GVCs would not have effective corporate governance structures and market-oriented incentives for their investment professionals. This would be counterproductive for the achievement of successful exits (Effenberg 2016). Critically, would also be their limited financing capacity as an obstacle for the subsequent financing rounds. As a result, Effenberg (2016) concludes that the public investors would only partly match the expectations of the independent investors for joint investments. Colombo et al. (2016) supplement that the public investors would be unable to pick winners due to the less qualified investment managers and the political influence. The public investors would also have smaller return expectations and would rather crowd-out than to stimulate private sector investments (Colombo et al. 2016). Moreover, Bertoni and Tykvová (2015) reason that the lower income level of the public investors would prevent the most qualified investment managers to join a governmental venture capital firm. This would be an explanation for both the modest support of the public investors and the weak patent stock development on the portfolio level as an indicator for the GVCs' ability to spur innovation (Bertoni and Tykvová 2015). On the other hand, Geyer and Heimer (2010) with regard to Germany's High-Tech-Gründerfund reason that this public investment vehicle would be able to generate a sufficient deal-flow for further private sector investments. In addition, they deny crowding-out effects on the level of seed financings as a result of the fund's investment activity in the German market (Geyer and Heimer 2010). Brandner et al. (2015), as a result of their research study in 25 countries, see neither crowding-out effects on the enterprise nor on the market level. Enterprises which receive mixed-funding would in total receive more funding in comparison to the

enterprises which are financed by a public or an independent venture capitalist alone. They also argue that markets with more governmental venture capital would benefit from both more total funding and more venture capital funding. Mixed funding would also be better for successful exits than the funding by private investors alone (Brandner et al. 2015). The impression arises that the real capacity of the governmental venture capitalists is not quite clear, in most of the cases limited to the nurturing, the financing and the innovation aspects alone and hence, the real contribution of the GVCs is still not fully examined. Pierrakis and Saridakis (2019) already criticised that an assessment of the public investors would require a broader research perspective than simply focusing on the financing aspect alone. According to their research, which was concerned with networks in regional innovation systems, public funds, indeed, interact more often with the entrepreneurial finance, the business support and with the knowledge creation community compared to privately-financed funds. As a result, Pierrakis and Saridakis (2019) conclude that the public investors would play an important role in the regional innovation ecosystem, because they would have the capacities for the creation and the development of such ecosystems. I follow this conclusion and my study therefore, also applied a social capital theoretical focus (Lin 1999) and not the application of a principal-agent theoretical lens (Rudolph 2006) alone.

In that context to social capital, Lin (1999) mentions two principal approaches in order to measure social capital. First, the embedded resources in networks and second, the network locations which in type of so-called bridges and the strength of ties might improve the accessibility to information (Lin 1999). Granovetter (1973) underlines the importance of weak ties for the diffusion of information. He points out that weak ties would reach a larger number of people in different network clusters, whereas strong ties would be associated with redundant information in a closed environment (Granovetter 1973). On the other hand, Burt (1993) stresses the importance of so-called structural holes in networks for the information flow. Under his point of view, it would be the bridge over a structural hole which ensures the access to non-redundant contacts and thus, complementary information. In this line of reasoning (Burt 1993), the argument of the relationship strength steps back. For the information quality it's not important if the bridge is a weak or a strong tie relationship, as long as the bridge overcomes a structural hole in the network (Burt 1993). Beside the pure bridging effect, the bridge also fulfills a broker function between otherwise unconnected network clusters. This equips the position holder with influence and power (Burt 1993). Hence, Burt's reasoning is twofold and concerned with information flow and control rather than with the information content alone (Granovetter 1973). Notwithstanding, out of Lin's (1999) point of view, every type of network has its relevance. On the one hand, a wider and diverse network, composed of weaker ties, structural holes and bridges is supportive during a job search. On the other hand, strong relationships in a closed and dense network are helpful for network cohesion and in order to protect against resource losses (Lin 1999). Applied to the venture capital market, Walske et al. (2007) recommend that venture capital firms should maintain an extensive network of weak ties to access many different resources and to achieve an information advantage. On the other hand, they also underline the importance of strong ties for the exchange of deeper information in an area where the information asymmetry is large (Walske et al. 2007).

Earlier research has already shown that venture capitalists maintain network contacts with venture capital firms, business angels, consultants, larger enterprises, but also with banks, attorneys, auditors, tax advisors and former portfolio companies (Aldinger 2005; Fiegler 2015; Pierrakis and Saridakis 2019). Fiegler (2015) concludes that the finance relationships would be the dominating network resource on the level of the venture capitalists, whereas the strategic and the business relationships would be rather small. In this network composition, the venture capitalist would be the focal actor who steers the different network resources effectively who and also would take on a broker function to provide the contacts on the portfolio level.

In order to establish networks and to exchange information and resources, syndication acts as a suitable mechanism (Seppä 2003; Krebs 2012). Beside this network related aspect of syndication on the fund level, syndication also contributes to the portfolio's diversification and to

the improvement of the venture capitalist's reputation (Krebs 2012). On the portfolio level, syndication networks improve the deal flow, the deal selection and also increase the available resources for the nurturing of the portfolio companies and the achievement of successful exits (Krebs 2012). Krebs (2012) mentions that venture capital firms with a central position in a syndication network would benefit from direct and also from indirect contacts from their syndication partners. Nevertheless, research results regarding the effects of the investor's network centrality on exit success are not consistent. Hochberg et al. (2007) conclude for the venture capital market in the United States, that investors with a more central position in a syndication network are, indeed, more successful in terms of IPOs and trade sales compared to the less integrated market protagonists. In addition, their research results show that the portfolio companies of the central investors benefit from a larger probability of a subsequent financing round (Hochberg et al. 2007). In contrast, Krebs (2012) deny a positive effect of the venture capitalist's network centrality on the number of successful exits. With regard to the funding amount on the start-up level as a further success indicator, Alexy et al. (2012) conclude that venture capital firms with an increasing number of contacts in a syndication network would provide more funding on the portfolio level in comparison to their less connected counterparts (Alexy et al. 2012). Further and more recent research regarding business angel networks has shown that the network effects on the funding amount were comparatively small (Lichti and Sandner 2019). This enumeration represents only a small fraction of network research in the venture capital realm, but surely indicates that this subject is still not fully exploited.

With regard to the principal-agent theoretical part of the examination, elsewhere, I already pointed out (Schlamp 2022a) that venture capitalists seem most concerned with the board establishment, with finance and controlling, and also with the development of the portfolio company's strategy in the post-investment phase. Also, earlier research has shown that the key customer acquisition and the provision of network contacts are of minor or rather no relevance, respectively during the post-investment phase, but that a deviating development from the business plan is discussed in quite every case (Brinkrolf 2002). More specifically, Grethe's (2010) research has shown that in the case of portfolio company's restructuring, the monitoring aspect, the strategic advice and the penetration of the product market are the most important measures of the investors in this particular situation. In context to that monitoring and mentoring phase, research has also shown that the governmental venture capitalists are, obviously, less concerned with the nurturing of their portfolio companies in comparison to the independent venture capitalists (Achleitner et al. 2010; Wexlberger 2012; Bertoni and Tykrová 2015; Effenberg 2016).

These developments in the venture capital market and the different assessments of the governmental venture capitalists leave several questions open. This applies both on the macro and on the micro level. According to the literature base, it's not quite clear if for example, the governmental venture capitalists follow a particular strategy in the case that their portfolio companies underperform or if the GVCs are fully aware of the network's relevance in context to their financing mandate. This requires a wider theoretical perspective and is reflected in the following research questions.

### ***3. The research questions***

The underlying study was concerned with the following research questions, both on the macro and on the micro level:

- a) on the macro level:
  - Did the long-term development of the venture capital markets justify the requirement of public involvement in Benelux, Austria and Germany between 2010 and 2020?

b) on the micro level:

- What was the strategy, the network composition and what were the syndication rationales of the public investors between 2015 and 2017, and in 2018, respectively?
- What was the mentoring behaviour of the public investors in the case of portfolio company's unsuccessful development?
- What were the exit routes of the public investors between 2015 and 2017 and did the venture capitalist's network size matter for exit success?

#### **4. The research methodology**

In order to address the different research questions, the underlying study considered both secondary data sources and empirical survey results. Secondary data sources from federations, research organisations and governmental institutions were processed regarding the long-term developments of the venture capital markets, of the crowdfunding markets and also of the business angel markets. This part of the research focused on the period between the financial crisis of 2010 and the recent pandemic of 2020. Additional documents from public institutions, ministries, federations and research organisations were also reviewed regarding the governmental involvement and the structure of the venture capital markets.

The empirical part of the underlying project based on a full survey of the governmental venture capitalists in Belgium, The Netherlands, Luxembourg, Austria and Germany which were concerned with seed-, start-up and expansion financings in 2018. Fund of fund concepts, the investment vehicles from universities and from research organisations as well as the daughter companies of the German savings banks were not considered in the sample frame. In order to achieve a complete picture of the governmental venture capitalists according to the selection criteria, firstly, the data bases from the national PE and VC associations in Benelux, Austria and Germany were reviewed several times. In addition, the homepages of the national promotional banks and of both the departments for research and education and for economic affairs were also scrutinised regarding additional public investors. The initial sample frame was then supplemented from free Google searches. The final result was validated by reviewing every sample member's homepage. Public investors were selected on every administrative level and irrespective if the public mandate was to develop a specific region or to support particular technological areas (Colombo et al. 2016). This resulted in the selection of 67 public investors, of which 17 were located in Belgium, nine in The Netherlands, one in Luxembourg, 11 in Austria and 27 in Germany. As a result of the several in depth reviews of the markets during June, July and August 2018, I assumed that this sample frame represented a full picture of the GVCs in the underlying countries.

The data was collected by means of a fully structured and pre-tested questionnaire which was derived from earlier research studies (table one) and adjusted to the underlying study's needs. The questionnaire composed of in total 18 questions regarding the firm's characteristics expressed by the fund volume, the investment volume and the number of investments, the firm's strategy expressed by the type of financings, investment radius and industry focus, the firm's network, the syndication rationales on the fund and on the portfolio company level, the monitoring and mentoring behaviour of the investors, and finally regarding the exit routes. The survey started in November 2018 and was finalised after four reminders in June 2019. In total, 17 public investors of which seven were located in Austria, eight in Germany and each one in Belgium and The Netherlands took part in the survey. This represented a response proportion of 25.4% from the initial sample frame.



The examination foundation	
Examination focus	Basic examination
Investment volume	Effenberg (2016)
Number of investments	Effenberg (2016)
Geographical investment radius	Effenberg (2016)
Industry sectors	BVK (2008 and 2017); Krebs (2012)
Network partners	Aldinger (2005); Schmidt (2008)
Public investor's broker role	Fiegler (2015)
Internal networking aspect	Geyer and Heimer (2010)
Syndication rationales	Aldinger (2005); Effenberg (2016)
Monitoring and mentoring	Brinkrolf (2002)
Public subsidy application	Colombo et al. (2016)
Exit channels	Krebs (2012); Effenberg (2016)

Table 1 The examination foundation (own development)

Due to the small participation of The Netherlands and Belgium and due to the non-response of the one and only public investor in Luxembourg, an additional validation study was conducted between November 2019 and January 2020. 43 governmental venture capitalists were purposively selected from the initial sample frame, of which 15 were located in Belgium, eight in The Netherlands, one in Luxembourg, three in Austria and 16 in Germany. The validation study members received the main study results regarding the network resources, the network support on portfolio company level, the syndication rationales and the monitoring and mentoring behaviour in a structured format. The validation study members were requested to indicate their agreement, their disagreement or the impossibility of an assessment. The Belgian, the Dutch and the Luxembourgish investors were requested to validate the total study results, whereas the Austrian and the German investors were requested to validate the main study results of their countries. Additional questions in the validation study questionnaire were associated with the portfolio internal networking, the types of financing measures, the fund volume and the founding year of the validation study participant. The validation study was finalised after four reminders and in total, eight public investors, one from Belgium, one from Austria and six from Germany participated in the validation study.

The responses were stored in MS-Excel data bases and checked regarding their plausibility and their completeness. In the case of missing or inconclusive indications, the survey participants were contacted again or I tried to receive the missing information from the investor's homepage.

The network-related part of the analysis was neither concerned with the assessment of the relationship strengths according to Granovetter (1973) nor with the examination of structural holes in a given network according to Burt (1993), or with the calculation of a specific centrality metrics as an indicator for influence and prominence (Hochberg et al. 2007). This would have required a closed network environment (Jansen 2006) for example, a syndication network as applied by Seppä (2003) or Krebs (2012). I do without a detailed explanation of the centrality metrics here and instead recommend Hochberg et al. (2007, pp. 297–299) with an impressive example in the appendix. My research study was rather concerned with the analysis of the network compositions on the investor level. Hence, this study represented a type of egocentric network analysis in which the venture capitalist is the focal actor, the so-called ego, and the network partners, the so-called alteri (Jansen 2006 and figure one).

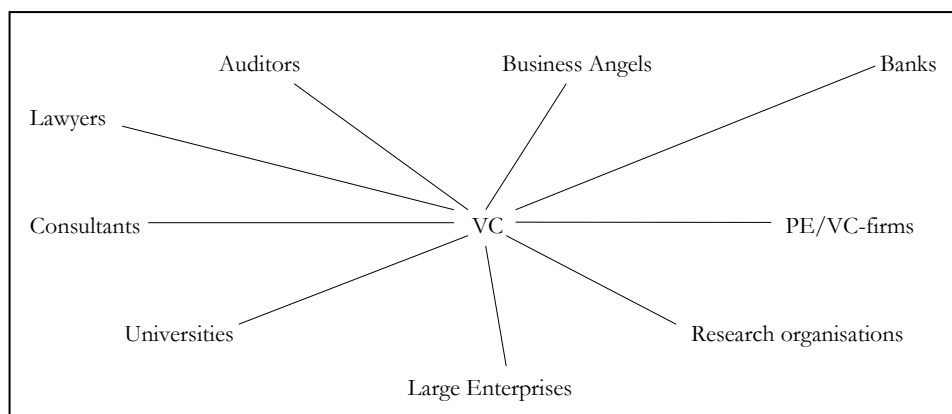


Figure 1 The ego-centric network example for venture capitalists  
(own development, derived from Jansen 2006, p. 82)

Descriptive statistics were calculated on the level of both the main study and the validation study. The secondary data regarding the venture capital, the crowdfunding and the business angel markets were analysed longitudinally in order to assess the appropriateness of the governmental involvement in the underlying countries. Finally, simple correlation analyses were conducted in order to examine the relationship between the number of network partners and the number of financing partners each with the number of successful exits expressed by IPOs and trade sales.

## 5. The results

### 5.1 The market developments

The secondary data has initially shown that the venture capital investments were increasing from approx. 995 million euros in 2010 to approx. 3,369 million euros in 2020 and thus by 239% in the total country perspective for Benelux, Austria and Germany (Invest Europe 2019 and 2021). The venture capital investments as of the national gross domestic development were increasing from a proportion of 0.020% in 2010 to 0.070% in 2020, and hence by a multiple of 3.5. This growth was largest in The Netherlands and resulted in 0.113% in 2020 (Invest Europe 2019 and 2021 and figure two).

The data has also shown that the fundraising volumes for the venture capital investments in the total country perspective, increased from approx. 1,038 million euros to 3,978 million euros and hence, by approx. 283% during the period of 2010 to 2020 (Invest Europe 2019 and 2021). During this period, the governmental proportion in these funds dropped from approx. 25.6% in 2010 to 12.8% in 2020, with an average annual proportion of approx. 24.3% during this period. This annual average proportion was largest in Austria with a value of 44.4% (Invest Europe 2021).

The investments of the visible business angel market, which is estimated with approx. ten per cent of the total market's value, also improved and increased from approx. 59.4 million euros in 2013 to approx. 150 million euros in 2020 (EBAN 2017, 2019, 2021). For comparison purposes, in the United Kingdom this increase was less significant, but the investments of the estimated nine thousand angels alone reached approx. 142 million euros in 2020 (EBAN 2017, 2019, 2021 and figure three).

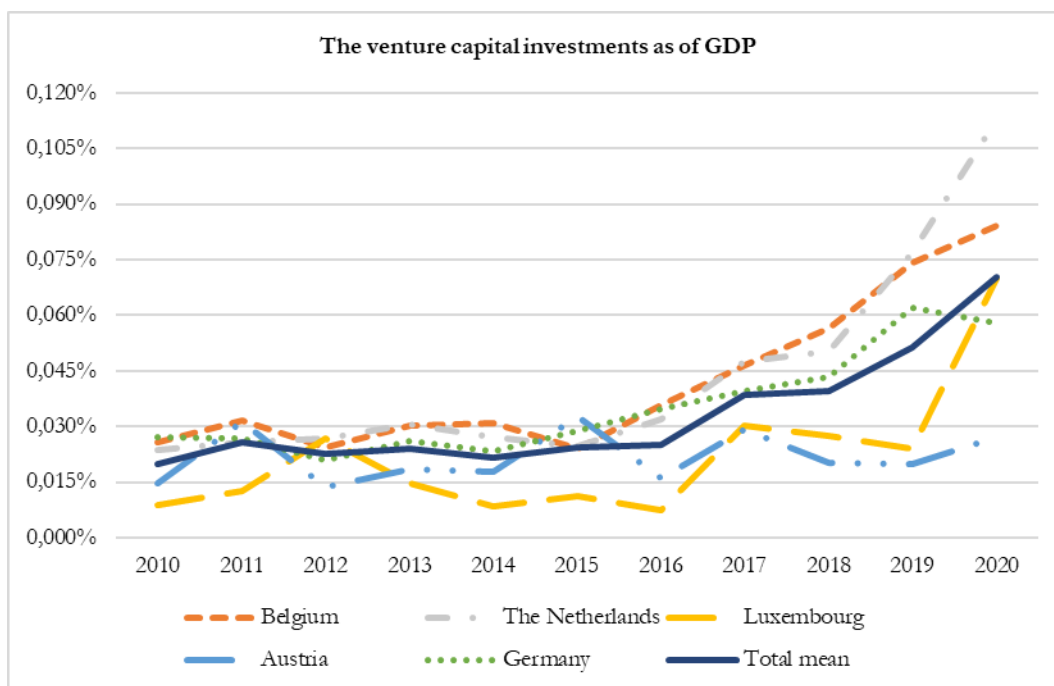


Figure 2 The venture capital investments as of GDP  
(own development, derived from Invest Europe 2019 and 2021, market statistics)

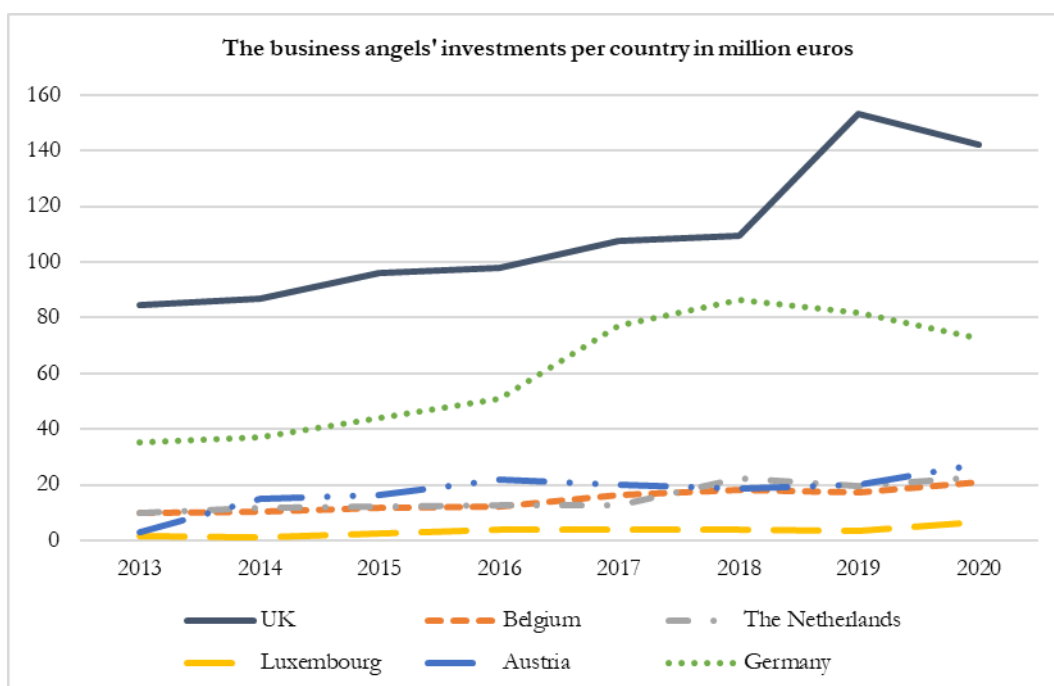


Figure 3 The business angels' investments per country in million euros  
(own development, derived from EBAN 2017, 2019, 2021, visible market statistics)

With regard to the crowdfunding markets, data revealed an increase from approx. 1.5 billion US-Dollar in 2013 to 22.6 billion US-Dollar in 2020 in Europe including the United Kingdom. This was an increase by 1,407%, whereas the crowdfunding market in Europe without the UK was increasing by approx. 2,375% during the same period. The more detailed view also showed that equity-crowdfunding in Europe without the UK increased from approx. 177 million US-Dollar in 2015 to approx. 280 million US-Dollar in 2020 (Ziegler et al. 2021 and table two).

Unfortunately, reliable equity-crowdfunding data for the underlying countries was not available in the long-term perspective (Ziegler et al. 2018 and 2021).

The European crowdfunding market's investment volumes									
Total investment volume in USD including the United Kingdom									
Year	2013	2014	2015	2016	2017	2018	2019	2020	Change
In billion USD	1.5	3.8	6.0	8.5	11.9	18.1	23.2	22.6	<b>1,407%</b>
Total investment volume in USD without the United Kingdom									
Year	2013	2014	2015	2016	2017	2018	2019	2020	Change
In billion USD	0.4	0.8	1.1	2.3	3.8	7.7	12.2	9.9	<b>2,375%</b>
Equity-based crowdfunding in Europe without the UK									
Year	2013	2014	2015	2016	2017	2018	2019	2020	Change
In million USD	-	-	177.0	242.0	238.0	278.0	224.0	280.0	<b>58%</b>

Table 2 The European crowdfunding market's investment volumes (Ziegler et al. 2021, pp. 70–71)

## 5.2 The structure of the public venture capital markets

The preparation phase of the present study has also shown that the structure of the public venture capital markets in the underlying countries differed. The Belgium market was dominated from the federal holding and investment company, the so-called sfpi/fpim in Brussels. This public investor with a fund volume of approx. 600 million euros was concerned with innovation, infrastructure and real estate investments. Moreover, the country maintained 14 different regional agencies for the nationwide provision of venture capital in the ten different provinces of the country. The Dutch system was different. The Netherlands had three different public promotional banks on the federal level which were either concerned with the public sector's refinancing, with infrastructure investments or with the funding of projects in developing countries. There was no public venture capital investor on the federal level, but nine different governmental venture capital facilities as part of the regional development agencies, which were mandated to provide venture capital in the country's 12 provinces. In Luxembourg, governmental venture capital and private equity investments were provided by the public promotional bank, the Société Nationale de Crédit et d'Investissement alone. In addition, two funds which are partly co-financed by public investments also provided spin-off and start-up financings. In Austria, the public promotional bank on the federal level, the so-called AWS provided both venture capital and SME financings over a daughter company. Furthermore, nine different organisations operated either as part of the regional development agencies or as independent public enterprises in the nine federal states of Austria.

In Germany, the provision of the public VC initiatives differed from the remaining countries significantly. On the federal level, public venture capital was meanwhile bundled in a separate investment arm of the Kreditanstalt für Wiederaufbau, Germany's most prominent public promotional bank. In addition, the High-Tech Gründerfund, a public-private-partnership was also mandated on federal level to provide seed and start-up investments. The governmental venture capital initiatives on the level of the federal states were either provided over the respective public promotional bank, the so-called Mittelständische Beteiligungsgesellschaft, a special purpose investment vehicle, or over the daughter companies of the so-called Landesbanken, the mother companies of the savings banks in Germany. Some federal states in Germany, at least for parts of the public funds, appointed independent venture capital firms for the management of the investment funds. For example, the federal states of Saxony-Anhalt or North-Rhine-Westphalia. A

smaller number of public VC initiatives were initiated by cities alone, for example in Hannover, Mannheim and Schwerin. The savings bank sector and their daughter companies were sometimes engaged as side investors in the public venture capital funds, for example in the seed-investment initiative of the federal state North-Rhine-Westphalia or mandated to nurture the portfolio companies of the governmental agencies, for example in Saxony. The recent developments in Germany lead to completely new types of the public involvement in the venture capital realm. For example, the so-called Gründerfund Ruhr in North-Rhine-Westphalia which is structured as a public-private-partnership and funded by both private and public investors, but managed by public employees completely alone. Or the so-called Futury Venture Fund in the federal state of Hesse which is funded by both public and private investors too, but lead by a management team of both civil servants and private employees. This mixed picture of the public initiatives resulted in a more detailed classification of the public involvement which I enclose to this article (table three in appendix A).

### 5.3 The survey results

Initially, the data showed that the average fund volume of the respondents resulted in approx. 100 million euros at the survey's moment in 2018. The fund volumes varied between two and 865 million euros due to the large fund volume of one public investor in Germany<sup>1</sup>. In addition, the data showed that the total investment volumes for venture capital investments during the period of 2015 until 2017, varied between 0.1 million and 200 million euros with an average investment amount of approx. 35 million euros. This in turn stands for an average annual investment volume in the amount of approx. 11.7 million euros during the examination period<sup>2</sup>. Moreover, the survey results showed that the survey respondents realised between one and 300 investments in the period between 2015 and 2017, with an average number of 66 investments<sup>3</sup>. This in turn stands for an average deal size of approx. 0.86 million euros<sup>4</sup> (table four in appendix B).

The data also showed that every survey participant was concerned with equity financings and approx. two thirds also with mezzanine investments. Only a minority of three participants indicated that they also provided loan financings. The vast majority of 14 out of 17 respondents were exclusively concerned with investments in the region of their location during the period of 2015 until 2017. The remaining participants were also concerned with countrywide and one of these investors with a smaller fraction of European-wide investments, at least in 2015 and 2016 (table 17).

In the total sample perspective, the responding GVCs were engaged in 19 out of 21 possible industry sectors during the examination period. The focus was on investments in the computer software and in the consumer goods sector. The portfolios were dominated from investments in the low-tech sectors with a proportion of approx. 64% in the total portfolio perspective (table five in appendix C). In the more detailed view, the public investors considered on average six different industry sectors<sup>5</sup> during 2015, 2016, and 2017, which represents a portfolio diversification of approx. 28%. The high-tech share in the portfolios varied between zero per cent and 100%, with a mean value of 26% and a median value of 14%, respectively (table 17).

With regard to the public investors' network, the entire sample was dominated from contacts with private equity and venture capital firms, with an open category which encompassed public authorities, technology clusters, federations and small-and-medium-sized enterprises, and also with business angels at the survey's moment in 2018 (table six in appendix D and figure four). The grouped perspective showed that the total network of the survey respondents composed of contacts with financing partners and thus, with PE and VC firms, with business angels and also

<sup>1</sup> Fund volumes:  $13.66 \leq \mu \leq 186.08$  (90% confidence level).

<sup>2</sup> Investment volume:  $12,29 \leq \mu \leq 58,17$  (90% confidence level).

<sup>3</sup> Number of investments:  $23,46 \leq \mu \leq 109,16$  (90% confidence level).

<sup>4</sup> Deal sizes:  $0.32 \leq \mu \leq 1.41$  (90% confidence level).

<sup>5</sup> Number of invested industry branches:  $3.80 \leq \mu \leq 7.90$  (90% confidence level).

with banks, which represented approx. 40% of the total network contacts on the sample level. The so-called innovative network (Schmidt 2008) which consists of universities and of non-university research institutions played only a minor role (table six in appendix D and figure five). On the other hand, the individual network compositions on the firm level differed significantly which is expressed by the larger deviation values (table seven in appendix D).

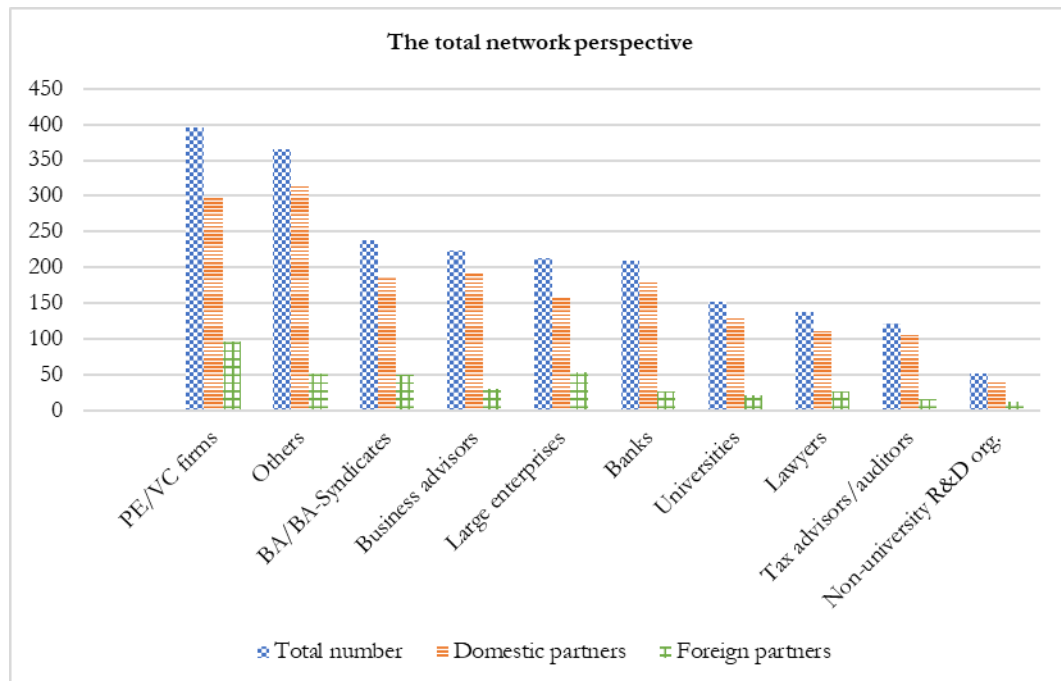


Figure 4 The total network perspective (own development)

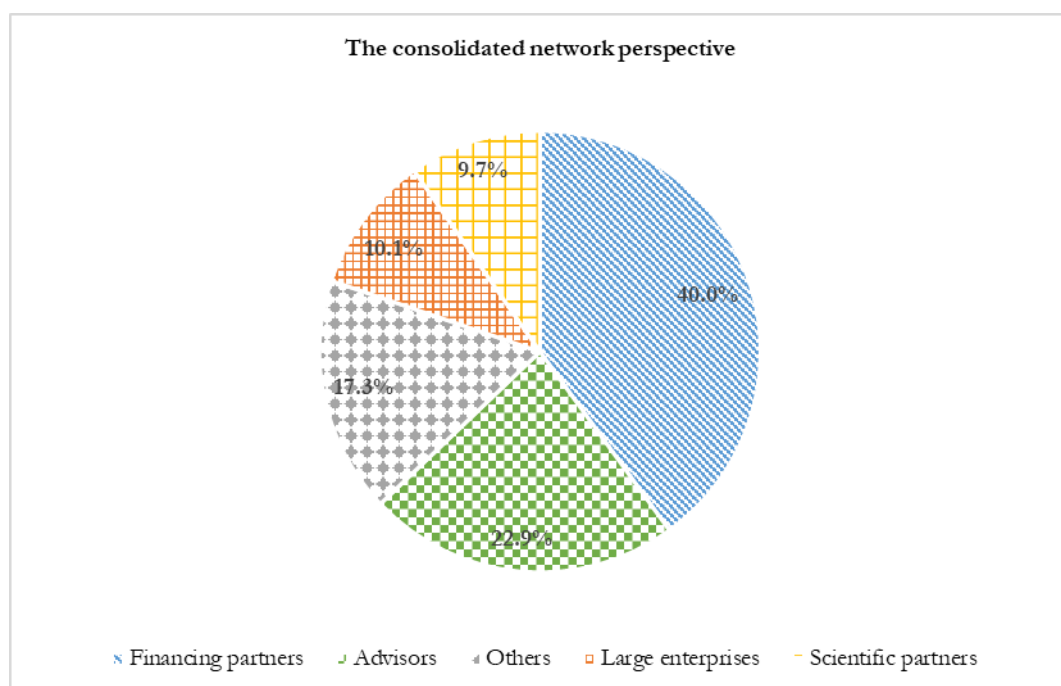


Figure 5 The consolidated network perspective (own development)

In accordance with the underlying study results, the GVCs indeed fulfilled a broker role (Burt 1993) and passed their network to their portfolio companies. The financing contacts were

provided comparatively often, whereas the provision of contacts with large enterprises, non-university research organisations and with suppliers was less often provided (table eight). In addition, the public investors in the majority of cases also tried to connect their portfolio companies internally, but only a smaller fraction as part of their support strategy (table nine).

The public investors' network support				
n=16				
(Five-point Likert scale: 1 never to 5 always)				
	Rank	Mean	Deviation	n
Type of network partner:				
Others <sup>1)</sup>	1	4.0	0.0	2
Business Angels	2	3.7	0.8	16
Banks	3	3.5	1.0	15
Tax advisors/auditors	4	3.1	0.8	15
Potential customers	4	3.1	0.9	15
Lawyers	4	3.1	1.0	16
Universities	5	2.9	1.1	16
Consultants	5	2.9	1.1	15
Large enterprises	6	2.7	0.8	14
Non university R&D org.	6	2.7	1.2	16
Potential suppliers	7	2.5	1.0	15

1) Public promotional organisations and SMEs.

Table 8 The public investors' network support (own development)

The public investors' internal network support			
n=17			
	Internal network support		
Country:	n	Yes	No
Belgium/The Netherlands	2	2	0
Austria	7	4	3
Germany	8	5	3
<b>Total</b>	<b>17</b>	<b>11</b>	<b>6</b>
Share	100%	64.7%	35.3%
Type of internal network support:	n	Share	
(multiple selection)			
Individually, between portfolio companies	10	58.8%	
Through other types of measures <sup>1)</sup>	4	23.5%	
As part of our support strategy	3	17.7%	
<b>Total</b>	<b>17</b>	100%	

1) Online, newsletters, events, lectures.

Table 9 The public investors' internal network support (own development)

On the level of the syndication rationales, the governmental investors qualified the risk minimisation of their investments, additional competencies and the network expansion as comparatively important on the fund level. Other reasons, such as additional knowledge in new industry sectors, the expansion of the deal flow and the diversification of the portfolio took a minor

role on the fund level. On the other hand, additional investment capital, the network's expansion and the improvement of the exit process, were the dominating reasons for the syndication of investments on the portfolio level (table ten).

With regard to the monitoring and mentoring procedures in the case of portfolio company's unsuccessful development, the provision of additional investment capital, a dividend waiver and a strategy change were the most important procedures of the GVCs. On the other hand, the contract's termination or the full management responsibility were rarely applied (table 11), but in the majority of cases the public VCs supported the portfolio companies for subsidy applications proactively and as part of their support strategy (table 12).

The reasons for syndication				
n=10				
(Five-point Likert scale: 1 not important to 5 very important)				
	Rank	Mean	Deviation	n
Reasons on the fund level:				
Other reasons <sup>1)</sup>	1	5.0	0.0	2
Investment risk reduction	2	3.9	1.1	10
Additional competencies	3	3.8	1.2	9
Network expansion	4	3.7	1.3	10
Knowledge in new industry sectors	5	3.1	1.0	10
Deal flow expansion	5	3.1	1.2	10
Portfolio diversification	5	3.1	1.3	10
Reasons on the portfolio level:				
Other reasons <sup>2)</sup>	1	5.0	0.0	1
Additional investment capital	2	4.9	0.3	9
Network expansion	3	4.1	0.7	10
Improvement of the exit process	4	3.9	1.1	10
Monitoring/mentoring improvement	5	2.9	0.9	10
Deal selection improvement	6	2.8	1.2	10
Reduction of the supervisory effort	7	2.6	1.0	10

1) EU competition law, improvement of the financing ability for additional investments. 2) Legislative obligation.

Table 10 The reasons for syndication (own development)



The monitoring and mentoring procedures				
n=16				
(Five-point Likert scale: 1 never to 5 always)				
	Rank	Mean	Deviation	n
Type of procedure:				
Additional investment capital	1	3.6	0.5	16
Dividend waiver	1	3.6	1.4	16
Strategy change	2	3.4	0.7	16
Mandating business consultants	3	3.1	0.7	16
Share sale	4	2.6	0.7	16
Change of the management team	5	2.4	0.6	15
Investment contract termination	6	1.8	0.8	16
Full management responsibility	7	1.5	0.9	16

Table 11 The monitoring and mentoring procedures (own development)

The public investors' support for subsidy applications				
n=17				
	BENL	Austria	Germany	Total
Type of support:				
Proactive, as part of the support strategy	0	6	7	13
We name advisors on request	2	1	1	4
No support, but recommendations	0	0	0	0
No advice and no application support	0	0	0	0
<b>Total responses</b>	<b>2</b>	<b>7</b>	<b>8</b>	<b>17</b>

Table 12 The public investors' support for subsidy applications (own development)

Finally, the public investors' exits were dominated from the repayment of silent investments. This result has to be considered with care, because one investor indicated 497 repayments and 90 total losses during the examination period alone (table 13).

The further analysis regarding the effects of the network size on the exit success has shown that there was, indeed, a strong correlation between network size and the number of successful exits expressed by IPOs and trade sales<sup>6</sup> and a weak correlation between the number of financing partners and the number of successful exits<sup>7</sup>. Nevertheless, this applied for the sample results only due to the lack of significance.

In addition, the average deal size of the GVCs for the period of 2015 until 2017, was significantly smaller in comparison to the average deal sizes of the venture capitalists in Benelux, Austria and Germany for the period of 2015 until 2017 (Invest Europe 2019) at the five per cent level of significance<sup>8</sup>.

<sup>6</sup> r: 0.5483435; t = 1.8546, df=8, p-value = 0.1008.

<sup>7</sup> r: 0.1456025; t = 0.41626, df=8, p-value = 0.6882.

<sup>8</sup> H<sub>0</sub>:  $\mu \geq 1.541$ ; H<sub>A</sub>:  $\mu < 1.541$ ; t=-2.1851; df=15; p-value 0.02258.

The exit channels between 2015 and 2017					
Year	2015	2016	2017	Total	Share in %
n	7	7	12		
Repayment of silent investments	140	173	205	518	74.2%
Total losses	39	33	32	104	14.9%
Trade sales	14	17	27	58	8.3%
Buy-backs	3	2	7	12	1.7%
Secondary purchases	2	1	2	5	0.7%
Initial Public Offerings	0	0	1	1	0.1%
<b>Total number of exits</b>	<b>198</b>	<b>226</b>	<b>274</b>	<b>698</b>	<b>100%</b>

1) Repayments, buy-backs, secondary purchases. 2) Total losses. 3) IPOs, trade sales.  
Table 13 The exit channels between 2015 and 2017 (own development)

#### 5.4 The validation study results

In accordance with the validation study questionnaire, the maximum possible number of confirmations per questionnaire was ten. This means that in relation to the number of eight respondents which participated in the validation study, a full confirmation of the results would have required 80 confirmations. Even though the main study results were all in all confirmed, expressed by a confirmation proportion of 82.5%, a strong disagreement referred to the question of the dividend waiver as one of the most important mentoring measures in the case of portfolio company's unsuccessful development. 100% of the German respondents alone denied the application of a dividend waiver. One respondent clarified in the open category that a dividend waiver would have overall no relevance, because dividends would play no role for venture capital financing. On the other hand, there was a full agreement regarding additional investment capital as the most important reason for syndication on the portfolio level. Moreover, the respondents agreed regarding the financing partners as the most important network resource and the support for subsidy applications (table 14).

The validation study summary				
n=8				
	Number of			
Country:	agreements	disagreements	no indications	Country total
Belgium	7	3	0	10
Austria	10	0	0	10
Germany	49	10	1	60
<b>Total</b>	<b>66</b>	<b>13</b>	<b>1</b>	<b>80</b>
Share	82.5%	16.25%	1.25%	100%

Table 14 The validation study summary (own development)

The additional results of the validation study have shown that the fund volumes varied between ten and 600 million euros with a mean value of 151 million euros (table 15). In addition, every investor provided equity investments and mezzanine financings, but only one investor also loan financings. Moreover, every investor supported the internal networking of the portfolio

companies (table 16). The results of the main study and of the validation study are summarised in table 17.

The fund volumes – validation study				
n=8				
Country	Belgium	Austria	Germany	All countries
	In MEUR			
n	1	1	6	8
Min	600	30	10	10
Max	600	30	200	600
Mean	600	30	97	151
Median	600	30	95	95
Deviation	-	-	65	191

Table 15 The fund volumes – validation study (own development)

The internal network support/type of financing – validation study			
n=8			
	Internal network support		
Country:	n	Yes	No
Belgium, Austria, Germany	8	8	0
<b>Total</b>	<b>8</b>	<b>8</b>	<b>0</b>
The types of financing – validation study			
n=8			
	Types of financing		
Country:	Equity	Mezzanine	Loans
Belgium, Austria, Germany	8	8	1
<b>Total</b>	<b>8</b>	<b>8</b>	<b>1</b>

Table 16 The internal network support/types of financing – validation study (own development)

The results' summary		
Variable	Mean value	Median value
Fund volumes in MEUR: <sup>1)</sup>	100 (116)	48 (56)
Investment volumes 2015–2017 in MEUR:	35	17
Number of investments 2015–2017:	66	26
Deal size 2015–2017 in MEUR:	0.86	0.30
Core types of financing:	Equity and mezzanine.	
Investment radius:	Regional: location of investor.	
High-tech proportion:	26%	14%
Portfolio diversification:	28%	29%
Dominating industry sector:	Computer software.	
Dominating investor's network resource:	Private equity and venture capital firms.	
Dominating investor's network support:	Business angels + banks.	
Proportion of internal network support: <sup>1)</sup>	65% (76%)	
Dominating syndication rationales: a) on the fund level: b) on the portfolio level:	Risk reduction, additional competencies, network's expansion, Additional investment capital, network's expansion.	
Dominating mentoring procedure:	Additional investment capital, dividend waiver, strategy change.	
Subsidy application attitude:	Proactive.	
Dominating exit channels 2015–2017:	Neutral: repayments, buy-backs, secondary purchases.	

1) Values in brackets are the adjusted values: main study + additional validation study results.

Table 17 The results' summary (own development)

## 6. The discussion and the concluding remarks

### 6.1 The discussion on the macro level

The long-term development has shown that the venture capital markets (Invest Europe 2019 and 2021), the crowdfunding market (Ziegler et al. 2021) and the business angels' investments (EBAN 2017, 2019, 2021) developed overall positive during the past periods in the underlying countries. Nevertheless, in parts of the countries, namely Austria and The Netherlands, the proportion of governmental funding with on average 44.4% and 26.6% between 2010 and 2020 remained comparatively large (Invest Europe 2021). Elsewhere (Schlamp 2022b), I already criticised the bulk of governmental support in Austria and in context to the unclear investment data of the business angels (EBAN 2021). This applies all the more for The Netherlands with an impressive growth of both the country's VC investments with approx. 500% and fundraising volume of approx. 716% between 2010 and 2020 (Invest Europe 2019 and 2021). Under the given circumstances, with an also positively developing crowdfunding market in Europe (Ziegler et al. 2021), I see the risk of crowding-out and price competitions and qualify the public involvement on that level as counterproductive. In that context, the literature review has also shown that the German government has meanwhile launched the so-called Future Fund, a ten billion euros facility on the federal level in 2021, in order to further stimulate venture capital investments (BMWK 2020; Röhl 2021). Even though the European venture capital market as a whole, but also the VC markets in the underlying countries still lack behind the lead market of the US, whose venture capital investments as of GDP alone reached 0.6% in 2020 (NVCA 2023; Statista 2023 and figure six), a direct comparison of the markets seems not reasonable.

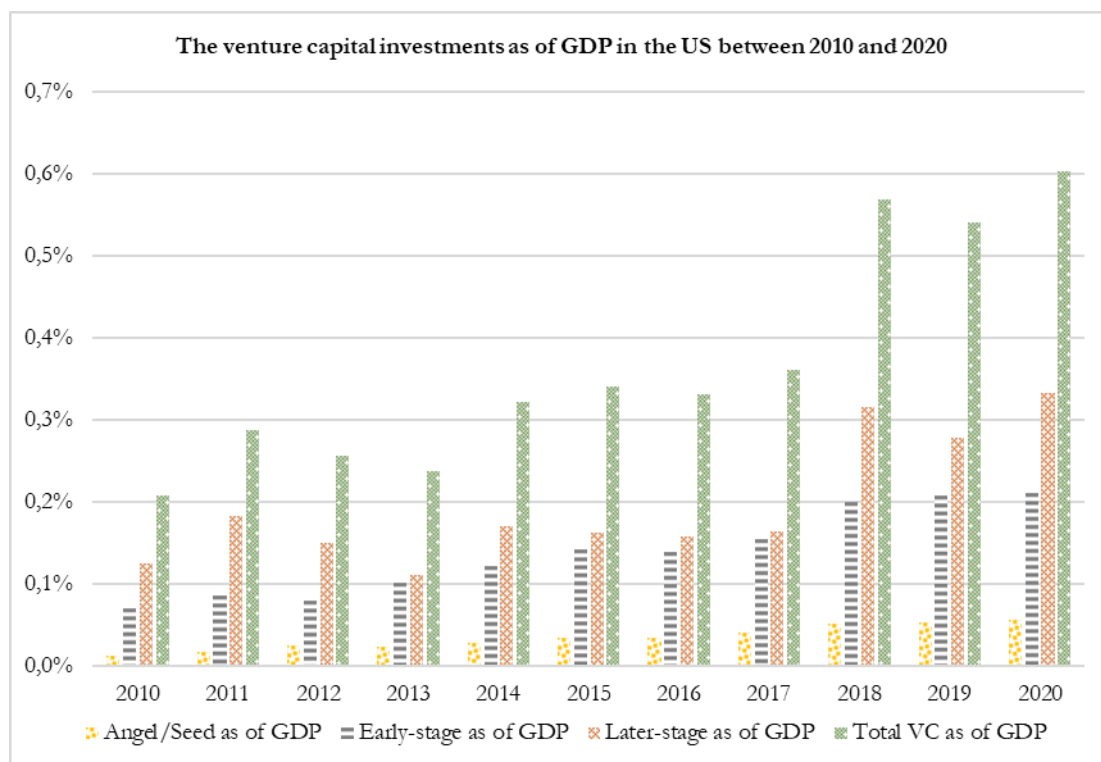


Figure 6 The venture capital investments as of GDP in the US between 2010 and 2020  
(own calculations, derived from NVCA 2019 and 2023; Statista 2019 and 2023)

In Europe, but in particular in Germany, it seems less supply which matters, but rather demand. OECD data showed that the average self-employment rate in Benelux, Austria and Germany was 12.5% for the period of 2011 until 2020, and that this proportion remained rather stable with no real movement during this period (table 18). A more sophisticated ratio in that regard, the so-called total-early-stage-entrepreneurial-activity which combines the number of enterprise founders and new business owners showed that in 2022, the ratio in Austria, Luxembourg, The Netherlands and Germany was on average 8.9% (Hill et al. 2023)<sup>9</sup>. For comparison purposes, the TEA ratio in the UK and in the US reached 12.9% and 19.2% in 2022, respectively (Hill et al. 2023). Hence, there seems simply more entrepreneurial activity in the United Kingdom and in the United States which justifies the demand for venture capital and which may be a bottleneck in the underlying countries of this study.

The self-employment rates in Benelux, Austria and Germany between 2011 and 2020										
In per cent from the total employment (>15 years old)										
Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belgium	14.30	14.35	15.08	14.61	15.18	14.84	14.29	14.03	14.20	14.70
The Netherlands	15.15	15.36	16.05	16.62	16.84	16.81	16.73	16.69	16.60	17.20
Luxembourg <sup>1)</sup>	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.58	8.70	9.40
Austria	13.28	13.07	13.20	13.29	13.00	12.72	12.38	12.01	12.20	12.20
Germany <sup>2)</sup>	11.67	11.57	11.20	10.96	10.75	10.42	10.20	9.90	9.60	10.00
<b>Average</b>	<b>12.48</b>	<b>12.47</b>	<b>12.71</b>	<b>12.69</b>	<b>12.75</b>	<b>12.56</b>	<b>12.32</b>	<b>12.24</b>	<b>12.26</b>	<b>12.70</b>

1) Own estimates for 2011 to 2017. 2) Own estimates for 2019 and 2020.

Table 18 The self-employment rates in Benelux, Austria and Germany between 2011 and 2020 (derived from OECD 2020 and 2023)

<sup>9</sup> Recent data for Belgium was unfortunately not available and the latest statistics goes back to 2014 (Holvoet et al. 2015).

## 6.2 *The discussion of the network and of the financial aspects*

The results have also shown that networks play an important role in the business model of the governmental investors too and not the financial aspects alone. This network aspect was also visible portfolio internally. The investors were obviously aware of their brokering role for the provision of contacts on portfolio level, which was also shown in the research of Fiegler (2015). This provision of network contacts is surely an important point for the start-ups in particular at the beginning and not the provision of investment capital alone. Enterprise founders should not have the relevant contacts at their start and their networks should lack the relevant business contacts. Lechner et al. (2006) in their research have already shown that the social networks of the enterprise founders unfold no positive effect, neither on the time-to-break-even nor on the sales amount in the years after foundation. In this research, it's rather the impact of the business-related contacts which are important in these points (Lechner et al. 2006). Therefore, the underlying study has surely shown that social capital theory expressed with embedded resources (Lin 1999) and the brokerage function (Burt 1993) play an important role in order to describe the public investors. Fiegler (2015) already concluded that the social capital theory would be an important aspect beside the so oftentimes applied principal-agent theory in the venture capital realm. Even though surely financing-oriented investors, which was also shown on the level of their network compositions (table six and table seven in appendix D), it seems a simplification of reality to reduce the governmental venture capitalists to the treatment (Luukkonen et al. 2013), to the financing (Brandner et al. 2015; Guerini and Quas 2016) or the patenting aspect (Bertoni and Tykvová 2015) alone.

At the end, this calls for the requirement of a wider research perspective in order to examine the real contribution and capacities of the public investors, as also mentioned by Pierrakis and Saridakis (2019). A social capital related research focus is such a suitable path. It seems to be simplified to qualify the public investors as a kind of watering can financier with a multidimensional strategy, whose investment managers lack the relevant expert knowledge (Effenberg 2016) and who would not be able to pick winners (Colombo et al. 2016). Instead, the underlying study has shown that the public investors seem to be patient investors who are willing to provide additional funds, even though the start-up is in an unstable situation. This alone should make them an interesting investor for the start-up entrepreneur and completely irrespective of their investment managers' competence or their firm's inherent strategy.

On the other hand, and with regard to the direct network effects, it was not possible to show that network size alone matters for exit success on a statistically significant level. This applies in the total as well as in the more detailed network perspective. The underlying results therefore comply with the earlier research results of Lechner et al. (2006) and of Krebs (2012) who have already called the sheer network size as a success indicator into question.

## 7. *The implications for theory and practice*

In accordance with the long-term developments, it seems advisable that political decision makers should find a balance between the supply and the demand side measures. At least in some of the countries, the past developments do not really support the requirement of the public involvement in the venture capital market. This applies all the more in context to the developing crowdfunding market. Even though the world market share of Europe's crowdfunding volume tripled from three per cent in 2018 to nine per cent in 2020, the market share of the US and of Canada together was 65% and of the UK still 11% in 2020 (Ziegler et al. 2021). Yet, the market's potential in Europe is obviously not fully exhausted. The same applies for the business angel market whose real financing contribution is unknown and rather based on rough estimates (EBAN 2017, 2019, 2021). The future potential of the crowdfunding market and of the business angel market should be considered in context to the future governmental measures. The business angels'

investments seem also advantageous in terms of monitoring and mentoring. The involvement of the business angels was recently estimated with approx. 23.5 hours on average per month and hence, seems comparatively large in relation to their smaller investments (EBAN 2019).

The examination also showed that some industry sectors were either not or at least underrepresented in the portfolios of the public investors and that the high-tech proportion with 14% was comparatively small. In particular, the computer software sector seemed the preferred investment field of the public investors, whereas the biotechnology sector with the comparatively larger investment risks and longer product development periods (Schmidt 2008), the chemistry sector or the logistic branch were clearly underrepresented (table five in appendix C). Risks remain that the GVCs are focused on industry sectors with a larger success probability and that their funds during increasing market periods contribute to price competitions in preferred industry branches, rather than to support additional sectors (Lerner 2002). This assumption is also supported by the comparatively small portfolio diversification of the public investors in this research (table 17 in section 5.4). The public investors' contribution to the structural change seems surely expandable. This on the other hand might perhaps require an overall strategy change of the public investors, which were obviously also endowed with smaller funds (table four in appendix B) and what might hamper larger and longer investments.

With regard to the market structure, at least for Germany, it seems advisable to rethink the entire provision of the public funds. This applies both on the federal and on the federal states level. There are simply too many different types of public or semi-public investors in the country's venture capital scene. It's difficult to understand why in context to the 50 savings bank daughters (DSGV 2023) and the 15 so-called Mittelständische Beteiligungsgesellschaften in the federal states of Germany in 2022, additional public venture capital firms are still launched without the exploitation of the existing investor base. The additional investors make it more and more difficult for entrepreneurs, not only for the technological start-ups, to apply for investment capital. Instead, they have to scrutinise the market both on the federal and on the federal states level in order to check for the relevant investors and more important, if the required funds are provided and adapt to their particular needs. The market structures in Belgium, The Netherlands and Austria are surely more comprehensible and also allow an easier assessment if the public money supply is efficient. This applies all the more due to the recent launch of the Future Fund in Germany, with its annual average investment volume of approx. 1 billion euros for the next ten years (Röhl 2021).

## ***8. The limitations and recommendations for further research***

The meaningfulness of the underlying study is limited due to the modest response from both the Belgian and the Dutch investors and the non-response from the one and only public investor in Luxembourg. As a result, additional research is surely of interest in a comparative perspective again.

The underlying study has shown that the public investors maintained a comprehensive network which was, at least partly, provided often to the portfolio companies (table eight in section 5.3). The establishment and maintenance of the network contacts causes opportunity costs (Franzen and Pointner 2007). Under this point of view, it's surely advisable to examine the public investors' network provision on the level of the portfolio companies too. This would at the end allow to assess if the network investments of the GVCs are reasonable as they step aside the core objective of money provision.

The preparation phase also revealed that new organisational types of public venture capital emerged. This mixed picture of the public initiatives resulted in a more fine-grained differentiation of the public measures (table three in appendix A) and at the end lead to the question which type of governmental venture capital still characterises GVC at all and, of course, is more successful.

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## Appendix A: The types of public venture capital

The types of public venture capital		
Investment concept	Fund management responsibility	Investment decision by
Direct investments	The public funds are managed by public-owned investments vehicles.	Management team of the public investor.
Direct investments	Independent PE and VC firms are mandated to manage the public funds.	Management team of the independent investor.
Direct investments	The public funds are managed by public-owned investment vehicles for co-investments with independent PE and VC firms.	Management team of the syndication partner.
Fund-of-fund	Public investments in the funds of independent VC and PE firms.	Management team of the independent investor.
Hybrid	The fund is financed by a public core investment plus private investments. The management is lead by civil servants.	Public management team.
Hybrid	The fund is financed by a public core investment plus private investments. The management team and the investment committee are occupied 50:50.	Public and private-sector employees in the investment committee and the management team.

Table 3 The types of public venture capital  
(own development, derived from Jellinghaus and Noreisch 2014 and 2018; Colombo et al. 2016)

**Appendix B:** The basic research results

<b>The basic research results</b>				
The fund volumes				
Country	BENL	Austria	Germany	Total
in MEUR				
n	2	7	8	17
Min	103	6	2	2
Max	200	70	865	865
Mean	152	28	150	100
Median	152	16	60	48
Deviation	68	24	291	204
The investment volumes				
Country	BENL	Austria	Germany	Total
in MEUR				
n	2	7	7	16
Min	21.7	0.1	1.5	0.1
Max	200	70	100	200
Mean	111	13	36	35
Median	111	5	28	17
Deviation	126	25	32	52
The number of investments				
Country	BENL	Austria	Germany	Total
in numbers				
n	2	7	7	16
Min	41	1	8	1
Max	143	30	300	300
Mean	92	12	113	66
Median	92	9	43	26
Deviation	72	11	129	98
The deal sizes				
Country	BENL	Austria	Germany	Total
in MEUR				
n	2	7	7	16
Min	0.15	0.10	0.14	0.10
Max	4.88	2.33	1.75	4.88
Mean	2.51	0.62	0.63	0.86
Median	2.51	0.31	0.30	0.30
Deviation	2.36	0.71	0.56	1.20

Table 4 The basic research results (own development)

## Appendix C: The industry sector focus

The industry sector focus			
n=13			
Industry sector	Rank	Number of investments between 2015 and 2017	Share in %
Computer software	1	187	28.6%
Consumer goods/retail/e-commerce	2	112	17.1%
Mechanical engineering	3	57	8.7%
Services (incl. consulting)	4	41	6.3%
Pharma	5	33	5.1%
Forestry/agriculture	5	33	5.1%
Other industrial goods	6	30	4.6%
Medical engineering	7	24	3.7%
Electronics/Semiconductor	8	23	3.5%
Catering/restaurants/hotel	9	19	2.9%
Biotechnology	10	16	2.5%
Chemistry	11	15	2.3%
Others	12	13	2.0%
Utility/environmental/recycling	12	13	2.0%
Telco/Internet	13	11	1.7%
Construction industry/real estate	14	9	1.4%
Computer hardware	15	8	1.2%
Logistics	16	6	0.9%
Automotive	17	3	0.4%
Financial services	-	0	0.0%
Media	-	0	0.0%
<b>Total number of investments</b>		<b>653</b>	<b>100.0%</b>
Total number of high-tech investments <sup>1)</sup>		119	18.2%
Total number of low-tech investments		419	64.2%
Total number of non-tech investments <sup>2)</sup>		115	17.6%
<b>Portfolio diversification: 19 out of 21</b>			<b>90.5%</b>

1) Pharma, medical engineering, electronics/semiconductor, biotechnology, chemistry, computer hardware. 2) Services/consulting, forestry/agriculture, catering/restaurants/hotels, others, construction industry/real estate.

Table 5 The industry sector focus (own development)

## Appendix D: The network statistics

The network statistics							
n=14							
The total network perspective by network partner							
	Rank	Total number	Share in %	Domestic partners	Share in %	Foreign partners	Share in %
PE/VC firms	1	396	18.8%	299	17.4%	97	25.1%
Others <sup>1)</sup>	2	365	17.3%	314	18.2%	51	13.2%
BA/BA-Syndicates	3	238	11.3%	188	10.9%	50	13.0%
Business advisors	4	223	10.6%	192	11.2%	31	8.0%
Large enterprises	5	213	10.1%	159	9.2%	54	14.0%
Banks	6	209	9.9%	182	10.6%	27	7.0%
Universities	7	153	7.3%	132	7.7%	21	5.4%
Lawyers	8	138	6.5%	111	6.4%	27	7.0%
Tax advisors/auditors	9	121	5.7%	105	6.1%	16	4.1%
Non-university R&D org.	10	51	2.4%	39	2.3%	12	3.1%
<b>Total number</b>		<b>2,107</b>	<b>100.0%</b>	<b>1,721</b>	<b>100.0%</b>	<b>386</b>	<b>100.0%</b>
The total network summary							
Financing partners	1	843	40.0%	669	38.9%	174	45.1%
Advisors	2	482	22.9%	408	23.7%	74	19.2%
Others	3	365	17.3%	314	18.2%	51	13.2%
Large enterprises	4	213	10.1%	159	9.2%	54	14.0%
Scientific partners	5	204	9.7%	171	9.9%	33	8.5%
<b>Total number</b>		<b>2,107</b>	<b>100.0%</b>	<b>1,721</b>	<b>100.0%</b>	<b>386</b>	<b>100.0%</b>

1) Public authorities, technology clusters, federations, SMEs.  
Table 6 The network statistics (own development)



The detailed network statistics													
	Rank	Total number	n	Mean	Deviation	Domestic partners	n	Mean	Deviation	Foreign partners	n	Mean	Deviation
PE/VC firms	1	396	14	28.3	24.4	299	14	21.4	18.8	97	8	12.1	5.6
Others <sup>1)</sup>	2	365	3	121.7	81.1	314	3	104.7	67.0	51	2	25.5	24.5
BA/BA-Syndicates	3	238	12	19.8	19.4	188	12	15.7	16.0	50	5	10.0	5.5
Business advisors	4	223	9	24.8	17.2	192	9	21.3	14.1	31	3	10.3	7.8
Large enterprises	5	213	8	26.6	17.2	159	8	19.9	13.6	54	4	13.5	6.8
Banks	6	209	12	17.4	16.3	182	12	15.2	16.2	27	4	6.8	3.4
Universities	7	153	12	12.8	12.0	132	12	11.0	11.2	21	4	5.3	2.9
Lawyers	8	138	12	11.5	10.9	111	12	9.3	8.9	27	4	6.8	3.4
Tax advisors/auditors	9	121	11	11.0	7.9	105	11	9.5	7.0	16	3	5.3	3.7
Non-university R&D org.	10	51	8	6.4	4.6	39	8	4.9	3.5	12	4	3.0	2.0
<b>Total number</b>		<b>2,107</b>				<b>1,721</b>				<b>386</b>			

1) Public authorities, technology clusters, federations, SMEs.  
Table 7 The detailed network statistics (own development)