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## **Startup Innovation during the Past Economic Crisis**

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Nabil Abou Lebdi, CREA, University of Luxembourg  
Katrin Hussinger, CREA, University of Luxembourg

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For editorial correspondence, please contact: [crea@uni.lu](mailto:crea@uni.lu)  
University of Luxembourg  
Faculty of Law, Economics and Finance  
162A, avenue de la Faiencerie  
L-1511 Luxembourg

# Startup Innovation during the Past Economic Crisis<sup>\*</sup>

Nabil Abou Lebdi<sup>a</sup> and Katrin Hussinger<sup>a,b,c</sup>

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<sup>a</sup> *University of Luxembourg, Center for Research in Economics and Management (CREA) (Luxembourg)*

<sup>b</sup> *KU Leuven, Dept. of Managerial Economics, Strategy and Innovation (Belgium)*

<sup>c</sup> *Centre for European Economic Research (ZEW), Mannheim (Germany)*

## Abstract

By the notion of creative destruction, a crisis can stimulate entrepreneurship and innovation through reallocation of unproductive assets to new ventures that exploit emerging opportunities. However, a crisis can also hamper innovation by exacerbated credit market imperfections that affect new innovative ventures disproportionately. This study investigates the innovation behavior of German startups founded during the past economic crisis in 2009. Empirical results show that crisis startup foundations in high-tech sectors are less likely to introduce innovations to the market than ventures started in the pre-crisis period. Yet, the degree of novelty of these product or service innovations is significantly higher as compared to products and services introduced by start-ups founded in pre-crisis years. Moreover, we do not find evidence for necessity entrepreneurship in German low-tech industries.

**Keywords:** creative destruction, economic crisis, entrepreneurship, innovation, startups

**JEL:** L26, M13, O31

Nabil Abou Lebdi: University of Luxembourg, Center for Research in Economics and Management, 162A, Avenue de la Faïencerie, 1511 Luxembourg, Luxembourg, phone: +49 152 337 605 22, e-mail: [nabil.abou.001@student.uni.lu](mailto:nabil.abou.001@student.uni.lu)

Katrin Hussinger: University of Luxembourg, Center for Research in Economics and Management, 162A, Avenue de la Faïencerie, 1511 Luxembourg, Luxembourg, phone: +352 46 66 44 6404, fax: +352 46 66 44 6341, e-mail: [katrin.hussinger@uni.lu](mailto:katrin.hussinger@uni.lu)

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## 1. Introduction

The past financial crisis has severely impacted European economies. Besides the negative ramifications for financial markets, also other areas of the economy have been negatively impacted. As a consequence, the GDP of all European economies plummeted (OECD, 2012a). Additionally, economic activities with a long run focus such as innovation and startup activities decreased sharply at the peak of the economic crisis in 2009 in most European economies (OECD 2012a, 2012b).

Notwithstanding the negative effects of the past crisis, an economic downturn changes the economic environment for innovation and entrepreneurship. It can be a favorable opportunity for some actors in the economy thereby triggering technological change (Schumpeter, 1942). In upswing and boom periods, innovation tends to be cumulative and is largely conducted by incumbent companies which innovate along established technology trajectories pre-empting market entry by challengers. An economic downturn can force inefficient industry incumbents to exit the market or to shrink their business, leading to a reallocation of resources thereby creating opportunities for newcomers (Eckhardt and Shane, 2003; Caballero and Hammour, 1994, 1999; Gomes et al., 1997; Hall, 1995).<sup>1</sup> New ventures, which are eager to exploit emerging technological opportunities, can take their chance to challenge the status quo starting a process of “creative destruction” (Schumpeter, 1942). As advocated by Schumpeter (1942), creative destruction becomes noticeable when technological progress results from the competition among entrepreneurs and emerges as the dominant driver of economic growth (Aghion and Howitt, 1990). The process of creative destruction can yield an opportunity for innovation leading the economy to a new growth path (Foster, Haltiwanger and Krizan, 2001; Hall, 1991). Some of the most radically innovative and successful companies in their field such as Disney, Microsoft, Oracle, Cisco and Hewlett Packard have been founded during economic downturns (OECD, 2012a). According to Stangler (2009), the majority of Fortune 500 firms has been founded during recessions or bear markets.

A positive response in terms of startup activities and their innovation activities in recessions can however not be taken for granted (Shane, 2011). During periods of economic downturn, entrepreneurs face significant financial constraints, which can hinder the foundation of new companies as well as the new ventures’ business activities and their innovation efforts in

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<sup>1</sup> There is weak empirical evidence supporting an increase in allocative efficiency during economic downturns (Bailey et al., 1992; Griliches and Regev, 1995)

particular (Aghion et al., 2012; Czarnitzki and Hottenrott, 2011; Himmelberg and Petersen, 1994). Ventures with higher financing requirements are affected disproportionately strong during economic downturns. In consequence, an economic crisis hampers the process of creative destruction through exacerbated credit market imperfections (Barlevy, 2002; 2003). In addition, recessions typically evoke a substantial number of so-called necessity entrepreneurs that chose entrepreneurship as a reaction to layoffs and decreased labor market opportunities (Blau, 1987; Evans and Leighton, 1990; Thompson, 2011).<sup>2</sup> Necessity entrepreneurs are less likely to have business ideas with significant growth prospects (Shane, 2009) and are less likely to start a business around a substantial innovation contributing to the process of technological change (Hessels, Van Gelderen and Thurik, 2008).

The arguments above render the impact of an economic crisis on entrepreneurship as a vehicle for innovation and technological change ambiguous which opens up a field for economic research (Koellinger and Thurik, 2012). This paper contributes to the literature by exploring the innovativeness of startups founded during the past economic crisis. Focusing on a matched sample of German startup companies that have been founded before and during the crisis in high-tech and low-tech sectors, descriptive statistics show that crisis startup foundations are more likely to be established based on the motive to develop a novel technological idea than pre-crisis startup foundations. Crisis foundations are not more likely to be set up in response to missing job opportunities.<sup>3</sup> This suggests that necessity entrepreneurship is not more prevalent during recessive periods.

Multivariate regression analysis further shows that crisis startup foundations in German low-tech are not more or less likely to introduce a new product or service into the market in their first years as compared to ventures founded before the crisis. Startups in high-tech sectors, in contrast, are less likely to introduce a new product or service when they have been founded during the crisis. This suggests that ventures in high-tech sectors which are more likely to conduct costly and risky innovation projects are probably experiencing stronger financial constraints during recessions (Czarnitzki and Hottenrott, 2011).

Digging deeper into the type of innovation that crisis startup foundations supply, we investigate whether marketed products and services are based on new in-house developed

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<sup>2</sup> The terms necessity and opportunity entrepreneur have been introduced along with the Global Entrepreneurship Monitor (GEM) (cf. Bosma and Harding, 2006; Reynolds et al., 2005).

<sup>3</sup> Other motives such as the lack of a suitable job, tax reasons or encouragement by past employers have not shown any differences between crisis and pre-crisis startup foundations either.

technologies or whether they rather represent combinations and applications of existing technologies. An interesting difference appears from our analysis. Conditional on having introduced a new product or service, crisis startup foundations are more likely to launch products or services that are based on in-house developed technologies than ventures started before the past economic crisis. While these results hold for startups in high-tech sectors, we do not find that pre-crisis and crisis startup foundations in low-tech sectors differ significantly from each other in terms of the degree of novelty of the products and services they introduce. This confirms our previous finding that there is no evidence for necessity entrepreneurship in Germany.

In conclusion, our results show that there is great heterogeneity among new ventures' innovation in high-tech industries. Crisis startup foundations in high-tech sectors are generally less likely to introduce new products or services, but there is a promising group of innovative ventures among them that is likely to contribute to technological change by launching more novel innovations than pre-crisis startup foundations. These firm level findings for Germany are in line with the notion that an economic downturn creates opportunities for some entrepreneurs or entrepreneurial teams which contribute to the process of creative destruction.

The remainder of this paper is structured as follows. First, the literature review will survey the most important contributions regarding entrepreneurship, innovation and the business cycle followed by the hypotheses development. Subsequently, the dataset, sample and descriptive statistics are presented followed by an outline of the estimation strategy and empirical analysis. The final section discusses the underlying results and ends with some concluding remarks.

## **2. Literature Review**

In a comprehensive review, Parker (2011) categorizes the theoretical literature regarding entrepreneurship, innovation and the business cycle into three categories: models of creative destruction, models of innovation and implementation cycles and models of production under asymmetric information. The following literature review will briefly summarize the most important contributions and at the same time update previous findings with recent empirical results.

## 2.1. Innovation and the business cycle

The relationship between innovation activities and the business cycle is ambiguous and has been subject to intense debates. Advocates of a pro-cyclical pattern argue that innovation strongly depends on demand so that incentives to innovate are lacking during a recession (Schmookler, 1966; Shleifer, 1986). Moreover, it is easier to finance innovation via internal and external funds during boom periods when access to finance is less problematic (Aghion et al., 2012; Hall, 1992; Himmelberg and Petersen, 1994).

Proponents of a countercyclical innovation behavior argue that the opportunity costs of allocating productive assets from manufacturing to innovation are lower in recessions than in boom periods (Aghion and Saint-Paul, 1998; Nickell, Nicolitsas and Patterson, 2001; Stieglitz, 1993).<sup>4</sup> Furthermore, profitability declines during recessions encourage companies to seek for measures to improve productivity, creating room for innovation (Aghion and Saint-Paul, 1998). Financial constraints play a crucial role here as well. Recent evidence shows that only financially constrained companies behave pro-cyclical while unconstrained companies show a counter-cyclical innovation behavior (Aghion et al., 2010; Aghion et al., 2012).

With regards to the past economic crisis, innovation expenses decreased in most European countries (OECD, 2012). In Germany, private sector R&D expenses decreased by 2.9%, while this effect was even stronger in other European countries such as the UK and Italy (OECD, 2012a). Companies in German manufacturing reduced their innovation expenditure by 9.5%-16.7%, whereby especially small and medium-sized companies were affected (Rammer, 2011). Service companies were less affected (ibid.). A counter-cyclical innovation policy in Germany helped R&D expenses to increase again shortly after the crisis peaked (Hud and Hussinger, 2015).

At the firm level, prior studies show mixed results. While the majority of companies decreased their innovation expenses during the past crisis in Germany (Kulicke et al., 2010), Europe (Archibugi, Filippetti and Frenz, 2013) and Latin America (Paunov, 2012), a few small companies and new entrants bucked the trend and expanded their innovation expenses (Antonioli et al., 2011, for manufacturing firms Italy; Archibugi, Filippetti and Frenz, 2013, for non-public service companies in Europe). In contrast, Kanerva and Hollanders (2009) find

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<sup>4</sup> Francois and Lloyd-Ellis (2003) find that during recessions entrepreneurs invest in R&D, but wait to capitalize on their findings until a new boom period.

no association between firm size and innovation declines during the past crisis for European companies using the Innobarometer 2009. However, highly innovative firms and companies in innovation leader countries such as Germany are found to be least likely to have decreased innovation investment during the past crisis (Kanerva and Hollanders, 2009).

## **2.2. Entrepreneurship and the business cycle**

The nature of the entrepreneurship and business cycle relationship as ambiguous as the innovation behavior throughout the cycle. The reciprocal influences have been modeled in a variety of studies.

The classical model of an individuals' decision to choose entrepreneurship over wage employment by Evans and Jovanovic (1989) helps to shed light on the mechanisms that explain observed effects of an economic downturn on entrepreneurial activity. In their model, the individual's choice to become self-employed centers on the comparison of the expected earnings from self-employment versus salary work: While demand for products and services is lower in recessions, individual wealth is reduced as well since the acquisition of external finance for entrepreneurship is increasingly difficult, leading entrepreneurs to self-finance their starting budget and lower their expected income. On the contrary, recessions also decrease the expected wage and opportunity costs of capital, rendering wage employment less attractive than in boom periods as well. At the same time, the costs of production are also lower during an economic downturn (especially rent and labor) increasing the expected income from entrepreneurship, while demand uncertainty may slow down sales efforts.

Besides the decision between entrepreneurship and wage employment, other theoretical models focus on the financing side of entrepreneurial activity (Bernanke and Gertler, 1989; Carlstrom and Fuerst, 1997). Both studies model entrepreneurship and the business cycle using a costly-state-verification framework.<sup>5</sup> Bernanke and Gertler (1989) state that entrepreneurial output is pro-cyclical as entrepreneurs will be financially more solvent during boom times resulting in lower agency cost. In contrast, Carlstrom and Fuerst (1997) predict entrepreneurial solvency to be countercyclical. This is due to the fact that during boom times entrepreneurship suffers increased bankruptcy rates, which are caused by higher risk premiums that are rooted in higher capital cost as well as technology shocks.

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<sup>5</sup> In these models, investments are optimally financed by debt contracts because a debt contract minimizes the verification costs since it incurs only in case the entrepreneur defaults.

Finally, Kihlstrom and Laffont (1979), Rampini (2004) as well as Atolia and Prasad (2012) focus on the risk profiles of entrepreneurs in pondering the entrepreneurial decision vs. wage employment. In advocating pro-cyclical patterns and indicating that increased price and policy uncertainty positively influence entrepreneurship rates, the authors build on the basic perception introduced by Knight (1921) that the entrepreneur is the risk bearer in society.

The mechanisms at work render the effect of the business cycle on the entrepreneurial decision inconclusive. Moving from the theoretical contributions and focusing on the empirical studies, Fairlie (2013) investigates the relationship between the entrepreneurial decision and the business cycle for the U.S. during the Great Recession. He finds that the labor market conditions – increased layoffs and fewer opportunities on the labor market – have been the main drivers of the decision to become self-employed. Yet, it has to be acknowledged that most European countries, such as Germany, have higher unemployment benefits compared to the US, which makes a general applicability of these results difficult. Offering another empirical analysis, Loayza and Rigolini (2011) show that self-employment rates are countercyclical for a sample covering 54 countries (including Germany) from 1984-2008.

In another recent empirical analysis, Koellinger and Thurik (2012) test whether entrepreneurship is pro-cyclical or countercyclical for a panel of 22 OECD countries from 1972-2007. Their analysis focuses on the national as well as on the aggregate level. Employing fixed-effect (country data) as well as autoregressive models (aggregate data), the authors find for the global business cycle that the entrepreneurship cycle granger-causes the business cycle in terms of GDP development. Koellinger and Thurik (2012) conclude that this finding alludes to entrepreneurial activities being an early recession recovery indicator. This is in line with Shapiro (2014) who argues that economies with higher self-employment rates recover faster from negative productivity shocks. Koellinger and Thurik (2012) further find that GDP as well as the unemployment cycle do not predict the entrepreneurship cycle. On the national level, the influence of the entrepreneurship cycle on the GDP is weaker than on the aggregate level.<sup>6</sup> Congregado, Volpe and Parker (2012) take a distinguished approach and find a pro-cyclical pattern for employer entrepreneurs, while reporting a countercyclical result for own-account entrepreneurs with no employees for Spain. For the UK, utilizing a

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<sup>6</sup> Germany has been excluded from the analysis since the unification effects could not be corrected for regarding the time series nature of the data.

sample over three decades, Parker, Congregado and Volpe (2012) also find a pre-dominantly pro-cyclical pattern of entrepreneurship over the business cycle.

Regarding the macro data of the past economic crisis, a short decline of startup activities was observed at the peak of the economic crisis in most OECD countries followed by an upswing in the subsequent quarters towards the pre-crisis level (OECD, 2012b). For Germany, OECD data show a spike in entrepreneurial activity in the year 2009 (OECD, 2012b). Regarding unemployment and GDP development, Germany saw a sharp decline in real GDP development in 2009 compared to 2008 while the unemployment rate did remain at the 2008 level (Funk, 2012). This was also due to a governmental stimulus package of € 82 bn. focusing on infrastructure projects and new investments (Paesler, 2011).

While the implications of the crisis for entrepreneurship in Germany and other European countries are not (yet) extensively discussed in the literature, there is a fierce debate ongoing in the U.S. Some scholars argue that the year 2009 shows the highest entry into entrepreneurial activity in the U.S. for one and a half decades (Fairlie, 2010). Others take a more nuanced stance. Shane (2011) argues that the economically more substantial firm foundations, such as employer firm foundations decreased in number during the past recession. For instance, he reports a decrease of employer firm foundations by 17.3% in 2009 as compared to 2007 (Shane, 2011). OECD data (2012b) seem to confirm the skeptics reporting no increase in entrepreneurial activity in terms of business foundation with at least one employee during 2009.

### **3. Hypothesis development**

The central role of entrepreneurship for innovation and technological change has long been acknowledged (Schumpeter, 1942; Drucker, 2014; Kortum and Lerner, 2000; Shane and Venkataraman, 2000). The entrepreneur is often regarded as an “agent of progress” who founds new entities and introduces new technologies, products and services and thus leads the economy to a new growth path (Audretsch, 2007; Schumpeter, 1934; Wennekers and Thurik, 1999).<sup>7</sup> An economic downturn can foster this process of creative destruction by facilitating the reallocation of assets from unproductive industry incumbents that exit the market or shrink their business to new ventures (Eckhardt and Shane, 2003; Caballero and Hammour,

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<sup>7</sup> Entrepreneurship thereby is not limited to the foundation of new firms but can also comprise entrepreneurial activity in or by existing firms (Wennekers and Thurik, 1999; Czarnitzki, Dick and Hussinger, 2010).

1994; 1999; Gomes et al., 1997; Hall, 1995). Some entrepreneurs are able to exploit the emerging opportunities and benefit from easier access to assets that are reallocated (Antonioli et al., 2011, Archibugi, Filippetti and Frenz, 2013).

The question is to which extent new ventures established during recessions are willing and able to introduce (radically) new products and services to the market and thus fulfill their role as “agents of progress” in order to help in leading the economy to new growth paths. Crisis startup foundations have been found to resemble at least partly necessity entrepreneurship in response to an increased number of layoffs. Analyzing the composition of entrepreneurs over the business cycle in a theoretical model, Thompson (2011) shows that during recessions the share of necessity entrepreneurs increases while the share of opportunity entrepreneurs decreases. High ability entrepreneurs chose self-employment independent of their occupational situation while low ability entrepreneurs are more inclined to starting a business when job markets are weak. Consequently, necessity entrepreneurs start new ventures due to a lack of job market opportunities (Blau, 1987; Block and Koellinger, 2009; Evans and Leighton, 1990). They typically have less human capital and financial resources than opportunity entrepreneurs that start a business in response to an upcoming opportunity (Block et al., 2015; Caliendo and Kritikos, 2009). As compared to opportunity entrepreneurs, necessity entrepreneurs are less likely to have business ideas with significant growth prospects (Shane, 2009). In response, they invest less in their business (Evans and Jovanovic, 1989, Santarelli and Vivarelli, 2007), are less likely to incorporate (Bruhn, 2008), show lower survival rates (Block and Wagner, 2010), lower earnings and growth rates (Bates, 1990; Preisendörfer and Voss, 1990). Nonetheless, Yu, Orazem and Jolly (2014) claim that during recessions, self-employment rises due to the sensitivity of wage employment to the business cycle and not because of necessity considerations.

The arguments above render the question whether the entrepreneurial activities observed in recessions is more likely to lead to innovation (in case the ventures founded during a recession grasp new opportunities) or less (in case most of the new ventures reflect necessity entrepreneurship) an empirical one. Accordingly, we formulate a null hypothesis and alternative hypothesis.

*H<sub>1a</sub>: Startups are more likely to market an innovative product or service when founded during the crisis compared to non-crises startup foundations.*

*H<sub>1b</sub>: Startups are less likely to market an innovative product or service when founded during the crises compared to non-crisis startup foundations.*

The Schumpeterian notion that entrepreneurs are “agents of progress” is not satisfied with the introduction of new products and services. It requires that these innovations are substantial so that they have the power to contribute to or start a process of creative destruction. Such innovative projects are often ambitious and expensive. Ventures with high financing needs can be affected disproportionately strong during economic downturns so that especially founders with an ambitious business idea can be struggling (Barlevy 2002; 2003). Complex innovation projects that are realized by the startup itself definitely belong to the type of activities that should be most seriously affected by financial constraints. Czarnitzki and Hottenrott (2011) show that firms focused on launching product novelties are disproportionately more affected by financial constraints than firms aiming at product improvements or the adaption of already existing technologies. Cowling, Liu and Ledger (2011) confirm for the UK that external financing was more readily available for larger and older firms while micro business were struggling obtaining external finance during the crisis. In a recent paper, Giebel and Kraft (2015) find that financial constraints impact innovative firms more than non-innovative firms in terms of diminished investment growth, as a direct result of the crisis. Against this evidence, it is likely that the innovative products and services initiated by ventures established during the crisis are less complex and demand less research and development than the products or services taken out by ventures established in non-crisis years due to financial constraints.

Taking a behavioral perspective, one could, on the contrary, argue that especially the crisis startup foundations develop more challenging innovations. Prospect theory suggests that the risk attitude of individuals depends on their reference point, which is defined by the situation to which an individual aspires (Kahneman and Tversky, 1979). A high level of risk aversion is typically observed among individuals that operate in a so-called gain position (not only financially) in which any change would most likely lead to a deterioration of the status quo. Individuals in gain frames, hence, strive for sustaining the status quo and avoid risky actions. Individuals in loss frames, in contrast, have a lot to gain and little to lose so that they behave risk seeking in order to improve their status quo. A recession can cause an individual’s income to fall below the reference point, e.g. in case of salary cuts or job loss, and, hence,

triggers risk seeking behavior, putting her into a loss frame and increasing her risk tolerance. This is in line with Koellinger's (2008) finding that very innovative business ideas associated with high risk and uncertainty are likely to be pursued by individuals who have "nothing to lose". The lower opportunity costs during a crisis thereby plays a pivotal role since the propensity to engage in risk seeking behavior increases as other alternatives become increasingly unattractive (Venkataraman, 1997).

The arguments above do not provide a clear-cut answer to the question whether innovations taken out by businesses founded during a crisis should be expected to be more or less novel and technologically advanced. On the one hand, financial constraints can hamper ambitious innovation projects; on the other hand, the risk attitude of entrepreneurs can have changed so that more risky and challenging innovative projects are pursued. Accordingly, we formulate a second null hypothesis and alternative hypothesis:

*H<sub>2a</sub>: Startups founded during the crisis launch products or services based on in-house developed new technologies rather than on pre-existing technologies or third party innovations.*

*H<sub>2b</sub>: Startups founded during the crisis launch products or services based on in-house developed new technologies rather than on pre-existing technologies or third party innovations.*

## **4. Data, Variables and Descriptive Statistics**

### **4.1. Data**

The empirical analysis is based on the KfW/ZEW Startup Panel (SuP), a large sample of startups located in Germany.<sup>8</sup> Started in 2008, the SuP is a joint project of the Centre for European Economic Research (ZEW) in Mannheim, the "Kreditanstalt für Wiederaufbau" (KfW) Bankengruppe, Germany's largest state-owned promotional bank, and "Creditreform", the largest credit rating agency in Germany. The SuP aims at providing a complete track record for entrepreneurial startups with respect to specific firm characteristics (e.g. sales, number of employees), strategic decisions (e.g. composition of the management team, product market entry strategy) and financial sources. The survey targets ventures that have been founded in the past three years. Firms drop out of the sample if they reach an age of

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<sup>8</sup> The SuP focuses on legally independent firms excluding de-mergers and subsidiaries.

eight years. The SuP is a stratified random sample covering most manufacturing and service industries with a focus on high-tech manufacturing.<sup>9</sup> For a detailed description of the survey and its sample design we refer to Fryges, Gottschalk and Kohn (2009).

For our analysis, we use the sample years 2007 - 2009 that include startups founded in the period 2005 - 2009. Startups that were founded in 2009 are regarded as startup crisis startup foundations since the crisis only started at the end of 2008. We are restricted to these three survey waves because the previous survey questionnaires do not include the variable that we use as dependent variable in our regression models. In order to avoid that our results are driven by the fact that ventures founded during the crisis might engage in different industries than ventures founded in the pre-crisis years and also by the fact that the crisis foundations are on average younger than the pre-crisis startup foundations, we use a matched sample of crisis and pre-crisis startup foundations.<sup>10</sup> Matching criteria are the venture's age and industry affiliation. In total, our sample comprises 1,904 venture year observations, 1,106 correspond to ventures that have introduced a new product or service since their foundation.

An important aspect of the past crisis is that it was not expected by potential entrepreneurs so that we can exclude strategic behavior. While recessions can often be predicted, this was not the case for the recent economic crisis. Based on information from the German Community Innovation Survey, Rammer (2011) shows for firms of all size classes that in the years 2006-2009 the actual innovation expenditures were almost equal to the innovation expenditures planned in the previous year. Only in the crisis year 2009, a gap between planned and actual innovation expenses arises (see Figure 1 in Rammer, 2011) suggesting that firms were taken by the crisis by surprise. Hence, we can exclude strategic behavior of the founders of the pre-crisis startup foundations in expectation of an economic downturn.

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<sup>9</sup> The industry sectors agriculture, mining and quarrying, electricity, gas and water supply, health care, and the public sector are excluded from the sample.

<sup>10</sup> We arrive at the same empirical results for the full sample. Results are available from the authors upon request.

## 4.2. Variables

We use the information whether ventures have introduced a product or service into the market in the first years after their foundation as a first dependent variable in order to test whether crisis startup foundations are more likely to introduce innovations than non-crisis startup foundations. The second dependent variable captures the degree of novelty of the product or service that the new ventures launch. Ventures were asked to rank their new product or service with regards to the novelty of the underlying technologies.<sup>11</sup> Respondents were given four specific options that relate to the origin of the technology on which the new product or service is based:

- Tested technologies and common combination of existing technologies
- New combinations of existing technologies
- New technologies developed by third parties
- New in-house developed technologies

The most challenging and ambitious type of innovation for the venture is the latter, which is based on in-house developed technologies. Ventures providing this type of innovation carry the full technology risk in addition to the market risk. The least challenging and least risky type of innovation is the first that relies on tested and common combinations of existing technologies.

Table 1 shows the number of ventures in the different categories. In addition to the four categories that depict the degree of novelty of the introduced product or service, a fifth category is presented that captures the ventures that did not introduce any new products or processes. Table 1 shows that the distributions of new ventures founded before and during crisis across the different categories of product/service novelty are different from each other. Ventures founded during the crisis appear relatively more often in the most extreme categories. They are more likely to have not introduced a new product or service at all and they are also more likely to offer a product or service that is based on a technology developed in-house, the most innovative venture category. Crisis startup foundations are comparatively less often found in the category of ventures that launch products or services that are based on well tested and established technologies. A  $X^2$ -test rejects the null hypothesis that the differences are not statistically significant at the 1% level of statistical significance. The

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<sup>11</sup> In case the company had more than one new product the response refers to the new product or process that generates the highest returns.

empirical section of this paper explores whether this descriptive pattern holds in a multivariate regression framework.

Table 1: Dependent variable

| Innovativeness of new product or service                             | Pre-crisis startup foundations | Crisis startup foundations |
|----------------------------------------------------------------------|--------------------------------|----------------------------|
| No new products or services                                          | 387 (40.65%)                   | 411 (43.17%)               |
| Tested technologies and common combinations of existing technologies | 219 (23%)                      | 190 (19.96%)               |
| New combinations of existing technologies                            | 157 (16.49%)                   | 121 (12.71%)               |
| New technologies developed by third parties                          | 74 (7.77%)                     | 87 (9.14%)                 |
| New in-house developed technologies                                  | 115 (12.08%)                   | 143 (15.02%)               |
| Total                                                                | 952                            | 952                        |

We use a number of control variables. We measure firm size in terms of employment. Firm size is likely to be correlated with the innovation capacity of the venture. We use the logarithm of the number of employees in order to account for the skewness of the venture size distribution. Further variables that control for the innovation capacity are the share of R&D employees over total employment and a dummy variable that indicates whether the firm has applied for at least one patent since its foundation.

We also account for the financial structure of the venture by including dummies that equal one if the firm is using internal and external funds. Internal sources of finance include the owner of the startup, family, friends, other supporters as well as mezzanine funding, which usually is a form of investment in between debt in equity in that it is senior to equity but junior to a bank loan (Sprink, 2003). External sources of finance include banks, the public funding institutions as well as overdrafts. Since not all firms answered the financing questions we also include a dummy for companies that did not answer both questions and set the dummies to zero. This is a common practice in order to not lose observations because of missing values for a control variable.

We further control for certain characteristics of the founder or the founding team. We use the number of founders as a measure for the size of the founder team. Larger founder teams are more likely to facilitate the progress and growth of the venture in the first years after firm foundation (Eisenhardt and Schoonhoven, 1990). Another control variable is employed to account for the experience of the founder(s). We include the industry experience of the founder, a dummy accounting for her leadership experience as well as a dummy that indicates

whether the founder team includes re-starters. Re-starters can have advantages due to their past experience if they learned from their past endeavor(s).

The survey further allows us to control for the motivation of the founder to start the business. Respondents were given six answers they could choose from:

- Desire to work independently
- Implementation of a specific business idea
- Lack of a suitable job
- Escaping unemployment
- Encouragement from the past employer
- Tax reasons

This information can provide some hints about the share of necessity entrepreneurs among the crisis startup foundations.

We also use information on the gender of the entrepreneur and on her nationality. We further utilize a set of industry dummies and dummies for the year of firm foundation. Finally, we include a dummy for the year of observation to control for possible differences in cyclical patterns. These variables are included in all regressions, but not reported.

### **4.3. Descriptive Statistics**

Table 2 shows the descriptive statistics for our variables distinguishing between ventures founded during the crisis and before. While we do not find significant differences between crisis and pre-crisis startup foundations in terms of firm size and innovation capacity for our matched sample, we find that there are more re-starters among the crisis-foundation and founders with less industry experience. Further, the number of founders of crisis startup foundations is significantly lower than the number of founders in the pre-crisis period.

The most interesting difference appears with regards to the motive for starting a business. Table 2 reveals that ventures founded during the crisis are more likely to start the business because they want to implement a specific business idea. Crisis startup foundations are not more likely to emerge because of a lack of employment opportunities or in order to escape unemployment. These findings do not suggest that necessity entrepreneurship was predominant during the past crisis in Germany. Moreover, Table 2 shows that ventures

started during the crisis were less likely to be motivated by the past employer or by tax reasons.

Table 2: Descriptive statistics

|                                                    | Pre-crisis startup foundations |         | Crisis startup foundations |         | mean diff. | t-test |
|----------------------------------------------------|--------------------------------|---------|----------------------------|---------|------------|--------|
|                                                    | mean                           | st.dev. | mean                       | st.dev. |            |        |
| Log(employment)                                    | 0.82                           | 0.82    | 0.83                       | 0.82    | 0.01       |        |
| Share of R&D employees                             | 0.08                           | 0.19    | 0.09                       | 0.20    | 0.01       |        |
| Patent dummy                                       | 0.02                           | 0.13    | 0.03                       | 0.16    | 0.01       |        |
| Internal finance dummy                             | 0.71                           | 0.46    | 0.69                       | 0.46    | -0.02      |        |
| External finance dummy                             | 0.35                           | 0.48    | 0.33                       | 0.47    | -0.02      |        |
| Years of industry experience                       | 12.94                          | 9.01    | 13.53                      | 9.57    | 0.59       |        |
| Restarter                                          | 0.39                           | 0.49    | 0.47                       | 0.50    | 0.08       | ***    |
| Leadership experience                              | 0.67                           | 0.47    | 0.72                       | 0.45    | 0.05       | **     |
| Number of founders                                 | 1.54                           | 0.95    | 1.47                       | 0.82    | -0.07      | *      |
| Motive: desire to work independently               | 0.44                           | 0.50    | 0.43                       | 0.50    | -0.01      |        |
| Motive: implementation of a specific business idea | 0.37                           | 0.48    | 0.43                       | 0.50    | 0.06       | ***    |
| Motive: lack of suitable job                       | 0.07                           | 0.25    | 0.08                       | 0.26    | 0.01       |        |
| Motive: escaping unemployment                      | 0.07                           | 0.26    | 0.06                       | 0.24    | -0.01      |        |
| Motive: encouragement by past employer             | 0.02                           | 0.15    | 0.00                       | 0.00    | -0.02      | ***    |
| Motive: tax reasons                                | 0.02                           | 0.14    | 0.00                       | 0.00    | -0.02      | ***    |
| Male founder                                       | 0.87                           | 0.34    | 0.86                       | 0.35    | -0.01      |        |
| Foreign founder                                    | 0.06                           | 0.25    | 0.07                       | 0.26    | 0.01       |        |
| High-tech manufacturing                            | 0.04                           | 0.21    | 0.04                       | 0.21    | 0.00       |        |
| Technology services                                | 0.34                           | 0.47    | 0.34                       | 0.47    | 0.00       |        |
| Software                                           | 0.11                           | 0.32    | 0.11                       | 0.32    | 0.00       |        |
| Non tech manufacturing                             | 0.16                           | 0.37    | 0.16                       | 0.37    | 0.00       |        |
| Knowledge-intense services                         | 0.08                           | 0.27    | 0.08                       | 0.27    | 0.00       |        |
| Other services                                     | 0.09                           | 0.28    | 0.09                       | 0.28    | 0.00       |        |
| Consumer oriented services                         | 0.17                           | 0.37    | 0.17                       | 0.37    | 0.00       |        |
| Commerce                                           | 0.1                            | 0.08    | 0.01                       | 0.08    | 0.00       |        |

## 5. Estimation Strategy and Empirical Results

### 5.1. Estimation Strategy

We are interested in analyzing whether crisis startup foundations are more likely to introduce new products and services than pre-crisis startup foundations (hypothesis 1) and whether the

products and services that ventures founded during the crisis introduced are different in terms of their degree of novelty as compared to the products and services of ventures that have been founded in pre-crisis years (hypothesis 2). Our dependent variable for hypothesis 2 is an ordinal variable. It describes the degree of novelty of the ventures' product or service, ranging from already existing to novel products and services so that we estimate ordered probit models. We estimate ordered probit models with selection (De Luca and Perotti, 2010) in order to answer the question whether crisis startup foundations are more likely to introduce new products or services (hypothesis 1) and in order to account for the fact that only ventures that already have products or service can answer the question about the degree of novelty of the product or service (hypothesis 2). The selection equation captures whether the firm has introduced a new product or service or not. The outcome equation measures the degree of novelty conditional on having introduced a new product or service and hence tests out second hypothesis.

In order to be identified the selection model requires an exclusion restriction, i.e. a variable that affects the selection equation, but has no impact on the outcome equation. For our application, this implies a need for a variable that explains whether the venture has introduced a new product or service, but has no impact on the novelty of that product or service. We suggest two different instrumental variables. The first one is a dummy variable indicating whether the founder is a foreigner. Foreigners might find it more difficult to deal with the German administration when setting up a venture and when introducing a new product or service as compared to natives. According to the World Bank studies on the ease of doing business, Germany only ranks 114 out of the 189 economies on the ease of starting a business with twice as many administrative procedures necessary and simultaneously incurring more than double the cost compared to the OECD average indicating significant bureaucratic burdens for founders in Germany (World Bank Group, 2015). Foreign entrepreneurs often lack country-specific human capital and a local business network which can slow down their business development and make them vulnerable to administrative burdens (Zacharakis, 1997). While administrative hurdles might be more difficult to handle by foreigners there is no reason to assume that the products and services that foreign entrepreneurs provide have a higher or lower degree of novelty.

The second instrumental variable is a male/female dummy variable to fulfill this requirement from a theoretical point of view. This exclusion restriction employs the gender of the founder. Female entrepreneurs have been found to have a lesser interest in growth (Cliff, 1998) and

superior difficulties to access external finance (Kwong, Jones-Evans and Thompson, 2012; Sexton and Bowman-Upton, 1990). These gender differences are likely to cause a difference between male and females to launch a product or service in the first venture years, but do not necessarily cause a difference in the degree of novelty of the product or service.

Our empirical estimation results confirm that both gender and being an immigrant significantly impact the likelihood of introducing a product or service in the first years after venture foundation, while there is no impact in the degree of novelty on the product or service. Hence, these variables are suitable exclusion restrictions for our ordered probit selection model.

## **5.2. Empirical Results**

Table 3 shows the estimation results. The first two columns of Table 3 show the results of the ordered probit selection model. The first column depicts the coefficients of the selection equation for having introduced a product or service. The second column shows the result for the ordered probit equation for the degree of novelty of the new product or service. The results of the selection equation reveal that crisis startup foundations are not more or less likely to introduce a new product or service to the market. This means that we do not find support for hypothesis 1 or the alternative hypothesis for our full sample. The external finance dummy surprisingly is significant and negative, which can partly be explained by the argument that riskier projects are often based on internal rather than on external finance (Bhagat and Welch, 1995; Friend and Lang, 1988; Hall, 1992; Hall and Lerner, 2010). Moreover, highly innovative projects are often difficult to evaluate and assess by external investors due to information asymmetries so that other financing options are more viable in the early stage of the venture (Nanda, Younge and Fleming, 2015). This holds especially true for firms with intangible assets and for those that develop novel technologies in-house rather than acquiring third-party technologies (Mina, Lahr and Hughes, 2013).

Before we move to the test for the degree of novelty of the products and services taken out by the crisis startup foundations a statistical finding deserves our attention. Table 3 illustrates that the selection and outcome equation are not correlated.  $\rho$  equals 0.08 and is not statistically significant from zero. This means that we can safely estimate the ordered probit equation for the degree of novelty without the selection equation. The third column of Table 4 displays the results of the ordinary ordered probit without selection. In order to test whether

we can further simplify our regression model, we test whether the coefficients of the ordered model are identical across the response categories, but an LR-test rejects this null hypothesis on the 1% level of statistical significance. Additionally, we checked whether the cutoff points are the same. Also this null hypothesis was rejected for both neighboring cutoff points on the 1% level of statistical significance so that we cannot further simplify our model and proceed with the ordinary ordered probit model.

Table 3: Ordered probit models

| Model                                              | Ordered probit model with selection    |                   | Ordered probit model  |
|----------------------------------------------------|----------------------------------------|-------------------|-----------------------|
| Dependent variable                                 | Introduction of new product or service | Degree of novelty | Degree of novelty     |
|                                                    | Coef<br>(s.e.)                         | Coef<br>(s.e.)    | Coef<br>(s.e.)        |
| Crisis foundation                                  | -0.09<br>(0.08)                        | 0.15**<br>(0.07)  | 0.15**<br>(0.07)      |
| Log(employment)                                    | -0.15***<br>(0.05)                     | 0.10*<br>(0.03)   | 0.11*<br>(0.06)       |
| Share of R&D employees                             | 0.42**<br>(0.20)                       | 2.15***<br>(0.18) | 2.14***<br>(0.18)     |
| Patent dummy                                       | -0.19<br>(0.23)                        | 0.48**<br>(0.23)  | 0.48**<br>(0.23)      |
| Internal finance dummy                             | -0.01<br>(0.08)                        | -0.02<br>(0.08)   | -0.01<br>(0.08)       |
| External finance dummy                             | -0.29***<br>(0.08)                     | -0.04<br>(0.09)   | -0.03<br>(0.08)       |
| Years of industry experience                       | -0.00<br>(0.00)                        | -0.00<br>(0.00)   | -0.00<br>(0.00)       |
| Restarter                                          | 0.06<br>(0.09)                         | 0.09<br>(0.09)    | 0.09<br>(0.09)        |
| Leadership experience                              | -0.07<br>(0.09)                        | 0.15<br>(0.10)    | 0.15<br>(0.10)        |
| Number of founders                                 | 0.17***<br>(0.05)                      | 0.04<br>(0.05)    | 0.04<br>(0.04)        |
| Motive: implementation of a specific business idea | 0.01<br>(0.08)                         | 0.22***<br>(0.08) | 0.22***<br>(0.08)     |
| Motive: lack of suitable job                       | -0.11<br>(0.14)                        | -0.19<br>(0.15)   | -0.19<br>(0.15)       |
| Motive: escaping unemployment                      | 0.05<br>(0.15)                         | 0.01<br>(0.15)    | 0.01<br>(0.15)        |
| Motive: encouragement by past employer             | -0.31<br>(0.32)                        | -0.15<br>(0.34)   | -0.14<br>(0.35)       |
| Motive: tax reasons                                | 0.23<br>(0.36)                         | -0.35<br>(0.35)   | -0.36<br>(0.35)       |
| Male founder                                       | 0.23**<br>(0.10)                       |                   |                       |
| Foreign founder                                    | -0.29*<br>(0.15)                       |                   |                       |
| Constant                                           | -0.29<br>(0.40)                        |                   |                       |
| $\rho$                                             | 0.08                                   |                   |                       |
| cut off points                                     | 0.05<br>0.78<br>1.28**                 |                   | -0.03<br>0.71<br>1.20 |
| #                                                  | 1,904                                  |                   | 1,106                 |
| LL                                                 | -2,129.83                              |                   | -1,336.17             |

\*\*\* (\*\*, \*) indicate a significance level of 1% (5%, 10%)

The regressions include a set of industry dummies, 2 foundation dummies and a dummy that picks up whether the finance information was not complete.

Table 4: Ordered probit model for the matched sample – marginal effects

| Dependent variable<br>Category                     | Degree of novelty                                              |                                           |                                             |                                     |
|----------------------------------------------------|----------------------------------------------------------------|-------------------------------------------|---------------------------------------------|-------------------------------------|
|                                                    | Tested and commonly used combinations of existing technologies | New combinations of existing technologies | New technologies developed by third parties | New in-house developed technologies |
|                                                    | Marginal effect<br>(s.e.)                                      | Marginal effect<br>(s.e.)                 | Marginal effect<br>(s.e.)                   | Marginal effect<br>(s.e.)           |
| Crisis foundation                                  | -0.05**<br>(0.02)                                              | 0.00<br>(0.00)                            | 0.01**<br>(0.01)                            | 0.04**<br>(0.02)                    |
| Log(employment)                                    | -0.04*<br>(0.02)                                               | 0.00<br>(0.00)                            | 0.01*<br>(0.00)                             | 0.03*<br>(0.02)                     |
| Share of R&D employees                             | -0.72***<br>(0.06)                                             | 0.02<br>(0.02)                            | 0.15***<br>(0.02)                           | 0.12**<br>(0.06)                    |
| Patent dummy                                       | -0.16**<br>(0.08)                                              | 0.01<br>(0.00)                            | 0.03**<br>(0.02)                            | 0.10***<br>(0.03)                   |
| Internal finance dummy                             | 0.01<br>(0.03)                                                 | -0.00<br>(0.00)                           | -0.00<br>(0.01)                             | -0.00<br>(0.02)                     |
| External finance dummy                             | 0.01<br>(0.03)                                                 | -0.00<br>(0.00)                           | -0.00<br>(0.01)                             | -0.00<br>(0.02)                     |
| Years of industry experience                       | 0.00<br>(0.00)                                                 | -0.00<br>(0.00)                           | -0.00<br>(0.00)                             | -0.00<br>(0.02)                     |
| Restarter                                          | -0.03<br>(0.03)                                                | 0.00<br>(0.00)                            | 0.01<br>(0.01)                              | 0.02<br>(0.02)                      |
| Leadership experience                              | -0.05<br>(0.03)                                                | 0.00<br>(0.00)                            | 0.01<br>(0.01)                              | 0.04<br>(0.02)                      |
| Number of founders                                 | -0.01<br>(0.02)                                                | 0.00<br>(0.00)                            | 0.00<br>(0.00)                              | 0.01<br>(0.01)                      |
| Motive: implementation of a specific business idea | -0.07***<br>(0.03)                                             | 0.00<br>(0.00)                            | 0.02***<br>(0.01)                           | 0.06***<br>(0.02)                   |
| Motive: lack of suitable job                       | 0.06<br>(0.05)                                                 | -0.00<br>(0.00)                           | -0.01<br>(0.01)                             | -0.05<br>(0.04)                     |
| Motive: escaping unemployment                      | -0.00<br>(0.05)                                                | -0.00<br>(0.00)                           | 0.00<br>(0.00)                              | 0.00<br>(0.04)                      |
| Motive: encouragement by past employer             | 0.05<br>(0.12)                                                 | -0.00<br>(0.00)                           | -0.01<br>(0.02)                             | -0.04<br>(0.09)                     |
| Motive: tax reasons                                | 0.12<br>(0.12)                                                 | -0.00<br>(0.00)                           | -0.03<br>(0.02)                             | -0.09<br>(0.09)                     |
| #                                                  | 1,106                                                          |                                           |                                             |                                     |

\*\*\* (\*\*, \*) indicate a significance level of 1% (5%, 10%)

The results from the ordinary ordered probit model as presented in column 3 of Table 3 confirm a significant relationship between being a crisis foundation and the degree of novelty of the new product or service introduced. As the coefficients of an ordered probit model

cannot be interpreted in terms of coefficient size or sign for the intermediary cells, Table 4 presents the marginal effects for the model.

It appears that the crisis foundation dummy has a negative sign on the likelihood of having the least novel type of new product or service and a positive one on the likelihood to have a product or service corresponding to the highest novelty category. The effect on the intermediary novelty categories indicating that the product or service is based on new technologies developed by third parties is positive and significant as well. The results demonstrate that crisis startup foundations tend to introduce more novel products and services than non-crisis startup foundations.

Marginal effects allow interpreting small changes in continuous variables on the likelihood of being in a specific category. For our application, the differences in probabilities for crisis startup foundations and pre-crisis startup foundations for the different novelty degrees are more informative. Table 5 illustrates that the likelihood of launching a product or service of the least novel category is about 7 percentage points lower for crisis startup foundations than for ventures that have been founded prior to the crisis. In contrast, the likelihood to be in the highest novelty category is 5 percentage points higher for crisis startup foundations. This pattern is in line with the arguments provided by prospect theory that entrepreneurs are risk seeking during crisis times when they have little to lose, but a lot to win, hence pursuing risky projects.

Table 5: Ordered probit model for the matched sample – probability of being in the different categories for crisis and non-crisis startup foundations

|                                                                            | Crisis startup foundation | Pre-crisis startup foundation | Difference | 95% confidence interval |
|----------------------------------------------------------------------------|---------------------------|-------------------------------|------------|-------------------------|
| Pr(y = Tested and commonly used combinations of existing technologies   X) | 0.4066                    | 0.4757                        | -0.0691    | [-0.1104, -0.0278]      |
| Pr(y = New combinations of existing technologies   X)                      | 0.2399                    | 0.2336                        | 0.0063     | [ 0.0054, 0.0073]       |
| Pr(y = New technologies developed by third parties   X)                    | 0.1547                    | 0.1372                        | 0.0175     | [ 0.0162, 0.0189]       |
| Pr(y = New in-house developed technologies   X)                            | 0.1988                    | 0.1536                        | 0.0452     | [ 0.0161, 0.0743]       |

With regard to the control variables, Table 4 shows that the probability of being in the lowest category decreases with firm size, the share of R&D employees and the patent variable. These variables have a positive impact on the likelihood of being in the two categories with the most novel products and services. Also, the motivation to start up a company is correlated with the degree of the venture's product or service. Ventures that are based on the realization of a specific business idea launch the more novel products and services, which are based on in-house developed technologies.

### **5.3. High-tech versus low-tech industries**

In order to dig deeper into potential evidence for necessity entrepreneurship and ventures started for radical innovation, it is instructive to split the dataset and focus on low-tech and high-tech industries separately. As a response to weak job markets (Blau, 1987; Block and Koellinger, 2009; Evans and Leighton, 1990), necessity entrepreneurship is more likely to occur in low-tech sectors where the required skill level for an entrepreneur and the required startup investment is typically lower. In contrast, an entrepreneur that starts a venture in order to radically innovate in terms of new technologies is more likely to be observed in high-tech industries.

For our empirical analysis, we follow the same approach as before. In a first step, we ran ordered probit models with selection. Since the correlation between both equations was insignificant, we switched to standard probit models and ordered probit models. Table 6 shows the probit model estimations for the likelihood of launching a new product or service. Table 7 and Table 8 below show the results for the ordered probit models for the degree of novelty for ventures in high-tech and low-tech industries respectively.

The results in Table 6 show, despite the insignificant effect for the full sample and the sample of low-tech industries that ventures founded during the crisis in high-tech sectors are significantly less likely to launch a new product or service. This supports hypothesis 1b. The result is most likely explained by the fact that ventures in high-tech industries are disproportionately affected by financial constraints since their innovation projects tend to be more costly and risky.

Regarding low-tech industries, Table 7 does not show significant differences between crisis and pre-crisis startup foundations. In other words, we do not find evidence for necessity entrepreneurship.

Table 6: Probit model for the matched sample – marginal effects

| Dependent variable                                 | New product or service launched |                           |                           |
|----------------------------------------------------|---------------------------------|---------------------------|---------------------------|
|                                                    | Full sample                     | High-tech                 | Low-tech                  |
|                                                    | Marginal effect<br>(s.e.)       | Marginal effect<br>(s.e.) | Marginal effect<br>(s.e.) |
| Crisis foundation                                  | -0.04<br>(0.03)                 | -0.07***<br>(0.02)        | 0.04<br>(0.03)            |
| Log(employment)                                    | -0.06***<br>(0.02)              | -0.00<br>(0.02)           | -0.06***<br>(0.02)        |
| Share of R&D employees                             | 0.16**<br>(0.08)                | 0.04<br>(0.04)            | 0.23***<br>(0.10)         |
| Patent dummy                                       | -0.08<br>(0.09)                 | -0.11<br>(0.08)           | 0.04<br>(0.11)            |
| Internal finance dummy                             | -0.01<br>(0.03)                 | -0.02<br>(0.02)           | 0.02<br>(0.03)            |
| External finance dummy                             | -0.11<br>(0.03)                 | -0.02<br>(0.03)           | -0.11<br>(0.03)           |
| Years of industry experience                       | -0.00<br>(0.00)                 | -0.00<br>(0.00)           | -0.00<br>(0.00)           |
| Restarter                                          | 0.02<br>(0.04)                  | 0.00<br>(0.02)            | 0.02<br>(0.04)            |
| Leadership experience                              | -0.02<br>(0.04)                 | -0.04<br>(0.03)           | 0.02<br>(0.04)            |
| Number of founders                                 | 0.06<br>(0.02)                  | 0.02<br>(0.01)            | 0.05<br>(0.02)            |
| Motive: implementation of a specific business idea | 0.00<br>(0.03)                  | -0.03<br>(0.02)           | 0.04<br>(0.03)            |
| Motive: lack of suitable job                       | -0.04<br>(0.06)                 | -0.04<br>(0.05)           | -0.01<br>(0.03)           |
| Motive: escaping unemployment                      | 0.01<br>(0.06)                  | 0.02<br>(0.04)            | 0.01<br>(0.06)            |
| Motive: encouragement by past employer             | -0.12<br>(0.13)                 | -0.20<br>(0.16)           | -0.00<br>(0.13)           |
| Motive: tax reasons                                | 0.10<br>(0.12)                  |                           | 0.11<br>(0.15)            |
| #                                                  | 1904                            | 942                       | 954                       |

\*\*\* (\*\*, \*) indicate a significance level of 1% (5%, 10%)

Note that the motive tax reasons could not be included in the high-tech regression due to a very low number of non-zero observations.

Table 7: Ordered probit model for the matched sample, high-tech only – marginal effects

| Dependent variable<br>Category                        | Degree of novelty                                                             |                                                    |                                                      |                                               |
|-------------------------------------------------------|-------------------------------------------------------------------------------|----------------------------------------------------|------------------------------------------------------|-----------------------------------------------|
|                                                       | Tested and<br>commonly<br>used<br>combinations<br>of existing<br>technologies | New<br>combinations<br>of existing<br>technologies | New<br>technologies<br>developed by<br>third parties | New in-<br>house<br>developed<br>technologies |
|                                                       | Marginal effect<br>(s.e.)                                                     | Marginal effect<br>(s.e.)                          | Marginal effect<br>(s.e.)                            | Marginal<br>effect<br>(s.e.)                  |
| Crisis foundation                                     | -0.07***<br>(0.03)                                                            | 0.00<br>(0.00)                                     | 0.01**<br>(0.01)                                     | 0.05***<br>(0.02)                             |
| Log(employment)                                       | -0.03<br>(0.02)                                                               | 0.00<br>(0.00)                                     | 0.01*<br>(0.00)                                      | 0.03<br>(0.02)                                |
| Share of R&D employees                                | -0.71***<br>(0.06)                                                            | 0.01<br>(0.02)                                     | 0.15***<br>(0.02)                                    | 0.55***<br>(0.04)                             |
| Patent dummy                                          | -0.19**<br>(0.09)                                                             | 0.00<br>(0.01)                                     | 0.04**<br>(0.02)                                     | 0.15**<br>(0.07)                              |
| Internal finance dummy                                | 0.01<br>(0.03)                                                                | -0.00<br>(0.00)                                    | -0.00<br>(0.01)                                      | -0.01<br>(0.02)                               |
| External finance dummy                                | -0.00<br>(0.03)                                                               | -0.00<br>(0.00)                                    | -0.00<br>(0.01)                                      | 0.00<br>(0.02)                                |
| Years of industry experience                          | -0.00<br>(0.00)                                                               | -0.00<br>(0.00)                                    | -0.00<br>(0.00)                                      | -0.00<br>(0.00)                               |
| Restarter                                             | -0.01<br>(0.03)                                                               | 0.00<br>(0.00)                                     | 0.00<br>(0.01)                                       | 0.01<br>(0.03)                                |
| Leadership experience                                 | -0.01<br>(0.03)                                                               | 0.00<br>(0.00)                                     | 0.01<br>(0.01)                                       | 0.04<br>(0.03)                                |
| Number of founders                                    | -0.01<br>(0.02)                                                               | 0.00<br>(0.00)                                     | 0.00<br>(0.00)                                       | 0.01<br>(0.01)                                |
| Motive: implementation of a specific business<br>idea | -0.09***<br>(0.03)                                                            | 0.00<br>(0.00)                                     | 0.02***<br>(0.01)                                    | 0.07***<br>(0.02)                             |
| Motive: lack of suitable job                          | 0.04<br>(0.05)                                                                | -0.00<br>(0.00)                                    | -0.01<br>(0.01)                                      | -0.03<br>(0.04)                               |
| Motive: escaping unemployment                         | -0.04<br>(0.06)                                                               | -0.00<br>(0.00)                                    | 0.01<br>(0.01)                                       | 0.03<br>(0.04)                                |
| Motive: encouragement by past employer                | -0.05<br>(0.13)                                                               | -0.00<br>(0.00)                                    | 0.01<br>(0.03)                                       | 0.04<br>(0.09)                                |
| Motive: tax reasons                                   | 0.06<br>(0.13)                                                                | -0.00<br>(0.00)                                    | -0.01<br>(0.03)                                      | -0.05<br>(0.10)                               |
| #                                                     | 848                                                                           |                                                    |                                                      |                                               |

\*\*\* (\*\*, \*) indicate a significance level of 1% (5%, 10%)

Table 8: Ordered probit model for the matched sample, low-tech only – marginal effects

| Dependent variable<br>Category                     | Degree of novelty                                              |                                           |                                             |                                     |
|----------------------------------------------------|----------------------------------------------------------------|-------------------------------------------|---------------------------------------------|-------------------------------------|
|                                                    | Tested and commonly used combinations of existing technologies | New combinations of existing technologies | New technologies developed by third parties | New in-house developed technologies |
|                                                    | Marginal effect (s.e.)                                         | Marginal effect (s.e.)                    | Marginal effect (s.e.)                      | Marginal effect (s.e.)              |
| Crisis foundation                                  | 0.03<br>(0.06)                                                 | -0.00<br>(0.01)                           | -0.01<br>(0.01)                             | -0.02<br>(0.04)                     |
| Log(employment)                                    | -0.06<br>(0.04)                                                | 0.01<br>(0.00)                            | 0.01<br>(0.00)                              | 0.04<br>(0.03)                      |
| Share of R&D employees                             | -0.77***<br>(0.15)                                             | 0.07*<br>(0.04)                           | 0.15***<br>(0.04)                           | 0.54***<br>(0.10)                   |
| Patent dummy                                       | -0.07<br>(0.15)                                                | 0.00<br>(0.01)                            | 0.01<br>(0.03)                              | 0.05**<br>(0.10)                    |
| Internal finance dummy                             | 0.01<br>(0.06)                                                 | -0.00<br>(0.01)                           | -0.00<br>(0.01)                             | -0.01<br>(0.04)                     |
| External finance dummy                             | 0.04<br>(0.06)                                                 | -0.00<br>(0.01)                           | -0.01<br>(0.01)                             | -0.03<br>(0.04)                     |
| Years of industry experience                       | 0.00<br>(0.00)                                                 | -0.00<br>(0.00)                           | -0.00<br>(0.00)                             | -0.00<br>(0.00)                     |
| Restarter                                          | -0.08<br>(0.06)                                                | 0.01<br>(0.01)                            | 0.01<br>(0.01)                              | 0.06<br>(0.05)                      |
| Leadership experience                              | -0.07<br>(0.07)                                                | 0.01<br>(0.01)                            | 0.01<br>(0.01)                              | 0.05<br>(0.05)                      |
| Number of founders                                 | 0.00<br>(0.04)                                                 | -0.00<br>(0.00)                           | -0.00<br>(0.00)                             | -0.00<br>(0.03)                     |
| Motive: implementation of a specific business idea | -0.01<br>(0.06)                                                | 0.00<br>(0.01)                            | 0.00<br>(0.01)                              | 0.01<br>(0.04)                      |
| Motive: lack of suitable job                       | 0.12<br>(0.11)                                                 | -0.01<br>(0.01)                           | -0.02<br>(0.02)                             | -0.08<br>(0.08)                     |
| Motive: escaping unemployment                      | 0.11<br>(0.11)                                                 | -0.01<br>(0.01)                           | -0.02<br>(0.02)                             | -0.07<br>(0.08)                     |
| Motive: encouragement by past employer             | 0.31<br>(0.25)                                                 | -0.03<br>(0.03)                           | -0.06<br>(0.05)                             | -0.22<br>(0.18)                     |
| Motive: tax reasons                                | 0.29<br>(0.24)                                                 | -0.03<br>(0.03)                           | -0.06<br>(0.05)                             | -0.20<br>(0.17)                     |
| #                                                  | 258                                                            |                                           |                                             |                                     |

\*\*\* (\*\*, \*) indicate a significance level of 1% (5%, 10%)

The marginal effects for the degree of novelty regressions of products or services in Table 7 display similar results for high-tech industries compared to the full sample. In particular, we find that crisis startup foundations are less likely to develop products based on tested and

commonly used combinations of new technologies and more likely to develop products based on new in-house developed technologies. Again, this result support hypothesis 2b. The finding is in line the prospect theory argument that entrepreneurs are risk seeking during crisis times when they have little to lose, but a lot to win when pursuing risky projects with potentially abnormal returns.

Regarding ventures in low-tech sectors, Table 8 shows no significant differences between crisis startup foundations and pre-crisis startup foundations regarding the degree of novelty of products or services that have been launched. The small number of observations in low-tech could drive the insignificance of the results. However, it should be noticed that the marginal effects also show the opposite signs for low-tech compared to high-tech industries indicating a tendency for a lower degree of novelty of products and services introduced by crisis startup foundations in low-tech sectors.

## **6. Discussion**

The past economic crisis has severely affected most economies in terms of GDP declines and reductions in long-term investments such as R&D (OECD, 2012a). Nevertheless, recessions can bear opportunities for some entrepreneurs because an economic downturn can force inefficient industry incumbents to exit the market or shrink their business allowing for a reallocation of assets within the economy (Caballero and Hammour, 1994, 1999; Gomes et al., 1997; Hall, 1995). Eager to exploit the newly emerging opportunities, entrepreneurs can act as “agents of progress” in times of crisis, taking their chance to challenge the status quo starting a process of “creative destruction” (Schumpeter, 1942). Counteracting forces to such innovative entrepreneurship during recessions constitute financial constraints that hinder business activities and innovation in particular. In addition, weak labor markets can drive individuals into entrepreneurship in response to missing employment opportunities, the so-called necessity entrepreneurs.

Despite the often-cited importance of entrepreneurship and innovation for the advancement of economies, there is little research on the influence of the business cycle on entrepreneurship and innovation (Koellinger and Thurik, 2012). This paper addresses this gap in the literature providing novel insights into the discussion about the role of startup innovation during the past economic crisis. With focus on new ventures founded in Germany

before and during the past economic crisis, we present several interesting findings. First, we show that startups founded in low-tech sectors during the past economic downswing are not more or less likely to introduce new products and services to the market than startups that were founded before the crisis. This finding does not support the argument that crisis startup foundations in low-tech sectors represent mostly necessity entrepreneurship in response to weak job market conditions with little prospect of significant innovation. Conditionally on having succeeded at introducing a new product or service, the products and services of crisis startup foundations in low-tech industries do not exhibit significant differences regarding their degree of novelty. Again, this does not support the notion of necessity entrepreneurship during the past economic downturn.

Second, regarding high-tech sectors, we show that the likelihood to introduce a new product or service in the first years is significantly lower for crisis startup foundations. This result is likely to be explained by exacerbated financial constraints that affect new ventures in high-tech industries that aim at pursuing complex, costly and risky innovation disproportionately strong (Czarnitzki and Hottenrott, 2011; Giebel and Kraft, 2015; Hall, 1992).

In high-tech sectors, however, we find that crisis startup foundations' products and services are more novel in the sense that they are more likely to be based on in-house developed technologies rather than on the applications or combinations of well-tested existing technologies. Ventures started during the crisis in high-tech sectors are even less likely to introduce products that are based on commonly known and well-tested technologies than pre-crisis startup foundations. The strength of crisis startup foundations in introducing challenging innovations is remarkable given the financial constraints they face during a crisis. The finding is in line with behavioral arguments derived from prospect theory that propose that entrepreneurs are more willing to undertake risky and challenging projects when they have nothing to lose (Koellinger, 2008; Kahneman and Tversky 1979). The finding is also in line with the Schumpeterian notion of creative destruction triggered by new ventures (Schumpeter, 1942).

These results display a great heterogeneity among the crisis startup foundations in high-tech sectors. On the one hand, they are less likely to introduce new products or services, but on the other hand, contain some outstanding ventures that are able to commercialize new in-house developed technologies in economically difficult times. This finding is in line with Archibugi, Filippetti and Frenz (2013) who report that a few small companies and new

entrants swam against the stream and expanded their innovation expenses during the past economic crisis. The results are also in line with the notion of Koellinger and Thurik (2012) that entrepreneurship focused on technological innovation by recombining limited resources in a more efficient way can be an early indicator of an economy's recovery after a recession.

These are important insights for policy makers and investors that may or may not decide to support ventures founded during recessions. The majority of the German ventures founded in economic downswings do not represent necessity entrepreneurship and some do well deserve funding or resemble promising investment opportunities.

Our study is not free of limitations and raises a couple of research questions for future research. First of all, we do not address a potential survivor bias in our regressions. This means that our results have to be interpreted as conditional on venture survival. Given our sample of ventures that are maximum three years old, the concern is less strong since we only focus on very young companies. For future research, it would be very interesting to explore the effects of the crisis on venture survival and to investigate performance differences and innovation of ventures founded before and during the crisis in the longer term. Second, since the survey questions of interest are not available in all years of our database our sample is limited to three years. It would be very interesting to compare the effects of the recent financial crisis on the innovativeness of crisis startup foundations with the effects of earlier recessions. Third, this study does not investigate the financing structure of new ventures founded before and during the crisis and has to be seen as descriptive in this respect. Given the complexity of this topic, we leave these matters for future research.

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