MAGYAR TUDOMÁNYOS AKADÉMIA
Közgazdaság- és Regionális Tudományi Kutatóközpont

MTA KRTK KTI

Centre for Economic and Regional Studies
HUNGARIAN ACADEMY OF SCIENCES

MŰHELYTANULMÁNYOK DISCUSSION PAPERS

MT-DP – 2018/23

Related and unrelated diversification in crisis and in prosperity

KÁROLY MIKLÓS KISS, LÁSZLÓ LŐRINCZ,

ZSOLT CSÁFORDI, BALÁZS LENGYEL

INSTITUTE OF ECONOMICS, CENTRE FOR ECONOMIC AND REGIONAL STUDIES,
HUNGARIAN ACADEMY OF SCIENCES - BUDAPEST, 2018

Discussion papers
MT-DP – 2018/23

Institute of Economics, Centre for Economic and Regional Studies,
Hungarian Academy of Sciences

Related and unrelated diversification in crisis and in prosperity

Authors:

Károly Miklós Kiss
senior research fellow
Institute of Economics, Centre for Economic and Regional Studies,
Hungarian Academy of Sciences
and Pannon University of Veszprém
Corresponding author: kiss.karoly.miklos@krtk.mta.hu

László Lőrincz
research fellow
Institute of Economics, Centre for Economic and Regional Studies,
Hungarian Academy of Sciences
and Corvinus University of Budapest

Zsolt Csáfordi
PhD Student
Erasmus University Rotterdam

Balázs Lengyel
senior research fellow
Agglomeration and Social Networks Lendület Research Group
Institute of Economics, Centre for Economic and Regional Studies,
Hungarian Academy of Sciences
and International Business School Budapest

September 2018

Related and unrelated diversification in crisis and in prosperity

Károly Miklós Kiss[1,2,*], László Lőrincz[1,3], Zsolt Csáfordi[4], Balázs Lengyel[1,5,6]

[1] Centre for Economic and Regional Studies, Hungarian Academy of Sciences, Tóth Kálmán u. 4, 1097 Budapest

[2] Pannon University of Veszprém, Egyetem u. 10, 8200 Veszprém

[3] Corvinus University of Budapest, Fővám tér 8, 1093 Budapest

[4] Erasmus University Rotterdam, Burgemeester Oudlaan 50, 3062 PA Rotterdam

[5] Agglomeration and Social Networks Lendület Research Group, Hungarian Academy of Sciences, Tóth Kálmán u. 4, 1097 Budapest

[6] International Business School Budapest, Záhony u. 7, 1031 Budapest

[*] Corresponding author: kiss.karoly.miklos@krtk.mta.hu

Abstract

How does technological relatedness influence the portfolio of multi-product firms hit by external shocks? To answer this question, we look at the effect of product-specific demand shocks on product portfolios of Hungarian firms in the 2005-2012 period. We find that production have become more cohesive in terms of technological relatedness if firms were exposed to demand shocks. Evidence suggests that firms in crisis drop or downsize additional products not related to their core product and concentrate resources on related products.

JEL: C23, D22, D24, L25

Keywords: product diversification, technological relatedness, industry space network, dynamics of product portfolio, crisis

Acknowledgements:

The authors acknowledge financial support from the Hungarian Scientific Research Fund (OTKA- K 112330)

Kapcsolódó és nem kapcsolódó diverzifikáció válság és fellendülés időszakában

Kiss Károly Miklós, Lőrincz László, Csáfordi Zsolt, Lengyel Balázs

Összefoglaló

Hogyan befolyásolja válság időszakban a többtermékes vállatok termékdiverzifikációs döntéseit a termékek közti technológiai közelség? E kérdés megválaszolásához megvizsgáltuk a termékspecifikus keresleti sokk hatását a magyar vállalatok termékportfóliójára 2005–2012 között. Azt találjuk, hogy a vállalatok termékportfóliója a termékek technológiai közelsége szempontjából koherensebbé vált, amikor a vállalatokat keresleti sokk érte. Az empirikus eredmények azt mutatják, hogy a vállalatok válságidőszakban azon másodlagos termékek termelését állítják le, vagy csökkentik nagyobb valószínűséggel, amelyek technológiailag kevésbé kapcsolódnak a fő termékükhöz és erőforrásaikat inkább a technológiailag kapcsolódó termékekre koncentrálják.

JEL: C23, D22, D24, L25

Tárgyszavak: termékdiverzifikáció, technológiai közelség, terméktérhálózat, termékportfólió-dinamika, válság

1. INTRODUCTION

Multi-product firms are thought to exploit economies of scope by diversifying into technologically similar activities because firms are motivated to introduce new products that require relatively few extra investments (e.g. Penrose, 1959; Teece, 1982; Montgomery and Hariharan, 1991). Technological similarities are therefore of central concern in strategic decision of firms and also in a wide variety of distinct economics literature including firm expansion, international development and regional diversification (Penrose, 1959, Berry, 1975, Teece et al. 1994; Farjoun, 1994; Lien and Klein, 2009). A growing body of empirical evidence suggests that related diversification of firms is the rule of expanding production portfolio (Breschi et al. 2003, Bryce and Winter, 2009; Farjoun, 1994; Chang, 1996; Fan and Lang, 2000; Lien and Klein, 2010, Neffke and Henning 2013). Further, the same logic has been applied to explain the development of industries (Wolff and Nadiri, 1993, Schön, 2000, Neffke-Hidalgo-Otto-Weyh, 2013), countries (Porter, 1990, Hidalgo et al. 2007) and regions (Neffke et al. 2011; Boschma et al. 2013) by claiming that these units diversify easier to technologically related activities than to unrelated ones.

Behind the related diversification (technologically similar product portfolio) are mainly efficiency arguments. Several studies have shown that synergies and complementarities may arise between the production processes of products classified in different industries that firms can exploit by creating an appropriate product portfolio (Teece [1982], Baumol [1988], Arora and Gambardella [1990], Milgrom and Roberts [1990], Antonelli [1993], Desruelle et al. [1996], Anbarci et al. [2002]).

Nevertheless, there are also many multi-product firms that produce technologically non-similar products. Nathanson and Cassano (1982), for example, have found nearly the same number of firms with related and unrelated product portfolios. Unrelated diversification is usually associated with risk mitigation and other managerial motives. For countries and regions, unrelated structures of production portfolio have been mainly associated with resilience against industry-specific shocks (Frenken et al. 2007). Multi-product firms can adjust their product portfolio in a flexible way in case of increasing competition (Eckel and Neary 2010). However, it is still unclear how firms react to crises and adjust production portfolio when demand or financial resources drop while risk and uncertainties rise.

Our aim in this paper is to better understand how multi-product firms react to negative external shocks by altering production portfolio and how technological proximity between products influences this decision. We observe corporate decisions during crisis and prosperity times, which allows us to sharpen our understanding about firms' diversification

decisions in specific situations. It is not obvious how technological similarities influence strategic decisions regarding production portfolio in crisis times. On the one hand, decreasing resources and cost efficiency considerations might drive firms to reducing cost by narrowing product portfolios and focusing on combinations of technologically similar products, in which economies of scope and mutual capabilities can be exploited (Kitching et al, 2012, Askenazy et al, 2013). On the other hand, firms might diversify the product portfolio into non-similar directions in order to minimize business risk across different activities so that additional products have contrary risk position than the main product of the firm (Amihud and Lev, 1981; Galbraith at al, 1986; Robson et al, 1993). However this strategy can reduce the impacts of an industrial crisis rather than a general financial crisis (Frenken et al. 2007).

The 2008 financial crisis provides great opportunities to observe the above dynamics because firms can adjust production to decreasing demand and to increasing uncertainties by either narrowing or diversifying the product portfolio. We look at the dynamics of product portfolios of a sample of Hungarian firms that report production volume and sales value at the product level. Our data covers the 2005-2012 period; thus, we can inspect times of prosperity and crisis as well. We follow the revealed relatedness method developed by Neffke and Henning (2008) and generate a technological relatedness network of industries, in which the edge weight between sectors *a* and *b* is defined as the difference between the observed number of firms producing the core product in sector *a* and additional product in sector *b* compared to the expected values that are calculated from characteristics of sectors *a* and *b*.

The contribution of recent paper is new evidence on how technological relatedness influences firm behaviour during economic downturn. We propose that the crisis makes the cost efficiency concerns more important for firms than escaping uncertainty by investing into unrelated new products. Thus, firms are more likely to choose better exploitation of economies of scope instead of risk-sharing concerns or other managerial motives of firm expansion. Indeed, we find that firms in crisis are more likely to drop or downsize additional products not related to their main product and concentrate resources on related products. Consequently, production becomes more cohesive in terms of technological relatedness if firms are exposed to demand shocks.

The structure of the paper is as follows. In the following section we summarize the theoretical background of product diversification and firms' strategies in crisis, and we propose research questions and hypotheses. We introduce the structure of the data and present the methodology of the measurements and the empirical model in Section 3. The results are discussed in Section 4. The main conclusions are drawn in Section 5.

2. THEORETICAL BACKGROUND AND RESEARCH QUESTIONS

2.1. DRIVERS OF RELATED DIVERSIFICATION

A common classification of product diversification distinguishes between related diversification, when the firm expands into technologically similar product lines (Khemani and Shapiro, 1993), and unrelated diversification, when these similarities do not exist. The related diversification is basically explained by efficiency motivations. Synergies between production processes can increase efficiency and motivate firms to diversify into related businesses (Montgomery, 1985; St. John & Harrison, 1999; Zhou, 2011). Several studies suggest that related diversification is superior to unrelated diversification when the primary goal is to increase the efficiency, because synergies increase firm performance (Barney, 1991; Lubatkin and Chatterjee, 1994; Wan et al., 2011; Yang et al, 2014).

The resource-based argumentation highlights that multi-product firms make more efficient use of resources (Montgomery, 1994). The underlying idea appears already in Penrose's (1959) explanation for corporate growth: if firms have indivisible resources, which cannot be fully exploited in their original core business (excess capacity arises) and these resources can be utilized in other industries, it encourages companies to grow through diversification. The theoretical foundation of the underlying cost-efficiency arguments was laid by Baumol et al (1977), Panzar and Willig (1975, 1977, 1981) and Baumol (1988). They transposed the theory of cost advantages derived from economies of scale to multi-product firms and introduced the new concept of economies of scope. In the case of multi-product firms, the cost subadditivity that generates economies of scope means that a single firm can produce a given quantity combination of a certain range of products together more cheaply than producing the same quantities by separate firms, each specializing in the production of a single product. Consequently, the unit cost to produce a product will decline as the variety of products increases.

Panzar and Willig (1981) argue that the source of economies of scope is the sharing or joint utilization of inputs. On the one hand they can arise if a given input is imperfectly divisible and its utilization in producing a single product would leave excess capacity. On the other hand, certain resources, such as information, skills or knowledge do not deteriorate and can be utilized in production of other goods, that is, these resources have certain properties of public goods in the sense that if it is purchased for a particular production process, it is also available freely for other production processes. Indivisible resources (or not fully divisible) incur as fixed costs (or quasi-fixed costs) (Panzar and Willig, 1981; Baumol, 1988; Chavas and Kim, 2010). If these fixed costs are divided across various products in case of multi-product

firms, then they result in lower unit costs[1]. For example, the significant fixed costs of a network infrastructure in communications networks can be split across different services if a variety of services are provided simultaneously on the network (phone calls, data traffic, broadcasting…).

Teece (1982) emphasizes that the resource-based explanation of diversification always includes the presence of market transaction costs. If the product and capital markets worked perfectly, these efficiency aspects could not justify the appearance of multi-product firms. If there were no transaction costs, excess capacity of indivisible resources could be efficiently sold or leased in the market, thus the cost advantages behind the economies of scale and scope could be exploited in the same way for single-product firms through market transactions; i.e., "market arrangements and internal organization are perfect substitutes" (Teece, 1982 p.41.)

Weiss (2016) critically reflects upon the conceptualizations and measures of relatedness. He emphasizes that the common notion of equating relatedness with similarity is incomplete because it does not take into account the additional mechanism of resource complementarity (when the joint use of distinct resources produces a higher total return than the sum of returns of independent utilization of each resources). Yu et al (2015) show that acquiring firms search for primarily complementary resources rather than similar resources. Speckbacher et al (2014) argue that resource complementarity can result in added value during acquisitions, because combination and integration of the acquirer's resources with target firm's resources might increase the efficiency of resource utilization.

2.2. DRIVERS OF UNRELATED DIVERSIFICATION

Explanations of unrelated diversification can be classified into three major groups: risk reduction motives, motivations to increase market power and individual managerial motives[2].

Early studies (Lewellen 1971, Higgins and Schall 1975, Gallai and Masulis 1976) have shown that if capital markets are not efficient, there may be financial motives for unrelated firm expansion, that is, the product diversification can be an *element of risk reducing strategies*. The firms can allocate their activities among industries with opposite market risks to reduce the exposure of their core business. Amit and Livnat (1988) revealed that unrelated diversification is associated with more stable cash flows, lower operating risk and increased

[1] For multi-product firms, the average cost is measured by the ray average cost, which measures the average cost of a selected fixed ratio composition of all products.

[2] Firms with unrelated product or activity portfolio are also called conglomerates, thus the literature of conglomerates also provides useful insights into the drivers of unrelated diversification.

levels of leverage. Galbraith et al (1986) showed that in R&D-intensive industries the unrelated diversification is frequently used as a hedging strategy against the unforeseen technological shocks. But this also requires market failures and transaction costs in capital market, otherwise these risks can be reduced by capital market instruments (by allocating investments among various financial instruments). Indeed, Dundas and Richardson (1980) revealed that market failures in product and technological markets motivate the firms to diversify into related industries, whereas imperfections in capital markets rise the probability of unrelated diversification. Robson et al. (1993) observe a similar risk-sharing motive of diversification in small firms. They argue that diversification is often used by small firms as a risk-spreading survival strategy rather than a growth strategy. The authors find a negative relationship between diversification and growth in the case of small firms (with less than 30 employees). They conclude that small entrepreneurs do not have the necessary resources and skills to manage diversified activities and therefore diversification can more likely be considered a risk-sharing strategy in small firms, these entrepreneurs rather tend to diversify to compensate a decline in their original core business. Guzzini and Iacobucci (2012) revealed similar relationship analyzing empirically a representative sample of Italian business groups. They found a U shaped relation between size and unrelated diversification, that is, unrelated diversification was observed in a much larger proportion both in large firms and small firms. The authors argue, that small groups are more diversified than medium-sized groups as a result of poor performance in the initial business, accordingly, small firms use unrelated diversification as a survival, risk reducing strategy.

Other explanations of firm expansion attempt to justify the unrelated diversification by the ability to increase market power. *Market-power-based approaches* emphasize that the anti-competitive effects of the formation of large conglomerates can lead to an increase in market power (Edwards (1955), Gribbin (1976), Hill (1985), Bernheim and Whinston (1990)). Through cross-subsidization, for example, when the profit earned in one market allows maintaining predatory pricing in another market (Edwards, 1955). Or through the mutual forbearance, when big conglomerates compete with each other in multiple markets and recognizing this interdependence they mutually respect each other's dominant markets, competing less vigorously (Bernheim and Whinston, 1990).

Finally, explanations of other *individual managerial drivers* are about the agency problem arising from the separation of ownership and management. Shleifer and Vishny (1989) present that managers use strong corporate expansion as a tool to increase the firm's demand for their particular personal skills. Amihud and Lev (1981) argue that managers also use corporate expansion (unrelated conglomerate mergers) to reduce their employment risk. They exhibit that while corporate owners can reduce their risks by spreading their shares,

that is, by creating sufficient capital market portfolios, corporate executives can only reduce their employment risk by expanding the company's activities to diversified directions. Hence managers use diversified expansion as a means of reducing total firm risk and at the same time their employment risk and smoothing the earnings stream, which could lead to excessive diversification. Amihud and Lev (1981) revealed that manager-controlled firms are more diversified than owner-controlled firms and that the conglomerate type (i.e. unrelated) expansion is more frequent in case of manager-controlled firms than owner-controlled firms.

2.3. FIRMS' STRATEGIES IN CRISIS

For firms, economic crisis can mean three main challenges: (1) falling demand; (2) increasing technological and market uncertainty; (3) scarcity of financial resources both inside and outside the firm (Filippetti and Archibugi, 2011). One of the most frequent behavioural response of firms to falling expected profits, decreasing cash flow and lack of financial resources is cost cutting. Several studies demonstrate the spread of cost reducing retrenchment strategies both during previous recessions (Rones 1981, Churcill and Lewis, 1984, Geroski and Gregg's, 1997, Michael and Robbins, 1998, DeDee and Vorhies, 1998) and during the latest 2008/2009 economic crisis (Kwapil, 2010, Almor, 2011, Cowling et al. 2015).

Studying 600 large UK companies during the early 1990s recession, Geroski and Gregg (1997) show that most firms repositioned business activities and reduced operational costs by cutting labour costs and closing establishments as a response to the recession. They found that product portfolios were rarely changed, only a small number of companies has expanded or reduced product lines. Instead, firms rather tend to refocus business lines by rearranging production volumes.

Regarding the 2008/2009 crisis, Kwapil (2010) summarizes two surveys made at Austrian firms by the European Central Bank just before the recession (in 2007) and in the middle of the heaviest period of the crisis (in 2009). They analyse firms' reactions to the crisis with a primary focus on their labour adjustments. Results illustrate the dominance of cost-cutting strategies: 85 percent of firms reported that cutting costs is their most relevant measure in crisis situation. Similarly, Almor (2011) presents that the recession forces many Israeli firms to retrench by cost-cutting and downsizing. Cowling et al. (2015) show that 40 per cent of UK small- and medium-sized enterprises chose cost reduction during the recession.

Askenazy et al. (2013) argue that cost reduction is one of the most efficient measure to improve profitability and it significantly improves the firm's chance of getting out of the crisis, because cost reduction enables companies to dynamically rearrange resources. Cost

reducing retrenchment strategies might include cutting operating costs and divestment of non-core assets. These retrenchment strategies can consist of a wide range of cost reducing actions: divestment of assets, establishment closure, labour cost reduction (downsizing or working hours reductions), cutting expenditures of non-core activities such as R&D, marketing and employee training (Shama 1993, Geroski and Gregg 1997, Michael and Robbins 1998, DeDee and Vorhies 1998, Dallago and Guglielmetti, 2012).

Despite cost reduction is the most frequent strategy of firms in economic crisis, especially in the short term; some authors debate its' effectiveness. Chastain (1982), Deans et al. (2009) and Kitching et al. (2009) emphasize a trade-off between short run benefits of cost-cutting due to capacity reduction and long-run benefits of maintaining greater capacity. They argue that those firms that cut costs in order to survive in the short-run must face long-run opportunity costs of capacity reduction, because they might be unable to adapt adequately during economic recovery. Kitching et al (2009) distinguish an investment-based expanding strategy, as against the cost reducing adaptation to crisis. As they show, some firms perceive crisis periods as opportunities to invest, innovate and expand into new markets. However they also emphasize that not every firm are able to implement such investment-based expanding strategy, because it requires resources (financial and managerial resources). Resource-abundant firms are more likely to follow such a strategy, while firms with limited resources are less able to implement it. Firms hit harder by the crisis have limited resources and focus more on short-term survival, choosing cost-cutting strategies more likely. However several studies show (Whittington, 1989; Geroski and Gregg, 1994, 1997; Tushman and O'Reilly, 1996; He and Wong, 2004; Raisch and Birkinshaw 2008; Kitching et al., 2009) that many firms combine retrenchment strategies (through rational cost- and asset-cutting and more efficient exploitation of existing resources) and investment strategies (through exploring new market opportunities and potential product innovations). Whittington (1989) and Geroski and Gregg (1994, 1997) reveal that significant proportion of firms implemented a wide range of varying mixtures of cost-cutting, asset divestment, capacity expansion and product and market diversification in crisis times. However, these studies do not examine which areas where firms retreat and which areas where they expand in times of crisis.

Goto (1981) studied the product diversification of the 124 largest Japanese firms in the 1963-1975 period that covered three recessions in the Japanese economy (in 1965, 1971 and 1974). He found that the degree of diversification among large firms was rising during the examined period of time, especially to unrelated industries, and he also explored a significant relationship between business cycles and diversification. The findings suggest that diversification was slowed down during every crisis periods and accelerated during the recovery periods.

Kitching et al. (2009) argue that a crisis provides incentives for firms to re-examine their activity and product portfolios and refocus on the core business lines, as well as to increase efficiency by cost reduction and divestment of non-core assets. Connaughton and Madsen (2009) found that economic crises have uneven effect on industries, countries, regions and firms and induce – through the firms' strategic responses – structural economic change as resources are transferred between industries.

2.4. RESEARCH QUESTIONS AND HYPOTHESES

Our research questions address firm behavior during the crisis, focusing on product diversification. As we summarized above, firms' diversification can be driven by efficiency considerations, risk reduction purposes, efforts to increase market power and individual managerial motives. One important source of cost efficiency arise in multiproduct firms is economies of scope, which can be exploited by joint production of technologically related products. Consequently, the efficiency-based drivers – the needs for more efficient use of resources – always encourage related diversification, while in the case of non-efficiency driven corporate expansion (driven by risk reducing motives or individual managerial and market-power-based drivers), the technological proximity of the industries either is irrelevant aspect or they even encourage unrelated diversification.

The literature of firm strategies in crisis suggests that firms frequently choose cost reducing retrenchment strategies in crisis periods as a response to the falling demand and expected profit, decreasing cash flow and lack of financial resources. Accordingly, we can suppose that the crisis makes the cost efficiency concerns more important for firms. In the context of product diversification, this means that more firms will choose the better exploitation of economies of scope, whereas other drivers of diversification (risk-sharing concerns or other managerial motives of firm expansion) take second place. Based on this, we expect that the product and activity portfolio of firms will be better aligned with technological relatedness of products during crisis period.

For example, if we measure the average technological proximity between the products in the firms' product portfolio, then this average technological proximity will increase in a crisis period. Firms will first eliminate those secondary activities where they are less able to utilize common capabilities, i.e., where technological proximity is lower. Therefore those products that are technologically close to the core product of the firm are more likely to stay in the product portfolio than those products that are technologically far.

Berry (1971) highlights that the degree of corporate diversification is not only determined by how many products belonging to different industries are produced by the firm, but also by

the distribution of the firm's productive activity among those industries. As some studies discussed above explored, firms frequently tend to refocus their business lines by rearranging production volumes. That is, the diversification reaction of firms to the crisis can be not only the realignment of the range of products included in the portfolio (what to produce), but redistributing the production volume of existing products (how many of each to produce). We also assume that firms are more likely to reduce the production volume of those secondary products that are technologically far to their core product (where cost efficiency of joint production is less exploitable).

However, as we introduced above, there are firms which perceive crisis periods as opportunities to invest, innovate and expand their activities. It means that we also find firms that increase the production volume of certain products in recession by taking advantage of the weakness of competitors. We assume that there are different motivations behind increasing and reducing production. The reduction of production is basically motivated by cost-efficiency considerations, that is, the exploitation of cost advantages of joint production of related products. While behind the increase in production there are expanding strategies in which relatedness of products does not play a role.

We can summarize these assumptions in two hypotheses:

H1: During economic crisis, company portfolios become technologically more cohesive.

H2: Companies are more likely to drop or downsize those additional products that are not related to their core product.

3. METHODS AND DATA

3.1. DATA

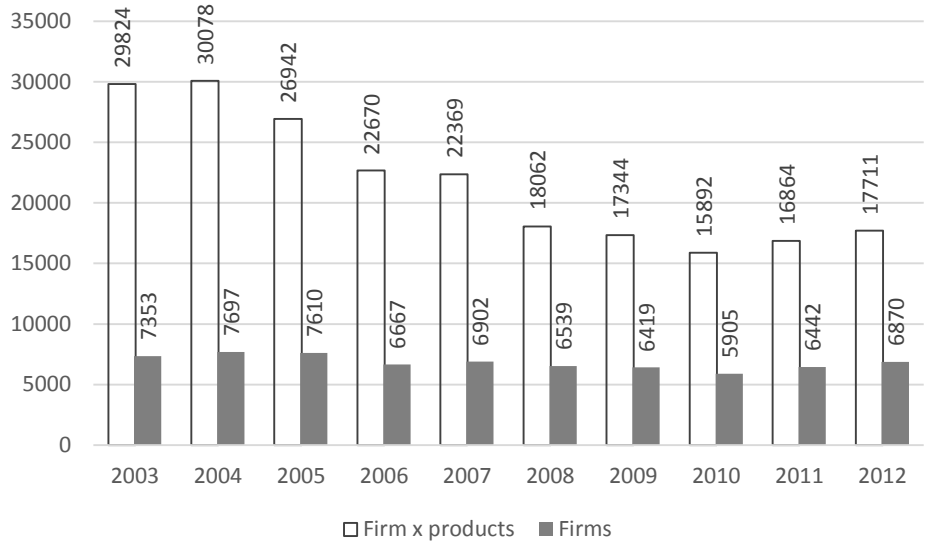
The empirical base for discovering the economic activities in firms, which belong to different industries is the PRODCOM database, which contains data of production volume of different products a firm produces. We use the Hungarian PRODCOM database for years 2003-2012, which was made available at the research room of the Central Statistical Office (CSO) of Hungary. It covers:

- all companies operating in the industrial sectors with more than 20 employees,
- a sample of industrial companies employing 5-19 workers, and
- all partnerships and companies with non-industrial primary activity, but having more than HUF 500 million (€ 1.65 million) sales revenue from industrial products a year and operating and industrial unit.

The database contains approximately 7000 firms, however, the number of reported products decreases over the examined period (Figure 1.), which may be an indication that firms have wound up some of their activities as a response to the crisis.

Figure 1.

Number of firms and products in the analysis



3.2. THE MEASUREMENT OF TECHNOLOGICAL PROXIMITY

To measure technological relatedness between *products*, we apply the revealed relatedness methodology developed by Neffke and Henning (2008). This method calculates relatedness measures between *industries*, and it is based on the assumption that two industries are technologically related; in case firms often produce the combination of products that belong to these industries.

Accordingly, in the first step of our data procession, we had to assign the *products* of the firms to *industries*. This was enabled using the PRODCOM classification for industrial activities. This classification (harmonized on the European Union level) specifies an 8-digit code for each product, of which the first 4 digits correspond to the NACE classification of industries.

Next, the core product of each company was identified. We define this as the product that the biggest part of the firm's total revenue stems from. We applied this definition on yearly bases; therefore it is possible that a firm changes its core product over time. Formalizing the

definition, let Y_{ipt} stand for the sales value of firm i from product p in year t, then for firm i across its products p, the firm's core product in year t is $c_{it} = p$, where $Y_{ipt} = \max_{it}(Y_{ipt})$.

Third, we defined the industry of the firms: each company the (4 digit) industry code was assigned, which corresponded in the PRODCOM classification to its core product.

Having this classification, we were able to calculate for each pairs of industries, how often firms produce products belonging to these jointly. A directed link from industry A to industry B was created, if a company's core product belonged to sector A, but also produced products, which belong to sector B according to the PRODCOM classification. By summing the links over the industries we got the co-occurrence network of industries, where each node corresponds to a (4 digit) industry, and each edge weight corresponds to the number of companies active in production in both industries.

As we discussed above, diversification into products are motivated not only by economies of scope and technological proximity. Other factors, such as high expected profits or industry size are important as well for firms decide to expand their activities to attractive industries. To control for other factors that influence the number of co-occurrence links Neffke and Henning (2008) predict the expected number of co-occurrences for each pair of industries using industry specific characteristics as predictors (e.g. profitability, sales volume, competition expectations, wage level etc.). Then the difference between the predicted and observed co-occurrences will reveal the relatedness between each industries concerned. As most of the potential pairs of industries do not occur along with each other in the same firm, i.e. there is a large number of zeros, Neffke and Henning (2008) suggest a zero-inflated negative binomial regression to estimate the level of co-occurrence. This regression technique first treats the dependent variable by a regime selection process, which determines the probability if the outcome is an excess zero. In the second step, the count data part of the model determines the count outcome in case it is not an excess zero, assuming negative binomial distribution. The model is formulated as follows:

$$E\left(L_{ij}\middle|v_i, w_j, \varepsilon_{ij}\right) = \left[1 - \Pi_0\left(\gamma + \delta_i v_i + \delta_j w_j\right)\right] e^{\alpha+\beta_i v_i+\beta_j w_j+\varepsilon_{ij}},$$

where L_{ij} is the number of actual co-occurrence links from industry i to j and v_i and w_j are the specific characteristics of industry i and j.

From the predicted values of the regression, we could get our revealed relatedness indicator:

$$\widehat{RR}_{ij} = \frac{L_{ij}^{obs}}{k\widehat{L_{ij}}},$$

where ^ indicates fitted value and k is a normalizing constant.

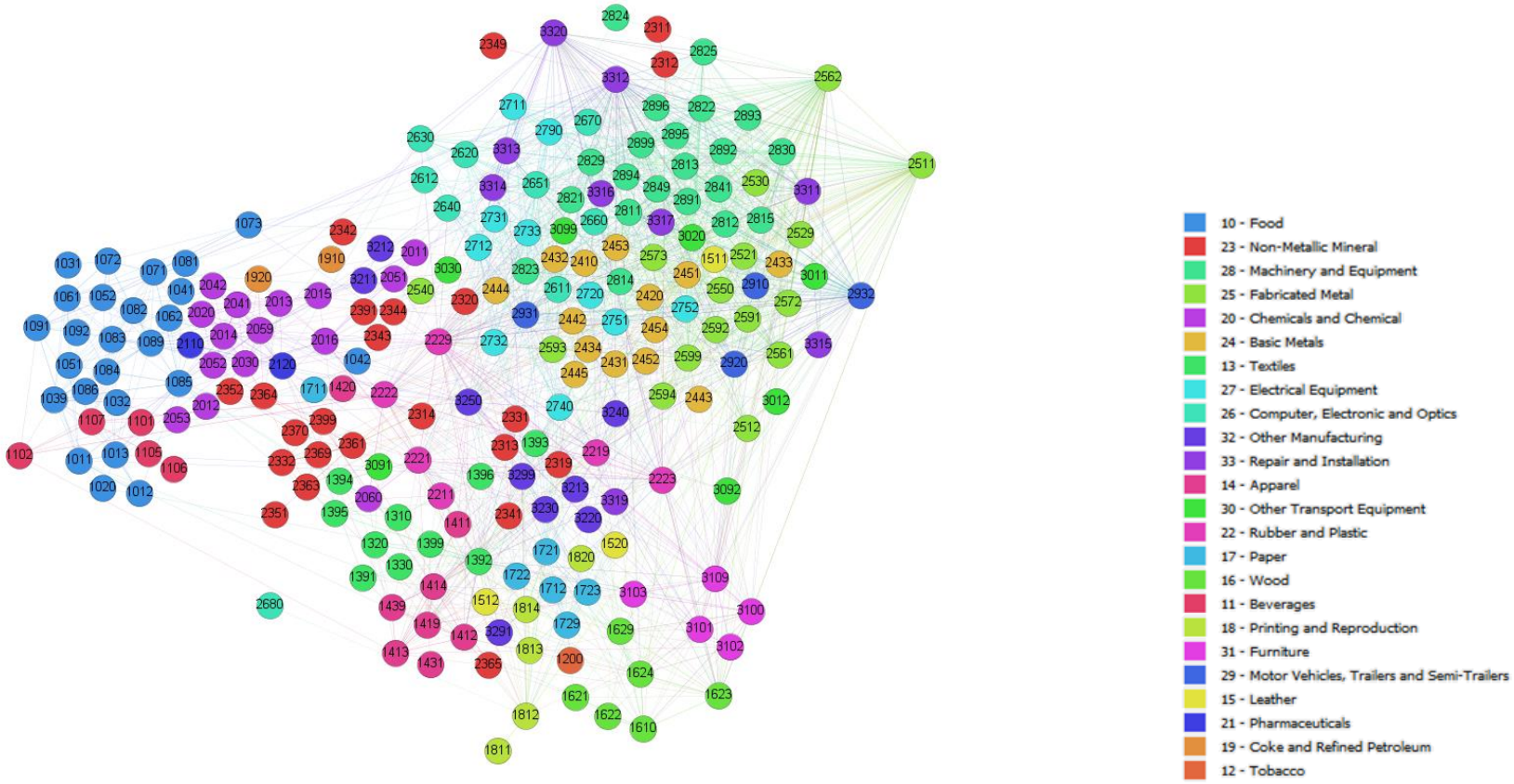
The matrix of *RR* indices can be visualized as technological proximity network of industries that one can use to explain firms' diversification behaviours and the dynamics of the product portfolio during crisis.

The Hungarian industry space network reveals that those NACE4 industries tend to cluster that are classified within same NACE 2 industries. For example, majority of subsectors in the food industry cluster together in the left corner of the network. Additionally, one might also find logic behind the relative position of industries in the network in two terms. First, there is a relatively more dense core of the network including machinery, basic metals etc; while there are less dense peripheries in the network including food, apparel, textiles, wood etc. industries. Second, those industries that one assumes to be similar by intuition (e.g. wood and furniture) are indeed neighbours.

Figure 2.

The industry space of Hungarian manufacturing sectors, 2003

Nodes depict manufacturing sectors according to NACE (Rev. 2) 4-digit level codes, edges represent the average revealed relatedness value for the period 2003-2012. Colour codes have been set according to NACE (Rev. 2) 2-digit industries. Position of the nodes is determined by the Force Atlas 2 algorithm of Gephi (Jacomy et al 2014)



3.3. MEASURING DIVERSIFICATION

We look at diversification of firm production portfolios and pay special attention to the technological relatedness between the firms' core product and additional products. We calculated Average Revealed Relatedness (AVRR) of firms' product portfolios as the simple arithmetic mean of relatedness between the firm's core product and all of additional products:

$$AVRR_{it} = \frac{\sum_{p \neq c} RR_{cp,t-1}}{N_{it}-1},$$

where c is the core product[3] of the firm i, $p \neq c$ represents its non-core products, N_{it} is the number of the firm's products in year t, (thus $N_{it} - 1$ is the number of its non-core products), and $RR_{cp,t-1}$ is the relatedness index between the industries of product p and c in the previous year. We used this lagged version to avoid endogeneity. As we infer relatedness from average product portfolio choices of firms, and use this relatedness to explain the decision of firms on product portfolio, without this lag we would mechanically introduce endogeneity to the model.

As a robustness checking we also use a weighted version of the average relatedness index. Weighted average relatedness (WAVRR) includes the sales value of each non-core product as weights, therefore, it also reflects redistribution of the sales value across the products, even when the product portfolio does not change:

$$WAVRR_{it} = \frac{\sum_{p \neq c} RR_{cp,t-1} Y_{ipt}}{\sum_{p \neq c} Y_{ipt}},$$

where Y_{ipt} is again the sales value of firm i from each product p, and $RR_{cp,t-1}$ is the relatedness index between the industries of product p and c in the previous year.

Descriptive statistics of our relatedness measures are displayed in Table 1. The *RR* and *AVRR* measures indicate that while the revealed relatedness between two randomly selected industries is rather low, but average relatedness of actual firms' portfolios is much higher. From the yearly averages it is visible that the relatedness of firm's product portfolio fluctuates around the crisis years: it decreases in 2007, then increases in the first crisis year, 2008, then decreases to low levels after the crisis (2009-2010), and turns back to the original levels to 2011-2012. These yearly tendencies are not sufficient to validate or falsify our hypothesis on firm's behaviour in crisis. Therefore, we need to examine the firms' exposure to crisis on a more detailed level.

[3] For simplicity from here on we omit the *it* indices from the notification of the core product and only refer to it a *c* instead of c_{it}.

Table 1.

Descriptives of the relatedness measures

Measure	mean	S.d.	N
RR_{ij}	0.0036	0.0351	60,939
$AVRR_{it}$	0.171	0.207	32,913
$WAVRR_{it}$	0.320	0.250	57,901

	$AVRR_{it}$		$WAVRR_{it}$	
Year	*mean*	*N*	*mean*	*N*
2004	0.187	4,484	0.357	7,249
2005	0.193	4,273	0.371	7,172
2006	0.192	3,680	0.365	6,266
2007	0.154	3,689	0.289	6,493
2008	0.186	3,535	0.341	6,270
2009	0.128	3,397	0.232	6,145
2010	0.113	3,104	0.203	5,593
2011	0.190	3,299	0.352	6,135
2012	0.184	3,452	0.341	6,578

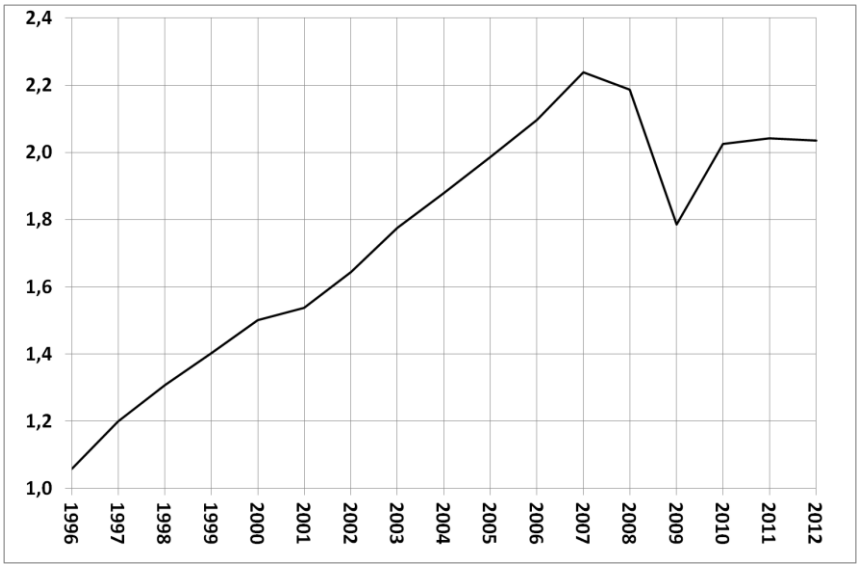
3.4. THE DEFINITION OF CRISIS

The financial crisis hit the Hungarian manufacturing sector significantly. After a constantly growing period of economic prosperity characterized by post-socialist transition and EU accession, the downturn was first observed in 2008, and a significant drop has happened to 2009. This fall was followed by a minor correction in 2010 and a stagnation period between 2010-2012 (Figure 1).

Figure 1.

Gross value added of the Hungarian manufacturing sector (1995=1)

Source of data: CSO Hungary



However, exposure to the crisis was different across industries and across products and therefore might have hit firms differently (Connaughton and Madsen, 2009).[4] Our analysis focuses on the effect of product-level demand-shocks on production portfolios, and thus we identified our crisis measure on the firm-product level. We classified a product being in crisis, if its production decreased over two subsequent years, or if its production dropped with more than 25% over a year. In order to avoid endogeneity, we disregarded the production of the examined firm, and calculated the production trend of a product produced by the firm by excluding the examined firm itself. Thus, our crisis measure on the firm-product level is:

$$\begin{cases} CR_{ipt} = 1 \; if \; \left(\dfrac{\sum_{i \neq i;p} Y_{ip,t}}{\sum_{i \neq i;p} Y_{ip,t-1}} < 1 \; and \; \dfrac{\sum_{i \neq i;p} Y_{ip,t-1}}{\sum_{i \neq i;p} Y_{ip,t-2}} < 1 \right), \\ CR_{ipt} = 1 \; if \; \dfrac{\sum_{i \neq i;j} Y_{ip,t}}{\sum_{i \neq i;j} Y_{ip,t-1}} < 0.75 \\ CR_{ipt} = 0 \; otherwise \end{cases},$$

where $Y_{ip,t}$ is the sales value of firm i from product p in year t.

[4] In Hungary production declined by 29% in the automotive industry from 2008 to 2009, but there was no significant decline in the pharmaceuticals industry (CSO Hungary: http://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_oia012a.html). On the more detailed levels even higher variation can be observed.

Using this definition, we could obtain firm-level measures of demand-shock; and distinguished whether the core product or any additional product of the firm was hit by crisis:

$$\begin{cases} CR_{it}^{core} = 1 \;\; if \; CR_{ict} = 1 \\ CR_{it}^{core} = 0 \;\; otherwise \end{cases},$$

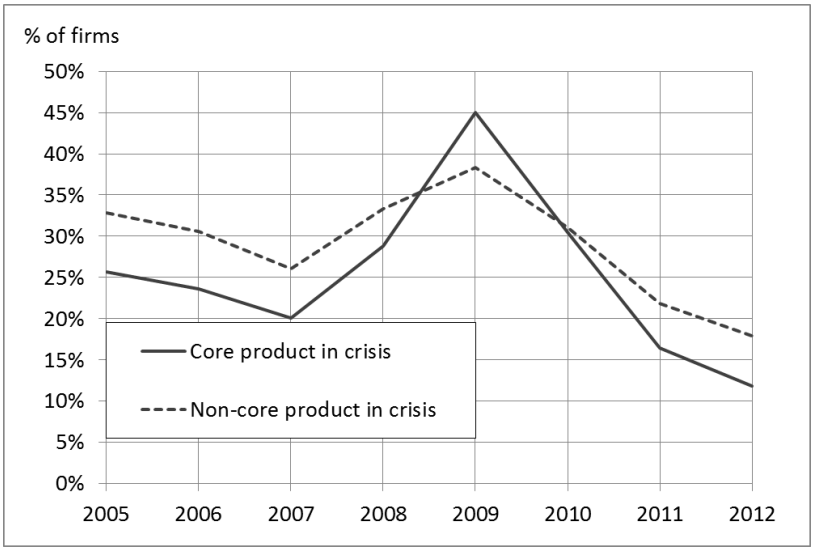
where c is the core product of firm i, and

$CR_{it}^{non-core} = \max_{p \neq c}(CR_{ipt})$.

The number of producing products in crisis is around 30% before the financial crisis and this ratio sharply increases in 2009 (Figure 2). One may recognize a minor peak also in 2005, which can be attributed to the industry transformation accompanying Hungary's joining the European Union.

Figure 2.

Exposure to the crisis across manufacturing firms



3.5. STATISTICAL METHODS

To analyse the impact of crisis on related diversification we apply two methods. In the first exercise, we look at how average relatedness in the product portfolio changes in firms when they have to face a crisis shock, and we compare this to changes during economic prosperity. In our second approach, we analyse how firms adjust their production volumes when they experience demand shocks and test whether technological relatedness affects this adjustment differently during crisis and in prosperity times.

In the first approach, panel regressions with firm-level fixed effects are used to analyse the relationship between exposure to crisis and the relatedness of the product portfolio. Our

dependent variables are the changes in the average relatedness indicators ($\frac{AVRR_{t+1}-AVRR_t}{AVRR_t}$ and $\frac{WAVRR_{t+1}-WAVRR_t}{WAVRR_t}$). The firm-level fixed effects enable us to exclude alternative explanations based on unobserved heterogeneity of firms (e.g. industries that exhibit more related diversification were also hit harder by the crisis), as we look at whether the firm increases or decreases diversification in the year following a crisis of its products by comparing AVRR to its previous values at the same firm. Our explanatory variables are the exposure of the core and non-core products of the firm to the crisis, and year dummies (*D*) accounting for yearly fluctuations. Thus the estimated equations are:

$$\frac{AVRR_{i,t+1} - AVRR_{i,t}}{AVRR_{i,t}} = \beta_0 + \beta_1 CR_{it}^{core} + \beta_2 CR_{it}^{non-core} + \boldsymbol{\beta_3 D} + \xi_i + \varepsilon_{it}$$

and

$$\frac{WAVRR_{i,t+1} - WAVRR_{i,t}}{WAVRR_{i,t}} = \beta_0 + \beta_1 CR_{it}^{core} + \beta_2 CR_{it}^{non-core} + \boldsymbol{\beta_3 D} + \xi_i + \varepsilon_{it}$$

In the second approach, our dependent variable is the change in the product-level revenues of firms. As a measure of relatedness, we used relatedness between the non-core products and the firm's core product, therefore we analysed only the trends of the additional, non-core products:

$$d_{i,p\neq c,t+1}^{Y} = \frac{Y_{ip,t+1} - Y_{ip,t}}{Y_{ip,t}}$$

Our key independent variable is the relatedness of the examined additional product to the core product of the firm. To smooth possible yearly fluctuations in measuring revealed relatedness, we used three year moving averages, and to avoid endogeneity, the moving averages for the three preceding years were included to the regressions.

As controls, we used the market trends: change of the sales of the each product across all firms except the observed ones both for the core and non-core products:

$$\text{Trend}_{i,p\neq c,\text{t}}^{non-core} = \frac{\sum_{i\neq i} Y_{ipt}}{\sum_{i\neq i} Y_{ip,t-1}}$$

$$Trend_{it}^{core} = \frac{\sum_{i\neq i} Y_{i,p=c,t}}{\sum_{i\neq i} Y_{i,p=c,t-1}}$$

We used separate regressions depending on the exposure of the examined product to crisis. We used fixed-effect panel regressions with firm - core product level fixed effects. We defined the fixed-effects on firm-core product levels, to compare the product volumes within

firms in only those years when they did not change their core products. Therefore we estimated the following equation:

$$d^{Y}_{ip\neq c,t+1} = \beta_0 + \beta_1 Avg^{t=-1}_{t=-3} RR_{cp} + \beta_2 Trend^{non-core}_{i,p\neq c,t} + \beta_3 Trend^{core}_{it} + +\boldsymbol{\beta_4 D} + \xi_{ic} + \varepsilon_{ipt}$$

Note that the units of analysis here are firm-products; therefore our identification comes from comparing products (with different relatedness to the core product) of the same firms in a year, and also from comparing these products within firms across the years.

4. RESULTS

Results indicate an increasing relatedness of the portfolio after a firm was exposed to crisis, either if it affected its core, or one of its additional products (Table 2.). The magnitude of this effect represents a half to one percentage increase of the average relatedness of the firm's product portfolios in the subsequent year, after their products were affected by crisis. However, the constant term indicates a general decreasing trend in the relatedness (increasing unrelated diversification) for firms not affected by the crisis at a comparable rate (half percent yearly), and average yearly fluctuations represent an approximately tenfold volume of this effect (-4 to +8 percentage). Interestingly, this yearly fluctuations indicate that relatedness of the product portfolios of the firms decreased the most in the year, when the crisis was the most severe (in 2009). Therefore one can speculate that for firms not affected by the crisis the crisis created an opportunity for unrelated diversification, while ones hit by the crisis concentrated more on their related products.

Table 2.

Change of the relatedness of firm's portfolios

	Avearage relatedness change	Weighted average relatedness change
Crisis of core product (previous year)	0.00550**	0.00446*
	(0.00220)	(0.00236)
Crisis of any additional products (previous year)	0.00994***	0.00822***
	(0.00221)	(0.00237)
year=2007	-0.0391***	-0.0424***
	(0.00284)	(0.00306)
year=2008	0.0317***	0.0317***
	(0.00300)	(0.00323)
year=2009	-0.0665***	-0.0702***
	(0.00307)	(0.00330)
year=2010	-0.0190***	-0.0210***
	(0.00318)	(0.00342)
year=2011	0.0774***	0.0827***
	(0.00313)	(0.00336)
year=2012	-0.00645**	-0.00698**
	(0.00315)	(0.00338)
Constant	-0.00647***	-0.00497*
	(0.00247)	(0.00265)
Observations	19,633	19,633
R-squared	0.286	0.285

Mean (s.e.) coefficient estimates of panel regressions with firm fixed effects. *p<0.1, **p<0.5, ***p<0.01

When analysing the change of the production volumes, results confirm that firms take into account the relatedness of the additional product to the core product, when they decide about their product portfolio. We have found a positive relationship between the technological relatedness of products and the change in output of non-core products (Table 3 Column 3). That is, the more related an additional product to the core product, the less the firm reduces (or the more it increases) its volume. It can also be seen from the coefficients of the first and second columns that this effect is really strong when the market for the non-core product is in crisis, that is, technological proximity between products becomes very important for firms during crisis. In a non-crisis period, relatedness of products is not significant.

However, the positive correlation described above may also mean that the volume of more related non-core products increases more or decreases less. We need to separate these

cases, because firms may behave differently in the two situations; we can assume that different considerations rule them when deciding on decreasing or increasing the volume of non-core products.

Table 3.

Adjustments of non-core products' volume by exposure to crisis

	Dependent variable: change of the revenue from a product compared to previous year		
	non-core product in crisis (1)	non-core product not in crisis (2)	together (3)
Relatedness of the product	0.393*	0.183	0.262**
	(0.234)	(0.187)	(0.119)
Trend of the product	0.0162*	0.00851	-0.0131
	(0.00932)	(0.0132)	(0.00948)
Trend of the core product	0.0391	0.0611***	0.0334**
	(0.0266)	(0.0210)	(0.0145)
Constant	0.129***	0.206***	0.139***
	(0.0436)	(0.0251)	(0.0185)
Observations	9,181	15,309	29,740
R-squared	0.343	0.289	0.203

Mean (s.e.) coefficient estimates of panel regressions with firm fixed effects. Additional controls: year dummies. *p<0.1, **p<0.5, ***p<0.01

Results of separate regressions differentiating those situations, when the firm decide to decrease the production from those, when they increase it are presented in Table 4. These indicate that the very difference in considering relatedness is between increasing and decreasing production volume. Firms tend to consider relatedness of their product portfolio when they decide about decreasing the volume: that is, if a product is more related to their core product, they reduce the production less, also in the cases, which we did not identify as crisis. On the other hand, when they increase the volume in non-crisis situations, relatedness is not significant (the sign of the coefficient is negative, which would indicate unrelated diversification). In the case, which we identified as crisis and increasing volume, the relatedness is again nonsignificant. Note, that this situation may also be labelled as one, when the examined firm is taking over the market: the examined firm increases sales, but the other firms' total sales decreases. We can conclude that when a firm increases the volume of a

non-core product in crisis, it does not driven by cost-efficiency that can be achieved by exploiting the technological proximity of products, but other motives.

Table 4.

Adjustments of non-core products' volume by non-core product's exposure to crisis (2)

Market situation:	non-core product in crisis		non-core product not in crisis	
Firm's reaction:	decreasing volume	increasing volume	decreasing volume	increasing volume
Relatedness of the product	0.217**	0.408	0.267***	-0.278
	(0.0992)	(0.405)	(0.0832)	(0.292)
Trend of the product	0.0274*	0.0102	0.00384	0.0142
	(0.0152)	(0.0151)	(0.00600)	(0.0210)
Trend of the core product	-0.00779	0.0435	0.00217	0.102***
	(0.0124)	(0.0466)	(0.00958)	(0.0340)
Constant	-0.439***	0.803***	-0.406***	0.743***
	(0.0200)	(0.0682)	(0.0139)	(0.0483)
Observations	4,849	4,332	7,763	7,546
R-squared	0.521	0.547	0.469	0.492

Mean (s.e.) coefficient estimates of panel regressions with firm fixed effects. Additional controls: year dummies. *p<0.1, **p<0.5, ***p<0.01

It is also necessary to see, how firms react, when the crisis affect their core product. In this examination, we also separated the cases when companies reduced or when they expanded the production volume of non-core products. When we examine their reaction by distinguishing the firm's decision to adjust the production of the non-core products downwards versus upwards (Table 5.), we see a very similar picture: relatedness considerations seem to be more important when deciding to decrease the volume.

Table 5.

Adjustments of non-core products' volume by core product's exposure to crisis

Market situation:	core product in crisis		core product not in crisis	
Firm's reaction:	decreasing volume	increasing volume	decreasing volume	increasing volume
Relatedness of the product	0.272***	0.427	0.214***	-0.236
	(0.104)	(0.427)	(0.0734)	(0.273)
Trend of the product	0.000471	-0.0395	0.00648	-0.0104
	(0.00843)	(0.0346)	(0.00545)	(0.0200)
Trend of the core product	-0.0291	0.157	-0.00583	0.0873**
	(0.0512)	(0.201)	(0.0104)	(0.0340)
Constant	-0.442***	0.740***	-0.392***	0.814***
	(0.0300)	(0.123)	(0.0112)	(0.0479)
Observations	3,947	3,475	8,632	8,330
R-squared	0.510	0.505	0.414	0.442

Mean (s.e.) coefficient estimates of panel regressions with firm fixed effects. Additional controls: year dummies. *p<0.1, **p<0.5, ***p<0.01

5. CONCLUSIONS

The recognized classification of the literature of product diversification distinguishes between related diversification, when the firm expands into technologically similar product lines, and unrelated diversification, when these similarities do not exist. Related diversification is explained by efficiency arguments, whereas unrelated diversification is justified with risk mitigation, individual managerial motives and market-power-based drivers. But we know little about dynamics of related and unrelated product diversification and only few empirical results are available.

In this paper, we examine how technological proximity of products affects the product diversification decision of multi-product firms in crisis and non crisis period. An economic crisis provides great opportunities to observe the dynamics of firm diversification, because firms can adjust production to decreasing demand and to increasing uncertainties by either narrowing or diversifying the product portfolio.

This paper provides new evidence on how technological relatedness influences firms' decisions on product portfolio during crisis and recovery, thereby contributing to a better understanding both of firm level product diversification decisions and corporate behavior in crisis.

To analyse the impact of crisis on product diversification of firms we apply two methods. In the first exercise, we look at how average relatedness in the product portfolio changes in firms when they face a crisis shock, and we compare this to changes during economic prosperity. In our second approach, we analyse how firms adjust their production volumes when they experience demand shocks and test whether technological relatedness affects this adjustment differently during crisis and in prosperity times.

Results of the first method indicate an increasing relatedness of the portfolio after a firm was exposed to crisis, either if it affected its core, or one of its additional products. Similarly, in analysis of production volume change, results confirm that firms take into account the relatedness of the additional product to the core product, when they decide about their product portfolio. We have found a positive relationship between the technological relatedness of products and the change in output of non-core products. That is, the more related an additional product to the core product, the less the firm reduces its volume during economic downturn. This effect proved to be stronger when the market for the non-core product is in crisis, that is, technological proximity between products becomes very important for firms during crisis.

We found evidence that the crisis makes the cost efficiency concerns more important for firms than risk-sharing concerns or individual managerial motives of unrelated firm expansion. We find that firms in crisis are more likely to drop or downsize additional products not related to their main product and concentrate resources on related products. Consequently, production becomes more cohesive in terms of technological relatedness if firms are exposed to demand shocks.

In addition, our results also indicate a general decreasing trend in the relatedness (increasing unrelated diversification) for firms not affected by the crisis. The relatedness of the product portfolios of the firms was also significantly decreased in 2009, when the crisis was the most severe. This result suggests that the crisis created an opportunity for unrelated diversification for firms not affected by the crisis, while ones hit by the crisis concentrated more on their related products. These results are consistent with previous finding of literature of firms'crisis strategies. Kitching et al (2009) argue that some firms perceive crisis periods as opportunities to expand into new markets. However they also emphasize that not every firm are able to implement such expanding strategy during crisis, because it requires resources. Firms hit hard by the crisis have limited resources and focus rather on short-term survival, choosing cost-cutting strategies more likely. We found empirical evidence for these strategies.

REFERENCES

Almor, Tamar (2011) Dancing as fast as they can: Israeli high-tech firms and the Great Recession of 2008. Thunderbird international business review, Vol.53 (2), March/April 2011, P. 195-208.

Amihud, Yakov and Lev, Baruch [1981]: Risk Reduction as a Managerial Motive for Conglomerate Mergers. Bell Journal of Economics, 1981, vol. 12, issue 2, 605-617.

Amit R. and Livnat J.: Diversification strategies, business cycles and economic performance. Strategic Management Journal. Vol. 9, No. 2 (1988), pp. 99-110

Askenazy P, Bozio A and García-Peñalosa C (2013) "Wage dynamics in times of crisis", Les Notes du Conseil d'Analyse Économique, No. 5, April.

Barney, J. B. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99-120.

Baumol, William J. 1988. Contestable markets and the theory of industry structure. Harcourt College Pub.

Baumol, W. J., Bailey, E. E. and Willig R.D. (1977): Weak Invisible Hand Theorems on the Sustainability of Multiproduct Natural Monopoly, in: The American Economic Review, Vol. 67, No. 3, pp. 350-365.

Bernheim, B. Douglas, and Michael D. Whinston, "Multimarket Contact and Collusive Behavior," RAND Journal of Economics, Spring 1990, 21, 1–26.

Berry C. H. 1975. *Corporate Growth and Diversification*, Princeton, NJ: Princeton University Press

Beveren, Ilke Van, Andrew B. Bernard, and Hylke Vandenbussche. 2012. *Concording EU Trade and Production Data over Time*. Working Paper 18604. National Bureau of Economic Research. http://www.nber.org/papers/w18604.

Boschma R. 2005. Proximity and innovation: a critical assessment. *Regional Studies*, 39 (1), 61-74.

Boschma R., Minondo A., Navarro M. 2013. The emergence of new industries at the regional level in Spain. A proximity approach based on product-relatedness, *Economic Geography*, 89 (1), 29-51.

Bryce D.J, Winter S.G. 2009. A general inter-industry relatedness index. *Management Science* 55: 1570–1585.

Breschi S.; Lissoni F. and Malerba F. 2003. Knowledge-relatedness in firm technological diversification, *Research Policy*, 32, 69-87.

Chang S.J. 1996. An evolutionary perspective on diversification and corporate restructuring: entry, exit, and economic performance 1981-89. Strategic *Management Journal* 17:587-611.

Chang S.J, Singh H. 1999. The impact of modes of entry and resource fit on modes of exit by multibusiness firms. *StrategicManagement Journal* 20: 1019-1035.

Chastain, C. (1982) 'Strategic Planning and the Recession', Business Horizons, 25, 6, 39-44.

Chavas, Jean-Paul, Kwansoo Kim. 2010. „Economies of diversification: A generalization and decomposition of economies of scope". International Journal of Production Economics 126 (2): 229–235.

Churchill, N. and Lewis, V. (1984) 'Lessons for small business from the recession', Journal of Small Business Management, 22, 2, 5-17.

Connaughton, J. and Madsen, R. (2009) 'Regional Implications of the 2001 Recession', Annals of Regional Science, 43, 2, 491-507.

Cowling, M., Liu, W., Ledger, A., Zhang, N. (2015) What really happens to small and medium-sized enterprises in a global economic recession? UK evidence on sales and job dynamics. International Small Business Journal 33 (5), 488-513.

Dallago, Bruno and Guglielmetti, Chiara (2012) The consequences of the international crisis for European SMEs : vulnerability and resilience. Routledge, 2012

Deans, G., Kansal, C. & Mehltretter, S. (2009). Making a Key Decision in a Downturn: Go on the Offensive of be Defensive? Ivey Business Journal Online, Jan/Feb.

Dedee, J. and Vorhies, D. (1998) 'Retrenchment Activities of Small Firms During Economic Downturn: An Empirical Investigation', Journal of Small Business Management, 36, 3, 46-61.

Dundas, K. M. and P. R. Richardson. 'Corporate strategy and the concept of market failure', Strategic Management Journal, 1, 1980, pp. 177-188.

Eckel C., Neary J.P. (2010) Multi-product firms and flexible manufacturing in the global economy. *The Review of Economic Studies* 77: 188-217.

Edwards, Corwin D., "Conglomerate Bigness as a Source of Power," Business Concentration and Price Policy (Princeton, N.J.: Princeton University Press, 1955), pp. 331–352

Engelsman E.C, Van Raan A.F.J. 1991. Mapping of Technology, A First Exploration of Knowledge Diffusion Amongst Fields of Technology. Policy Studies on Technology and Economy (BTE) Series, The Hague

Farjoun M. 1994. Beyond Industry Boundaries: Human Expertise, Diversification and Resource-Related Industry Groups. *Organization science* 5(2): 185-199.

Farjoun M. 1998. The independent and join effects of the skill and physical bases of relatedness in diversification. *Strategic Management Journal* 19(7): 611-630.

Fan J.P.H, Lang L.H.P. 2000. The Measurement of Relatedness: An application to Corporate Diversification. *Journal of Business* 73(4): 629-660.

Filippetti, A., Archibugi, D. (2011). Innovation in times of crises: National systems of innovation, structure, and demand. Research Policy, 40, 179–192.

Frenken, K., Van Oort, F.G., Verburg, T. 2007. Related variety, unrelated variety and regional economic growth. *Regional Studies*, 41(5), 685–697.

Galai, D. – Masulis, R. (1976): The Option Pricing Model and The Risk Factor of Stock Journal of Financial Economics (3) 53-81.

Galbraith, C., B. Samuelson, C. Stiles and G. Merrill. 'Diversification, industry research and development and performance', Academy of Management Proceedings, 1986, pp. 17-20.

Geroski, P.A. and Gregg, P. (1994) 'Corporate Restructuring in the UK during the Recession', Business Strategy Review, 5, 2, 1-19.

Geroski, P.A. and Gregg, P. (1997) Coping with Recession: UK Company Performance in Adversity, Cambridge University Press, Cambridge.

Goto, Akira, 1981. "Statistical Evidence on the Diversification of Japanese Large Firms," Journal of Industrial Economics, Wiley Blackwell, vol. 29(3), 271-278.

Greene W.H. 1994. Accounting for Excess Zeros and Sample Selection in Poisson and Negative Binomial Regression Models. *NYU Working Paper No. EC-94-10*

Gribbin, J. D., "The Conglomerate Merger," Applied Economics, March 1976, 8, 19–35.

Guzzini, Enrico and Iacobucci, Donato (2012) Firm size and unrelated diversification. An empirical test on the 'survivalist hypothesis'. Inter-University Centre for Applied Economic Studies on Industrial Policy, Local Development and Internationalization, c.MET Working paper 7/2012.

He, Z.-L., P.-K. Wong. 2004. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. Organization Science, 15(4), 481–494.

Hidalgo, C. A.; Klinger, B.; Barabási, A.-L.; Hausmann, R. (2007). The product space conditions the development of nations, *Science*, 317, 482-487.

Higgins, R. C. and Schall, L. D.: Corporate Bankruptcy and Conglomerate Merger. The Journal of Finance, Vol. 30, No. 1 (Mar., 1975), pp. 93-113

Hill, Charles W. L., "Diversified Growth and Competition: The Experience of Twelve Large UK Firms," Applied Economics, October 1985, 17, 827–47.

Jackson, M.O. 2010. *Social and economic networks*. Princeton University Press.

Khemani, R. S. and Shapiro, D. M. (ed) (1993): Glossary of Industrial Organisation Economics and Competition Law, commissioned by the Directorate for Financial, Fiscal and Enterprise Affairs, OECD, 1993. http://www.oecd.org/dataoecd/8/61/2376087.pdf

Kitching, J. & Blackburn R. & Smallbone .D & Dixon S. (2009, October) Business Strategies And Performance During Difficult Economic Conditions. URN 09/1031, London, Kingston University and Bath University. 2009. Available online: http://eprints.kingston.ac.uk/5852/1/Kitching-J-5852.pdf [Accessed: June 7, 2018]

Kwapil, Claudia (2010) Firms' reactions to the crisis and their consequences for the labour market – Results of a company survey conducted in austria. Eurepean Central Bank, Working Paper Series No 1274 / December 2010

Lewellen, W. G.: A Pure Financial Rationale for the Conglomerate Merger. The Journal of Finance, Vol. 26 (2), (May, 1971), pp. 521-537

Lien B.L, Klein P.G. 2009. Using competition to measure relatedness. *Journal of Management* 35(4): 1078-1107.

Lubatkin, M., & Chatterjee, S. (1994). Extending modern portfolio theory into the domain of corporate diversification: Does it apply? Academy of Management Journal, 37(1), 109-136.

Michael S. and Robbins D. (1998) 'Retrenchment among Small Manufacturing Firms during Recession', Journal of Small Business Management 36, 3, 35-45.

Montgomery, C. A. (1985). Product-market diversification and market power. Academy of Management Journal, 28(4), 789-798.

Montgomery, C.A, Hariharan, S. 1991. Diversified expansion by large established firms. *Journal of Economic Behavior and Organization* 15: 71-89.

Montgomery, C. A. 1994. Corporate Diversification. The Journal of Economic Perspectives, Vol. 8, No. 3, pp. 163-178

Nathanson D A, Cassano J S (1982): Organisation, diversity and performance. Wharton Magazine 61, 19-26.

Neffke, F., Henning, M. (2008) Revealed relatedness: mapping industry space. Papers in Evolutionary Economic Geography, Utrecht University.

Neffke F, Henning M, Boschma R. 2011. How do regions diversify over time? Industry relatedness and the development of new growth paths in regions, *Economic Geography*, 87 (3): 237-265.

Neffke F, Henning M, Boschma R. 2011. The impact of ageing and technological relatedness on agglomeration externalities: a survival analysis. *Journal of Economic Geography*, 12(2): 485-517.

Neffke F, Henning M. 2013. Skill-relatedness and firm diversification. *Strategic Management Journal*, 34(3): 297-316

Neffke F, Hidalgo C, Otto A, Weyh A. 2013. Inter-industry labor flows. Mimeo.

Panzar, John C., Robert D. Willig. [1975] Economics of Scale and Economies of Scope in Multi-Output Production. Bell Laboratories discussion paper 33.

Panzar, John C., Robert D. Willig. [1977] Economies of Scale in Multi-Output Production. Quarterly Journal of Economics 91(3):481-93 · August 1977

Panzar, John C., Robert D. Willig. 1981. „Economies of scope". The American Economic Review 71 (2): 268–272.

Penrose E.T. 1959. *The Theory of the Growth of the Firm*. Blackwell: Oxford

Porter M. 1990. *The Competitive Advantage of Nations*. London, Macmillan

Raisch, S. and Birkinshaw, J. (2008) 'Organisational Ambidexterity: Antecedents, Outcomes, and Moderators', Journal of Management, 34, 3, 375-409.

Robson, G., Gallagher, C., Daly, M., 1993. Diversification strategy and practice in small firms. Int. Small Bus. J. 11, 37–53.

Rones, P. (1981) 'Response to Recession: Reduce Hours or Jobs?', Monthly Labor Review, October, 3-11.

Shama, A., 1993. Marketing strategies during recession: a comparison of small and large firms. Journal of Small Business Management, 31, 62-73.

Schön L. 2000. Electricity, technological change and productivity in Swedish industry, 1890-1990. *Europian Review of Economic History*, 4, 175-194.

Shleifer, Andrei, and Robert W. Vishny, "Management Entrenchment: The Case of Manager-Specific Investments," Journal of Financial Economics, November 1989, 25, 123–39.

Speckbacher, G., Neumann, K., & Hoffmann, W. H. (2014). Resource relatedness and the mode of entry into new businesses: Internal resource accumulation vs. access by collaborative arrangement. Strategic Management Journal, 36(11), 1675-1687.

St. John, C. H., & Harrison, J. S. (1999). Manufacturing-based relatedness, synergy, and coordination. Strategic Management Journal, 20(2), 129-145.

Teece DJ. 1982. Towards an economic theory of the multiproduct firm. *Journal of Economic Behavior and Organization* 3: 39–63.

Teece D. J.; Rumelt, R.; Dosi, G. and Winter, S. 1994. Understanding corporate coherence: Theory and Evidence, *Journal of Economic Behaviour and Organization*, 23, 1-30.

Tushman, M. L. and O'Reilly, C. A. (1996) 'Ambidextrous Organisations: Managing Evolutionary and Revolutionary Change', California Management Review, 38, 4, 8-30.

Wan, W. P., Hoskisson, R. E., Short, J. C., & Yiu, D. W. (2011). Resource-based theory and corporate diversification: Accomplishments and opportunities. Journal of Management, 37(5), 1335-1368.

Weiss, M. (2016), Related Diversification: A Critical Reflection of Relatedness and the Diversification-Performance Linkage. in Sydney Finkelstein , Cary L. Cooper (ed.) Advances in Mergers and Acquisitions (Advances in Mergers and Acquisitions, Volume 15) Emerald Group Publishing Limited, 161 – 180.

Whittington, R. (1989) Corporate Strategies in Recession and Recovery: Social Structure and Strategic Choice, Unwin Hyman, London

Wolff E.N. and Nadiri I.M. 1993. Spillover effects, linkage structure, and research and development. Structural Change and Economic Dynamics, vol. 4, no. 2, 315-331.

Yang, Y., Narayanan, V. K., & De Carolis, D. M. (2014). The relationship between portfolio diversification and firm value: The evidence from corporate venture capital activity. Strategic Management Journal, 35(13), 1993-2011.

Yu, Y., Umashankar, N., & Rao, V. R. (2015). Choosing the right target: Relative preferences for resource similarity and complementarity in acquisition choice. Strategic Management Journal, 37(8), 1808-1825.

Zhou, Y. M. (2011). Synergy, coordination costs, and diversification choices. Strategic Management Journal, 32(6), 624-639.