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Related trade linkages, foreign firms, and employment growth in less developed regions

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Abstract: How does international trade of foreign-owned companies contribute to regional economic growth in less developed regions? Are there knowledge externalities at play between co-located trade activities of foreign and domestic firms? We address the above questions by analysing the impact of technological relatedness of regional import and export activities in manufacturing, performed by foreign and domestic companies on regional employment growth in Hungary between 2000 and 2012. Results suggest that the related variety of export activities and the relatedness between import and export products benefits regional employment growth in general, while the host economy benefits more from the technological relatedness of domestic firms' trade activities, rather than relatedness to or between foreign firms' activities. Employment of domestic firms benefits from the trade activity of co-located foreign firms only if it is in the same product class.

Keywords: related trade variety, trade similarity, foreign-owned and domestic firms, regional employment growth

JEL codes: B52, O30, R11, R12

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INTRODUCTION

International trade has long been considered a decisive underlying mechanism in regional development because export is a major source of income for regions, which can be multiplied by internal input-output relations (North 1955), and also because the level of success in international trade is linked to the cumulative emergence of agglomeration economies in the region (Krugman 1991). The intensification of globalization gave rise to empirical explorations on this matter (for an overview see Brülhart 1998), and also brought the role of foreign-owned firms in regional development into the focus of interest (Beugelsdijk et al. 2010, Dicken 1994, Iammarino – McCann 2013, Young et al. 1994). This is because multinational firms are more active than other firms in the global division of labour (Greeneway – Keller 2007), because spillovers from foreign firms increase the productivity of domestic companies (Haskel et al. 2007), and also decrease the entry cost for other potential exporters (Aitken et al. 1997). However, the effect of foreign firms in less developed regions is far from being clear since local economies might differ in the ways in which they can exploit the presence of foreign firms through production links and spillovers (Görg – Greeneway 2003, Phelps 2008, Soci 2003).

The recently emerging literature of evolutionary economic geography stresses the role played by technological relatedness in local knowledge spillovers (Frenken et al. 2007), because co-located firms might learn from each other if their technological profile is not too different, but cannot benefit much from learning if their knowledge bases are identical (Boschma 2005). It has been shown that related variety – *i.e.* the diversity of economic activities that are technologically related – benefits economic growth at the regional level (Frenken et al. 2007). Another influential research showed that the technological relatedness of export products of a country determines the development of said country because export portfolios are more likely to be diversified into new products that are related to the existing products (Hidalgo et al. 2007). Based on these arguments Boschma and Iammarino (2009) established an empirical framework for analysing the role of relatedness between import and export profiles in regional economic growth. They argue that technological relatedness matters for growth, because import can be considered as knowledge inflow into the region. This external knowledge may create new growth potentials if it is related but is not identical to existing productive knowledge of the region, captured by its export portfolio. Additionally, one can argue that if regions are the units of production, imports are inputs and exports are the outputs, then combining related rather than similar products yields more complex products, representing more value-added, leading to higher economic growth.

We wish to contribute to the above discussion in three ways. First, we offer evidence on the effect of related variety in trade activities from a less developed economy, as empirical results so far predominantly focused on regions of more developed economies. We find this important because less developed economies are much more dependent on the international value chains of foreign-owned firms, and knowledge spillovers from these firms to the host economy through relatedness may be even more crucial for regional development. Second, we aim to show that relatedness between import and export has stronger positive effect on regional employment growth as it was proposed by Boschma and Iammarino (2009) in the case of Italy. Indeed, we find a strongly significant effect, which suggests that relatedness between import and export is a crucial point for less developed regions depending on external knowledge sources. Third, to our knowledge no previous work offered evidence on the relationship between regional growth and the technological relatedness of trade activities performed by foreign firms and the host economy. For this purpose we offer a new way of measuring the relatedness between trade activities of foreign and domestic firms based on Boschma and Iammarino’s (2009) work. Thus, the following research questions will be addressed:

(1) Do knowledge spillovers across export activities affect employment growth in less developed regions?
(2) Do knowledge externalities between import and export activities affect regional growth?
(3) How do foreign firms affect regional growth through trade-mediated knowledge spillovers to domestic firms in less developed regions?

In order to answer these questions, we rely on a panel dataset of Hungarian exporter firms containing balance sheet variables, firm location, and the value of export and import products by SITC product codes for the period between 2000 and 2012. We argue that the Hungarian case is suitable to discuss the above issues because the country has a small and open economy, which means that most of the inputs has to be imported, and also because the economy is dominated by a small set of foreign-owned firms.

In the following section we describe the economic context of Hungarian import and export activities and the historically formed duality of foreign- and domestic-owned companies and formulate our hypotheses. Next we elaborate on our research design by describing the quantitative approach and explaining our key variables. We report our key findings in the results section, and finish the paper by offering conclusions.

CONTEXT AND HYPOTHESES

In order to answer our research questions, we first elaborate on the related variety literature recently developed in the field of evolutionary economic geography. Scholars have previously argued that firms of a region benefit from various positive externalities like localization economies (Marshall 1920), urbanization economies (McCann 2008), and Jacobs-externalities (Jacobs 1960). The relative importance of these externalities in regional growth is debated to this day (Beaudry – Schiffaeurova 2009, Glaeser et al. 1992, Henderson et al. 1995). In their influential paper Frenken et al. (2007) proposed that it is not specialization (spillovers within industries), nor the variety (spillovers between industries) of economic activities *per se* what matters for growth, but the extent of *related variety* in a region. Related variety in a region is composed of industries that are not too close in their technological knowledge base, so that they can learn from each other, but not too far either, so that they are able to understand each other (Boschma 2005). The variety of industries too dissimilar in their knowledge base so as to learn effectively from one another is then considered unrelated variety. Following Frenken et al. (2007) related variety is expected to increase employment in the region due to knowledge spillovers across technologically related industries and thus the improved innovation potential. Empirical evidence so far systematically shows that related variety is beneficial for regional employment growth in particular (Frenken et al. 2007, Boschma – Iammarino 2009, Boschma et al. 2012), and that these benefits are not equally available to all industries (Bishop – Gripaios 2010, Hartog et al. 2012, Mameli et al. 2012), and region sizes (Van Oort et al. 2013, Lengyel – Szakálné 2013) (see overview on the effect of related variety in *Appendix 1*).

The variety of export activities plays an important role in the explanation of economic growth based on spillovers. Saviotti and Frenken (2008) showed that long term economic growth of countries is stemming from the increase in variety (doing new things), not specialization (doing more of the same). Furthermore, Boschma and Iammarino (2009) and Boschma et al. (2012) showed a positive relationship between related variety of export products and the growth of employment in regions. Based on these findings we formulate our first hypothesis:

HYPOTHESIS 1: Related variety of export activities has a positive effect on regional employment growth.

A further aspect to take into account in regional growth is the role of interregional trade flows, because new knowledge may reach regions from the outside as well and regional growth might depend on the re-combination of the external knowledge. Hidalgo et al. (2007) argued that the economic development of countries is driven by their endowment of productive knowledge, which can be combined in meaningful ways into new products. This productive knowledge entails technological knowledge and production experience, industry-specific and general institutions, and scientific knowledge among others. They found that countries seldom "jump" from the production of less complex products (requiring less productive knowledge) to the most complex ones. On the regional scale, Boschma and Iammarino (2009) proposed that the variety of import would be beneficial for growth when it was related to export activities, *i.e.* some elements of productive knowledge for a product were already present. Following this latter approach, we expect that relatedness between import and export industries is beneficial for growth, and state our second hypothesis:

HYPOTHESIS 2: Related variety of export and import products has a positive effect on regional employment growth.

With this paper we would like to further improve our understanding on the local impact of foreign firms' trading activity on the domestic firms' trading activity using a related trade linkages approach. This has central importance in our research context because after the post-socialist transition, similarly to other countries in Central and Eastern Europe, regional economic development in Hungary was decisively driven by investment decisions of multinational and foreign-owned companies (Lengyel – Leydesdorff 2011, 2015, Lengyel – Szakálné Kanó 2014, Radosevic 2002, Resmini 2007). Productivity spillovers have been found between foreign-owned firms and domestic companies (Csáfordi et al. 2016), which decrease as geographical distance grows (Halpern – Muraközy 2007). However, the interactions between co-located foreign and domestic companies evolved slowly, and technological relatedness between them affected regional employment growth and entry-exit of domestic companies only in the 2000s (Lengyel – Szakálné Kanó 2013, Szakálné Kanó et al. 2016). These phenomena might be due to the fact that only those domestic companies could benefit from the presence of foreign-owned firms that were productive enough to absorb the positive externalities (Békés et al. 2009); and the productivity of domestic companies evolved gradually. The majority of foreign trade in Hungary can be attributed to foreign firms, especially in the case of the manufacturing industries, and they are also the drivers of export growth (Holland et al. 2000, Sass 2003). Further evidence based on Hungarian data shows that foreign firms use imported inputs more effectively than domestic firms (Halpern et al. 2015), and that trading firms benefit more from agglomeration economies than non-trading firms (Békés – Harasztosi 2013).

Figure 1 illustrates the trends of international trade in Hungary over the period of our investigation between 2000 and 2012, when the divide between foreign and domestic manufacturing export widened. The number of employees in foreign-owned manufacturing exporter firms was 350,000 in 2000, which fell to 260,000 by 2012 (*Figure 1A*).

(A) **(B)**

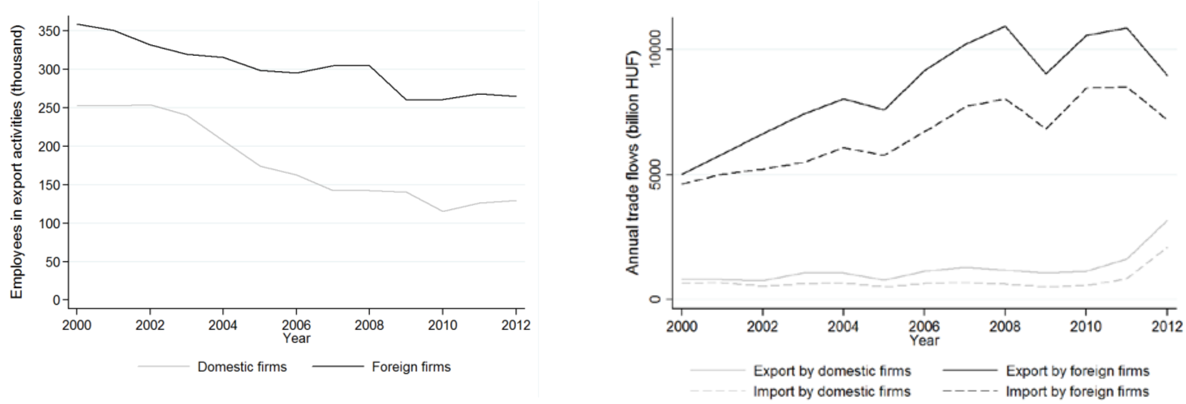


Figure 1. International trade and employment in a dual economy context, 2000-2012.
Notes: **(A)** Total annual employment in manufacturing export (thousand employees) performed by foreign and domestic companies. **(B)** Total annual export and import in manufacturing (billion HUF) by foreign and domestic companies.

One can observe a much sharper decrease in the case of domestic firms: the number of employees fell from 250,000 to 130,000. However, the foreign-domestic gap is even more pronounced in terms of trade flow values; the volume of foreign export increased sharply over the period in question and exceeded import significantly, which was hardly the case for domestic companies (*Figure 1B*). *Appendix 2* illustrates major trends in Hungarian trade in the period of our investigation when the divide between foreign- and domestic manufacturing export widened and foreign companies were more likely to recombine imported inputs and also to induce employment growth than domestic companies.

As discussed above, it is often proposed that foreign-owned firms may generate knowledge spillovers to domestic companies in the form of increased human capital, management routines and new technologies. However, domestic firms in Hungary in general are less innovative (Halpern – Muraközy 2010). Furthermore, foreign-owned firms are usually less embedded in the local production networks than domestic firms (Barta 2009). Additionally, the benefits of relatedness might be unequally available for domestic and foreign firms, as was the case with different industries (Bishop – Gripaios 2010), leading us to propose that spillovers between trade activities might be structured along firm ownership. Indeed Szakálné et al. (2016) showed that the best fitting model for the Hungarian economy was the one assuming no relatedness between domestic and foreign firms, compared to the models assuming stronger proximity between ownership groups. In such a case we would expect that foreign and domestic firms interact predominantly through value-chain linkages rather than knowledge spillovers (Barta 2009). This is also in line with the characteristics of Hungarian manufacturing export relying on low value-added assembling activities, pointing towards the combination of more similar, rather than related products. For these reasons we state our last hypothesis concerning employment growth:

HYPOTHESIS 3: *Similarity of international trade by foreign and domestic firms has a positive effect on regional employment growth.*

RESEARCH DESIGN

Data

Our empirical exercise relies on firm-level data that matches balance-sheet and trade information made available by the Hungarian Central Statistical Office. The dataset, consists of the value of all international export and import flows in HUF by trading firm and by SITC product classes detailed at the 4-digit level, location of company seat (microregion level), the NACE class of the firms main activity (detailed at the 4-digit level), the number of employees and various balance sheet data (*e.g.* net revenue, total capital, foreign capital). The dataset consists of data ranging from 2000 to 2012.

Data cleaning consisted of the following efforts. First, products had to be recoded from SITC rev. 4 to rev. 3 between 2006 and 2012. Second, price indexes of SITC product classes, provided by the Hungarian Central Statistical Office, were used to deflate current values of trade flows (2000=100%). Third, we filled missing numeric variables with the average of last and next year values if a firm was missing in the data for exactly one year. For categorical variables (*e.g.* region, NACE class), we used the value of the previous year.

We focused only on those manufacturing firms that had at least two employees in every year between 2000 and 2012 for two reasons. First, company seat data is more likely to represent the location of actual production activities in the case of manufacturing industries, because 90% of firms have only one site, and in the remaining cases 67% of the employees are working at the main site of the firm (Békés and Harasztosi 2013). Second, this way we excluded those firms that only trade and have no productive activities, and consequently cannot benefit from spillovers of productive knowledge. We opted for the two employee limit because it is adequate to exclude unreliable observations (*e.g.* one employee firms with no revenue), but it is also loose enough to retain a large number of domestic firms. This is important as domestic firms tend to be smaller than foreign ones, and a higher threshold would introduce bias towards foreign firms (*Figure 2A*).

(A) **(B)**

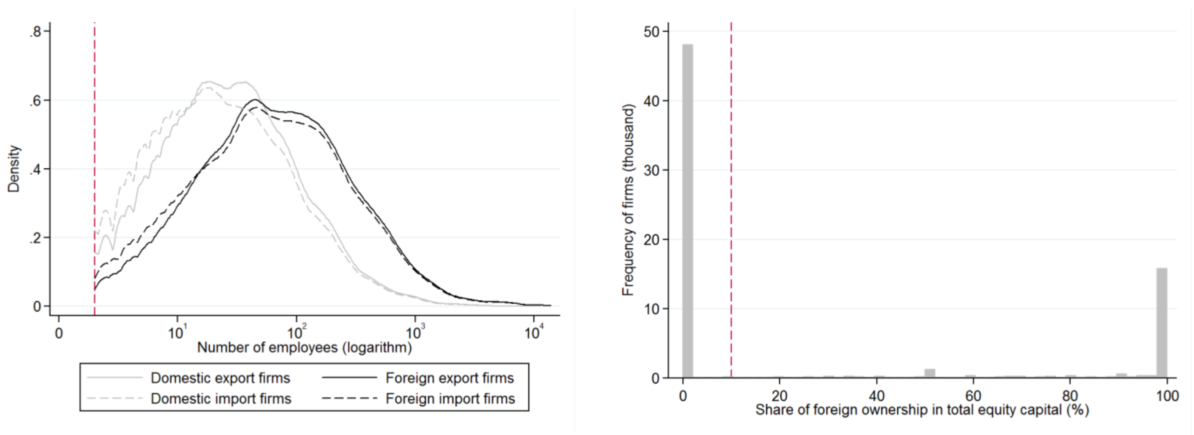


Figure 2. Distribution of firms in the sample by the number of employees and ownership.

Notes: **(A)** Distribution of firms by the number of employees on a logarithmic scale. The red dashed line indicates the two employee threshold. **(B)** Distribution of firms (aggregated between 2000 and 2012) over the share of foreign owned total equity capital. The red dashed line indicates the 10% ownership threshold.

For analytical purposes we consider a firm "foreign", if at least 10% of the total equity capital of the firm is in foreign ownership. This limit is in accord with the OECD (2008) benchmark definition on foreign direct investment. The fact that the vast majority of foreign entities in Hungary either obtain more than 90% of total equity capital of a firm or none at all further justifies the 10% threshold (*Figure 2B*). We opted for 175 microregions (LAU1) as the spatial unit of analysis.

Estimation framework

Fixed-effect panel regression was chosen[1] for estimation framework as this approach allows us to control for time-invariant unobserved effects such as institutions in different regions (Cameron – Trivendi 2009). Formally

$$Y_{it} = \beta X_{it-1} + u_i + \varepsilon_{it} \tag{1}$$

where Y_{it} is the level of the dependent variable in region i at time t, X_{it-1} is the vector of the region-specific independent variables at time $t-1$, u_i is the region-specific fixed-effect and ε_{it} is the error term. In this panel estimation framework levels of the variables are introduced but overall the changes compared to the means of each panel item are being explained by similar changes in the independent variables. As the Hungarian spatial structure is extremely skewed, *i.e.* Budapest, the capital holds 20-25% of total employees in export and total export volume, we apply the natural logarithm of the dependent, as well as the independent variables[2]. One period lagged values of independent variables are used, because we expect that changes in the variety of the regional product mix need some time to influence regional employment[3].

The dependent variable is regional employment in export ($REGEMP$). We also measure regional employment in export within the domestic ($REGEMP^D$) and foreign ($REGEMP^F$) sets of firms separately to get a more detailed insight on regional growth. We rely on the following regional level controls. First, urbanization economies or urban size is controlled for by population density ($POPDENS$), as it is commonly used in economic

[1] Hausman tests for the non-heteroskedasticity-robust estimations were applied to see whether fixed-effect or random-effect models are more adequate. Based on the overall χ^2 statistic in each model, we concluded that random effect models are not appropriate for our analysis.
[2] As a robustness check we ran models leaving Budapest out yielding similar results.
[3] Application of two year lags led to similar results, with weaker significance of the similarity measures.

geography. We attempt to control for the effect of intra-industry spillovers and localization economies with the Herfindahl-Hirschman concentration index (HHI) of employment at the 4-digit NACE level in the regional portfolio. A high HHI value would suggest higher endowment in productive knowledge specific to a few industries only. We used the average number of employees of firms ($AVGSIZE$) to control for employment growth differences by firm size. It is commonly argued in the literature of economics, that higher labour productivity facilitates the growth of firms without necessarily increasing the volume of labour used. Therefore we controlled for this negative effect on employment growth with regional productivity (export per employees) ($REGPROD$). Finally, gross investments ($INVEST$) were used as regional control variable of new ventures either increasing employment through the use of additional labour input, or decreasing it through the replacement of labour by capital input. All control variables with the exception of urban size were split into the categories of foreign and domestic ownership so as to fit our logic of differentiating between these groups of firms (see *Appendix 3* for detailed description of control variables). This way we can use the controls in a more refined way, as they are likely to be different in the foreign and domestic case (*e.g.* foreign average firm size is higher in general compared to the domestic case, as seen in *Figure 2A*). In most cases pairwise correlation of covariates are below 0.6 with the notable exceptions between HHI and some of the more aggregated variety measures like $VARIETY$, $UNRELVAR$ and $IMPVAR$. We opted for keeping HHI as control, because the VIF values of the multicollinearity statistics[4] in such cases were in the acceptable range (see *Appendix 4* for details on the pairwise correlation of covariates and VIF values of multicollinearity statistics).

Indicators of related variety of the regional export product mix

Two main approaches have been proposed to measure relatedness in the literature. *Ex ante* measures make use of classification systems (*e.g.* NACE or SITC nomenclatures), and assume that items classified in the same group are more related than items classified in different groups. Originally Frenken et al. (2007) used this approach in their demonstration of the effects of related variety on the growth of Dutch regions. More recently *ex post* measures gained more traction as they do not assume relatedness but measure it directly. This is done

[4] The variance inflation factor (VIF) measures the linear association between an independent variable and all the other independent variables. A VIF value of higher than 5 warrants further investigation, and a value of higher than 10 indicates a high chance of multicollinearity (Rogerson 2001).

either by analysing the co-occurrence of products produced (*e.g.* Hidalgo et al. 2007, Neffke – Henning 2008), or through tracking the labour flows between industries (*e.g.* Neffke – Henning 2013). As Blažek et al. (2016) pointed out in a recent paper, the different approaches of measurement entail a different content for technological relatedness.

In this paper we opted for the first approach because it offers more comparable results as the majority of empirical papers on related variety and regional growth are based on the *ex ante*-type measurement. This means that we made use of an entropy-based approach of measuring variety. By entropy one can measure the observable variety in a probability distribution (Frenken 2007). Empirical applications most commonly observe distributions in the classification of economic activities or products. In this paper we rely on the SITC product classification, thus in this case the entropy-measure takes its maximum value, when productive activities have an equal distribution over the classification (entropy of this system is maximal), and entropy takes its minimum value when activities are concentrated in one of the classes (entropy of this system is minimal). An attractive feature of the entropy-measure is its decomposability. The total entropy of a distribution with several subclasses equals the sum of the average within class entropy and the between class entropy (Frenken 2007).

First, we measure the overall diversity of productive activities with the VARIETY variable. It is the entropy of export product volumes at the 4-digit SITC level. Formally, let $i = 1, \dots, N$ be a 4-digit export product in a region. Let p_i be the share of that export product i in the regional export. Then VARIETY can be calculated as

$$VARIETY = \sum_{i=1}^{N} p_i \log_2 \left(\frac{1}{p_i}\right) \qquad (2)$$

A region with diverse export portfolio has a high value of VARIETY as compared to a region with a specialized export portfolio. The positive effect of VARIETY on regional growth would suggest the prevalence of inter-industry knowledge spillovers.

However, as it is argued in the evolutionary economic geography literature, inter-industry spillovers can be expected when said industries are technologically related, *i.e.* not too different, yet not too similar in their productive knowledge. This is captured by the decomposition of the overall variety of the regional export portfolio into related variety and unrelated variety, as first proposed by Frenken et al. (2007). The related variety of regional export products is the weighted average entropy of export products within 2-digit product classes. Formally every SITC 4-digit product i falls under an SITC 2-digit product class S_g, where $g = 1, \ldots, G$. Related variety is calculated as

$$RELVAR = \sum_{g=1}^{G} P_g H_g \tag{3}$$

where P_g is the aggregation of the 4-digit export shares:

$$P_g = \sum_{ieS_g} p_i \tag{4}$$

The entropy within each 2-digit product class S_g is H_g:

$$H_g = \sum_{ieS_g} \frac{p_i}{P_g} \log_2 \left(\frac{1}{p_i / P_g} \right) \tag{5}$$

In the decomposition of the overall entropy, unrelated variety captures the variety that can be observed between export products that are considered technologically unrelated, *i.e.* inter-industry knowledge spillovers are less likely to occur between them. We measure unrelated variety as the entropy of 2-digit export products in a region:

$$UNRELVAR = \sum_{g=1}^{G} P_g \log_2 \left(\frac{1}{P_g} \right) \tag{6}$$

Indicators of related variety of trade linkages

For assessing the impact that extra-regional trade linkages have on regional growth, we adopted the approach taken by Boschma and Iammarino (2009). We measured the overall variety of import products by the import entropy at the 4-digit level. Formally let $i = 1, \ldots, N$ be a 4-digit import product in a region, and let p_i be the share of that 4-digit import product i in the regional import volume. Then the variable can be calculated as

$$IMPVAR = \sum_{i=1}^{N} p_i \log_2 \left(\frac{1}{p_i}\right) \tag{7}$$

However, the overall import variety may not be the strongest indicator of potential access to extra-regional knowledge, as export industries might not be able to absorb that new knowledge. Therefore, a related trade variety indicator of import and export industries was proposed by Boschma and Iammarino (2009). Here we slightly modified this measure to match the available SITC product data. The related trade variety measure determines for each 4-digit import product the import entropy within the same 2-digit class, excluding the 4-digit product in question. These cases are then weighted by the relative share of the same 4-digit product in the regional export. Finally the weighted entropy values are aggregated at the regional level. Formally, let $i = 1, \ldots, N$ be a 4-digit export activity in a region. Let $OE_4^M(i)$ be the import entropy within the 2-digit class that activity *i* belongs to, but excluding activity *i*. Finally let $X_4(i)$ be the relative size of activity *i* in the overall regional export portfolio:

$$RELTRADVAR = \sum_{i=1}^{N} OE_4^M(i) * X_4(i) \tag{8}$$

Following Boschma and Iammarino (2009) we check as well whether the import of products have any effect on regional growth, if the import activity is the same as the export activity the region is already specialized in. A high value of the similarity indicator suggests that productive knowledge is combined in less radical ways with lower value added in the region. The similarity of trade as an indicator is determined by the product of the absolute values of regional import and export volumes for each 4-digit product, aggregated at the regional level. Formally let $EXP_4(i)$ be the absolute trade value of export activity *i* in the regional export portfolio, and let $IMP_4(i)$ be the absolute trade value of import activity *i* in the regional import portfolio:

$$TRADESIM = \log \sum_{i=1}^{N} EXP_4(i) * IMP_4(i) \tag{9}$$

Indicators of related variety in and between ownership groups

In this paper we are particularly interested in whether the impact of related variety and related trade variety on regional growth is structured by ownership, *i.e.* whether the dual character of the less developed economy of Hungary makes this impact different according ownership group. We applied this structuring perspective on our dependent and independent variables as well. We calculated the values of the dependent variable of regional employment in export separately for the foreign and the domestic group of firms.

In the case of the variety indices, we calculated the measures separately for ownership groups, and also between them. In the former case we calculated entropy measures from equation (2) to (6) separately for export activities of domestic and foreign firms, yielding us six measures of variety and relatedness (*Table 1.*).

Table 1. Indicators of relatedness structured by ownership and direction of trade flow.

	Export not considered	**Export by domestic firms**	**Export by foreign firms**
Import not considered		$VARIETY^D$ $RELVAR^D$ $UNRELVAR^D$	$VARIETY^F$ $RELVAR^F$ $UNRELVAR^F$
		$RELFDIVAR$ $FDISIM$	
Import by domestic firms	$IMPVAR^D$	$RELTRADVAR^{DD}$ $TRADESIM^{DD}$	$RELTRADVAR^{DF}$ $TRADESIM^{DF}$
Import by foreign firms	$IMPVAR^F$	$RELTRADVAR^{FD}$ $TRADESIM^{FD}$	$RELTRADVAR^{FF}$ $TRADESIM^{FF}$

Notes: single character upper indexes signify variables calculated within the domestic ("D") or foreign ("F") subset of firms; double character upper indexes signify direction of foreign trade, and ownership groups involved: the first character represents import (by foreign or domestic firms), while the second character represents export (by foreign or domestic firms).

In the latter case we relied on a slightly modified version of equations (8) and (9) in order to establish relatedness between the ownership groups. Modification means that the original measures quantified the relatedness between import and export, while we also use it to establish the relatedness between foreign and domestic export, as well as the pairwise relatedness of foreign/domestic export/import activities. First, we calculated the average level of relatedness of export between foreign and domestic firms ($RELFDIVAR$), as well as the complementary similarity indicator ($FDISIM$). Second, we applied the same approach in the case of international trade linkages in general leaving us with two structuring dimensions (direction of trade and ownership) and a total of eight relatedness or similarity measures (*Table 1*). For example $RELTRADVAR^{FD}$measures the related foreign import variety around domestic export products, aggregated at the regional level (see *Appendix 3* for detailed description of all indicators).

RESULTS

The effect of (related) trade linkages overall

An overall picture on the impact of relatedness in trade activities can be drawn from *Table 2*. First, we introduce *VARIETY* in *Model 1*, and then decompose it into *RELVAR* and *UNRELVAR* in *Model 2* in order to assess the impact of relatedness within the export portfolio of regions – *i.e.* the productive knowledge agglomerated – on regional employment in export. *Model 1* indicates that the sheer variety of export products benefits regional employment growth. Indeed, it is often argued in evolutionary economics, that novel activities are more likely to emerge when there are more opportunities to combine existing productive knowledge (*e.g.* Saviotti – Frenken 2008). The related variety argument puts emphasis on this opportunity.

Model 2 offers support for the claim that even though variety in itself has a positive and significant effect on employment, this is only due to the positive effect of related variety of export activities. In contrast, unrelated variety has no significant effect. This result suggests that employment in export activities of regions increases if the general level of technological relatedness across export products is high in the regional export portfolio. This finding is in accord with our expectation based on the literature of evolutionary economic geography: related variety of export activities allows for novel combinations of productive knowledge, leading to new market niches and employment growth in the context of less developed Hungarian regions as well, therefore we accept *HYPOTHESIS 1*.

Table 2. The relationship between related trade variety and employment in export activities in Hungarian microregions between 2000 and 2012.

	Model (1) $(REGEMP)$	**Model (2)** $(REGEMP)$	**Model (3)** $(REGEMP)$	**Model (4)** $(REGEMP)$
ln $POPDENS_{t-1}$	0.528** (2.23)	0.488** (2.04)	0.469** (2.26)	0.481** (2.11)
ln HHI^{D}_{t-1}	–0.122*** (–6.52)	–0.124*** (–6.76)	–0.118*** (–6.52)	–0.124*** (–6.70)
ln HHI^{F}_{t-1}	–0.093*** (–3.50)	–0.104*** (–4.01)	–0.092*** (–3.61)	–0.115*** (–4.66)
ln $AVGSIZE^{D}_{t-1}$	0.136*** (6.28)	0.125*** (5.63)	0.133*** (6.52)	0.126*** (6.13)
ln $AVGSIZE^{F}_{t-1}$	0.134*** (5.16)	0.129*** (4.84)	0.126*** (4.79)	0.123*** (5.16)
ln $REGPROD^{D}_{t-1}$	–0.005 (–0.38)	–0.002 (–0.20)	0.010 (0.79)	–0.000 (–0.02)
ln $REGPROD^{F}_{t-1}$	–0.020 (–1.18)	–0.020 (–1.23)	–0.023 (–1.43)	–0.037** (–2.28)
ln $INVEST^{D}_{t-1}$	0.004 (0.35)	0.004 (0.40)	0.004 (0.40)	0.014 (1.33)
ln $INVEST^{F}_{t-1}$	0.030** (2.05)	0.032** (2.27)	0.029** (2.00)	0.025* (1.75)
ln $VARIETY_{t-1}$	0.096*** (4.09)			
ln $RELVAR_{t-1}$		0.097*** (5.14)		
ln $UNRELVAR_{t-1}$		0.029 (1.42)		
ln $IMPVAR_{t-1}$			0.105*** (5.59)	
ln $RELTRADVAR_{t-1}$				0.083*** (5.44)
$TRADESIM_{t-1}$				0.039* (1.85)
N	1778	1778	1778	1778
R–squared	0.260	0.274	0.276	0.269
Adj. *R*–squared	0.255	0.270	0.272	0.265
F	19.53	19.37	22.59	21.95
Sig.	0.0000***	0.0000***	0.0000***	0.0000***

Notes: standardized beta coefficients; *t* statistics in parentheses; * p<0.1,** p<0.05,*** p<0.01

Now we turn to our models on the relatedness of import and export activities. In *Model 3* and *4* we look at the relationship between regions import and export portfolios and find significant effect of the relatedness in trade flows on employment growth. First, *Model 3* suggests that the variety of import flows in itself has a positive effect on employment. This means that the more diverse import products are combined into exported products in a region, the higher the growth of employment. The variety of export products may indicate the value added in the production process, but one can also think of these import products as access to a variety of productive knowledge that may not be present in the region beforehand. However, following Hidalgo et al. (2007) and Boschma and Iammarino (2009), one might expect the variety of new knowledge to have an effect on growth when it is somewhat compatible with the existing productive knowledge portfolio of the region, represented in its export mix. Thus, in *Model 4* we consider related and similar trade flows only ($RELTRADVAR$ and $TRADESIM$, respectively)[5]. Findings indicate that in general, benefits of import variety are – to a larger extent – stemming from the technological relatedness of regional import and export portfolios. Import and export in the same product class shows less significant positive effect on growth. These findings seem to support the argument that import related to export activities is beneficial for employment growth, thus *HYPOTHESIS 2* can be accepted.

All models are statistically significant based on the F-statistic at the 0.01 level. Among our control variables, urban size shows a strong positive relation to employment growth, as one would expect based on the literature of agglomeration economies. Concentration of employment in fewer industries (HHI) shows a stable negative effect on employment growth regardless of ownership group, indicating that a more specialized portfolio of productive knowledge decreases the opportunities for establishing new market niches. The control on average firm size ($AVGSIZE$) indicates that a higher number of larger firms in a region leads to higher employment growth. Finally, coefficients of $INVEST^F$ show a significant positive effect on growth, pointing towards that the investment activities of foreign firms in particular are followed by an increase in the utilisation of labour input.

The effect of (related) trade linkages structured by ownership

To get a clearer picture about the role that the variety of trade activities of domestic and foreign firms play in the growth of regional economies, in *Table 3* we turn to the models structured along ownership. First, we specifically look at the relationship between employment growth of domestic and foreign firms and the variety of export. *Model 1D* and *1F* of *Table 3* show that variety within a specific ownership group in itself is statistically significant only for the employment growth in the same ownership group, *i.e.* export variety of domestic firms yield growth in the domestic group and variety in the foreign group yields

[5] Unrelated variety between import and export activities was also calculated, but was subsequently omitted from the models due to multicollinearity.

growth in the foreign group. Comparing *Models 2D* and *2F* refines the insight gained on the role of technological relatedness so far in *Table 2*. While related variety in general was beneficial for employment growth, this effect is mainly stemming from the positive effect of relatedness within the domestic group of firms on the growth of these firms. The related variety of export activities by foreign firms has hardly any effect on the growth of either ownership group.

Unrelated productive activities, as well as relatedness of export by domestic firms to the foreign subgroup have weakly significant effect on the employment of either firm group. Interestingly, a strong positive effect on the growth of both ownership groups can be found in the case of $FDISIM$, meaning that both firm groups benefit from the similarity of export activities in regions. Additionally, the coefficient is higher when we consider the growth of domestic firms, showing that the host economy benefits more from the similarity of export than foreign firms do. These findings shows first that while foreign firms have the dominant share in export employment, domestic firms benefit from foreign firms only when they export similar products. Second, the host economy does not seem to receive new productive knowledge through spillovers between the ownership groups, when it comes to technological relatedness. This gives further support to the concerns regarding the existence and impact of knowledge spillovers between foreign and domestic firms in transition economies, and the technological gap between them. Third, spillovers from the related variety of export activities are accessible first and foremost to domestic firms, pointing towards the importance of local embeddedness in accessing these spillovers.

In *Table 4* we focus on the connection between growth by ownership group and the relatedness of import to export activities at the regional level. In this step we assess whether the relatedness of trade activities *within* or *between* ownership groups matters for the growth of employment. Once again, we gain a general picture on the role of variety in growth in *Models 3D* and *3F*. The variety of import, *i.e.* access to extra-regional productive knowledge benefits both domestic and foreign firms (*Table 2*), however domestic firms mainly benefit from the import variety of domestic firms: $IMPVAR^D$ has a strong significant effect on the employment growth of domestic firms. Foreign firms on the other hand benefit from import variety of both domestic and foreign firms. This may indicate a more central role of foreign firms in international value-chains, as one would expect in the case of Hungary, where foreign trade is dominated by the foreign group of firms.

Table 3. The relationship between related export variety and employment in export activities of domestic and foreign firms in Hungarian microregions between 2000 and 2012.

	Model (1D) $(REGEMP^{D})$	**Model (2D)** $(REGEMP^{D})$	**Model (1F)** $(REGEMP^{F})$	**Model (2F)** $(REGEMP^{F})$
$\ln POPDENS_{t-1}$	0.909*** (2.64)	0.764** (2.38)	–0.012 (–0.07)	–0.066 (–0.40)
$\ln HHI^{D}_{t-1}$	–0.175*** (–4.58)	–0.171*** (–4.52)	–0.061*** (–4.17)	–0.058*** (–3.73)
$\ln HHI^{F}_{t-1}$	–0.101** (–2.48)	–0.098** (–2.48)	–0.139*** (–5.18)	–0.134*** (–4.99)
$\ln AVGSIZE^{D}_{t-1}$	0.318*** (7.97)	0.297*** (7.47)	0.034** (2.25)	0.025 (1.54)
$\ln AVGSIZE^{F}_{t-1}$	–0.043 (–1.44)	–0.064** (–2.23)	0.351*** (10.38)	0.345*** (10.11)
$\ln REGPROD^{D}_{t-1}$	0.019 (0.72)	0.017 (0.65)	–0.036*** (–3.21)	–0.040*** (–3.50)
$\ln REGPROD^{F}_{t-1}$	–0.069** (–2.57)	–0.078*** (–3.00)	0.012 (0.75)	0.008 (0.46)
$\ln INVEST^{D}_{t-1}$	0.024 (1.37)	0.026 (1.47)	–0.009 (–0.80)	–0.009 (–0.80)
$\ln INVEST^{F}_{t-1}$	–0.001 (–0.03)	0.003 (0.16)	0.063*** (3.99)	0.063*** (4.09)
$\ln VARIETY^{D}_{t-1}$	0.119*** (3.71)		0.020 (1.41)	
$\ln VARIETY^{F}_{t-1}$	0.004 (0.16)		0.063*** (3.01)	
$\ln RELVAR^{D}_{t-1}$		0.083*** (3.78)		0.015 (1.32)
$\ln RELVAR^{F}_{t-1}$		0.031 (1.41)		0.034* (1.85)
$\ln UNRELVAR^{D}_{t-1}$		0.051* (1.66)		0.001 (0.07)
$\ln UNRELVAR^{F}_{t-1}$		–0.044 (–1.61)		0.035* (1.84)
$\ln RELFDIVAR_{t-1}$		0.026* (1.66)		–0.008 (–0.77)
$FDISIM_{t-1}$		0.070*** (3.23)		0.037*** (3.60)
N	1693	1693	1696	1696
R–squared	0.284	0.305	0.333	0.339
Adj. *R*–squared	0.280	0.299	0.329	0.333
F	17.64	18.17	20.54	17.23
Sig.	0.0000***	0.0000***	0.0000***	0.0000***

Notes: standardized beta coefficients; *t* statistics in parentheses; * p<0.1,** p<0.05,*** p<0.01

Table 4. The relationship between related trade variety and employment in export activities of domestic and foreign firms in Hungarian microregions between 2000 and 2012.

	Model (3D) ($REGEMP^D$)	**Model (4D)** ($REGEMP^D$)	**Model (5D)** ($REGEMP^D$)	**Model (3F)** ($REGEMP^F$)	**Model (4F)** ($REGEMP^F$)	**Model (5F)** ($REGEMP^F$)
$\ln POPDENS_{t-1}$	0.540** (2.08)	0.736** (2.57)	0.920*** (2.73)	–0.093 (–0.64)	–0.069 (–0.42)	–0.030 (–0.18)
$\ln HHI^D_{t-1}$	–0.175*** (–5.69)	–0.173*** (–5.32)	–0.216*** (–6.61)	–0.052*** (–3.52)	–0.044*** (–2.89)	–0.056*** (–3.94)
$\ln HHI^F_{t-1}$	–0.094** (–2.51)	–0.102*** (–2.88)	–0.094** (–2.45)	–0.132*** (–5.24)	–0.159*** (–5.97)	–0.150*** (–5.76)
$\ln AVGSIZE^D_{t-1}$	0.297*** (8.00)	0.268*** (7.14)	0.317*** (8.35)	0.027* (1.79)	0.003 (0.20)	0.020 (1.35)
$\ln AVGSIZE^F_{t-1}$	–0.036 (–1.25)	–0.044* (–1.68)	–0.047 (–1.54)	0.339*** (10.20)	0.347*** (10.44)	0.338*** (11.19)
$\ln REGPROD^D_{t-1}$	0.012 (0.50)	–0.014 (–0.57)	–0.001 (–0.02)	–0.029*** (–2.99)	–0.045*** (–4.43)	–0.039*** (–3.76)
$\ln REGPROD^F_{t-1}$	–0.050** (–2.20)	–0.058** (–2.33)	–0.076*** (–3.08)	0.015 (0.90)	0.010 (0.64)	–0.001 (–0.08)
$\ln INVEST^D_{t-1}$	0.021 (1.35)	0.021 (1.23)	0.026 (1.48)	–0.009 (–0.85)	–0.007 (–0.64)	–0.006 (–0.55)
$\ln INVEST^F_{t-1}$	–0.007 (–0.35)	–0.008 (–0.38)	–0.007 (–0.33)	0.063*** (3.98)	0.064*** (4.15)	0.063*** (3.95)
$\ln IMPVAR^D_{t-1}$	0.189*** (8.69)			0.040*** (3.29)		
$\ln IMPVAR^F_{t-1}$	0.039* (1.73)			0.085*** (5.55)		
$\ln RELTRADVAR^{DD}_{t-1}$		0.081*** (4.43)			0.043*** (3.89)	
$\ln RELTRADVAR^{DF}_{t-1}$		0.041** (2.26)			–0.011 (–0.83)	
$TRADESIM^{DD}_{t-1}$		0.054** (2.33)			0.012 (1.25)	
$TRADESIM^{DF}_{t-1}$		0.069*** (2.71)			0.039*** (2.72)	
$\ln RELTRADVAR^{FD}_{t-1}$			0.022 (1.29)			0.014 (1.65)
$\ln RELTRADVAR^{FF}_{t-1}$			0.050* (1.94)			0.027** (2.13)
$TRADESIM^{FD}_{t-1}$			0.083*** (3.72)			0.042** (2.37)
$TRADESIM^{FF}_{t-1}$			–0.035** (–2.21)			0.010 (0.36)
N	1693	1693	1693	1696	1696	1696
R–squared	0.326	0.315	0.282	0.354	0.342	0.336
Adj. *R*–squared	0.322	0.310	0.276	0.350	0.337	0.331
F	30.21	23.24	17.55	23.96	19.92	24.32
Sig.	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***

Notes: standardized beta coefficients; *t* statistics in parentheses; * p<0.1,** p<0.05,*** p<0.01

Models 4 and *5* offer refinement on the results of *Table 2*, *i.e.* it is mainly the relatedness of import to export that matters for growth. First, *Model 4D* and *4F* shows that the relatedness between the import of domestic firms and the export of either foreign or domestic firms has a positive and significant effect on the growth of domestic firms. The related import of foreign firms however has barely any effect on the growth of domestic firms. This means that we can expect new combinations of productive knowledge and employment growth in the host region (seen in *Table 2*) specifically when domestic firms import. Additionally, import of domestic firms related to the export of foreign firms is the only case in which relatedness between these groups has spillover effect on the employment of domestic firms. These are likely the cases when foreign firms are more embedded in the local economy, however the lower value of the coefficient suggests that this is less of a widespread phenomenon. As for the growth of foreign firms, the same *Models 4F* and *5F* suggest that foreign firms benefit from relatedness of import and export when foreign firms perform both these activities or when domestic firms do. These results further support the findings across *Models 1* to *3* that knowledge spillovers between foreign and domestic firms are a rarity, and that domestic firms can combine productive knowledge with other domestic firms more easily.

Previously the similarity of products had a mixed effect on regional employment yielding the low level of significance in *Table 2*. From *Models 4* and *5* of *Table 4* it seems like both domestic and foreign firms benefit from similarity of trade (*i.e.* value-chain linkages), when different ownership groups import and export. Identical ownership groups benefit growth only when domestic firms import, as well as export similar products. Import and export of similar products by foreign firms even affect the employment growth of domestic firms negatively, suggesting a crowding-out effect by foreign firms. The significant effects of the similarity indicators point towards the strong dependence of domestic firms on international value-chains, thus we accept *HYPOTHESIS 3*. Therefore, one might think that employment grew the most in those Hungarian regions where production combines imports into exports within the same product category, thus suggesting low value added. These findings are plausible in the context of the Hungarian economy. In particular, large foreign firms are known to install only a very limited scope of their value chain into the region and the value added of their production is relatively low in less developed regions.

Once again all our models are statistically significant based on the F-statistic at the 0.01 level. Urbanization economies play less of a role in the growth of foreign firms, as the control is only significant in the case of the domestic group. Concentration of employment over NACE codes shows no difference in the detailed tables compared to *Table 2*:

specialization affects employment growth negatively. Average firm size in either ownership group effects mainly the growth of the same group. Regional labour productivity has a more detailed effect in the models structured along ownership than before. Employment growth in either ownership group is affected in a negative way by the productivity in the other group, suggesting that more a skilled workforce in the other ownership group shrinks the available resource base of firms at the regional level. Interestingly, investments in the domestic group have no effect on the growth of either group. The benefits of foreign investments on overall employment seen in *Table 2* come from new employment opportunities in foreign firms created by these investments. Indeed, foreign firms are the main investors in the FDI-driven regional economies of Hungary.

CONCLUSIONS AND FURTHER RESEARCH

In this paper we set out to estimate (1) the impact of related variety in export activities on regional employment growth; (2) the impact of technological relatedness between import and export activities on regional employment growth; (3) the impact of technological relatedness between the trade activities of foreign and domestic firms on the employment growth of regions. To do this, we relied on a panel of Hungarian microregions between 2000 and 2012 provided by the Hungarian Central Statistical Office, and used a fixed-effect panel regression method. Based on our results, a number of conclusions can be drawn regarding the role of foreign firms in the regional employment growth of the transition economy of Hungary.

First, our findings support the claims made in evolutionary economic geography that related variety of productive knowledge is beneficial for regional employment growth. This means that knowledge externalities between related industries are important drivers of economic development in less developed regions as well. Second, we are first to find systematic evidence that the variety in import products is more beneficial when related to the export, as proposed by Boschma and Iammarino (2009). Furthermore, import activities seem to be an important way of external knowledge sourcing in general, when they are related to existing productive knowledge in some way. The reason why these indicators perform well might lie in the characteristics of our case: almost all inputs to regional exports have to be imported in the small and open economy of Hungary unlike in larger countries where the effect of import-export relatedness on regional growth is therefore less significant. Third, knowledge spillovers based on the related variety of productive knowledge are more likely to occur between trade activities of domestic firms, while these kinds of benefits seldom spill over ownership groups. This finding seems to underline that learning between trade activities of foreign and domestic firms is not widely available to all firms of the host economy. A notable exception is when domestic firms import products related to export products of foreign firms. In our view this represents those cases when foreign firms are more embedded in the local economy. Fourth, the host economies of Hungarian regions depend heavily on international value-chains. It seems that in Hungary, characterized by the dominance of assembly activities in manufacturing, growth is driven by the access to these value-chains represented by foreign firms. This accentuates the vulnerability of Hungarian regions: the sources of growth are largely dependent on external factors.

Naturally, there are ways in which we can continue our investigation. First, it may shed further light on our findings if relatedness was measured by other means. *Proximity of products* (Hidalgo et al. 2007) or *revealed relatedness* (Neffke – Henning 2008) are ways in which we could open the "black boxes" of regions. Second, it seems that value-chain connections are central factors in our analysis, therefore they could be controlled for by the means of regionalized input-output networks. Third, foreign and domestic-owned firms may contribute in different ways to the changes in related variety of regions observed here. In this latter case, observing the entry and exit patterns of firms and their export products could further our understanding on the patterns of related diversification in less developed regions.

REFERENCES

Aitken, B. – Hanson, G.H. – Harrison, A.E. (1997): Spillovers, foreign investment, and export behaviour. *Journal of International Economics*, Vol. 43. No. 1-2. pp. 103–132.

Barta Gy. (2009): A külföldi működőtőke szerepe a magyar ipar duális struktúrájának és regionális differenciálódásának kialakulásában. In Lengyel I. – Rechnitzer J. (eds): *A regionális tudomány két évtizede Magyarországon*. Akadémiai, Budapest, pp. 275–291.

Beaudry, C. – Schiffauerova, A. (2009): Who's right, Marshall or Jacobs? The localization versus urbanization debate. Research Policy, Vol. 38. No. 2, pp. 318–337.

Békés G. – Harasztosi P. (2013): Agglomeration premium and trading activity of firms. *Regional Science and Urban Economics*, Vol. 43. No. 1. pp. 51–64.

Békés G. – Kleinert J. – Toubal F. (2009): Spillovers from multinationals to heterogeneous domestic firms: evidence from Hungary. *The World Economy*, Vol. 32. No. 10. pp. 1408–1433.

Beugelsdijk, S. – McCann, P. – Mudambi, R. (2010): Introduction: Place, space and organization–economic geography and the multinational enterprise. *Journal of Economic Geography*, Vol. 10. No. 4. pp. 485–493.

Bishop, P. – Gripaios, P. (2010): Spatial Externalities, Relatedness and Sector Employment Growth in Great Britain. *Regional Studies*, Vol. 44. No. 4. pp. 443–454.

Blažek, J. – Marek, D. – Květoň, V. (2016): The Variety of Related Variety Studies: Opening the Black Box of Technological Relatedness via Analysis of Inter-firm R&D Cooperative Projects. *Papers in Evolutionary Economic Geography*, No. 1301. University Utrecht, Faculty of Geosciences.

Boschma, R. (2005): Proximity and Innovation: A Critical Assessment. *Regional Studies*, Vol. 39. No. 1. pp. 61–74.

Boschma, R. – Eriksson, R. – Lindgren, U. (2014): Labour Market Externalities and Regional Growth in Sweden: The Importance of Labour Mobility between Skill-Related Industries. *Regional Studies*, Vol. 48. No. 10. pp. 1669–1690.

Boschma, R. – Iammarino, S. (2009): Related Variety, Trade Linkages, and Regional Growth in Italy. *Economic Geography*, Vol. 85. No. 3. pp. 289–311.

Boschma, R. – Minondo, A. – Navarro, M. (2012): Related variety and regional growth in Spain. *Papers in Regional Science*, Vol. 91. No. 2. pp. 241–256.

Brachert, M. – Kubis, A. – Titze, M. (2013): Related Variety, Unrelated Variety and Regional Functions: A spatial panel approach. *Papers in Evolutionary Economic Geography*, No. 1301. University Utrecht, Faculty of Geosciences.

Brülhart, M. (1998): Economic geography, industry location and trade: the evidence. *The World Economy*, Vol. 21. No. 6. pp. 775–801.

Cameron, A. C. – Trivendi, P. K. (2009): *Microeconometrics Using Stata*. Stata Press, College Station, Texas.

Csáfordi, Zs – Lőrincz, L. – Lengyel, B. – Kiss, K. M. (2016) Productivity spillovers through labor flows: the effect of productivity gap, foreign-owned firms, and skill-relatedness. *Discussion Papers 1610*, institute of Economics, Hungarian Academy of Sciences. http://econ.core.hu/file/download/mtdp/MTDP1610.pdf

Dicken, P. (1994): The Roepke lecture in economic geography. Global-local tensions: firms and states in the global space-economy. *Economic Geography*, Vol. 70. No. 2. pp. 101–128.

Frenken, K. (2007): Entropy statistics and information theory. In Hanusch. H. – Pyka, A. (eds.): *Elgar Companion to Neo-Schumpeterian Economics*. Edward Elgar, Cheltenham – Northampton, pp. 544–555.

Frenken, K. – Van Oort, F. – Verburg, T. (2007): Related Variety, Unrelated Variety and Regional Economic Growth. *Regional Studies*, Vol. 41. No. 5. pp. 685–697.

Glaeser, E. – Kallal, H. D. – Scheinkman, J. D. – Shleifer, A. (1992): Growth in Cities. Journal of Political Economy, Vol. 100. No. 6. pp. 1126–1152.

Görg, H. – Greenaway, D. (2003): Much ado about nothing? Do domestic firms really benefit from foreign direct investment? *IZA Discussion Paper No. 944*. Available at SSRN: http://ssrn.com/abstract=475044.

Greeneway, D. – Keller, R. (2007): Firm heterogeneity, exporting and foreign direct investment. *The Economic Journal*, Vol. 117. No. 517. pp. 134–161.

Halpern L. – Muraközy B. (2007): Does distance matter in spillover? *Economics of Transition*, Vol. 15. pp. 781–805.

Halpern L. – Muraközy B. (2010): Innováció és vállalati teljesítmény Magyarországon. Közgazdasági Szemle, Vol. 57. No. 4. pp. 293–317.

Halpern L. – Koren M. – Szeidl A. (2015): Imported inputs and productivity. *American Economic Review*, Vol. 105. No. 12. pp. 3660–3703.

Hartog, M. – Boschma, R. – Sotarauta, M. (2012): The impact of related variety on regional employment growth in Finland 1993-2006: High-tech versus medium/low-tech. *Industry and Innovation*, Vol. 19. No. 6. pp. 459–476.

Haskel, J.E. – Pereira, S.C. – Slaughter, M.J. (2007): Does inward foreign direct investment boost the productivity of domestic firms? *The Review of Economics and Statistics*, Vol. 89. No. 3. pp. 482–496.

Henderson, J. V. – Kuncoro, A. – Turner, M. (1995): Industrial Development in Cities. *Journal of Political Economy*, Vol. 103. pp. 1067–1085.

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

Holland, D. – Sass M. – Benacek, V. – Gronicki, M. (2000): The determinants and impact of FDI in Central and Eastern Europe: a comparison of survey and econometric evidence. *Transnational Corporations*, Vol. 9. No. 3. pp. 163–212.

Iammarino, S. – McCann, P. (2013): *Multinationals and economic geography*. Edward Elgar, Cheltenham – Northampton.

Jacobs, J. (1960): *The Economy of Cities*. Random House, New York.

Krugman, P. (1991): Increasing returns and economic geography. *Journal of Political Economy*, Vol. 99. No. 3. pp. 483–499.

Lengyel B. – Leydesdorff, L. (2011): Regional Innovation Systems in Hungary: The Failing Synergy at the National Level. *Regional Studies*, Vol. 45. No. 5. pp. 677–693.

Lengyel B. – Leydesdorff, L. (2015): The effects of FDI on innovation systems in Hungarian regions: where is synergy generated? *Regional Statistics*, Vol. 5. No. 1. pp. 3–24.

Lengyel B. – Szakálné Kanó, I. (2013) Related variety and regional growth in Hungary: towards a transition economy approach. *Regional Statistics*, Vol. 3. No. 6. pp. 98–116.

Lengyel, B. – Szakálné Kanó, I. (2014): Regional economic growth in Hungary 1998-2005: what does really matter in clusters? *Acta Oeconomica*, Vol. 64. No. 3. pp. 257–285.

Mameli, F. – Iammarino, S. – Boschma, R. (2012): Regional variety and employment growth in Italian labour market areas: services versus manufacturing industries. *Papers in Evolutionary Economic Geography*, No. 1203. Utrecht University.

Marshall, A. (1920): *Principles of Economics (8th ed)*. MacMillan, London.

McCann, P. (2008): Agglomeration economies. In Karlsson, C. (ed.): *Handbook of Research on Cluster Theory*. Edward Elgar, Cheltenham – Northampton, pp. 23–38.

Neffke, F. – Henning, M. (2008): Revealed Relatedness: Mapping Industry Space. *Papers in Evolutionary Economic Gegraphy*, No. 0819, University Utrecht, Faculty of Geosciences.

Neffke, F. – Henning, M. (2013): Skill Relatedness and Firm Diversification. *Strategic Management Journal*, Vol. 34. No. 3. pp. 297–316.

North, D.C. (1955): Location theory and regional economic growth. *Journal of Political Economy*, Vol. 63. No. 3. pp. 243–258.

OECD (2008): *OECD Benchmark Definition of Foreign Direct Investment*. *Fourth Edition*. OECD, Paris.

Phelps, N.A. (2008): Cluster or Capture? Manufacturing Foreign Direct Investment, External Economies and Agglomeration. *Regional Studies*, Vol. 42. pp. 457–473.

Quatraro, F. (2010): Knowledge coherence, variety and economic growth: Manufacturing evidence from Italian regions. *Research Policy*, Vol. 39. No. 10. pp. 1289–1302.

Quatraro, F. (2011): Knowledge Structure and Regional Economic Growth: The French case. In Hoskinson, S. – Libecap, G. (eds): *Entrepreneurship and Global Competitiveness in Regional Economies: Determinants and Policy Implications*. Emerald Goup Publishing Limited, Bingley, pp. 185–217.

Radosevic, S. (2002): Regional Innovation Systems in Central and Eastern Europe: Determinants, Organizers and Alignments. *Journal of Technology Transfer*, Vol. 27. pp. 87–96.

Resmini, L. (2007): Regional patterns of industry location in transition countries: does economic integration with the European Union matter? *Regional Studies*, Vol. 41. No. 6. pp. 747–764.

Rogerson, P. A. (2001): *Statistical Methods for Geography*. SAGE Publications, London – Thousand Oaks – New Delhi.

Sass, M. (2003): *Competitiveness and Economic Policies Related to Foreign Direct Investment. Mimeo*, Ministry of Finance of Hungarian Government, WP No. 3.

Saviotti, P. P. – Frenken, K. (2008): Export variety and the economic performance of countries. *Journal of Evolutionary Economics*, Vol. 18. pp. 201–218.

Soci, A. (2003): FDI: a difficult connection between theory and empirics. In Fingleton, B. (ed.): New Directions in Economic Geography. Edward Elgar, Cheltenham – Northampton, pp. 277–314.

Szakálné Kanó I. – Lengyel B. – Elekes Z. – Lengyel I. (2016): Related variety, ownership, and firm dynamics in transition economies: the case of Hungarian city regions 1996-2012. *Papers in Evolutionary Economic Gegraphy*, No. 1612. University Utrecht, Faculty of Geosciences.

Van Oort, F. (2015): Unity in variety? Agglomeration economics beyond the specialization-diversity controversy. In Karlsson, C. – Andersson, M. – Norman, T. (eds): *Handbook of Research Methods and Applications in Economic Geography*. Edward Elgar, Cheltenham – Northampton, pp. 259–271.

Van Oort, F. – De Geus, S. – Dogaru, T. (2013): Related Variety and Regional Economic Growth in a Cross-Section of European Urban Regions. *Papers in Evolutionary Economic Gegraphy*, No. 1312. University Utrecht, Faculty of Geosciences.

Wixe, S. – Andersson, M. (2016): Which Types of Relatedness Matter in Regional Growth? *Regional Studies*, http://dx.doi.org/10.1080/00343404.2015.1112369.

Young, S. – Hood, N. – Peters, E. (1994): Multinational Enterprises and Regional Economic Development. *Regional Studies*, Vol. 28. pp. 657–677.

APPENDIX

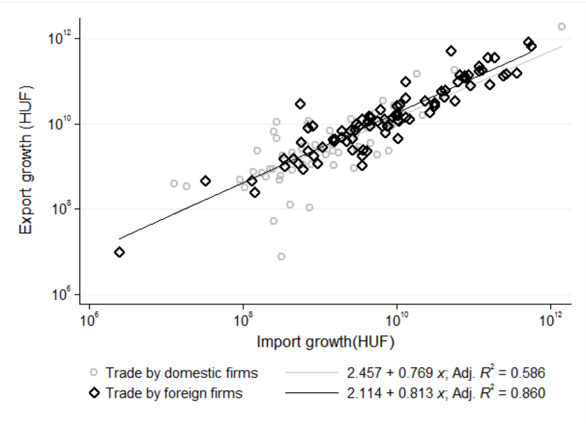
Appendix 1. Empirical findings on the effect of related variety on regional economic growth.

Study	Value-added growth	Productivity growth	Employment growth
Bishop – Gripaios (2010)			–, 0, +
Boschma – Iammarino (2009)	+	+	+
Boschma et al. (2012)	+	0	0, +
Boschma et al. (2014)		+	+
Brachert et al. (2013)			+
Frenken et al. (2007)		–	+
Hartog et al. (2012)			0, +
Lengyel – Szakálné Kanó (2013)			–, +
Mameli et al. (2012)			+
Quatraro (2010)		+	
Quatraro (2011)		+	
Van Oort et al. (2013)			+
Wixe – Andersson (2016)		–	+

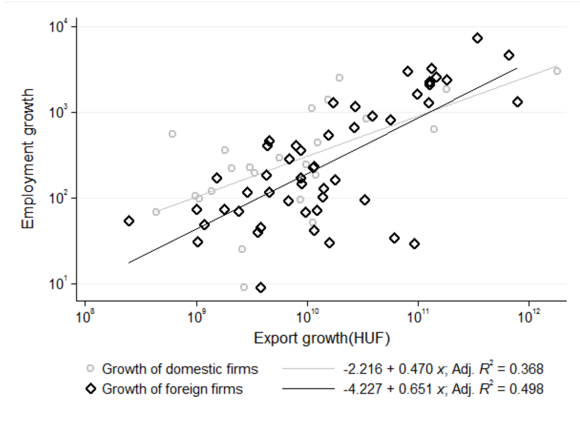
Note: „+” indicates positive effect, „–” indicates negative effect, „0” indicates no significant effect.

Appendix 2. International trade and economic growth in a dual economy context, 2000-2012.

(C)



(D)



Notes: **(C)** Correlation of import and export growth in foreign and domestic companies at the regional level. Grey hollow circles represent the aggregate of domestic companies and black hollow diamonds represent the aggregate of foreign companies in the region. Only growing regions are depicted. The solid lines represent a linear estimation. Foreign firms are more likely to combine imported inputs and re-export than domestic firms. **(D)** Correlation of employment and export growth in foreign and domestic companies at the regional level. Grey hollow circles represent the aggregate of domestic companies and black hollow diamonds represent the aggregate of foreign companies in the region. Only growing regions are depicted. The solid lines represent a linear estimation. Foreign export increases foreign employment in the region more than domestic export increases domestic employment in the region.

Appendix 3. Descriptive statistics of variables.

Variable	Operationalization	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
$REGEMP$	Total employees in export.	2237	2804.207	8850.183	3	153022.5
$REGEMP^D$	Total employees in export in the domestic group.	2163	1081.878	3304.837	3	56524
$REGEMP^F$	Total employees in export in the foreign group.	1996	1970.395	6045.231	3	98300.5
$POPDENS$	Total population of a region divided by its area.	2275	1.17121	2.573171	.2108901	34.49655
$AVGSIZE^D$	Mean of employees in domestic firms in a region.	2163	79.49888	84.93592	2	953.3333
$AVGSIZE^F$	Mean of employees in foreign firms in a region.	1996	179.4738	281.2378	2	4466
HHI^D	Herfindahl-Hirschman concentration index of employees of industries at the 4-digit NACE level in the domestic group.	2163	.4250336	.2799564	.0170694	1
HHI^F	Herfindahl-Hirschman concentration index of employees of industries at the 4-digit NACE level in the foreign group.	1996	.511111	.2892356	.0528338	1
$REGPROD^D$	Export volume in a region, divided by the number of employees, in the domestic group.	2163	5247290	9437977	2611.956	1.74e+08
$REGPROD^F$	Export volume in a region, divided by the number of employees, in the foreign group.	1996	1.92e+07	4.26e+07	47.55442	9.00e+08
$INVEST^D$	Total gross investments of export firms in a region in the domestic group.	2163	1209107	2.56e+07	0	1.14e+09
$INVEST^F$	Total gross investments of export firms in a region in the foreign group.	1996	2292847	9026548	0	1.32e+08
$VARIETY$	Export variety at the 4-digit SITC level.	2237	.7642979	.3482038	0	1.982359
$VARIETY^D$	Export variety at the 4-digit SITC level within the domestic group.	2163	.6569503	.3650513	0	2.095189
$VARIETY^F$	Export variety at the 4-digit SITC level within the foreign group.	1996	.6202543	.3509413	0	1.85207
$RELVAR$	Related variety of export.	2237	.2092287	.1634823	0	1.101889
$RELVAR^D$	Related variety of export within the domestic group.	2163	.1872451	.1711344	0	1.101889
$RELVAR^F$	Related variety of export within the foreign group.	1996	.1759219	.1596602	0	1.018179
$UNRELVAR$	Unrelated variety of export.	2237	.5550692	.2624452	0	1.316182
$UNRELVAR^D$	Unrelated variety of export within the domestic group.	2163	.4697052	.2834904	0	1.37779
$UNRELVAR^F$	Unrelated variety of export within the foreign group.	1996	.4443324	.2651708	0	1.269275

Appendix 3. Descriptive statistics of variables, continued.

Variable	Operationalization	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
$RELFDIVAR$	Regional aggregate of related export variety of foreign firms around 4-digit export activities of domestic firms.	2237	.0570791	.1100253	0	.7777508
$FDISIM$	Regional aggregate of the products of foreign and domestic firms' export volumes of the same 4-digit productive activity.	2237	11.62523	7.535098	0	21.56866
$IMPVAR$	Import variety at the 4-digit SITC level.	2229	1.162821	.4107309	0	2.326223
$IMPVAR^{D}$	Import variety at the 4-digit level within the domestic group.	2149	.9549614	.4628414	0	2.37611
$IMPVAR^{F}$	Import variety at the 4-digit level within the foreign group.	1994	1.07547	.3913055	0	2.234777
$RELTRADVAR$	Regional aggregate of related import variety around 4-digit export activities.	2258	.2579452	.2101415	0	1.038224
$RELTRADVAR^{DD}$	Regional aggregate of related import variety of domestic firms around 4-digit export activities of domestic firms.	2220	.1579489	.1941938	0	1.097797
$RELTRADVAR^{DF}$	Regional aggregate of related import variety of domestic firms around 4-digit export activities of foreign firms.	2232	.0815134	.1512501	0	.9415808
$RELTRADVAR^{FD}$	Regional aggregate of related import variety of foreign firms around 4-digit export activities of domestic firms.	2234	.1142083	.1696692	0	.9217352
$RELTRADVAR^{FF}$	Regional aggregate of related import variety of foreign firms around 4-digit export activities of foreign firms.	2032	.2524511	.2118008	0	1.039627
$TRADESIM$	Regional aggregate of the products of import and export volumes of the same 4-digit productive activity.	2258	17.0956	4.417541	0	24.05829
$TRADESIM^{DD}$	Regional aggregate of the products of domestic firms' import and domestic firms' export volumes of the same 4-digit productive activity.	2220	13.93715	6.090932	0	22.72737
$TRADESIM^{DF}$	Regional aggregate of the products of domestic firms' import and foreign firms' export volumes of the same 4-digit productive activity.	2232	11.39432	7.204946	0	22.29474
$TREDESIM^{FD}$	Regional aggregate of the products of foreign firms' import and domestic firms' export volumes of the same 4-digit productive activity.	2234	12.02569	6.997697	0	21.85528
$TRADESIM^{FF}$	Regional aggregate of the products of foreign firms' import and foreign firms' export volumes of the same 4-digit productive activity.	2032	16.95718	4.747892	0	24.05692

Appendix 4a. Pairwise correlation of coefficients and VIF values of variables in the models of *Table 2*.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**VIF values in**			
																M (1)	**M (2)**	**M (3)**	**M (4)**
ln $POPDENS$	1.00															1.87	1.89	1.87	1.89
ln $AVGSIZE^D$	0.07	1.00														1.50	1.51	1.49	1.51
ln $AVGSIZE^F$	0.24	0.11	1.00													1.56	1.63	1.62	1.84
ln HHI^D	–0.57	0.00	–0.21	1.00												2.44	2.47	2.41	2.20
ln HHI^F	–0.56	–0.10	–0.22	0.53	1.00											2.57	2.71	2.41	2.28
ln $REGPROD^D$	0.21	0.34	0.14	–0.23	–0.18	1.00										1.24	1.25	1.24	1.27
ln $REGPROD^F$	0.21	0.16	0.38	–0.13	–0.26	0.17	1.00									1.28	1.31	1.23	1.55
ln $INVEST^D$	0.41	0.41	0.20	–0.53	–0.41	0.34	0.16	1.00								1.93	1.94	1.94	1.95
ln $INVEST^F$	0.43	0.15	0.53	–0.33	–0.58	0.19	0.30	0.33	1.00							2.10	2.15	2.10	2.10
ln $VARIETY$	0.39	0.21	0.14	–0.59	–0.62	0.26	0.07	0.43	0.30	1.00						2.01			
ln $RELVAR$	0.22	0.17	0.19	–0.33	–0.32	0.14	0.10	0.21	0.11	0.70	1.00						1.26		
ln $UNRELVAR$	0.39	0.17	0.07	–0.59	–0.65	0.24	0.03	0.46	0.35	0.89	0.30	1.00					2.19		
ln $IMPVAR$	0.42	0.19	0.33	–0.57	–0.61	0.20	0.19	0.43	0.44	0.69	0.44	0.65	1.00					1.99	
ln $RELTRADVAR$	0.41	0.18	0.30	–0.41	–0.48	0.19	0.21	0.33	0.34	0.58	0.53	0.45	0.60	1.00					1.45
$TRADESIM$	0.37	0.29	0.56	–0.40	–0.47	0.33	0.58	0.38	0.50	0.43	0.23	0.43	0.63	0.50	1.00				2.70

Appendix 4b. Pairwise correlation of coefficients and VIF values of variables in *Models 1* and *2* of *Table 3*.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**	**(17)**	**VIF values in**	
																		M (1)	**M (2)**
ln $POPDENS$	1.00																	1.86	1.98
ln $AVGSIZE^D$	0.07	1.00																1.55	1.60
ln $AVGSIZE^F$	0.24	0.11	1.00															1.69	1.74
ln HHI^D	–0.57	0.00	–0.21	1.00														3.45	3.73
ln HHI^F	–0.56	–0.10	–0.22	0.53	1.00													3.14	3.72
ln $REGPROD^D$	0.21	0.34	0.14	–0.23	–0.18	1.00												1.24	1.29
ln $REGPROD^F$	0.21	0.16	0.38	–0.13	–0.26	0.17	1.00											1.23	1.31
ln $INVEST^D$	0.41	0.41	0.20	–0.53	–0.41	0.34	0.16	1.00										1.93	1.97
ln $INVEST^F$	0.43	0.15	0.53	–0.33	–0.58	0.19	0.30	0.33	1.00									2.10	2.18
ln $VARIETY^D$	0.45	0.19	0.16	–0.74	–0.45	0.21	0.12	0.46	0.30	1.00								2.44	
ln $VARIETY^F$	0.40	0.06	0.34	–0.42	–0.72	0.12	0.23	0.30	0.43	0.37	1.00							2.28	
ln $RELVAR^D$	0.16	0.20	0.09	–0.30	–0.21	0.15	0.03	0.17	0.11	0.66	0.19	1.00							1.27
ln $RELVAR^F$	0.28	0.04	0.29	–0.28	–0.33	0.05	0.18	0.15	0.16	0.26	0.70	0.16	1.00						1.45
ln $UNRELVAR^D$	0.49	0.12	0.16	–0.77	–0.48	0.17	0.13	0.50	0.33	0.89	0.37	0.24	0.24	1.00					2.68
ln $UNRELVAR^F$	0.38	0.07	0.27	–0.40	–0.78	0.13	0.19	0.32	0.49	0.35	0.90	0.16	0.33	0.37	1.00				2.78
ln $RELFDIVAR$	0.35	0.07	0.25	–0.32	–0.40	0.05	0.19	0.19	0.26	0.30	0.43	0.21	0.43	0.27	0.33	1.00			1.54
$FDISIM$	0.45	0.27	0.39	–0.51	–0.53	0.28	0.37	0.45	0.46	0.50	0.47	0.32	0.29	0.46	0.45	0.44	1.00		2.02

Appendix 4c. Pairwise correlation of coefficients and VIF values of variables in *Models 3* to *5* of *Table 4*.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**	**(17)**	**(18)**	**(19)**	**VIF values in**		
																				M (3)	**M (4)**	**M (5)**
ln $POPDENS$	1.00																			1.89	2.13	1.91
ln $AVGSIZE^D$	0.07	1.00																		1.58	1.85	1.50
ln $AVGSIZE^F$	0.24	0.11	1.00																	1.72	1.67	2.13
ln HHI^D	–0.57	0.00	–0.21	1.00																2.74	2.58	2.28
ln HHI^F	–0.56	–0.10	–0.22	0.53	1.00															2.64	2.25	2.49
ln $REGPROD^D$	0.21	0.34	0.14	–0.23	–0.18	1.00														1.19	1.39	1.32
ln $REGPROD^F$	0.21	0.16	0.38	–0.13	–0.26	0.17	1.00													1.22	1.32	1.46
ln $INVEST^D$	0.41	0.41	0.20	–0.53	–0.41	0.34	0.16	1.00												1.87	1.93	1.94
ln $INVEST^F$	0.43	0.15	0.53	–0.33	–0.58	0.19	0.30	0.33	1.00											2.05	2.10	2.11
ln $IMPVAR^D$	0.50	0.27	0.19	–0.66	–0.50	0.25	0.08	0.53	0.36	1.00										2.29		
ln $IMPVAR^F$	0.37	0.08	0.43	–0.42	–0.63	0.09	0.25	0.28	0.49	0.41	1.00									2.06		
ln $RELTRADVAR^{DD}$	0.44	0.29	0.14	–0.38	–0.40	0.23	0.06	0.36	0.27	0.57	0.30	1.00									1.75	
ln $RELTRADVAR^{DF}$	0.51	0.13	0.10	–0.45	–0.45	0.14	0.04	0.35	0.24	0.50	0.33	0.53	1.00								1.84	
$TRADESIM^{DD}$	0.35	0.48	0.22	–0.48	–0.35	0.50	0.17	0.49	0.30	0.65	0.29	0.48	0.33	1.00							2.60	
$TRADESIM^{DF}$	0.48	0.32	0.43	–0.52	–0.53	0.30	0.38	0.47	0.46	0.62	0.54	0.46	0.45	0.60	1.00						2.69	
ln $RELTRADVAR^{FD}$	0.39	0.07	0.35	–0.37	–0.49	0.08	0.28	0.26	0.38	0.30	0.44	0.38	0.36	0.27	0.48	1.00						1.65
ln $RELTRADVAR^{FF}$	0.32	0.10	0.35	–0.32	–0.45	0.15	0.25	0.24	0.32	0.30	0.55	0.27	0.35	0.28	0.45	0.45	1.00					1.52
$TRADESIM^{FD}$	0.45	0.27	0.45	–0.50	–0.54	0.32	0.41	0.45	0.49	0.54	0.59	0.42	0.36	0.55	0.80	0.52	0.43	1.00				2.53
$TRADESIM^{FF}$	0.32	0.13	0.63	–0.28	–0.47	0.16	0.54	0.24	0.50	0.31	0.63	0.22	0.19	0.26	0.56	0.37	0.47	0.59	1.00			2.71