APPLICATION OF WEIGHTED BLOCKMODELING IN THE ANALYSIS OF SMALL EU STATES' EXPORT PATTERNS[1]

Matevž Rašković, University of Ljubljana Faculty of Economics
Anja Žnidaršič, University of Maribor Faculty of Organizational Studies
Boštjan Udovič, University of Ljubljana Faculty of Social Sciences, Centre for International Relations

Abstract
This research note builds on the recent renaissance of network-based methodologies from the social sciences within economics. It outlines the applicability of (social) network analysis, and in particular builds on the recent methodological developments related to generalized blockmodeling of weighted networks. The research illustratively analyzes the inter-country EU export flows for 2008, and in particular focuses on the issue of universality vs. contingency of export patterns of small EU states. It provides a short interdisciplinary overview of the employed methodology, key theoretical concepts, and highlights possible extensions and avenues for further application. The presented results refute the universality perspective of small states' export patterns, at least in an inter-country EU context. The research note will hopefully stimulate the increasing use of network analysis and generalized blockmodeling in the analysis of international trade, as well as the fields of international economics and business.

Key words: *Network analysis, weighted blockmodeling, export patterns, EU small states*

1. INTRODUCTION

Social network analysis emerged at the beginning of the 20th century from sociometry and its *peripheral* position within the social sciences (Granovetter, 1973; Freeman, 1996). Building on the *interaction approach* and the *"primacy of relationships over atomized units"*, its origins can be traced far back into the history of scientific thought to *"influential thinkers from Heraclites to Einstein and from giants of sociology theory such as Marx, Durkheim. Weber, Goffman and even Parsons"* (Marin & Wellman, 2009, p. 5-6).

Social network analysis first became mainstream in the social sciences, where it was employed in the analysis of interaction within small groups, relating *"micro-level interactions to macro-level patterns"* (Granovetter, 1973, p. 1360), and the analysis of effects of various

[1] The authors wish to thank Marjan Svetličič (University of Ljubljana Faculty of Social Sciences) and Peter V. Marsden (Harvard University, FAS Sociology) for their comments and suggestions on how to improve the paper.

social structures. With the gradual *“narrowing of economics”* by the 1980s (Manski, 2000, p. 115), and the abandonment of atomized individualism, centralized and anonymous interaction, perfect rationality and symmetry of information the *“netization of economics”* (Fulik, 2001) over the last two decades begun to harness the interpretative power of network analysis in economics (Jackson, 2008, Goyal, 2011). This has led not only to a more ‘socialized’ and realistic account of economic behavior and its analysis, but towards the fundamental substantive understanding *“that economic actions are influenced by the context in which they occur”* (Gulati, 2007, p. 2).

The purpose of this research note is to outline the applicative and interpretative power of network analysis; and more specifically generalized blockmodeling of weighted network data of inter-country EU export flows. In this regard, it actually goes back to the earlier tradition of the *League of Nations’* (1942) network-influenced analysis of world trade flows, and Hilgerdt’s (1943) case for multinational trade; both of which can be regarded as the earliest employment of network analysis in the international trade literature.

Empirically, the research note focuses on a descriptive analysis between country size and export pattern diversification (e.g. Krugman, 1980; Melitz, 2003; Melitz & Ottaviano, 2005; Akerman & Forslid, 2007). Based on the obtained partitions within generalized blockmodeling of weighted network data, it compares the partitioning and positions of individual EU small states (up to 5 million inhabitants) within an inter-country EU export weighted network. In this respect, the deductive nature of the obtained results also sheds insight on small states’ export patterns. In the literature, export patterns of small states have been most often treated as universal, and with small states mostly being analyzed as *“a collective whole”* vis-à-vis other states (Liou & Ding, 2002).

2. COUNTRY SIZE AND TRADE PATTERN DIVERSIFICATION

Despite a growing interest in small states lead by the World Bank, and the alleged ‘vulnerability’ of small states in face of the global economic convergence (Briguglio, 1995), most of the work in the area of research on small states’ trade patterns remains peripheral[2], fragmented and/or case based. In a comprehensive review of research methodologies in

[2] Relative to either trade patterns of large states, or the distinction between developed or developing countries.

international business by Yang, Wang & Su (2006) published in the *International Business Review*, the authors show how 60.9 per cent of the reviewed international business studies in the period 1992-2003 published in the six leading international business journals are based on single country samples, 88.9 per cent from large Western markets.

While Liou & Ding (2002), and Udovič & Svetličič (2007) point to the absence of a universal typology of states according to their size, attempts have been made to systematically address the 'negative economic endowment' of small states (e.g. Easterly & Kraay, 2000; Holmes & Stevens, 2005) both in the international business and international economics literature, which are briefly overviewed next. While four different criteria may be applied for the selection of small countries (population size, geographical size, GDP / GNP size, and terms of trade) population size seems to be the most widely employed criterion (Read, 2001). Having said this, the population cut-off values for small countries range from 20 million proposed by UNIDO (1979) to 1.5 million by Commonwealth Secretariat (Commonwealth Advisory Group, 1997). In this paper the small state population threshold is set at 5 million as proposed by Collier & Dollar (1999); Looney, (1988); and Jalan (1982). While Udovič & Svetličič (2007) point to the most frequent cut-off value for small states is set in the literature at 10 million inhabitants, this cut-off value is usually set in analyzing world-wide trade patterns. In our opinion, a 5 million inhabitant cut-off value is more appropriate, given the characteristics of EU member states.

2.1 Short overview of the small states' trade perspective in the international economics literature

Economists have long been interested in the impact of country size on myriad international economic indicators, including trade patterns (Holmes & Stevens, 2005). In particular, the link between country size and export patterns was explored by the Nobel economist Paul Krugman (1980)[3] and inspired by the initial work of Grubel & Lloyd (1975) on intra-industry international trade in differentiated products. Krugman's conclusions were that small countries tend to focus their export structures to goods with constant returns, shying away

[3] Followed by a stream of research by Helpman & Krugman (1985), Krugman (1991) and Krugman & Venables (1995). However, especially Krugman (1991) and Krugman & Venables (1995) work focuses on the issue of the so called *agglomeration economies of scales* and the economic geography of trade between developed and developing countries, mainly in a North-South economic geography trade context.

from industries characterized by economies of scale and increasing returns[4]. However, Krugman's (1980) model and results rest on a set of "extreme" assumptions of *homogeneity of all firms* (homogeneity of productivity), *full labor mobility* and *zero transportation costs* for the constant-return sectors. The latter assumption was challenged by Davis (1998), who has showed it to be *"implausible"*; and relaxing this assumption actually *"overturns"* Krugman's results (Holmes & Stevens, 2005, p. 490).

More importantly however, Melitz (2003) extended Krugman's (1980) model and included *firm (productivity) heterogeneity* showing, how only the most productive firms can afford to incur the high costs of exporting. If firm heterogeneity in productivity is a key contribution of Melitz to the international economics literature, then the observation of Syverson (2004, 2007), Melitz & Ottaviano (2005), and Akerman & Forslid (2007) that *"firms [are] being more productive in larger (denser) markets"* (Akerman & Forslid, 2007, p. 2) has clear implications also for the relationship between country size and export patterns of small countries, especially given Melitz's firm-level perspective. This has in turn further been complemented by the work of Damijan, Kostevc & Polanec (2010) who have included *financial constraints* and *demand risks* to show why a great majority of firms stop exporting after their first year or why firms expand their exporting operations at a slower pace. In both cases a strong argument lends itself to believing that such constraints may be more prevailing and detrimental in small markets vs. large markets.

In addition, *extensive and intensive margin structures* (Holmes, 1999; Hummels & Klenow, 2005; Felbermayr & Kohler, 2005) and the *resources-capabilities-product-space configurations* (Hidalgo & Hausmann, 2009) may also be inferred from the international economics literature as possible sources of small countries' international trade 'disadvantages'. Alesina, Spolaore & Wacziarag, (2005) also showed how small states may be more risk averse and have *different preferences for economic policies*, as well as a different motivation and propensity towards *preferential trade agreements* (Michaely, 1998) and inclusion in Regional Trade Agreements (Magee, 2008; Egger & Larch, 2008). In particular, small states are thought to benefit more from preferential bilateral trade agreements that are on the decline due to both regional and global integration processes (Armstrong & Read, 1998). The moderating impact of country size on the impact and role of international trade

[4] For more about this please see Krugman (1980), and Holmes & Stevens (2005).

institutions such as WTO should also be considered (Rose, 2004), as small states tend to have limited international political and economic sway (Subramanian & Wei, 2007). In addition, Crossley (2001, p. 219) also points out how small states are also more *"vulnerable to the influence of international agendas, partly because of the dependency of their economies upon transitional markets and global socio-political trends."*

2.2 Short overview of the small states' trade perspective in the international business literature

In the international business and marketing literature the relevance of country size is in the context of international trade perhaps most obvious through the concept of company *internationalization motives* (Czinkota, Ronkainen & Moffett, 2004; Hollensen, 2007). Similarly, empirical evidence by Glas et al. (1999) indicates that a small domestic market has not only a direct impact on the internationalization of small and medium-sized enterprises (SMEs), as it forces them to internationalize much sooner and without the safety net of a large domestic market, but also impacts the survival and growth aspect of internationalized SMEs and entrepreneurship (see also Chetty & Blakenburg Holm, 2000). Complementing this view Ruzzier, Hisrich & Antoncic (2006, p. 481; *cf.* Buckley & Casson, 1993) outline how traditional internationalization theory *"centers on the notion that firms aspire to develop their own internal markets"* which enable them cost advantages. These are matched to the benefits of internationalization to result in optimal internationalization patterns of companies. Thus, by country size affecting the cost structures of company "internal (domestic) markets", it affects also their cost-benefit equilibriums and trade patterns. Such a view may also be linked to the *cost vs. value added trade-offs* outlined by Porter (1990). Making an inference about the impact of the domestic market size on the scale economics of these *"internal markets"* does not require a huge leap of faith. Furthermore, as small domestic market size impacts the internationalization behavior of companies in small states, this also leads to differences in *international experience and know-how* (Hollensen, 2007), which additionally constrain future internationalization patterns. On the other hand domestic market size does not only impact the cost aspect of company *"internal markets"* but also impacts their available resources. In this light, not only financial, but also other resources should be considered. Thus, Streeten (1993) points to more limited human capital pools, while Crossley (2001, p. 219) points to a stronger overall need for *"capacity-building and human resource development."*

Linking both perspectives, empirical evidence shows that small states tend to *concentrate their exports* both geographically (see Udovič & Rašković, 2010 for an overview) and in terms of industries (Meilak, 2008), indicating limited resources, capabilities, experience and skills in exporting. Adding to this, different propensities towards *foreign direct investments* also impact the global competitiveness of small states, both in terms of their domestic markets, as well as their internationalization scopes (Greaney, 2003). Higher levels of *risk aversion* (Malhotra, Sivakumar & Zhu, 2011) additionally profoundly impact the market entry modes of companies from small markets. And last, but not least, *cross-cultural and psychic distances* between large and small markets also play a key role in the internationalization patterns of small states (Guo, 2004; Dow & Karunaratna, 2006).

3. WEIGHTED BLOCKMODELING AND THE NETWORK ANALYSIS PERSPECTIVE

3.1 Network operationalization

A network can be described simply as a graph with some additional information about the vertices (units of observation), and the ties (links) between them. Let the following notations describe a network in mathematical form (Wasserman & Faust, 1994):

- A set of vertices (actors): $U = \{u_1, u_2, \dots , u_n\}$.
- A set of ties (relationships) between vertices: $R = \{r_1, r_2, \dots , r_m\}$.
- And where a network can be operationalized as: $N = (U, R)$.

Extending the above mathematical notation of a network to weighted or value networks, where the ties between vertices do not simply exist, but take on various values (weights), the following mathematical notation can be used to describe a weighted network (Wasserman & Faust, 1994):

- A real-valued $n \times n$ adjacency matrix w, where w_{ij} corresponds to the (possibly weighted and/or directed) tie between i and j.
- Where in case of the directed network $w_{ij} \neq w_{ji}$ (and $w_{ij} = w_{ji}$ for the undirected network).
- And where a weighted network can be operationalized simply as: $N = (U , W)$.

3.2 Generalized blockmodeling of network data

The general idea of blockmodeling, as a partitioning procedure assigning network actors into clusters called positions can be traced back to the work by Lorrain & White (1971) on structural equivalence[5], and followed by Breiger et al. (1975), and Burt (1976). This was subsequently expanded to regular equivalence[6], *"as another principle for blockmodeling network data"* (Doreian, Batagelj & Ferligoj, 2004, p. 29). By the beginning of the 1990s blockmodeling procedures of network data were employed indirectly, through converting the network into a similarity or dissimilarity matrix, and applying to it various possible clustering algorithms. By 1992 Batagelj et al. (1992a, 1992b) devised an alternative direct blockmodeling approach. As Doreian, Batagelj & Ferligoj (2003, p. 29) summarize: *"their approach was built upon the recognition that both structural and regular equivalence define certain block types if a partition of actors and ties is exact and consistent with the type of equivalence. For structural equivalence, the ideal blocks are null and complete (Batagelj et al. 1992a), and for regular equivalence, the ideal block types are null and regular (Batagelj et al. 1992b). Subsequently, blockmodeling was generalized to permit many new types of blocks."*[7] By 2007 Žiberna (2007, 2008) extended the work by Doreian, Batagelj & Ferligoj on generalized blockmodeling of binary one-mode and two-mode network data to weighted (one-mode) network data, which is summarized in the next section of the paper (based on the assumption that due to its mathematical background and novelty, most readers are not familiar with this methodology).

3.3 Operationalization and description of the weighted blockmodeling approach

Mathematically, *weighted generalized blockmodeling* can be operationalized and described as follows (Žiberna, 2007, p. 107):

- $N = (U, W)$; where W corresponds to the weighted matrix of relations R with elements w_{ij}, and where $w: R \rightarrow \mathbb{R}$, where:

[5] For a formal definition of structural equivalence related to weighted network data, please see Žiberna (2007).
[6] For a formal definition of regular equivalence, please see White & Reitz (1983).
[7] For more on this, please see Doreian et al. (1994), Batagelj (1997), and Doreian, Batagelj & Ferligoj (2005).

$$w_{ij}\begin{cases} w\ (i,j), (j,i) \in R \\ 0, otherwise \end{cases}$$

- C_i corresponds to a cluster of units, and where **C** = $\{C_1, C_2, \ldots, C_n\}$ is a partition of the set U; $\bigcup_{i=1}^{n} C_i = U$; and $C_i \cap C_i = 0$; $i \neq j$
- And where ϕ corresponds to a set of feasible partitions
- Where **C** also partitions R into a series of blocks; $R\left(C_i, C_j\right) = R \cap C_i \times C_j$
- Each block contains unit belonging to C_i and C_j and all ties leading from cluster C_i to C_j. If $i = j$, a block $R\ (C_i, C_i)$ is referred to as a diagonal block
- $T\ (C_i, C_j)$ denotes a set of *ideal blocks*[8], corresponding to an empirical block $R\ (C_i, Cj)$
- f corresponds to a function, which assigns to a valued vector of length n a real value $f: \mathbb{R}^n \rightarrow \mathbb{R}$ (Žiberna outlines a series of possible functions, e.g. *mean, maximum, sum* etc.).
- Next, *"The criterion function of the valued blockmodeling measures block inconsistencies as the deviation of appropriate values from either 0 or the value determined by the parameter m"* (Žiberna, 2007, p. 106).
- Furthermore $\delta(R(C_i, C_j), T)$ corresponds to the measure of deviation (i.e. inconsistency) of the empirical block $R(C_i, C_j)$ vis-à-vis the ideal block $T \in T(C_i, C_j)$; and where $p(C_i, C_j)$ corresponds to block inconsistency.
- Žiberna (2007, p. 109) concludes that *"the total inconsistency of P(***C***) of a partition* **C** *can be expressed as sum of inconsistencies within each block (block inconsistencies) across all blocks"*.

Describing it most simplistically, the weighted generalized blockmodeling approach (based on Žiberna's algorithm) consists of three key steps. In the first step *homogeneity blockmodeling* is performed on the weighted network data (inter-country EU export patterns). This produces a series of *image matrices* for the estimation of the m parameter. In the second step, the m parameter is chosen arbitrarily (usually at an interval), and corresponds to the minimally important cut-off value that characterizes a tie between units in a network. In the third step, valued blockmodeling is performed based on the estimated m parameter(s), and the best final partitioning of the original weighted network data is selected.

[8] Žiberna (2007) outlines a series of different types of *ideal blocks*; please refer to Žiberna (2007) for more on this.

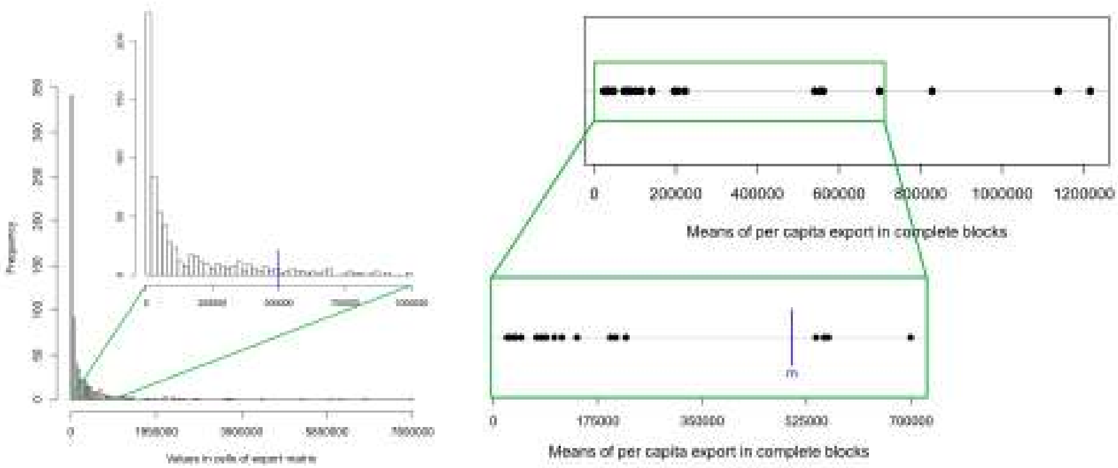
4. RESULTS

The data for our analysis of inter-country EU-27 export flows are given for the year 2008, and were obtained from the EU statistical office of Eurostat. The analyzed export flows from country *i* to *j* are per capita export flows (in 1000 EUR), standardized with the population of exporting country *i*. Weighted generalized blockmodeling was performed in the statistical software package *R*, based on Žiberna's (2007) algorithm for weighted generalized blockmodeling of network data.

4.1 Results of homogeneity blockmodeling

The general foundation for homogeneity blockmodeling was laid by Borgatti & Everett (1992). As outlined by Žiberna (2007, p. 114) homogeneity blockmodeling *"searches for the partition where the sum of some measure of within block variability over all blocks is minimal"* and *"the measure of variability measures the inconsistency of an empirical block with the ideal block. Based on this definition of block inconsistency, ideal blocks for homogeneity blockmodeling can be defined"* and corresponded to an appropriate criterion function. Figure 1 shows the results of the homogeneity blockmodeling approach on the original inter-country standardized and weighted export data for obtaining optimal partitions based on sum of squares measure of variability, and mean-regular blocks.

Figure 1: Means of per capita exports in complete blocks obtained from homogeneity blockmodeling



Source: Own analysis in *R*, based on sum of squares measure of variability, and mean-regular blocks.

Based on Žiberna's (2007) recommendations, and looking at the distributions of export flows in the original weighted country-by-country data matrix the most appropriate *m* parameter interval was determined to be between 222,500 and 540,000 EUR of per capita exports.

4.2 Estimation of the m parameter

According to Žiberna's (2007) recommendations, the estimation of the *m* parameter within an obtained interval, obtained from homogeneity blockmodeling, is still to a degree arbitrary, and should be complemented by additional knowledge and background data, as well as subject to the interpretative power of the obtained end result of valued blockmodeling. Having said this Table 1 provides supporting descriptive data for the estimation of the *m* parameter.

Table 1: Descriptive statistics of inter-country EU export trade (2008 data)

Country (size)	Share of EU exports	Normalized share of neighboring market EU exports*	Average p. c. export to EU country	Country (size)	Share of EU exports	Normalized share of neighboring market EU exports*	Average p. c. export to EU country
Austria (M)	72%	11.6%	396,210	Latvia (S)	68%	13.7%	76,860
Belgium (M)	76%	15.2%	856, 220	Lithuania (S)	64%	11.0%	106,650
Bulgaria (M)	64%	14.4%	44,130	Luxemburg (S)	87%	14.2%	1,168,060
Cyprus (S)	67%	38.4%	27,910	Malta (S)	42%	11.7%	81,620
Czech R. (M)	85%	15.0%	301,730	Netherlands (M)	77%	15.2%	771,970
Denmark (M)	67%	15.6%	372,100	Poland (L)	79%	11.2%	87,600
Estonia (S)	69%	15.1%	162,920	Portugal (M)	75%	18.1%	93,360
Finland (M)	56%	11.0%	256,060	Romania (L)	74%	6.6%	40,870
France (L)	62%	10.2%	153,250	Slovakia (M)	86%	9.7%	283,050
Germany (L)	63%	5.2%	280,030	Slovenia (S)	69%	11.2%	291,070
Greece (M)	63%	14.6%	37,020	Spain (L)	69%	20.0%	107,200
Hungary (M)	79%	5.2%	212,640	Sweden (M)	58%	6.7%	300,430
Ireland (S)	61%	38.6%	451,270	UK (L)	55%	12.4%	107,320
Italy (L)	57%	7.2%	134,560				

Source: Eurostat, 2010. Notes: S-small state (up to 5 million inhabitants), M-medium state (up to 20 million inhabitants), L-large state (over 20 million inhabitants). * Total share of EU exports, divided by the number of EU neighboring markets. For island states and states with sea access, neighboring markets were constrained to a 1,000 km parameter.

Based on the corresponding descriptive statistics in Table 1, a normal average flow of per capita exports to an individual EU country ranges 295,520 EUR per capita for a small state, 327,077 EUR per capita for a medium sized state, and 130,119 EUR per capita for a large state. In terms of the alleged propensity of small states towards a higher concentration of their exports to neighboring markets, we can say that in general this is not the case, taking into account the number of actual EU neighbors (as seen in our normalized share of neighboring

EU market exports), and some 'outlier' countries (e.g. Luxemburg and Ireland) with high FDI intakes. Calculating a weighted[9] composite average of inter-country export flows for the last quartile[10] for each individual country, the obtained estimate comes just below the 500,000 EUR per capita cut-off value, and corresponds well within our interval estimate of the *m* parameter, which was consequently set at 500,000 EUR per capita exports.

4.3 Final weighted blockmodeling partitions

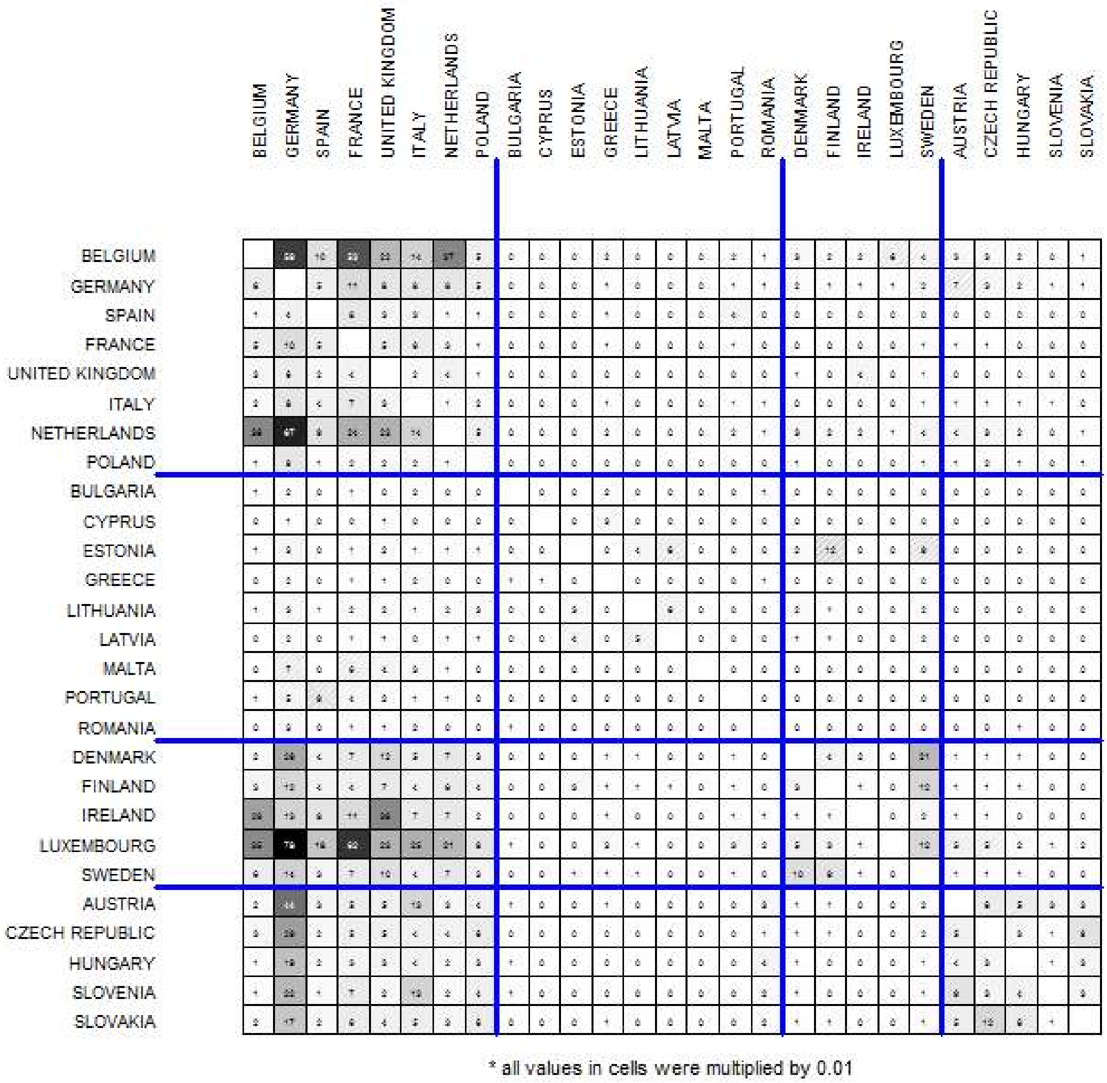
Setting the *m* parameter at 500,000 EUR per capita exports Figures 2 and 3 display two final valued blockmodeling partitions, based on 4 and 5 country clusters respectively. A 4-cluster country solution is based on a dissimilarity hierarchical clustering approach, using Ward's method, which identified a set of 4 distinct and interpretable clusters.

The obtained partitioning, based on a 4-cluster solution, shows the first cluster of the most important economic markets in the EU, accompanied by Poland, which is the only accession and eastern country in the group. Within this block, the level of intra-country exports is quite strong, and on average exceeds the 500,000 EUR per capita value (corresponding to a complete block in terms of blockmodeling). A similar observation also holds for the Scandinavian cluster, which also includes Luxembourg, and the last Central-European cluster grouped around Austria.

Turning our attention to a small states' perspective within this blockmodeling solution, we can see the second cluster includes Cyprus, the three Baltic countries, and Malta or five out of the eight EU small states. Apart from Estonia, these are relatively comparable in terms of economic development and level of incoming FDIs. Characterizing this cluster is a relatively low level of inter-country exports, which are in turn tied closest to the first cluster of the most economically important markets within the EU. On the other hand, the three remaining small states, namely Luxemburg, Ireland and Slovenia are all assigned to clusters with high inter-country exports, as well as strong ties to the most economically important markets within the EU. In this regards, a bipartite structure of small states emerges, where the less economically developed ones seem to be tied only to the economic EU 'core' and remain at the periphery, while the more economically developed ones are well integrated into regional 'cliques'.

[9] Where weights correspond to country population sizes.
[10] Assuming this corresponds to high inter-country export intensity.

Figure 2: A final weighted generalized blockmodel, based on 4 clusters and m=500,000[11] EUR per capita exports



Source: Own analysis in *R*; data from Eurostat, 2010. Note: A cell value between e.g. Netherlands and Germany of 67 corresponds to 6,700,000 EUR of per capita exports (since original data was in 1000 EUR and cell values were multiplied by 0.01 for better representation of the data).

Complementing this perspective Table 2 offers some additional supporting data on the small states in question.

[11] Since original Eurostat data was in 1000 EUR.

Table 2: Additional descriptive data on EU small states (data for 2008)

Country	Assigned cluster	Within block average p. c. exports	GDP per capita as a % of EU average	Share of exports to EU	EU tenure
Cyprus	2nd cluster	< 500,000 EUR	Between 80% and 100%	67%	new
Estonia	2nd cluster	< 500,000 EUR	Below 80%	69%	new
Latvia	2nd cluster	< 500,000 EUR	Below 80%	68%	new
Lithuania	2nd cluster	< 500,000 EUR	Below 80%	64%	new
Malta	2nd cluster	< 500,000 EUR	Below 80%	42%	new
Ireland	3rd cluster	> 500,000 EUR	Over 100%	61%	old
Luxembourg	3rd cluster	> 500,000 EUR	Over 100%	87%	old
Slovenia	4th cluster	> 500,000 EUR	Between 80% and 100%	69%	new

Source: Eurostat, 2010.

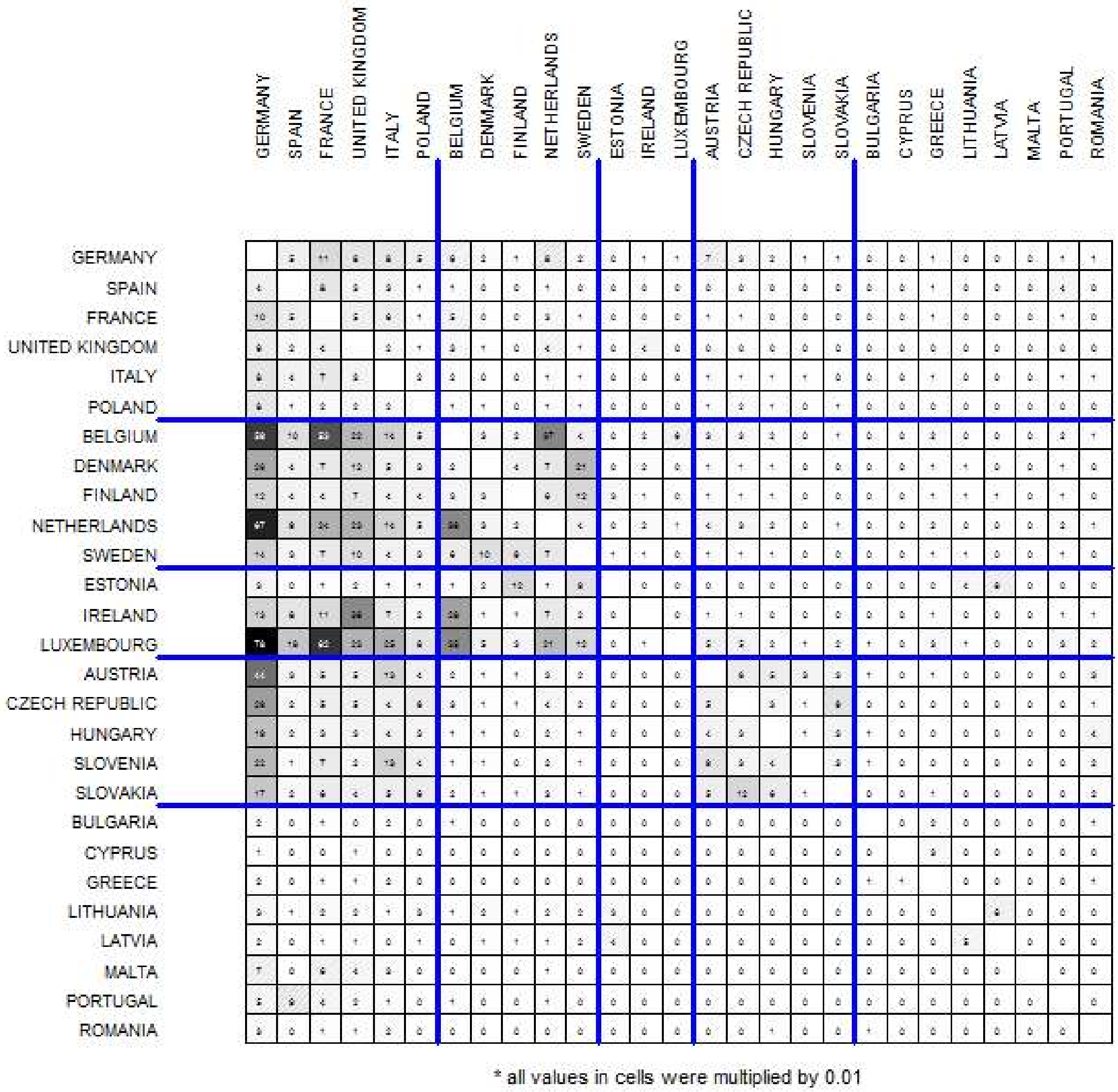
Next, Figure 3 displays also a 5-cluster solution[12] where most importantly Estonia joins Ireland and Luxemburg in their own cluster.

In a 5-cluster partitioning solution the main economic 'core' remains the same and still includes Poland. The second cluster shows a strong Scandinavian-Benelux group, with strong inter-country exports also among themselves. Interestingly, the third cluster includes only Estonia, Ireland and Luxemburg, which are all small states with intake of FDIs. The fourth cluster again includes a strong Central European 'clique', while the fifth cluster can be described as the less developed group of Southern and East European member states.

More specifically addressing the perspective of particular small states within a 5-cluster partitioning solution, we see a three-part structure. The first group includes high recipients of FDIs (Estonia, Ireland and Luxembourg), which are closely tied to specific EU markets but have a low level of exports among themselves. The second type of a small state is represented in Slovenia, which is relatively economically developed and well integrated within a strong CEE regional clique.

[12] This solution was obtained through an interactive-split CONCOR partitioning procedure in the social network analysis statistical package UCINET VI, producing the best overall goodness-of-fit statistic (density) of 0.55.

Figure 3: A final weighted generalized blockmodel, based on 5 clusters and *m*=500,000[13] EUR per capita exports



Source: Own analysis in *R*; data from Eurostat, 2010. Note: A cell value between e.g. Netherlands and Germany of 67 corresponds to 6,700,000 EUR of per capita exports (since original data was in 1000 EUR and cell values were multiplied by 0.01 for better representation of the data).

The third group of small states is represented in the last cluster, and pertains to relatively less developed small member states, which are tied mostly to the most important EU markets, but have a low level of exports among themselves.[14]

[13] Since original Eurostat data was in 1000 EUR.
[14] This remains persistent even, if we further split this cluster into a South European and East European subgroup.

5. LIMITATIONS OF THE RESEARCH

The first set of limitations of our research pertain to the fact that our analysis of inter-country EU export flows does not represent a strictly complete network set, since it does not capture inter-country export patterns outside the EU. These patterns are particularly important for countries with substantial offshore FDIs (e.g. Ireland, Hungary etc.) and for countries with close historic, cultural and trade colonial ties outside the EU (e.g. France, Portugal, the UK etc.). Furthermore, other bases for the standardization of export flows could also be employed, apart from simple population sizes of exporting countries.

The second set of limitations can be related to the discretionary nature of setting the *m* parameter for valued blockmodeling within Žiberna's procedure of weighted generalized blockmodeling. In this context, substituting structural equivalence with regular equivalence and a mean-based function with some other function within homogeneity blockmodeling produced fairly comparable results. However, our homogeneity blockmodeling procedure produced quite a broad interval for the *m* parameter, ranging between 222,500 and 540,000 EUR of inter-country per capita exports. In this regard, our final decision on the value of the *m* parameter still remains arbitrary, although based on additional descriptive data, based on a weighted composite average of last quartile per capita exports for each EU country.

The third reservation relates directly to the data itself. Although the year 2008 saw only the beginning of the current economic and financial crisis in Europe in the last quarter, it may have already impacted export behavior of countries with substantial overseas FDIs (mainly from the US, as e.g. with Ireland). In addition, the analyzed data was based on current market prices, and further subject to currency exchange biases, since not EU-27 member states are members of the Eurozone.

6. FURTHER USE OF THE WEIGHTED NETWORK METHODOLOGY TOOLS

As outlined by Freeman (2004), and Wasserman & Faust (1994) *"most [traditional] social network measures are solely defined for binary situations and, thus, unable to deal with weighted networks directly"* (Opsahl, Agneessens & Skvoretz, 2010, p. 245). However, the exponential growth of employment of social network analysis tools in a plethora of economic contexts (Goyal, 2009), and the valued nature of economic phenomena (Jackson, 2008) have also posed new challenges to the field of social network analysis itself, and consequently resulted in the development of new tools for the analysis of weighted network data. This may be linked to the view of Goyal (2009, p. 7) that the *"distinctiveness of the economic approach"* applied to traditional network contexts calls for *"different methodology"* and analytical approaches, which in turn challenge and benefit the field of social network analysis as well.

Having said this, current methodological development for analyzing weighted network data currently support the calculation of weighted *degree*, *closeness* and *betweeness* centrality scores (see Opsahl, Agneessens & Skvoretz, 2010), which can be used to measure the relative and unique importance of specific (small) states within the whole inter-country EU export network. Complementing the recent developments on generalized weighted blockmodeling by Žiberna (2007, 2008) Opsahl & Panzarasa (2009) have also proposed a generalization of the *global clustering coefficient* for weighted network data, which could also be applied to the inter-country EU export network to test the general propensity of EU member states towards clustering. Moving beyond the descriptive nature of the outlined weighted network analysis tools the developments related to *exponential random graph modeling* (ERGMs) of weighted network data (see the *statnet project* and Handcock et al., 2003) signal a new potential area in probability-based network modeling.

Moving beyond the field of network analysis itself, the outlined generalized weighted blockmodeling procedure, as well as the other highlighted weighted network analysis tools can easily and effectively be complemented by regression analysis, gravity models and multi-level modeling. Furthermore, the recent work on country *resources, capabilities and product-space configurations* by Hidalgo & Hausmann (2009) also highlight the potential of two- or even three-mode weighted network analysis, in helping explain country trade patterns.

7. CONCLUSION

The purpose of this research note was to introduce and highlight the applicability of network analysis, and in particular the recent methodological developments in weighted generalized blockmodeling for the analysis of inter-country export patterns. In this regard, the focus on inter-country EU exports in general, and the export patterns of small EU member states in particular, served as an illustrative example. Our results show that small states cannot be treated simply as a collective whole in terms of their export patterns, as has been often the case in the international economics and business literature. Within an inter-country EU export context small states in general do not tend to concentrate their exports to neighboring EU markets, once taking into account the number of EU neighboring markets of a particular country. In addition, the results of our generalized weighted blockmodeling show that some EU member states display very high within-cluster exports, while others are more individually tied only to specific large EU economic 'core' markets. This distinction seems to correspond to the level of economic development, as well as the level of incoming FDIs, and future research should explore this perspective in more detail.

The descriptive nature of the employed analysis on the one hand corresponds to the descriptive nature of network analysis itself. Thus, according to (Kadushin, 2004) social network analysis is one of the few methodologies which are not reductionist. In this regard, it can be used as a power methodological tool and combined with other more confirmatory methodological approaches used traditionally in the analysis of trade patterns, such as e.g. regression analysis and gravity models.

REFERENCES

1. Akerman, A., and Forslid, R., "Country Size, Trade, and Productivity: An analysis of heterogeneous firms and differential beachheaded costs," accessed November 30, 2010, http://www.ne.su.se/paper/wp07_14.pdf.
2. Alesina, A., and Spoalare, E., "On the number and size of nations," *Quarterly Journal of Economics* 112 (2005): 1027-1056.
3. Armstrong, H. W., and Read, R., "Trade and growth in small states: the impact of global trade liberalization," *The World Economy* 21 (1998): 563-585.
4. Batagelj, V., Doreian, P., and Ferligoj, A., "An optimizational approach to regular equivalence," *Social Networks* 14 (1992a): 121-135.
5. Batagelj, V., Ferligoj, A., and Doreian, P., "Direct and indirect methods for structural equivalence," *Social Networks* 14 (1992b): 63-90.
6. Batagelj, V., "Notes on blockmodeling," *Social Networks* 19 (1997): 143-155.

7. Breiger, R. L., Boorman, S. A., and Arabie, P., “An algorithm for clustering relational data with applications to social network analysis and comparison to multidimensional scaling,” *Journal of Mathematical Psychology* 12 (1975): 328–383.
8. Briguglio, L., “Small island developing states and their economic vulnerabilities,” *World Development* 23 (1995): 1615-1632.
9. Buckley, P. J., and Casson, M., *The internationalization of the firm: a reader* (London, UK: Academic Press, 1993).
10. Burt, R. S., “Positions in networks,” *Social forces* 55 (1976): 93-122.
11. Chetty, S., and Blakenburg Holm, D., “Internationalization of small and medium-sized manufacturing firms: a network approach,” *International Business Review* 9 (2000): 77-93.
12. Collier, P., and Dollar, D., “Aid, risk, and the special concerns of small states,” (paper presented the World Bank – Commonwealth Secretariat Conference on Small States, St. Lucia, February 17-19, 1999).
13. Commonwealth Advisory Group, *A future for small states: overcoming vulnerability* (London, UK: Commonwealth Secretariat, 1997).
14. Crossley, M., “Cross-cultural issues, small states and research: capacity building in Belize,” *International Journal of Educational Development* 21 (2001): 217-229.
15. Czinkota, M. R., Ronkainen, I. A., and Moffett, M. H., *International Business*, 7th ed (Mason, OH: Thomson/South-Western, 2004).
16. Damijan, J., Kostevc, Č., and Polanec, S., “From innovation to exporting or vice versa?” *The World Economy* 33 (2010): 374-398.
17. Davis, D. R., “The home market, trade, and industrial structure,” *American Economic Review* 88 (1998): 1264-1276.
18. Doreian, P., Batagelj, V., and Ferligoj, A., “Partitioning networks based on generalized concepts of equivalence,” *Journal of Mathematical Sociology* 19 (1994): 1-27.
19. Doreian, P., Batagelj, V., and Ferligoj, A., “Generalized Blockmodeling of Two-mode Network Data,” *Social Networks* 26 (2004): 29-53.
20. Doreian, P., Batagelj, V., and Ferligoj, A., *Generalized blockmodeling* (Cambridge, UK: Cambridge University Press, 2005).
21. Dow, D., and Karunaratna, A., “Developing a multidimensional instrument to measure psychic distance stimuli,” *Journal of International Business Studies* 37 (2006): 578-602.
22. Easterly, W., and Kraay, A., “Small States, Small Problems? Income, Growth, and Volatility in Small Sates,” *World Development* 28 (2000): 2013-2027.

23. Egger, P., and Larch, M., “Interdependent preferential trade agreement memberships: An empirical analysis,” *Journal of International Economics* 76 (2008): 384-399.
24. Felbermayr, G., and Kohler, W., “Exploring the Extensive and Intensive Margins of World Trade,” *Review of World Economics* 142 (2005): 642-674.
25. Freeman, L. C., “Some antecedents of Social Network Analysis,” *Connections* 19 (1996): 39-42.
26. Freeman, L. C., *The Development of Social Network Analysis: A Study in the Sociology of Science* (North Charleston, SC: BookSurge, 2004).
27. Fulik, J., “Global network organizations: Emergence and future prospects,” *Human Relations* 54 (2001): 91-99.
28. Glas, M., Hisrich, D. R., Vahčič, A., and Antončič, B., “The internationalization of SMEs in transition economies: Evidence from Slovenia”, *Global focus* 11 (1999): 107-124.
29. Goyal, S., *Connections: An introduction to the Economics of Networks*. 2ed (Princeton and Oxford: Princeton University Press, 2009).
30. Goyal, S., “Social Networks in Economics,” in *The SAGE Handbook of Social Network Analysis*, eds. Carrington, P., and Scott, J. (London, UK: SAGE Publications, 2011).
31. Granovetter, M., “The Strength of Weak Ties,” *The American Journal of Sociology* 78 (1973): 1360-1380.
32. Greaney, M. T., “Reverse importing and asymmetric trade and FDI: a network explanation,” *Journal of International Economics* 61 (2003): 453-465.
33. Grubel, H., and Lloyd, P., *The Intra-industry Trade: The Theory and Measurement of International Trade in Differentiated Products* (London, UK: Basingstoke, 1975).
34. Gulati, R., *Managing network resources: Alliances, affiliations, and other relational assets* (New York: Oxford University Press, 2007).
35. Guo, R., “How culture influences foreign trade: evidence from the US and China,” *The Journal of Socio-Economics* 33 (2004): 785-812.
36. Handcock, M. S., Hunter, D. R., Buttes, C. T., Goodreau, S. M., and Morris, M., *Statnet: Software Tools for the Statistical Modeling of Network Data*, available since 2003 at http://statnetproject.org.
37. Hidalgo, A. C., and Hausmann, R., “The building blocks of economic complexity,” *PNAS* 106 (2009): 10570-10575.
38. Hilgerdt, F., “The Case for Multilateral Trade,” *American Economic Review* 33 (1943): 393-407.

39. Hollensen, S., *Global marketing: A decision-oriented approach*, 4ed (New York: Financial Times/Prentice Hall, 2007).
40. Holmes, T. J., “Scale of location production and city size,” *American Economic Review* 89 (1999): 317-320.
41. Holmes, T. J., and Stevens, J. J., “Does home market size matter for the pattern of trade?” *Journal of International Economics* 65 (2005): 489-505.
42. Hummels, D. L., and Klenow, P. J., “The Variety and Quality of a Nation’s Exports,” *American Economic Review* 95 (2005): 704-723.
43. Jackson, M. O., *Social and Economic Networks* (Princeton and Oxford: Princeton University Press, 2008).
44. Jalan, B., *Problems and Policies in Small Economies* (New York: St. Martin's Press, 1982).
45. Kadushin, C., *Introduction to Social Network Theory*: *Some Basic Network Concepts and Propositions*, paper accessed on March 17, 2011, http:// www.communityanalytics.com/Portals/0/Resource_Library/Social%20Network%20Theory_Kadushin.pdf.
46. Krugman, P. R., “Scale economies, Production differentiation, and Pattern of Trade,” *American Economic Review* 70 (1980): 950-959.
47. League of Nations, *The World Trade Network* (Princeton: Princeton University Press, 1942).
48. Liou, F. M., and Ding, C. G., “Subgrouping small states based on socioeconomic characteristics,” *World Development* 30 (2002): 1289-1306.
49. Looney, R. E., “Macroeconomic consequences of size: the effectiveness of government expenditures in smaller developing nations,” *Manchester Papers on Development* 4 (1988): 503-525.
50. Lorrain, F., and White, H. C., »Structural equivalence of individuals in social networks, ” *Journal of Mathematical Sociology* 1 (1971): 49–80.
51. Magee, C., “New measure of trade creation and trade diversion,” *Journal of International Economics* 75 (2008): 349-362.
52. Malhotra, S., Sivakumar, K., and Zhu, P., “A comparative analysis of the role of national culture on foreign market acquisitions by U.S. firms and firms in foreign emerging countries,” *Journal of Business Research*, forthcoming issue (no volume or pages yet given), 2011.

53. Manski, C., "Economic Analysis of Social Interactions," *The Journal of Economic Perspectives* 14 (2000): 115-136.
54. Marin, A., and Wellman, B., "Social Network Analysis: An Introduction," in 2010: *Handbook of Social Network Analysis*, eds. Carrington, P., and Scott, J. (London, UK: SAGE Publications, 2011).
55. Melitz, J. M., "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica* 71 (2003): 1695-1725.
56. Meilak, C., "Measuring Export Concentration: The Implication for Small States," *Bank of Valletta Review* 37 (2008): 35-48.
57. Melitz, J. M., and Ottaviano, G. I. P., "Market size, trade and productivity," *NBER Working paper no. 11393* (2005).
58. Michaely, M., "Partners to preferential trade agreement: Implications of varying size," *Journal of International Economics* 46 (1998): 73-85.
59. Opsahl, T., and Panzarasa, P., "Clustering in weighted networks," *Social Networks* 31 (2009): 155-163.
60. Opsahl, T., Agneessens, F., and Skvoretz, J., "Node centrality in weighted networks: Generalizing degree and shortest path," *Social Networks* 32 (2010): 245-251.
61. Porter, E. M., *The Competitive Advantage of Nations* (New York, NY: Free Press, 1990).
62. Read, R., "Growth economic development and structural transition in small vulnerable states," *United Nations University Discussion Paper* 59 (2001).
63. Rose, A. K., "Do we really know that the WTO increases trade?" *American Economic Review* 94 (2004): 98-114.
64. Ruzzier, M., Hisrich, R. D., and Antoncic, B., "SME internationalization research: past, present and future," *Journal of Small Business and Enterprise Development* 13 (2006): 476-497.
65. Streeten, P., "The special problems of small countries," *World Development* 21 (1993): 197-202.
66. Subramanian, A., and Wei, S. J., "The WTO promotes trade, strongly but unevenly," *Journal of International Economics* 72 (2007): 151-175.
67. Udovič, B., and Svetličič, M., "Majhne države v novih teorija mednarodne trgovine," *Teorija in praksa* 44 (2007): 29-4.
68. Udovič, B., and Rašković, M., "Export markets and types of international market(ing) cooperation of top Slovene exporters: has the crisis taught us nothing?" *MM Akademija* 15 (2010): 69-84.

69. UNIDO, *World Industry Since 1961: Progress and Prospects* (Vienna: UNIDO, 1979).
70. Yang, Z., Wang, X., and Su, C., "A review of research methodologies in international business," *International Business Review* 15 (2006): 601-617.
71. Wasserman, S., and Faust, K., *Social Network Analysis: Methods and Applications* (New York: Cambridge University Press, 1994).
72. White, D. R., and Reitz, K. P., "Graph and semigroup homomorphisms on networks of relations," *Social Networks* 5 (1983): 193-234.
73. Žiberna, A., "Generalized blockmodeling of valued networks," *Social Networks* 29 (2007): 105-126.
74. Žiberna, A., "Direct and indirect approaches to blockmodeling of valued networks in terms of regular equivalence," *Journal of Mathematical Sociology* 32 (2008): 57-84.