Measuring economic globalization: Spatial hierarchies and market topologies

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Abstract

Measuring the degree and extent of economic globalization is subject to a variety of issues ranging from theoretical conceptualization to the selection of appropriate data. This examination of economic globalization underscores the importance of a geographic perspective that is necessarily situated within a temporal context. International trade data and exploratory spatial data analyses (ESDA) are used to assess patterns of economic globalization between 1970 and 1997. Results indicate that preserving topological relationships between states in the global economy can guide, inform and extend future studies of the processes and patterns of economic globalization.

Keywords: economic globalization, spatial dependence, exploratory spatial data analysis (ESDA)

Introduction

Though there is general agreement about what economic globalization encompasses as a concept, finding comparable analyses and indicators on the subject can be difficult. This obstacle, in part, can be attributed to differences in what processes are believed to constitute economic globalization, and how the patterns resulting from these processes are measured. The characterization of such patterns typically follows one of two paths (Allen and Thompson 1997, 213). The first path leads to examinations of the experiences associated with the various processes of globalization, such as the implications of increased economic interdependence at the regional scale (e.g., Amin and Thrift, 1994) or the impacts of foreign direct investment upon development (e.g., OECD, 1998). The second path is more concerned with obtaining a purchase on globalization through the analysis and comparison of economic indicators, such as levels of international trade or the number of internet hosts within a country (e.g., Foreign Policy, 2001).

Both approaches, however, suffer from notable geographic and temporal scale limitations. In particular, the framing of analyses about global processes and patterns inevitably leads to a series of trade-offs between the "where" and the "when", which implicate judgments about the universal and the particular. In an attempt to bridge the gap between space and time, and the universal and the particular, economic globalization is evaluated using exploratory spatial data analyses. Of particular interest is whether and to what degree the spatial arrangement of nation-states, and changes to this arrangement, influence the patterns of economic globalization. By situating economies of the world in geographic context, and exploring how such contexts can change over time, this exploratory framework provides both a succinct profile of economic globalization, and sheds light upon particular features of the global economic system at various points in time.

'Global Shift' or 'Global Drift'?

The patterns of economic stratification and the role of geographic concepts and entities within the global economy (e.g., distance and the nation-state) figure prominently within discussions about globalization and international political economy (e.g., Gilpin, 2000; Hirst and Thompson, 1999; Waters, 1995; Agnew and Corbrige, 1995). Held et al. (1999) document three competing "tendencies" of globalization, each of which speak directly to the above. At one end of the globalization spectrum is the "hyperglobalist" tendency that suggests the traditional hierarchies present in the world economy will fade away, as will the nation-state, as capitalism and technology force the economies of the world to converge economically. Conversely, globalization "skeptics" argue that nation-states and markets will remain paramount, with the gap between the developed and underdeveloped regions of the world continuing to grow, in light of increased economic bloc formation. What lies between, if not beyond, these two perspectives is the "transformationalist" tendency which views globalization as the intensive and extensive restructuring and reordering of social, political and economic relations, processes and actors throughout the world in the face of modernity.

Evaluating the patterns of international trade can put the merits and shortcomings of each globalization tendency into a wider spatiotemporal context, and can illuminate both particular experiences, as well as regional and global trajectories of economic globalization. Trade as an economic activity predates the nation-state and can be documented back several thousands of years (Grant, 2000). Since international trade is practiced and documented widely, in both historic and geographic terms, international trade data are used as surrogate measures of contemporary economic globalization from 1970 to 1997. Though foreign direct investment (FDI) and the locational decisions made by multinational firms are often

used to examine economic globalization (e.g., Dicken 1992; Braunerhjelm and Ekholm, 1998), data about FDI and multinational firms are relatively limited in terms of temporal availability and lack the geographic coverage that is present in much of international trade data. For instance, UNCTAD (1999, 18) reports that 80 percent of the nearly US$650 billion of FDI outflows in 1998 originated in only ten countries. This is not to say that FDI and multinational firms are not significant features of contemporary economic globalization, but international trade data permit analyses that are more geographically inclusive and more historically comprehensive.

International trade theory, or more specifically the theory of comparative advantage, also provides a useful backdrop for this analysis. Briefly, this tenet of international economics asserts that a country should specialize in producing a good in which it has a relative cost advantage compared to other countries, and import those goods in which it is at a relative cost disadvantage. Theoretically, differences in factor endowments (i.e., land, labor, capital and technology) determine what a country produces and exports, and what goods a country needs to obtain through imports. Ultimately, the gains from trade outweigh the costs of remaining autarkic since post-specialization production exceeds that of the pre-specialization period within the trading system. What is of interest here is not the theory of comparative advantage per se, but the neoclassical assumptions upon which it rests – free trade and perfect markets.

Free trade and perfect markets represent the ideal of economic efficiency, and coincide with one of the ideal-types of globalization identified by Held et al. (1999), the hyperglobalist tendency. It is widely acknowledged, however, that international trade is not free, but restricted by tariffs, quotas and barriers, and markets are not perfect, but suffer from imperfections such as incomplete information. A more fundamental obstacle to the

activity of international trade is geography. The costs of overcoming distance, in financial, political and cultural terms, remain significant and though the world trading system has expanded over time, countries still trade more with their immediate neighbors than with countries that are farther away (Frankel, 1997; Limão and Venables, 1999). Furthermore, not only are markets imperfect and trade restricted, but the economies and the industries that compose the world trading system at large are not static over time or across space; regimes expand, collapse and disintegrate, the modes and means of production change, and markets emerge and disappear (e.g., Wallerstein 1980; Schoenberger, 1994). Such events not only can change the character of the global economy, but they can alter the geographic array of factor endowments.

By combining the limits of international trade theory and the tendencies of globalization a set of competing hypotheses is constructed. The objective of the following analyses is to evaluate each globalization scenario, first, by examining selected hierarchies of the global economy at large, and second, by evaluating the significance of market topologies. The competing hypotheses are:

- Hyperglobalist (or neoclassical) hypothesis: Over time, barriers to trade will disappear and market perfection is achieved, distance is effectively overcome. Traditional hierarchies of the global economy disappear and levels of trade converge according to the geographic distribution of factor endowments.

- Skeptical hypothesis: The world trading system is characterized by regional blocs and poor economies become more marginalized over time. Nation-states remain *primus inter pares* as actors within the global economy.

- Transformational hypothesis: A restructuring of the global trading system leads to the transformation of economic activities and the emergence of fundamentally new patterns and hierarchies.

Four general measures of economic globalization are used to evaluate the above hypotheses: exports, imports, exports as a percentage of gross domestic product, and per capita exports. International trade data were obtained from the *International Financial Statistics* database of the International Monetary Fund, and gross domestic product and population data were provided by the *Economic Growth Research Program* of the World Bank. All financial data were converted from current US dollars to constant 1996 dollars using the GDP implicit price deflator available from the Federal Reserve Bank of St. Louis. Visual descriptions and preliminary interpretations of the data as they relate to economic globalization are provided in Figure 1.

Figure 1 here

Each grouped series of boxplots corresponds to the identified measures of economic globalization at five year intervals, beginning in 1970, except for the last 1990 to 1997 period. Boxplots reveal how each respective vector of data is dispersed around the median (i.e., the white line) and in relation to the inter-quartile range (i.e., gray boxes), with extreme, or outlying, observations (i.e., $\pm$ 1.5 $\times$ IQR) represented as short lines. What is important to note in these four series of boxplots are the overall patterns and trends, rather than individual observations in specific years. Due to the high volume of exports and imports for a very small set of countries, the inter-quartile range boxes in every graph, except for exports

as a share of GDP (Figure 1c), are compressed and at the bottom of the vertical scales. Dramatically increasing levels of exports, imports, and per capita exports, therefore, seem to be more of an exception than a rule within the global trading system since 1970. Though there appears to be an upward trend in the value of world exports and imports (Figures 1a and 1b), again, a handful of outlying countries can account for most of this change. Perhaps a more accurate description is that the distribution of export and import levels remain concentrated at the bottom of the vertical scales over the study period, suggesting that most economies of the world have experienced only modest changes in levels of trade, which calls into question the geographic extent of economic globalization as measured by international trade.

To measure the importance of trade in the global economy, boxplots of exports as a share of GDP are provided in Figure 1c, and boxplots of per capita exports, which serve to control for the relative size of economies, are presented in Figure 1d. No distinct pattern or trend emerges in either of these last two series of boxplots, though between 1990 and 1997, the lengthening of the interquartile box and the upper fence in the former series indicates that trade increased in significance for many economies. Though larger economies tend to trade smaller proportions of their GDP for several reasons (see Perkins and Syrquin, 1989), and in some cases, the value of exports systematically rises slower than GDP, which in turn can inflate and exaggerate the significance of trade (see Sutcliffe and Glyn, 1999), this particular measure of economic globalization is nevertheless considered useful within these preliminary descriptive analyses. The last series of boxplots is similar to the graphics for exports and imports, and reveals that a relatively small number of countries enjoys high levels of exports per capita.

The boxplots in Figure 1 provide a convenient visual summary of economic globalization through international trade for the period 1970 – 1997. Identifying individual observations within the boxplots reveals the various hierarchies of economic globalization, which in turn can be used to evaluate the globalization hypotheses presented previously. Table 1 provides the rank-order of the top and bottom three countries according to each indicator of economic globalization for selected years, which correspond to the top and bottom three observations in a selected boxplot.

Table 1 here.

Looking at the rankings for the volume of exports and imports for each specified year, the identification of the top three countries – the United States (or U.K. in 1970), Germany and Japan – is not surprising, nor is the identification of countries that are ranked at the bottom. With regard to the latter, and as would be expected, small countries tend to export and import little in absolute terms, and small isolated island nations export and import even less. The reported variances for exports and imports, and their notable increases, are of particular interest because they address directly the hypotheses outlined earlier. The increasing variances and the stability of the upper tiers of the export and import hierarchies between 1970 and 1997 dispute the hyperglobalist assumptions that old hierarchies will disappear and markets will converge. Further, the very high and very stable coefficients of variation (i.e., $V = \sigma / \bar{x}$) for exports and imports indicate that the divergence between the upper and lower echelons of international trade is quite persistent, again disputing the argument that levels of trade will equalize over time.

The next two sets of rankings provide a different perspective on economic globalization. The top ranking countries in terms of exports as a proportion of GDP and exports per capita can be described as small, wealthy and/or oil-exporting. Note, however, that between 1990 and 1997 the oil-exporting countries yielded to the east Asian centers for entrepot trade, Singapore and Hong Kong, the former maintaining numerous economic linkages with third-ranked Malaysia. While the top of the list is somewhat predictable, the countries ranked at the bottom vary considerably in character as well as geographic location. For example, in 1970, the two most populous countries of the world, China and India, ranked at the bottom of the exports/GDP vector and China ranked at the bottom in terms of per capita exports. Nearly 30 years later, countries recently affected by war (i.e., Ethiopia, Lebanon and Sierra Leone) rank at the bottom of both indicators, signifying that China and India have since risen in the rankings.

Though the global average of per capita exports increased between 1970 and 1997, the concurrent increase in variance and the large value of the coefficient of variation, again support the skeptical hypothesis that the economic gap between developed and underdeveloped countries remains considerable, and may be increasing. The two moments reported for exports as a share of GDP are inconclusive, but the decline of oil-exporting countries and the rise of the Asian entrepot economies may indicate that a more fundamental change to the global economy is occurring, as the transformationalist hypothesis suggests. Numerous hierarchies of economic globalization can be constructed from any number of data sources, and those presented above provide interesting insights into the how the global economy has changed since 1970 and how, in some respects, it has remained remarkably stable. It is clear that a quantitative shift in international trade has occurred since 1970, but this shift may be accompanied by an increasing divergence, or

drifting apart, between wealthy and poor economies (see also, Prichitt 1997; Jones 1997). The next section uses exploratory spatial data analyses (ESDA) to evaluate further economic globalization by gauging the significance of geography within the context of international trade.

Distance is dead. Long live distance!

International trade is spatially dependent. In other words, because trade is not free, markets are not perfect and the costs associated with trade are often a function of distance, countries trade more with their immediate neighbors than with countries that are far away. Yet to what degree is trade or any other indicator of economic globalization spatially dependent? Does geography matter more in some regions than in others? How does the significance of geography change over time? Research on the formation of regional trading blocs indicate that both distance and contiguity are significantly related to levels of interstate trade (e.g., Frankel, 1997). Held et al.'s (1999) skeptical tendency of globalization also suggests that such trading blocs will establish themselves as features of the world economy. The remainder of this article concentrates on determining the significance of geography to international trade, and pinpointing particular spatial-temporal contexts of economic globalization.

Explicitly incorporating a spatial or geographic component into this analysis of economic globalization requires a means to measure space, and a method to assess spatial dependence. Spatial relationships between countries can be summarized in the form of binary contiguity matrices, where a "1" represents adjacency or contiguity, and a "0" indicates geographic separation. Such matrices, often referred to as spatial weights matrices, have been used to study a variety of questions in the social sciences, ranging from the

formation of American, Japanese and German trading blocs (O'Loughlin and Anselin, 1996) to the geography of war and peace (Gleditsch and Ward, 2000a). Representing geographic relations with such matrices permits the subsequent evaluation of spatial autocorrelation, which within the context of this study, refers to the geographic concentration of similarly high or low levels of exports, imports, exports as a share of GDP and per capita exports.

The statistical indicator most commonly used to detect spatial dependence is Moran's I (for details, see Cliff and Ord, 1981; Anselin, 1988; 1995). When a row-standardized spatial weights matrix, $\mathbf{W}$, and a standardized variable, $\boldsymbol{y}$, are used, Moran's I is expressed formally:

$$I = \boldsymbol{y}' \mathbf{W} \boldsymbol{y} / \boldsymbol{y}' \boldsymbol{y}$$

Positive values of Moran's I indicate the presence of spatial dependence or clustering, while negative values suggest a pattern of dissimilarity. A value of "1" indicates perfect spatial autocorrelation, or for example, that a country's level of trade can effectively be predicted by that of its neighbors. In the following analyses, spatial weights matrices based upon an arbitrarily selected distance threshold of 100 statute kilometers summarize the geographic relations between countries for the years 1970, 1980, 1990 and 1997 (i.e., countries are considered contiguous if the shortest distance between them is 100 kilometers or less) (see Gleditsch and Ward, 2000b). Note that the relations between countries summarized in the weights matrices are not necessarily a function of a country's size (e.g., Canada is a large country with few neighbors, while Austria is a small country with many neighbors). Table 2 reports Moran's I statistics and associated *z*-scores for each indicator of economic

globalization, with inference based on the randomization assumption (see Anselin 1995), over the period of study.

Table 2 here.

Exports, imports, exports as a share of GDP and per capita exports all exhibit statistically significant levels of positive spatial autocorrelation in each year. Variations in the significance and levels of spatial dependence are probably related to fluctuations in the levels of trade between countries, as well as to changes in the spatial structure of the global economy (i.e., variations in the number of states in the international trading system), which can influence the fortunes and failures of individual and regional economies. Though missing data forces the exclusion of some countries from these analyses, a sufficiently large, and geographically diverse pool remains to approximate the profile of the global trading system each year. Until 1997, levels of imports were more geographically concentrated than were exports, and after an increase in the geographic concentration of exports as a share of GDP, the level of spatial dependence for this variable decreased slightly. The Moran's I results suggest that international trade, and globalization indicators based upon trade, are indeed a function of distance, but that over time, such spatial dependence is unstable or non-constant.

Moran's I provides a concise summary of spatial dependence, or spatial autocorrelation, as a single statistic. An interesting feature of Moran's I, when using standardized variables and row-standardized matrices, is that it is equivalent to the slope coefficient of a linear regression of $\mathbf{Wy}$ on $\boldsymbol{y}$ (see Anselin 1995). Note that multiplying $\mathbf{W}$ and a vector of observations, $\boldsymbol{y}$, returns what is referred to as the spatial lag of $\boldsymbol{y}$, a vector

which contains the weighted average of neighboring values for each observation. The spatial lag of $\boldsymbol{y}$, (i.e., $\boldsymbol{Wy}$) can be plotted against $\boldsymbol{y}$ as a scatterplot, which permits the evaluation of each observation's contribution to the Moran's I statistic. Figure 2 provides Moran's scatterplots for exports (top row) and for exports as a share of GDP (bottom row) for 1970 and 1997. Note that for the top row of plots the natural log of exports was taken in order to facilitate graphing.

Figure 2 here.

In each plot, Moran's I is represented by the straight, dashed line, the slope of which is equivalent to Moran's I. A local regression line, with a 95 percent confidence envelope, is also superimposed upon each data cloud. Differences between the linear and local regression lines indicate how Moran's I tends to under- and/or over-estimate local spatial relationships, and show the influence of extreme observations, some of which are identified. Each quadrant of each plot also corresponds to a different type of spatial association. High values surrounded by similarly high values are situated in the upper-right quadrants, while low values surrounded by low neighboring values are found in the lower-left quadrant. High values surrounded by dissimilar low values are in the lower-right quadrant, and the converse of low values neighbored by high values are found in the upper-left quadrant. Since each vector is standardized, comparisons can be made between years and variables.

Several interesting features emerge from a visual perusal of each set of plots. Making direct comparisons between 1970 and 1997, the slope for exports (top row) increases noticeably, indicating an apparent increase in the levels of spatial dependence, while Moran's I in the exports as a share of GDP plots (bottom row) appear to be similar for both years.

Referring back to Table 2, however, the slopes for all vectors vary when the values calculated for 1980 and 1990 are considered. The placement of the local regression lines in each set of plots shows how Moran's I tends to over-estimate the degree of spatial autocorrelation for exports, and underestimates slightly the spatial dependence of exports as a share of GDP. Additional investigations indicate that most countries falling in the upper right quadrant in 1970, high exports surrounded by high exports, are again situated in this same quadrant in 1997 (e.g., EU member states, Japan), with South Korea a marginal outlier in both years (i.e., ROK). Similarly, countries in the lower left quadrant in 1970, low trade surrounded by low trade, for the most part remained in this quadrant in the 1997 plot (e.g., Senegal – SEN). The scatterplot for exports as a share of GDP in 1970 appears to be quite similar to that for 1997, and slight changes are noticeable for a few of the identified countries (e.g., Singapore – SIN; Indonesia – INS).

With regard to evaluating particular spatial-temporal contexts using these scatterplots, two types of change can be identified. First, individual cases that shift in a horizontal direction between plots indicate domestic changes in either exports or exports as a share of GDP, and second, cases that shift vertically connote that regional levels of each respective variable are changing. Countries that exhibited relatively high levels of change in exports, and exports as a share of GDP, between 1970 and 1997 are subset from the data, and each subset plotted in Figure 3.

Figure 3 here.

For each observation, the symbol used to denote 1970 is a small crosshair and 1997 is drawn as a small circle. Arrows connect the years, from 1970 to 1997, and provide a visual

indication of the amount and direction (i.e., type) of change between these years. For example, looking at the first plot of standardized exports (logged), South Korea (ROK) is exporting more in 1997 relative to 1970, but its neighbors are exporting slightly less, hence the arrow points downward and to the right. In relative terms, between 1970 and 1997, few countries changed dramatically their profile in terms of exports.

A different picture emerges in the graph that plots exports as a share of GDP. The significance of trade for a number of economies changed over time, as has the regional complexion of, in particular, west-central Africa (i.e., Gabon, Equatorial Guinea and Republic of the Congo). The recent discovery of petroleum reserves account for the rightward shifts of Equatorial Guinea and the Republic of the Congo since 1970, and is also reflected in the upward shift by neighboring Gabon, which has been exporting oil for several decades. African economies less reliant upon exports in 1997 than in 1970 include Gambia and Zambia, and exports as a share of GDP have noticeably decreased for those countries neighboring Malawi. Luxembourg's upward shift to the left is also interesting, and shows that exports as a share of GDP have decreased in importance since 1970, but for countries surrounding this small European state, the opposite has occurred, perhaps due to policies related to what is now the European Union. These analyses underscore the importance of geography to patterns and measures of economic globalization. It is apparent that distance not only matters, but that its significance varies from country to country, region to region and over time as well. The ability to detect such changes, and identify particular spatiotemporal contexts, serves to inform competing conceptions of economic globalization and extend our understanding of how economics is both spatially and temporally dependent.

Final thoughts

The analytic techniques implemented highlight the geographic dynamism of the global economy. Though the nation-state is privileged as the unit of analysis in this study, examinations of other processes and patterns of globalization can be conducted using similar techniques, at different scales of analysis. Spatial analysis can be used to measure and evaluate agglomeration, for example, within the regions of Europe or between different metropolitan areas. Recent methodological developments, such as those which permit the evaluation of the spatial association in flow data (e.g., Berglund and Karlström, 1998), also lend themselves to the re-evaluation of the geography of international trade and foreign direct investment at various scales of analysis, and at different periods in time.

It is difficult to argue against the notion that there is an unprecedented awareness about 'things' that are global. Determining how global the world economy is, however, proves to be a more difficult task. Measurements and analyses of economic globalization reveal that the gap between wealthy and poor nations continues to increase, but also suggest that such patterns of stratification need to be situated within a broader geographical and historical context. Economies are not independent from one another, but are inextricably intertwined unlike at any other period in history. Further, economies are not static entities, but change and transform over time and space, and are likewise affected by developments beyond – or even to - their borders.

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