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The development of trade blocs in an era of globalisation

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Abstract. This study investigates the economic geography of international trade during the period 1950–2005. We introduce a new trade bloc variable that relies on the intramax hierarchical clustering technique to identify endogenous trade blocs with annual trade flows. Multivariate analysis with gravity-equation-based variables is used to explain how mechanisms of globalisation have affected trade patterns over the past half century. In particular, proximity and economic integration agreements are key to explaining the persistence of region-based trade blocs in a globalising world economy.

Keywords: international trade, proximity, regionalism, economic integration, trade clusters, intramax, gravity model

1 Introduction

The past two decades have witnessed an ongoing debate about the (ir)relevance of geography in the face of economic globalisation. The 'end of geography' literature is perhaps best captured by Friedman's (2005) assertion that "the world is flat": that is, technological innovations have radically reduced transportation and knowledge-information transmission costs to the point that the distance between economic agents has become irrelevant to their location decisions.

In contrast, McCann (2008) argues that the world has in fact become 'steeper' and that geography plays an increasingly important role in the global economy. The key insight is that the decline in transportation and transmission costs is more than offset by spatial transaction costs associated with an increasing complexity, need for face-to-face communication, and need for timeliness, particularly in knowledge-intensive industries. It is because of the inherently spatial nature of these transaction costs that geographic distance contributes to a 'curved' world characterised by agglomerations of economic activity, rather than a flat world where distance has become meaningless. Indeed, empirical studies using the gravity equation of international trade show that the greater the geographic distance between two trading nations, the smaller the amount they trade. This suggests that cross-border trade is mainly regional and reflected by regionally oriented trade blocs.(1)

However, a message of the 'spaghetti bowl' of economic integration agreements (EIAs)—see Kohl (2011) for the video—is that trade policy is no longer organised in a strictly regional setting.(2) While nations used region-based EIAs such as Benelux, European Community,

(1) Trade blocs and trade clusters interchangeably refer to functional areas obtained using cross-border trade flows.

(2) EIAs include agreements liberalising trade bilaterally or plurilaterally: eg, free trade agreements and customs unions.

and Association of Southeast Asian Nations to strengthen their economic ties with their geographic neighbours until the 1980s, an increasing number of agreements have since then been enforced between countries from different regions, including treaties involving Chile and the US, China, and India, and combinations of European and South American nations (Baldwin, 2006; Bhagwati, 2008; Kohl, 2012).

Given the importance of EIAs in fostering cross-border trade, the rise of interregional trade policy raises the question of how the geography of international trade is affected. Are nations still predominantly trading with their neighbours in regional trade clusters, or have the forces of globalisation and interregional trade pacts shaped a flat world economy where the geography of international trade has become truly global?

Understanding the determinants and geographic configuration of trade blocs has important policy implications. Ghemawat and Altman (2012) underline the importance of trade flows for economic prosperity. They argue that connectedness within a region generates more international trade and leads to economic growth. Aussilloux et al (2011) discuss the case of the EU and find that further strengthening the EU's Single Market would strongly benefit all members, for example resulting in an increase of the UK's GDP by 7% over a ten-year period.

Geographic space can be defined by its administrative, economic, cultural, historic, socio-political, and/or legal context. Economic activities, however, do not strictly occur within these boundaries. Studies on the economic development of trade blocs typically divide space into time-invariant regions such as the so-called triad of North America, the EU, and Japan (Ohmae, 1985; O'Loughlin and Anselin, 1996). This approach suffers from the fact that predefined trade clusters remain static over time and do not reflect changes in the geographic orientation of international trade flows, especially in times of changes in spatial transaction costs and increasingly globally oriented trade policy.

Instead of relying on predefined, exogenous trade blocs, we use annual bilateral trade flows and the intramax clustering technique to identify data-driven, endogenous trade clusters. Here, the dynamic nature of trade is emphasised because it gives rise to trade blocs that, as we will show below, are vastly different from those that are constructed exogenously. Our dataset covers the period 1950 to 2005 so that countries' respective trade bloc orientations can be identified and monitored at twelve observed intervals. In tracking the geographic orientations of the world's trade blocs over six decades, we find, for example, that Brazil, Russia, India, and China (BRICs) have played an important role in their respective trade clusters long before being identified as 'emerging markets' in the literature (O'Neill, 2001).

In addition to identifying dynamic trade clusters in the world economy, we investigate how their configuration and development are associated with explanatory variables commonly used in the international trade literature (compare Frankel et al, 1995; 1996; Ravenstein, 1985). This is done by considering the role of geographic distance, institutional arrangements embodied in EIAs, trade partners' economic mass, cultural similarity, shared colonial history, common border(s), and the extent to which nations are geographically isolated.

Contrary to what would be expected from the 'death of distance' literature, the empirical results indicate that distance and regionalism both strongly contribute to trade clusters that are strikingly region based in the present era of globalisation.

This study is organised as follows. The literature is reviewed in section 2. Section 3 explains how the intramax technique is used to obtain endogenous trade blocs and illustrates major developments in their geographic configuration for 1950–2005. Section 4 presents the empirical findings, after which section 5 discusses the main findings and concludes.

2 Literature

The international trade literature abounds with studies on the determinants of the *volume* of cross-border trade. The gravity equation is a popular tool to explore how geographic proximity, market size, and a host of additional variables of interest affect the amount of international trade (for an overview, see Van Bergeijk and Brakman, 2010). Among its many applications, it is widely used to determine the impact of EIAs (Baier and Bergstrand, 2007; Frankel, 1997; Tinbergen, 1962), World Trade Organisation membership (Chang and Lee, 2011; Rose, 2004; Tomz et al, 2007) and diplomatic relations (Pollins, 1989a; 1989b; Van Bergeijk, 2009). Joining EIAs, participating in the multilateral trade system, and having a lack of conflict and strong diplomatic ties all reportedly increase the extent to which countries trade with each other.

The question remains, however, how the geography of international trade can be explained. While conventional applications of the gravity equation provide insight into the determinants of trade *volumes*, it has to our knowledge not been used to explain the existence of trade *blocs* in the world economy. As will be discussed below, our methodology observes the processes of trade clustering directly, rather than relying on exogenous assumptions about trade bloc membership. In addition, our empirical strategy deals with how the evolution of these clusters can be explained.

What drives the (geographic) clustering of trading nations? From the literature that will be discussed below, it can be argued that regional clusters exist due to forces of natural and institutional regionalisation (Andresen, 2009a; 2009b; Glenn, 2008; MacLeod and Jones, 2007; Poon, 1997a; 1997b; Poon and Pandit, 1996; Poon et al, 2000).

Economic activities occur within supranational or regional states, resulting in functionally interconnected transnational spaces. The 'space' where trade takes place is defined by flows of economic activity, rather than by political boundaries (Glenn, 2008; Jackson, 1999; Newman, 2003; Smith, 1913).

Poon (1997a; 1997b) argues that the regionalisation of international trade is a 'natural phenomenon' mainly driven by market forces. 'Natural trading regions' consist of countries having high trading intensities with one another due to geographic proximity, lower transaction costs, and cultural affinities creating spatial biases (Frankel et al, 1995; 1996). It must be noted that this regionalisation process based on trade differs significantly from closed trade blocs. Political institutions and decisions basically form the latter, whereas the former reveals the workings of global markets (Poon and Pandit, 1996). The creation of the North American Free Trade Agreement is a case in point. With low levels of trade between Canada and Mexico, the Canadian government's request to be included in the US–Mexican negotiations was entirely a political decision (Baldwin, 1997).

Now that we are in an era of globalisation, an increasing number of countries have become integrated in the global economic system. Several authors subsequently declared the 'end of geography' (Friedman, 2005; Greig, 2002; O'Brien, 1992). This spurred the powerful counterargument that 'the world is not flat', stating that globalisation sometimes makes geodesic distance less important due to, for example, improved mobile and electronic communication methods reducing spatial knowledge-information transmission costs (Christopherson et al, 2008).

At the same time, however, distance continues to be relevant, as witnessed by the growing role of trade in knowledge-intensive sectors, where face-to-face contact is required to facilitate transferring specific sectoral knowledge, in turn increasing spatial transaction costs (Dicken, 2007; McCann, 2008). This remains important even in the presence of decreasing costs to accessing foreign markets (Andresen, 2009b). Rodríguez-Pose and Crescenzi (2008) add that not all nations have the same capacity to maximise the advantages of globalisation while minimising its disadvantages so that the global landscape will remain heterogeneous. In this context it is uncertain how distance will ultimately configure global trade flows: does it lead to a 'flat' world with a single, global trade bloc, or a 'curved' world with several trade clusters where regions still matter? And how will changes in institutional costs, as witnessed by the rise of interregional trade pacts, affect this outcome?

Most countries show an increasing amount of economic activity in 'relationship' with a growing number of economic partners (Andresen, 2009a; 2009b). Do these global flows of trade increase the probability of regionalisation with a larger number of countries? Are fewer trade clusters the result of this growing number of relationships? According to Glenn (2008), this is not the case. Even though trade might increase at a global level, the distance to a nation's trade partners will affect the volume of trade and therefore the regionalisation processes.

In a conceptual framework MacLeod and Jones (2007) agree that distance is the most dominant determinant for generating economic regions, but underline the influence of culture, politics, and history on *relative* distance ('spatial flows') as discontinuous or strengthening forces. The territories (or economic regions, rather) that are created by these spatial flows have strong, yet breakable ties because they are victim to continuous "territorial restructuring" (page 1182) in a world of political and economic turbulence. The present study provides an empirical application to this conceptual idea.

Poon et al (2000) argue that, although the forces of globalisation have led to a decrease in the number of trade blocs since 1985, they find no evidence of a triadisation of the world economy. They demonstrate that the changing shape and nature of trade clusters is largely ascribed to continental lines and at the same time strengthened by foreign direct investment (FDI) that appears to have a 'network' shape and does not need continuous continental regions. Andresen (2009a) concurs with these findings. According to Poon et al (2000), the fluctuation of trade clusters is "operated by centrifugal and centripetal forces operating simultaneously, resulting in constellations of relationships (eg, trade clusters) where space is both sticky (*important*) and fluid (*flexible*) at the same time" (page 440, emphasis added). Economic flows do not only follow absolute space, but are also led by relative distance, formed by historical ties, shared cultures, and (changing) political systems. Countries trade with their 'natural partners' (Anderson and Norheim, 1993, Frankel et al, 1995; 1996; Michalak and Gibb, 1997).

Poon and Pandit (1996) investigated the importance of spatial structure in the process of regionalisation. They find, rather than a triad structure of global trade, evidence for six trade clusters focused around six core market countries—the US, Germany, France, the UK, and the former USSR—underlining that these clusters are not geographically contiguous regions but "functional units" defined by the volume of trade interactions and explained by the intensity of bilateral trade between the members. They argue in accordance with the New Trade Theory that "scale economies and large efficient markets are instrumental in shaping emerging regional configuration" (page 284). Michalak and Gibb (1997) indicate that this evidence is a strong case for "regionalism as one of the most influential factors determining world trade flows" (page 266).

Andresen (2009a) finds that, over time, trade clusters have become more regionally focused due to an increasing importance of distance. Hanink and Cromley (2005) report similar results for the importance of proximity to increasing trade intensification. McCann (2011) ascribes a significant increase in distance costs to 1989 onwards, "when institutional and technological aspects of trade costs were falling most dramatically" (page 315), reflecting an increasingly regional orientation of economic clusters.

As Andresen (2009a; 2009b) states, the arrangements of nations in economic space originate from trading networks that in turn are strongly influenced by historical and political ties (see also Lee and Park, 2005; Shin, 2002). According to Andresen's (2009a) analysis, historical ties significantly influence regionalisation until 1981, especially if the historical ties have led to a shared institutional context. For example, a shared religious majority could create similar cultures for nations, as Yamazaki (1996) finds that Christianity has provided a unifying framework for Europe. Other cultural ties such as language can also improve trade relationships, especially because a shared language is often combined with historical colonial ties (Beugelsdijk et al, 2010; Head et al, 2010; Lee and Park, 2005; Shin, 2002).

Our reading of the literature suggests that trade clusters emerge not only due to proximity, but also on account of other geographic, economic, political, historical, and cultural characteristics. As discussed above, it is of particular interest whether trade blocs have been regionally focused in the period leading up to the 1980s, owing to geographic proximity and the regionally focused nature of trade policies embedded in EIAs.

Have trade blocs become more interregionally oriented in the wake of globalisation and interregional EIAs since the 1980s? These questions cannot be adequately addressed when countries are grouped into trade blocs a priori. Although previous studies have used the intramax clustering technique to obtain data-driven trade clusters, they focus on a select set of countries and observe two to three years. Our first contribution is to expand the range of observations, based on twelve years, for most countries engaged in international trade. Doing so allows us to track the evolution of trade clusters in the global economy for the period 1950–2005. These developments are described in section 3. Given these developments, our second contribution is then to explore the underlying determinants of trade clusters in an empirical setting inspired by the gravity equation of international trade. To our knowledge, the determinants of trade bloc formation have not been yet been examined in this fashion. Our empirical findings are presented in section 4.

3 Trade blocs in the world economy

3.1 Method

The intramax hierarchical clustering technique identifies functional areas using flow data. All trade flow data are arranged in a square contingency table, or an origin–destination matrix, for a given year. The origins (exporting countries) are in rows and the destinations (importing, reporting countries) in columns.

The intramax algorithm maximises the proportion of the total interaction that takes place within the aggregation of basic data units—the amount of within-group interaction—while minimising the number of cross-boundary movements (Masser and Brown, 1975). The objective function applied by the intramax procedure is based on the differences between the observed flows (a_{ij}) and their expected probabilities, as indicated by the marginal row and column totals (a^*_{ij}):

$$\text{maximise } I = (a_{ij} - a^*_{ij}) + (a_{ji} - a^*_{ji}), \qquad i \neq j. \tag{1}$$

In applying this function, a transformed matrix is calculated that measures the largest total interactions between pairs of countries in excess of the total of the expected values derived from the row and column totals. The expected value of each element is the product of the column sum times the ratio of the row sum to the total interaction. For example, the expected flow out of country 2 to country 1 (a_{21}), where a_{ij} is the element in row i and column j of the contingency table, is given as:

$$a^*_{21} = \sum_i a_{i1} \frac{\sum_j a_{2j}}{\sum_i \sum_j a_{ij}} = \sum_i a_{i1} \frac{\sum_j a_{2j}}{n} . \tag{2}$$

The row sum of the contingency table is $a_{i*} = \Sigma_j a_{ij}$, the column sum is $a_{j*} = \Sigma_i a_{ij}$, and the total interaction is the sum of row sums, $n = \Sigma_i \Sigma_j a_{ij}$. Normalising the flows such that $n = 1$ and $a^*_{ij} = a_{i*} a_{j*}$ means that "the difference between observed and expected values $a_{ij} = a^*_{ij}$ for the flow between zone i and j may be taken as a measure of the extent to which the observed flow exceeds (or falls below) the flow that would have been expected, simply on the basis of the size of the row and column marginal totals" (Masser and Brown, 1975, page 512).

Based on this procedure, the pair of countries with the highest absolute level of interaction are merged and henceforth considered to belong to the same functional area. Their interaction (ie, cross-border trade) becomes intrazonal. This merger causes the matrix to be reduced by one column and one row. The objective function can then be reapplied and the modified matrix recalculated to yield the next pair with the highest level of interaction. This procedure is repeated until the $(n - 1)$th iteration has been completed.

When should a functional area be identified? The literature does not provide a uniform answer. Some authors draw the proverbial line at a level of clustering where homogeneity within a cluster is lost (Goetgeluk and de Jong, 2006), but it is unclear how homogeneity should then be defined. One option is by choosing clusters if there is a large increase in the intrazonal flows. However, a large increase in the intrazonal flows during the fusion process does not generally indicate "a merger of two rather homogeneous zones". Still, the most practical "stop criterion" is one that uses the functional areas found "just before the high increase in intrazonal flows" (Goetgeluk and de Jong, 2006, page 11), although some degree of freedom may need to be maintained to identify realistic clusters. For each year of output the dendograms are used to determine if countries belong to the same functional area. Following Poon et al (2000), a cutoff of approximately 10% is applied to identify large breaks in intracluster interactions. Countries that are in the same part of the dendogram after such a break occurs belong to the same trade bloc.(3)

Andresen (2009a, page 29) discusses two possible limitations to the intramax method. First, it is assumed that every country ultimately belongs to a trade cluster. Although the algorithm facilitates the endogenous identification of clusters in the sense that regions are not defined up front, it does not allow for the possibility that marginalised countries may not belong to a trade cluster at all. Second, small, open economies that do not trade reciprocally with large countries may be unjustly associated with the latter's trade cluster. The author attempts to solve these issues by preselecting countries that have reciprocal trade relationships. In contrast, we do not superimpose any restrictions on the data to facilitate comparison with Poon et al (2000).

3.2 Results

The trade clusters obtained from the intramax procedure are mapped for the period 1950–2005 in figures 1–7. The underlying trade data are described in section 4.2. For ease of comparison, each cluster is labelled as being oriented towards the major economy (country) in that cluster. This orientation is simply based on the dominant economy in that particular cluster based on its economic size in terms of GDP. Most strikingly, the BRICs show up much earlier than implied by O'Neill (2001). Visual inspection reveals a decrease in the number of clusters over time and that they have become more geographically focused. Table 1 illustrates that the clusters vary in terms of their overall share in world trade. Triad regions account for the largest share, but that nontriad clusters increases over time.

Before looking into the specific cases of the BRICs, we first provide a general description of the major developments of trade blocs for the period 1950–2005. According to figure 1,

(3) Dendograms are available upon request. The robustness of our findings using different cutoff thresholds is explored in section 4.4.

Table 1. Trade shares.

Orientation	1950	1960	1970	1980	1990	2000	2005
Brazil	0.7	1.1	1.4	1.5	1.0	2.3	2.5
China	na	na	na	na	na	12.3	32.8
France	na	8.9	na	na	na	12.8	na
Germany	32.8	19.4	41.3	43.0	64.0	23.6	28.2
India	3.2	na	0.2	0.3	1.5	na	3.0
Japan	2.2	5.3	11.1	26.4	18.2	12.4	na
Middle East	na	na	0.7	na	na	na	na
Portugal	0.4	0.5	na	na	na	na	na
Russia/USSR	na	8.0	1.2	0.8	0.4	na	0.5
South Africa	na	na	na	na	0.1	na	na
UK	16.2	20.6	14.7	7.2	na	5.8	12.6
US	44.5	36.3	29.4	20.7	14.8	30.8	20.5
Triad	96.1	91.0	96.5	97.3	97.0	85.4	61.3
BRICs	3.9	9.1	2.8	2.6	2.9	14.6	38.8
Other	0.0	0.0	0.7	0.0	0.1	0.0	0.0
Total	100.0	100.1	100.0	99.9	100.0	100.0	100.1

Note: Trade shares represent the total imports between bloc members as a percentage of total world imports. Trade bloc orientations are based on the clusters obtained from the intramax analyses. na means not applicable. Totals are not always exactly 100% due to rounding. BRICs—Brazil, Russia, India, and China.

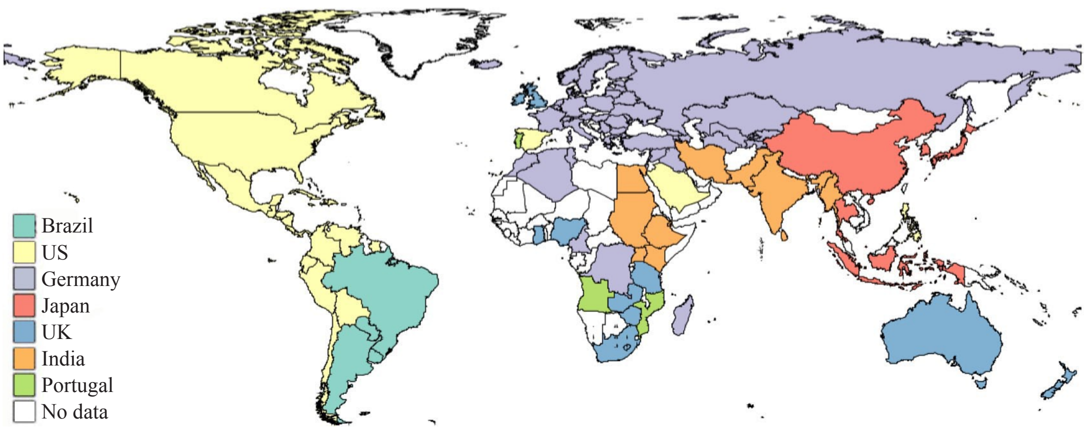

Figure 1. [In colour online.] Trade bloc orientations in 1950.

some clusters have the expected colonial ties with African countries or India in the 1950s. These ties become weaker after the 1960s. Colonial ties with France and the UK are still visible, but the northeastern part of Africa is clustered with the USSR. In this period the European cluster splits into different clusters and the US dominance in Latin America decreases (figure 2). This trend continues into the 1970s. Colonial ties become weaker, although, with the exception of Australia, the link with the Commonwealth remains strong. Two clusters emerge in Europe, with one focusing on Germany and the other cluster in the eastern part focusing on the USSR. Note that the French bloc is intermittently oriented towards the (larger) German cluster. The cluster around Japan increases strongly (figure 3). The US regains importance in Latin America in the 1980s (figure 4). The largest cluster in

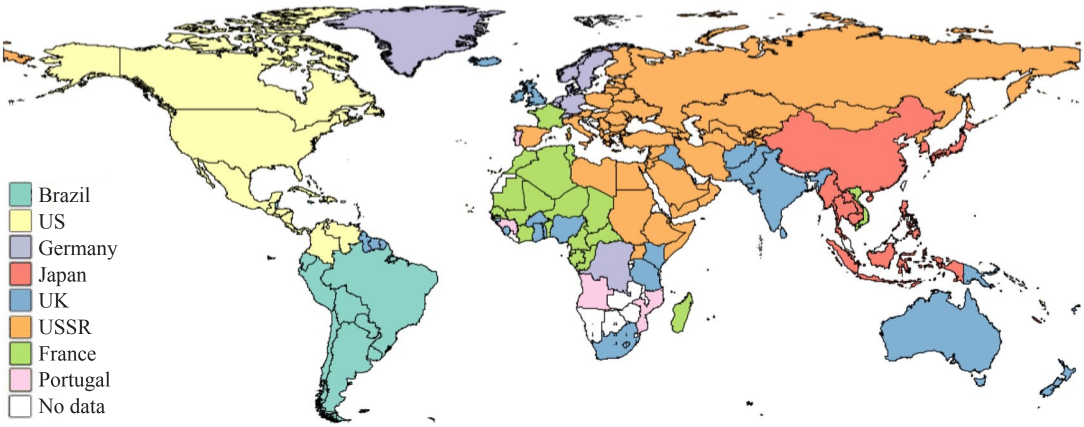

Figure 2. [In colour online.] Trade bloc orientations in 1960.

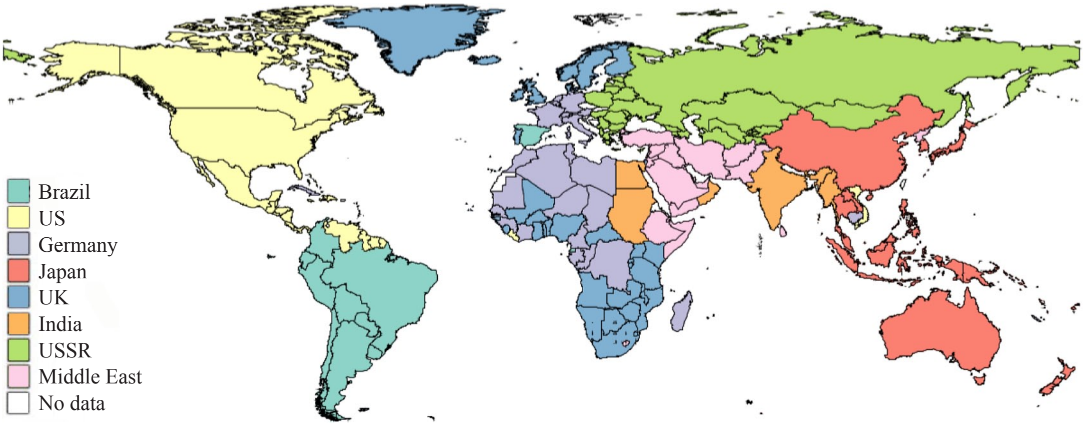

Figure 3. [In colour online.] Trade bloc orientations in 1970.

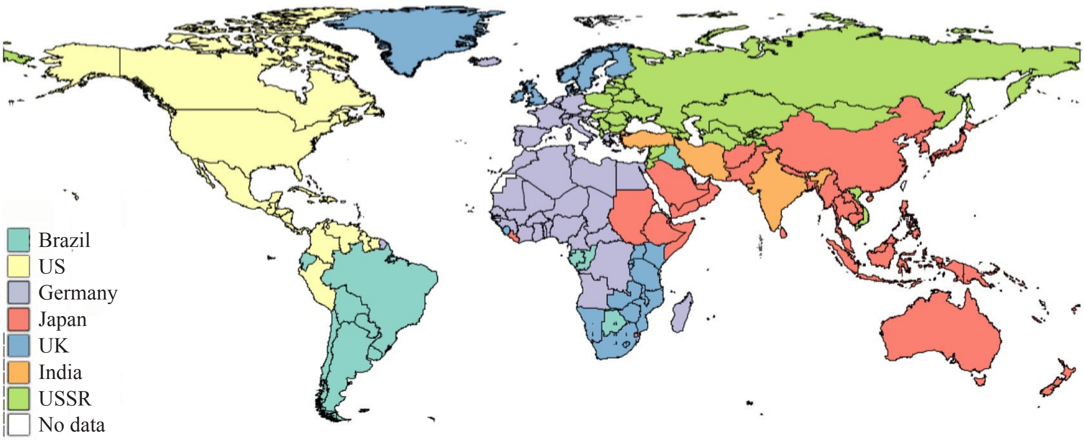

Figure 4. [In colour online.] Trade bloc orientations in 1980.

Africa has links with most of Europe. The trade cluster around Japan gets even larger and extends into East Africa.

In general, the clusters start becoming more geographically connected. The most noticeable change in the 1990s is the emergence of the South African cluster and the strong increase of the Indian cluster (figure 5). Furthermore, this is the only period when the UK has no trade cluster dominance and is included in the one oriented towards Germany. The US dominance in Latin America disappears.

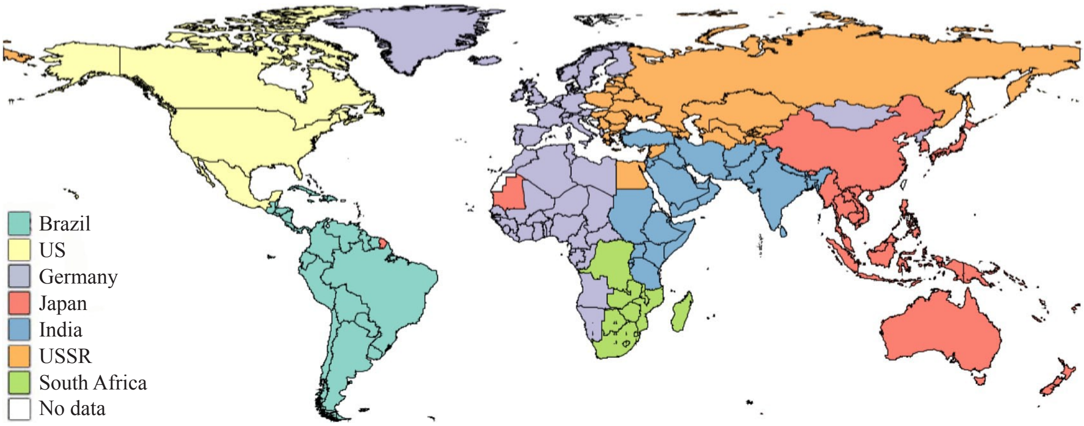

Figure 5. [In colour online.] Trade bloc orientations in 1990.

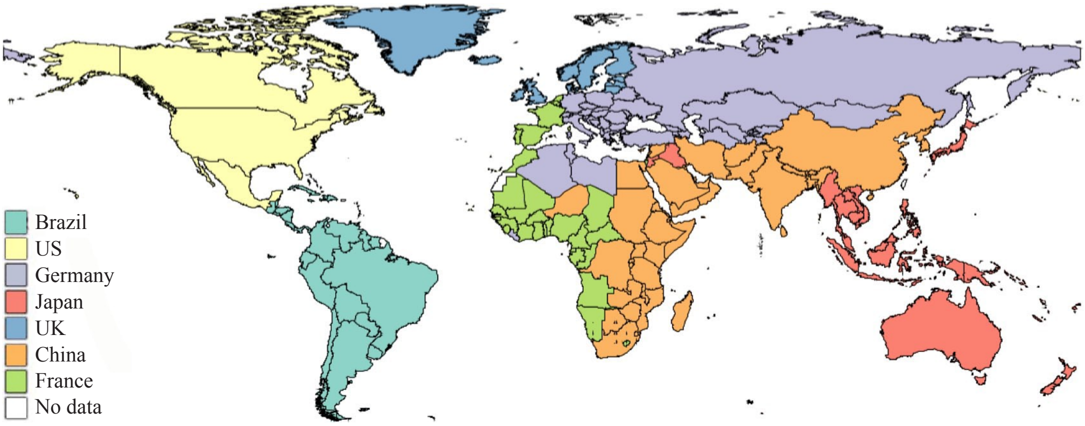

Figure 6. [In colour online.] Trade bloc orientations in 2000.

By the turn of the millennium, the Indian and South African clusters merge and include China (figure 6). This is the only time China is in a different cluster. France has a strong cluster with Africa and the UK returns, only this time not in the context of the Commonwealth but as the centre of a northern European cluster. Europe is split in three clusters: one around the northern European countries, one around east Europe and Russia, and the third cluster is southern Europe and Africa. The clusters appear to be even more geographically continuous around 2005 (figure 7). Africa seems to have settled mostly in one cluster with India and a strong geographic focus is evident in the case of Europe and the Asian Pacific.

Interestingly, the clustering methodology reveals a stable presence of 'emerging markets' throughout our period of investigation. We find that clusters involving the BRICs economies are identifiable for at least as early as 1950. Brazil is visible as a central economy in the South American cluster for the entire period. A clear divide between Western Europe on the one hand and Eastern Europe and the USSR/Russia on the other emerges in the postwar period. Although the exact configuration of these clusters changes over time, strong USSR/Russian ties remain clearly visible throughout 1960–2005. A cluster oriented towards India is visible as early as 1950, just three years after its independence. Despite its ties to the Commonwealth (visible in 1960 only), the Indian cluster is almost always identified as a functional region. Interestingly, the cluster's limited size in the 1950s–1980s suggests a relation with India's widely protectionist economic policies at that time. In contrast, the Indian cluster's growing involvement with its neighbours in the South Asian and East African regions seem to reflect

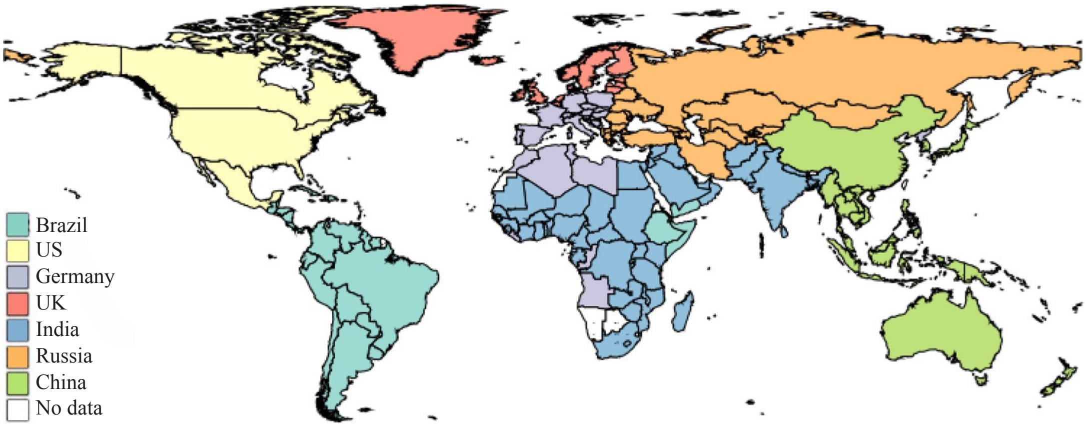

Figure 7. [In colour online.] Trade bloc orientations in 2005

the economic reforms implemented in the 1990s. Its interaction with the Chinese cluster (visible in 2000) indicates a growing economic interdependence between these 'emerging markets'. For the period of investigation the Chinese economy is visible as part of the Japan-oriented cluster (1950–1990), reflecting the strength of the Japanese economy in the region and China's conservative economic policies. Post liberalisation, and in particular with regards to its accession to the WTO, China's role in the world economy has become incredibly relevant.

Three conclusions can be drawn from our description of how trade blocs have developed over the past six decades.

First, as discussed in the introduction, the rise of interregional EIAs and economic globalisation may have altered the scope of the world's trade blocs to be less geographically oriented. Nevertheless, the trade blocs do not reflect this development. Despite regionalism's increasingly interregional coverage, the configuration of the underlying trade blocs has remained remarkably regionally focused.

Second, the intramax method yields no evidence of triadisation. Although there are clusters with an orientation towards the US, Germany, and Japan for the period 1950–2000, the latter disappears in 2005. In fact, the results show strong evidence of other trade clusters next to the so-called triad. Surprisingly, the clusters orientated towards Brazil, Russia, India, and Japan and/or China have been important for their regional economies for many decades, although some of these countries have only recently attracted the literature's attention as 'emerging markets'.

Third, the North and Latin American clusters are much more stable over time in terms of the number of countries and the trade bloc orientation compared to the rest of the world. Most 'turbulence' seems to occur in Europe, Africa, and Asia. It is also clearly seen that the importance of historical/colonial ties fade after the 1980s (compare Andresen, 2009a; 2009b; Head et al, 2010; Poon et al, 2000). This coincides with the finding that the cost of distance has actually increased as of the late 1980s, marking the beginning of the present age of globalisation (McCann, 2011).

4 What drives the development of trade blocs?

4.1 Method

The intramax hierarchical clustering technique has been used to determine if pairs of countries belong to the same trade bloc in a given year. But what drives this trade bloc formation? This section discusses the modelling strategy that is used to obtain insight into how geographic, economic, political, historical, and cultural factors are associated with the trade blocs identified by the intramax procedure.

A probit model is estimated according to:

$$\Pr(B_{ijt} = 1 \mid \boldsymbol{X}_{ijt}) = \phi(\boldsymbol{X}_{ijt}^{\mathrm{T}}\boldsymbol{\beta}) \,, \tag{3}$$

where B_{ijt} is a binary variable that is 1 if both countries in a country pair, with importer i and exporter j, belong to the same functional area obtained from the intramax technique in year t. $\boldsymbol{X}_{ijt}$ is a vector of regressors, with:

$$\boldsymbol{X}_{ijt} = [\ln \mathsf{Distance}_{ij}, \mathsf{EIA}_{ijt}, \ln \mathsf{GDP}_{ijt}, \mathsf{Border}_{ij}, \mathsf{Landlocked}_{ij}, \mathsf{Language}_{ij},$$
$$\mathsf{Colony}_{ij}, \mathsf{Coloniser}_{ijt}, \mathsf{Country}_{ijt}, \mathsf{F}_i, \mathsf{F}_j, \mathsf{F}_t]^{\mathrm{T}} \,. \tag{4}$$

The time-varying regressors are as follows. EIA_{ijt} is a binary variable that is 1 if the country-pair enforces an EIA and 0 otherwise. GDP_{ijt} is the average real GDP of both trade partners as a proxy for their joint economic mass, or market size. F_t represents year dummies in the pooled regression to account for unobserved time-varying phenomena.

The remaining regressors are time invariant. $\mathsf{Distance}_{ij}$ is the geographic distance between countries i and j in kilometres and Border_{ij} is a binary variable that is 1 if the countries share a land border and 0 otherwise. $\mathsf{Landlocked}_{ij}$ accounts for countries' access to the ocean and takes on the values 0, 1, or 2, depending on the number of countries in the dyad that are landlocked. $\mathsf{Language}_{ij}$ is a binary variable that is 1 if the country pair shares a common language and 0 otherwise. Colony_{ij} is a binary variable that is 1 if the country pair has ever been in a colonial relationship and 0 otherwise and $\mathsf{Coloniser}_{ijt}$ is a binary variable that is 1 if the country pair has a common coloniser after 1945. $\mathsf{Country}_{ijt}$ is a binary variable that is 1 if both countries are the same country and 0 otherwise, thereby accounting for cases such as Czechoslovakia breaking into two nations at some point in the dataset.

F_i and F_j represent dummies for countries i and j, respectively, allowing for variations in the import prices faced by trade partners vis-à-vis the prices relative to all their other trade partners. These country-level effects are known as the 'multilateral resistance term' (MRT) (Anderson and van Wincoop, 2003). Because bilateral trade flows are influenced by the MRT and the dependent (intramax clustering) variable relies on these flows, the MRT also needs to be controlled for in the present empirical setting. Country-level fixed effects control for unobserved phenomena pertaining to pairs of countries, though spatial autocorrelation may not be fully accounted for. Robust standard errors computed at the dyad level account for heteroskedasticity.

4.2 Data

The panel dataset covers a maximum of 211 countries and contains observations for the period 1950–2005 in five-year intervals. The panel is arranged by country pair and year, regardless of trade flows being missing or valued zero. Each country pair is represented twice, once as *ij* and once as *ji*. This is done because bilateral imports are used as the dependent variable. Although annual data on intramax-driven trade blocs may provide for a richer analysis, their construction is a labour-intensive task. Moreover, the objective is to study the long-term evolution of these trade blocs and not year-by-year changes by themselves.

Bilateral trade data [imports CIF (cost, insurance, and freight) and exports FOB (free on board) in US$ million] were obtained from the IMF (1995; 2008). The dependent variable of choice is bilateral imports due to data coverage. In case of missing values, the country's trade partner's bilateral exports are used as a proxy of that country's bilateral imports. A 10% CIF rate is assumed when exports are used to replace missing imports. Real trade values were obtained from the Bureau of Labor Statistics (2008) by deflating with the US Consumer Price Index (All Consumer Goods, 1983−4 = 100). Data on GDP (in 1990 international dollars) are from Maddison (2007). Additional data are from World Bank (2011) using the GDP in 2000 international dollars series and that were reconverted to be consistent with Maddison's data.

Data on simple geodesic distance (in kilometres), country size (in square kilometres), whether countries share a common major/official language, a border, whether countries are landlocked, and details on their colonial history are from CEPII (2008). The countries and EIAs included are from Kohl (2012, chapter 3).

4.3 Results

Estimation results for the pooled dataset spanning 1950–2005 are displayed in table 2, column 1.

As expected, the results indicate that the probability that countries belong to the same trade cluster is very much influenced by distance in both absolute and relative terms. The negative sign of the distance coefficient means that, if the physical distance between two countries increases, the probability of being in the same trade bloc declines. Although related, there is a slight difference between how the effect of distance is interpreted in the standard gravity equation and how it should be interpreted in the present study. The standard interpretation is that countries trade less over greater distances. Here, the findings reflect that countries are likely to be clustered in the same trade bloc, the greater their proximity. Indeed, the one implies the other: the negative effect of distance on trade volumes between import and exporter also decreases their probability of being clustered in the same trade bloc. However, the contribution of the present approach lies in its explicit focus on the clustering of trade partners.

Strikingly, participation in EIAs is found to increase a country pair's likelihood of being in a trade bloc. This result is robust for most of the cross-sections in table 2. It supports one of the key findings that already became apparent in the previous section: namely, that trade blocs have remained surprisingly regional despite the increasingly global focus of the web of EIAs active in the world economy.

The positive GDP coefficient means that poorer countries have a lower probability of being in a trade cluster than rich countries due to the purchasing power of the (extended) market. With respect to the geographic controls, contiguity (having a common border) is a complicated variable. Instinctively, sharing a border should increase the probability of being in a cluster (compare Andresen, 2009a), but the nations in the trade blocs are often in a cluster with more than sixteen nations with whom they obviously cannot all share a border. This has a negative bearing on the estimated parameter value. The geographic position of countries or the set of countries also has a strong influence on the probability of being in a trade cluster. Being landlocked means less access to seaports and hence an increase in transportation costs (compare Frankel et al, 1996). If one of the countries in a dyad is not landlocked, it is less likely to be part of a landlocked country's trade cluster than when both are landlocked.

A common language (as a proxy for cultural similarity) has a positive effect on the probability of being in a trade bloc, confirming the discussed literature. This result is not robust to the inclusion of a lagged dependent variable. When one of the two countries has been a colony of the other country in the past (such as Senegal being colonised by France, Angola by Belgium, and India by the United Kingdom), this is reflected in a positive effect on the probability of being in the same trade cluster. Similar effects are found for two countries in a dyad that have a common former coloniser [such as Senegal and Nigeria do with respect to France and India and Myanmar (Burma) with respect to the UK]. Not unexpectedly, having been the same country (such as the Czech Republic and Slovakia) has positive effects on the probability of being in the same trade cluster, although this is not robust to the inclusion of a lagged dependent variable.

Next, we investigate the variation of these findings across time by estimating equation (3) in cross-sections of five-year intervals. The parameter estimates are presented in table 2, columns 2–13. The effects for proximity reflect our discussion of the literature. The declining

Table 2. Probit estimation results with an intramax cutoff threshold of approximately 10%.

	(1) pooled	(2) 1950	(3) 1955	(4) 1960	(5) 1965	(6) 1970	(7) 1975	(8) 1980	(9) 1985	(10) 1990	(11) 1995	(12) 2000	(13) 2005
lnDistance	−0.860***	−1.085***	−1.000***	−0.833***	−0.543***	−0.693***	−0.700***	−0.875***	−0.954***	−1.510***	−1.495***	−1.299***	−1.284***
	(0.015)	(0.045)	(0.037)	(0.029)	(0.027)	(0.028)	(0.025)	(0.024)	(0.026)	(0.041)	(0.057)	(0.045)	(0.054)
EIA	0.370***			0.739**	1.479***	0.442**	0.405**	−0.024	−0.092	−0.255**	0.839***	0.457***	0.274***
	(0.024)			(0.232)	(0.207)	(0.157)	(0.130)	(0.098)	(0.077)	(0.087)	(0.077)	(0.058)	(0.068)
lnGDP	0.098***	0.359***	0.352***	0.230***	0.261***	0.205***	0.059*	0.153***	0.028	0.287***	0.301***	0.168***	−0.069*
	(0.011)	(0.084)	(0.060)	(0.043)	(0.042)	(0.036)	(0.024)	(0.022)	(0.021)	(0.029)	(0.030)	(0.027)	(0.033)
Border	−0.238***	−0.502**	−0.536***	−0.256*	−0.008	0.031	0.058	0.151	0.139	−0.157	−0.307*	−0.467***	−0.350**
	(0.053)	(0.186)	(0.162)	(0.105)	(0.105)	(0.100)	(0.097)	(0.098)	(0.105)	(0.136)	(0.151)	(0.124)	(0.109)
Landlocked													
one	0.880***	0.978**	−0.05	1.517***	1.615***	0.616	0.923*	0.925**	1.047**	3.912***	0.635	2.053***	0.035
	(0.164)	(0.362)	(0.447)	(0.319)	(0.349)	(0.370)	(0.369)	(0.292)	(0.394)	(0.573)	(0.584)	(0.531)	(0.462)
both	1.809***	1.996**	−0.001	3.046***	3.417***	1.523*	1.711*	1.736**	2.590**	7.920***	1.265	3.994***	0.528
	(0.329)	(0.749)	(0.978)	(0.654)	(0.709)	(0.751)	(0.750)	(0.592)	(0.800)	(1.147)	(1.169)	(1.065)	(0.926)
Language	0.172***	0.852***	0.867***	0.574***	1.085***	0.584***	0.207***	0.241***	−0.041	−0.012	−0.216***	−0.319***	0.187***
	(0.018)	(0.091)	(0.068)	(0.052)	(0.052)	(0.045)	(0.043)	(0.039)	(0.041)	(0.044)	(0.052)	(0.042)	(0.041)
Colony	0.678***	1.841***	0.718***	0.883***	1.313***	1.279***	0.628***	0.519***	0.728***	0.172	0.762***	0.842***	0.614***
	(0.067)	(0.236)	(0.152)	(0.147)	(0.136)	(0.123)	(0.124)	(0.109)	(0.119)	(0.153)	(0.174)	(0.171)	(0.161)
Coloniser	0.324***	1.360***	1.014***	0.553***	0.655***	0.496***	0.266***	0.459***	0.603***	0.267***	0.435***	0.394***	−0.037
	(0.022)	(0.157)	(0.108)	(0.074)	(0.064)	(0.058)	(0.050)	(0.050)	(0.047)	(0.054)	(0.055)	(0.048)	(0.053)
Country	0.087	0.415	0.365	−0.051	−0.14	−0.129	0.185	0.086	0.278	0.007	0.855*	0.21	0.11
	(0.081)	(0.305)	(0.280)	(0.147)	(0.136)	(0.144)	(0.141)	(0.136)	(0.162)	(0.225)	(0.339)	(0.198)	(0.205)
Constant	4.055***	2.592	1.561	2.181**	−1.514	1.123	2.303***	3.218***	4.611***	3.513***	3.403***	4.636***	8.138***
	(0.273)	(1.433)	(1.078)	(0.805)	(0.808)	(0.686)	(0.617)	(0.489)	(0.630)	(1.016)	(0.935)	(0.937)	(0.947)
N	216 086	6006	7482	13 572	14 520	16 256	19 460	20 880	22 350	22 350	22 350	22 952	19 182
McFadden's R^2	0.27	0.463	0.423	0.312	0.334	0.307	0.288	0.319	0.349	0.463	0.559	0.463	0.469

Notes: The dependent variable is binary, where a country pair in the same functional cluster scores 1 and 0 otherwise. Estimates marked ***/**/* are significant at the 1/5/10% level. Robust standard errors (clustered by country pair) are in parentheses. Estimates for intercepts and fixed effects are omitted to save space.

importance of distance on trade bloc formation until the 1970s can perhaps be ascribed to the notion that proximity becomes less restrictive to the geographic distribution of economic activity due to the forces of globalisation. However, the need for personal information exchanges and the location-bound nature of multinational enterprises' firm-specific advantages may have contributed to the importance of proximate countries being in the same trade cluster (see Rugman and Verbeke, 2004).

Higher GDP levels and the presence of EIAs increase the probability of trade bloc formation, although the coefficients show some fluctuation across time periods. This may be explained by the changing 'North–South' orientation of trade: that is, more market extension rather than cheap imports (Poon and Pandit, 1996). Contiguity has a negative effect on clustering. As explained before, this has to do with the number of countries in a trade bloc that do not share a border due to their geographic layout. Again, being landlocked increases the probability of belonging to the same trade cluster.

The language variable is not robust across all time periods, but tends to suggest that cultural familiarity promotes trade bloc formation. Having common colonial ties has a positive

Table 3. Probit estimation results with different intramax cutoff thresholds.

	(1) 10%	(2) 20%	(3) 30%	(4) 40%
lnDistance	−0.860***	−0.919***	−0.988***	−0.587***
	(0.015)	(0.013)	(0.013)	(0.010)
EIA	0.370***	0.249***	0.233***	0.350***
	(0.024)	(0.023)	(0.023)	(0.024)
lnGDP	0.098***	0.147***	0.187***	0.127***
	(0.011)	(0.009)	(0.009)	(0.008)
Border	−0.238***	−0.428***	−0.593***	−0.192***
	(0.053)	(0.053)	(0.058)	(0.044)
Landlocked				
one	0.880***	1.180***	1.165***	0.497***
	(0.164)	(0.144)	(0.136)	(0.122)
both	1.809***	2.301***	2.280***	0.992***
	(0.329)	(0.289)	(0.272)	(0.246)
Language	0.172***	0.192***	0.145***	−0.037*
	(0.018)	(0.017)	(0.018)	(0.015)
Colony	0.678***	0.501***	0.214***	−0.028
	(0.067)	(0.058)	(0.050)	(0.053)
Coloniser	0.324***	0.320***	0.273***	0.302***
	(0.022)	(0.019)	(0.019)	(0.019)
Country	0.087	−0.042	−0.127	0.039
	(0.081)	(0.077)	(0.083)	(0.071)
Constant	4.055***	3.826***	4.580***	3.370***
	(0.273)	(0.239)	(0.238)	(0.200)
N	216 086	216 086	216 086	216 086
McFadden's R^2	0.270	0.226	0.203	0.088

Notes: The dependent variable is binary, where a country pair in the same functional cluster scores 1 and 0 otherwise. Estimates marked ***/**/* are significant at the 1/5/10% level. Robust standard errors (clustered by country pair) are in parentheses. Estimates for intercepts and fixed effects are omitted to save space.

effect on the probability of being in the same cluster (compare Head et al, 2010). Note that the colonial effect might be overtaken by shared language, shared cultural background, and institutional similarities (compare Andresen, 2009b; Glenn, 2008). The results for common coloniser are similar to the long-timespan estimations. The effect of two countries having been one country in the past tends not to be significant.

4.4 Sensitivity analyses

As discussed in section 3.1, there is no clear-cut stop criterion at which functional areas should be defined. The dendograms obtained from our intramax analyses indicate that thresholds lower than approximately 10% yield trade clusters that are even more regionally focused than those illustrated in the previous section. Conversely, higher cutoff thresholds yield trade clusters that are more geographically dispersed. We therefore use two strategies to determine whether our findings are robust to cases when higher cutoff thresholds are employed.

First, we compare estimates of equation (3) on the pooled sample using the four different cutoff thresholds presented in table 3. Estimates based on our default threshold of approximately 10% are repeated in column 1. Column 2 uses a higher threshold of approximately 20%; column 3 assumes a value of around 30% and column 4 roughly 40%. As expected, we observe that the model fit deteriorates with a higher degree of clustering due to less variation in the dependent variable. Nevertheless, our key empirical findings are robust to various intramax cutoff thresholds.

Second, we use the cutoff threshold of 20% to repeat our cross-sectional investigation of how the determinants of trade blocs have changed over time. The results in table 4 demonstrate that, although the size of the coefficients is obviously not identical to those in table 2, there are no substantive differences in their interpretation. Again, the behaviour of our key variables of interest, namely geographic distance and EIAs, is very similar to what we find with a cutoff threshold of 10%.

Overall, our sensitivity analyses reinforce the main finding that geographic proximity and regionalism are associated with trade bloc formation.

5 Discussion and conclusion

We contribute to the literature by providing estimates of dynamic trade bloc formation for the period 1950–2005 with more comprehensive coverage than those used in previous exercises. It assesses how trade blocs have evolved and shows how geographic, economic, political, historical, and cultural factors are associated with their composition. Furthermore, the insights derived here from aggregate trade data regarding the evolving geographical regionalism of trade blocs are also very consistent with the multinational-based findings of Rugman (2000; 2005) and UNCTAD (2003). Our findings are summarised as follows.

First, intramax provides strong evidence that trade blocs are highly dynamic and different to those obtained by static classifications based on countries' geographic or political characteristics. These results oppose the notion of triadisation in the international business literature, suggesting that the world economy can simply be divided in three static regions. Our visual results also indicate that emerging economies such as Brazil, Russia, India, and China have played a central role in trade bloc formation long before attracting attention as 'BRICs' in the recent literature.

Second, increasing distance reduces the probability that countries belong to the same trade bloc. Although countries do not have to be strict neighbours to belong to the same trade cluster, negative distance coefficients they are only likely to belong to the same trade cluster if the distance between them is not too large. These results complement the gravity-equation literature by showing that distance not only affects the level of trade between nations, but that it also influences their probability of belonging to the same trade cluster.

Table 4. Probit estimation results with an intramax cutoff threshold of approximately 20%.

	(1) pooled	(2) 1950	(3) 1955	(4) 1960	(5) 1965	(6) 1970	(7) 1975	(8) 1980	(9) 1985	(10) 1990	(11) 1995	(12) 2000	(13) 2005
lnDistance	−0.919***	−1.403***	−0.613***	−0.883***	−0.517***	−0.755***	−0.740***	−1.105***	−1.044***	−1.560***	−1.904***	−1.705***	−1.173***
	(0.013)	(0.045)	(0.030)	(0.029)	(0.024)	(0.025)	(0.022)	(0.027)	(0.024)	(0.042)	(0.052)	(0.052)	(0.041)
EIA	0.249***			0.444	0.623***	0.407*	0.344**	−0.418***	−0.221**	0.028	−0.068	−0.007	0.385***
	(0.023)			(0.240)	(0.174)	(0.174)	(0.121)	(0.095)	(0.073)	(0.098)	(0.064)	(0.063)	(0.058)
lnGDP	0.147***	0.510***	0.261***	0.176***	0.194***	0.208***	0.157***	0.224***	0.135***	0.231***	0.317***	0.260***	0.116***
	(0.009)	(0.079)	(0.050)	(0.035)	(0.033)	(0.029)	(0.021)	(0.020)	(0.018)	(0.022)	(0.025)	(0.024)	(0.027)
Border	−0.428***	−0.516*	0.008	−0.621***	−0.221*	−0.026	−0.209*	−0.263*	−0.187	−0.182	−0.585***	−0.956***	−0.431***
	(0.053)	(0.242)	(0.148)	(0.109)	(0.104)	(0.099)	(0.094)	(0.105)	(0.105)	(0.165)	(0.158)	(0.163)	(0.124)
Landlocked													
one	1.180***	1.604***	−0.246	1.406***	1.404***	0.690*	1.853***	0.854**	1.858***	3.581***	3.185***	2.921***	1.615***
	(0.144)	(0.352)	(0.374)	(0.272)	(0.272)	(0.350)	(0.262)	(0.301)	(0.394)	(0.476)	(0.494)	(0.640)	(0.434)
both	2.301***	2.242**	−0.265	2.553***	3.186***	1.507*	3.591***	1.486*	3.626***	7.008***	6.209***	5.509***	3.316***
	(0.289)	(0.764)	(0.822)	(0.555)	(0.553)	(0.707)	(0.528)	(0.610)	(0.801)	(0.954)	(0.990)	(1.284)	(0.870)
Language	0.192***	0.680***	0.555***	0.799***	0.939***	0.605***	0.359***	0.164***	−0.03	0.061	−0.257***	0.049	0.080*
	(0.017)	(0.090)	(0.056)	(0.045)	(0.044)	(0.041)	(0.038)	(0.037)	(0.034)	(0.038)	(0.043)	(0.038)	(0.038)
Colony	0.501***	2.557***	0.604***	0.767***	0.885***	0.951***	0.439***	0.401***	0.215	−0.311*	0.620***	0.564***	0.357**
	(0.058)	(0.256)	(0.125)	(0.132)	(0.129)	(0.112)	(0.121)	(0.108)	(0.110)	(0.129)	(0.152)	(0.149)	(0.137)
Coloniser	0.320***	0.512***	1.203***	0.857***	0.498***	0.387***	0.187***	0.468***	0.508***	0.183***	0.516***	0.224***	0.031
	(0.019)	(0.152)	(0.093)	(0.063)	(0.056)	(0.052)	(0.045)	(0.047)	(0.042)	(0.045)	(0.048)	(0.044)	(0.047)
Country	−0.042	1.435***	0.978**	−0.082	−0.307*	−0.417**	0.031	−0.194	0.269	−0.386	−0.029	0.333	−0.118
	(0.077)	(0.417)	(0.355)	(0.160)	(0.140)	(0.142)	(0.136)	(0.143)	(0.181)	(0.263)	(0.254)	(0.288)	(0.177)
Constant	3.826***	2.907*	0.053	3.817***	−0.381	1.401*	1.381**	4.466***	2.934***	4.974***	6.242***	5.458***	3.312***
	(0.239)	(1.356)	(0.915)	(0.671)	(0.645)	(0.588)	(0.500)	(0.452)	(0.612)	(0.813)	(0.907)	(1.030)	(0.840)
N	216 086	6006	7482	13 572	14 520	16 256	19 460	20 880	22 350	22 350	22 350	22 952	19 182
McFadden's R^2	0.226	0.514	0.24	0.317	0.257	0.266	0.249	0.32	0.315	0.415	0.487	0.481	0.388

Notes: The dependent variable is binary, where a country pair in the same functional cluster scores 1 and 0 otherwise. Estimates marked ***/**/* are significant at the 1/5/10% level. Robust standard errors (clustered by country pair) are in parentheses. Estimates for intercepts and fixed effects are omitted to save space.

Third, cultural similarities promote trade bloc formation. Geographic positioning is also relevant in the sense that the probability that countries belong to different trade blocs decreases with their access to seaports. Countries that used to be colonial dependencies are more likely to trade with their colonisers than with other countries. Unsurprisingly, having a common coloniser increases the probability that nations are in the same trade cluster.

The trade blocs obtained with intramax show that their orientation has become surprisingly more regional despite the prevalence of an interregional ‘spaghetti bowl’ of EIAs. In fact, distance and EIAs are key contributors to the ‘curved’ world economy characterised by several, regionally focused trade blocs. This evidence indicates that this has been so for a long period and has become stronger over time: trade starts at home. Policy makers seeking economic growth through trade should focus on enhancing economic integration with regional partners.

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