The University of Nottingham

research paper series

Globalisation, Productivity and Technology

Research Paper 2011/11

Trade Costs and Trade Composition

by

Danny McGowan and Chris Milner

The Centre acknowledges financial support from The Leverhulme Trust
under Programme Grant F/00 114/AM

Leverhulme Centre for Research on Globalisation and Economic Policy

The Authors

Chris Milner is Professor of International Economics at the University of Nottingham and an internal GEP research fellow.

Danny McGowan is a Research Fellow in the School of Economics at the University of Nottingham.

Acknowledgements

The authors gratefully acknowledge financial support from the Leverhulme Trust under Programme Grant F/00114/AM. They are grateful also for helpful comments received on earlier drafts of this paper from participants of GEP Conferences at the University of Nottingham (Nottingham, 2009; Kuala Lumpur, 2010 and 2011) and the European Trade Study Group 2010.

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Abstract

Do trade costs have consequences other than on the volume of international trade? In this paper we investigate whether countries' trade costs act like other national endowments by affecting the composition of countries' exports. Using an econometric approach that controls for endogeneity by accounting for potentially relevant omitted variables we find strong evidence for a sample of 37 industrialised and transition countries that national trade costs systematically affect the composition of trade and can be viewed therefore as a source of comparative advantage. Industries located in countries with low trade costs capture significantly higher shares of world exports where this effect is stronger in trade cost intensive industries.

JEL Classification: F11, F14

Key words: Trade costs, comparative advantage, endowments, exports

Outline

Non-Technical Summary

Overall trade costs include all the costs associated with delivering a good from the producer to final users overseas, other than the cost of producing the good itself. A number of recent studies have indicated that these costs are large. There are good grounds for believing, therefore, that patterns of international trade may be affected not only by relative production costs but also by trade costs. The literature on international trade has tended to concentrate on the trade volume effects of trade costs and on whether goods are traded or not. There has been relatively little consideration of how trade costs affect the composition of trade and sources of comparative advantage internationally. In the present study we concentrate on how trade costs matter empirically for the industry or commodity composition of trade; in particular on whether differences in trade costs across countries associated with geographical, institutional and infrastructure characteristics or 'endowments' are a source of comparative advantage. It follows on from a recent strand of the literature that considers whether specific types of trade costs affect comparative advantage and the composition of trade. Nunn (2007) for example finds that countries with good contract enforcement (good "rule of law" conditions) export more goods for which contract enforcement is more important. In similar fashion, Levchenko (2007) shows that countries with better institutions specialize in goods that are more complex in terms of the range of inputs used in production. To the extent that institutions, in general or specific types of institutions, affect trade costs, then trade costs are represented as a source rather than modifier of comparative advantage and trade patterns. In this paper we extend on this tradition by considering the whole gamut of institutional and infrastructure characteristics of countries which induce inter-country differences in overall national trade costs. Indeed, we find empirical support for country trade costs being an 'endowment' which affect the pattern of comparative advantage and export composition globally. This is revealed in export performance at the industry level for a sample of 37 industrial and transitional countries over the period 1990 to 2004. Countries with lower trade costs are found to export a greater share of world manufactured exports for which trade costs are more important, having controlled for other influences (including traditional factor endowment influences) on export performance by introducing time-varying country- and industry-specific effects into our panel estimation framework. Further, this finding is robust for a wide range of specifications capturing additional industry and country characteristics.

1. Introduction

Trade costs, especially if defined to include less easily identified and measurable information-related costs of transacting internationally as well as costs of transportation, have been shown by a number of recent studies to be large (Anderson and van Wincoop, 2004; Hummels, 2007). The gravity model literature has identified many factors, ranging from economic to cultural and institutional elements that account for the high cost of international trade. Although trade costs are currently of great interest (Anderson and van Wincoop, 2004; Obstfeld and Rogoff, 2000; Hummels, 2007; Jacks et al., 2011), studies have by and large been confined to explorations either of their magnitude and/or subsequent impact on trade volumes. For example, using a comprehensive dataset on international trade volumes across the years 1870-2000, Jacks et al. (2011) show changes in countries' trade costs underlay both the booms and busts in international trade volumes throughout recent history.[1]

Despite such insights, little is known about the consequences of trade costs beyond their impact upon the volume of trade. Indeed there are reasons to believe that trade costs may also affect the composition of trade since recent evidence shows institutional quality, a component of national trade costs, to shape comparative advantage. Institutions represent a sub-set of the influences on trade costs which affect transaction and production costs, raising information and procurement costs in institutionally inferior environments. For example, Levchenko (2007) shows institutional quality to be a significant determinant of the import shares of 116 countries into the United States in 1997, with countries endowed with better institutions capturing a larger share of imports in more institutionally intense industries. Similarly, Nunn (2007) finds empirical evidence that the ability to enforce contracts (a component of legal institutions contained within the broader definition of country-specific institutions) affects a country's comparative advantage in the production of goods requiring relationship-specific investments.

In this paper we consider how trade costs affect the composition of international trade and therefore act as a source of comparative advantage or disadvantage. We therefore extend the analysis of specific types of trade costs by incorporating the entire universe of institutions, infrastructure characteristics and endowments of countries which induce differences in overall national trade costs. To answer this question we apply and adapt a recently proposed micro-founded method for measuring international trade costs (Novy, 2008) to a large sample of developed and transition countries for the period 1990-2004. This provides comprehensive information which is interesting in its own right, relating to the evolution of trade costs over time and the differences across country types and regions. The primary aim of the study is, however, to empirically test whether differences in aggregate, or national trade costs,

[1] A small number of papers show institutional quality, a facet of trade costs, to be correlated with bilateral trade relationships (Anderson and Marcouiller, 2002) and bilateral trade volumes (Ranjan and Lee, 2007). Other papers such as Dornbusch et al. (1977) have dealt with the related issue of traded and non-traded goods.

systematically affect the commodity composition of countries' trade, and whether by implication overall trade costs may be viewed as an endowment and source of comparative advantage differences. We explore econometrically whether industry export shares (for 15 two-digit manufacturing industries) in 37 countries over the period 1990-2004 tend to be larger (smaller) in trade cost sensitive industries in countries 'endowed' with relatively low (high) trade costs, having controlled for other influences on the composition of trade.

The study draws upon that strand of the empirical factor proportions literature that explores the cross-commodity or –industry relationship between export performance and factor intensities of commodities or industries. This strand dates back to correlations established by Keesing (1966) between US export performance and industry skill intensities; a positive correlation for the highest skilled and a negative one for unskilled labour. Similarly regressions of US net exports (aggregate and bilateral) by industry reported by Baldwin (1971) showed a range of significant relationships to cross-industry factor intensities. This strand of the literature was rendered unfashionable, however, by Leamer's (1980, 1984) critique that cross-commodity or industry comparisons had weak theoretical underpinning. He demonstrated that industry export performance did not depend in a strict Heckscher-Ohlin (H-O) model on the input characteristics or factor intensities of industries. As with that strand of the empirical literature interested in measuring factor content to test the Heckscher-Ohlin-Vanek (HOV) model, the cross industry methodology has been revived. Among other things, this revival has been driven by recognition of and allowance for non-factor price equalization (and cross country differences in production techniques). With the factor price equalization (FPE) requirement removed, the commodity (industry) structure of production and trade can be determined. Romalis (2004), for example, shows that, conditional on factor prices, industry export performance in a quasi-H-O model is determined by industry input characteristics, or more specifically in terms of the interaction between industry factor intensity and relative factor prices (or relative national endowments of factors).

A concern for the possible effects of endogeneity bias on our estimated effects of trade costs leads us to use a difference-in-difference approach as our estimation strategy similar to that in Rajan and Zingales (1998). This identification strategy arises out of a belief that other time-varying country- and industry-specific factors are likely to affect export shares and are collinear with trade costs, leading to a correlation with the error term in our model and therefore biased coefficient estimates. For example, these country-time factors might include the deregulation of international trade through reductions in tariff and non-tariff barriers, as well as institutional reforms and endowment factors for which there exists little data.[2] At the industry level changes in the fixed costs of exporting, which play a vital role in

[2] The effect of endowment factors such as these upon trade composition will be entirely captured by the country-year fixed effects we include in our regressions. We do not include endowment interactions in the later regressions

determining firm export behaviour in recent heterogeneous firm models of international trade, as well as changes in the cost of transporting goods across borders (Hummels et al., 2009), might also affect trade costs. To overcome this endogeneity bias we exploit the panel structure of the data and include country-time and industry-time fixed effects. As the country-time effects are collinear with changes in national trade costs, we identify the effects of trade costs on export shares by exploiting the inherent differences in the production characteristics of sectors that determine the average trade cost intensity of exports in the industry.

We measure trade cost intensity using recently released OECD data on the share of imported intermediates used in the production of exports in each 2-digit manufacturing industry. These differences in trade cost intensity between sectors determine the extent to which differences in trade costs across countries affect the cost of producing exports in a given industry. For example, a good that requires a high share of imported intermediate inputs will be relatively more expensive to produce in a country with high trade costs since these affect the cost of the imported intermediates to a greater extent compared to a country with low trade costs. The core hypothesis in this paper is that countries with low trade costs (or good trade cost endowments) specialise in exporting goods that have high trade cost intensity.[3] We find strong evidence in support of this view for a sample of 37 countries over the period 1990-2004. This finding is robust to a series of further tests that include a number of potentially confounding country- and industry-specific variables in the regression.

The remainder of the paper is organised as follows. The empirical model is set out in section 2. The nature and measurement of trade costs is explored in section 3, along with some evidence on measured trade costs across countries and over time. The results of applying the empirical model are reported and discussed in section 4. Finally, section 5 offers some conclusions.

2. Empirical Model

To investigate whether trade costs act as a source of comparative advantage, we model industry *i*'s share of world exports using the following regression

$$x_{ijt} = \alpha + \alpha_1 t_i T_{jt} + \gamma_{it} + \gamma_{jt} + \varepsilon_{ijt} \quad , \qquad (1)$$

because it was not possible to obtain time-varying country measures of human or physical capital (see for example, Hall (1999) and Antweiler and Trefler (2002) which provide time invariant measures).

[3] Throughout the paper the phrases trade cost intensity and trade cost sensitivity are used interchangeably.

where x_{ijt} is the share of world exports of industry i in country j at time t, t_i denotes trade cost intensity in the industry and T_{jt} are trade costs in country j in year t. Also included in the model are a set of country-year fixed effects, γ_{jt}, and industry-year fixed effects, γ_{it}. ε_{ijt} denotes a stochastic error term.

An important concern that arises when trying to identify the effect of trade costs upon industry export shares is their possible correlation with the error term such that the variable is endogenous and OLS will yield biased and inconsistent estimates. Of the potential sources of endogeneity (simultaneity bias, omitted variables, measurement error) perhaps the most important in this context is the omission of other relevant variables.[4] The error term in the regression may contain elements of political, economic and cultural factors, which could potentially determine export shares that are not accounted for by the independent variables but which are correlated with trade costs. We control for these time-varying country-specific factors by including a set of country-time fixed effects. These effects will therefore capture the deregulation of international trade through reductions in tariff and non-tariff barriers which has taken place during the period, changes in human and physical capital endowments, the point in the business cycle and other factors such as institutional reforms which may affect exports. Where trade agreements at the bilateral, regional or multilateral level are an important determinant of exports or where accession to the World Trade Organisation occurs, these effects will also be absorbed within the country-year effects.

Alongside country factors there may be a number of time-varying, industry-specific variables contained within the error term that may also be endogenous. For example, the productivity of firms in the industry may affect exporting behaviour (Bernard and Jensen, 1995). Likewise the extent to which the production of intermediate inputs can be offshored, or outsourced, may affect the costs of producing in an industry and subsequently affect export shares. Since variables such as these may also be correlated with trade costs we also include industry-year fixed effects, γ_{it}, in the regression equation.

In some respects the econometric model specified in equation (1) may be viewed as the panel data equivalent of that used by Romalis (2004), Nunn (2007) and Levchenko (2007) in their studies of endowment-driven comparative advantage. Our choice of modelling strategy is motivated by the study of financial development and growth by Rajan and Zingales (1998). As in that paper, the inclusion of country-year effects in the regression equation means that we exploit the cross-industry differences in the effects of trade costs upon export shares in a difference-in-difference estimation framework. However, the inclusion of country-time effects in the regression results in perfect collinearity with the trade costs that are of interest. Therefore our identification assumption is that there are inherent

[4] Simultaneity bias would suggest that future changes in trade costs are explained by current changes in the industry export shares. The importance of this bias is likely to be reduced in our data given that export shares vary across industries.

differences in the production characteristics of a given sector that determine the average trade cost intensity of goods produced in the industry. These differences in trade cost intensity across sectors determine the extent to which trade costs will affect the cost of producing a good and in turn the share of the global export market. Changes in trade costs therefore can be expected to affect the cost of production in a given sector by affecting the cost of the intermediate inputs that must be imported in order that the good is assembled.

The source of identification in our model therefore comes through the variation between industries within the country-time dimension. For example, a change in trade costs at the aggregate level triggers a different response across industries within the country at that point in time. The core hypothesis of this paper is that trade costs act as an endowment source of comparative advantage in a manner similar to other endowments such as human or physical capital. Thus we posit that an increase in a country's trade costs reduce that country's share of world exports in each sector, and that this effect is larger in industries with higher trade cost intensities (and more sensitive to trade costs).

Our modelling strategy also implicitly incorporates standard country, industry and year fixed effects. The country fixed effects are intended to capture differences in the distance to foreign markets, landlockedness and other geographical, cultural and historical characteristics shown to be important determinants of trade by the gravity literature. The industry fixed effects control for product features such as the bulk and ease of containerisation and transportation which may affect whether a given good is traded internationally, while the year dummies absorb the effect of technology and business cycles common to all industries.

3. Nature and Measurement of Trade Costs

When defined broadly, trade costs include all costs incurred in delivering a traded good from its producer to a final user overseas (other than the marginal cost of producing the good itself). Anderson and van Wincoop (2004) define trade costs so as to include transport costs (freight and time), costs induced by tariff and non-tariff barriers, information costs, contract enforcement costs, legal and regulatory costs, and local distribution costs in export markets. They review a range of literatures and methodologies to provide direct and indirect (inferred) estimates of the individual components of aggregate or country-wide trade costs. They report an overall (average) *ad valorem* tax equivalent for trade costs for a representative industrial country (USA) of 170%; broken down multiplicatively into local distribution costs (55%) and international transaction costs (74%). Alternatively we might express trade costs in relative terms, with the cost of moving goods across borders being about 74% higher than moving goods within borders.[5] It is recognised that there will be variations in overall trade costs across countries (in particular between industrial and developing countries), but also that there are constraints on the systematic measurement of aggregate costs across countries and over time by this type of a bottom-up approach.

Some, but only some trade costs, will vary across products, due to variations in policy barriers or in transportability. In the present study we allow in part for these variations by measuring differences in the trade cost sensitivity of product groups at the industry level. There are, however, likely to be systematic differences across countries for all products associated with geographic and developmental differences in the quality and efficiency of countries' institutions, infrastructure, business and policy environments. It is these differences in (average) overall trade costs that we wish to concentrate on here.

The bulk of the existing literature on trade costs has focussed on how trade flows are shaped by specific types of trade costs, for example informational barriers (Rauch and Trindade, 2002; Felbermayr, Jung and Toubal, 2009), geography (Limao and Venables, 1999), currency unions (Rose and van Wincoop, 2001) and the monopoly power of shipping cartels (Hummels, Lugovskyy and Skiba, 2009). In spite of this wealth of analysis we still know relatively little about the importance or share of each component in total trade costs. The comprehensive measurement of country trade costs is challenging methodologically and in terms of data demands. This is particularly so for a large sample of developed and developing countries over time but also because it is difficult to aggregate the individual components of policy and non-policy sources of trade costs.[6]

In contrast to the number of studies investigating the effect of specific trade costs on international trade, only a small number of papers study national trade costs. One of the first studies in this area by Limao and Venables (2001) sought to quantify international transportation costs by measuring the cost of shipping a standardised freight container from Baltimore to a foreign port. Their findings indicate a non-linearity between distance and transport costs and suggest the importance of other more difficult to measure variables such as port infrastructure, liner connectivity and institutions. In their pioneering study Anderson and van Wincoop (2004) attempt to construct a broad measure of ad valorem trade costs in the United States by combining direct and indirect measures from a variety of sources. Others have used a more pragmatic approach by adapting the gravity model. For example, Hiscox and Kastner (2008) look to capture policy barriers to trade by specifying a simple gravity model of bilateral imports with controls for GDP in the exporter and partner, distance between the countries and a bilateral pair

[5] By way of comparison, we estimate the tariff equivalent of US trade costs to be approximately 60% in our sample.

[6] Recent work for instance by Kee, Nicita and Olarreaga (2009) aggregates across tariff and non-tariff barriers for a large range of countries, but it does so for one year and abstracts wholly from non-policy sources in measuring trade restrictiveness.

fixed effect. All factors that affect trade volumes between countries other than size and distance are then captured by the fixed effect term. Closely related to this are the studies by Head and Mayer (2004) and Redding and Venables (2004) which use a gravity model to construct measures of market and supplier access. However, these could at best be viewed as proxies for trade costs: they are more representative of demand (or market size) and import propensity. Finally, Pomfret and Sourdin (2010) use CIF-FOB ratios to calculate national trade costs but their study is limited to 5 countries due to data constraints and is a narrower concept of trade costs.

Novy (2008) proposes a micro-founded means of dealing with the problems facing a direct gravity model approach, namely of correctly specifying the determinants of trade costs (distance, borders, language etc.) and of measuring multilateral resisitance.[7] He shows that bilateral trade costs can be inferred from the volumes of intra-country trade relative to inter-country trade, while still controlling for the impact of multilateral resistance on trade costs. Using the familiar gravity formulation of Anderson and van Wincoop (2003), Novy shows that this inference can be drawn irrespective of whether the model is derived from a Ricardian (Eaton and Kortum, 2002) or heterogeneous firms (Chaney, 2008; Melitz and Ottaviano, 2008) model of international trade. Exports between a pair of countries are given by:

$$x_{ij} = \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \qquad (2)$$

where x_{ij} denotes exports from country i to j, t_{ij} are bilateral trade costs between the pair, $\Pi_i P_j$ denote price indices in the two countries which correspond to the multilateral resistance term between the pair, and σ is the elasticity of substitution.

The gravity model posits that all else being equal, larger countries trade more with each other. Bilateral trade costs decrease bilateral trade but they are measured relative to multilateral resistances to trade: where the barriers between country i and the rest of the world (multilateral barriers) are lower relative to bilateral barriers between i and j, country i will trade less with j relative to all other destinations. Novy (2008) shows that a change in bilateral trade costs affects both inter- and intra-national trade. For example, when the barriers to trade between country i and all other countries fall some of the goods that were previously consumed domestically are now shipped to foreign countries. Hence, it is not just international trade that is shaped by trade costs but intra-national trade as well.

Formally this can be seen through the representation of intra-national trade as:

[7] This approach to measuring trade costs is also used in Jacks et al. (2011), where the authors measure bilateral trade costs for 130 country pairs over the period 1870-2000. This methodology is similar to that proposed by Head and Ries (2001).

$$x_{ii} = \frac{y_i y_j}{y^W}\left(\frac{t_{ii}}{\Pi_i P_i}\right)^{1-\sigma} \qquad (3)$$

where t_{ii} represents intra-national trade costs: domestic transportation costs. y_i and y_j denote GDP in country i and j respectively and y^W represents GDP in the rest of the world. Through rearrangement equation (3) can be solved for inward multilateral resistance:

$$\Pi_i P_i = \left(\frac{x_{ii}/y_i}{y_i/y^W}\right)^{\frac{1}{1-\sigma}} t_{ii} \qquad (4)$$

To eliminate the multilateral resistance terms from equation (2) Novy shows that the product of bilateral trade ($x_{ij}*x_{ji}$) is given as:

$$x_{ij}x_{ji} = \left(\frac{y_i y_j}{y^W}\right)^2 \left(\frac{t_{ij}t_{ji}}{\Pi_i P_j \Pi_j P_i}\right)^{1-\sigma} \qquad (5)$$

Incorporating equation (4) into (5) leads to the eventual solution for bilateral trade costs by using a geometric average and subtracting 1 to give a tariff equivalent:

$$\tau_{ij} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}}\right)^{\frac{1}{2(\sigma-1)}} - 1 \qquad (6)$$

where τ_{ij} measures bilateral trade costs, $t_{ij}t_{ji}$, relative to domestic trade costs, $t_{ii}t_{jj}$. The intuition underpinning (6) is straightforward. The gravity equation tells us how consumers decide to allocate spending across different countries. If bilateral exports increase relative to domestic trade flows, it must have become easier for the two countries to trade with each other. The key advantage to this approach is that trade costs can then be captured using observable trade flows. To implement equation (6) we rely upon estimates of trade cost elasticities reported in the recent literature. In their survey of trade costs Anderson and van Wincoop (2004) report trade cost elasticities that fall within the range 5 to 10 and based upon this suggest a value of 8.[8]

The data required to estimate (6) are drawn from two datasets. Information on bilateral manufacturing exports is taken from the IMF Direction of Trade Statistics dataset. Although the panels are balanced

[8] Novy (2008) uses a value of 8 to calculate bilateral trade costs between the US and trading partners. Similarly, Jacks et al. (2011) use a value of 8 when studying trade costs between 130 bilateral pairs. We are constrained to adopt a common trade cost elasticity value and recognise the possibility that this may induce bias in the calculations. However, as demonstrated in Jacks et al. (2011), using alternative trade cost elasticities does not greatly impact upon the resulting trade cost estimates. We also investigated the possibility of estimating trade cost elasticities for each country by using the translog gravity specification in Novy (2010), but estimation proved to be data constrained.

within years, that is, each country is matched to every possible destination country, they are unbalanced across years due to the entry of newly created countries into the dataset. Where zero trade flows are reported we impute a value close to zero so as to make estimation of (6) possible. To calculate intra-national trade we use the UN's data on output at basic prices and aggregate this to cover the entire manufacturing industry.[9] For some countries there are gaps in the output data. Where this occurs we use an imputation technique using a linear regression of (observed) output at basic prices on GDP for each country over the period to form a prediction of the relationship and impute output values according to GDP.[10] Alternative specifications using regional level information returned similar estimates, with the resulting trade cost calculations unaffected. The export and output series are converted and deflated into real US 2000 dollars and cover the years 1990-2004.

In total this provides estimates of bilateral trade costs for 37 countries and up to 213 partners in any one year. To calculate aggregate (national) trade costs we generate an annual weighted average of the bilateral trade costs for each country, where the weights with each partner are defined as bilateral exports between the countries in a frictionless world divided by total exports to all countries in the frictionless world. Rather than weight by actual exports, we calculate the volume of exports that would apply with zero trade costs using the trade cost elasticity of 8 used in the calculations of trade costs. Our aggregate trade cost measure is the weighted average of the bilateral trade costs (t_{ij} and t_{ji}) for any one country (i) with all of its trading partners (j). It therefore does not capture the trade costs of country i alone, but given there is a virtually common set of trading partners for each country, during each year, it provides a basis for comparing relative aggregate trade costs both of importing and exporting by each country. Given the importance of the ability to import intermediate imports to manufacturing competitiveness, capturing both import and export side trade costs is attractive.

Countries can have specific attributes (e.g. remoteness or landlockedness, (in) efficiency in customs clearance procedures) that make them relatively more or less expensive in exporting or importing than others. Thus for trade with the same trading partner (and at the same distance and in the same product) there can be trade cost differences across countries. Simultaneously, for each country there are likely to be differences in trade costs, depending on whom it is trading with. An obvious driver is distance between trading partners. However, there will also be country-specific characteristics of each trading partner (e.g. landlockedness, port efficiency etc) that induce differences in trade costs. These differences in trading partner attributes will affect products differentially, depending on the weight, perishability etc. of products.

[9] This data was obtained from the UN Data Table 2.3 "Output, gross value added, and fixed assets by industries at current prices".
[10] Further details are provided in the Appendix.

Figure 1: Average Aggregate Trade Costs 1990-2004

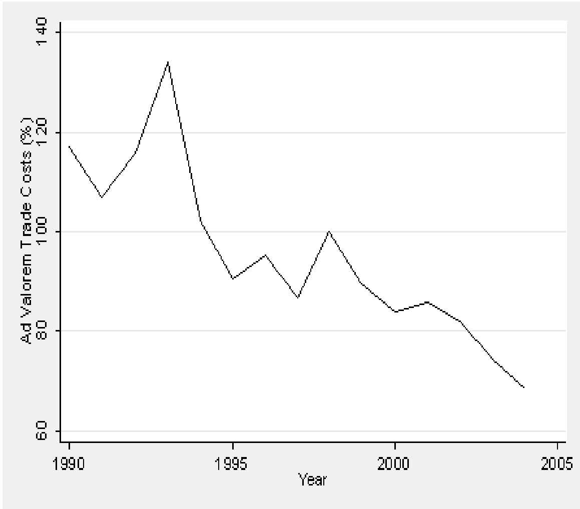
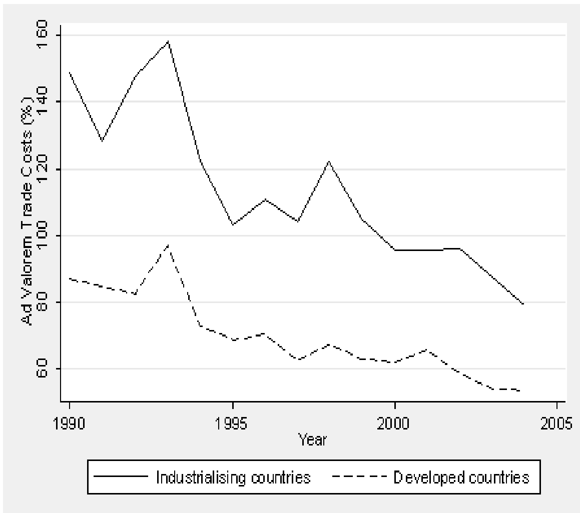


Figure 2: Trade Costs in Developed and Industrialising Economies



Notes: The industrialising economies are defined as those with GDP per capital below $10,000 at any time during the sample. The graph displays fitted values where these are calculated using a linear regression and fitted using the data accordingly. The countries belonging to this group are Argentina, Brazil, Chile, China, Czech Republic, Estonia, Greece, Hungary, India, Indonesia, Korea, Mexico, Poland, Romania, Russia, Slovenia, South Africa and Turkey.

Table 1: Average National Trade Costs 1990-2004 (%)

Belgium	31	Czech Republic	74	Poland	99	India	123
Netherlands	37	Spain	74	Korea	104	Chile	127
Canada	44	Switzerland	77	Australia	106	Brazil	133
Germany	52	Sweden	80	Denmark	107	South Africa	150
Mexico	55	China	82	Greece	109	New Zealand	152
France	60	Portugal	82	Indonesia	109	Romania	160
US	60	Norway	83	Israel	112	Argentina	193
UK	61	Hungary	89	Russia	115		
Italy	68	Slovenia	94	Turkey	120		
Austria	69	Finland	96	Estonia	121		

Notes: Trade costs are reported in percentages as the ad valorem tax equivalent of international trade costs relative to domestic trade costs. 35% therefore means that international trade costs are 35% higher relative to domestic trade costs.

In Figure 1 we present average trade costs across the 37 countries included in the sample for the years 1990 to 2004. Generally trade costs have fallen during this period from approximately 110 per cent at the start of the period to 66 per cent in 2004.[11] Inevitably the data hide substantial variation between countries over the period. For example, trade costs fell by approximately 50 per cent in China compared with a 24.6 percent decline in the United States. The largest reduction in trade costs occurs in the case of Argentina for whom trade costs fell from 443 per cent in 1990 to 133 per cent in 2004. While the smallest change is recorded for Korea (11.5 per cent reduction), with these patterns tending to reflect differences between countries' level of integration with global markets at the start of the period. However, as shown by Figure 2, there are apparent differences among countries according to their level of industrialisation or income. Industrialising economies are found to have considerably higher trade costs compared to industrialised countries, reflecting the differences in infrastructure and institutional quality between these groups.

Unsurprisingly, the broad aggregates in Figures 1 and 2 mask to a certain extent the heterogeneity between countries' trade costs. In Table 1 we present evidence on average trade costs in each country for the period 1990-2004. From this we continue to observe that transition economies typically have higher trade costs relative to industrialised countries with Argentina, Brazil, India, Romania, and South Africa recording trade cost values at the top end of the distribution. However, distance from markets also appears to play a role with New Zealand (152%) and Australia (106%) being found to have relatively high trade costs despite being high income countries. At the other end of the scale, the countries with the lowest trade costs are typically European, presumably due to their close proximity with trading partners and the European Union's single market agreements. However, even within this

[11] Given the focus of this paper and the broad measure of trade costs we use, we do not look to examine the determinants of the reductions in trade costs in our sample. Note, however, that our average trade cost figure is lower than the Anderson and van Wincoop (2004) estimate of total trade costs for the US (although their estimate is for 1993 only), but that it is similar in terms of the relative costs of moving goods domestically and internationally.

group there is considerable differences: trade costs in Italy are roughly twice as high compared with the Belgium, while trade costs in Greece and Denmark are similar to those of Israel and Indonesia. The three NAFTA countries also rank among the lowest trade cost countries in 2000 with the more open economies of Canada (44%) and Mexico (55%) recording lower values compared with the United States (60%). The country with the lowest trade costs in Table 1 is Belgium closely followed by the Netherlands.[12]

4. Estimation and Econometric Evidence

To address the question in which we are interested, namely of how trade costs affect the composition of trade, we use a separate industry-level dataset of exports taken from the OECD Structural Analysis database. This provides total bilateral exports from 37 countries in 15 2-digit ISIC manufacturing industries over the period 1990-2004 giving a balanced panel of 625 observations for each year, although owing to missing data the maximum number of observations is 7935.[13] The dataset also contains information on world exports in each 2-digit industry which we use in calculating our dependent variable. Trade cost intensity is measured as the share of imported intermediates used in the production of exports, a variable with is taken from the OECD STAN I-O Imports Content of Exports dataset. Again this variable is provided at the 2-digit ISIC industry level. Finally, we link the estimates of national trade costs to this data detailed above. For a summary of the main variables see Appendix Table A2.

As is standard in the literature that uses methodologies along the lines of Rajan and Zingales (1998), our measure of industries' trade cost intensities are constructed using data from the 'frontier' economy.[14] In this paper we use Ireland in the year 2000, since this is the country with the highest average trade cost intensity across sectors.[15] There are a number of reasons for this choice. First, Ireland has one of the most advanced and sophisticated systems of international sourcing of inputs and is often used as an export platform (Eckholm et al., 2003; Barry, 2004; Ruane and Sutherland, 2005), which makes it reasonable to assume that the behaviour of Irish companies reflects firms' optimal choice on importing intermediate inputs. Second, using Ireland (which is not in our sample of countries in the econometric modelling) as a reference country eliminates the potential for sector's trade cost intensity to

[12] Hiscox and Kastner (2008) report Belgium as being the 'free trade benchmark' in their sample when constructing a trade cost proxy.
[13] See Appendix Table A1 for a list of countries included in the dataset.
[14] See for example, Rajan and Zingales (1998) and Manova et al. (2010) for examples using financial development and credit constraints respectively.
[15] The average share of imported intermediates used in Ireland is 0.46. By way of comparison the corresponding values for the United States, France and China are 0.13, 0.27 and 0.19 respectively.

endogenously respond to country-level trade costs.[16] Where industries in other countries actually use a lower share of imported intermediate inputs in the production of exports, our results would be biased downwards. What is required for identification is not that industries have the same trade cost intensity across countries but rather that the ranking of sectors remain relatively stable across countries.[17]

Table 2: Trade Cost Intensity by Industry

Industry	**Trade Cost Intensity**
Food, beverages and tobacco	0.355
Textiles and textile products	0.387
Wood and products of wood and cork	0.409
Pulp, paper and paper products	0.597
Coke, petrol and nuclear fuel	0.653
Chemicals	0.535
Rubber and plastics	0.475
Non-metallic mineral products	0.314
Basic metals	0.378
Fabricated metal products	0.409
Machinery and equipment	0.516
Electrical machinery	0.589
Medical, precision & optics	0.419
Transport equipment	0.486
Manufacturing n.e.c	0.472

In Table 2 we present information on the trade cost intensity of the industries used in our dataset. It is clear from the table that there are key differences in the use of imported intermediate inputs between industries with the coke, petrol and nuclear fuel industry using approximately twice the share of imported intermediates as the non-metallic mineral products. To a certain extent such differences reflect resource endowments: there are only a limited number of countries that produce nuclear fuel and most countries in the dataset are net importers of petrol. Other explanations for the broad differences may be the ease with which intermediate input production can be outsourced abroad, which may partly explain the high trade cost intensity in the machinery and equipment and electrical machinery sectors.

As a reminder, we use equation (1) to estimate the effect of trade costs upon export shares. By controlling for country-year effects, the source of identification in the model comes through variation in

[16] The choice of the year 2000 is motivated by the fact that we only have data on trade cost intensity for the years 1995, 2000 and 2005 and because this lies in the middle of the period it is likely to be relevant across a greater number of years.

[17] Using the original OECD STAN I-O dataset we analysed the ranking of industries' trade cost intensity within countries and across years to ascertain whether there was consistent ranking. We found that the correlation between an industry's ranking within a country across time to be 0.82 indicating a high degree of stability. The second test we conducted was to compute the correlation between industry *i*'s ranking across countries. Here we found the correlation to be lower at 0.65 though we conclude that the ranking of industries' trade cost intensity is similar across countries.

the reaction of industries within the country at time, *t*. The inclusion of country-year, and industry-year, effects is motivated by concern that there may be potentially relevant country and industry factors that may determine export shares but may also be correlated with trade costs such that trade costs are endogenous. Our identification assumption is that there are inherent production characteristics of each industry that determine the trade cost intensity of the goods it produces and that the effect of trade costs upon export shares is mediated through this channel. This methodology is also used in Romalis (2004), Levchenko (2007) and Nunn (2007). Although those papers use cross-sectional data, the sources of identification and variation (across industries within the country) is the same as in our panel data setup.

We begin the testing of the core hypothesis by exploring the impact of trade costs upon industry export shares. Using our preferred specification in regression 1 of Table 3, we find strong evidence that an increase in national trade costs reduces industry export shares where this effect is stronger in industries that export goods which are more trade cost intensive or sensitive. We calculate that a one standard deviation increase in within country-industry national trade costs reduces the export share of the average industry by 0.77 percentage points. It is worth noting that this regression contains country-year and industry-year fixed effects, with the effect of trade costs upon export shares being identified through differences between how industries within the country-year dimension react to the change in trade costs.

Table 3: Interactions between industry trade cost intensity

Regression	**1**	**2**	**3**
Dependent variable : x_{ijt}			
Trade cost intensity$_i$ x			
Trade costs$_{jt}$	-1.298**	-1.182**	-0.369**
	(-7.32)	(-7.15)	(-7.08)
Country, industry and year dummies	Yes	Yes	Yes
Country *x* year dummies	Yes	Yes	No
Industry *x* year dummies	Yes	No	Yes
Observations	0.79	0.79	0.77
R^2	7935	7935	7935

Notes: The reported coefficient estimates were obtained using an OLS estimator using STATA 11. Robust t-statistics are reported in parentheses. +, * and ** denote statistical significance at the 10%, 5% and 1% levels respectively. The dependent variable is the natural logarithm of the export share of industry *i* in country *c* at time *t*. The trade costs variable is in natural logarithms.

This result is consistent with our hypothesis that trade costs act as a form of endowment in ways similar to traditional endowments of human and physical capital. Our results also provide evidence that the effect of trade costs is not only to reduce trade volumes; rather they also shape the composition of trade. Specifically, countries with low national trade costs have a comparative advantage in exporting in industries which have high trade cost intensities. Where trade costs are low the cost of importing intermediate inputs required in the production of exports is lower relative to an environment of high trade costs. Recent theoretical contributions such as Deardorff (2004) have emphasised that trade costs may act as a source of comparative advantage at a local level. However, our results imply that this is true at the global level.

In the remaining columns of Table 2 we test whether our results are sensitive to excluding the country-year and industry-year fixed effects. We find that this is not the case: trade costs remain a negative and highly statistically significant determinant of export shares. However, the change in the coefficient estimates in columns 2 and 3 suggest that there are important time-varying omitted variables, particularly at the country level, for which it is important to control.

4.1 Robustness Tests

So far our econometric model has controlled for potentially important country- and industry-level determinants of export shares by including country-year and industry-year fixed effects. In this section we examine whether a number of time-varying country-industry specific factors affect our results. A description of these variables and their source may be found in the Appendix. Many of the variables we use are indexes from the Economic Freedom Institute. A key advantage of these measures is that they are directly comparable across a large number of countries and time.

Recent theoretical models of heterogeneous firms and international trade demonstrate that due to sunk costs of exporting, only the most productive firms sell abroad (Melitz, 2003). To capture these effects we introduce a labour productivity index variable into the regression which captures the average productivity of firms within the industry, allowing us to see the extent to which productivity governs export shares by altering trade costs. We find that this is not the case, trade costs remain a strongly negative determinant of export shares, but more productive industries specialise in exporting goods with relatively lower trade cost intensities. In light of the predictions of heterogeneous firm models of international trade it may be expected that sectors with a greater share of high productivity firms would capture a larger share of exports. However, given that it tends to be large firms which account for the majority of a country's exports (Mayer and Ottaviano, 2008) it may be that the labour productivity variable performs poorly in capturing the average productivity of firms in the industry. In regression 2 of the table we consider whether this is due to how the productivity index is specified by using an alternative productivity measure, unit labour costs. Higher values of this variable therefore indicate lower labour productivity in the industry. This time we find that industries with high unit labour costs (equivalent to low labour productivity) have lower export shares, with this effect stronger in more trade cost intensive sectors. This would support the view that productivity affects export shares since the cost of production is lower in an industry with low unit labour costs, but given the results in regression 1 we treat this with caution.

Table 4: Interactions between industry characteristics

Regression	1	2	3
Dependent variable : x_{ict}			
Trade cost intensity$_i$ x			
Trade costs$_{jt}$	-0.322+	-0.399*	-0.395*
	(-1.87)	(-2.26)	(-2.41)
Labour productivity index$_{ijt}$	-0.004**		
	(-5.75)		
Unit labour costs$_{ijt}$		-0.003*	
		(-2.14)	
R&D intensity$_{ijt}$			0.066**
			-12.83
Country, industry and year dummies	Yes	Yes	Yes
Country *x* year dummies	Yes	Yes	Yes
Industry *x* year dummies	Yes	Yes	Yes
Observations	0.77	0.78	0.80
R^2	4056	3960	4093

Notes: The reported coefficient estimates were obtained using an OLS estimator using STATA 11. Robust t-statistics are reported in parentheses. +, * and ** denote statistical significance at the 10%, 5% and 1% levels respectively. The dependent variable is the natural logarithm of the export share of industry *i* in country *c* at time *t*. The trade costs variable is in natural logarithms while the labour productivity index, unit labour costs and R&D intensity variables are in levels.

Success in export markets has been shown to be affected by previous investment in new plant and machinery as well as innovation (Alvarez and Lopez, 2005; Iacavone and Javorcik, 2008). To capture such effects, in regression 3 we include a measure of industry-level R&D intensity in the regression. The results indicate that more R&D intensive sectors tend to have larger export shares in goods requiring more intermediates from abroad. To a certain extent this reflects similar properties to that for labour productivity: R&D spending may be used to implement superior production processes or procurement channels to source inputs more cheaply. Again, while this is found to be a significant determinant of export shares the trade cost interaction remains a highly statistically, and negative, determinant.

Table 5: Country, Institutional and Policy Interactions

Regression	1	2	3	4	5	6	7	8
Dependent variable : x_{ict}								
Trade cost intensity$_i$ x								
Trade costs$_{jt}$	-0.899**	-0.703**	-0.873**	-0.829**	-1.046**	-1.707**	-0.638**	-0.530**
	(-4.95)	(-3.13)	(-4.61)	(-4.37)	(-5.83)	(-6.06)	(-3.33)	(-3.00)
Legal institutions$_{jt}$	0.487**							
	(6.35)							
Cost of importing$_{jt}$		0.627**						
		(3.31)						
Hidden import costs$_{jt}$			0.336**					
			(3.35)					
Regulatory trade barriers$_{jt}$				0.420**				
				(3.79)				
Regulations index$_{jt}$					0.597**			
					(5.43)			
Tariffs$_{jt}$						0.018		
						(0.51)		
Freedom to trade index$_{jt}$							0.926**	
							(7.62)	
ln(GDP per capita$_{jt}$)								0.985**
								(10.47)
Country, industry and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country *x* year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry *x* year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	0.78	0.78	0.77	0.77	0.78	0.79	0.78	0.79
R^2	7830	2730	5250	5250	7800	6270	7905	7875

Notes: The reported coefficient estimates were obtained using an OLS estimator using STATA 11. Robust t-statistics are reported in parentheses. +, * and ** denote statistical significance at the 10%, 5% and 1% levels respectively. The dependent variable is the natural logarithm of the export share of industry *i* in country *c* at time *t*. The trade costs variable is in natural logarithms while the legal institutions, cost of importing, hidden import costs, regulatory trade barriers, regulations index and tariff variables are in levels.

During the past twenty years policy makers in many countries have pursued measures of integration designed to remove trade frictions. These actions have encompassed the signing of both bilateral and multilateral free trade agreements, the adoption of common currencies and general reductions in the regulations governing international trade. In Table 5 we conduct a further series of robustness tests that address the impact of institutional reforms and changes in country-level variables that may affect trade composition. Given the findings in Nunn (2007), in regression 1 we consider whether trade costs are merely capturing the effect of improvements in legal quality across countries. We find that this is not the case, but an improvement in legal institutions is found to raise export shares of trade cost intensive goods, an indication that relationship specificity may play a role in the sourcing of intermediate inputs from abroad. While this effect is found to be highly robust, the magnitude of the effect is small when compared with the coefficient estimate for the trade cost interaction. This suggests that, while legal quality plays a role in shaping institutional comparative advantage, there are a number of other factors which are quantitatively more important.

In regressions 2 and 3 we consider the effect of broad changes in the cost of importing at the country level, since this may affect the incentive to export goods that are sensitive to trade costs by affecting the cost of importing the necessary intermediate inputs. The results show that increases in both the cost of importing and hidden costs of importing have a profoundly negative impact upon industry export shares, but this does not explain the effect of trade costs. We find similar results in regressions 4 and 5 of Table 4 when we account for the effect of regulatory barriers to trade and regulations in general. These may be seen to affect the cost of importing in similar ways compared to import costs by raising the price of intermediate inputs. However, as before, while regulatory burdens enter with a negative sign the effect of wider trade costs remains undiminished.

In the sixth column of Table 5 we consider how changes in an important policy-related driver of trade costs, namely tariffs, affect export shares. Generally over the period of our analysis tariffs have been reduced in many countries. The entry of many countries into the WTO, as well as increasing integration at the regional level, has spurred a reduction in tariff barriers. Where tariff barriers are high they may impose a high cost of exporting to that country and result in high trade costs within a bilateral pair. Surprisingly the coefficient on the tariff interaction is estimated to be positive but the value is close to zero and is far from being statistically significant. It may be that tariffs were already low in many countries and their removal therefore had little impact. Alternatively, other non-policy trade barriers such as language, institutions and infrastructure may be more important factors in shaping the cost of international trade. We find some evidence in support of this in column 7 when we include an index measuring the freedom to engage in international trade in the regression. Here we find a large estimated effect of trade policy where industries located in countries with fewer restrictions on international trade capture larger export shares. Moreover, the inclusion of the freedom to trade index results in the estimated coefficient on the trade cost interaction being found to be half that compared with the baseline case in Table 3, suggesting that policy variables may be a key component in affecting trade costs.

Finally, we consider the extent to which the level of development affects our core result. As shown earlier in Figure 2, there are large differences in average trade costs according to whether a country's level of development. It may be that this imposes constraints upon exporters, say through poor infrastructure. Where high skilled workers are necessary in the production of exports low income countries may have lower export shares in certain industries because of inferior education systems. In column 8 of Table 5 we interact the natural logarithm of GDP per capita with trade cost intensity to study the effect of development upon export shares and trade costs. We find that high income countries capture larger export shares where this effect is stronger in trade cost intensive industries. As in the case of trade policy, we also find that this serves to roughly half the coefficient estimate on the trade cost interaction which implies that there may be a number of factors which are correlated with development which explain at least part of the effect of trade costs upon trade composition.[18]

5. Conclusions

There now exists a wide range of evidence that shows a myriad geographical, cultural and economic factors which reduce bilateral export flows (see Anderson and van Wincoop (2004) for a review). When grouped together the net effect of these trade costs has been shown to be large. In this paper we find evidence that, despite substantial decreases in trade costs across a sample of 37 countries during the period 1990 to 2004, trade costs remain large and vary significantly across countries. Moreover, trade costs are shown to affect the composition of trade and a country's comparative advantage in exporting.

Using export data on 15 2-digit manufacturing industries we find that countries with low trade costs export a higher share of goods in industries that have high trade cost intensities. Trade cost intense industries are defined as those where imported intermediate inputs account for a greater share of the total inputs used to produce exports. In an environment of high trade costs the sourcing of these inputs from abroad will be relatively higher compared to a country with low trade costs. Consequently low trade cost countries have a comparative advantage in exporting goods which are more sensitive to changes in trade costs. Our results build on a relatively small literature which considers institutional comparative advantage in exporting (Levchenko, 2007; Nunn, 2007) and show that trade costs in aggregate and as

[18] A number of further robustness tests included the explanatory variables from Table 5 simultaneously in the regression. This had considerable effects upon the sample size though we experimented with several permutations of the model. Throughout the trade cost interaction remained significant and GDP per capita was found to be the only other significant explanatory variable (with a large positive coefficient). When GDP per capita was omitted from the regression the freedom to trade internationally and legal institutions indexes entered with a positive sign, while hidden import costs were found to be negatively correlated with the share of world exports and the remaining variables were insignificant. These results are available from the authors on request.

fashioned by countries' geographical, infrastructural and institutional 'endowments' serve to affect the commodity composition of trade.

We use a difference-in-difference estimator, as specified in Rajan and Zingales (1998), to purge the regressions of endogeneity and potentially omitted time-varying country- and industry-specific variables. We therefore identify the effect of changes in trade costs upon export shares by the difference between how industries react to this change. Our baseline results suggest that a one standard deviation increase in trade costs increases the average industry's share of world exports by 1.52 percentage points and that the effect is greater in industries which have higher trade cost intensities. A series of robustness tests are also conducted to verify the validity of our results. While we find that changes in regulatory barriers and the cost of importing at the country level are negatively related to industry export shares, they do not alter our core findings. Likewise industry productivity, as measured through unit labour cost, is positively related to export shares but trade costs remain a source of comparative advantage.

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Appendix

Table A1: Sample of Countries in Econometric Modelling

Argentina	Hungary	South Africa
Australia	India	Spain
Austria	Indonesia	Sweden
Belgium	Israel	Turkey
Brazil	Italy	United Kingdom
Canada	Korea	United States
Chile	Mexico	
China	Netherlands	
Czech Republic	New Zealand	
Denmark	Norway	
Estonia	Poland	
Finland	Portugal	
France	Romania	
Germany	Russia	
Greece	Slovenia	

Data Sources and Imputation Technique

1. Calculating trade costs

The bilateral export data used to construct trade costs comes from the IMF's Direction of Trade Statistics data base for the years 1990-2004. This provides information on export volumes between the 37 countries listed in Table A1 and a maximum of 213 partner countries. As mentioned in the text, the number of partners is balanced within years, that is, each country, i, trades with the same number of partners in year t. However, due to the entry of new countries into the dataset over time the number of partner countries differs across years. Where exports are reported as zero, or where no value is reported, a value close to zero is imputed to make calculation of bilateral trade costs possible.

Information on output at basic prices is provided by the United Nations database "UN Data Table 2.3 Output, gross value added, and fixed assets by industries at current prices". This provides information on output in broad industries defined according to the NACE classification. Since the export data contains information only on the trade in goods, we aggregate together output in NACE codes A to D to obtain a value for output in the goods sector.[19] In so doing we exclude the service sector and as well as sectors in which public provision of services is more likely.

In some instances information on output is missing (unreported or unavailable). To overcome this problem we first calculate the ratio of output to GDP for each continent. This ratio is relatively uniform

[19] NACE codes A to D cover the agriculture, forestry and fishing, mining and manufacturing industries.

with continents and relatively stable over time, ranging, on average between 1.746 for Africa to 1.876 for the Pacific region countries. Where GDP data is available from the World Development Indicators we impute aggregate output at basic prices using the continental ratio between output and GDP. A linear regression is used to estimate the relationship between output at basic prices and GDP at the continental level. We then use information on GDP and impute a value for output using the linear estimates from the regression of output on GDP at the continental level. We prefer to use information at the continental, rather than country, level since where data is missing for a significant number of years there would be a lack of precision in the linear estimates of the relationship between GDP and output at the country level.

National trade costs are constructed for each country in year *t* as the weighted average of the bilateral trade costs between that country and all partner countries. Rather than use observed exports we prefer to use hypothetical 'frictionless' exports between county *i* and each partner. 'Frictionless' exports are the volume of exports between the countries which would occur in a case where bilateral trade costs were zero. To calculate this value we use the following equation,

$$T_{ijt}^{F} = \sigma \tau_{ijt} T_{ijt} \quad , \qquad (1A)$$

where σ is the elasticity of trade with respect to trade costs equal to 8 (as in Anderson and van Wincoop (2004) and Novy (2008)), τ_{ijt} are bilateral trade costs between country *i* and *j* at time *t* estimated in the first step and T_{ijt} and T^{F}_{ijt} are actual and frictionless exports between the countries at time *t*. The weights are then calculated as

$$w_{ijt} = \frac{T_{ijt}^{F}}{\sum_{j=1}^{N} T_{ijt}^{F}} \quad . \qquad (2A)$$

2. Export data used in the regression analysis

Data on exports used in the regression analysis is drawn from the OECD Structural Analysis database. This provides information on the total value of exports from each 2-digit ISIC industry in each country to the world for the years 1990-2004. This source also provides data on the total value of exports in industry *i* to the world at time *t*.

Industry and Country Variables Description

The industry variables used in Table 3 were obtained from the EU Klems database. Not all countries present in the export data are covered by the EU Klems dataset. However, in total this provides information on 21 countries at the 2-digit ISIC industry level. The included industry variables are:

1. Labour productivity index – EU Klems
2. Unit labour costs – EU Klems
3. R&D intensity – EU Klems; measured as the ratio of value added to gross output

The country variables in Table 4 are taken from the EFI (Economic Freedom Index) database described in Gwartney and Lawson (2005). Each variable is measured as an index with values ranging between 0 and 10.

1. *Legal and Property Rights Index*: with values between 0-10 capturing judiciary independence, the impartiality of the legal system, the strength of intellectual property rights protection, intervention by the military in politics and a measure of law and order taken from Gwartney and Lawson (2005). Higher values on the index indicate better legal and property rights.

2. *Cost of importing*: EFI index with values between 0-10 capturing the administrative burden on new business taken from Gwartney and Lawson (2005). Higher values of the index indicate higher regulatory burdens.

3. *Hidden import costs:* index with values between 0-10 capturing judiciary independence, the impartiality of the legal system, the strength of intellectual property rights protection, intervention by the military in politics and a measure of law and order taken from Gwartney and Lawson (2005).

4. *Regulatory trade barriers:* index with values between 0-10 capturing judiciary independence, the impartiality of the legal system, the strength of intellectual property rights protection, intervention by the military in politics and a measure of law and order taken from Gwartney and Lawson (2005). Higher values on the index indicate higher regulatory trade burdens.

5. *Regulatory Burden*: EFI index with values between 0-10 capturing the administrative burden on new business taken from Gwartney and Lawson (2005). Higher values on the index indicate higher regulatory burdens.

6. *Tariffs*: EFI index capturing the average level of tariffs levied upon exports from country *i* taken from Gwartney and Lawson (2005). Higher values on the index indicate higher regulatory burdens.

7. *Freedom to trade internationally*: EFI index capturing the average level of tariffs levied upon exports from country *i* taken from Gwartney and Lawson (2005). Higher values on the index indicate lower restrictions on international trade.

8. GDP per capita: Taken from the CEPII Ultimate Gravity database.

Table A2: Summary Statistics of the Main Variables

Variable	Obs	Mean	Std. Dev	Min	Max
Export share	8445	-4.956	1.737	-12.994	-1.411
Trade cost intensity	8550	0.466	0.094	0.314	0.653
Trade costs	7935	4.42	0.602	-0.319	6.180
Labour productivity	4161	94.57	28.28	9.66	686.92
Unit labour cost	4065	98.19	25.18	6.98	721.58
R&D intensity	4168	3.935	6.321	0	55.794
Legal quality	8325	7.046	1.612	2.9	9.6
Cost of importing	2805	8.640	1.029	5.2	9.8
Hidden import costs	5475	7.050	1.419	3.3	9.7
Regulatory trade burdens	5475	7.470	1.339	3.3	9.8
Regulatory index	8475	5.795	1.191	2.5	8.8
Tariffs	6840	14.338	8.490	2.085	50.819
GDP per capita ($)	7890	9.102	1.217	5.623	10.924

Notes: The export share, trade costs variable and GDP per capita are presented in logarithms. All other variables are in levels.