The World Economy (2011) 34(1), 101-122.

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Allen Dennis, The World Bank.

Ben Shepherd, Principal.

developing trade consultants
policy • research • capacity building

349 5th Avenue
New York, NY 10016
Ben@Developing-Trade.com

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Allen Dennis and *Ben Shepherd*[1]

Abstract: This paper shows that improved trade facilitation can help promote export diversification in developing countries, where this issue has long been an important concern of policymakers. We find that ten per cent reductions in the costs of international transport and exporting (documentation, inland transport, and port/customs charges) are associated with export diversification gains of four and three per cent respectively in a sample of 118 developing countries. Customs costs play a particularly important role in these results. Lower market entry costs can also promote diversification, but the effect is weaker (one per cent). We also find evidence that trade facilitation has stronger effects on diversification in poorer countries. Our results are highly robust to estimation using alternative dependent and independent variables, different country samples, and alternative econometric techniques. We link these findings to recent advances in trade theory that emphasize firm heterogeneity, and trade growth at the extensive margin.

Keywords: International trade; Economic development; Product variety; Diversification; Trade policy.

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[1] DENNIS: Economist, Doing Business, the World Bank. ADennis@WorldBank.org. SHEPHERD: Principal, Developing Trade Consultants. Ben@Developing-Trade.com. This work is part of a project on trade facilitation and development supported through a Trust Fund of the U.K. Department for International Development (http://econ.worldbank.org/projects/trade_costs). We are grateful to an anonymous referee, as well as to the following people, for helpful comments: Chad Bown, Simeon Djankov, Joe Francois, Matthias Helble, Bernard Hoekman, Beata S. Javorcik, Will Martin, Patrick Messerlin, Christian Volpe, and John S. Wilson. In addition, Shepherd wishes to thank the Niehaus Center for Globalization and Governance at Princeton University, where he revised this text as a Postdoctoral Fellow.

1 INTRODUCTION

Export diversification has long been a policy concern for developing countries. Dependence of export revenues on just a handful of products--often primary commodities--can create excessive short-run volatility in national income. Di Giovanni and Levchenko (2009), for example, show that openness to trade is strongly correlated with sectoral and aggregate volatility, and that the link is around five times stronger in developing compared with developed countries. In addition, commodity dependence is frequently associated with lower growth rates over the long-run, and stagnation at relatively low levels of per capita income. Imbs and Wacziarg (2003) show that a higher level of per capita income tends to be correlated with a more diverse production structure, at least until relatively late in the development process when specialization effects begin to dominate. Although their analysis did not address causation, recent work by Cadot et al. (2007) finds similar results for exports, and provides some indications that the link might be causal. Funke and Ruhwedel (2001) similarly find that export diversification is positively related to per capita GDP and TFP growth in OECD countries.

If diversification is positively associated with a country's growth and development prospects, what are the policy options available to support that process? This paper shows that trade facilitation can be highly effective in promoting export diversification in developing countries. We use a broad definition of trade facilitation, in line with the approach taken by forums such as the Asia-Pacific Economic Cooperation (APEC): trade facilitation is any policy that reduces the transaction costs of international trade. To measure it, we use data from the World Bank's *Doing Business* project that capture all official costs that must be paid in order to export a standardized container-load of goods (Djankov et al., Forthcoming). We use data from the same source on the official costs of starting a business to proxy the cost of market entry (Helpman et al., 2008). Concretely, we find that reducing by ten per cent the costs of exporting, international transport, or market entry, can increase export diversification by three, four, and one per cent respectively. Our results prove to be highly consistent across a series of robustness checks covering alternative samples, alternative independent and dependent variable sets, and alternative estimation methods.

These findings build on and extend two recent literatures. On the one hand, existing work on trade facilitation has focused exclusively on its potential to promote growth in existing trade flows (for example: Djankov et al., Forthcoming). One implication of our findings is that existing analysis tends to underestimate the potential of trade facilitation measures, since it does not take account of their potential to promote export diversification as well. In addition, our characterization of export diversification in terms of trade growth at the extensive ('new products') margin means that our paper is also a test of some central predictions of recent models of trade with heterogeneous firms, such as Helpman et al. (2008). These models suggest that trade costs and market entry barriers should be negatively associated with the range of products exported by countries. Existing empirical work shows that larger, richer countries systematically trade in a wider range of goods (Hummels and Klenow, 2005), and that growth in import variety can lead to substantial national welfare gains (Broda and Weinstein, 2006). However, the only trade costs that have been considered by the empirical literature on extensive margin growth are international transport charges and tariffs (Debaere and Mostashari, 2005; and Feenstra and Kee, 2008).[2]

The paper proceeds as follows. In the next section, we develop a definition of export diversification in terms of trade growth at the extensive margin. We draw on recent theoretical and empirical work to develop a series of hypotheses that we proceed to test in the remainder of the paper. Section Three presents our dataset and sets out our approach to measuring export diversification, export costs, and

[2]After the working paper version of the present paper appeared, Persson (2008) compared the influence of trade facilitation on the intensive and extensive margins of trade using similar data and methods to ours, but focusing on the distinction between homogeneous and differentiated goods. Her results are highly consistent with ours.

market entry costs. Our empirical strategy is discussed in Section Four, and estimation results are presented. Section Five concludes and puts forward some suggestions for future research in this area.

2 CONCEPTUALIZING EXPORT DIVERSIFICATION

Empirical work on export diversification has tended to use intuitively appealing, but theoretically ad hoc, measures of diversification, such as a Herfindahl-Hirschman Index of export values across a given range of products or sectors (e.g., Amin Gutiérrez de Piñeres and Ferrantino, 1997). The intent behind such measures is clear: they are designed to pick up the extent to which different countries rely more or less heavily on a small range of products for the bulk of their export earnings. From a theoretical perspective, there are two mechanisms by which such measures of diversification can increase (Cadot et al., 2007). One possibility is that export goods at low aggregate values grow more quickly than those goods at high aggregate values. This kind of diversification can be thought of as occurring at the intensive margin, in the sense that it does not involve exporting any new products. A second way in which diversification can occur is through the extensive margin: introducing new products into a country's export bundle necessarily increases its level of diversification, keeping all else constant.

From a development policy perspective, extensive margin diversification is particularly important. Indeed, we would argue that it forms the core of the concept. Export diversification is often linked with a shift in export composition from primary commodities to manufactured goods (Collier and Venables, 2007). Such a process necessarily involves extensive margin diversification. It is for this reason that we focus exclusively on the extensive, or 'new products', margin in this paper.

In addition to policy relevance, our focus on the extensive margin also has another important advantage: it enables us to leverage the recent literature to better understand the policy factors behind export diversification. It is now well established, for instance, that not all countries export all products to all other countries, and thus bilateral trade matrices tend to contain a large number of zero entries (Haveman and Hummels, 2004). The broader the country sample, and the greater the level of product disaggregation, the more common zero entries become. There is thus considerable scope for export diversification at the extensive margin, in particular in developing countries.

In an important contribution, Helpman et al. (2008) have recently shown that a heterogeneous firms model in the spirit of Melitz (2003) provides a powerful explanation for the presence of zeros in the trade matrix, and thus, conversely, for the fact that some countries have more diversified export bundles than others. The basic mechanism behind their model is straightforward. In a world with multiple countries and multiple sectors, each firm manufactures a unique product under Dixit-Stiglitz monopolistic competition. Firms can sell in their home market without paying transport costs, but if they sell overseas they face iceberg trade costs, such as transport charges, and tariffs in the importing country. Firms differ in their marginal cost of production, which can be thought of as having been drawn at random from a given probability distribution. By assuming that productivity is drawn from a Pareto distribution, it is possible to ensure that low-productivity firms are relatively common, and high-productivity firms are relatively uncommon, in equilibrium. This feature accords well with the available empirical evidence.

Fixed market entry costs differ from country to country. Firms that enter only one market need only pay one entry cost, whereas firms that enter multiple markets must pay multiple entry costs. Based on the combination of market entry costs, trade costs, and productivity distributions, individual firms self-select into three groups: those with very low productivity cannot profitably produce for any market, and so drop out of the model altogether; those with intermediate productivity draws service the domestic market only; and those with high productivity serve the domestic market, and, in addition, at least one export market. Because of the assumption that each firm manufactures a distinct product, the more high productivity firms a given country has, the wider the range of products that it exports to at least one foreign market. Another way of putting this condition is in terms of productivity cutoffs: the lower the threshold level of productivity required in order to profitably export to at least one overseas market, the more firms become exporters in equilibrium, and the greater the aggregate range of products the country exports.

The productivity cutoff for a given country-pair depends intimately on the level of trade and market entry costs facing producers in both markets. Helpman et al. (2008) show that higher market entry costs tend to increase the productivity cutoff, thereby making it more difficult for domestic firms to access foreign markets. Similarly, trade costs facing exporters--such as international transport charges, export costs, and import country tariffs--make it more difficult for firms to start exporting. On the other hand, tariffs in the exporting country can potentially protect local producers from foreign competition, and in so doing make it easier for them to export.[3]

From a policy point of view, the Helpman et al. (2008) model thus suggests two main hypotheses of interest:

H_1: Lower levels of trade costs are associated with a more diverse export bundle; and

H_2: Lower market entry costs are associated with a more diverse export bundle.

[3]We are not suggesting that infant industry protection is a sensible policy option to promote export diversification. The analysis we have presented is based on comparative statics, and thus does not take account of the many dynamic inefficiencies that are associated with such policies in practice. Trade facilitation is preferable to infant industry protection on policy grounds, since it does not distort incentives across sectors, or across firms within sectors.

It is important to note that diversity as used here refers to a within-sector phenomenon. It is driven by increased entry of firms into overseas markets. Since each firm produces a unique product variety, increased entry means greater diversity. Similar insights apply in a comparative advantage (between-sectors) setup, but the intuition and model workings are considerably more complex (see Bernard et al., 2007).

In the empirical part of their paper, Helpman et al. (2008) do not test either of the above hypotheses. Instead, they estimate a two-stage gravity model which shows that the factors listed above indeed affect the probability that two countries trade with each other (i.e., that their entry in the bilateral trade matrix is not zero). However, they use aggregate trade data for their regressions. So although their results are consistent with a positive association between both sets of factors and export diversification, it is nonetheless impossible to draw any strong conclusions about product mix.[4] Part of the value added of the present paper lies exactly in its focus on the new products margin: by dealing explicitly with export diversification, it extends the results of Helpman et al. (2008) in a policy-relevant way. This paper also complements recent work by Kee and Feenstra (2008) showing that trade costs such as tariffs and distance affect export diversification in the sense in which we are using that term. It does so by expanding the range of policy variables beyond tariffs to include market entry costs, and trade facilitation.

3 DATA AND MEASUREMENT

[4]Similar comments apply to the results of Debaere and Mostashari (2005): although they use disaggregated trade data, their use of a logit model makes it impossible to distinguish between trade growth at the 'new products' and 'new markets' margins.

Full details of our dataset, for which many of the sources are standard, are presented in Tables 1 and 2. In this section, we focus on two aspects of our data that are novel: measures of export diversification covering 118 developing countries, and measures of the costs of exporting and domestic market entry for those same countries.

a Measuring Export Diversification

In terms of the characterization adopted in the previous section, export diversification means an increase in the range of products a country exports.[5] The most obvious approach to measurement is to simply count the number of exported products for each country. (We return to the question of alternative approaches below, when we check the robustness of our empirical results.) In practice, this approach is not as simple as it seems because individual "products" identified in the trade data usually map in reality to a number of distinct varieties. The most detailed trade data available on a worldwide basis are at the 6-digit level of the Harmonized System (HS), and distinguish amongst 5,000 or so different products. However, counts based on 6-digit data are likely to understate the true level of export diversity due to aggregation effects.

In this paper, we improve on the level of detail provided by the six-digit HS classification by using a six-digit classification that provides roughly twice as much product-level detail: 10,753 distinct product lines.[6] We extract these data from a freely available Eurostat database covering exports from and

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[5]This paper limits consideration to growth in the number of products exported, and do not examine the separate question of the number of markets to which countries export.

[6]The data are classified using the EU's Combined Nomenclature (CN), which is based on the Harmonized System (HS) but contains additional subdivisions at the eight-digit level.

imports into the European Union.[7] To our knowledge, these data have not previously been used in product variety work, where the focus has been either on cross-country data at the six-digit level, or on more detailed US data.

Our strategy is to use EU data on imports from developing countries to construct new mirror measures of export diversification in those same countries. Although it is true that we thereby measure export diversification vis-à-vis the EU and not the world as a whole, we believe that our measures remain highly relevant since the EU is one of the most important outlets for developing country exports. Moreover, this approach offers two concrete advantages over the use of cross-country export data at the 6-digit level. First, the aggregation problem is reduced (although not eliminated) due to the much greater level of detail in which products are defined and flows recorded. Second, import data from the EU are likely to be more reliable than the corresponding export data from developing countries due in part to stronger governance and customs agency capacity.

Taking 2005 as our base year, we start with a dataset of 470,035 observations across 246 countries and customs areas (including EU members), and 10,753 distinct products.[8] In this paper, we focus only on the developing country component of that dataset, namely countries that are neither members of the EU-25 nor the OECD. (We return to this definition in the context of robustness checks below.) Our first measure of export diversification, $lines$, is a count of the number of 8-digit product lines in which a given country exported to the EU-15 in 2005. It has one observation per country. To provide greater detail, we also construct $lines\_cn2$ following the same pattern as for $lines$, but with counts by 2-digit

[7]See http://fd.comext.eurostat.cec.eu.int/xtweb/.

[8]We use only a single year of data due to limited availability of our explanatory variables, in particular export costs (see below). Combined cross-section time-series estimates are not currently feasible, but will become possible as more trade cost data are published.

sector rather than aggregated to the country level. The $lines\_cn2$ variable therefore has 97 observations per country (the number of 2-digit Chapters in the CN classification). Given that the CN 8-digit classification scheme is inconsistent in the level of detail (i.e., individual 'products') it accords each sector, we will need to take care to correct for this when using $lines\_cn2$ as an indicator of export diversification.

In Table 3 we provide a list of the countries included in our sample divided up according to the quintiles of $lines$. On average, they exported 1,138 8-digit product lines to the EU in 2005. However, the range is extremely wide: from nine lines (Palau) to 8053 (China), out of a possible 10,753. In broad terms, the country rankings accord with the sensible prior that larger, more developed countries tend to have more diversified export bundles (see Hummels and Klenow, 2005). Thus, we find China, India, and Brazil at the top of the table, while Palau, Micronesia, and the Comoros are at the opposite end.

b Measuring Export and Market Entry Costs

We use new data from the World Bank's *Doing Business* database to measure trade costs, which we conceptualize as an inverse measure of broad sense trade facilitation. For the first time in 2006, the 'Trading Across Borders' component of *Doing Business* captures the total official cost for exporting a standardized cargo of goods ('Export Cost'), excluding ocean transit and trade policy measures such as tariffs. The four main components of the costs that are captured are: costs related to the preparation of documents required for trading, such as a letter of credit, bill of lading, etc.; costs related to the transportation of goods to the relevant sea port; administrative costs related to customs clearance, technical controls, and inspections; and ports and terminal handling charges. The indicator thus provides a useful cross-section of information in relation to a country's approach to trade facilitation. To our knowledge, these data have not previously been used in empirical work, although Djankov et al. (Forthcoming) use closely related *Doing Business* series on the amount of time and number of administrative procedures required to export and import. As expected, they find that these factors impact bilateral trade negatively.

These *Doing Business* data are collected from local freight forwarders, shipping lines, customs brokers, and port officials, based on a standard set of assumptions, including: the traded cargo travels in a 20ft full container load; the cargo is valued at $20,000; and the goods do not require any special phytosanitary, environmental, or safety standards beyond what is required internationally. They disclose a considerable range of country experiences: these export operations cost as little as $300-$400 in Tonga, China, Israel, Singapore, and UAE, whereas they run at nearly ten times that level in Gabon and Tajikistan. On average, the cost is around $1,278 per container (excluding OECD and EU countries).

To measure market entry costs, we use the 'Starting a Business' component of *Doing Business* (see Djankov et al., 2002). This source includes indicators on the costs, time, and number of procedures required for an entrepreneur to start-up and formally operate a local limited liability company with general industrial or commercial activities. This includes legally required pre-registration, registration, and post-registration activities. Only official costs are considered, based on information gathered from the company law, commercial code, and specific regulation and fee schedules. Together, we refer to these as the costs of market entry ('Entry Cost'). As far as we are aware, this is the most comprehensive source of cross-country information on business start-up costs, and has previously been used in the trade context by Helpman et al. (2008): they find that higher entry costs are negatively associated with the probability that two countries engage in trade.

4 EMPIRICAL MODEL AND RESULTS

Our baseline empirical strategy to test the hypotheses from Section 2 is a straightforward one, based on a reduced form estimating equation. Since our diversification measure is discrete (i.e., count data), we postulate that the number of 8-digit product lines exported in every 2-digit sector follows a Poisson distribution with mean and variance equal to μ_{es} (where e indexes exporters and s indexes sectors).[9] Its density conditional on a set of independent variables $\mathbf{X}_{es}$ is:

$$f(lines\_cn2_{es}|\mathbf{X}_{es}) = \frac{\exp(-\mu_{es})\mu_{es}^{lines\_cn2_{es}}}{lines\_cn2_{es}!} \qquad (1)$$

We specify the conditional mean function μ_{es} in terms of the parameters of the theoretical model developed above and a set of sector fixed effects (δ_s) to control for unobserved heterogeneity affecting all exporters in a particular sector in the same way.[10] Thus:

$$\mu_{es} = \delta_s \exp\begin{bmatrix}\beta_1 \ln(entry_e) + \beta_2 \ln(export_e) + \beta_3 \ln(1 + t_{es}^{EU}) + \beta_4 \ln(dist_e) \\ +\beta_5 \ln(1 + t_{es}^{own}) + \beta_6 \ln(gdp\_\hbar s2_{es}) + \beta_7 \ln(gdppc_e)\end{bmatrix} \qquad (2)$$

We use $entry_e$ to refer to restrictions on entry in a given exporting country, which we proxy using the *Doing Business* entry costs data referred to above. Export-specific trade costs are proxied using MAcMap bilaterally disaggregated applied tariff data for the EU (t_{es}^{EU}) and the exporting country (t_{es}^{own}), along with *Doing Business* data on the costs of exporting ($export_e$). While ad valorem tariffs impose only variable trade costs, the types of costs captured by *Doing Business* include both fixed and variable components: for instance, export documentation needs to be agreed and drafted prior to any export

[9]We estimate the model at the sectoral (2-digit) level, since three of the variables of interest--EU and own tariffs, and sectoral expenditures--vary at that level. However, we are conscious that the other variables of interest vary only at the country level, and so we adjust all standard errors for clustering by exporting country. Estimating at the aggregate (country) level does not change our conclusions materially (see Table 4 column 3).

[10]We expect the sector fixed effects to account for influences such as trade-related measures applied on an MFN basis within our country sample (e.g., product standards), as well as the different numbers of 8-digit product lines included in each 2-digit sector within the CN classification.

activity taking place (fixed cost), but then needs to be copied and slightly adapted for each shipment (variable cost).[11] We use the distance between the exporting country and Europe ($dist_e$) as an indicator of the extent of other international trade costs such as international transport charges, while sectoral expenditures and technology are proxied by (respectively) GDP multiplied by a sectoral (2-digit) import share (gdp_hs2_{es}), and GDP per capita ($gdppc_e$).[12] We can therefore summarize the core contentions of this paper as follows: $\beta_1, \beta_2, \beta_3, \beta_4 < 0$.

Maximum likelihood estimates of our baseline Poisson model are presented in column 1 of Table 4.[13] Overall, the model has reasonable explanatory power, with R^2 equal to 0.20—however, there are

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[11]In additional results (available on request), we show that the interaction between export costs and a measure of the intra-sectoral elasticity of substitution has a positive and statistically significant coefficient. This is consistent with export costs capturing some fixed costs, as shown by Chaney (2008).

[12]To construct our tariff measures and sectoral expenditure proxies, we use the reference group approach of Laborde et al. (Forthcoming), which relies on observed imports for a group of similar countries so as to avoid the endogeneity inherent in using a simple import weighted average. Our results do not change substantially if aggregate GDP or simple average tariffs are used instead. (Results available on request.)

[13]The Poisson estimator has identical first order conditions to those obtained by running weighted non-linear least squares on (2) with $lines\_cn2$ in place of μ_{es} (Santos Silva and Tenreyro, 2006). Thus, the model does not suffer from the usual limitation of log-log models in relation to zero observations: these can simply be included in the estimation sample as usual. This is an important point, since $lines\_cn2$ contains a relatively high proportion of zeros (4,825 out of 13,192 observations, or 37 per cent). In addition, Poisson provides consistent estimates regardless of whether or not the data are in fact distributed as Poisson. In additional results (available on request), we show that using a common alternative model—the Negative Binomial—does not materially change our findings.

clearly a number of other features of the data that are not fully captured by this reduced form estimating equation.[14] All coefficients--which can be interpreted as elasticities--carry the expected signs: entry costs, export costs, distance, and EU tariffs are all negative, while sectoral expenditures, GDP per capita, and exporter country tariffs are positive. The coefficients on entry costs, export costs, distance, sectoral expenditures, per capita income, and own tariffs are all statistically significant at the one per cent level. The only coefficient that is not statistically significant is EU tariffs. This is probably due to the extensive availability of preferences for developing countries, which results in a data series with a very large number of zero entries (9,686 out of 13,056 observations, or 74 per cent). The resulting lack of variation makes it difficult to obtain precise estimates.

These results are broadly consistent with previous work examining the diversification impacts of GDP, per capita income, and trade costs, such as Hummels and Klenow (2005), Debaere and Mostashari (2005), and Feenstra and Kee (2008). Similarly, our finding that lower market entry costs are associated with greater export diversification is consistent with the results of Helpman et al. (2008), who find a negative and statistically significant coefficient on market entry costs in the first stage of a sample selection gravity model.[15]

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[14]We follow Santos Silva and Tenreyro (2006) in using $R^2 = \left[corr\left(lines_{cn2}, \widehat{lines_{cn2}}\right)\right]^2$ as a convenient summary measure of fit. We prefer it to the more common (for count data) pseudo-R^2 measures due to its ease of interpretation.

[15]Our results for market entry costs might appear to contrast with those of Klinger and Lederman (2006). However, those authors take a different approach in which they view diversification through the lens of export "discoveries", rather than as an increase in the proportion of nationally produced varieties that make it to the international market. Their explanatory variable set is also different, including a wider set of entry cost data, but excluding trade costs.

In terms of the magnitudes of the estimated coefficients on the trade and entry cost variables, Table 4 indicates that EU tariffs have the largest elasticity in absolute value terms (-0.6), followed by distance and own tariffs (-0.4 and 0.4 respectively), then export costs (-0.3), and finally entry costs (-0.1). These magnitudes are clearly of economic significance, with (for example) a ten per cent decrease in export costs being associated with a three per cent increase in export diversification. While this ordering of effects should clearly be interpreted with caution due to the relative imprecision with which the two tariff effects are estimated, it nonetheless suggests that trade facilitation--which reduces export and market entry costs--has considerable potential to boost export diversification.

We can push the data a little further to try and unbundle the effects of different trade facilitation measures on diversification. Column 2 uses the same Doing Business data, but disaggregates them into four components: customs costs; documentation costs; inland transport costs; and port costs. Results suggest that it is customs costs that are primarily driving our finding on trade facilitation: they have a negative and one percent significant coefficient. Port costs, by contrast, have an unexpected positive and significant coefficient, and the other trade costs variables are statistically insignificant.

a Additional Exporter Country Characteristics

While the set of explanatory variables used in our baseline formulation accords well with intuition and the theoretical models discussed in Section 2, we are conscious that the literature discloses a number of additional factors that might be expected to impact export diversification. For instance, the gravity model literature includes a wide range of geographical and historical trade cost factors. Feenstra and Kee (2008) include measures of factor endowments as instruments for export variety. Given that the mechanism driving diversification in our theoretical model is investment related, it may also be appropriate to take account of macroeconomic conditions.

We deal with these considerations in two ways. First, we augment our baseline model with four additional sets of control variables. In column 4, we include data to capture trade costs from the gravity literature, namely dummies for countries colonized by the major colonial powers, and those that speak an 'international' language. Column 5 includes data on factor abundance, following Romalis (2004). Column 6 includes a measure of government effectiveness from the World Bank's World Governance Indicators. Column 7 includes the real interest rate and the GDP deflator as measures of macroeconomic stability.

In nearly all cases, the sign, magnitude, and significance of the estimated coefficients is very close to the baseline. EU tariffs are again an exception: they are imprecisely estimated, and thus tend to fluctuate in sign across specifications; however, they are never statistically significant.

The second approach to dealing with possible omitted country-level covariates is to estimate a mixed effects Poisson model including fixed effects by sector, and random effects by country. This is obviously a second best solution compared with a two dimensional fixed effects specification, but the data do not currently allow us to obtain such estimates. The advantage of the mixed effects specification is that it accounts for unobserved cross-country heterogeneity, under the assumption that it can be adequately captured using a Gaussian distribution. Results in column 8 of Table 4 show that the baseline specification is highly robust to this alternative approach. Together with the evidence discussed in the previous paragraph, these findings suggest that it is unlikely that our results are being driven by excluded country-level factors.

b Alternative Measures of Diversification, Entry Costs, and Trade Costs

In addition to checking the robustness of our results to the inclusion of additional exporter characteristics, it is also important to ensure that they are not unduly sensitive to the way in which our primary variables of interest are measured. For instance, there are suggestions in the literature (e.g., Klinger and Lederman, 2006) that measures of the number of administrative procedures required to enter the market may be more accurate than the corresponding cost data. To take account of this possibility, Table 5 column 1 re-estimates our baseline model using these alternative data. Specifically, we use *Doing Business* data on the number of procedures required for market entry, and the number of documents required for exports. Results are qualitatively identical to the baseline

The results discussed thus far use $lines\_cn2$ as the dependent variable, i.e. a count of the number of 8-digit product lines exported to the EU in each 2-digit sector. The remaining columns of Table 5 show that our results are not sensitive to the way in which we have operationalised our definition of export diversification. Columns 2-3 use a more narrowly defined dependent variable, in which 8-digit export flows are only considered to be non-zero if they are greater than $100,000 or $1,000,000 respectively. Although there are some small changes in coefficient estimates as a result of these alterations to the dependent variable, the substance of our results is unchanged: entry and export costs, as well as distance, exert a negative and statistically significant impact on diversification. The positive impact of own tariffs is statistically significant, but the negative impact of EU tariffs is not.

In column 4, we show that our results are largely unchanged when we run the regression using data on the manufacturing sector only, i.e. excluding all data from HS Chapters 1-24. We do this to deal with the possibility that the theoretical models discussed in Section 2--which rely on product differentiation and monopolistic competition--apply more naturally to the industrial sector than to agriculture and commodities. Thus, our measures of diversification may be more appropriate to the former than to the latter.[16]

[16]In additional robustness checks, available on request, we have also estimated separately by sector. In addition, we have interacted entry and export costs with two-digit average elasticities of substitution from Broda and Weinstein (2006). Coefficients for both cost terms remain negative, statistically significant, and close to their

The final two columns of Table 5 take different approaches to measurement of the dependent variable, again using 8-digit EU import data to construct diversification measures by 2-digit chapter. We start in column 5 with the theory-consistent measure of relative variety proposed by Feenstra (1994) and used with modifications by, for instance, Hummels and Klenow (2005), and Broda and Weinstein (2006). We adopt the formulation used by Feenstra and Kee (2008), indexing varieties by i and using J^H and J^W to refer to the sets of varieties exported by country H and the world respectively:

$$\Lambda = \frac{\sum_{i \in J^H} p_i^W q_i^W}{\sum_{i \in J^W} p_i^W q_i^W} \qquad (3)$$

The numerator in this measure is the total value of world exports in product lines exported by country H, and the denominator is the total value of world exports across all products. In a cross-sectional setting like this one, Λ can only change due to differences in export composition across countries.

Column 6, on the other hand, replaces $lines\_cn2$ with the inverse of the Herfindahl index of export concentration (using J as the set of products exported by a given country):

$$\frac{1}{HHI} = \frac{1}{\sum_{i=1}^{J} \left(\frac{p_i q_i}{\sum_{j=1}^{J} p_j q_j} \right)^2} \qquad (4)$$

Although lacking a theoretical basis of the type provided by Feenstra (1994) for Λ, this measure is sometimes used in policy and applied work (e.g., Amin Gutiérrez de Piñeres and Ferrantino, 1997; Cadot et al., 2007). We use the inverse HHI rather than the traditional measure so that regression results can be interpreted in terms of diversification rather than concentration.

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baseline values. The interaction terms are positive, and statistically significant in the case of export costs. These results strengthen our conclusions, and highlight their particular relevance for strongly differentiated products.

The table shows that both alternative measures of diversification produce very similar results to those in our baseline formulation. The estimated signs are as expected in all cases except EU tariffs, while entry costs, export costs, distance, and GDP remain statistically significant at the 5 per cent or 1 per cent level. This is unsurprising, given how closely correlated our $lines\_cn2$ measure is with the two alternatives: $\rho = 0.95$ for Λ and $\rho = 0.52$ for the Herfindahl index.

c Alternative Country Samples

The definition of a developing country that we have used thus far is a wide one: all countries that are not members of the OECD or the EU-25. It is important to ensure that our results hold using a more focused approach that might take better account of the differing situations of developing countries according to their income level. Progressively narrower definitions are applied moving from left to right across the first three columns of Table 6 based on World Bank country income groups. The first column excludes high income countries, the second excludes in addition upper-middle income countries, while the third includes only the low income group. There is very little substantive change from our baseline results. Interestingly, the estimated elasticities for entry and export costs become larger in absolute value as the income group becomes poorer, which suggests that these factors may be particularly important for low income developing countries--exactly the group with the most significant policy interest in diversification.

While own tariffs are positive in all three columns but only statistically significant in one case, EU tariffs only have the expected negative sign in the first two columns. We suspect that the counter-intuitive result in column 3 (low income countries only) is again due to the very high proportion of zeros in the EU's applied tariff matrix: over 85 per cent vis-à-vis the low income group, versus 70 per cent for the full sample. More puzzling is the distance coefficient in column 3, which carries an unexpected sign and is statistically insignificant. This result varies starkly with all others that we report, which show distance as having a negative and 1 per cent significant impact on diversification. We can only surmise that it is a function of greatly reduced sample size--about 1/3 of the full dataset--and the relative lack of variance this introduces into the distance data.

A second sample selection issue relates to possible differences between highly diversified and highly export-concentrated countries. It is possible that that our results are being driven to some extent by dynamics that primarily affect relatively diversified, and wealthy, countries. To examine this empirically, column 4 of Table 6 excludes the top quintile of most diversified countries from the sample. We find results that are identical to the baseline in all cases except entry costs, where the coefficient is statistically insignificant. Moreover, the coefficient on EU tariffs is now negative, large in absolute value, and statistically significant. Excluding highly diversified countries therefore tends to strengthen our results, and highlight their applicability across a wide range of country situations.

d Endogeneity

To deal with the possibility that our measures of trade costs might be endogenous--for example, due to political economy considerations--we re-estimate the baseline model with two changes. First, we use five year lags of GDP and per capita GDP, since these measures should be genuinely exogenous with respect to the current level of export diversification. Next, we use an instrumental variables strategy to identify exogenous variation in our measures of export costs and own tariffs. We use alternately the IV Poisson model of Mullahy (1997), and the more standard two-stage least squares estimator; in the latter case, we use a log-linearised version of the model in which the dependent variable is log(1+lines_cn2). This change is necessary in order to retain zero observations in the sample.

We exploit variation in geography to identify exogenous movements in the variables of interest. The idea is that a country's economic and social institutions should be correlated with distance from the equator (Hall and Jones, 1999). In addition, country land area should be correlated with Doing Business trade costs, since they capture internal transit. Thus we expect both instruments to be correlated with the currently observed levels of trade and entry costs, while being exogenous to current export diversification.

Our first stage regressions are reported in Table 6 columns 7-8. *F*-tests of the null hypothesis that all excluded instruments jointly have zero coefficients are 2979.13*** and 84.25*** respectively. These instruments are clearly strong.

Results from the second stage regression TSLS regression are in column 6, and the comparable IV Poisson results are in column 5. The coefficients on entry costs, export costs, distance, GDP, per capita income, and own tariffs all carry the expected sign. All coefficients are 1 per cent significant, except for own tariffs in both equations, and export costs in the IV Poisson specification. EU tariffs carry an unexpected coefficient sign, and have a significant coefficient.

Should the instrumental variables results be preferred to the baseline (uncorrected) results? A Durbin-Hausman-Wu endogeneity test suggests that they should not. It does not reject the null hypothesis ($Chi^2(2) = 0.222$), thereby indicating that endogeneity is not a serious issue in these data. The generally close correspondence between the coefficients in the baseline and IV models supports this interpretation. Since IV estimation inevitably involves a loss of precision, we tend to prefer the baseline estimates in this case. The IV results are presented as a robustness check only, to show that our findings are not driven by reverse causation.

5 CONCLUSION

The results presented in Section 4 show that the data strongly support the core contention of this paper, namely that export costs and market entry costs, as well as international transport costs, impact negatively on developing country export diversification. Thus, improved trade facilitation represents a set of policy options that would appear to have significant scope to promote export diversification. Interestingly, the evidence in relation to EU tariffs is much more mixed: the estimated parameters are not statistically significant in most formulations, and they change sign from one model to the other. This tends to suggest that the type of improved access to developed country markets that developing countries currently receive may be more limited as an export diversification policy than is trade facilitation (cf. Collier and Venables, 2007). Although our model supports the existence of a link between tariff protection at home and diversification, infant industry protection is a much riskier dynamic proposition than is trade facilitation in terms of promoting export diversification. The unifying factor behind the set of policies we have considered in this paper is that they envisage diversification not as a result of governments 'picking winners' through industrial policy, but as a natural outcome of winners picking themselves through an intensification of the Schumpeterian process at the heart of the Melitz (2003) model. Unlike some other policies that could promote diversification, the problem of 'white elephant' industries does not arise with trade facilitation, because it retains neutral incentives across sectors, and within sectors across firms.

Our results can be used to sketch out areas that future work could explore in greater depth. On the one hand, additional work on complementary market access policies, such as relaxing rules of origin (de Melo and Portugal-Perez, 2008), would be needed before drawing a strong conclusion as to the efficacy of developed country trade policy reforms as a means of helping developing countries pursue export diversification (Collier and Venables, 2007). Since *Doing Business* data on entry and trade costs are being updated annually, we are also hopeful that future research will be able to exploit the availability of panel data to assist with achieving identification and controlling for unobserved cross-country heterogeneity, and to provide greater clarity on the dynamics involved in the diversification process.

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TABLES

Table 1: Variables and sources.

Variable	Description	Units (Yr.)	Source
Colony	Dummies equal to one if a country was colonized by UK, France, Spain, Portugal, the Netherlands, or Russia).	NA	CEPII
Distance	Average of the great circle distances between the main cities of the exporting country and Germany, weighted by population shares.	Km	CEPII
Entry Cost	Official cost of starting up and formally operating an industrial or commercial business in the exporting country.	USD (2006)	Doing Business
Export Cost	Official fees levied on a 20 foot container leaving the exporting country. Includes document preparation costs, administrative fees for customs clearance and technical control, terminal handling charges, and inland transit.	USD (2006)	Doing Business
Factor Abundance	Capital to output ratio; land to labour ratio; and human capital. All relative to the USA.	Various (1999; 2005)	WDI; Hall and Jones (1999)
GDP HS2	Sectoral expenditure, proxied by gross domestic product multiplied by sectoral import shares derived using the reference groups methodology of Boumelassa et al. (2009).	USD (2005)	WDI
GDP Defl.	GDP deflator.	(2005)	WDI
GDPPC	Per capita GDP.	USD (2005)	WDI
Governance	Government effectiveness index.	(2005)	WGI
Landlocked	Dummy equal to one for countries that are landlocked.	NA	CEPII
Language	Dummies equal to one if a country has English, French, or Spanish as an official language.	NA	CEPII
Latitude	Latitude of the main city in the exporting country (absolute value).	Deg.	CEPII
Lines	Number of 8-digit product lines in which a country has strictly positive exports to the EU.	(2005)	Eurostat
Lines_CN2	Number of 8-digit product lines in a 2-digit sector for which a country has strictly positive exports to the EU.	(2005)	Eurostat
Real Int. Rate	Real interest rate.	(2005)	WDI
Tariffs	Average applied ad valorem tariff by HS2 sector. Aggregated from 6-digit data using the reference group methodology of Boumelassa et al. (2009).	(2005)	MAcMap

Table 2: Descriptive statistics (baseline variables only).

Variable	Obs	Mean	Std. Dev.	Min	Max
Distance	13095	6825.18	3405.65	853.23	16597.13
Entry Cost	13192	3193.04	25367.69	43.03	297400.9
Export Cost	12804	1278.33	804.92	265	4300
GDP HS2	11520	6.24E+08	5.50E+09	6.69E+03	2.88E+11
GDPPC	12998	2761.85	4635.01	104.64	29944.97
Lines_CN2	13192	11.74	37.37	0	944
Tariff (EU)	13056	0.01	0.02	0	0.39
Tariff (Own)	11520	0.14	0.17	0	11.44

Table 3: Country sample, sorted by quintile of lines.

Range	Countries
0-118	Belize, Bhutan, Burundi, Central African Republic, Chad, Comoros, Djibouti, Dominica, Eritrea, Grenada, Guinea-Bissau, Haiti, Kiribati, Lesotho, Marshall Islands, Micronesia, Palau, Rwanda, Samoa, Serbia, Solomon Islands, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, São Tomé and Principe, Tajikistan, Tonga, Vanuatu
131-281	Afghanistan, Antigua and Barbuda, Armenia, Benin, Botswana, Burkina Faso, Equatorial Guinea, Fiji, Gambia, Guinea, Guyana, Iraq, Kyrgyz Republic, Malawi, Maldives, Mali, Mauritania, Mozambique, Nicaragua, Niger, Papua New Guinea, Seychelles, Sierra Leone, Sudan, Swaziland, Togo, Zambia
296-685	Angola, Azerbaijan, Bolivia, Cambodia, Cameroon, Cape Verde, Congo, Rep., El Salvador, Ethiopia, Gabon, Georgia, Guatemala, Honduras, Jamaica, Kazakhstan, Lao PDR, Mongolia, Namibia, Panama, Paraguay, Suriname, Tanzania, Trinidad and Tobago, Uganda, Uzbekistan, Yemen, Zimbabwe
746-1815	Albania, Algeria, Bangladesh, Belarus, Bosnia and Herzegovina, Colombia, Costa Rica, Côte d'Ivoire, Dominican Republic, Ecuador, Ghana, Jordan, Kenya, Kuwait, Lebanon, Macedonia, FYR, Madagascar, Mauritius, Moldova, Nepal, Nigeria, Oman, Peru, Senegal, Syria, Uruguay, Venezuela
1876-8053	Argentina, Brazil, Bulgaria, Chile, China, Croatia, Egypt, Hong Kong, China, India, Indonesia, Iran, Israel, Malaysia, Morocco, Pakistan, Philippines, Romania, Russia, Saudi Arabia, Singapore, South Africa, Sri Lanka, Thailand, Tunisia, Ukraine, United Arab Emirates, Vietnam

Table 4: Baseline regression results, and additional controls.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lines_CN2	Lines_CN2	Lines	Lines_CN2	Lines_CN2	Lines_CN2	Lines_CN2	Lines_CN2
Log(Entry cost)	-0.142***	-0.123***	-0.133**	-0.189***	-0.203***	-0.032**	-0.103***	-0.302***
	[0.011]	[0.010]	[0.059]	[0.017]	[0.013]	[0.016]	[0.010]	[0.098]
Log(Export cost)	-0.322***		-0.282***	-0.306***	-0.064***	-0.128***	-0.132***	-0.955***
	[0.018]		[0.101]	[0.024]	[0.020]	[0.027]	[0.018]	[0.216]
Log(Customs cost)		-0.068***						
		[0.005]						
Log(Documentation cost)		-0.002						
		[0.005]						
Log(Inland transport cost)		0.008						
		[0.005]						
Log(Port cost)		0.085***						
		[0.006]						
Log(Distance)	-0.418***	-0.412***	-0.434***	-0.505***	-0.303***	-0.478***	-0.410***	-0.488***
	[0.026]	[0.028]	[0.087]	[0.030]	[0.030]	[0.027]	[0.025]	[0.178]
Log(1+EU tariff)	-0.639	-0.868	0.089	0.126	0.686	-0.426	0.381	-1.426***
	[0.672]	[0.712]	[6.187]	[0.751]	[0.805]	[0.610]	[0.617]	[0.140]
Log(1+Own tariff)	0.431***	0.566***	-0.233	0.274**	0.466***	0.719***	0.364**	0.547***
	[0.123]	[0.159]	[1.099]	[0.117]	[0.127]	[0.185]	[0.143]	[0.032]
Log(GDP-HS2)	0.452***	0.513***	0.470***	0.403***	0.438***	0.479***	0.473***	0.016**
	[0.014]	[0.015]	[0.038]	[0.015]	[0.016]	[0.016]	[0.016]	[0.008]
Log(GDPPC)	0.087***	0.112***	0.089	0.090***	0.117***	-0.140***	0.03	0.352***
	[0.019]	[0.018]	[0.062]	[0.019]	[0.020]	[0.012]	[0.022]	[0.101]
Observations	11328	11328	118	11232	7488	11328	9600	11328
Groups	96	96		96	96	96	96	96 (FE); 118 (RE)
Fixed / *Random* effects	Sector	Sector	N/A	Sector	Sector	Sector	Sector	Sector. *Exporter.*
Controls				Colony, Language, Landlocked	Factor Abundance	Governance	Interest Rate, GDP Deflator	

*Estimation is by Poisson with sectoral fixed effects, plus country random effects in column 8 only. Additional controls are suppressed for brevity. Standard errors are robust, and corrected for clustering by HS 2-digit sector in all estimates except column 3.Statistical significance is indicated by: * (10 per cent), ** (5 per cent), and *** (1 per cent).*

Table 5: Regressions with alternative independent and dependent variables.

	(1) Lines_CN2	(2) Lines_CN2>$100k	(3) Lines_CN2>$1m	(4) Lines_CN2 Excl. Ag.	(5) Lambda_CN2	(6) 1/HHI_CN2
Log(Entry cost)		-0.254***	-0.314***	-0.142***	-0.153***	-0.308***
		[0.018]	[0.032]	[0.012]	[0.018]	[0.038]
Log(Export cost)		-0.506***	-0.644***	-0.327***	-0.376***	-0.906***
		[0.051]	[0.088]	[0.021]	[0.038]	[0.106]
Log(Entry procedures)	-0.394***					
	[0.027]					
Log(Export documents)	-0.408***					
	[0.022]					
Log(Distance)	-0.364***	-0.537***	-0.569***	-0.456***	-0.425***	-0.878***
	[0.026]	[0.048]	[0.071]	[0.026]	[0.039]	[0.127]
Log(1+EU tariff)	0.335	-1.413	-0.518	-0.406	2.236***	5.366
	[0.725]	[0.955]	[1.396]	[1.025]	[0.821]	[4.386]
Log(1+Own tariff)	0.436***	0.424***	0.462**	0.335***	0.313*	0.117
	[0.134]	[0.156]	[0.201]	[0.115]	[0.187]	[0.376]
Log(GDP-HS2)	0.504***	0.604***	0.672***	0.461***	0.486***	0.922***
	[0.015]	[0.026]	[0.031]	[0.017]	[0.019]	[0.088]
Log(GDPPC)	-0.004	0.058	-0.004	0.094***	0.072***	0.046
	[0.020]	[0.045]	[0.055]	[0.021]	[0.019]	[0.049]
Observations	11328	11328	11328	8496	7659	7642
Groups	96	96	96	72	96	96
Fixed effects	Sector	Sector	Sector	Sector	Sector	Sector

*Estimation is by Poisson with sectoral fixed effects, except in column 5 (Flogit) and column 6 (Tobit with lower censoring at unity). Standard errors are robust, and corrected for clustering by HS 2-digit sector. Statistical significance is indicated by: * (10 per cent), ** (5 per cent), and *** (1 per cent).*

Table 6: Regressions with alternative samples, and instrumental variables estimates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					IV Poisson		Two Stage Least Squares	
	Lines_CN2	Lines_CN2	Lines_CN2	Lines_CN2	Lines_CN2	Log(1+Lines_CN2)	Log(Export cost)	Log(1+Own tariff)
Log(Entry cost)	-0.117***	-0.141***	-0.207***	-0.016	-0.137***	-0.091***	-0.100***	-0.004***
	[0.015]	[0.021]	[0.053]	[0.017]	[0.018]	[0.008]	[0.001]	[0.001]
Log(Export cost)	-0.329***	-0.365***	-0.563***	-0.304***	-0.088	-0.331***		
	[0.022]	[0.033]	[0.057]	[0.041]	[0.136]	[0.116]		
Log(Distance)	-0.460***	-0.359***	0.228	-0.426***	-0.560***	-0.296***	-0.153***	-0.004***
	[0.027]	[0.032]	[0.152]	[0.035]	[0.025]	[0.024]	[0.001]	[0.001]
Log(1+EU tariff)	-0.158	-0.539	2.910*	-2.649***	3.374**	2.778***	0.108	-0.373***
	[0.799]	[1.055]	[1.654]	[0.837]	[1.318]	[1.066]	[0.191]	[0.127]
Log(1+Own tariff)	0.206*	0.01	0.106	0.703***	3.721	0.96		
	[0.105]	[0.144]	[0.178]	[0.162]	[2.675]	[1.619]		
Log(GDP-HS2)	0.461***	0.434***	0.520***	0.367***	0.616***	0.357***	-0.183***	-0.004***
	[0.015]	[0.018]	[0.027]	[0.012]	[0.017]	[0.013]	[0.004]	[0.001]
Log(GDPPC)	0.113***	0.172***	0.084	0.035*	0.162***	0.078***	0.027***	-0.006***
	[0.018]	[0.020]	[0.070]	[0.020]	[0.030]	[0.016]	[0.004]	[0.001]
Log(Latitude)							-0.058***	-0.008***
							[0.001]	[0.001]
Log(Land area)							0.100***	0.004***
							[0.002]	[0.000]
Observations	10656	8256	3744	8736	11328	11328	11328	11328
Groups	96	96	96	96	96	96	96	96
Fixed effects	Sector	Sector	Sector	Sector	Sector	Sector	Sector	Sector
Sample	Low + Middle income	Low + Lower middle income	Low income	Excl. 5th quintile of lines	All	All	All	All
R2						0.53	0.35	0.05
Instrument F-Test							2979.13***	84.25***

*Estimation is by Poisson with sectoral fixed effects in columns 1-4, and IV Poisson in column 5.Columns 6-8 present two stage least squares results, with sectoral fixed effects. Standard errors are robust, and corrected for clustering by HS 2-digit sector. Statistical significance is indicated by: * (10 per cent), ** (5 per cent), and *** (1 per cent).*