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The Multiple Impacts of the Exchange Rate on Export Diversification

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Abstract

There is evidence that suggests that one of the channels through which the exchange rate could have an impact on growth is export product diversification. I distinguish between the variety and concentration dimensions of export diversification and review the theoretical and empirical literature relating these two dimensions to the level and the volatility of the exchange rate. Using disaggregated trade data for a long panel of countries, I investigate these relationships employing an econometric methodology that allows for heterogeneity of coefficients across countries, and discuss two sources of bias which are often overlooked.

I find that the variety dimension of export diversification is positively related to a weaker exchange rate and negatively related to exchange rate volatility. These relationships seem to be stronger for goods with higher technological intensity. I do not find a clear relationship between the exchange rate and the concentration of exports.

Keywords: export diversification, variety, concentration, exchange rate, exchange rate volatility, pooled mean group.

JEL codes: F14, F40, O30.

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1 Introduction

Several 'successful' middle-income countries have managed to have important output growth episodes but, with the exception of some Asian countries, they have not been able to sustain this growth for long enough to go beyond a 'middle-income' status. Many factors have been blamed for this, but the one that has been most consistently mentioned, especially in policy circles (e.g. Lin and Treichel, 2012), is the lack of export diversification towards more differentiated and technologically intensive goods that can help trigger dynamic and sustainable growth processes.

There are two broad categories of arguments in favour of higher export diversification: a portfolio and a dynamic argument, the former more related to the stability and the latter to the long-term sustainability of growth. A 'better' export portfolio can improve long term growth by reducing its volatility along its trend. The 'dynamic' argument is related to 'Schumpeterian', long-term growth, based on a permanent structural transformation, where new products are continually renewing an economy's productivity growth potential.

Many developing countries have highly volatile exchange rates, which are closely related to short-term capital flows, dependence on commodities with volatile prices, or both. In recent years, monetary policy in developed countries has become another important headache because of the appreciations it has caused on developing countries' currencies. Exogenous factors beyond the fundamentals of the real economy can be key determinants of exchange rates.

There is growing empirical evidence suggesting that competitive and stable real exchange rates (RER) as well as higher export diversification, are both associated with output growth[1]. The basic premise behind this paper is that one of the channels through which the exchange rate might have an impact on growth is through the promotion of export diversification. Figure 1 summarises these ideas.

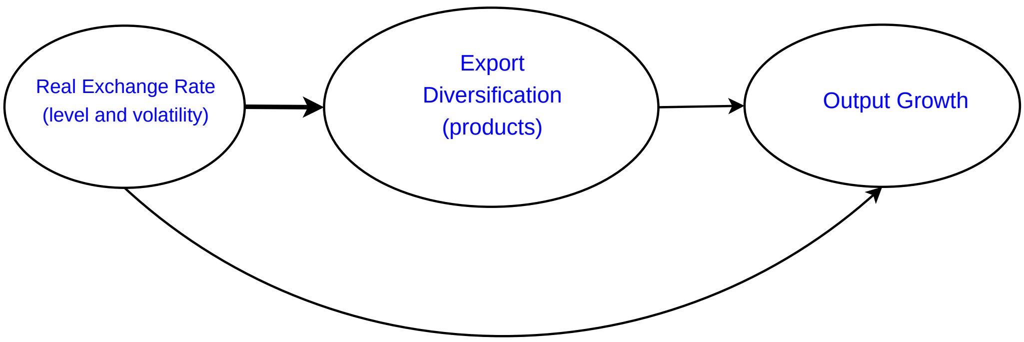

Figure 1: RER, export diversification and growth.

[1]For the exchange rate, Eichengreen (2008) reviews the literature and concludes that both RER level and volatility matter for growth. Evidence of these relationships is given by Rodrik (2009), Schnabl (2007) and Eichengreen and Leblang (2003), among others.

For diversification, evidence is provided by Funke and Ruhwedel (2005), Addison (2003), Feenstra and Kee (2008) and Lederman and Maloney (2003), to name some.

1.1 Understanding diversification

Before proceeding any further a discussion of this concept is necessary. Two related but conceptually very different phenomena are encompassed by the idea of diversification: variety and concentration.

By *variety* I refer simply to the number of different products exported. *Concentration*, on the other hand, refers to whether the shares of different export categories are relatively similar or only a few categories represent the lion's share of exports. And there is evidence of a relationship between both dimensions of diversification and growth[2]. The concentration dimension is more directly related to the *portfolio* diversification-growth argument, while variety is related to the *dynamic* growth argument.

The more common distinction between *intensive* and *extensive* margins of export growth is related, but not equivalent, to that proposed here: the extensive margin of export growth can refer to *export growth* due to new products – closely related but different to the idea of variety used here – but it is also commonly used to refer to the increase in exports due to new exporting firms[3]. The intensive margin of export growth refers to the increase in volume of already existing products (or firms), regardless of whether this has any impact on the distribution of the shares of the different products or sectors that make up the export basket. Moreover, the intensive and extensive margins refer to two separate marings of growth of a variable. Here, variety and composition refer to different variables.

While some papers on diversification mention the distinction between the variety and the concentration aspects of diversification, it is seldom given a central role, and sometimes the concepts are used interchangeably in empirical work (and in policy discourse). It is important to understand that they are closely related but different phenomena, and both need to be considered to understand diversification. Figure 2 adds these two dimensions to the previous diagram.

There is another distinction that may cause confusion: there is diversification of both export products and export markets and both of them have a variety and a concentration component. This paper is restricted to *product* diversification.

[2]Its variety dimension has been associated with growth by Funke and Ruhwedel (2001a, 2005), and a relationship between variety and productivity growth has been found by Feenstra et al. (1999), Addison (2003) and Feenstra and Kee (2008). Evidence of a negative relationship between export concentration and growth is provided by Al-Marhubi (2000), Agosin (2007), Lederman and Maloney (2003) and Hesse (2006).

[3]In standard monopolistic competition models – which dominate the trade literature – there is a one to one correspondence between firms and varieties; this is why the term is sometimes used interchangeably for firms and goods. Here the focus will be on products.

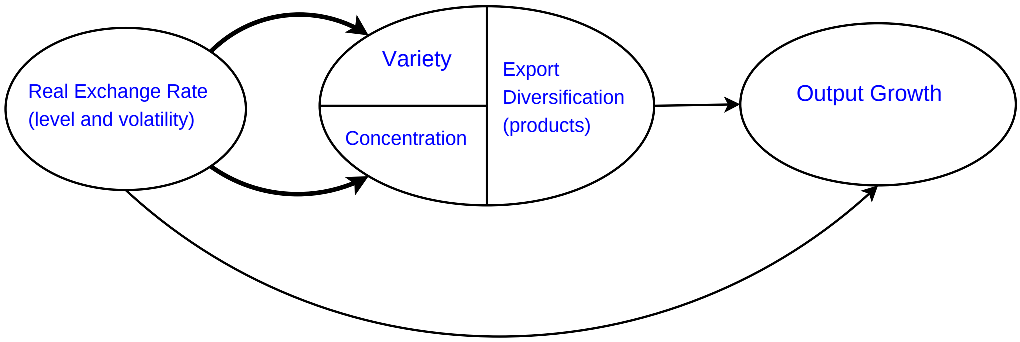

Figure 2: RER, the two dimensions of export diversification and growth. The bold arrows show the channels that will be studied here.

1.2 Research questions and structure of the paper

The level and the volatility of the exchange rate could have an impact on firm-level decisions about exporting new products or abandoning existing ones. This could in turn have an impact on total *export variety*, defined as the number of products that a country exports. This is the first question I will study.

If the exchange rate does have a relationship with export variety, is it the same for all types of products? The long-term productivity growth potential does not seem to be the same for all types of goods, as is acknowledged by many growth models (e.g. Lucas, 1988; Young, 1991) and suggested by empirical evidence (e.g. Johnson et al., 2007; Dell et al., 2008; Hausmann et al., 2007). Those worried about the 'middle-income trap' also emphasise the importance of the *direction* of diversification as fundamental for sustaining growth and escaping from this trap (e.g. Aiyar et al., 2013; Lin and Treichel, 2012; Palma, 2011). My second question is whether the potential impact of the exchange rate on export variety is different for goods with different degrees of sophistication or technological intensity.

Finally, the other dimension of diversification is the concentration of the export basket. I will study whether changes in the exchange rate are associated to systematic changes on the overall concentration of the export basket.

In the next section I will review the theoretical arguments and the existing empirical evidence on the relationships I just discussed, and explain how this paper contributes to this literature. Section 3 describes the data and variables, Section 4 the econometric approach and Section 5 presents the results. Section 6 discusses and interprets the results. Finally, Section 7 summarises my findings, discusses their policy implications and suggests some directions for future research.

2 Literature Review

When thinking about exchange rates and diversification, the first concept that comes to mind is that of the Dutch Disease (see Corden and Neary, 1982; Frankel, 2010). This literature focuses on *RER level shocks* and the *contraction of manufacturing.* The focus of this paper is broader, considering the impacts of the *level and the volatility* of the exchange rate on *export variety and on export concentration.*

2.1 Exchange rate and export variety

Exchange rate level

As reviewed by Auboin and Ruta (2011), the relationship between the level of the exchange rate and the volume of exports is quite complex and debated. But when thinking about export variety, most theory and evidence points towards a negative impact of a strong currency on variety. As discussed by Berthou and Fontagné (2008), in Melitz's (2003) type models of firms with heterogeneous productivities, higher variable or fixed trade costs would have a negative impact on the number of exporting firms (equivalent to varieties in monopolistic competition models[4]). The risks associated with exchange rate volatility can be modelled as a variable cost. And while the level is in some cases more directly related to the value of sales, it is also possible to think of it as changing trade costs (for example, if it induces the exporter to obtain currency in futures markets at a cost)[5,6]. The reason for this relationship between costs and number of varieties is that if expected profits increase, firms (or varieties) that were previously too inefficient to export, will start exporting. A negative relationship between trade costs and the set of exported goods can also be obtained from a Ricardian model such as that by Eaton and Kortum (2002).

There is some empirical evidence which looks explicitly at *product variety*, and it supports the theoretical argument described above. Tang and Zhang (2012) find that an exchange rate appreciation has a negative impact on the firm-level extensive margin, measured as each product-destination pair served by a firm. They pool entries into new products and new markets, in contrast with my interest in product variety only.

Freund and Pierola (2008) study surges in manufacturing exports and they find that they are preceded by strong real devaluations and a reduction in exchange rate volatility. They find that depreciation increases entry into new products and new markets and that these account for 25% of the growth during the surges.

Colacelli (2010) studies the responses to bilateral RER fluctuations. She decomposes trade into extensive and intensive margins following Feenstra (1994) and Hummels and Klenow (2005)[7],

[4]See Melitz (2003), or Bernard et al. (2011) for the same result with multi-product firms.

[5]This is a simplification, as the relationship between domestic costs, exchange rate, and price in foreign currency is complicated and depends on issues like the currency for invoicing and whether the firm has price setting power or not.

[6]Trade costs seem to play an important role in export diversification, as found for different measures of both export variety and composition by Amurgo-Pacheco and Pierola (2008), Dennis and Shepherd (2007), Cadot et al. (2011) and Parteka and Tamberi (2008).

[7]This 'extensive margin' measure adjusts for the importance of the products, giving more weight to those that represent a higher share of the exports of a reference group. It is attractive because of it sound roots in consumer

and finds that '*the extensive margin of trade has a significant role in overall yearly export responses to real exchange rate fluctuations*', especially among less substitutable exports. Studying further whether the level of the exchange rate has a differentiated impact on the variety of different types of goods is one of the contributions of this paper.

There are also evidence and theoretical arguments pointing in other directions. For example, Álvarez et al. (2009), accounting for possible endogeneity of the exchange rate using money supply growth as an IV, find no significant relationship between the level of the bilateral exchange rate and the extensive margin of exports.

Taglioni (2012) using detailed data for four developing countries shows evidence of a positive impact of appreciation on export volume through the entry *and* exit of product varieties. She attributes this to a pro-competitive effect of the appreciation on existing firms. Appreciation would have a rationalising effect, leading to only the most efficient exporters surviving, which in turn might grow and be more able to expand their production into new varieties.

Another factor that can produce a positive relationship between appreciation and variety is the cost of imported inputs (and that of servicing foreign-denominated debt). Burstein et al. (2004) show that exchange rate pass-through is higher for imported equipment than for the nontradable component of investment. If new varieties rely strongly on imported inputs or equipment, an appreciation of the local currency makes these investments more profitable.

Exchange rate volatility

Baldwin and Taglioni (2004) and Lin (2007) develop models where exchange rate uncertainty is detrimental for the number of firms. Cavallari and D'Addona (2013) produce evidence supporting the prediction from some models that a fixed exchange rate would be positive for the extensive margin.

Evidence of a negative impact of exchange rate volatility on measures of export variety is found by Lin (2007), Berthou and Fontagné (2008), Álvarez et al. (2009) and Héricourt and Poncet (2013). All of these however look at firm-level or bilateral measures of export variety. This paper differs in looking at the *total* variety exported by each country, as its motivation is the potential relationship between this and long run growth.

In the opposite direction, it can be argued that exchange rate volatility could be good for export variety in the long run. If a floating rate (in contrast to a peg) is effective in insulating an economy from real shocks, increasing stability and avoiding episodes of crises, it could foster investment in new varieties.

The nature of a change in exchange rate volatility can be determinant in shaping its impact on trade. Bergin and Lin (2008) develop a model (and provide evidence) where a currency union increases trade through new varieties, while a peg through increased volume in existing varieties. The reason is that currency unions are expected to have a longer horizon, thus providing the necessary incentive for the long-term investments needed to enter into new export varieties. Similarly, Ruhl (2008) constructs a model where firms might start exporting in response to per-

theory, but it is not necessarily the best measure if the interest is in variety itself. In what follows, when I refer to evidence about the 'extensive margin' it means that this measure is being used.

manent shocks, but not to cyclical, non-persistent fluctuations.

Monetary policy

Another important determinant of variety suggested by theory – and related to the exchange rate – is monetary policy: both the level and the general stance of monetary policy can have a direct impact on the entry of new varieties – and at the same time on the exchange rate. Cavallari (2010) presents a model where the exchange rate and product varieties are simultaneously determined. In her model, interest rates have two opposing effects on entry; one through changes in consumption and the resources available for investment and the other through the demand for goods. With respect to the policy stance, Bergin and Corsetti (2008) develop a model where uncertainty (when there is no full stabilisation) is detrimental for entry.

When thinking about uncertainty, it is important to consider the source of the shocks – which will determine how firms react – and how they interact with other macroeconomic factors. For example, under some conditions, exchange rate movements are counteracted by changes in wages. In some cases, the lack of exchange rate volatility might be an issue, for instance due to a peg that aggravates other problems. The exact relationships between these variables are complicated and depend to some extent on issues like the type of invoicing and very strongly on the nature of the macroeconomic shocks behind the exchange rate or monetary uncertainty (domestic or foreign monetary policy, commodity prices, capital flows, etc.).

2.2 Exchange rate and export concentration

Hysteresis is an important factor in understanding the possible effects of the exchange rate on export concentration. For example, regarding the *exchange rate level*, Krugman (1987) presents a model where temporary overvaluation can produce permanent changes in the pattern of specialisation because of learning-by-doing. As is shown by Baldwin and Krugman (1986), strong temporary changes in the exchange rate, when there are sunk costs (e.g. a production plant) result in persistent effects. In other words, firms might not simply 'come back' when the shock has passed; markets – and technological capabilities – may be permanently lost. In the opposite – optimistic – direction, appropriate timing and scale economies might mean that a newly developed export variety becomes dominant in the world market (in the spirit of Krugman, 1987).

In the model by Rodrik (2009), the differing intensity of market failures between tradables and non-tradables results in a suboptimal specialization pattern, and the exchange rate can act as a second best policy that corrects these failures.

Other models predict a relationship between *exchange rate volatility* and the concentration of exports. Baldwin et al. (2005) develop a model where exchange rate uncertainty has a stronger negative impact on smaller firms . Bergin and Corsetti (2013) show how the uncertainty resulting from the lack of a stabilisation policy can have a negative impact on the share of manufacturing exports.

None of the models above refer directly to the question of whether exports are concentrated or evenly distributed across many different sectors, but they are closely related, and they show

how the level of the exchange rate or different forms of uncertainty can have an impact on the concentration of exports.

In terms of empirical evidence, Agosin, Álvarez, and Bravo-Ortega (2011) find that exchange rate volatility (but not its level) is positively related to export concentration in one of their specifications. Kaltani, Elbadawi, and Soto (2009) study the impact of foreign aid and overvaluation in Sub-Saharan Africa. They find that undervaluation fosters growth and reduces export concentration. Elbadawi (1998) – focusing on developing countries, especially in Africa – concludes that '*appropriate and stable real exchange rates*' are necessary to increase the share of non-traditional exports over GDP. There is also evidence related to the share of manufacturing. For example, Rajan and Subramanian (2011) find a negative effect of aid-induced appreciation on the growth rate of manufacturing.

3 Data and Variables

3.1 Diversification measures

For both types of export diversification measures, what is needed is disaggregated export data. The main source is the World Trade Flows dataset compiled by Feenstra et al. (2005), which contains 4-digit SITC revision 2 data for over 130 countries for the period 1962-2000[8]. In practice however, at most 59 countries (listed in Appendix B) and 29 time periods[9] are used in any single regression. Although the data has been harmonized, there are still some possible issues – notably a change in the original data after 1983 – that will be considered as part of the robustness checks in Section 6.1.4.

Also to check for robustness, I used the BACI database (Gaulier and Zignago, 2010), Comtrade data, and mirror data from US imports from Feenstra et al. (2002), all of which have data at a higher level of disaggregation. US import data ensures homogeneous data quality across countries, but it provides only a proxy for *total* export variety.

3.1.1 Variety

The interest here is in *total* and not *bilateral* export variety (i.e. the total number of products exported, not the number exported to each country). This is because the dynamic growth and productivity benefits which motivate this paper are associated with new varieties, more than with new export destinations.

The simplest export variety measure is a count of the number of categories exported, which at a high disaggregation level can be interpreted as products. This measure is used as the baseline. It can be modified – in arbitrary ways – to ensure that the new exports are 'really' new exports, for example, requiring a minimum export volume. This is left for the robustness checks discussed in Section 6.1.4. The reason why the baseline is the rough count of varieties is

[8]SITC stands for "Standard International Trade Classification". At four digits, the revision 2 classification comprises 778 product categories.

[9]For most countries the 1980-2000 period is used.

that attempts to 'clean up' the measure could end up removing the marginal changes in variety induced by changes in the exchange rate that I am interested in.

Another possibility is using a measure that considers the importance of the products, giving more weight to those that represent a higher share of the exports of a reference group. Hummels and Klenow (2005), following Feenstra (1994), split exports into an intensive and an extensive margin, with the latter representing a weighted count of the exported varieties. The appeal of this measure arises from its weighting and its sounder (vis-à-vis a simple count) theoretical basis (it is derived from a CES utility function).

An important issue to keep in mind is that *really new* products cannot be observed: the classification system is not updated continuously. This means that increases in variety within the technological frontier are observable, but those pushing the frontier forward are not.

To investigate whether the impact of the exchange rate is different for products with differing degrees of technological intensity it is necessary to find ways of classifying products. After classifying them, variety measures for each group can be constructed. I used the 'prody' implied productivity measure from Hausmann et al. (2007)[10], and counted the amount of products exported with values of *prody* above and below its median. For robustness, other classification systems were checked, including Rauch's (1999) distinction between homogeneous and differentiated goods and a primary/manufactures classification.

3.1.2 Concentration

The third question is whether the exchange rate has an impact on the concentration of the export basket. Concentration is only explored in its most general form, i.e. whether the shares of different exports are similar or not, as a way to contribute to a more coherent discussion of the concept of diversification.

I built three different concentration indices, which are commonly used in this context (e.g. Agosin, 2007; Cadot et al., 2012). These are the Gini, Theil and (normalised) Herfindahl-Hirschman indices, as defined in Appendix A. I computed these measures at the product level (4-digit SITC) and at the sector level (2-digit SITC), although only results for the former are reported.

3.2 Exchange rate measures

The data for the exchange rate measures was obtained from the IMF's International Financial Statistics (IFS). The baseline measures are simple: for the level, a yearly real effective exchange rate index (based on a price deflator) is used. An effective rate is used because the interest is in *total* and not *bilateral* variety. A higher value is associated with a more competitive currency. Figure 3 shows the distribution of the real exchange rate index for counts of exported varieties above and below the median[11].

[10] It is defined as *"a weighted average of the per capita GDPs of countries exporting a given product, and thus represents the income level associated with that product"* (Hausmann et al., 2007).

[11] The top 5% values for the exchange rate are dropped to obtain a clearer grah.

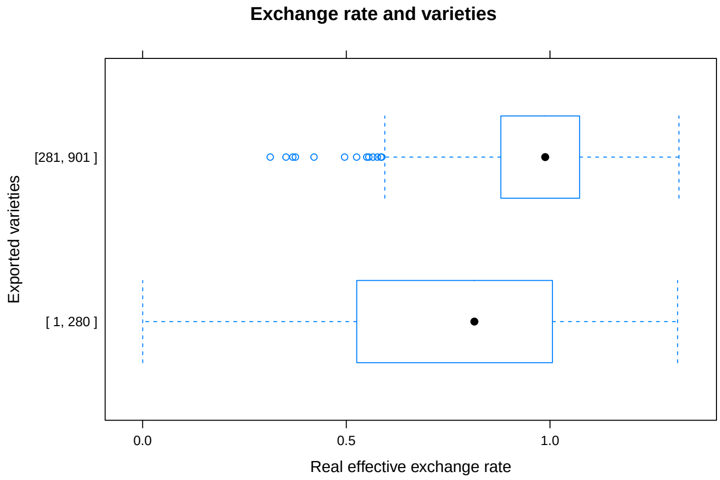

Figure 3: Exchange rate and export variety.

To build yearly volatility measures, the monthly version of the variable described above was used. Many different exchange rate volatility measures are used in the literature. For example, exchange rate regime classifications, absolute percentage changes or residuals from ARIMA models[12]. I use the most commonly used one: the standard deviation of log differences of monthly rates.

I confirmed the results using other measures, including nominal rates for the level and the volatility, as well as measures based on black market rates obtained from from Reinhart and Rogoff (2004).

To summarise, Table 1 shows the main variables that will be used.

	Concept	Measured used
Diversification (dependent variables)	Export variety	Count of different SITC4 categories exported
	Export concentration	Gini, Theil and Herfindahl-Hirschman indices
Exchange rate (independent variables)	Exchange rate level	Real effective exchange rate index (REER). Higher is weaker
	Exchange rate volatility	Standard deviation of log differences of monthly REER

Table 1: Summary of main variables.

3.3 Additional controls

Based on previous theoretical and empirical work, four variables will be used as controls in all specifications: GDP per capita[13], population, openness to trade (imports and exports over GDP), and public education expenditure (current and capital, as a share of GDP), which is the education measure available for more country-year pairs. These data comes from the World Bank's World Development Indicators (WDI).

[12] McKenzie (1999) reviews some of the measures used.

[13] Although there is evidence of a nonlinear relationship between income per capita and both dimensions of diversification (Imbs and Wacziarg, 2003; Klinger and Lederman, 2006), my regressions include only one term for GDP per capita. The reason is that the specifications in logs were preferred, and in most cases the quadratic relationship was not so evident after this transformation. In any case, the parameters of interest did not appear to be affected by the omission of the quadratic term.

Other controls were discarded because the available time series were not long enough for Pooled Mean Group (PMG) estimation. Results controlling for monetary policy will also be reported, although the sample size drops dramatically. I used the lending interest rate adjusted for inflation, measured by the GDP deflator (from the IFS).

4 Econometric Approach

This section describes the general specification, as well as the econometric approach used to study the relationships that are of interest.

I start by assuming the following long-run relationship for both types of diversification measures:

$$Diversif_{it} = \theta_{0i} + \theta_{1i} GDPpc_{it} + \theta_{2i} RER_{it} + \theta_{3i} X_{it}^{3} + ... + \theta_{Ri} X_{it}^{R} + u_{it} \quad (1)$$

$i = 1, 2, ..., N, \quad t = 1, 2, ..., T,$
Where $Diversif$ is a diversification measure, $GDPpc$ stands for Gross Domestic Product per capita, RER is the Real Exchange Rate level, the X^rother controls and u_{it} the unobserved determinants of diversification. There are N countries, T time periods and R controls. All the regressions reported include both a measure of exchange rate level and one of volatility. Only the former and one additional control are included here for simplicity of exposition. It is important to note that the θ_i are allowed to be country-specific.

The variety and concentration measures are highly persistent[14], suggesting that the u_{it} from (1) could contain an autoregressive term for the dependent variable, meaning that a dynamic model would be more appropriate.

My starting point then will be the following ARDL specification[15]:

$$Diversif_{it} = \mu_i + \rho_i Diversif_{i,t-1} + \delta_{10i} GDPpc_{it} + \delta_{11i} GDPpc_{i,t-1} + \delta_{20i} RER_{it} + \delta_{21i} RER_{i,t-1} + \varepsilon_{it} \quad (2)$$

with its error correction form:

$$\Delta Diversif_{it} = \phi_i (Diversif_{i,t-1} - \theta_{0i} - \theta_{1i} GDPpc_{it-1} - \theta_{2i} RER_{it-1}) - \delta_{11i} \Delta GDPpc_{it} - \delta_{21i} \Delta RER_{it} + \varepsilon_{it} \quad (3)$$

Where
$\theta_{0i} = \frac{\mu_i}{1-\rho_i}$,$\theta_{1i} = \frac{\delta_{10i}+\delta_{11i}}{1-\rho_i}$, $\theta_{2i} = \frac{\delta_{20i}+\delta_{21i}}{1-\rho_i}$ and $\phi_i = -(1-\rho_i)$.
The structure of the unobserved term ε_{it} will be analysed in more detail in Section 6.1.1.

The previous empirical work most closely related to my questions was based on fixed-effects (e.g. Colacelli, 2010; Freund and Pierola, 2008) or dynamic GMM (e.g. Agosin et al., 2011) estimation. Some of the weaknesses of these methodologies are well-known and commonly discussed: fixed effects can only control for time-invariant country-level unobserved heterogeneity, and dynamic GMM estimators (e.g. Arellano and Bond, 1991; Blundell and Bond, 1998) have serious problems in terms of the exogeneity and the relevance of the internal instruments they exploit and their specification tests (see Roodman, 2009; Bowsher, 2002). When a long T panel

[14] The first-order autocorrelation of the baseline variety measure is 0.9875, and the values are between 0.917 and 0.960 for the concentration measures.

[15] To simplify the exposition, I will assume an ARDL(1,1,1) model.

is available, data is often averaged over 5-year periods (to reduce business cycle noise), but this also increases Nickell's (1981) fixed-effects bias, which is decreasing in T.

On top of these problems, these estimators make a strong assumption that is usually overlooked: they assume homogeneity of coefficients across groups (i.e. that the relationship between the variables is the same for all the countries in the sample), and this allows them to pool over groups and increase efficiency by estimating only one equation, common to all groups by assumption. But Robertson and Symons (1992) and Pesaran and Smith (1995) showed that when regressors are autocorrelated, the methods traditionally used with short dynamic panels, such as fixed-effects, instrumental variables, and GMM estimators such as Arellano and Bover (1995) "*can produce inconsistent, and potentially very misleading estimates of the average values of the parameters in dynamic panel data models unless the slope coefficients are in fact identical*", even when T goes to infinity (Pesaran et al., 1999). In a non-stationary context, as has been argued by Eberhardt and Teal (2011), mistakenly assuming slope homogeneity could potentially lead to spurious results.

In response to this, there is a growing theoretical literature on estimators for large T and large N panels which emphasises coefficient heterogeneity. However, as has been argued by Eberhardt (2012), these estimators still don't make their way into the mainstream empirical work, which is dominated by pooled dynamic estimators designed for large N and small T, even when large T panels are available.

The differences in market and institutional conditions across countries makes it reasonable to think that the way that export variety and concentration adjust to changes in the level or the volatility of the exchange rate can differ across countries, especially in the short run. This – together with the problems of dynamic GMM estimators – makes me focus on estimators designed for large T and large N datasets, which allow for heterogeneity in the coefficients of different groups.

Using yearly data to estimate multi-country relationships, there are two extreme opposite ways to proceed: one is to assume homogeneous slopes and intercepts and to pool over groups (pooled OLS). The other is to allow for full heterogeneity, estimating the relationship separately for each country without imposing cross-country restrictions on the parameters. These estimates can then be averaged over groups to obtain consistent estimates of the mean short and long-run parameters: this is Pesaran and Smith's (1995) Mean Group (MG) estimator. There are several alternatives between these two extremes. The dynamic fixed-effects (DFE) estimator imposes slope homogeneity but allows for heterogeneity in the intercepts. The Pooled Mean Group (PMG) estimator developed by Pesaran, Shin, and Smith (1999) allows for heterogeneity in the intercepts, short-run adjustment parameters (the δ_i in equation 3), and error variances, but it imposes homogeneity on the long-run parameters (the θ_i in equation 3 become θ).

The main assumptions required for consistent PMG estimation are: a) that the ARDL model in equation 2 is stable (ensuring the existence of a long-run relationship between the diversification measures and the independent variables) ; b) that the long run coefficients are the same across every group ($\theta_i = \theta\ \forall i$); and c) that the disturbances ε_{it} are independently distributed across i and t and independent of the regressors[16].

Assumption a) can be informally tested by checking that the error correction model adjustment speed coefficients ϕ_i are significantly negative but above -1. A formal test can be conducted following Pesaran, Shin and Smith (2001). PMG estimation does require the existence of a long-run relationship, but consistent estimation is possible regardless of the order of integration of the regressors (Pesaran et al., 1999), rendering the pre-testing of orders of integration and of cointegration unnecessary.

Assumption b) points to the usual tradeoff between consistency and efficiency. As stronger homogeneity restrictions are imposed efficiency increases, but at the expense of a loss in robustness. That is, the estimators with stronger cross-country restrictions will be more efficient, but if the assumptions behind those restrictions are not valid, they will produce inconsistent estimates.

In this context, the Mean Group (MG) estimator (Pesaran and Smith, 1995) is useful. It will provide consistent estimates of the mean of the long-run parameters, even if they are heterogeneous across countries, but these estimates will be inefficient if the long-run slopes are in fact homogeneous. Therefore, it can be used as the basis for a Hausman (1978) style test for the assumption of long-run slope homogeneity needed by the PMG estimator.

In economic terms, the PMG estimator assumes that the relationship of interest is the same *in the long run* across all countries, but that *the short-run adjustment dynamics* can differ across them. Reasons why diversification can react differently in response to changes in the exchange rate level or volatility include differences in financial development, labour market flexibility, availability of educated labour, etc.

Assumption c) has several parts. Regarding regressor exogeneity and independence across time, Pesaran and Shin (1998) have shown that sufficient augmentation of the lag order of the ARDL model can deal with these issues and standard inference on the long-run parameters is valid. Moreover, endogeneity is more of an issue for the short-run parameters (Pesaran et al., 1999), which are not of central interest here.

Independence of ε_{it} across groups, or cross-sectional independence, is a more complicated issue: so much so that most empirical studies assume it away[17]. I will discuss this in detail in Section 6.1.1.

[16] There are other more technical assumptions, such as the true parameter being an interior solution, positive variance of the unobserved, etc.

[17] Some exceptions include Eberhardt and Teal (2010); Holly et al. (2010); Cavalcanti et al. (2011).

5 Results

The variety and concentration aspects of diversification are closely related. The emergence of new export products is irrelevant if they cannot survive and grow, and the concentration of exports is not likely to change significantly without changes in the elements that make up the basket.

This section presents three sets of results. First, the relationship between the exchange rate and export variety, measured as the count of 4-digit SITC (SITC4) categories exported. Then, I look at whether this relationship is heterogeneous across different types of products. Finally, I present the – inconclusive – results for the relationship between the exchange rate and export concentration. In Section 6 I discuss some possible problems with my results and interpret them.

Most tables below present Mean Group (MG), Pooled Mean Group (PMG) and Dynamic Fixed Effects (DFE) estimates of two different specifications, differing in their lag structures and the included regressors. Specification A includes only the first lag of the dependent (log of the number of exported varieties) and independent variables (the logs of GDP per capita, real exchange rate, real exchange rate volatility, trade openness, population and public education expenditure). Specification B augments the lag structure of the ARDL model, including the first two lags of the dependent variable and of each independent variable. To do this however, only GDP per capita is included as an additional regressor, to preserve degrees of freedom. Country dummies are always included, and data is always cross-sectionally demeaned (equivalent to including time dummies). Only the implied long run coefficients are reported. The level of the exchange rate is defined in such a way that a higher value is associated with a weaker (more competitive) currency.

5.1 Exchange rate and export variety

The results in table 2 show that the coefficient for the level of the exchange rate is significantly positive for all models except the MG version with less lags. The coefficient for exchange rate volatility is significantly negative in both PMG and DFE specificatios. This means that variety is positively related to depreciation and negatively related to exchange rate volatility. The estimated real exchange rate level elasticities of export variety are in the range of 0.17 to 0.53 approximately, and the exchange rate volatility elasticities lie in a more narrow range, between -0.07 and -0.12 approximately.

GDP per capita is in most cases significantly positive. Trade openness is always negative, as expected if openness induces specialization. Population and education expenditure do not appear to be significant determinants of export variety.

Ideally, all series used should have at least 20 observations, but 17 is used as the minimum because many countries would need to be discarded otherwise. For all regressions in Table 2, the speed of adjustment is significantly negative and smaller than one in absolute value, as required for a long-run relationship to exist. Residual autocorrelation is evaluated for each country's equation and reported only for MG and PMG estimates, which have country-specific equations. Only the MG A model presents some problems here, one lag might not be enough. In none of the specifications does the Hausman test reject that the differences between the coefficients are not systematic, both for PMG and DFE estimates. This means that in principle we can rely on the assumption of homogeneous coefficients and prefer the more efficient DFE estimates, although their coefficients for the exchange rate level are much smaller than the PMG ones, something that might be caused by mistakenly imposing short run homogeneity.

Where all specifications show signs of trouble however is with the assumption of cross-sectional independence of the residuals, as indicated by Pesaran's (2004) CD test. As this problem is not so well-known, I will discuss it in detail in Section 6.1.1.

Finally, looking at residual stationarity all specifications pass the test with ease. I used Pesaran's (2007) Augmented Dickey Fuller (ADF) test, which includes cross sectional averages to be robust to cross sectional dependence[18].

5.2 Heterogeneous impact on variety

The possibility – suggested by previous empirical studies – that the exchange rate had a heterogeneous impact on export variety across different sectors is especially important for the potential growth effects of export variety. To explore this, I use the 'prody' measure of implied productivity from Hausmann et al. (2007)[19]. I count the number of exported varieties which have a high or low 'prody' value, using the median as the cutoff.

Tables 3 and 4 show the results for the counts of low and high 'prody' varieties respectively. All the PMG and DFE estimates are significantly positive for the exchange rate level and significantly negative for its volatility. The point estimates are much higher in magnitude for high prody exports, giving support to the idea that the impact of the exchange rate is not the same for all types of products.

The MG B models should be discarded, as their adjustment speeds are not consistent with the existence of a long run relationship (although this might be the result of a bias that will be discussed later, so I still rely on the Hausman test to validate PMG and DFE estimates). The Hausman and ADF tests are passed. There is some evidence of groups with serial correlation, but not an important number of groups for the PMG estimates.

As in table 2, the CD test shows evidence of strong cross sectional dependence. The test statistics are always much higher for high prody exports, something that will be discussed in Section 6.1.1.

5.3 Exchange rate and export concentration

There are arguments and some evidence asserting that the concentration of exports is important for the stability of export – and therefore output – growth. The question here is whether this dimension of diversification could in part be explained by the level and the volatility of the exchange rate.

I studied three measures of export concentration: the Gini, Theil and Herfindahl–Hirschman indices[20], which produced inconclusive results. The results in Table 5 are for concentration

[18] Being statistically rigorous, the standard errors should be adjusted because the test is being applied to an estimated series, but it is not likely that this would have an important impact on the results.

[19] This variable was defined in footnote 10.

[20] As defined in Appendix A.

defined at the product-level (4-digit SITC), but unreported regressions for sector-level (2-digit SITC) concentration produced very similar results. Only the results for model B are shown, as they are representative of the overall inconsistency of the findings.

As these are *concentration* measures, now the signs on the coefficients have the opposite meanings: a positive coefficient is 'bad', as it is associated with higher export concentration. All coefficients are insignificant for the Gini index except for the PMG coefficient for volatility which is positive. For the Theil, MG and PMG coefficients for the level have opposite signs and both are significant. This result is puzzling. The Herfindahl–Hirschman index produces clearly negative and significant coefficients for the level of the exchange rate, and one significantly negative coefficient for its volatility.

Specification tests show no sign of trouble. Even most of the CD tests do not reject the null.

6 Discussion and interpretation

The estimates show a relationship between the exchange rate and export variety, which seems to be stronger for products with higher technological intensity. The results for the exchange rate and export concentration are weak and contradictory.

I will discuss the results for the first two questions together. First I will discuss potential econometric problems, then interpret my findings, and finally mention some robustness checks. Then I will discuss possible explanations for the ambiguous findings for the exchange rate and export concentration.

6.1 The exchange rate and export variety

6.1.1 Cross-sectional dependence

If the assumption of cross-sectional independence of the residuals does not hold, it could cause in the best case a loss of efficiency and in the worst inconsistent estimates (Coakley et al., 2006).

Often empirical papers using the PMG estimator mention the issue in passing, saying that by including time dummies they *hope* that cross-sectional independence will be achieved[21]. The problem is that this only works when the unobserved factors have the same impact on all groups. We can impose the following structure on the unobserved ε_{it} from equation 2:

$\varepsilon_{it} = \gamma_i' \mathbf{f}_t + \epsilon_{it}$,

where ϵ_{it} is white noise and the unobserved column vector of common factors $\mathbf{f_t}$ has a differentiated impact across groups if factor loadings are heterogeneous ($\gamma_i \neq \gamma_j$). If this is the case, then time dummies will not suffice to remove contemporaneous correlation of the errors across countries. And when the common factors $\mathbf{f_t}$ are present in the unobserved and in the regressors (which happens by construction in dynamic models if the common factors are serially correlated[22]), there is an endogeneity problem and standard estimates will be inconsistent. In

[21] Cross-sectional dependence in the residuals is not a problem only for PMG estimation, but for a wide variety of estimators. For reviews of this on a stationary setting see Sarafidis and Wansbeek (2012) and Breitung and Pesaran (2008) for nonstationary panels.

[22] If $\mathbf{f_t} = \lambda_\mathbf{t} \mathbf{f_{t-1}} + \xi_\mathbf{it}$, then $Diversif_{i,t-1}$ is correlated with the unobserved ε_{it} through $\mathbf{f_{t-1}}$. $\lambda_\mathbf{t}$ is a square matrix defining factor persistence, diagonal if the factors are independent.

economic terms, cross-sectional correlation could be the result of spillover effects (e.g. the diffusion of new products across countries) or common macroeconomic shocks that affect all countries, potentially in a heterogeneous way (Eberhardt et al., 2013).

There are two questions then: is there evidence of cross-sectional dependence in the residuals? If there is, could this be biasing coefficients and driving the results?

I evaluate the first question using Pesaran's (2004) CD test. The null of the test, in contrast with the Lagrange Multiplier type tests (see Breusch and Pagan, 1980), is not cross-sectional independence, but only weak dependence, as defined by Chudik et al. (2011). As argued by Pesaran (2012), this is a more appropriate test for large panels, where it is strong and not weak dependence what might cause inference problems, and complete independence might be unnecessarily restrictive. The Monte Carlo evidence in Pesaran (2012) and Chudik and Pesaran (2013) shows that the CD test performs well in dynamic models with sample sizes similar to the one used here. The test is also valid under nonstationary regressors (Pesaran, 2012). On the other hand, the test can break down if the common factors are serially correlated or have a non-constant variance, and it might have low power when time dummies are included[23].

Pesaran's CD test rejects the null of weak dependence of the residuals for all specifications in Tables 2 through 4 (the test statistic is distributed as a standard normal under the null). The test statistics are much larger for high prody exports, suggesting there could be some real difference in the way the exchange rate relates to different types of exports, possibly in the form of spillovers which are stronger for some types of products.

If we believe the CD test results, the question then is whether the remaining cross-sectional dependence could be driving the results. There are three reasons to think that the answer is no: first, unreported results without demeaning show an interesting pattern: CD test statistics are much higher but only for total variety and low prody variety. High prody exports have very small CD statistics, to the point that in some cases the null is not rejected. And the direction and relative magnitudes of the point estimates are the same as before. This not only confirms that there is something different about the two groups of products, but shows that even if there is a bias – the coefficients do change in magnitude – the signs and significance of the coefficients, and the differences between low and high prody exports are the same under different degrees of residual cross-sectional dependence.

The second argument to discard a serious bias can be seen in Table 6[24]. When all OECD countries are dropped from the sample[25], the CD statistics drop until they do not reject weak dependence for the baseline and low prody exports, and they barely reject it for high prody

[23]De Hoyos and Sarafidis (2006), Sarafidis and Wansbeek (2012) and Chudik and Pesaran (2013) argue that the CD test will have low power and might not be consistent after cross sectional demeaning, as is the case in all results presented here. There are however several reasons to think that the CD test is working here: the test is still rejecting the null after time dummies, and the opposite should happen if it lacked power; the CD test statistic still behaves as expected, dropping when additional controls are added, when cross-sectional averages are added (see Pesaran, 2006), or when the sample changes towards one with less spatial propagation of the shocks; and as I discuss later on, the examination of the potential heterogeneity biases in the adjustment speeds shows that another type of bias is affecting coefficients precisely in the cases where the CD test takes higher values. Nevertheless, alternative tests should be considered in the future, for instance – for GMM estimators – that by Sarafidis et al. (2009).

[24]For succinctness, only the specification with longer lags is displayed.

[25]See Appendix B for the list of countries.

exports. The results from Sections 5.1 and 5.2 still hold. Cross-sectional dependence should fall in this case for two resasons: OECD countries are very interdependent among them, and shocks in OECD countries are likely to propagate more to developing countries than shocks from other developing countries. The main results clearly hold for this group of countries, where strong cross-sectional dependence does not seem to be a concern[26].

The third argument is related to the direction of the heterogeneity bias, this is discussed in the following section.

6.1.2 Other sources of endogeneity

The theoretical result by Pesaran and Shin (1998) states that after appropriate augmentation of the lag order of an ARDL model, standard estimates of the long run coefficients – such as the PMG ones – are superconsistent (and this is independent of whether the regressors are stationary or not). The problems of endogeneity and residual autocorrelation are both eliminated at the same time. However, if the empirical ARDL process used is not the right one, or if the regressors cannot be modelled as finite-order autoregressive processes (as assumed by Pesaran and Shin, 1998), endogeneity could still be a concern.

It is possible to think of endogeneity due to a 'Dutch Disease' type effect. Finding and exporting oil (for example) has a strong impact on a country's currency. This form of endogeneity could be biasing the results[27]. But the type of export discovery that can have an impact on the exchange rate is a rare event. Most changes in export variety are due to small new exports or to abandoning products that are not profitable anymore. Nevertheless, to discard this risk it is possible to isolate the cases where the changes in variety are associated to non-marginal changes in export volumes. First I checked dropping everything pre-1984 (because of changes in Feenstra et al.'s [2005] source data that can induce misleading changes in volumes)[28]. Then, I additionally dropped all countries which on any single year had entries or exits that represented over 5% of their exports, to discard possible reverse causality running from variety to the exchange rate. In the first case all results hold, in the second, results are the same as before for low and high prody exports, but they break down for total variety. In both cases however T drops, making estimates unreliable[29].

Another concern is the possibility of omitted variable bias. Confounding with monetary policy is the greatest concern: monetary policy could be driving changes in variety and on the exchange rate at the same time. Table 7 presents the main results adding a real interest rate measure as a control[30]. Sample size drops dramatically, but Hausman tests still support the consistency of PMG and DFE estimates. Coefficients for the level of the exchange rate are

[26]If only OECD countries are included – arguably more appropriate for PMG estimation – most results break down. Examining different groups of countries in detail is an interesting avenue for further research.

[27]Particularly, it could be biasing downwards the coefficients for the level for low prody exports, if most commodities which could cause a Dutch Disease are in this group.

[28]This additionally drops the few pre-1973 observations, when exchange rate behaviour might have been different.

[29]These and all other results mentioned are available upon request.

[30]This specification was selected because it allowed for a larger sample size than others.

positive and for its volatility negative, except in one case where the sign changes. The sign for the interest rate is ambiguous.

With such a small sample size, MG and PMG estimates are not very reliable. Nevertheless, the results suggest that after controlling for monetary policy, the baseline results hold, especially for the level of the exchange rate. Results are also robust to adding a trade liberalization dummy, which is almost always insignificant.

MG, PMG and DFE estimators are all affected by the well known bias of dynamic fixed effects models (see Nickell, 1981). The coefficient on the lagged dependent variable will be downward biased, making the adjustment speed seem faster than what it really is – this could explain why some MG models had adjustment speeds below -1. This bias in the adjustment speed will in turn attenuate the estimates of the long run coefficients. On the other hand, also following Nickell (1981), the direction of the bias on the other short run coefficients will be such that it will tend to increase the magnitude of the long run coefficients. Thus, the overall direction of this bias on the long run parameters is ambiguous.

The pooled estimators (DFE and to a lesser extent PMG) also risk the heterogeneity bias described by Robertson and Symons (1992), that would bias upward the coefficient on the lagged dependent variable, inducing an underestimation of the adjustment speed. Consistent with this, as homogeneity restrictions are imposed going from MG to PMG and from PMG to DFE, the adjustment speed falls in Tables 2 through 6. The only exception is with DFE estimates for high prody exports (Table 4), which also happen to have relatively large CD test statistics. But for non-OECD countries (Table 6), when CD tests fall, the adjustment speeds are back in line, decreasing as homogeneity is imposed. This suggests that there was some bias due to cross-sectional dependence in the results for high prody, but when this bias is reduced, the same pattern as before emerges for low and high prody exports, reinforcing the idea from the previous subsection that cross-sectional dependence in the residuals is not driving my findings[31].

The results for specification B in tables 3 and 4 show that the findings for volatility, including the fact that the coefficient is larger in absolute value for high-prody exports, cannot be driven by heterogeneity bias, as they hold for the robust MG estimator. The results for the level of the exchange rate should be interpreted more carefully, as the MG estimates are insignificant for high-prody exports, and as discuss before, they seem to be affected by CSD bias. In table 6, where CSD bias should not be a serious concern, MG estimates for the level are still insignificant, but always positive and larger in magnitude for high-prody than for low-prody exports. MG results for volatility loose significance, but the point estimates are very close to those in tables 3 and 4.

Although the discussion above shows that the results do not seem to be driven by bias due to coefficient heterogeneity or cross-sectional dependence, both issues – which are often overlooked in empirical applications – are clearly a concern.

[31]The heterogeneity bias on the long run DFE coefficients should be upwards, as shown by Robertson and Symons (1992) and generalized by Pesaran and Smith (1995). This is not always observed in practice, possibly because of the assumptions under which the expression for that bias is derived, or due to another source of bias acting in the opposite direction.

As a general check against different potential sources of endogeneity, Difference and System GMM estimates (see Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998) for low and high prody export varieties are presented in Table 8[32]. Data is averaged over four years instead of five as is usually done in the literature, to increase sample size (which would otherwise fall to 116 for Difference GMM). Sargan, Hansen and second-order residual AR tests are passed, and the coefficients on the lagged dependent variables for GMM estimators lie between the upper and lower bounds provided by OLS and two-ways fixed effects respectively. The coefficients are consistent with the results presented before. The implied long run coefficients are never significant for GMM estimators, but these cannot really be compared with the estimates that use yearly data. GMM results are presented only to reinforce the idea that endogeneity does not seem to be driving the results. Even if in principle they deal with endogeneity, these estimators are plagued by problems (risk of weak instruments, problems with the overidentification tests, sensibility to changes in moment conditions, the imposition of homogeneity, inconsistency under residual cross-sectional dependence[33], etc.).

The exercises discussed here cannot be taken as evidence of a causal relationship, but they do show that the correlations between the exchange rate and the export variety measures are robust to some of the most evident concerns.

6.1.3 Interpreting the results

The most evident endogeneity concerns have been discarded. What is the causal story that could justify an impact of the exchange rate on export variety?

My results support the idea that an *appreciation* would be *negative* for export variety because of the reduction in profits, instead of positive because of cheaper imported inputs or a rationalisation effect. Regarding *volatility*, they support the view that this uncertainty is *bad* for variety, instead of good because of the stabilising effect of a floating exchange rate. These results are consistent with previous findings by Freund and Pierola (2008), Álvarez et al. (2009) and Colacelli (2010). The difference is that here I found that *both the level and the volatility* of the exchange rate are related to export variety, and to *total* (country level) export variety, not bilateral variety (for country pairs).

There is a fairly straightforward causal story behind these results: the exchange rate level has a direct impact on a firm's expected profit level. If we think that firms obtain utility from profits, and they are risk averse[34], the uncertainty associated with exchange rate volatility has a negative impact on the expected utility from experimenting with new export varieties. Even if firms were risk neutral, currency volatility produces information and hedging costs, reducing expected profits. The level and the volatility effects should, at the margin, change firms' and entrepreneurs' decisions regarding investments in new exports or abandoning some of them, having an effect on total export variety[35].

[32]Results for total variety are only omitted to save space and are available on request.

[33]See Sarafidis and Robertson (2009).

[34]See Sandmo (1971), and some evidence by Abdel-Khalik (2007) and Cronqvist et al. (2012).

[35]It is possible however that exchange rate volatility is acting here as a proxy for general macroeconomic volatility.

The variation studied here includes the exit and re-entry of product lines, i.e. it does not refer only to export *discoveries*. The impact of marginal changes in profitability is probably asymmetric for entries and exits, as well as for new entries and for re-entries. The point here is that the results observed are consistent with the exchange rate having an impact on profitability and firms reacting to this. Focusing exclusively on export discoveries, unreported results show that the level and the volatility of the exchange rate have similar impacts on the entry of completely new-to-the-country varieties. And even though completely new varieties might be more important for the growth argument that motivates these questions, the existence of more varieties, even if they are re-entries, is associated with potential increases in productivity and to technological spillovers.

Results point to a stronger impact of the exchange rate on the variety of more sophisticated or technologically intensive goods. This is consistent with Colacelli (2010), who found that the exchange rate level has a stronger impact on the (bilateral) extensive margin of less substitutable products.

This finding could be especially important if not all sectors have the same potential to contribute to output growth (e.g. Young, 1991; Lucas, 1988), and as suggested by some (e.g. Lin and Treichel, 2012), diversification towards more technologically intensive goods is what is needed for sustaining growth in the long run.

There are several possible explanations for this finding. First, it could be purely an artefact of the way the data is classified if, for example, the classification system is more detailed and has more categories for one group of products. This cannot be the case here, as the cutoff was defined as the product with the median prody value.

I will briefly discuss some possible explanations for the finding of a stronger relationship between the exchange rate and the variety of goods with higher technological intensity. The first follows the idea by Rauch (1999). He argues that homogenous goods, that can be traded in organised exchanges, are not affected by uncertainty in the way differentiated goods are. My findings could at least in part be explained by this difference in how the goods are traded and their sensitivity to uncertainty.

The results are also consistent with the idea of 'costly discovery' proposed by Hausmann and Rodrik (2003): there are information externalities that reduce experimentation in new varieties (i.e. the experimenter must pay the discovery costs, and then potential new entrants would have access to this information for free). If we assume that varieties with higher technological intensity are more difficult to imitate, this will reduce the impact of this information externality on them. So, when there is a marginal change in profitability due to a change in the exchange rate, we can expect that products that were marginally unprofitable before and that can easily be imitated will *not* be developed, while those that are difficult to imitate might be developed.

Campa and Goldberg (2001) argue that the response of different industries to changes in the exchange rate depends on the industries' degrees of export orientation, import competition, and reliance on imported inputs. These differences might also help explain the heterogeneity found here.

A more general explanation – which nests the last two – is that many things differ across sectors: costs, technological capabilities, the intensity of market failures, etc. This might lead to different distributions of profitabilities for different types of goods: for example, it could be the case that for high prody goods, an important number of varieties are on the verge of positive expected profits, while most varieties of low prody goods have either very high or very negative expected profits – depending on the countries' comparative advantage – and only a small fraction of them is on the limit between positive and negative expected profits. If this was the case, a marginal change in expected profits would induce the entry of only a few varieties of low prody goods, but of a larger number of high prody goods. However, these theoretical distributions of profitabilities are likely to differ across countries. My results show the average for very different countries, so this is something that should be studied in more detail.

6.1.4 Other robustness checks

I will briefly mention some of the tests that were conducted to confirm that the main results (for the exchange rate level and volatility, as well as their differences for low and high prody exports) are robust to changes in the sample, the dataset and the definition of the variables[36].

Sample and dataset

As already mentioned, results are robust to dropping all countries which have entries or exits of products that represent over 5% of total exports any given year and to dropping everything prior to 1984 – when the original data source changes. Alternatively, the variety measure can be redefined to consider only products with exports over 100,000 USD, to avoid possible inconsistencies across countries or perids[37]. Results also hold in this case. If education – which is almost never significant – is not controlled for, results also hold.

There are countries which have had several episodes of exchange rate crises and these could be affecting or even driving my findings. I dropped the observations for the lower and upper five centiles of the real exchange rate level and of its volatility. Results hold in both cases. This also suggests that results are not driven by the particular functional form used (log-log).

Checking results with another database is a good precaution to discard issues with the classification system. It is also interesting to check whether results hold if variety is defined at a higher or lower level of aggregation. If less than four digits are used, there is little change in variety within countries across time. With one or two digits, we are clearly talking about sectors and not products. On the other hand, the risk when defining products at a more disaggregated level is that there could be too much noise. I checked the results with US mirror data from Feenstra et al. (2002). This is only a proxy for total variety, but it has the advantage of a broad coverage and homogeneous data quality across countries[38]. Using 5- and 10-digit classifications (SITC and HTS respectively), results hold for the level of the exchange rate, but not for its volatility. When OECD countries are dropped, in some specifications results also hold for volatility at 10-digit variety. Another test was to use the BACI database (Gaulier and Zignago,

[36] All of these results are available upon request.

[37] Feenstra et al.'s (2005) dataset has exports with volumes smaller than this only for the years before 1984 and for some countries after that year.

[38] Moreover, effective exchange rates were used, while it would be more appropriate to build bilateral ones to the US.

2010), with products classified at 6 digits with the Harmonized System. Due to the shorter time span available, PMG estimation was not feasible, but results hold for the exchange rate level with the DFE estimator. Finally, the original Comtrade data (used to generate most of Feenstra et al.'s [2005] data) at 5-digits was checked, allowing to have longer series for some countries. Results hold, but are somewhat weaker (as expected due to the noise in the unharmonised data).

Variable definition

Using Feenstra's extensive margin measure (see Section 3.1.1) instead of a rough count of exported varieties, the main results hold. If instead of counting the number of varieties, the count of *discoveries* is used (i.e. counting only the new exports that have not been exported before, discarding re-entries), results also hold.

Using the level and volatility of black market nominal exchange rates (from Reinhart and Rogoff, 2004) results hold for the level, but are ambiguous for volatility. Using the nominal effective exchange rate from the IFS, all but one of the specifications studied confirmed the original results. If an exchange rate volatility measure based on this nominal exchange rate is used all results hold.

Finally, all results hold if PPP GDP per capita (from the WDI) is used as a control, instead of GDP per capita in constant dollars.

Heterogeneity across product types

Two alternative product classifications were used. I counted the varieties of primaries and manufactures (using the Eurostat classification) and those of homogeneous and differentiated goods, following Rauch (1999). The coefficients on the exchange rate variables are larger for manufactures than for primaries, and for differentiated relative to homogenous goods, and the differences are even starker than for low and high prody exports. This suggests that there is indeed a difference in the way the exchange rate relates to products with different degrees of technological intensity.

6.2 The exchange rate and export concentration

Results in Section 5.3 regarding the exchange rate and export concentration were ambiguous and inconclusive. Previous studies have found some evidence of a negative relationship between export concentration and exchange rate stability or depreciation, but they have provided no clear theoretical explanations for these findings.

Two factors are important to understand why the ambiguity of the results is not surprising: the initial composition of exports, and whether the exchange rate has a homogenous impact across different types of goods or not. If the exchange rate has a different impact on different types of products, its overall impact on concentration will depend on the original composition of exports. And this initial composition differs greatly across countries, meaning there is no reason to expect a uniform effect across all of them. Moreover, concentration can be defined at the product level (e.g 4-digit SITC) or the sector level (e.g. 2-digit SITC), and the interaction between each of these two measures and the exchange rate might follow different logics[39].

Furthermore, the possibility of reverse causality seems much stronger when the dependent variable is export concentration: while marginal changes in variety are not likely to have an impact on the exchange rate (except for situations like discovering oil), it is easier to imagine how a change in the concentration of exports could have an impact on the exchange rate. For example, if the share of commodities with volatile prices grows, this can certainly have an impact on the volatility of the currency.

The bottom line is that it is not surprising that no clear relationship is found. Instead of investigating general measures of concentration, it could be more meaningful to investigate the shares of particular sectors (e.g. manufacturing), which can also be mapped more directly to existing theory. But this should not mean that any measure used is called 'diversification'.

It should be kept in mind however that out of the three indices, the Herfindahl-Hirschman produced the most consistent results across estimators, and it was also the only one where all estimators had cross-sectionally weakly dependent residuals. These indicated the existence of a negative relationship between depreciation and export concentration, consistent with the findings by Kaltani, Elbadawi, and Soto (2009).

7 Conclusions

7.1 Summary of results

A less concentrated export basket could help stabilise export growth and output growth. And new export varieties could promote growth through the volume of exports, but also through productivity increases, as their production processes are improved. And, through knowledge and information spillovers, they open the way for further new varieties and improvements, making possible sustained, dynamic, innovation-based growth. This might explain why such an emphasis is put on diversification as fundamental for escaping from what has been called the 'middle-income trap' (e.g. Lin and Treichel, 2012; Foxley and Sossdorf, 2011).

If export diversification is indeed fundamental for sustaining growth in the long run, a better understanding of its determinants is needed. This paper attempts to contribute in this direction, and it also proposes a simple framework for thinking about diversification, distinguishing between the *variety* and *concentration* components of diversification, which are often confused in applied work.

My empirical results show that a competitive and stable exchange rate is associated with a higher number of exported varieties. And this relationship appears to be stronger for products with higher technological intensity or sophistication – precisely the kind of products that are usually associated with technological spillovers and dynamic growth effects. The results are robust to using different estimators, lag structures, samples, datasets, and definitions for the variables of interest. The results for the impact of the exchange rate on export concentration

[39]For example, the exchange rate could have an impact on concentration defined at the product level if it has a relatively stronger impact on the growth of small or large products, even if the relationship is the same for all types of products. This would not necessarily have a impact on concentration defined at the sector level.

however, are weak and ambiguous. The concentration index which produced stronger results points to a negative relationship between a competitive currency and export concentration.

The estimated real exchange rate level elasticities of export variety are in the range of 0.17 to 0.53, and as high as 0.90 for the variety of high prody exports. These point estimates should be interpreted carefully, as they are estimates of the long-run relationship between the variables, and most exchange rate shocks are of a temporary nature. But, considering the lack of empirical work on this subject, my contribution is not estimating the size of the impacts, but showing that a significant and robust relationship does indeed exist.

Regardless of the magnitude of an eventual impact of the exchange rate on export variety, whether it is economically meaningful or not depends on the persistence of those changes in variety. Does hysteresis mean that some products disappear during a negative shock and never come back? Do all new export varieties disappear after a positive shock is gone, or some of them manage to increase productivity, capture a market and survive? Not enough work has been done to answer these questions.

For the volatility of the exchange rate, the elasticities are smaller in magnitude, between -0.07 and -0.12 (and up to -0.18 for high prody exports), but their interpretation is even more difficult than for the level. Nonetheless, it is important to recognize that volatility and level shocks are closely related. Volatility might be more easily targeted by policy, and this could in turn prevent large negative level shocks.

Although results do not seem to be driven by them, there is evidence of two types of biases that are too often neglected in empirical work: one due to imposing parameter homogeneity, and the other caused by strong cross-sectional dependence in the residuals. Empirical applications should make more use of the theoretical advances on long panel techniques.

7.2 Policy implications

The main policy implication that can be derived from this evidence − assuming that having more high prody exports is good for growth − is that appreciations that are not in line with fundamentals and excessive exchange rate volatility should be avoided. However, trying to aim for a particular exchange rate level in economies with an open capital account is likely to produce more harms than benefits. Exchange rate volatility can be more effectively targeted by policy. Adjustments after permanent changes are appropriate and necessary, but there are situations in which freely floating rates are affected by temporary factors, such as short-term shifts in commodity prices or sudden – and reversible – capital flows. And these short term adjustments have costs.

For advanced countries with an already diversified export structure, the impact of the exchange rate on diversification might not be as crucial. But for those developing countries with concentrated export baskets and little variety in the goods they export, an appreciated and volatile currency could be reinforcing this situation and seriously harming their long-run growth prospects.

Which policy instruments can be used to tackle excessive volatility is another story. One alternative is the management of capital flows, recently acknowledged as a valid policy measure under some conditions even by the International Monetary Fund (2012). The case of Chile in the early 1990's is a successful example of price capital controls. An alternative to this might be an aggressive management of reserves together with a sterilisation policy.

7.3 Future research

There is ample space for the development of empirical and theoretical work related to export diversification, both on its causes and its consequences. This paper leaves some particular questions open.

The first is one of confirming the direction of causality of the results presented here. The error correction form used shows that a long-run relationship between the variables does exist. And while endogeneity was in theory removed simply by augmenting the ARDL lag order, it cannot be completely ruled out. One possibility would be to look at these questions with some kind of natural experiment, or to find suitable instruments for the exchange rate variables.

Another open question is the relationship between the exchange rate and the concentration of exports. The ambiguous results suggest that this should be studied in more detail. Possibly general indices of diversification are not the appropriate measure of analysis. Instead, looking for example at the impact of the exchange rate on the share of manufacturing exports, or at the impact on certain groups of countries (e.g. energy exporters or countries with a similar initial composition of exports) might be more informative.

A related issue is explaining why the exchange rate seems to have a stronger impact on the variety of products with higher technological intensity. Is it related to the distribution of expected profits for different types of goods? Are information externalities and ease of imitation part of the answer?

What happens after the emergence of a new variety? Does the exchange rate play a role in whether it survives and grows? Which other factors are determinant in these respects? Firm-level export data might be helpful for understanding these issues.

Yet another issue to study in more detail is the role played by monetary policy in export diversification. Few results were presented here controlling for monetary policy and the sample sizes were not large enough to produce conclusive results.

Finally, the dynamic, long-run impact of new varieties on productivity growth, especially from some types of products, was taken for granted here. This is also something that has received relatively little attention and that if confirmed by future research, would reinforce the importance of my findings.

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Table 2: Log of the number of **total** SITC4 categories exported

	A: 1 lag in short run eq.			B: 2 lags in short run eq.		
	MG	PMG	DFE	MG	PMG	DFE
GDP per capita	2.458	0.655***	0.453***	0.596	0.579***	0.448***
	(0.104)	(0.000)	(0.000)	(0.275)	(0.000)	(0.000)
RER level	2.023	0.459***	0.170***	0.369***	0.527***	0.216***
	(0.200)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Exchange rate volatility	0.0159	-0.0711***	-0.0946***	-0.0144	-0.124***	-0.0936***
	(0.781)	(0.000)	(0.000)	(0.768)	(0.000)	(0.000)
Trade openness	-0.854*	-0.209***	-0.0107			
	(0.074)	(0.001)	(0.897)			
Population	4.274	-0.112	0.228*			
	(0.380)	(0.316)	(0.077)			
Education expenditure	0.911	-0.0310	0.0217			
	(0.381)	(0.585)	(0.829)			
Adjustment speed	-.875***	-.405***	-.355***	-.996***	-.639***	-.482***
N	1200	1200	1200	1084	1084	1084
Number of countries	58	58	58	58	58	58
Minimum number of years	19	19	19	17	17	17
Average number of years	20.69	20.69	20.69	18.69	18.69	18.69
Maximum number of years	29	29	29	27	27	27
Pesaran CD	3.571	7.451	9.702	8.431	6.032	6.112
CD p value	0.000	0.000	0.000	0.000	0.000	0.000
ADF p (1 lag)	0.000	0.000	0.000	0.000	0.000	0.000
Groups with serial correlation	16	1		6	3	
Hausman test		0.999	1.000		0.811	1.000

p-values in parentheses

Only the long run coefficients are reported. Time and country dummies are included (implicitly) in all regressions. All variables in logs. Models A and B have one and two lags respectively for every variable in the short run equation. 'ADF p' reports the p-value for Pesaran's (2007) panel unit root test. The null is that all series are non-stationary. At most one lag seemed to be necessary. 'Pesaran CD' and 'CD p value' are the test statistic and p-value for Pesaran's (2004) cross-sectional dependence test for the residual. Residual autocorrelation was evaluated equation by equation for MG and PMG estimates. I report the number of countries where it was significant at the 5% level. 'Hausman test' reports the p-value for the Hausman test comparing the MG to PMG or DFE estimates (rejection means the efficient estimator is inconsistent).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Log of the number of **'low prody'** SITC4 categories exported

	A: 1 lag in short run eq.			B: 2 lags in short run eq.		
	MG	PMG	DFE	MG	PMG	DFE
GDP per capita	0.484	0.438***	0.342***	-0.147	0.502***	0.335***
	(0.134)	(0.000)	(0.000)	(0.599)	(0.000)	(0.000)
RER level	0.296**	0.286***	0.141***	0.351**	0.359***	0.198***
	(0.036)	(0.000)	(0.000)	(0.026)	(0.000)	(0.000)
Exchange rate volatility	-0.00360	-0.0386***	-0.0592***	-0.0462*	-0.0497***	-0.0581***
	(0.905)	(0.001)	(0.007)	(0.064)	(0.000)	(0.007)
Trade openness	-0.252	-0.0771**	0.0115			
	(0.242)	(0.045)	(0.879)			
Population	-0.559	-0.0781	0.159			
	(0.502)	(0.301)	(0.307)			
Education expenditure	-0.131	-0.0453	-0.0366			
	(0.490)	(0.158)	(0.630)			
Adjustment speed	-.989***	-.488***	-.361***	-1.05***	-.601***	-.405***
N	1095	1095	1095	989	989	989
Number of countries	53	53	53	53	53	53
Minimum number of years	19	19	19	17	17	17
Average number of years	20.66	20.66	20.66	18.66	18.66	18.66
Maximum number of years	29	29	29	27	27	27
Pesaran CD	2.455	4.827	9.764	6.548	4.439	6.443
CD p value	0.007	0.000	0.000	0.000	0.000	0.000
ADF p (1 lag)	0.000	0.000	0.000	0.000	0.000	0.000
Groups with serial correlation	14	3		7	0	
Hausman test		0.999	1.000		0.840	1.000

p-values in parentheses

Only the long run coefficients are reported. Time and country dummies are included (implicitly) in all regressions.
All variables in logs. Models A and B have one and two lags respectively for every variable in the short run equation.
'ADF p' reports the p-value for Pesaran's (2007) panel unit root test. The null is that all series are non-stationary.
At most one lag seemed to be necessary. 'Pesaran CD' and 'CD p value' are the test statistic and p-value for
Pesaran's (2004) cross-sectional dependence test for the residual. Residual autocorrelation was evaluated equation
by equation for MG and PMG estimates. I report the number of countries where it was significant at the 5% level.
'Hausman test' reports the p-value for the Hausman test comparing the MG to PMG or DFE estimates
(rejection means the efficient estimator is inconsistent).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Log of the number of **'high prody'** SITC4 categories exported

	A: 1 lag in short run eq.			B: 2 lags in short run eq.		
	MG	PMG	DFE	MG	PMG	DFE
GDP per capita	2.006**	0.883***	0.630***	0.539	0.754***	0.602***
	(0.048)	(0.000)	(0.000)	(0.191)	(0.000)	(0.000)
RER level	0.462	0.660***	0.187***	0.233	0.901***	0.275***
	(0.333)	(0.000)	(0.004)	(0.279)	(0.000)	(0.003)
Exchange rate volatility	-0.125	-0.112***	-0.158***	-0.120*	-0.181***	-0.157***
	(0.502)	(0.000)	(0.000)	(0.058)	(0.000)	(0.000)
Trade openness	-0.759	-0.396***	0.0263			
	(0.192)	(0.000)	(0.846)			
Population	-0.115	-0.710***	0.170			
	(0.955)	(0.000)	(0.336)			
Education expenditure	0.441	-0.0243	-0.00935			
	(0.309)	(0.764)	(0.944)			
Adjustment speed	-.913***	-.457***	-.460***	-1.01***	-.598***	-.610***
N	1095	1095	1095	989	989	989
Number of countries	53	53	53	53	53	53
Minimum number of years	19	19	19	17	17	17
Average number of years	20.66	20.66	20.66	18.66	18.66	18.66
Maximum number of years	29	29	29	27	27	27
Pesaran CD	5.989	13.321	15.034	7.877	7.807	11.038
CD p value	0.000	0.000	0.000	0.000	0.000	0.000
ADF p (1 lag)	0.000	0.000	0.000	0.000	0.000	0.000
Groups with serial correlation	13	1		9	8	
Hausman test		0.999	1.000		0.750	1.000

p-values in parentheses

Only the long run coefficients are reported. Time and country dummies are included (implicitly) in all regressions.
All variables in logs. Models A and B have one and two lags respectively for every variable in the short run equation.
'ADF p' reports the p-value for Pesaran's (2007) panel unit root test. The null is that all series are non-stationary.
At most one lag seemed to be necessary. 'Pesaran CD' and 'CD p value' are the test statistic and p-value for
Pesaran's (2004) cross-sectional dependence test for the residual. Residual autocorrelation was evaluated equation
by equation for MG and PMG estimates. I report the number of countries where it was significant at the 5% level.
'Hausman test' reports the p-value for the Hausman test comparing the MG to PMG or DFE estimates
(rejection means the efficient estimator is inconsistent).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Log of the **concentration measures** for SITC4 product categories

	Gini			Theil			Herfindahl-Hirschman		
	MG	PMG	DFE	MG	PMG	DFE	MG	PMG	DFE
GDP per capita	0.0445	0.0235***	-0.0119	0.647	0.0921***	-0.0240	-0.517	-0.0724	-0.341**
	(0.632)	(0.000)	(0.121)	(0.389)	(0.000)	(0.554)	(0.582)	(0.179)	(0.015)
RER level	-0.0472	-0.000266	0.00133	-0.593*	0.196***	0.0294	-1.666**	-0.117***	-0.265***
	(0.462)	(0.857)	(0.721)	(0.098)	(0.000)	(0.144)	(0.017)	(0.000)	(0.000)
Exchange rate volatility	-0.0190	0.00865***	0.000547	-0.307	0.00763	-0.000716	0.0565	-0.0425**	0.00589
	(0.105)	(0.000)	(0.922)	(0.299)	(0.339)	(0.981)	(0.602)	(0.046)	(0.957)
Adjustment speed	-.815***	-.451***	-.363***	-.820***	-.362***	-.292***	-.769***	-.346***	-.201***
N	1104	1104	1104	1104	1104	1104	1104	1104	1104
Number of countries	59	59	59	59	59	59	59	59	59
Minimum number of years	17	17	17	17	17	17	17	17	17
Average number of years	18.71	18.71	18.71	18.71	18.71	18.71	18.71	18.71	18.71
Maximum number of years	30	30	30	30	30	30	30	30	30
Pesaran CD	0.906	0.093	6.136	0.376	-0.459	3.500	-0.526	0.084	-1.278
CD p value	0.182	0.463	0.000	0.354	0.677	0.000	0.700	0.466	0.899
ADF p (1 lag)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Groups with serial correlation	5	1		3	2		6	2	
Hausman test		0.462	1.000		0.805	1.000		0.456	1.000

p-values in parentheses

Only the long run coefficients are reported. Time and country dummies are included (implicitly) in all regressions.

All variables in logs. Two lags of every variable included in the ARDL model.

'ADF p' reports the p-value for Pesaran's (2007) panel unit root test. The null is that all series are non-stationary. At most one lag seemed to be necessary.

'Pesaran CD' and 'CD p value' are the test statistic and p-value for Pesaran's (2004) cross-sectional dependence test for the residual.

Residual autocorrelation was evaluated equation by equation for MG and PMG estimates. I report the number of countries where it was significant at a 5%.

'Hausman test' is the p-value for the Hausman test comparing the MG to PMG or DFE estimates (rejection means the efficient estimator is inconsistent).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Log of the number of SITC4 categories exported – **Non-OECD countries** only

	Total variety			**Low prody** variety			**High prody** variety		
	MG	PMG	DFE	MG	PMG	DFE	MG	PMG	DFE
GDP per capita	0.580**	0.513***	0.381**	0.0659	0.355***	0.258**	1.051	0.756***	0.472
	(0.047)	(0.000)	(0.013)	(0.868)	(0.000)	(0.037)	(0.121)	(0.000)	(0.103)
RER level	0.0940	0.253***	0.192***	0.0685	0.231***	0.184***	0.179	0.484***	0.226***
	(0.274)	(0.000)	(0.000)	(0.621)	(0.000)	(0.000)	(0.560)	(0.000)	(0.002)
Exchange rate volatility	-0.0339	-0.0433***	-0.0694**	-0.0285	-0.00594	-0.0389	-0.136	-0.0943***	-0.120**
	(0.358)	(0.000)	(0.035)	(0.470)	(0.312)	(0.205)	(0.206)	(0.000)	(0.022)
Adjustment speed	-1.15***	-.650***	-.418***	-1.13***	-.604***	-.371***	-1.08***	-.676***	-.579***
N	681	681	681	642	642	642	642	642	642
Number of countries	38	38	38	36	36	36	36	36	36
Minimum number of years	17	17	17	17	17	17	17	17	17
Average number of years	17.92	17.92	17.92	17.83	17.83	17.83	17.83	17.83	17.83
Maximum number of years	22	22	22	22	22	22	22	22	22
Pesaran CD	-0.295	0.462	-1.266	-0.687	-0.011	-1.614	1.855	2.013	1.590
CD p value	0.616	0.322	0.897	0.754	0.505	0.947	0.032	0.022	0.056
ADF p (1 lag)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Groups with serial correlation	3	1		5	0		6	2	
Hausman test		0.945	1.000		0.736	1.000		0.914	1.000

p-values in parentheses

Only the long run coefficients are reported. Time and country dummies are included (implicitly) in all regressions.

All variables in logs. Two lags of every variable included in the ARDL model.

'ADF p' reports the p-value for Pesaran's (2007) panel unit root test. The null is that all series are non-stationary. At most one lag seemed to be necessary.

'Pesaran CD' and 'CD p value' are the test statistic and p-value for Pesaran's (2004) cross-sectional dependence test for the residual.

Residual autocorrelation was evaluated equation by equation for MG and PMG estimates. I report the number of countries where it was significant at a 5%.

'Hausman test' is the p-value for the Hausman test comparing the MG to PMG or DFE estimates (rejection means the efficient estimator is inconsistent).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Log of the number of **total** SITC4 categories exported

	A: 1 lag in short run eq.			B: 2 lags in short run eq.		
	MG	PMG	DFE	MG	PMG	DFE
GDP per capita	0.303	0.849***	0.141	0.501	1.569***	0.163
	(0.547)	(0.000)	(0.219)	(0.270)	(0.000)	(0.274)
RER level	0.0891	0.168***	0.277***	0.346**	0.198***	0.256
	(0.796)	(0.000)	(0.000)	(0.028)	(0.000)	(0.111)
Exchange rate volatility	0.0263	-0.0290***	-0.0673**	-0.0786*	0.0761***	-0.0987*
	(0.433)	(0.005)	(0.028)	(0.052)	(0.000)	(0.054)
Trade openness	-0.417	-0.0385	-0.181***			
	(0.266)	(0.383)	(0.009)			
Population	-1.798*	-0.0122	0.310**			
	(0.078)	(0.901)	(0.043)			
Real interest rate	0.0313	0.0449***	0.0183	0.0186	-0.147***	-0.0173
	(0.557)	(0.000)	(0.525)	(0.678)	(0.000)	(0.747)
Adjustment speed	-.935***	-.447***	-.462***	.4072	-.080*	-.269***
N	332	332	332	296	296	296
Number of countries	17	17	17	17	17	17
Minimum number of years	17	17	17	15	15	15
Average number of years	19.53	19.53	19.53	17.41	17.41	17.41
Maximum number of years	23	23	23	21	21	21
Pesaran CD	6.789	7.214	9.813	1.195	2.947	9.898
CD p value	0.000	0.000	0.000	0.116	0.002	0.000
ADF p (1 lag)	0.000	0.000	0.000	0.000	0.000	0.000
Groups with serial correlation	2	2		3	1	
Hausman test		0.455	1.000		0.346	1.000

p-values in parentheses

Only the long run coefficients are reported. Time and country dummies are included (implicitly) in all regressions. All variables in logs. Models A and B have one and two lags respectively for every variable in the short run equation. 'ADF p' reports the p-value for Pesaran's (2007) panel unit root test. The null is that all series are non-stationary. At most one lag seemed to be necessary. 'Pesaran CD' and 'CD p value' are the test statistic and p-value for Pesaran's (2004) cross-sectional dependence test for the residual. Residual autocorrelation was evaluated equation by equation for MG and PMG estimates. I report the number of countries where it was significant at the 5% level. 'Hausman test' reports the p-value for the Hausman test comparing the MG to PMG or DFE estimates (rejection means the efficient estimator is inconsistent).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Log of the number of SITC4 categories exported

	Low prody exports				**High prody** exports			
	OLS	2FE	Difference GMM	System GMM	OLS	2FE	Difference GMM	System GMM
Lagged variety	0.899***	0.409***	0.518**	0.783***	0.822***	0.273***	0.819**	0.675***
	(0.000)	(0.000)	(0.027)	(0.000)	(0.000)	(0.002)	(0.026)	(0.000)
GDP per capita	0.0264**	0.0332	-0.0269	0.0517	0.113**	0.226	-0.286	0.149
	(0.038)	(0.759)	(0.891)	(0.461)	(0.021)	(0.175)	(0.445)	(0.163)
Population	0.0523***	0.298**	0.287	0.0894	0.0979***	0.556**	0.723	0.161**
	(0.000)	(0.031)	(0.137)	(0.155)	(0.002)	(0.034)	(0.281)	(0.038)
Trade openness	0.0694***	0.0288	0.131	0.123	0.127**	-0.0699	0.382	0.266
	(0.009)	(0.626)	(0.304)	(0.473)	(0.011)	(0.519)	(0.208)	(0.223)
RER level	0.221***	0.128*	0.108	0.360**	0.237**	0.0318	0.223	0.472**
	(0.000)	(0.093)	(0.499)	(0.034)	(0.020)	(0.824)	(0.372)	(0.021)
Exchange rate volatility	-0.957***	-0.995***	-1.367***	-1.672***	-1.503***	-1.111***	-2.417**	-3.223***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.033)	(0.009)
Constant	-0.916***	-2.893		-1.647	-2.271***	-8.035		-3.752*
	(0.003)	(0.267)		(0.249)	(0.007)	(0.121)		(0.090)
Long run exchange rate coef.	2.194**	0.216	0.223	1.665	1.334*	0.044	1.229	1.454
p value	0.012	0.146	0.590	0.361	0.053	0.825	0.715	0.147
Long run exchange rate volatility coef.	-9.518**	-1.684***	-2.836	-7.722	-8.456**	-1.528***	-13.346	-9.929
p value	0.011	0.000	0.109	0.255	0.014	0.000	0.659	0.117
N	253	253	205	253	253	253	205	253
AR(1) p			0.070	0.001			0.148	0.037
AR(2) p			0.175	0.235			0.528	0.443
Number of instruments			18	24			18	24
Overidentifying restrictions			5	10			5	10
Sargan p			0.089	0.545			0.886	0.745
Hansen p			0.927	0.827			0.946	0.496
Diff-in-Hansen for levels p			.	0.466			.	0.332
Hansen for assumed exogenous p			.	0.939			.	0.603

p-values in parentheses. All equations include time dummies and 2FE also includes country dummies. All regressors are in logs. Data is averaged over four-year periods.
Robust standard errors clustered at the country level reported for all estimators.
'AR(1) p' and 'AR(2) p' : p-values for the Arellano-Bond (1999) tests for first and second order error autocorrelation in the differenced equation.
'Sargan p' and 'Hansen p' : p-values for the Sargan/Hansen tests of overidentifying restrictions. 'Diff-in-Hansen for levels p' : p-value for the Difference-in-Hansen test of exogeneity of the instruments for the levels equation. 'Hansen for assumed exogenous p' : p-value for the Hansen test for the instruments assumed exogenous for the Difference-in-Hansen test.
One step GMM used because the sample is too small to estimate the optimal weight matrix appropriately. In GMM estimators, population assumed exogenous, the lagged dependent variable assumed predetermined (instrumented with its first and second lags in the differenced equation) and all other regressors assumed endogenous (instrumented with their second and third lags in the differenced equation). Instrument matrix collapsed (see Roodman, 2006).
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendices

A Definition of concentration measures

The indices are defined for every country for every year. Given

$N : \, Number\, of\, products\, exported,$

$x_i : \, Volume\, of\, product\, i\, exported,$

$\overline{x} = \sum_{i=1}^{N} \frac{x_i}{N}$ and

$s_i = \frac{x_i}{\sum_{i=1}^{N} x_i}$

The indices are defined as follows:

$$Theil = \frac{1}{N} \sum_{i=1}^{N} \frac{x_i}{\overline{x}} ln \left(\frac{x_i}{\overline{x}} \right)$$

$$Normalised\ Herfindahl - Hirschman = \frac{\sum_{i=1}^{N} \left(s_i^2 \right) - \frac{1}{N}}{1 - \frac{1}{N}}$$

If products are ordered such that $x_i \leq x_{i+1} \, \forall \, i \in (1, N-1)$, then the Gini coefficient can be computed as:

$$Gini = 1 - \frac{2}{N-1} \left(N - \frac{\sum_{i=1}^{N} i \, x_i}{\sum_{i=1}^{N} x_i} \right)$$

B List of countries

These are the countries that are effectively used in the regressions (at least once), classified as OECD or non-OECD.

Non-OECD	**OECD**
Algeria	Australia
Bahrain	Austria
Belize	Belgium
Bolivia	Canada
Brazil	Denmark
Cameroon	Finland
Central African Republic	France
Chile	Greece
China	Hungary
DR Congo	Israel
Costa Rica	Japan
Cyprus	Netherlands
Côte d'Ivoire	New Zealand
Dominican Republic	Norway
Ecuador	Portugal
Fiji	Spain
Gambia	Sweden
Ghana	Switzerland
Guyana	United Kingdom
Iran	United States
Malawi	
Malaysia	
Malta	
Mexico	
Morocco	
Nicaragua	
Pakistan	
Papua New Guinea	
Paraguay	
Philippines	
Saudi Arabia	
Sierra Leone	
Singapore	
Togo	
Trinidad and Tobago	
Tunisia	
Uruguay	
Venezuela	
Zambia	