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Trade Diversification, Income, and Growth: What Do We Know?

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1. Introduction

Policy interest in export diversification is not new but, as noted by Jose Salazar-Xirinachs in his comment on Cimoli, Dosi and Stiglitz (2009), for over two decades it was mired in an ideologically-loaded debate about the role of the State. Old-time industrial policy having died of its own excesses, the debate over what, if anything, the government should do to promote export growth was contained to the fringe of the economics profession. Mainstream economists were happy to believe that whatever market failures there were out there, government failures were worse, and that anyway most governments in developing countries lacked the means to do anything. But by an ironic twist of history, years of (Washington-consensus inspired) fiscal and monetary discipline have put a number of developing-country governments back in a position to do something for export promotion, having recovered room of maneuver in terms of both external balance and budget position. So the question is back.

With limited guidance from theory, the economics profession's answer to the return of the industrial-policy debate has been to go back to descriptive statistics (as opposed to the investigation of causal chains). The result is a wealth of new stylized facts. For instance, surprising patterns of export entrepreneurship have emerged from the use of increasingly disaggregated data. Decompositions of export growth into intensive and extensive margins have revealed interesting patterns, and so has the study of export survival.

One area where theory has proved useful is in the exploration of the links between productivity and trade. So-called "new-new" trade models (featuring firm heterogeneity) have highlighted complex relationships between trade diversification and productivity, with causation running one way at the firm level and the other way around (or both ways) at the aggregate level.

Even at the aggregate level, new issues have appeared. First, Imbs and Wacziarg (2003) uncovered a curious pattern of diversification and re-concentration in production, prompting researchers to explore whether the same was true of trade. Second, a wave of recent empirical work has questioned traditional views on the "natural-resource curse", challenging the notion that diversification out of primary resources is a prerequisite for growth.

Thus, our current understanding of the trade diversification/ productivity/growth nexus draws on several theoretical and empirical

literatures, all well developed and growing rapidly. It is easy to get lost in the issues, and the present paper's objective is to sort them out and take stock of elements of answers to the basic questions.

Among those questions, the first are simply factual ones—how export diversification is measured and what are the basic stylized facts about trade export diversification, across time and countries, which we explore in Section 2 and 3 respectively. The third one is about diversification's drivers, and is tackled in Section 4. In Section 5, we turn to the relationship between diversification and growth. Section 6 focuses on the import side; we review the evidence on import diversification and productivity and extend the discussion to labor-market issues. In Section 7, we consider some tentative policy implications and conclusions.

2. Measuring diversification

2.1 Overall indices

Although much of the talk is about trade *diversification*, quantitative measures, most of them borrowed from the income-distribution literature, are about concentration. We will review these measures taking the example of export diversification (which has anyway been the focus of most papers) keeping in mind that they apply equally well to imports. All concentration indices basically measure inequality between export shares; these shares, in turn, can be defined at any level of aggregation. Of course, the finer the disaggregation, the better the measure.

The most frequently used concentration indices are the ones used in the income-distribution literature: Herfindahl, Gini, and Theil. These indices are formalized in the technical Appendix 8.1.1. All three indices can be easily programmed but are also available as packages in Stata. Authors have used one or several of these measures. Across the board, results are not dependent on the index chosen.

The Theil index has decomposability properties that make it especially useful. It can indeed be calculated for groups of individuals (export lines) and decomposed additively into within-groups and between-groups components (that is, the within- and between-groups components add up to

the overall index).[1] It is thus possible to distinguish an increased concentration (diversification) that occurs mainly within groups from one that occurred mainly across groups. We will see in the next section a useful application of this property in our context.

2.2 Intensive and extensive margins

Export concentration measured at the intensive margin reflects inequality between the shares of active export lines.2 Conversely, diversification at the intensive margin during a period t_0 to t_1 means convergence in export shares among goods that were exported at t_0. Concentration at the extensive margin is a subtler concept. At the simplest, it can be taken to mean a small number of active export lines. Then, diversification at the extensive margin means a rising number of active export lines. This is a widely used notion of the extensive margin (in differential form), and the decomposition of Theil's index can be usefully mapped into the intensive and extensive margins thus defined.

Suppose that, for a given country and year, we partition the 5'000 or so lines making up the HS6 nomenclature into two groups: group one is made of active export lines for this country and year, and group "zero" is made of inactive export lines (i.e., export lines for which there are no exports). This partition can be used to construct within-groups and between-groups components of the overall Theil index. As shown in the technical appendix 8.2, by distinguishing the Theil sub-index for the group of inactive line from the Theil sub-index for the group of active lines, changes in concentration/diversification within and between groups can be set apart. More importantly, it can be shown that given this partition, changes in the within-groups Theil index measure changes at the intensive margin whereas changes in the between-groups Theil index measure changes at the extensive margin. In sum, Theil's decomposition makes it possible to decompose changes in overall concentration into extensive-margin and intensive-margin changes.[3] This is a particularly important feature as changes at the intensive margin or extensive margin reflect very different

[1] Appendix 8.1.2 presents the Theil index decomposition.
[2] An active line corresponds to a non-zero export line of the HS6 nomenclature (about 5000 lines) for a given year.
[3] This mapping between the Theil decomposition and the margins was first proposed by Cadot et al. (2009).

evolution of a country productive activities and policies aiming at enhancing diversification in either margin entail distinct recommendations.

The extensive margin defined this way (by simply counting the number of active export lines) leaves however out important information. To see why, observe that a country can raise its number of active export lines in many different ways. For instance, it could add "embroidery in the piece, in strips or in motifs" (HS 5810); or, it could add "compression-ignition internal combustion piston engines (HS 8408, i.e. diesel engines). Clearly, these two items are not of the same significance economically, although a mere count of active lines would treat them alike. Hummels and Klenow (2005) proposed an alternative definition of the intensive and extensive margins that takes this information into account. They define the intensive margin as the share of country *i*'s exports value of good *k* in the world's exports of that good. That is, country *i*'s intensive margin is its market share in what it exports. The extensive margin is defined as the share, in world exports, of those goods that country *i* exports (irrespective of how much *i* itself exports of those goods). That is, it indicates how much the goods which *i* exports count in world trade.[4]

2.3 The other margins

Brenton and Newfarmer (2007) proposed an alternative definition of the extensive margin based on bilateral flows. The index measures how many of destination country *j*'s imports are covered (completely or partly—the index does not use information on the value of trade flows) by exports from country *i*. The numerator of Brenton and Newfarmer's index for country *i* is the number of products that *i* exports to *j*, while its denominator is the number of products that (i) *j* imports from anywhere and (ii) *i* exports to anywhere (see Appendix 8.3). It is thus the sum of actual and potential bilateral trade flows (for which there is a demand in *j* and a supply in *i*), and the fraction indicates how many of those potential trade flows take place actually.

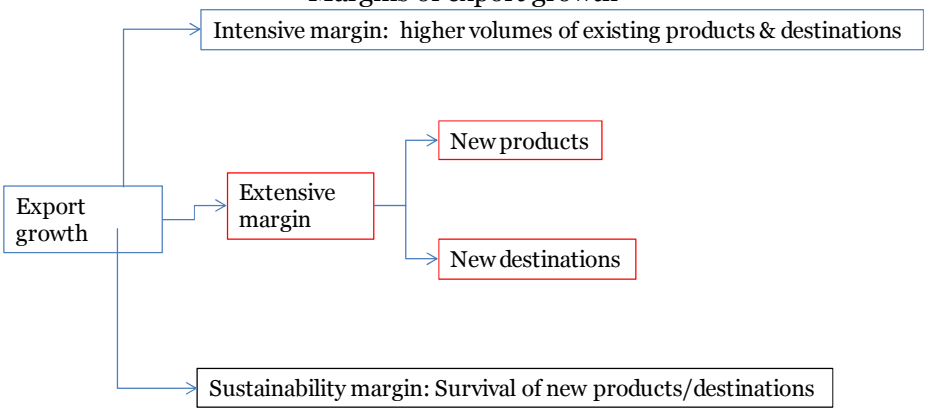
Finally, yet another non-traditional margin of export expansion is the export sustainability, measured by the survival of trade flows analyzed for the first time in Besedes and Prusa's seminal work (Besedes and Prusa 2006). The length of time during which bilateral exports of a given good

[4] See Technical Appendix 8.2.2 for a formalization of the Hummels and Klenow index.

take place without interruption is a dimension along which exports vary and which may also be a margin for export promotion.

Figure 1 summarizes our decomposition of export growth.

Figure 1
Margins of export growth



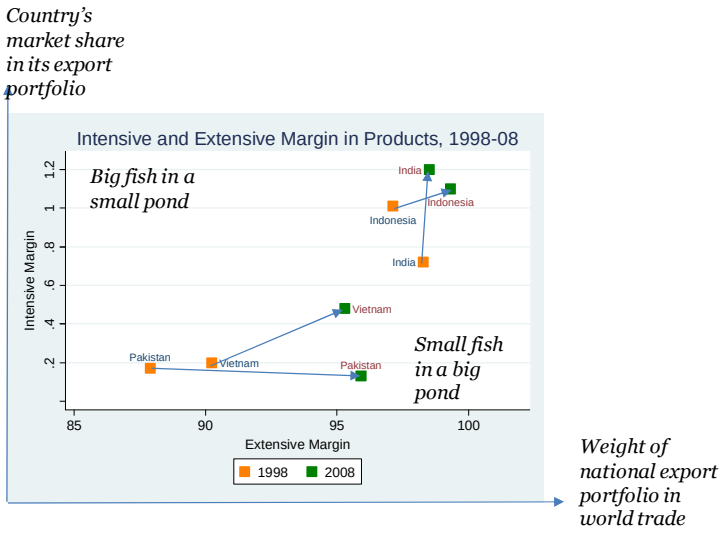
Theil's index,[5] Hummels and Klenow's, and Brenton and Newfarmer's provide different pieces of information and should be used accordingly. The former index measures the concentration in products. It thus informs policy makers on the distribution of economic activity across existing product/sectors (intervention at the intensive margin) and the potential for broadening the country's export portfolio to new sectors (intervention at the extensive margin). Brenton and Newfarmer's index gives information about geographic diversification at the extensive margin. For existing products, it shows how many markets are reached and informs on the potentiality of extending production to new markets. Policies aimed at increasing the scope of exports in terms of products or destination markets are obviously very different. It is therefore important for policy makers to use the right tool for the right policy question. Finally, Hummels and Klenow's index gives an idea of whether national exporters are "big fish in a small pond" (large intensive margin, small extensive margin) or "small fish in a big pond (small intensive, large extensive).

As an illustration of how these concepts can be put to work for policy analysis, Figure 2 shows the evolution of the intensive and extensive margins for selected countries over the decade preceding the global

[5] The interpretation for Herfindhal or Gini indices is obviously similar.

financial crisis. It can be seen for instance that Pakistan's extensive margin has been rising, suggesting active export entrepreneurship. By contrast, its intensive margin has slightly shrunk, suggesting that existing Pakistani exporters are finding it difficult to maintain competitiveness. This type of broad-brush observation is useful to get a first shot at potential constraints on growth—say, the problem may be declining competitiveness in the textile and clothing sector due to the elimination of MFA quotas. By contrast, India has grown almost only at the intensive margin, which is to be expected given that it is already fully diversified (as the products that belong to its export portfolio account for close to 100% of world trade). Overall, countries can be expected to walk a crescent-shaped trail, first eastward as they broaden their portfolio, then full North as they consolidate positions.

Figure 2
Evolution of the intensive and extensive margins, selected countries, 1998-2008



Source: Comtrade. The authors are grateful to Swarnim Wagle, of the World Bank's Trade Division, for sharing this graph.

3. Putting the measures at work

3.1 Overall evolution

Although one might expect that diversification of economic activities rises monotonically with income, Imbs and Wacziarg's seminal work (Imbs and Wacziarg 2003) showed that this is not the case. Past a certain level of

income ($9'000 in 1985 PPP dollars), countries re-concentrate their production structure, whether measured by employment or value added. Using different data, Koren and Tenreyro (2007) confirmed the existence of a U-shaped relationship between the concentration of production and the level of development.

Since then, a number of papers have looked at whether a similar non-monotone pattern holds for trade. Looking at trade made it possible to reformulate the question at a much higher degree of disaggregation since trade data is available for the 5'000 or so lines of the six-digit harmonized system (henceforth HS6). In terms of concentration levels, exports are typically much more concentrated than production. This concentration, which was observed initially by Hausmann and Rodrik (2006), is documented in detail for manufacturing exports in Easterly, Reshef and Schwenkenberg (2009). A striking (but not unique) example of this concentration is the case of Egypt which, "[out] of 2'985 possible manufacturing products in [the] dataset and 217 possible destinations, [...] gets 23 percent of its total manufacturing exports from exporting one product—"ceramic bathroom kitchen sanitary items not percelain"—to one destination, Italy, capturing 94 percent of the Italian import market for that product." (p. 3) These "big hits", as they call them, account for a substantial part of the cross-country variation in export volumes. But they also document that the distribution of values at the export × destination level (their unit of analysis) closely follows a power law; that is, the probability of a big hit decreases exponentially with its size.

In terms of evolution, Klinger and Lederman (2006) used a panel of 73 countries over 1992-2003, while Cadot et al. (2009) used a larger one with 156 countries representing all regions and all levels of development between 1988 and 2006. In both cases, and in Parteka (2007) as well, concentration measures obtained with trade data turned out to be much higher than those obtained with production and employment data.[6] But the U-shaped pattern

6 The reason has to do with the level of disaggregation rather than with any conceptual difference between trade, production and employment shares. Whereas Imbs and Wacziarg calculated their indices at a relatively high degree of aggregation (ILO 1 digit, UNIDO 3 digits and OECD 2 digits), Cadot et al. (2009) uses very disaggregated trade nomenclature. At that level there is a large number of product lines with small trade values, while a relatively limited number of them account for the bulk of all countries' trade (especially so of course for developing countries but even for industrial ones). The reason for this pattern is that the harmonized system used by COMTRADE is derived from nomenclatures originally

showed up again, albeit with a turning point at much higher income levels ($22,500 in constant 2000 PPP dollars for Klinger and Lederman, and $25,000 in constant 2005 PPP dollars for Cadot et al.). Note that, as the turning point occurs quite late, the level of export concentration of the richest countries in the sample is much lower than that of the poorest.

3.2 Which margin matters?

Decompositions of the growth of exports into intensive- and extensive-margin growth have typically shown that the former dominates by far. The pioneer work of Evenett and Venables (2002) used 3-digit trade data for 23 exporters over 1970-1997 and found that about 60% of total export growth is at the intensive margin, i.e. comes from larger exports of products traded since 1970 to long-standing trading partners. Of the rest, most of which was the destination-wise extensive margin, as the product-wise extensive margin accounted for a small fraction (about 10%) of export growth. Brenton and Newfarmer (2007), using SITC data at the 5 digit-level over 99 countries and 20 years, also found that intensive-margin growth accounts for the biggest part of trade growth (80.4%), and that growth at the extensive margin was essentially destination-wise (18%). Amurgo-Pacheco and Pierola (2008) found that extensive-margin growth accounts for only 14% of export at the HS6 level for a panel of 24 countries over 1990-2005.

The observation that the product-wise extensive margin accounts for little of the growth of exports may seem puzzling, as Cadot et al. (forthcoming) found precisely that margin to be very active, especially at low levels of income. Thus, export entrepreneurship is not lacking. Why then doesn't it generate export growth? There are two answers, one technical and one of substance. The technical answer is that when a new export appears in statistics, it typically appears at a small scale and can only contribute marginally to growth. But the following year, it is already in the intensive margin. Thus, *by construction*, the extensive margin can only be small. But there is a deeper reason. In work already cited, Besedes and Prusa (2006) showed that the churning rate is very high in all countries' exports, and especially so for developing ones. That is, many new export products are

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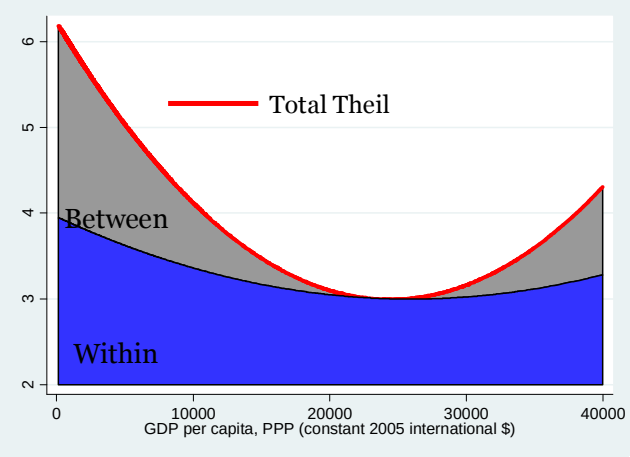
designed for tariff-collection purposes rather than to generate meaningful economic statistics. Thus, it has a large number of economically irrelevant categories e.g. in the textile-clothing sector while economically important categories in machinery, vehicles, computer equipment etc. are lumped together in "mammoth" lines.

tried, but many also fail. Raising the contribution of the extensive margin to export growth requires also improving the "sustainability" margin.

Although not predominant quantitatively as a driver of export growth, the extensive margin can react strongly to changes in trade costs, an issue we will revisit later on in this survey. For instance, Kehoe and Ruhl (2009) found that the set of least traded goods, which accounted for only 10% of trade before trade liberalization, may grow to account for 30% of trade or more after liberalization. Activity at the extensive margin also varies a lot along the economic development process. Klinger and Lederman (2006) and Cadot et al. (forthcoming) show that the number of new exports falls rapidly as countries develop, after peaking at lower-middle income level. The poorest countries, which have the greatest scope for new-product introduction because of their very undiversified trade structures, unsurprisingly have the strongest extensive-margin activity.[7]
Figure 3 depicts the contribution of the between-groups and within-groups components to Theil's overall index, using the formulae derived in the previous section.

Figure 3
Contributions of within- and between-groups to overall concentration, all countries



Source: Cadot et al. (forthcoming).

[7] The average number of active export lines is generally low at a sample average of 2'062 per country per year (using Cadot et al.'s sample), i.e. a little less than half the total, with a minimum of 8 for Kiribati in 1993 and a maximum of 4'988 for Germany in 1994 and the United States in 1995.

It can be seen that the within component dominates the index while the between component accounts for most of the evolution. Put differently, most of the concentration in levels occurs at the intensive margin (in goods that are long-standing exports) while changes in concentration are at the extensive margin (for example the decreased concentration for lower income countries results mainly from a rise in the number of exported goods).

As discussed in the previous section, the extensive margin in Figure 3 is measured only by the number of exports, not their economic importance. Correcting for the economic importance of the products introduced calls for Hummels and Klenow's decomposition. Using UNCTAD trade data at the HS6 level (5,017 product lines) for 1995, Hummels and Klenow (2005) performed a cross-sectional analysis of exports for 126 countries in decomposing exports into extensive and intensive margins. Interestingly, they found that 38% of the higher trade of larger economies to typical markets is explained by the intensive margin while 62% occurs for the extensive margin. That is, once the extensive margin is corrected for the importance of the new exports introduced, the previous result (the relative unimportance of the extensive margin) is reversed.

4. Drivers of diversification

4.1 Diversification and productivity: chicken or egg?

Traditional trade theory has little insight to offer on the potential determinants of export diversification beyond the observation that, in Ricardian models, causation runs from productivity to trade patterns and not the other way around. Recent developments from "new-new trade theory" give a bit more insight. In the specification proposed by Melitz (2003) firms are heterogeneous in productivity levels, and only a subset of them—the most productive—become exporters. Thus, exporting status and productivity are correlated at the firm level. However, causation runs only one way, like in Ricardian models, as productivity is distributed across firms as an i.i.d. random variable and is not affected by the decision to export, be it through learning or any other mechanism. At the firm level, the correlation between exporting status and productivity, in Melitz's model, comes only from a selection effect.

At the *aggregate* level, however, causation can run either way in a Melitz

model, depending on the nature of the shock. To see this, suppose first that the initial shock is a decrease in trade costs. Melitz's model and recent variants of it (e.g. Chaney 2008, Feenstra and Lee 2008) show that more firms will export, which will raise export diversification since in a monopolistic-competition model each firm sells a different variety. But low-productivity ones will exit the market altogether, pushing up aggregate industry productivity—albeit, again, by a selection effect. In this case, trade drives aggregate productivity.

Suppose now that the shock is an exogenous—say, technology-driven—increase in firm productivity across the board, i.e. affecting equally all firms and all sectors. Think of a multi-sector heterogeneous-firm model à la Bernard, Redding and Schott (2007) in which the distribution of firm-level productivities is Pareto in all sectors but differs in Melitz's $\tilde{\varphi}$ (and only in it). Ordering sectors by increasing value of $\tilde{\varphi}$, for a given trade cost there will be a cutoff $\tilde{\varphi}_0$ such that sectors with $\tilde{\varphi} > \tilde{\varphi}_0$ have an upper tail of firms that are productive enough to export (comparative-advantage sectors), and sectors with $\tilde{\varphi} \leq \tilde{\varphi}_0$ don't (comparative disadvantage sectors). Ceteris paribus, the productivity shock will raise the number of sectors with $\tilde{\varphi} > \tilde{\varphi}_0$, and thus the number of active export lines. In this case, productivity will drive trade.

The pre-Melitz empirical literature on the productivity-export linkage at the firm level was predicated on the idea that firms learn by exporting (see e.g. Haddad 1993, Aw and Hwang 1995, Tybout and Westbrook). However, Clerides, Lach and Tybout (1998) argued theoretically that the productivity differential between exporting and non-exporting firms was a selection effect, not a learning one, and found support for this interpretation using plant-level data in Columbia, Mexico and Morocco. Subsequent studies (Bernard and Jensen 1999; Eaton et al. 2004, 2007; Helpman et al. 2004; Demidova 2006) confirmed the importance of selection effects at the firm level. The most recent literature extends the source of heterogeneity to characteristics other than just productivity; for instance, several recent papers consider the ability to deliver quality (Johnson 2008, Verhoogen 2008, or Kugler and Verhoogen 2008). Hallak and Sivadasan (2008) combine the two in a model with multidimensional heterogeneity where firms differ both in their productivity and in their ability to deliver quality. They find, in conformity with their model, that the empirical firm-level determinants of export performance are more complex than just the level of productivity.

At the aggregate level, most of the literature so far has put export

diversification on the left-hand side of the equation and income on the right-hand side. As we already saw, Klinger and Lederman (2006), Parteka (2007) and Cadot et al. (2009), all found a U-shaped relationship between export concentration and GDP per capita by regressing the former on the latter. This can be interpreted as supporting the income-drives-export-diversification conjecture, as the hypothetical reverse mapping, from diversification to income, would, in a certain range, assign two levels of income (a low one and a high one) to the same level of diversification. While multiple equilibria are common in economics, the rationale for this particular one would be difficult to understand. Feenstra and Kee (2008) were the first to test empirically the importance of the reverse mechanism—from export diversification to productivity. They do so by estimating simultaneously a GDP function derived from a heterogeneous-firm model and a TFP equation where the number of export varieties (i.e. of exporting firms) is correlated with aggregate productivity through the usual selection effect. On a sample of 48 countries, they find that the doubling of product varieties observed over 1980-2000 explains a 3.3% cumulated increase in country-level TFP. Put differently, changes in export variety explain 1% of the variation in TFP across time and countries. The explanatory power of product variety is particularly weak in the between-country dimension (0.3%). Thus, product variety does not seem to explain much of the permanent TFP differences across countries, but an increase in export diversification—say, due to a decrease in tariffs—seems to trigger non-negligeable selection effects. To recall, this selection effect means that the least efficient firms exit the domestic market when trade expands, raising the average productivity of remaining firms. Still, even in the within-country dimension, two thirds of the variation in productivity is explained by factors other than trade expansion.

4.2 Diversification, market access, and trade liberalization

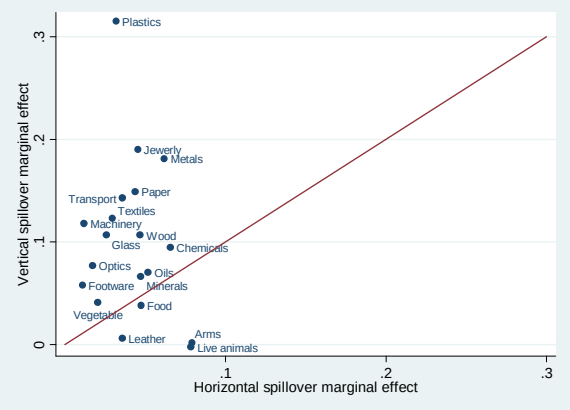
Returning to a formulation in which export diversification is on the left-hand side, we now consider some of its non-income determinants. In a symmetric (representative-firm) monopolistic-competition model, the volume of trade, the number of exporting firms, and the number of varieties marketed are all proportional. In a heterogeneous-firms model, the relationship is more complex, but the ratio of export to domestic varieties is also directly related to the ratio of export to domestic sales. Thus, it is no surprise that gravity determinants of trade volumes also affect the diversity of traded goods. For instance, Amurgo-Pacheco and Pierola (2008) find that the distance and size of destination markets is related to the diversity

of bilateral trade.

Parteka and Tamberini (2008) apply a two-step estimation strategy to uncover some of the systematic (permanent) cross-country differences in export diversification. To do so, they break down country effects into a wide range of country-specific characteristics such as size, geographical conditions, endowments, human capital and institutional setting. Using a panel data-set for 60 countries and twenty years (1985-2004), they show that distance from major markets and country size are the most relevant and robust determinants of export diversity, once GDP per capita is controlled for. These results are consistent with those of Dutt et al. (2009), who show that distance to trading centers and market access (proxied by a host of bilateral and multilateral trading arrangement) are key determinants of diversification.

To some extent, diversification feeds on itself through spillovers. Shakurova (2010) showed this by estimating how the probability of exporting a good (irrespective of volume) depended on previous experience in exporting either similar goods (what she called "horizontal spillovers") or upstream ones ("vertical spillovers"). She defined similar goods as those that were classified in the same HS chapter, and upstream products as those that belonged to the most intensive source of intermediate purchases (as measured through input-output tables). Cross-country regressions at the industry level showed that the size of those spillovers varied across industries but was in most cases statistically significant. Figure 4 shows those spillovers in the form of marginal effects for each industry.

Figure 4
Vertical and horizontal export spillovers



Note: Marginal effects from a probit regression of export status in product *i* on export status in product *j* at t-1 on a cross-section of countries. Those shown were significant at 5% or more.
Source: Adapted from Shakurova (2010).

Shakurova's work suggests that industrial policy aimed at generating vertically-linked clusters would make more sense in heavy industries such as plastics, transport or machinery than in food products, but that, by and large, the extensive margin could be considered as feeding on itself through spillovers, suggesting that encouragement policies could prove useful—notwithstanding our earlier observation that the extensive margin's contribution to overall export growth was limited.

Although preferential trade liberalization has received considerable attention in the empirical literature (e.g. Amurgo-Pachego, 2006, Gamberini, 2007, Feenstra and Kee 2007, or Dutt et al., 2009) as a driver of product diversification, unilateral trade reforms have not. Yet, we will see in Section 5 that the link between import diversification and TFP is strongly established at the firm level. Thus, import liberalization can be taken as a positive shock on TFP which should, according to the argument discussed in the previous section, raise the number of industries with an upper tail of firms capable of exporting—and thus overall export diversification. Indeed, arguments running roughly along this line can be found in Bernard, Jensen and Schott (2006) or in Broda, Greenfield, and Weinstein (2006), although the statistical linkage between trade liberalization and export diversity has not been tested formally so far.[8] This section presents a brief statistical analysis of this relation.

To do so, we combine the Theil index of export concentration computed at the HS6 level by Cadot et al. (2009) for 1988-2006 with the trade liberalization date of Wacziarg and Welch (2008). The sample used includes 100 countries, 62 Middle income and 38 Low income countries over 1988-2006, with respectively 68% and 49% of country-year observations occurring in liberalized regimes (see annex Table A1). We exclude from the sample 34 high income countries as 95% of the observations of this group occurs in liberalized regime throughout the period (Estonia and Iceland are the only countries considered as non liberalized and they do not change regime over the period - see annex Table A1).

[8] Using plant level panel data on Chilean manufacturers, Pavcnik (2002) evidences that the massive Chilean trade liberalization of the 1970s has significantly improved *within* plant productivity through import diversification (see Section 6).

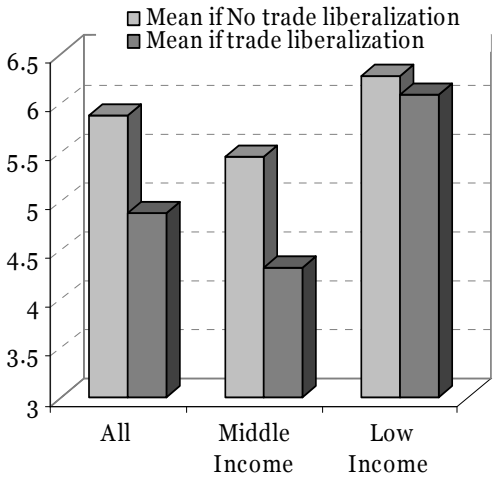
Wacziarg and Welsh (2008) proposes an update to the late 1990s of Sachs and Warner (1995)'s trade liberalization dates. Such data were first collected from a comprehensive survey of broad country-specific case studies. More precisely, Sachs and Warner determine trade liberalization dates based on primary-source data on annual tariffs, nontariff barriers, and black market premium. A variety of secondary sources was also used, particularly to identify when export marketing boards were abolished and multiparty governance systems replaced Communist Party rule.[9]

As shown in Figure 5, the conditional mean of Theil's concentration index is 4.8 in a liberalized regime vs. 5.9 in a non-liberalized one, while the number of exported products is clearly higher when the trade regime is liberalized (1'893 products vs 1'178 in a non liberalized trade regime). The difference in Theil's means is higher for middle-income than for low-income countries, although it is still statistically significant for low income countries. This suggests a stronger dynamic between trade liberalization and diversification of exports in developing countries with better infrastructure and higher skill levels.

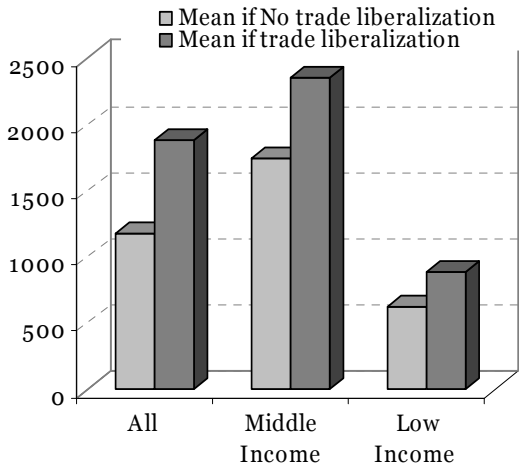
Figure 5
Differential of Means in a liberalized regime vs non liberalized one (100 middle and low income countries over 1988-2006)

5.a. Theil's concentration index 5.b. Number of exported products

[9] Rodriguez and Rodrik (2000) criticized the Sachs-Warner (1995) openness variable, showing that its explanatory power on growth was driven by only two of its five components: the black market premium on foreign exchange (a measure of overvalued exchange rates rather than trade openness) and the presence of export marketing boards. By contrast, tariffs and nontariff barriers correlated poorly with growth. As export marketing boards essentially characterized sub-Saharan Africa and overvalued exchange rate Latin America, the Sachs-Warner measure was indistinguishable from African and Latin American "dummy variables". Wacziarg and Welch (2008) improved the methodology by better identifying export marketing boards and trade liberalization dates. Using their improved openness definition and panel data over a long period, they confirmed that openness correlates with faster growth, delivering on average two percentage points of additional growth (largely driven by additional investment).



Note: for each group, the difference in means is tested to be *significantly higher* in non liberalized regime than in a liberalized one (at 1% level for All and MI and 5% for LI countries).



Note: for each group, the difference in means is tested to be *significantly lower* in non liberalized regime than in a liberalized one (at 1% level).

We then run fixed-effects regressions of the Theil index on a binary liberalization indicator defined by the dates of liberalization (equal to one when liberalized) to assess the within-country effect of trade liberalization on the diversification of exports. We use a difference-in-difference specification similar to the one used by Wacziarg and Welsh (2008):

$$Theil_{it} = \lambda_i + \delta_t + \phi LIB_{it} + \varepsilon_{it} \qquad (1)$$

where $Theil_{it}$ is the Theil index of country *i* exports in year *t*, LIB_{it} a dummy equals to 1 if t is greater than the year of liberalization (defined by Wacziarg and Welsh) and 0 otherwise. We introduce both country and year fixed-effects (λ_i and δ_t respectively). The sample is not restricted to countries that underwent reforms.

The regression for 1988-2006 shows a highly significant within-country difference in export diversification between a liberalized and a non-liberalized regime (ϕ reported in column 1), with a coefficient twice higher for middle- than for low-income countries, confirming the pattern observed in figure 2. We also regress equation (1) using the Theil index's decomposition (within-groups vs. between-groups, see Section 2). Results are reported in columns (2)-(6). Controlling for country and year effects, the results

suggest that middle income countries that undertook trade liberalization reforms have a significant more diversified structure of exports along the intensive margin. By contrast, low-income countries diversify mostly along the extensive margin.

Table 1
Fixed-Effects Regressions of Diversification index on Liberalization Status

	Theil		Theil-within		Theil_between	
Liberalization (LIB)	-0.190*		-0.075		-0.100*	
	(2.0)		*(0.8)*		*(2.8)*	
LIB - Middle Income		-0.241*		-0.271*		0.067
		(2.0)		*(2.0)*		*(0.5)*
LIB - Low Income		-0.138*		0.053		-0.209*
		(1.6)		*(0.5)*		*(2.0)*
Number of Obs.	1794		1394		1394	
Number of countries	100		100		100	
Period	1988-2006		1990-2004		1990-2004	
Country fixed effects	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
R^2 within	0.39	0.39	0.28	0.29	0.75	0.75

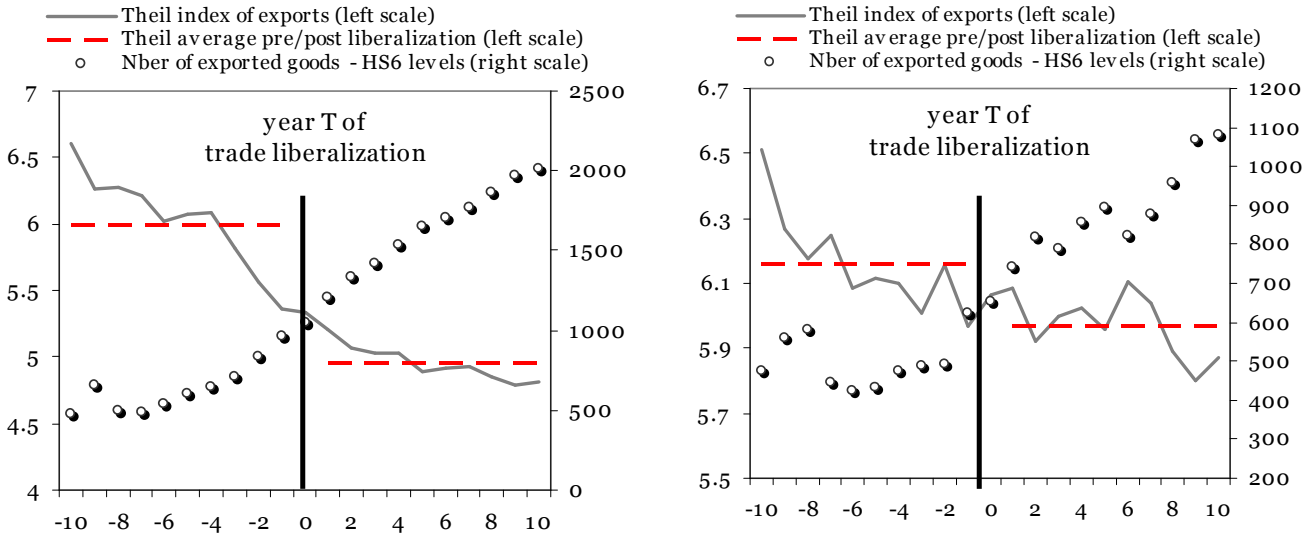
Note: * means a significant coefficient (at 10% level) standard errors in parenthese, heteroscedasticity consistent and adjusted for country clustering.

Figure 6shows the time path of export diversification for an average country before and after liberalization for middle and low income countries respectively. The plain curve shows the Theil index (left-hand scale) and the dotted one shows the number of exported products at the HS6 level (right-hand scale) over a window of 10 years before and after liberalization. The sample is made of countries that underwent permanent (non-reversed) liberalizations. For middle income countries, a strong diversification trend (shrinking Theil index) is apparent over the entire post-liberalization windows, and particularly strong in the 5 years following it. The figure also suggests an anticipation effects in the 3 years preceding liberalization. Patterns are less clear in the low income countries figure.

Figure 6
Time pattern of exports diversification pre and post liberalization

5.a. Middle Income countries

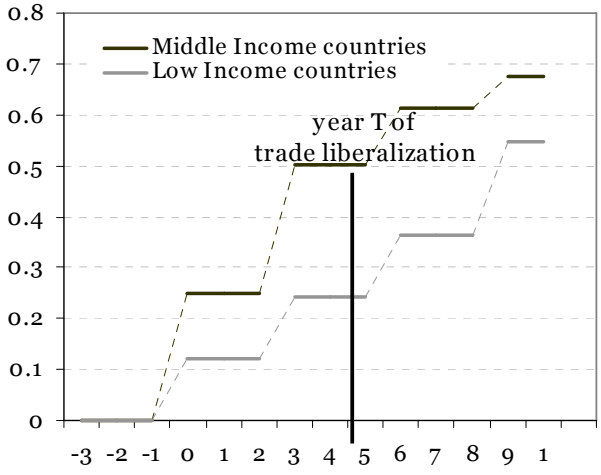
5.b. Low Income countries



In order to further examine the timing of export diversification, we follow Wacziarg and Welsh (2008) and replace the LIB variable with five dummies, each capturing a two-year period immediately before and after the trade-liberalization date *T*. Coefficients on these dummies capture the average difference in the Theil index (and number of exported lines) between the period in question and a baseline period running from sample start to *T-3*. Estimated coefficients (in absolute value) are reported in Figure 7.

Figure 7 shows that the anticipation effect apparent in Figure 7 disappears in formal tests using the fixed-effects regression, i.e. in the presence of country and year effects. Diversification starts at the date of trade liberalization and proceeds steadily thereafter, as shown by the rising coefficients (in absolute value) on the period dummies.

Figure 7
Estimated marginal increase in the Export Diversification around a trade liberalization event.



5. Export diversification and growth

In this section, we move export diversification from the left-hand side to the right-hand side of the equation, i.e. from dependent to explanatory variable, but replacing the focus on productivity of the previous section by a focus on *growth*. Specifically, we will review the existing evidence on the relationship between initial diversification and subsequent growth, starting with a widely discussed hypothesis dubbed the "natural resource curse".

5.1 The "natural-resource curse"

The central empirical findings behind the belief in a "natural resource curse" are the results of cross-sectional growth regressions in Sachs and Warner (1997) showing that a large share of natural-resource exports in GDP is statistically associated, ceteris paribus, with slow growth. Similar results can be found in the work of Auty (2000, 2001). There is no dearth of possible explanations for this negative correlation, but a good start is a set of arguments put forth by Prebisch (1959): deteriorating terms of trade, excess volatility, and low productivity growth. A host of other growth-inhibiting syndromes associated with natural-resource economies are discussed in Gylfason (2008). As we will see, each potential channel has been a subject of controversy; moreover, the very conjecture holds only when looking at natural-resource dependence, which is endogenous to a host of influences. *Endowments* of natural resources, by contrast, do not seem to correlate negatively with growth.

The notion that the relative price of primary products has a downward

trend is known as the Prebisch-Singer Hypothesis. Verification of the Prebisch-Singer hypothesis was long hampered by a (suprising) lack of consistent price data for primary commodities, but Grilli and Yang (1988) constructed a reliable price index for 24 internationally traded commodities between 1900 and 1986. The index has later been updated by the IMF to 1998. The relative price of commodities, calculated as the ratio of this index to manufacturing unit-value index, indeed showed a downward log-linear trend of -0.6% a year, confirming the Prebisch-Singer Hypothesis. However, Cuddington, Ludema and Jayasuriya (2007) showed that the relative price of commodities has a unit root, so that the Prebisch-Singer hypothesis would be supported by a negative drift coefficient in a regression in first differences, not in levels (possibly allowing for a structural break in 1921). But when the regression equation is first-differenced, there is no downward drift anymore. Thus, in their words, "[d]espite 50 years of empirical testing of the Prebisch-Singer hypothesis, a long-run downward trend in real commodity prices remains elusive." (p. 134).

The second argument in support of the natural resource curse has to do with the second moment of the price distribution. Easterly and Kray (2000) regressed income volatility on terms-of-trade volatility and dummy variables marking exporters of primary products. The dummy variables were significant contributors to income volatility over and above the volatility of the terms of trade. Jansen (2004) confirms those results with variables defined in a slightly different way. Combining these results with those of Ramey and Ramey (1995) who showed that income volatility is statistically associated with low growth suggests that the dominance of primary-product exports is a factor of growth-inhibiting volatility. Similarly, Collier and Gunning (1999), Dehn (2000) and Collier and Dehn (2001) found significant effects of commodity price shocks on growth.

However, these results must be nuanced. Using VAR models, Deaton and Miller (1996) and Raddatz (2007) showed that although external shocks have significant effects on the growth of low-income countries, together they can explain only a small part of the overall variance of their real per-capita GDP. For instance, in Raddatz, changes in commodity prices account for a bit more than 4% of it, shocks in foreign aid about 3%, and climatic and humanitarian disasters about 1.5% each, leaving a whopping 89% to be explained. Raddatz's interpretation is that the bulk of the instability is home-grown, through internal conflicts and economic mismanagement. Although this conclusion may be a bit quick (it is nothing more than a conjecture on a residual), together with those of Deaton and Miller, Raddatz's results suggest that the effect of commodity-price volatility on growth suffers from a missing link: Although it is a statistically significant

causal factor for GDP volatility and slow growth, it has not been shown yet to be quantitatively important.

A third line of arguments runs as follows. Suppose that goods can be arranged along a spectrum of something that we may loosely think of as technological sophistication, quality, or productivity. Hausmann, Hwang and Rodrik (2005) proxy this notion by an index they call PRODY, which is calculated as

$$PRODY_k = \sum_j \omega_{kj} Y_j \tag{2}$$

where *k* stands for a good, *j* for a country, Y_j is country j's GDP per capita, and

$$\omega_{kj} = \sum_j \left[\frac{x_{kj}/x_j}{\sum_k (x_k/x)} \right] \tag{3}$$

is a variant of Balassa's index of revealed comparative advantage (in which x_{kj} stands for country *j*'s exports of good *k*, x_j for country j's total exports, x_k for world exports of good *k*, and *x* for total world exports). They show that countries with a higher average initial PRODY (across their export portfolio) have subsequently stronger growth, suggesting, as they put it in the paper's title, that « what you export matters ». As primary products typically figure in the laggards of the PRODY scale, diversifying out of them may accelerate subsequent growth. In addition, according to the so-called "Dutch disease" hypothesis (see references in Sachs and Warner 1997 or Arezki and van der Ploeg 2007) an expanding primary-product sector may well cannibalize other tradeable sectors through cost inflation and exchange-rate appreciation. Thus, natural resource might by themselves prevent the needed diversification out of them. Dutch-disease effects can, in turn, be aggravated by unsustainable policies like excessive borrowing (Manzano and Rigobon 2001 in fact argue that excessive borrowing is more of a cause for slow growth than natural resources—more on this below).

However, Hausmann et al.'s empirical exercise must be interpreted with caution before jumping to the conclusion that public policy should aim at structural adjustment away from natural resources. Using a panel of 50 countries between 1967 and 1992, Martin and Mitra (2006) found evidence of strong productivity (TFP) growth in agriculture—in fact, higher in many instances than that of manufacturing. For low-income countries, for instance, average TFP growth per year was 1.44% to 1.80% a year

(depending on the production function's functional form) against 0.22% to 0.93% in manufacturing. Results were similar for other country groupings. Thus, a high share of agricultural products in GDP and exports is not necessarily, by itself (i.e. through a composition effect) a drag on growth.

Other conjectures for why heavy dependence on primary products can inhibit growth emphasize bad governance and conflict. Tornell and Lane (1999), among many others, argued that deficient protection of property rights would lead, through a common-pool problem, to over-depletion of natural resources. Many others, referenced in Arezki and van der Ploeg (2007) and Gylfason (2008) put forward various political-economy mechanisms through which natural resources would interact with institutional deficiencies to hamper growth. In a series of papers, Collier and Hoeffler (2004, 2005) argued that natural resources can also provide a motive for armed rebellions and found, indeed, a statistical association between the importance of natural resources and the probability of internal conflicts.

However, recent research has questioned not just the relevance of the channels through which natural-resource dependence is supposed to inhibit growth, but the very existence of a resource curse. The first blow came from Manzano and Rigobon (2001) who showed that once excess borrowing during booms is accounted for, the negative correlation between natural-resource dependence and growth disappears. However, this could simply mean that natural-resource dependence breeds bad policies, which is not inconsistent with the natural-resource curse hypothesis.

More recently, Brunnschweiler and Bulte (2008) argued that measuring natural-resource dependence by either the share of primary products in total exports or that of primary-product exports in GDP makes it endogenous to bad policies and institutional breakdowns, and thus unsuitable as a regressor in a growth equation. To see why, assume that mining is an "activity of last resort"; that is, when institutions break down, manufacturing collapses but well-protected mining enclaves remain relatively sheltered. Then, institutional breakdowns will mechanically result in a higher ratio of natural resources in exports (or natural-resource exports in GDP), while being also associated with lower subsequent growth. The correlation between natural-resource dependence and lower subsequent growth will then be spurious and certainly not reflect causation. In order to avoid endogeneity bias, growth should be regressed on (exogenous) natural-resource *abundance*. The stock of subsoil resources, on which the World Bank collected data for two years (1994 and 2000), provides just one such measure. But then instrumental-variable techniques yield no evidence

of a resource curse; on the contrary, natural-resource abundance seems to bear a positive correlation with growth. Similarly, Brunnschweiler and Bulte (2009) find no evidence of a correlation between natural-resource abundance and the probability of civil war.[10] Thus, it is fair to say that at this stage the evidence in favor of a resource curse is far from clear-cut.

5.2 A "concentration curse"?

Notwithstanding the role of natural resources, it is possible that export concentration *per se* has a negative effect on subsequent growth. Lederman and Maloney (2007) found a robust negative association between the initial level of a Herfindahl index of export concentration and subsequent growth. Dutt, Mihov and van Zandt (2008) also found that export diversification correlates with subsequent GDP growth, especially if the initial pattern of export specialization is close to that of the US.

The idea that all countries should strive to imitate the US export pattern as a recipe for growth sounds slightly far-fetched and would probably not fly very well as policy advice in developing countries. But there are additional difficulties with the notion of a "curse of concentration". First, if there is one, we still don't know why, as many of the arguments that could support it were questioned in the debate on the natural-resource curse (e.g. the transmission of terms-of-trade volatility to income volatility). Second, we already saw in our discussion of Easterly, Reshef and Schwenkenberg (2009) in Section 2 that export concentration is a fact of life. More than that: As they argued, concentration may well be the *result* of success, when export growth is achieved by what they call a "big hit". Costa Rica is an example. Thanks to good policies that make it an attractive production platform for multinationals, it was able to attract Intel in the late 1990s and became one of the world's major exporters of micro-processors. But as a result, microprocessors now dwarf all the rest—including bananas—in Costa Rica's exports, and concentration has gone up, not down.

5.3 EPZs, export diversification, and employment

Notwithstanding the caveats above, export diversification is widely seen by

[10] However, Arezki and van der Ploeg (2007) still found evidence of a resource curse for relatively closed economies when instrumenting for trade à la Frankel and Romer and for institutions à la Acemoglu, Johnson and Robinson. The debate is thus not quite close.

governments not just as insurance against the risks associated with excessive concentration, but also as a way of fostering manufacturing employment growth. One of the main policy tools used for this objective is the creation of Export processing zones (EPZs).[11]

EPZs have spread rapidly over the last two decades. The ILO's EPZ database counted 176 of them in 47 countries in 1986; by 2006, there were 3'500 in 130 countries. Overall, they account for 68 million jobs worldwide, a sizable figure which however represents only a very small share of global employment. Table 2 shows that the share of national workforces employed in EPZs is above one percent only in the Asia/Pacific region (which accounts for 61 million of the 68 million worldwide EPZ employment), in the Americas, and in the Middle East and North Africa (MENA) region.

Table 2
Direct employment in EPZs, 2007

	Direct employment (millions)	% of nat. employment
Global	68.441	0.21
Asia & Pacific	61.089	2.30
Americas	3.084	1.15
Western Europe	0.179	0.00
CEECs & Central Asia	1.590	0.00
MENA	1.458	1.59
Sub-Saharan Africa	1.040	0.20

Source: World Bank 2008, Table 15.

Outliers include Mauritius, whose EPZ accounts for 24% of its workforce, the UAE (25%), and Tunisia (8%). In addition to generating relatively modest increases in employment, EPZs have sometimes been criticized for relying on anti-union regulations and lax labor standards to attract investors (see e.g. ILO 2003 or ECFTU 2003). For instance, collective bargaining and freedom of association are restricted in EPZs in the Dominican Republic (a highly successful one in terms of employment), Bangladesh, Nigeria, Pakistan, Panama, Sri Lanka and Egypt. Strikes are banned in the EPZs of Bangladesh, Namibia, Zimbabwe, Nigeria, Panama

[11] EPZs are also known under various other names such as "free zones", "special economic zones", etc. For simplicity, we will stick to the "EPZ" acronym throughout to designate them, irrespective of their precise legal form).

and Turkey (World Bank 2008). Other EPZs, however, show a less labor-hostile set up; for instance, those of the Philippines, Singapore, and Trinidad e Tobago have labor representatives on their board. In terms of wages, fragmentary evidence suggests that they tend to be higher in EPZs than outside (Kusago and Tzannatos 1998).

Beyond their record on employment creation and labor relations, Farole (2010) notes that EPZs have a highly uneven record as tools of industrial policy. Few of them have led to substantial skill development, the most notable exception being Malaysia's Penang Skills Development Center. In Africa, in particular, EPZs do not seem to have played the role of catalysts for foreign investment that authorities hoped for them. In essence, EPZs were viewed by governments—and sometimes donors—as ways of cutting through "impossible reforms". When reforms aimed at the elimination of red tape, high tariff or non-tariff barriers on intermediate products, or predatory taxes seemed impossible, it was hoped that fencing exporters in a sort of good-governance enclave could offer an attractive alternative. But as Farole notes, EPZs have tended to flourish in countries that were otherwise improving governance and moving forward with reforms. In countries plagued by bad governance and political instability—in particular in sub-Saharan Africa—EPZs failed to shelter investors and consequently never really took off.

Farole's cross country regression of EPZ export performance on EPZ characteristics showed little correlation with labor costs (suggesting that "social dumping" was a poor way of luring investors) and even with the size of fiscal incentives; instead, performance seemed to correlate with the EPZs' infrastructure and logistics quality.

The main lesson from Farole's study (whether from the econometrics or from the narrative based on case studies) is that EPZs are no substitute for domestic reforms. Far from being sheltered enclaves, they reflect the general quality of the host country's business environment. Thus, countries whose export portfolios are dominated by a few primary products can hardly count on EPZs alone to generate export diversification. Ironically, the failure of Africa's EPZs to generate sizable employment in the garment sector prompts Farole to recommend targeting natural-resource based sectors for EPZ development in Africa. So long export diversification.

6. Another look at trade diversification:

Imports

Discussing trade diversification while overlooking that of imports would miss half the story. Trade liberalization or facilitation has indeed entailed a large increase in imports diversification. Countries not only import more but they also import more varieties. Such diversification in imports has important implications for aggregate welfare, productivity, employment, and inequality. These are the focus of the next sections.

6.1 Gains from diversity and "import competition"

Krugman's (1979) seminal paper was the first to show how countries gain from trade through imports of new varieties. Since then, most models of the new and new-new trade type encompass a "love-for-variety" element at the consumer and/or the producer level. However, empirical work assessing the gains from trade due to increased import diversification (i.e., an increase in the number of varieties imported) remains scarce, and the results point to modest gains.

Broda and Weinstein's (2006) paper stands as an exception. The paper provides evidence of the welfare gains due to growth in varieties imported. As is common in the literature, a variety is defined as the smallest product category available (seven- to ten-digit) and categories produced in different *countries* are seen as different varieties. The paper shows that, over the past tree decades years (1972–2001), the number of varieties (products × origin countries) imported by the U.S. has more than trebled while the share of imports in US GDP more than doubled. Roughly half of the increase in varieties is caused by an increase in the number of products, the other half resulting from an increase in origin countries.

The authors find that consumers have a low elasticity of substitution across similar goods produced in different countries, yet at the same time the welfare gains due to increase product diversity seem small. Using their elasticities of substitution, they calculate an exact import-price index (one that accounts for the increase in varieties) and show that it is 28% lower than the conventionally measured one. This is large, but assuming an economic structure as in Krugman (1980), they show that consumers are willing to spend only 2.6% of their income to have access to these extra varieties; put differently, U.S. welfare is 2.6 percent higher than otherwise due to the import of new varieties.

Using Indian data, Goldberg et al. (2008) find that lower input tariffs

reduced the conventional import price index of intermediate inputs by reducing the price of existing imported inputs, but also reduced the *exact* price index by adding new varieties; as a result, the exact price index is a modest 4.7% lower that the conventional one on average.

A rise in diversification of import may also lead to productivity gains through "import competition". As a country import new products from abroad, local producers of close substitute have to shape up in order to stay competitive. Productivity increase through this competitive effect but also though rationalization as less productive firms are forced to exit. For example, using Chilean data for 1979-1986, Pavcnik (2002) shows that following trade liberalization productivity of plants in the import competing sector increased by 3 to 10 % more than in other sector of the economy. She finds evidence of both an increase in productivity within plants and a reallocation of resources from the less to the most efficient producers. Other studies on developing countries include Levinsohn (1993) for Turkey, Harrison (1994) for Ivory Coast, Tybout and Westbrook (1995) for Mexico and Krishna, Mitra (1998) for India or Fernandes (2007) for Columbia. All these papers find a positive effect of increased import competition on domestic productivity. Trefler (2004) shows that Canadian plants labor productivity increased by 14% following the Canada-U.S. Free trade agreement. It also provides industry level evidence for those industries that experience the biggest decline in tariffs. Productivity increases by 15% (half of this coming from rationalization) while employment decreases by 12% (5% for manufacturing as a whole). This paper is one of the few to consider both the impact on productivity and on employment of lower tariffs trough more diversified imports. As stated in the paper, it points out the issue of adjustment costs which encompasses unemployment and displaced workers in the short run. It is worth mentioning that Trefler finds a rise in aggregate welfare.

Another strand of literature focuses on gains from increasing varieties of imported inputs. In such case, most gain is measured in term of productivity growth realized through lower input prices, access to higher quality of inputs and access to new technologies embodied in the imported varieties. Early models from Ethier (1982), Markusen (1989) or Grossman and Helpman (1991) provide such evidence. Increase import of input may also impact the labor market as varieties produced abroad may substitute for local labor or/and may require specific labor skills in order to be processed. The next sections provide empirical findings on these features, studying in turn the effect of increased import diversification on productivity, employment and inequalities.

6.2 Imported inputs: productivity, employment and more.

As evidence in Hummels et al. (2001), Yi (2003) or Strauss-Kahn (2004) the share of imported inputs in production has increase drastically over the past 30 years (e.g., Hummels et al. finds an increase of 40% between 1970 and 1995). Amador and Cabral (2009) shows that this phenomenon is not specific to developed countries but also concerns developing countries such as Malaysia, Singapore or China. This recent pattern of trade reflects the increased ability of firms to "slice the value chain" and locate different stages of production in different countries thanks to reduced transportation and communication costs. Micro-level studies, as the one listed below, also provide evidence of such an increase in the use of imported intermediate good and henceforth of an increased diversification in imported inputs. For example, Goldberg et al. finds that imported inputs increased by 227% from1987 to 2000 in India while imported final goods rose by 90% over the period. How does this increased diversification impact the domestic economy? Does it entail technological transfer and productivity growth? What is its impact on employment and exports? These are the questions we now address.

How do intermediate goods affect productivity? Halpern at al. (2009) suggest two mechanisms: access to higher quality and better complementarity of inputs. The complementarity channel encompasses elements of gains from varieties and of learning spillovers between foreign and domestic goods. Variety gains come from imperfect substitution across goods, as in the love-of-variety setting of Krugman (1979) and Ethier (1982) and as evidence by Broda and Weinstein (2006). Technological spillovers occur as producers of final goods learn from the technology embodied in the intermediate goods through careful study of the imported product (the blueprint) (Keller (2004)).

Several studies have analyzed the effect of an increase in imported inputs on productivity. Coe and Helpman (1995) and Coe et al. (1997) find that foreign knowledge embodied in imported inputs from countries with larger R&D stocks has a positive effect on aggregate total factor productivity. Keller (2002) shows that trade in differentiated intermediate goods is a significant channel of technology diffusion. He finds that about 20% of the productivity of a domestic industry can be attributed to foreign R&D, accessed through imports of intermediate goods. Using plant level data for Indonesia for 1991 to 2001, Amiti and Konings (2007) disentangle the impact of a fall in tariff on output from a fall in tariff on inputs. They find that a decrease in inputs tariffs of 10 percentage point increases

productivity by 12% in importing firms whereas non-importing firms benefit only by 3% suggesting productivity gains through technology effect embodied in the imported inputs rather than trough import price effect. [12] Similarly, Kasahara, and Rodrigue (2008) uses Chilean manufacturing plants data from 1979 to 1996 and find a positive and immediate impact of increased use of imported inputs on importers productivity. They also provide some evidence of learning by importing (i.e., past import positively impact current productivity). Muendler (2004) does not find however a substantial impact of increased use of imported inputs on productivity for Brazil in the early 1990s. Loof, H. and M. Anderson (2008) uses a database of Swedish manufacturing firms over an eight-year period (1997-2204) and finds that the distribution of imports across different origin countries matters (i.e., productivity is increasing in the G7-fraction of total import). By and large, empirical studies thus evidence that diversification of imported inputs increases the productivity of domestic firms.

As mentioned above this increase in productivity may occur through several channels: increased quality and/or complementarity. Very few papers to date analyze the relative contribution of these mechanisms. A notable exception is Halpern at al. (2009). The authors use a panel of Hungarian firms from 1992 to 2003 to examine the quality and variety channel (imported inputs are assumed imperfect substitutes to domestic inputs), through which imports can affect firm productivity. [13] They find that imports lead to significant productivity gains, of which two thirds are attributed to the complementarity argument and the remainder to the quality argument. Obviously, these two mechanisms have different implications on the economy. When quality is important, an increase in imported inputs entails large import substitution, hurting domestic intermediate good producers and thereby employment. By contrast, when complementarities matter, an increase in imported inputs affects the demand for domestic goods much less, because they must be combined with foreign goods to maximize output. Thus employment is barely impacted.

Diversification in imports of intermediate goods may also affect the number of good produced domestically (diversification in production) and exported

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[12] Interestingly, the effect of a decrease in input tariffs is much larger (more than twice as large) than the one found with a decrease in output tariffs.
[13] Their model includes a term related to the number of intermediate imported goods in the production function which reflects the complementarity channel.

(diversification in exports). Kasahara and Lapham (2006) extend Melitz model to incorporate imported intermediate goods. In their model, productivity gains from importing intermediates (through the increasing returns to variety in production) may allow some importers to start exporting. Importantly, because import and export are complementary, import protection acts as export destruction. Goldberg et al. (2008) shows that imports of new varieties of inputs lead to a substantial increase in the number of domestic varieties produced. The paper provides evidence that the growth in product scope results from the access to new varieties of imported inputs rather than the decrease in the import price index for intermediate products.

The literature thus provides strong evidence that an increase in the import of intermediate goods boosts productivity. This growth in productivity is a direct consequence of the rise in the number of varieties of imported inputs trough the channels of a better complementarity with domestic varieties and of learning effect of foreign technology. The increase diversification in imported inputs also entails an increase in the number of domestic varieties produced and exported. It therefore impacts greatly the economic activity. Concerning the effect of increase diversification on employment, the evidence is scarce. As far as we know, no study analyzes the impact of imported inputs diversification on the labor market. Productivity in most studies is measure as total factor productivity and is therefore X-neutral (no impact on employment trough variation of the input mix). Moreover, if domestic and foreign intermediate goods are not perfectly substitute, as shown in several studies, higher diversification of imported inputs should not affect the aggregate level of employment.

More generally one may wonder how productivity gains affect employment. Unfortunately and as common in the literature, there is no clear cut answer to this question. Gali (1999)'s seminal work finds that productivity gains resulting from positive technology shocks reduced hours worked for the US and several other G7 countries except for Japan. While these findings were reinforced by consecutive studies (e.g., Gali(2004), Basu et al. (2006) or Francis and Ramey (2005)), other studies have challenged these views, primarily on methodological grounds, finding positive correlations of hours worked with technology shocks. These studies include Christiano et al. (2003), Uhlig (2004) and Chang and Hong (2006). In a nutshell and apart from the different specifications used in the papers, the impact on employment seems to depend on whether labor productivity or total factor productivity (TFP) is considered, and on the time lag (i.e., short run and long run effect differ). It also varies widely across industries (see Chang and Hong (2006)). In the long run the positive effect of productivity gains on

employment seems predominant (e.g., this result is also found in the pro-contractionary paper of Basu et al. (2006)). Concerning the measure of productivity, a negative correlation between increased labor productivity and hours worked is common to most studies. As explained in Chang and Hong (2006), labor productivity reflects change in input mix as well as improved efficiency. Thus changes in input prices affecting the material-labor ratio increases labor productivity whereas TFP is unchanged. How can we use this information in our context? As seen above, the increased diversification of imports affects productivity mostly through the channels of better complementarity and learning spillovers. The channel of decreased intermediate inputs prices leading to increased labor productivity and consequently decreased employment is far less important.

6.3 Skilled labor and absorptive capacities

It is however likely that the benefit of higher productivity accrue to the countries/industries which present a significant level of absorptive capacities. Human capital and spending in R&D stands out as the main absorptive capacities in term of adoption and integration of foreign technologies into domestic production process (see Keller (2004) or Eaton and Kortum (1996) for early work on the topic). Using a database of 22 manufacturing industries in 17 countries for the 1973-2002 period, Acharya and Keller (2007) shows that import is a major channel of international technology transfer and finds that some countries benefit more from foreign technology than others. As asserted by the authors, such finding suggests an important difference in absorptive capacity. On the same token, Serti and Tomasi (2008) finds than importers sourcing from developed countries are more capital and skilled intensive than firms buying only from developing countries. This may reflect the importance of absorptive capacities or may be a consequence of "learning by importing".

One important paper on the topic is Augier et al. (2009). This paper not only evaluates the impact of increased imports on firms' productivity but it also explores the importance of firms absorptive capacity in firms abilities to capture technologies embodied in foreign imports. Importantly, the paper considers imported inputs but also imports in capital equipment which represents another channel through which technology may spill. Augier et al. (2009) uses a panel of Spanish firm from 1991 to 2002 which includes information on the proportion of skilled labor per firms. As mentioned above, such variables may proxy for absorptive capacities. Firms with a share of skilled labor 10% above the average experience a productivity gain of 9 percentage points in the first two years after they

start importing and of 7 percentage points in the following year. As these results are much higher than the one found with lower skilled-labor-intensive firms, firms heterogeneity in absorptive capacities seems to affect greatly the contribution of imported input and equipment in increasing productivity.

Although more research exploring the role of absorptive capacity in capturing technology embodied in new imported varieties is needed (looking for example at the role of R&D spending, the quality of infrastructures or institutions), there exist some evidence that skilled labor is a necessary requirement for technology transfer. The positive impact of the diversification of imports seems hence conditional on the absorptive capacities of a country or industry.

6.4 Offshoring and wages

Finally, rising intermediate imports may impact income inequality between skilled and unskilled workers if it reflects a substitution of domestic labor by foreign labor for cost purposes. A first wave of studies considering this issue focused on manufacturing firms. It included Feenstra and Hanson (1996, 1999) for the US, Egger and Egger (2003) for Austria, Hijzen, et al. (2005) for the UK or Strauss-Kahn (2004) for France. These papers investigated the impact of rising intermediate imports on the relative demand for skilled vs. unskilled workers and the skill premium. All evidenced that international sourcing had a large and significant impact on relative wages and/or employment, the growth in imported inputs accounting for 11% to 30% of the observed increase in the skill premium.

A more recent literature has looked at service offshoring, a new feature of international trade. Amiti and Wei (2006) show that imported service inputs from U.S. manufacturing firms have grown at a annual rate of 6% over 1992-2000, but they find little impact on employment. This might be because (i) their measure of employment is too broad, as sourcing in services may affect the less-skilled workers among the skilled, and (ii) in countries with relatively flexible labor markets like the U.S. or U.K., the bulk of the adjustment is on wages rather than employment. Indeed, using household-level panel data combined with industry level data on imported services inputs over 1992-2004, Geishecker and Gorg (2008) found a positive impact of service outsourcing on the skill premium.

How does the increase in imported inputs by developed countries affect inequalities in the developing world? Traditional Heckscher-Ohlin trade theory and its corollary (the Stolper-Samuelson theorem) posits that

developed countries import goods that are relatively intensive in factors they do not have abundantly (i.e., imports are relatively unskilled intensive). This should benefit unskilled workers in the exporting developing country relative to skilled workers. Thus inequalities in developing countries should decrease. However, most of the empirical evidence goes the other way (see e.g. Arbache et al. (2004) for Brazil, Attanasio et al. (2004) for Colombia, Berman and Machin (2000) for 14 low- and middle-income countries, Gorg and Strobl (2002) for Ghana, Hanson and Harrison (1999) for Mexico, or Robbins and Gindling (1999) for Costa Rica). Several channels have been proposed to explain the increased wage gap in developing countries. Feenstra and Hanson (1996, 1997) as well as Zhu and Trefler (2005) explain that products characterized as unskilled-intensive by developed countries may appear skilled-intensive from a developing countries perspective, hence increasing the relative demand for skilled labor. Similarly, Xu (2003) shows that by expanding a developing country's export set trade can raise wage inequality. Other studies (e.g., Yeaple (2005) or Verhoogen (2008)) argue that exporting to developed countries entail quality upgrading and adoption of new technologies that could explain the increase demand in skilled labor and increase wage inequality in developing countries. Thus by and large the increased diversification in imported inputs by developed countries entails an increase in inequality between skilled and unskilled workers in the developing world. One comments and a policy recommendation still have to be made. First, the increased inequality in developing countries can also be widely attributed to skilled-bias technological change (e.g., personal computers, automated assembly lines, and so on) that touches the developed as well as developing countries (although mainly through international transfer of technology for the latter) and allows important productivity gains. Policy wise, investment in education seems primordial in order to create sufficient skilled labor supply and thereby reduce the skilled wage gap widening.

7. Conclusions and policy implications

To sum up: Poor countries have, on average, undiversified exports. As they grow, they diversify, then re-concentrate at high income levels. The extensive margin (new products) dominates the action in terms of diversification, but the intensive margin (higher volumes) dominates the action in terms of export growth. Thus, if governments are ultimately interested in export (and employment) growth, the intensive margin appears as a better bet. The reason is that there is enormous churning, so that many of today's new products are tomorrow's failed products.

The direction of causation between income and diversification is unclear, perhaps because of the observation just outlined—namely, that diversification is driven by the extensive margin whereas growth is driven by the intensive margin. Even seemingly well-established 'stylized facts' liming concentration to growth, like the natural-resource curse (a negative correlation between the importance of natural resources in a country's wealth and its subsequent growth), do not appear very robust. Thus, diversification and growth appear to be distinct objectives.

One would wish that the enormous amount of attention that export diversification has attracted, both theoretically and empirically, would naturally lead to robust policy prescriptions, for which developing countries are hungry. Unfortunately, how best to achieve export diversification, and how it should rank in the list of government priorities, are still very much open questions—part of a wider debate on the usefulness of industrial policy.

In spite of the many open questions, a few remarks emerge from the literature as it stands today. First, we find that trade liberalization, which might have been expected to lead to concentration on a country's comparative-advantage sectors, statistically correlates with export *diversification* at both the intensive and extensive margin.

As for targeted industrial policy, as Easterly et al. (2009) show, the probability of a big hit decreases exponentially with its size, making "picking winners" a lottery game. What industrial planner would have dreamt of advising the Egyptian government to target the Italian market for "ceramic bathroom kitchen sanitary items, not porcelain"? We know very little about the channels by which producers of that product got informed of the market opportunities.

Who is best positioned, of the market or government, to identify potential "big hits"? One traditional argument in favor of industrial policy is that the government is better placed than the market to overcome market failures (say in the search for information). But the market compensates for this by its ability to generate an endless stream of gamblers, each trying his luck in a particular niche. Besedes and Prusa's work (see e.g. Besedes and Prusa 2008 and references therein) shows the importance of this trial-and-error process by the very low survival rate of "export spells" (by which they mean periods of uninterrupted exports in one product between two countries).

Recent work on African exports using firm-level data (Iacovone et al. 2010) provides empirical support to the idea that there are agglomeration externalities in export. This suggests that export promotion by the

government may be useful to overcome collective-action problems. Indeed, Volpe and Carballo (2008, 2010) find that export promotion has a statistically traceable effect on the export performance of targeted firms. Thus, the new firm-level evidence seems rather supportive of the idea that government intervention can help—although with two caveats. First, the evidence suggests that export promotion works better at the intensive margin than at the extensive one. That is, the rate of growth of the exports of "assisted" firms is higher than that of non-assisted firms (although by a small margin) but the rate at which new products are introduced is unaffected. This does not square well with the conjecture that government intervention can mitigate market failures in "export entrepreneurship". Second, the intervention studied by Volpe and Carballo is more like a "little push" than a big one.

Third, the export-diversification literature has focused largely on the *what* is produced rather than on the *how* it is produced. Yet Acemoglu and Zilibotti (2000) developed a model highlighting differences in production methods, themselves driven by differences in the availability of skilled labor. Their work highlights that technologies developed in the North are typically tailored to the needs of a skilled workforce and therefore inappropriate for skill-scarce countries. This implies that policy advice based on reasoning à la Hausmann, Hwang and Rodrik (export what rich countries export, and you will become rich) may be simply missing a traditional determinant of trade patterns—factor endowments. If countries do not have the capabilities to master the tacit knowledge needed to produce sophisticated goods, no industrial policy will make them successful exporters. The most sensible policies are then supply-side ones, like the one India followed for years when it gradually built a world-class network of technology institutes.

As a last remark, although one aim of the export-diversification literature is, ultimately, to generate useful policy advice for developing countries, it sweeps under the carpet an important historical regularity. Practically all latecomers in the industrial revolution, in particular the big ones—France in the early XIXth century, Japan under the Meiji, Germany at the turn of the XXth century, China today, to name but a few—have been aggressive imitators of the technology of more advanced economic powers. All those countries expanded their basket of exports by plundering technology, sometimes (often) with government assistance and with little regard for intellectual property. This process was badly received in advanced countries, but it was a major driver of the diffusion of the Industrial Revolution. We don't know much about the policies that were put in place in the catching-up countries, and the literature has been largely silent on

this. No wonder: intellectual-property enforcement is now widely taken as one of the basic good-governance prerequisites for development, and encroachments on the intellectual property of advanced countries are now fought more vigorously than ever before. But for countries that were yesterday's imitators, this might well be a modern version of List's famous expression, "kicking away the ladder".

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8. Technical Appendices

8.1 Overall indices

8.1.1 Herfindhal, Gini and Theil

For a given country and year (but omitting country and time subscripts), the Herfindahl index of export concentration, normalized to range between zero and one, is given by the following formula:

$$H = \frac{\sum_{k=1}^{n} (s_k)^2 - 1/n}{1 - 1/n}$$

where $s_k = x_k / \sum_{k=1}^{n} x_k$ is the share of export line *k* (with amount exported x_k) in total exports and *n* is the number of export lines.

As for the Gini index, several equivalent definitions have been used in the literature, among which one of the simplest can be calculated by first ordering export items (at the appropriate level of aggregation) by increasing size (or share) and calculating cumulative export shares $X_k = \sum_{l=1}^{k} s_l$. The Gini coefficient is then

$$G = 1 - \sum_{k=1}^{n} (X_k - X_{k-1}) / n \quad .$$

Finally, Theil's entropy index (Theil 1972) is given by

$$T = \frac{1}{n} \sum_{k=1}^{n} \frac{x_k}{\mu} \ln\left(\frac{x_k}{\mu}\right) \quad \textit{where} \quad \mu = \frac{\sum_{k=1}^{n} x_k}{n} \quad .$$

8.1.2 Theil decomposition

Let *n* be the notional number of export products (the 5'016 lines of the HS6 nomenclature), n_j the number of export lines in group *j*, μ the average

dollar export value, μ_j group *j*'s average dollar export value, and x_k the dollar value of export line *k*. The between-groups component is

$$T^B = \sum_{j=0}^{1} \frac{n_j}{n} \frac{\mu_j}{\mu} \ln\left(\frac{\mu_j}{\mu}\right) \tag{4}$$

and the within-groups component is

$$\begin{aligned} T^W &= \sum_{j=0}^{1} \frac{n_j}{n} \frac{\mu_j}{\mu} T^j \\ &= \sum_{j=0}^{1} \frac{n_j}{n} \frac{\mu_j}{\mu} \left[\frac{1}{n_j} \sum_{k \in j} \frac{x_k}{\mu_j} \ln\left(\frac{x_k}{\mu_j}\right) \right] \end{aligned} \tag{5}$$

where T^j stands for Theil's sub-index for group *j* = 0,1. It is easily verified that $T^W + T^B = T$.

8.2 the intensive and extensive margins

8.2.1 Theil decomposition

Let the *n* lines of the HS6 nomenclature be partition into two groups *i* = 0,1 where group one is made of active export lines for this country and year, and group "zero" is made of inactive export lines. The Theil index is then decomposed as in 8.1.2. Note however that the between-groups sub-index is not defined since $\mu_0 = 0$ and expression (1) contains a logarithm. Thus, we have to take a limit. By L'Hôpital's rule,

$$\lim_{\mu_0 \to 0} \left[\frac{\mu_0}{\mu} \ln\left(\frac{\mu_0}{\mu}\right) \right] = 0 \tag{6}$$

so, based on our partition

$$\lim_{\mu_0 \to 0} T^B = \frac{n_1}{n} \frac{\mu_1}{\mu} \ln\left(\frac{\mu_1}{\mu}\right). \tag{7}$$

As $\mu_1 = (1/n_1)\sum_{k \in G_1} x_k$, $\mu = (1/n)\sum_k x_k$ and, by construction, $\sum_{k \in G_1} x_k = \sum_k x_k$, it follows that

$$\lim_{\mu_0 \to 0} T^B = \ln\left(\frac{n}{n_1}\right).$$

(8)

and, as n is fixed,

$$\lim_{\mu_0 \to 0} \Delta T^B = \Delta n_1 \qquad (9)$$

where Δ denote a period-to-period change. That is, given our partition, the between-groups component measures changes at the extensive margin.

As for the "within-groups" component, it is a weighted average of terms combining group-specific means and group-specific Theil indices T^j. In group G_0 (inactive lines), again $\mu_0 = T^0 = 0$; so, in our case, T^W reduces to T^1, the group Theil index for active lines. Thus, given our partition, changes in the within-groups Theil index measure changes at the intensive margin.

8.2.2 Hummels and Klenow margins

Let x_k^i be the value of country *i*'s exports of good *k* and x_k^W the world's exports of that good; let also G_1^i stand for the group of country i's active export lines. The intensive margin (IM^i) and extensive margin (EM^i), for country *i*, are defined as

$$IM^i = \frac{\sum_{k \in G_1^i} x_k^i}{\sum_{k \in G_1^i} x_k^W}; \qquad EM^i = \frac{\sum_{k \in G_1^i} x_k^W}{\sum_{k=1}^m x_k^W}.$$

8.3 Brenton and Newfarmer margins

Let again G_1^i be the set of goods exported by country *i* to any destination, G_1^{ij} be the set of goods exported by *i* to destination country *j*, and M_1^j the set of goods imported by destination country *j* from any origin. Based on these groups, define binary variables

$$g_k^{ij} = \begin{cases} 1 & \text{if } k \in G_1^{ij} \\ 0 & \text{otherwise} \end{cases}$$

and

$$m_k^j = \begin{cases} 1 & \text{if } k \in M_1^j \\ 0 & \text{otherwise.} \end{cases}$$

Brenton and Newfarmer's index for country *i* is then

$$IEMP_i = \frac{\sum_{k \in G_1^i} g_k^{ij}}{\sum_{k \in G_1^i} m_k^j}.$$

Table A1
Countries in the sample

Countries (134)	Date of trade Liberalization (1950-2001)	Export Theil index (1988-2006)	Countries (134)	Date of trade Liberalization (1950-2001)	Export Theil index (1988-2006)
Angola	closed	8.18	Ecuador	1991	6.02
Albania	1992	4.60	Egypt, Arab Rep.	1995	4.69
Argentina	1991	3.58	Spain	1959	2.13
Armenia	1995	5.43	Estonia	closed	3.24
Australia	1964	3.60	Ethiopia	1996	6.33
Austria	1960	1.88	Finland	1960	3.00
Azerbaijan	1995	6.28	France	1959	1.95
Burundi	1999	7.36	Gabon	closed	7.56
Belgium	1959	2.20	United Kingdom	Always	2.15
Benin	1990	6.90	Georgia	1996	4.74
Burkina Faso	1998	6.87	Ghana	1985	5.73
Bangladesh	1996	4.68	Guinea	1986	6.97
Bulgaria	1991	2.76	Gambia, The	1985	6.26
Belarus	closed	4.01	Guinea-Bissau	1987	6.98
Bolivia	1985	5.21	Greece	1959	2.89
Brazil	1991	3.11	Guatemala	1988	4.45
Botswana	1979	7.34	Guyana	1988	6.10
Central African Republic	closed	6.66	Hong Kong, Chin	Always	2.56
Canada	1952	3.15	Honduras	1991	4.84
Switzerland	Always	2.32	Croatia	closed	2.74
Chile	1976	4.57	Haiti	closed	5.08
China	closed	2.17	Hungary	1990	2.55
Cote d'Ivoire	1994	5.63	Indonesia	1970	3.71
Cameroon	1993	6.22	India	closed	2.98
Congo, Rep.	closed	7.45	Ireland	1966	3.63
Colombia	1986	4.88	Iran, Islamic Rep	closed	7.45
Cape Verde	1991	5.77	Iceland	closed	5.12
Costa Rica	1986	4.97	Israel	1985	3.78
Cyprus	1960	3.71	Italy	1959	1.56
Czech Republic	1991	2.04	Jamaica	1989	5.92
Germany	1959	1.71	Jordan	1965	4.85
Denmark	1959	2.22	Japan	1964	2.47
Dominican Republic	1992	4.65	Kazakhstan	closed	5.16
Algeria	closed	6.98	Kenya	1993	4.73

Table A1 (cont'd)

Countries (134)	Date of trade Liberalization (1950-2001)	Export Theil index (1988-2006)	Countries (134)	Date of trade Liberalization (1950-2001)	Export Theil index (1988-2006)
Kyrgyz Republic	1994	4.81	Paraguay	1989	5.70
Korea, Rep.	1968	2.71	Romania	1992	2.93
Liberia	closed	6.72	Russian Ferderat	closed	4.34
Sri Lanka	1991	3.58	Rwanda	closed	7.26
Lesotho	closed	6.10	Senegal	closed	5.07
Lituania	1993	3.37	Singapore	1965	3.66
Luxembourg	1959	3.20	Sierra Leone	2001	5.98
Latvia	1993	3.99	El Salvador	1989	4.72
Morocco	1984	3.82	Slovak Republic	1991	2.67
Moldova	1994	4.08	Slovenia	1991	2.39
Madagascar	1996	5.11	Sweden	1960	2.39
Mexico	1986	3.51	Swaziland	closed	4.64
Macedonia, FYR	1994	3.43	Syrian Arab Repu	closed	6.57
Mali	1988	7.22	Chad	closed	7.83
Mozambique	1995	5.74	Togo	closed	6.00
Mauritania	1995	6.73	Thailand	Always	2.91
Mauritius	1968	4.93	Tajikistan	1996	6.29
Malawi	closed	6.68	Turkmenistan	closed	7.23
Malaysia	1963	3.64	Trinidad and Tob	1992	5.72
Niger	1994	6.64	Tunisia	1989	3.83
Nigeria	closed	7.99	Turkey	1989	2.73
Nicaragua	1991	5.20	Tanzania	1995	5.09
Netherlands	1959	2.00	Uganda	1988	6.74
Norway	Always	4.60	Ukraine	closed	3.16
Nepal	1991	5.27	Uruguay	1990	3.73
New Zealand	1986	3.26	United States	Always	1.97
Pakistan	2001	3.81	Uzbekistan	closed	5.98
Panama	1996	4.25	Venezuela	1996	6.27
Peru	1991	4.60	Yemen, Rep.	Always	7.91
Philippines	1988	4.06	South Africa	1991	3.41
Papua New Guine	closed	6.33	Congo, Dem. Rep	closed	6.43
Poland	1990	2.36	Zambia	1993	6.58
Portugal	Always	2.73	Zimbabwe	closed	4.80