Tools for applied trade-policy analysis :
An introduction

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Abstract

This paper provides a non-technical introduction to some of the issues faced by a beginner trade-policy analyst: where to find data, how to calculate descriptive indices, what are the practical difficulties involved in measurement and calculation, how to perform simple statistical analyses of the effect of trade policies on domestic incomes, and how to approach ex-ante simulation analysis. Throughout the paper, we keep the level of exposition at a level that is accessible to a reader trained in economics but with limited proficiency in formal theory and econometrics. The last part of the paper, which describes Computable General Equilibrium (CGE) analysis, is not meant to enable the reader to perform such analysis but rather to read existing simulation results and understand what to look for.

1. Introduction

Not so long ago, the analysis of trade policy required not just a sound knowledge of theory and analytical tools, but also familiarity with cranky software and a willingness to replace missing data with heroic assumptions. The picture has changed drastically over the last quarter-century. The availability and quality of trade statistics has improved under the combined effort of researchers and statisticians at UNCTAD, the World Bank, and others institutions. Software has also become more user-friendly, making the calculation of complex indices easy even with minimal computing skills.

Thus, there is no excuse anymore for staying away from formal analysis, whether it be calculating descriptive indices or estimating statistical relationships. This paper presents a palette of tools which, taken together, enable the analyst to produce a rigorous yet "readable" picture of the policy-relevant features of a country's trade and of the consequences of trade-policy choices. All these tools have been proposed and explained in the literature. For instance, Michaely (1996), Yeats (1997), Brulhart (2002), Hummels and Klenow (2005), Hausmann, Hwang, and Rodrik (2005), Shihotori, Tumurchudur and Cadot (2010), or Cadot, Carrère and Strauss-Kahn (forthcoming) discussed the indices presented in Section 2 of this paper. Kee et al. (2004, 2006) discuss in detail the construction of trade restrictiveness indices discussed in section 3. The gravity equation has been discussed in too many papers and contexts to be counted here. The collection of essays in Francois and Reinert (1997) give a thorough analytical discussion of the ex-ante simulation tools presented in Section 4, and Jammes and Olarreaga (2006) discuss the World Bank's SMART model. But most of these readings remain difficult and leave a gap between the needs of a theoretical or classroom discussion and those of the practitioner.

This paper intends to fill some of this gap by discussing practical data and implementation issues for the most widely used among those tools. Starting with the simplest descriptive methods, we will move progressively to more analytical ones, but always keeping the exposition at a level comprehensible to the non-academic practitioner. The last part of the paper, devoted to ex-ante simulation analysis (in partial and general equilibrium), however, remains difficult. The construction of simulation models requires advanced mastery of both economic theory and appropriate programming languages such as GAMS and remains largely beyond the capability of the beginning analyst, although specialized training programs are regularly given around the world. The models are inherently complex and sensitive to assumptions, making mistakes and misinterpretations easy. Thus, our aim in that part of the paper is limited: essentially, to enable the reader to get a feel for how these models are

constructed, and to be in a better position to understand what can be asked from those models and what cannot.

Given the space limitations of a survey paper, there is necessarily a trade-off between depth and breadth. We have chosen to err on the "depth" side, not by going into deep discussions of the underlying concepts −those can be found in the original papers and in standard trade textbooks− but rather by discussing practical implementation issues of relevance to the novice practitioner. The price to pay for this is that we had to limit the number of indices and approaches we cover.

The paper is organized as follows. Section 2 discusses how to present a panorama of a country's trade performance, and how to present standard measures of its trade-policy stance. Section 3 presents some of the econometric techniques that can be used to assess, ex post, the effect of trade policies on trade flows and the domestic economy. Section 4 presents some of the tools used in the ex-ante assessment of trade policy, first in partial equilibrium settings, then in general-equilibrium ones. Section 5 concludes.

2. Analyzing trade flows & policy: descriptive tools

2.1 Trade flows

2.1.1. Data

The first issue the analyst must deal with is the data. What database is appropriate depends on whether the analysis is to be performed at the aggregated (total) level or at the disaggregated one (by commodity). In the former case, the IMF's Direction of Trade Statistics (DOTS) is the right source. In the latter case, it should be UNCTAD's COMTRADE database. COMTRADE is much more voluminous than the DOTS because it contains data on bilateral trade between all countries in the UN system for over 5'000 commodities.[1]

Next, if dealing with disaggregated data, the analyst must choose between several classification systems. First and foremost is the Harmonized System (HS) in which all countries report their trade data to COMTRADE. Under revision in 2007, the HS system has four levels: 21 sections, 99 chapters (also called "HS2"

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[1] The DOTS are available on CD ROM by subscription for a moderate price. COMTRADE is available only online, either through the World Bank's WITS gateway or directly, but in any case by subscription, for a price that is considerably higher than the DOTS.

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because chapters are coded in two-digit codes from 01 to 99), 1'243 headings (HS4) and 5'052 sub-headings (HS6). More disaggregated levels (HS8 and HS10) are not harmonized and need considerable cleaning up before use.[2] As is well known, at high levels of disaggregation (in particular HS6), the HS system has the peculiarity that it is very detailed for some sectors like textile and clothing, but much less so for others like machinery. As a result, the economic importance of subheadings can very considerably and care should be exercised when using simple averages (more below). However this oft-mentioned bias should not be overstated: as Figure 1 shows, the share of each HS section in the total number of HS6 lines is highly correlated with its share in world trade.

Figure 1
HS sections shares in HS6 lines and in world trade
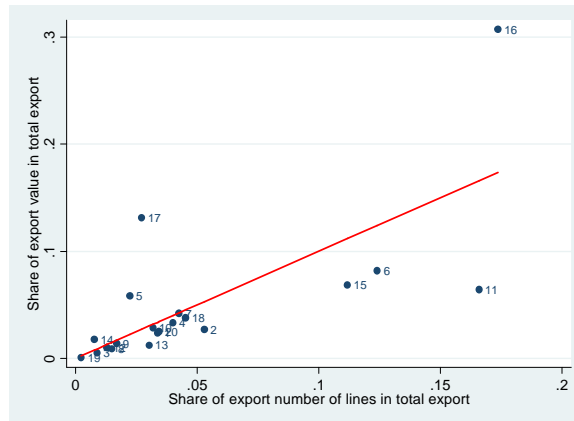
Notes: 131 countries, average 1988-2004. Section 11 is textile & apparel, section 16 is machinery, section 17 is transport equipment.

The main alternative classification system is the SITC Rev. 4 (adopted in 2006) which has 5 levels of disaggregation, also by increasing number of digits. Although SITC subgroups (4 digits) number about as many (1'023) as HS4 headings, they don't match perfectly, so concordance tables must be used (see Annex II.5 of United Nations 2006). Whether the HS or the SITC should be used is largely governed by the type of data to which raw trade numbers are to be matched in the analysis. If it is confined to pure trade analysis, the choice is inconsequential. More importantly, a number of classifications exist in which goods are classified under different logics. For instance, the UN has devised "Broad Economic Categories" (BEC) by end use: capital goods (01), raw materials

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[2] For the EU, Eurostats provides HS 8 data on its COMEXT CD ROM, but frequent reclassifications require considerable caution in use. HS 10 data is available only internally. For the US, the NBER provides a clean HS 10 database compiled by Robert Feenstra and updated by Feenstra, John Romalis and Jeffrey Schott.

(02), semi-finished goods (03), and final ones (04). This classification is useful for instance to assess "tariff escalation" (higher tariffs on final goods than on other categories, a practice that is used to protect domestic downstream transformation activities and is frequent in developing countries). James Rauch devised a alternative classification of goods according to their degree of differentiation, from homogenous to reference-priced to fully differentiated.[3] The former uses HS codes, the latter SITC ones. Rauch's classification is useful for many purposes; for instance, competition is likely to take different forms on homogenous vs. differentiated-good markets (price-based for the first, quality, service or technology-based for the second).

2.1.2 Measurement

One might think that trade flows are about the easiest thing to measure since merchandises must be cleared at customs. Unfortunately, the statistics that measure them are surprisingly erratic. Country A's measured imports from B seldom match B's measured exports to A, and the latter are typically reported with large errors because customs do not monitor exports very closely. Thus, whenever possible partner import data should be used in lieu of direct export data, a technique called "mirroring". Sometimes, however, and in particular for poor countries, even import data are very erratic, in which case mirroring should be used using export data from source countries. Figure 2, which shows Zambia's mirrored against direct import data at the HS6 level, illustrates the problem. Although the two are clearly correlated, the dispersion around the diagonal (along which they are equal, as they should be) is substantial. Moreover, direct data is not systematically under-estimated compared to mirror data: the bias seems to go either way.

Figure 2
Zambia's mirrored imports against direct data

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[3] Details on the BEC classification can be found in UN (2003). Rauch's classification can be found on Jon Haveman and Raymond Robertson's web page.
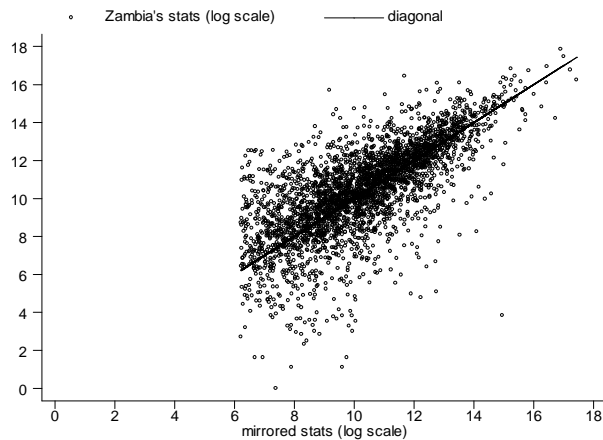
Source : Cadot et al. 2006a
Note: truncation point along horizontal axis equal to US$403'000; no partner indications for annual trade values below that threshold.

Discrepancies between importer and exporter data are reconciled in BACI, a database put together by the CEPII in Paris. However BACI trails COMTRADE with an approximate two-year lag.

In addition to trade values, COMTRADE reports trade volumes (in tons, units, etc.) from which unit values can be recovered by dividing values by volumes. Unit values can be useful e.g. to convert specific tariffs into ad-valorem ones. They are however very erratic because volumes, which are measured less precisely than values, are in the denominator. When they are under-reported by mistake, unit values can become absurdly large. In addition, unit values vary −and should vary− across countries because of composition problems. Schott (2004) showed that they are correlated with the exporter's GDP per capita, as goods exported by richer countries are likely to embody higher quality or technology even if classified under the same heading as those exported by poorer countries. They should therefore be used very cautiously.

2.2 Trade composition

The sectoral composition of a country's trade should be in the TS for two reasons. First, it may matter for growth if some sectors are growth drivers, although whether this is true or not is controversial.[4] Second, constraints to growth may be more easily identified at the sectoral level.[5] The geographical composition

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[4] See Hausmann, Hwang and Rodrik 2005.
[5] On this, see McKinsey Global Institute 2010.

highlights linkages to dynamic regions of the world (or the absence thereof) and helps to think about export-promotion interventions. It is also a useful input in the analysis of regional integration, an item of rising importance in national trade policies.

The simplest way of portraying the sectoral orientation of a country's exports is in the form of a "radar screen", as in Figure 1. When displaying a graph of that type, sectoral aggregates have to be selected carefully (more detail in the categories that matter for that country), and so has to be the scale. When one sector/product hugely dominates the picture, it will be more readable on a log scale. Log transformations are often useful to prevent outliers from obfuscating the picture.

Figure 1
Sectoral orientation of Nepal's exports

The geographical composition can be shown the same way, with the same scaling issues, or in percentages, as in Figure 2. Notice the drastic re-orientation of Nepal's exports toward India. This calls for an explanation, which we postpone to Section 3.

Figure 2
Geographical orientation of Nepal's exports, 1998 and 2008
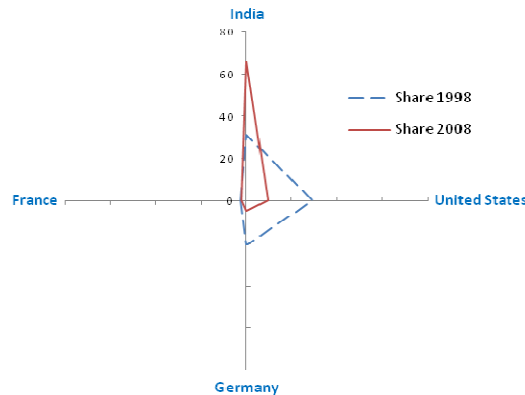
One can go a step further and assess, with a simple graph, to what extent outside demand-pull factors affect domestic trade performance. Consider the geographical version of the thing; the sectoral version goes the same way. Take all destination countries for home exports; calculate their share in total home exports, call it x, and put it in logs.[6] Next, record the growth rate of total imports

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[6] Logs will be negative because shares are less than one. That is not a problem.

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for each of those countries over the last ten years; call it y. Do a scatterplot of y against $\log(x)$ and draw the regression line. If it slopes up, larger destinations have faster import growth; the orientation is favorable. If it slopes down, as in Figure 3, larger destinations (to the right of the picture) have slower import growth; the orientation is unfavorable. In the latter case, the story may e.g. reflect a mixture of the country's location and policy choices; in Pakistan's case, proximity to slow-growing Gulf and Central Asian states combined with failure to promote trade integration with fast-growing India to produce a negative orientation.

Figure 3
Geographical orientation of Pakistan's exports
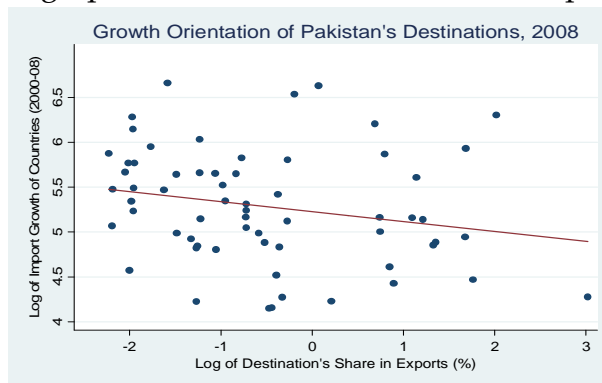
A similar scatterplot can be constructed using product shares in home export and the rate of growth of world trade in those products, or, even better, product-destination shares. A negative correlation, indicating positioning on slow-growing products, may provide a useful factual basis for discussions about whether Government resources should be used to foster growth at the extensive margin (e.g. through sector-specific fiscal incentives).

When one is interested in the convergence of trade and production patterns between a developing ("Southern") country and "Northern" trade partners, a useful indicator is Grubel and Lloyd's intra-industry trade index,

$$GL_k^{ij} = 1 - \frac{\left| X_k^{ij} - M_k^{ij} \right|}{X_k^{ij} + M_k^{ij}}$$

where, as usual X_k^{ij} is i's exports to j of good k and the bars denote absolute values. The standard interpretation of the GL index, which runs between zero (for inter-industry trade) to one (for intra-industry trade). High values of the GL index are consistent with the type of trade analyzed in, say, Krugman's monopolistic-competition model. For a developing country's trade with an

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industrial country, rising values are therefore typically associated with convergence in income levels and industrial structures.[7]

However GL indices should be interpreted cautiously. First, they rise with aggregation (i.e. they are lower when calculated at more detailed levels), so comparisons require calculations at similar levels of aggregation. More problematic, unless calculated at extremely fine degrees of disaggregation, GL indices can pick up "vertical trade", a phenomenon that has little to do with convergence and monopolistic competition. If, say, Germany export car parts (powertrains, gearboxes, braking modules) to the Czech Republic which then exports assembled cars to Germany, a GL index calculated at an aggregate level will report lots of intra-industry trade in the automobile sector between the two countries; but this is really "Heckscher-Ohlin trade" driven by lower labor costs in the Czech Republic (assembly is more labor-intensive than component manufacturing, so according to comparative advantage it should be located in the Czech Republic rather than Germany).

2.3 Margins of expansion/diversification

Export Diversification, in terms of either products or destinations, can be at the intensive margin (a more evenly spread portfolio) or at the extensive margin (more export items). Diversification is measured (inversely) by indices like Herfindahl's concentration index (the sum of the squares of the shares) or Theil's (more complicated but pre-programmed in Stata). If the indices are calculated over active export lines only, they measure concentration/diversification at the intensive margin. Diversification at the extensive margin can be measured simply by counting the number of active export lines. The first thing to observe is that, in general, diversification at both the intensive and extensive margins goes with economic development, although rich countries re-concentrate (see Figure 4).

Figure 4
Export concentration and stages of development

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[7] In this regard one may prefer to use marginal IIT indices, discussed in Brülhart (2002).

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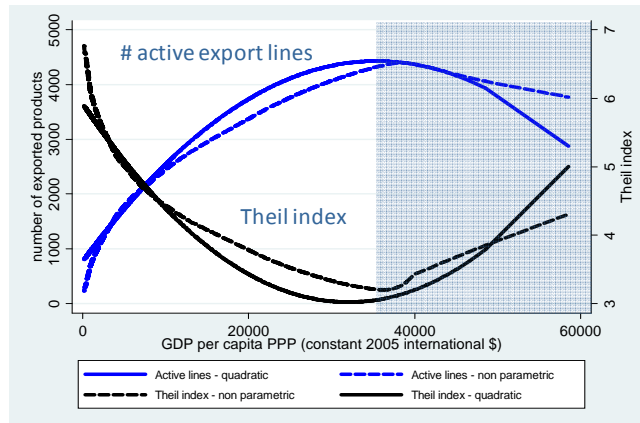
Source: Cadot, Carrere and Strauss-Kahn (forthcoming).

Whether diversification is a policy objective in itself is another matter. Sometimes big export breakthroughs can *raise* concentration, as semiconductors did for Costa Rica. Diversification is also often justified to avoid the so-called "natural resource curse" (a negative correlation between growth and the importance of natural resources in exports), but whether the curse is real or a statistical illusion has recently become a matter of controversy.[8] So one should be careful in taking diversification as a policy objective *per se*. What is clear is that, in principle, diversification reduces risk, although the concept of "export riskiness" has been relatively unexplored.[9] In addition, diversification at the extensive margin reflects "export entrepreneurship" and, in that sense, is useful evidence on the business climate.

One drawback of measuring diversification by just counting active export lines (as in Figure 4) is that whether you diversify by starting to export crude petroleum or mules, asses & hinnies is the same: you add one export line (at a given level of product disaggregation). Hummels and Klenow (2005) have proposed a variant where new export lines are weighted by their share in world trade. Then, starting to export a million dollars worth of crude counts more than starting to export a million dollar worth of asses, because the former is more important in world trade (and therefore represents a stronger expansion potential).

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[8] On export breakthroughs raising concentration, see Easterly, Resheff & Schwenkenberg (2009). On the natural-resource curse, see e.g. Brunnschweiler and Bulte (2009) and the contributions in Lederman and Maloney (2009).
[9] The World Bank is working on a concept of "export riskiness" for foodstuffs, using econometric analysis of counts of sanitary alerts at the E.U. and U.S. borders. Di Giovanni and Levchenko (2010) propose a more general measure of riskiness based on the variance-covariance matrix of sectoral value added.

Let K^i be the set of products exported by country i, X_k^i the dollar value of i's exports of product k to the world, and X_k^W the dollar value of world exports of product k. The (static) intensive margin is defined by HK as

$$IM^i = \frac{\sum_{K^i} X_k^i}{\sum_{K^i} X_k^W}$$

In words, the numerator is i's exports and the denominator is world exports of products that are in i's export portfolio. That is, IM^i is i's market share in what it exports. The extensive margin (also static) is

$$XM^i = \frac{\sum_{K^i} X_k^W}{\sum_{K^W} X_k^W}$$

where K^w is the set of all traded goods. XM^i measures the share of the products belonging to i's portfolio in world trade. Both measures are illustrated in Figure 5.

Figure 5
Evolution of intensive and extensive margins, Pakistan and Costa Rica
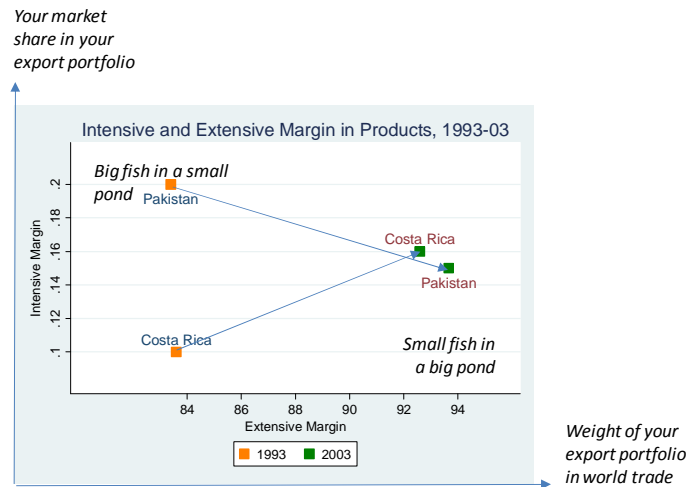
For Pakistan, the picture shows that its export portfolio was broadening during the period, but that existing exporters failed to maintain market share.

As for Costa Rica, it managed to diversify at *both* the intensive and extensive margins after Intel's investment in 1996. This may seem surprising — one would have expected the country to move from big fish in the (relatively) small pond of banana exporters to small fish in the larger pond of semiconductor exporters. Yet it became "bigger fish in a bigger pond". The reason for this paradox is simple: Costa Rica was *already* exporting semiconductors, albeit in very small quantities,

before Intel. This highlights another golden rule: Always look at the raw numbers, not just indicators. It is very easy to get puzzled or misled by indicators, and the more complicated the trickier.

Export expansion can also be defined at the intensive margin (growth in the value of existing exports), at the extensive margin (new export items, new destinations) or at the "sustainability margin" (longer survival of export spells). A useful decomposition goes as follows. Using notation already introduced, let base-year exports be

$$X_0 = \sum_{K_0} X_{k0}$$
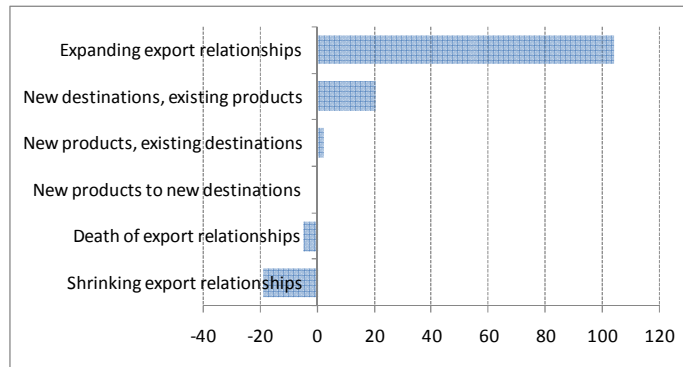
and terminal exports

$$X_1 = \sum_{K_1} X_{k1}.$$

The variation in total export value between those two years can be decomposed into

$$\Delta X = \underbrace{\sum_{K_0 \cap K_1} \Delta X}_{} + \underbrace{\sum_{K_1 \setminus K_0} X_k}_{} - \underbrace{\sum_{K_0 \setminus K_1} X_k}_{}$$

where the first term is export variation at the intensive margin, the second is the new-product margin, and the third is the "product death margin". In words, export growth can be boosted by exporting more of existing products, by more new products, or by fewer failures. Note that the new-product margin, which is conceptually equivalent to the extensive margin, is measured here by the dollar value of new exports, not by their number.

More complicated decompositions can be constructed, along the same lines, combining products and destinations. One useful fact to know is that the contribution of the new-product margin to export growth is generally small (Figure 6).

Figure 6
Decomposition of the export growth of 99 developing countries, 1995-2004

Expanding export relationships								
New destinations, existing products								
New products, existing destinations								
New products to new destinations								
Death of export relationships								
Shrinking export relationships								

Source: Brenton and Newfarmer (2009).

There are two reasons for that, one technical and one substantive. The technical one is that a product appears in the extensive margin only the first year it is exported; thereafter, it is in the intensive margin. So unless you start exporting on a huge scale the first year (unlikely) the extensive margin's contribution to overall export growth can only be small. The substantive reason is that most new exports fail shortly after they have been launched: median export spell length is about two years for developing countries. There is a lot of export entrepreneurship out there, but there is also a lot of churning in and out. Raising the sustainability of exports (which requires an understanding of the reasons for their low survival) is one under-explored margin of trade support.[10]

2.4 Export-expansion potential

Suppose that it is easier for a producer to expand into new markets with existing products than to start exporting new products. Based on this idea, Brenton and Newfarmer (2009) proposed an index of export market penetration defined, at the product level, as the share of potential destination markets that the country actually reaches (i.e. the ratio of the number of i's destination countries for product k relative to the number of countries importing product k from anywhere). This type of information is useful background for trade-promotion interventions.

When the issue is *regional* export-expansion potential (e.g. to be expected from a preferential agreement) one useful index is Michaely's bilateral trade-complementarity index (Michaely 1996). Intuitively, it is best thought of as a correlation between country A's exports *to the world* with country B's imports

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[10] The World Bank is currently exploring the causes of Africa's low export survival. Surveys highlight the unavailability of credit as a key binding constraint not just to export entrepreneurship but to the survival of existing export relationships.

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from the world. A is likely to have a comparative advantage in products it exports a lot to the world (i.e. without the help of tariff preferences); if those products are those in which B has a comparative *dis*-advantage (because it imports a lot of it), well then A and B should marry.

Formally, the TCI is not a statistical correlation but an (algebraic) indicator. Let m_k^A be product k's share in A's imports from the world and x_k^B its share in B's exports to the world; both should be at the HS6 level of disaggregation. The formula is

$$C^{AB} = 100 \left[1 - \sum_k |m_k^A - x_k^B|/2 \right]$$

and can easily be calculated in excel. The higher the index, the higher the scope for non-diversion (efficient) trade expansion between A and B. Note that there are two indices for each country pair, one taking A as exporter and one taking it as importer. Sometimes the two indices are quite different. The country in a bloc whose *import* pattern fits with its partners' exports will act as a trade engine for the bloc; the one whose *export* pattern fits with its partners' imports will benefit (in political-economy terms) from the agreement.

Table 1 shows two illustrative configurations with three goods. In panel (a), i's offer does not match j's demand as revealed by their exports and imports respectively. Note that these exports and imports are by commodity but to the world, not to each other.

Table 1
Trade complementarity indices

	Dollar amount of trade			
	country i		country j	
goods	X_k^i	M_k^i	X_k^j	M_k^j
1	0	55	108	93
2	0	0	0	0
3	23	221	35	0
Total	23	276	143	93

	Shares in each country's trade				Intermediate calculations			
	country i		country j		Cross differences		Absolute values	
goods	x_k^i	m_k^i	x_k^j	m_k^j	$m_k^j - x_k^i$	$m_k^i - x_k^j$	$|m_k^j - x_k^i|/2$	$|m_k^i - x_k^j|/2$
1	0.00	0.20	0.76	1.00	1.00	-0.56	0.50	0.28
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	1.00	0.80	0.24	0.00	-1.00	0.56	0.50	0.28
sum	*1.00*	*1.00*	*1.00*	*1.00*	*0.00*	*0.00*	*1.00*	*0.56*
Index value							*0.00*	*44.40*

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2.5 Comparative advantage

The current resurgence of interest for industrial policy sometimes confronts trade economists with demands that they are loath to respond to — providing guidance to pick winners. In general, there is little to rely on to predict the viability of an infant industry, beyond comparative advantage. But even identifying comparative advantage is tricky. The traditional measure is Balassa's Revealed Comparative Advantage (RCA) index, a ratio of product k's share in country i's exports to its share in world trade. Formally,

$$RCA_k^i = \frac{X_k^i / X^i}{X_k / X}$$

where X_k^i is country i's exports of good k, $X^i = \sum_k X_k^i$ its total exports, $X_k = \sum_i X_k^i$ world exports of good k and $X = \sum_i \sum_k X_k^i$ total world exports. An RCA over one in good (or sector) k for country i means that i has a revealed comparative advantage in that sector. RCA indices are very simple to calculate from COMTRADE and can be calculated at any degree of disaggregation. But Balassa's index simply records country i's current trade pattern; it cannot be used to say whether or not it would make sense to support a particular sector.

An alternative approach draws on the PRODY index developed by Hausmann, Hwang and Rodrik (2005). The PRODY approximates the "revealed" technology content of a product by a weighted average of the GDP per capita of the countries that export it, where the weights are the exporters' RCA indices for that product (adjusted to sum up to one). Intuitively, a product exported by high-income countries is likely to be more technology intensive than one exported by low-income countries. A recent database constructed by UNCTAD extends that notion to revealed factor intensities. Let $k^i = K^i / L^i$ be country i's stock of capital per worker, and let H^i be a proxy for its stock of human capital, say the average level of education of its workforce, in years. These are *national factor endowments*. Good j's revealed intensity in capital is

$$\kappa_j = \sum_{i^j} \omega_j^i K^i$$

Where I^j is the set of countries exporting good j and the weights ω are RCA indices adjusted to sum up to one.[11] For instance, if good j is exported essentially by Germany and Japan, it is revealed to be capital-intensive. If it is exported essentially by Vietnam and Lesotho, it is revealed to be labor-intensive. Similarly,

$$h_j = \sum_{I^j} \omega_j^i H^i$$

is product j's revealed intensity in human capital. The database covers 5'000 products at HS6 and over 1'000 at SITC4-5 between 1970 and 2003; UNCTAD plans to update it in Fall 2010. Because the weights sum up to one, revealed factor intensities can be shown on the same graph as national factor endowments. The distance between the two is an inverse measure of comparative advantage. The resulting picture is shown in the two panels of Figure 7 for Costa Rica, which are separated roughly by a decade and, most importantly, by Intel's arrival.

Figure 7
Evolution of Costa Rica's export portfolio and endowment
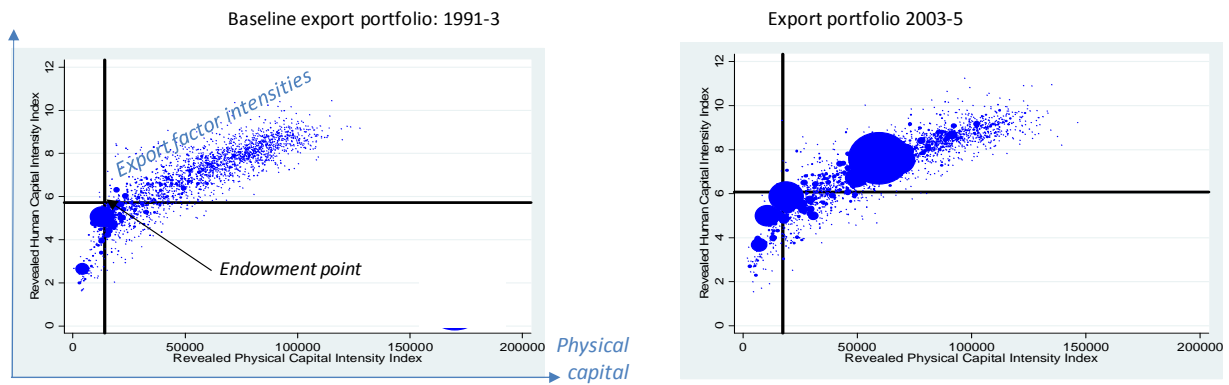
In each panel, the horizontal axis measures capital per worker (in constant PPP dollars) and the vertical axis measures human capital (in average years of educational attainment). The intersection of the two black lines is the country's endowment point. The ink stains are the country's export items, with the size of each stain proportional to export value in the period.

The LHS panel shows Costa Rica before Intel. A dust of small export items in the NE quadrant indicates exports that are typical of countries with more capital and

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[11] Adjustments based on the World Bank's agricultural distortions database (Anderson et. All 2008) were also made to avoid agricultural products subsidized by rich countries (say, milk or beacon) to appear artificially capital- and human-capital intensive.

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human capital than CR has. The RHS panel shows the huge impact of Intel's arrival (the large stain in the NE quadrant, which corresponds to semiconductors). Note that it is located not too far from Costa Rica's comparative advantage: the reason is that semiconductor assembly (which produces the final product) is performed typically in middle-income countries. Yet, it remains that semiconductors exports are typical of countries with two years of educational attainment more than Costa Rica (and over twice more capital per worker).

Comparing the two panels shows that there was more change in Costa Rica's export portfolio than in its factor endowment. Is this sustainable? Figure 8 shows a negative relationship, (across countries and products, between export survival and "comparative disadvantage" (the distance between a product's revealed factor intensity and the exporting country's endowment point). The relationship is significant, although the magnitude of the effect is small. In plain English, it may be a good idea for industrial policy to shoot for sectors that are "better" than the country really is, but you don't want this to go one bridge too far.

Figure 8
Comparative advantage and export survival
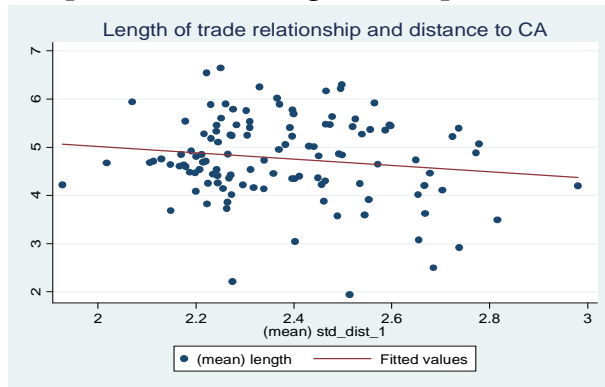
What this all means is that a look at the adequacy of a country's export portfolio to its current capabilities can say something about the portfolio's viability. It can also help provide a factual basis for discussions on "picking winners" via fiscal or other incentives, providing a graphical entry point for arguments about building capabilities (policies on education, infrastructure, investment climate and so on), and linking trade with other dimensions of the policy dialogue.

2.2 Trade policy

2.2.1 Tariff and NTB data

Developed by UNCTAD, the TRAINS database (for TRade Analysis and INformation System) provides data on tariff and non-tariff barriers to trade for 140 countries since 1991. Tariffs reported in TRAINS are of two sorts. First, Most-Favored Nation (MFN) tariffs −i.e. non-discriminatory tariffs applied by any WTO member to all of its partners− are reported under the MHS code. Second, applied tariffs, which may vary across partner countries depending on preferential trade agreements, are reported under the code AHS. In both cases, tariffs are reported at the HS6 level.

Information on a wide range of Non-Tariff Barriers (NTBs) is also collected and reported in TRAINS, but the only year with complete coverage is 2001. Data on NTBs is organized and reported in TRAINS in the form of incidence rates ("coverage ratios") at the HS 6 level. That is, each NTB is coded in binary form at the level at which measures are reported by national authorities (one if there is one, zero if there is none) and the incidence rate is the proportion of items with ones in each HS 6 category. UNCTAD's original (1994) coding has become obsolete, as it featured old-style measures—quantitative restrictions and the like—that have largely been phased out, while grouping into catch-all categories many measures important now, such as product standards.

In 2006, UNCTAD's Group of Eminent Persons on Non-Tariff Barriers (GNTB) started working on a new classification, more appropriate to record the new forms taken by NTMs (and closer to the WTO's). The new classification, adopted in July 2009, is shown at the broadest level of aggregation (one letter) level in box 1. It provides better disaggregation of NTMS, at one letter and one digit (64 categories), one letter and two digits (121 categories), or even one letter and three digits (special cases). It covers a wide range of measures, some of which are clearly behind the border (like anti-competitive measures, which include arcane measures like compulsory national insurance). It has not been widely used yet, and some ambiguities will need to be dealt with; but it will provide the basis for the new wave of NTM data collection to replace TRAINS (under way as of 2010).

One limitation in the reporting of NTBs is their binary form, which does not distinguish between mild and stiff measures. For instance, a barely binding quota is treated the same way as a very stiff one. We will return to this issue in our discussion of QR coverage ratios later on in this theme; suffice it to note here that there is no perfect fix for this problem and that the binary form is probably the best compromise between the need to preserve as much information as is possible and that of avoiding errors in reporting (the more detailed is the coding, the larger the scope for errors).

The WTO's Integrated Data Base (IDB) is a tariff database at the tariff-line level covering 122 Member Countries' MFN and bound tariffs since 2000. Information on ad-valorem equivalents of specific tariffs[12] as well as preferential tariffs is not exhaustive. Access to the IDB is free for Government agencies of Member Countries.

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[12] An ad-valorem tariff is expressed as a percent of the good's CIF price. A specific tariff is expressed as local currency units per physical unit of the good (say, 75 euros per ton). Specific tariffs can be converted into Ad Valorem Equivalents (AVEs) using prices (trade unit values), but the result will obviously fluctuate with those prices: when they go down, the AVE goes up, when they go up, the AVE goes down (which incidentally illustrates the fact that specific tariffs impose time-varying distortions on the domestic economy).

The Agricultural Market Access Database (AMAD) results from a cooperative effort of Agriculture Canada, the EU Commission, the US Department of Agriculture, the FAO, the OECD and UNCTAD. It includes data on agricultural production, consumption, trade, unit values, tariffs, and "tariff-quotas" (tariffs applied only on limited quantities, after which they jump to typically higher levels). Fifty countries are covered since 1995 in version 2.0 (released in October 2001). Some of the tariff-quotas are reported at the HS 4 level rather than HS 6. The database is covered in the AMAD user's guide, available upon free login at www.amad.org (the database is also freely available online).

Based on TRAINS, the MACMAP database has been developed jointly by CEPII and by the ITC in order to provide a comprehensive and consistent set of ad-valorem equivalents (AVEs) of all tariffs, whether already in ad-valorem form or in specific form (of the form, say, of "x dollars or euros per ton"−see the discussion below). MACMAP also includes a treatment of tariff-rate quotas (the original data being from AMAD). For instance, suppose that a tariff rate of 20% is levied on imports within a quota of 10'000 tons a year, and a tariff of 300% on any additional quantities, if applicable. The treatment is as follows. First, import volume data is compared with the quota to determine if it is binding or not. If binding (import volume above 10'000 tons) the out-of-quota tariff of 300% is used as the tariff equivalent; if not, the in-quota tariff of 20% is used. The methodology used in MACMAP is discussed in detail in Bouët et al. (2005).

In 2006, version 2.1 of the Global Anti-Dumping (AD) database was released by Chad Bown at Brandeis University. This rich database, put together with funding from the World Bank, provides detailed information on all AD measures notified by the WTO. It includes determination and affected countries, product category (at the HS 8 level), type of measure, initiation, final imposition of duties, and revocation dates, and even information on the companies involved.[13] It has been regularly updated since.

Direct measures of trade costs are collected in the Logistics Performance Index (LPI) and in the Doing Business. Both are survey-based indices, i.e. reflect perceptions, and have been developed as tools to raise awareness rather than to be used for statistical analysis, although they are used for that purpose. The LPI includes assessments by international freight forwarders of the quality of the logistics environment of a country (border processes, infrastructure, and logistic services such as trucking, warehousing, brokerage and so on). The Doing business covers a wide array of issues, but one of its dimensions, trading across

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[13] The database can be downloaded free of charge at http://people.brandeis.edu/~cbown/global_ad/.

borders, specifically covers trade-related costs using assessments by local freight forwarders, shipping lines, customs brokers, port officials and banks of the documentation, cost, and time needed to complete procedures for importing or exporting a 20-foot container. Both the LPI and the Doing Business's "cost of trade" aggregate information into rankings. They are illustrated in the case of Pakistan in Table 1.

Table 1
LPI and Doing Business (Trading Across Borders): Pakistan 2010

(a) Doing Business: Trading Across Borders

Documents to export (number)	9.0	8.5	4.3
Time to export (days)	22.0	32.4	10.5
Cost to export (US$ per container)	611.0	1,364.1	1,089.7
Documents to import (number)	8.0	9.0	4.9
Time to import (days)	18.0	32.2	11.0
Cost to import (US$ per container)	680.0	1,509.1	1,145.9

(b) LPI

	Score	Rank
Customs	2.05	134
Infrastructure	2.08	120
International shipments	2.91	66
Logistics competence	2.28	120
Tracking & tracing	2.64	93
Timeliness	3.08	110
Overall LPI	*2.53*	*110*

The information in the LPI and the Doing Business' export cost (which excludes maritime freight) should be somewhat related (negatively). Across countries, the correlation is indeed negative and significant at 1%, but it is noisy, as shown in Figure 9.

Figure 9
Doing Business's Export cost vs. LPI across countries
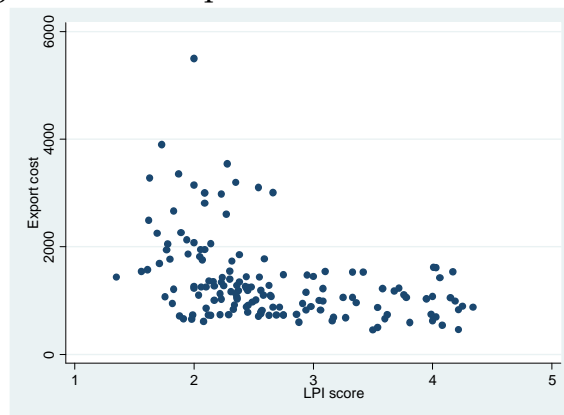
Given the imperfect correlation between the two, it is a matter of judgment which one to use. A natural criterion is the number of respondents per country, as one should treat carefully perception-based indices built from small samples. On the Doing Business's country/topic page, this number is shown in the "local partners" tab. In Pakistan, for instance, the *Trading Across Borders* module had 13 respondents.

2.2.2 Analyzing tariff and non-tariff barriers

Tariff schedules are typically defined at the HS6 or HS8 levels, meaning that there are at least around 5'000 different tariffs and possibly more. Aggregating them can be done in two ways: by simple averaging or by using import shares as weights. The first method is straightforward to calculate. Under the second one, the average tariff is given by

$$\bar{\tau} = \sum_{k} w_k \tau_k$$

where k indexes imported goods and $w_k = M_k / M$ is good k's share in the country's overall imports (the Greek letter τ is used in place of t to avoid confusion with time indices). The advantages and drawbacks of the two methods are illustrated in Table 2, in which a country imports three goods: good one, whose tariff varies between zero and 440% going down the table; good two, with a tariff of 40%, and good three, with a tariff of 5%. Simple averaging gives equal weight to all three tariffs. As imports of good 3 are very small, it gives excessive weight to good 3. For instance, when the tariffs on goods 1 and 2 are both at 40%, the simple average tariff is 28.3%: it is "pulled down" by good 3 even though the reality is that there is a 40% tariff on pretty much all that is imported.

Table 2
Simple vs. trade-weighted average tariffs

Good 1		Good 2		Good 3		Total	Simple	Weighted
Tariff	Imports	Tariff	Imports	Tariff	Imports	imports	average	average
0	1'000	40	670	5	10	1'680	15.0	15.99
50	607	40	670	5	10	1'286	31.7	44.46
100	368	40	670	5	10	1'048	48.3	60.75
150	223	40	670	5	10	903	65.0	66.81
200	135	40	670	5	10	815	81.7	66.16
250	82	40	670	5	10	762	98.3	62.19
300	50	40	670	5	10	730	115.0	57.29
350	30	40	670	5	10	710	131.7	52.72
400	18	40	670	5	10	698	148.3	48.97
450	11	40	670	5	10	691	165.0	46.11
500	7	40	670	5	10	687	181.7	44.03

This suggests the use of a weighted average instead. Indeed, in the same line the weighted-average tariff is a more reasonable 39.75%. But then look at what happens when the tariff on good 1 increases: imports of good 1 decrease, and then so does its weight. When the tariff on good 1 rises to prohibitive levels (bottom of the table), the weighted average *decreases* and converges to the 40%

tariff on good 2. This effect, which is shown graphically in Figure 5, is a known bias of weighted averages, which "under-represent" high tariffs.[14]

Figure 5
Bias of trade-weighted average tariffs
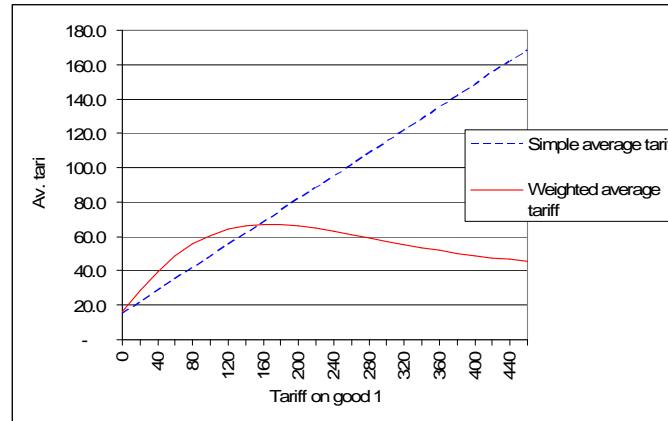
In order to avoid this problem, one would want to use unrestricted (free-trade) import levels as weights; but those are unobservable. Leamer (1974) proposed to use world trade, but this does not properly represent the unrestricted trade structure of each country. The MACMAP database strikes a compromise between "national" and "global" weights by defining reference country groups on the basis of income levels. Alternatively, the best solution is probably to report a battery of tariff measures: simple and weighted averages, minima, maxima and standard deviations, by HS section and overall. Minima, maxima and standard deviations can be calculated either by section or overall, but in any case they should be calculated directly from HS6 data rather than from aggregates, because otherwise they would tend to be underestimated. Again, the choice of HS sections is a compromise between total aggregation (large information loss) and excessive disaggregation (loss of synthetic value).

Because tariffs are typically imposed not just on final goods but also on intermediates, the protection offered to local value added may not be correctly represented by nominal rates of protection: the final tariff protects domestic transformation, whereas the intermediate ones penalize it. Ideally one would want to report *Effective* Rates of Protection (ERPs), by which is meant the percentage increase in local value added when moving from world prices to domestic prices (i.e. the increase in the "price" of domestic transformation

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[14] On this, see, *inter alia*, Anderson and Neary (1999) or Bureau and Salvatici (2004).

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induced by the array of tariffs on the final good and all imported intermediates). However the calculation of ERPs involves the use of input-output matrices typically recorded in nomenclatures other than trade ones and at highly aggregated levels. The resulting calculations therefore reflect many approximations aggregation biases, while being fairly cumbersome to do.

As for Non-tariff Barriers (NTBs),[15] their effect can be assessed in several ways (see the survey in Deardorff and Stern 1997). The simplest is to code their presence in binary form, as in TRAINS, and to calculate the percentage of imports that are affected.[16] An example of this approach is OECD (1995). This calculation, known as an "NTB coverage ratio", is vulnerable to the same bias as that of trade-weighted average tariffs. Namely, when an NTB −say, a quota− on one good is very stiff, imports of that good become very small, and, mechanically, so does the good's weight in the final calculation.

An alternative consists of calculating the Ad-Valorem Equivalents (AVEs) of NTBs using price-based methods (see e.g. Andriamananjara et al. 2004).[17] A particularly simple approach is the "price gap" method spelled out in Annex V of the WTO's Agricultural Agreement. It compares the domestic price of the NTB-affected good with either it landed price before import licenses are purchased or its landed price in a comparable but otherwise unrestricted market. In practice, this is typically where problems start. Consider for instance the EU market for bananas prior to the elimination of the tariff-quota in 2006. One possible comparator country was Norway, which is about the same distance from producing countries but had no QR in place. However Norway being a small market, prices were likely to be higher than in large-volume market like the EU, biasing the price-gap calculation downward. Alternatively, the US could be used as a comparator country, but distances to the US being typically shorter and distribution networks not really comparable, it was not clear that US prices really represented the counterfactual prices that would obtain in the EU in the absence of the tariff-quota. The last problem is that price data is available for

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[15] Sometimes the acronym "NTM" (for Non-Tariff Measures) is preferred to "NTB" in order to avoid a normative connotation.
[16] UNCTAD's classification of non-tariff measures can be found, inter alia, in François and Reynert (1997).
[17] These methods are based on a well-known equivalence theorem, namely that under perfect competition, a quota of, say, a thousand units has the same price and welfare effects as a tariff reducing imports to a thousand units. It should be kept in mind however that the equivalence breaks down under domestic market power, on which the researcher is unlikely to have reliable information.

only about 300 products, a small proportion of the 5'000 products at the HS6 level.

Kee, Nicita and Olarreaga (2006) proposed a more elaborate two-step approach. Step 1 consists of estimating import-demand equations across countries, product by product (at the HS6 level), giving around 5'000 equations to estimate on about 80 observations each. Step 2 consists of retrieving their AVEs algebraically using import-demand elasticities themselves estimated econometrically in Kee, Nicita and Olarreaga (2005). This is probably the most complete and reliable method currently available. Kee et al. used it to construct an aggregate trade-restrictiveness index which we will discuss in the next section. Their results show that "core" NTB use and (unsurprisingly) agricultural support rise with income levels, suggesting that as countries grow then tend to substitute non-tariff to tariff barriers.

A final route to assessing the effect of NTBs on trade flows consists of using all the information available in the variation of trade volumes across pairs of countries to construct a statistical counterfactual based on the so-called "gravity equation", to which we will turn in Section 3 (for an example of this approach, see e.g. Mayer and Zignano 2003).

2.2.3 Measuring overall openness

As is well known, Smith's and Ricardo's general prescription in favor of free trade is based on essentially static efficiency arguments. Empirically, the static welfare losses involved by trade protection vary considerably, from large in small countries (see e.g. Conolly and de Melo eds.1994) to small in large countries (see e.g. Messerlin 2001). Perhaps more importantly, trade openness is statistically associated with higher growth (see e.g. Wacziarg and Welsh 2008). Thus, assessing a country's openness is crucial and, indeed, International Financial Institutions use a variety of indices of trade openness or restrictiveness. The problem is, of course, to control, as much as possible, for non-policy influences on observed openness, and that is where difficulties start.

The most natural measure of a country's integration in world trade is its degree of openness. Let X^i, M^i and Y^i be respectively country i's total exports, total imports and GDP. We will try to reserve superscripts for countries and subscripts for commodities and time throughout. Country i's openness ratio is defined as

$$O_t^i = \frac{X_t^i + M_t^i}{Y_t^i} \qquad\qquad (0.1)$$

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and is calculated for a large sample of countries and years in the Penn World Tables (PWT).[18] The subscript t indexes time, if the index is traced over several years.

Can we use O^i as is for cross-country comparisons? The problem is that it is correlated, inter alia, with levels of income, as shown in the scatter plot of Figure 5 where each point represents a country. The straight line is fitted by ordinary least squares and therefore gives the best "straight-line" approximation to the relationship between GDP per capita and the ratio of foreign trade to GDP. Countries below the line can be considered as trading less than their level of income would "normally" imply.

Figure 5
Trade and per capita GDP
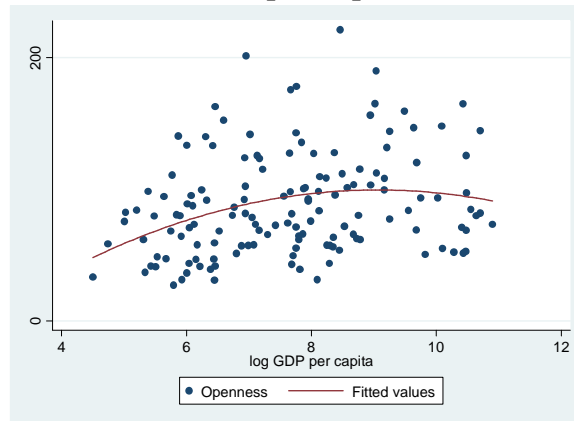
Source: authors' calculations from COMTRADE and WDI
Note: Vertical axis is measured in percent of GDP. Curve is fitted by OLS using a quadratic polynomial. Turning point is around exp(9) which is US$8'000 at PPP.

Thus, at the very least income levels should be taken into account when assessing a country's openness. Many further adjustments to the relationship in Figure 4 can be made, leading to openness measures estimated as residuals from cross-country regressions of O^i on geographical determinants of trade. This approach goes back to the work of Leamer (1988) and is illustrated in Figure 7.

Figure 10
Nepal's openness in comparison

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[18] The data is on the PWT's site at
http://pwt.econ.upenn.edu/php_site/pwt_index.php.
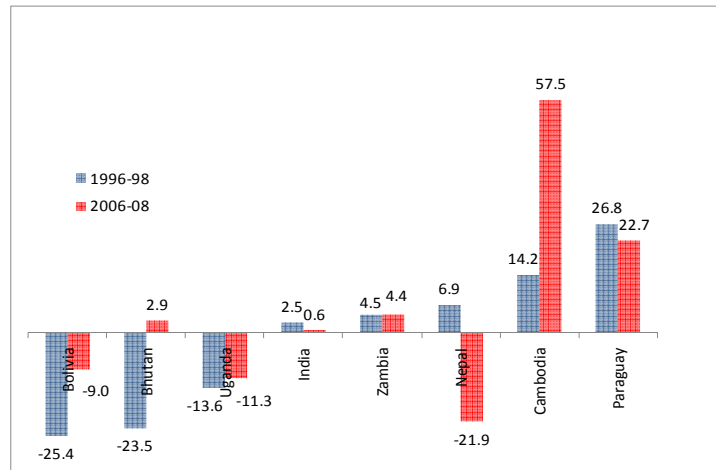
Beyond the relationship between openness and incomes, policymakers can be interested in assessing the overall stance of a trade policy, which can affect, for instance, the disbursement of structural-adjustment or other funds from International Financial Institutions. This, however, involves a double aggregation problem: across goods and across instruments. In order to overcome the difficulties involved in this aggregation, economists have constructed indices based on observation rules to determine how open a country's trade policy is. In a celebrated study, Sachs and Warner (1995) proposed a binary classification of countries (one for "open" ones, zero for closed ones) according to five criteria: average tariffs above 40%, NTB coverage ratios above 40%, trade monopolies, black-market premium on foreign exchange above 20% for a decade, or a centrally-planned system. However, Rodriguez and Rodrik (1999) showed that the trade dimension of the Sachs-Warner (SW) index was hardly correlated with growth, as most of its explanatory power came from the last three (non-trade) criteria. The IMF has also devised an index based on the following observation rules: Countries are given a score for each type of trade barrier: average tariff, proportion of tariff lines covered by QRs, and so on, after which scores are averaged for each country, giving a Trade Restrictiveness Index (TRI) going from one (most open) to ten (least open). The TRI, on which details can be found in IMF (2005), is used in IMF research papers but not indicated in staff reports.

An alternative approach, more directly grounded in theory, was recently proposed by Kee, Nicita and Olarreaga (Kee et al. 2006b). They Draw from Anderson and Neary (1994, 1996) who proposed a Trade Restrictiveness Index (TRI) defined as the uniform ad-valorem tariff on imports that would be equivalent to the set of existing tariff and non-tariff measures in terms of the importing country's *welfare*. Kee et al.'s Overall Trade Restrictiveness Index (OTRI) is the uniform ad-valorem tariff on imports that would result in the same

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import volume as the set of existing tariff and non-tariff measures. That is, country i's OTRI τ^{i*}, which is a single number, solves

$$M^i = \sum_k M_k\left(\tau^i_k\right) = \sum_k M_k\left(\tau^{i*}\right)$$

where k indexes goods at the HS6 level, τ^i_k stands for the ad-valorem equivalent of country i's barriers (tariff and non-tariff) on imports of good k, and $M_k(.)$ is an import-demand function estimated econometrically across countries. They also proposed a mirror image of the OTRI, the uniform ad-valorem tariff that would be equivalent to the set of existing measures affecting a country on its export market, and called it the MA-OTRI (MA for market access). They estimated all three indices for a wide range of countries and the results, which are freely available on the web, show that trade restrictiveness decreases with income while market access improves (i.e., both the OTRI and the MA-OTRI decrease with income levels, as shown in Figure 6).

Figure 6
OTRI and MA-OTRI by income levels
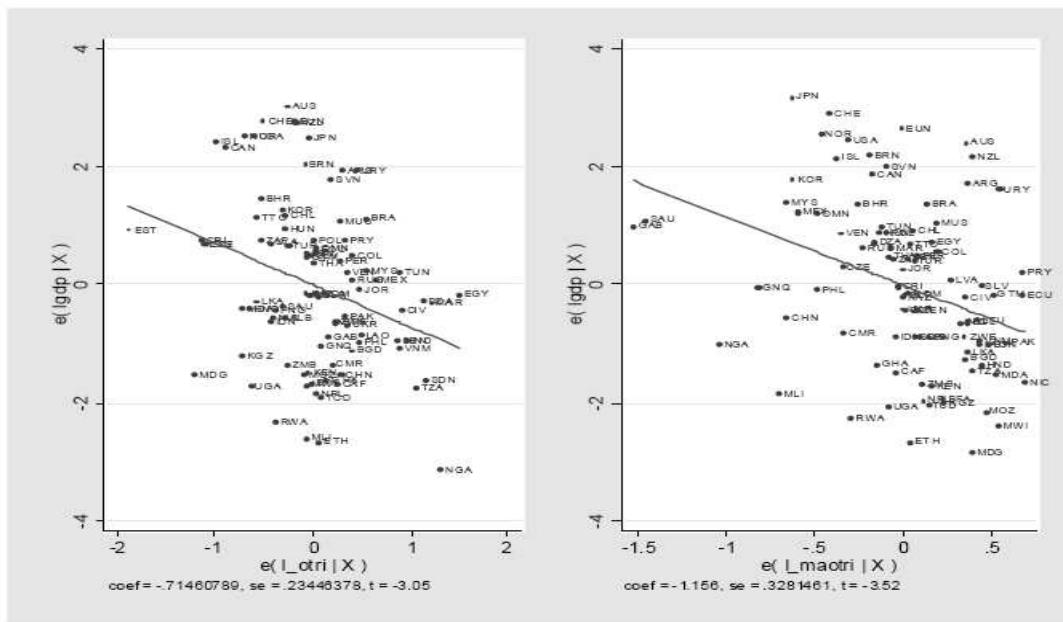
Source: Kee, Nicita and Olarreaga (2006a).

3. Ex-post analysis

3.1 Revisiting trade flows with the gravity equation

It has been known since the seminal work of Jan Tinbergen (1962) that the size of bilateral trade flows between any two countries follows a law, dubbed the "gravity equation" by analogy with physics, whereby countries trade more, ceteris paribus, the closer they are, the larger they are, and the more similar they are, the latter two in terms of their GDPs.[19] Whereas empirics predated theory in this instance, the robustness of the gravity relationship is attributable to the fact that it is a direct implication of a model of trade based on monopolistic competition developed by Paul Krugman (1980) and which has established itself as the workhorse of trade analysis between industrial countries.

Practically, the gravity equation relates the natural logarithm of the dollar value of trade between two countries to the log of their respective GDPs, a composite term measuring barriers and incentives to trade between them (typically the log of the distance between their capitals, and terms measuring barriers to trade between each of them and the rest of the world.

The rationale for including these last terms, dubbed "multilateral trade-resistance" (MTR) terms by Anderson and van Wincoop (2003) who argued for their inclusion, is as follows. Ceteris paribus, two countries surrounded by other large trading economies, say Belgium and the Netherlands surrounded by France and Germany, will trade less between themselves than if they were surrounded by oceans (such as Australia and New Zealand) or by vast stretches of deserts and mountains (such as Kyrgyzstan and Kazakhstan). Several alternative ways of proxying MTR terms are possible. One is to use iterative methods to construct estimates of the price-raising effects of barriers to multilateral trade (Anderson and van Wincoop 2003). A simpler alternative is to control for each country's "remoteness" by using a formula that measures its average distance to trading partners. An even simpler −and widely used− method consists of using country fixed effects for importers and exporters (Rose and van Wincoop 2001).[20]

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[19] A clear and concise introduction to the gravity equation can be found in Head (2003). A thorough treatment for the advanced reader is in Chapter 5 of Feenstra (2004).

[20] "Fixed effects" are dummy (binary) variables that "mark" an individual in a panel in which individuals are followed over several periods. In a gravity equation, one such variable will be set to one whenever the exporting country is, say, Kazakhstan, and zero otherwise. Another one will be set to one whenever the importing country is Kazakhstan

In sum, the gravity equation in its baseline form is as follows. Let V_t^{ij} denote country j's total imports from i at time t (we keep the convention of writing country indices as superscripts and putting the source first and the destination second), and $\ln V_t^{ij}$ its natural logarithm. Let D^{ij} be the distance between the two. Let also I^i be a dummy variable equal to one when the country is i and zero otherwise. The equation is:

$$
\ln V_t^{ij} = \alpha_0 + \alpha_1 \ln GDP_t^i + \alpha_2 \ln GDP_t^j + \alpha_3 \ln D^{ij} \\
+ \alpha_4 I^i + \alpha_5 I^j + \sum_{\tau=1}^{T} \alpha_{5+\tau} I_\tau + u_t^{ij}
$$
(1)

Note that, because all variables are in logs, the coefficients can be interpreted as elasticities. That is, a coefficient estimate $\hat{\alpha}_2 = 1$ indicates an income elasticity of (aggregate) imports equal to unity.

To this baseline formulation can be added any controls and variables of interest. Thus, estimation requires data on bilateral trade, GDPs, distances, and possibly other determinants of bilateral trade including contiguity (common border), common language, colonial ties, exchange rates, and so on. There is a wealth of databases from which the researcher can draw for these variables.

Bilateral trade flows can be found in the IMF's DOTs, in COMTRADE, or in the CEPII's BACI. They are typically expressed in current dollars. GDPs in current dollars, converted at current exchange rates, can be found in the IMF's IFS. GDPs at Purchasing Power Parity (PPP)[21] can be found in the World Bank's World Development Indicators (available online by subscription or on CD-ROM) together with a wealth of other indicators, in the Penn World Tables (PWT).[22]

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and zero otherwise, and so on for each country. In a cross section with n countries, if one-way trade flows are not combined, there are 2n2 country pairs (the unit of observation) but only 2n such fixed effects, so estimation is still possible.

[21] An explanation of how PPP exchange rates are constructed is given in Annex I.

[22] PWT Mark 6.1 is freely available on the web at http://pwt.econ.upenn.edu/php_site/pwt_index.php. It can also be found with a different data-extraction interface at the CHASS center of the University of Toronto at http://datacentre2.chass.utoronto.ca/pwt/. Country codes are not identical across databases but concordance tables can be found on Jon Haveman's page at http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/Concordances/OthMap/country.txt

The gravity equation can be used in various ways to estimate the effect of trade policy on trade flows. At the aggregate level, gravity equations have been used extensively to assess, ex post, the effect of Regional Trade Agreements (RTAs), one of the seminal contributions in this area being Frankel, Stein and Wei (1995). The crudest way to do so is to include in the set of gravity regressors a "dummy" (zero/one) variable marking pairs of countries linked by RTAs. However, as discussed in Carrère (2006), this methodology is fraught with problems, including the fact that RTAs are likely to be endogenous to trade flows (countries that are natural trading partners are more likely to form RTAs if governments decide to form them on welfare grounds). In estimating a gravity equation, several estimation issues should be kept in mind. First, results may differ depending on whether or not zero trade flows (about half the country pairs every year) are included in the dataset or not. If not, OLS can be used, but the results may be biased. If they are, a ML estimator, Poisson or Tobit, is better. More sophisticated approaches include Heckman's selection model which corrects for the fact that non-zero trade flows are not random, or Helpman, Melitz and Rubinstein's (2008), which "purges out" the effect of firm heterogeneity.

The gravity equation has been less frequently used at the disaggregated level but it can also be put to work for sectoral studies. Suppose that we observe, around the world, both tariffs and quotas on the market for a homogenous good, say bananas. The estimates on those can be used to retrieve directly a tariff equivalent of the quotas. Specifically, let τ_t^{ij} and Q_t^{ij} be respectively any tariff and quota imposed by j on i in the good in question (here bananas), and other variables be as before. Omitting a few additional explanatory variables like exchange rate, a gravity equation estimated at the sectoral level looks like this:

$$\ln V_t^{ij} = \beta_0 + \beta_1 \ln GDP_t^i + \beta_2 \ln GDP_t^j + \beta_3 \ln D^{ij}$$
$$+ \beta_4 \ln\left(1 + \tau_t^{ij}\right) + \beta_5 Q_t^{ij} + FE + TE + u_t^{ij}$$

(2)

where FE and TE stand respectively for the "fixed effects" I^i and I^j in (1) and for its "time effects" I_τ. Note that one has been added to the tariff because, the equation being in logs, zero tariffs would send the log to minus infinity whereas $\ln(1) = 0$. Estimates from (2) can then be used to retrieve the tariff equivalent of the quota. Let us use hats over variables for estimated coefficients and predicted trade values. Letting Z stand for everything but $\hat{\beta}_5 Q_t^{ij}$ in (2), we have

$$\ln \hat{V}^{ijt} = Z + \hat{\beta}_5 Q_t^{ij}.$$

(3)

Note that Q_t^{ij} is equal to one if a quota applies and zero otherwise. Thus, the predicted difference in trade between a country pair *with* a quota and the same country pair *without* the quota would be

$$\ln \hat{V}_{t,\text{quota}}^{ij} - \ln \hat{V}_{t,\text{no quota}}^{ij} = Z + \hat{\beta}_5(1) - \left[Z + \hat{\beta}_5(0) \right] = \hat{\beta}_5. \tag{4}$$

Using again Z as shorthand for everything except $\hat{\beta}_4 \ln(1 + \tau_t^{ij})$ in (2), a similar calculation can be performed for the effect of a tariff at rate τ_t^{ij} compared to no tariff at all:

$$\ln \hat{V}_{t,\text{tariff}}^{ij} - \ln \hat{V}_{t,\text{no tariff}}^{ij} = Z + \hat{\beta}_4 \ln(1 + \tau_t^{ij}) - \left[Z + \hat{\beta}_4 \ln(1) \right]$$
$$= \hat{\beta}_4 \ln(1 + \tau_t^{ij}). \tag{5}$$

A tariff equivalent of quota Q_t^{ij} is a tariff that has the same effect on trade flows. This is equivalent to equating the left-hand sides of (4) and (5). But if their left-hand sides are equal, so are their right-hand sides; thus, the tariff equivalent $\tilde{\tau}$ of quota Q_t^{ij} satisfies

$$\hat{\beta}_4 \ln(1 + \tilde{\tau}) = \hat{\beta}_5$$

or

$$\tilde{\tau} = \exp\left(\hat{\beta}_5 / \hat{\beta}_4 \right) - 1.$$

This simple calculation can be easily programmed after the estimation of the gravity equation, yielding an ad-valorem tariff equivalent to the quota.

3.2 Analyzing a policy's distributional effects

If the textbook treatment of trade policy is usually cast in terms of its welfare effects, policymakers are often as much if not more interested by its *distributional* effects. From a conceptual point of view, the distributional effects of trade have been extensively discussed as part of the so-called "trade and wages" debate, where the issue was essentially whether Stolper-Samuelson effects were responsible for the observed increase in the skill premium in Northern countries. That debate settled with the observation that most of that increase was within industries rather than across and was thus likely to be due to technical progress more than trade.

More recently, a considerable literature has gone into exploring the effects of trade on poverty and inequality, especially in developing countries (see Koujiannou-Goldberg and Pavcnik 2004 for a survey). Tracing the effects of, say, trade liberalization on poor rural households is typically difficult because, even if prices were measured correctly at the border through trade unit values (which is already unlikely, see supra), the pass-through of border-price changes to changes in the domestic producer and consumer prices effectively faced by poor rural households is difficult to assess. A very good treatment of this question can be found in Nicita (2004). Here we will illustrate something less ambitious, namely how to measure the regressivity or progressivity of a trade policy.

Whether a given trade policy has a regressive or "anti-poor" bias, i.e. whether it penalizes poor households more than rich ones is an important policy question in the context of trade reform. In general, various tools can be used to quantify the effects of trade barriers on domestic residents' incomes, some of which will be discussed in the next section. Here we will limit ourselves to a tool that is simple to use −although its data requirements can be nontrivial− but nevertheless provides a crisp answer to the question of regressivity.

Consider for instance a farming household that consumes and produces n products indexed by indexed by k, and let $w_k^i\left(Y^i\right)$ and $W_k^i\left(Y^i\right)$ stand for their respective shares in the household's expenditure and income, with the argument in parentheses meant to highlight that those shares are themselves likely to vary with income levels (goods whose budget shares go down with income are "necessities", and crops grown at lower income levels may e.g. require lower input use). Let μ_k be the income elasticity of good k, and observe that tariffs on goods produced by households *protect* them whereas tariffs on consumption goods *tax* them. If tariffs on production goods are positively correlated with income elasticities, they are pro-rich because they protect disproportionately the goods produced by rich households (think e.g. of crops grown predominantly by large and high-income farmers); if tariffs on consumption or intermediate goods are positively correlated with income elasticities, by contrast, they are pro-poor, because they tax disproportionately goods consumed by the rich.

Formally, one can construct a production-weighted average tariff for each household as

$$\overline{\tau}^{i,\text{prod}} = \sum_{k=1}^{n} W_k^i \tau_k$$

where τ_k is the tariff on good k, and a consumption-weighted average tariff as

$$\overline{\tau}^{i,\text{cons}} = \sum_{k=1}^{n} w_k^i \tau_k \; .$$

Note that the sets of goods produced and consumed need not overlap; an urban, salaried household would simply have zero production weights on all goods. The net effect of the tariff structure on household i is then the difference between the two :

$$\overline{\tau}^i = \sum_{k=1}^{n} \left(W_k^i - w_k^i \right) \tau_k \; .$$

All three can be plotted against income levels in order to get a picture of the regressive or progressive nature of tariffs. One way of doing this could be to simply regress $\overline{\tau}^i$ on income levels. However nothing guarantees that the relationship between the two will be linear or even monotone, as it may well have one or several turning points. As an alternative to linear or polynomial regression, one may fit what is known as a "smoother" regression, which essentially runs a different regression for each observation, using a sub-sample centered around that observation.[23] The result is a "regression curve" on which no particular shape is imposed and which can therefore have as many turning points needed to fit the data. In addition, for readability, households are typically grouped into centiles and the smoother regression is run on the average incomes of the centiles rather than on individual household incomes. An example of the result is shown in Figure 8.

Figure 8
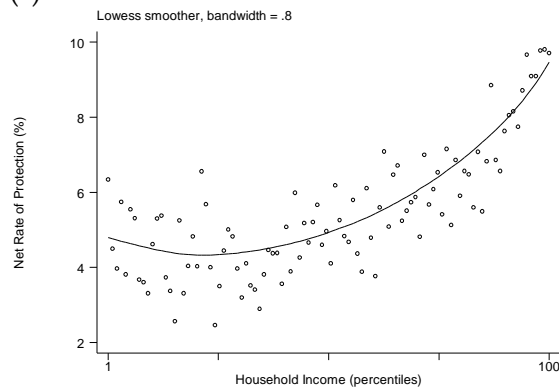Smoother regression of tariffs on income-distribution centiles
(a) Effect on consumption (b) Effect on production

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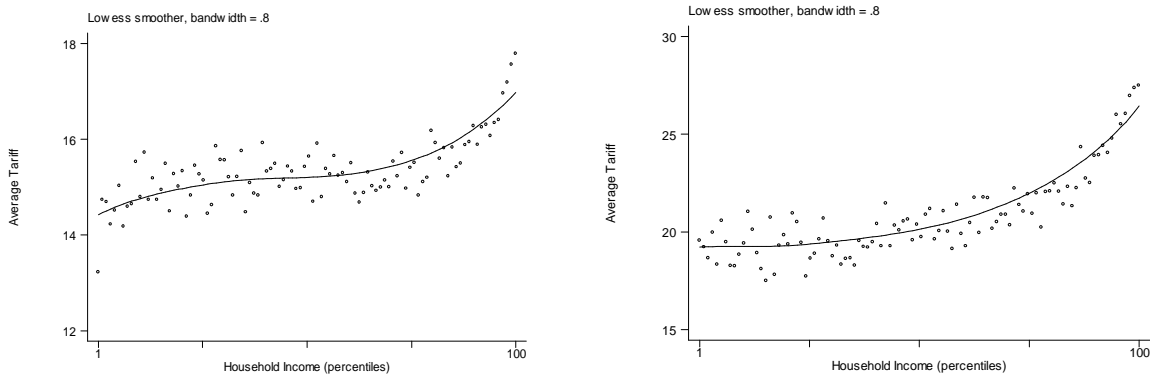
[23] Although it sounds involved, this procedure is in practice very simple because it is pre-programmed as the "ksm" command in Stata.

(c) Net effect

Lowess smoother, bandwidth = .8

Source: Olarreaga and Nicita (2002).

Note that if the smoother regression is very easy to run, the real difficulty in the exercise is to get data on consumption and production shares. This requires the use of household surveys, which are typically very large data sets requiring substantial cleaning before use.

4. Ex-ante assessment of Trade Policy Changes

In addition to the descriptive statistics and ex-post type of analyses described earlier, trade policy analysts also make use of ex-ante (or simulation) modelling techniques to assess or preempt the likely (overall and sectoral) impact of trade policy changes. These are tools that help analysts and policymakers evaluate and quantify the potential economic effects of various trade policy alternatives. Generally, they help answer *"What if"* types of questions (or counterfactual/anti-monde): Using information on the observed state of the world, they ask how things will be different if a variable (usually a policy instrument) is altered. Ex-ante models are useful distillation of economic theory that can provide a handle on the often complicated interactions between different economic variables in a consistent and tractable way. When properly designed and constructed, simulation models offer a coherent framework built upon rigorous economic theory that can provide solid empirical support (or even justification) for a chosen trade policy.

Simulation models can be structured either in a partial or in a general equilibrium setting. A partial equilibrium model generally only focuses on one part or one sector of an economy and assume that changes in that sector have no, or minimal, impact on other sectors. It takes into account neither the linkages between sectors, nor the link between income and expenditures. In contrast, a general equilibrium analysis explicitly accounts for all the links between the different elements of a considered economy. These elements may be household,

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branches of activity, factors of production. Such analysis imposes a set of conditions on these elements in such a way that basic economic identities and resource constraints are always satisfied. For instance, an expansion in a given sector would be associated with a contraction in another sector since the existing factors of production will move to the expanding one and away from the contracting one.

The choice of the appropriate model depends on the nature of the policy being studied, the availability of resources and information, and the variables of interest to policymakers. Whatever their exact nature however, number of key elements are common across models and are necessary to make them useful for conducting rigorous quantitative trade policy analysis: economic theory, data (endogenous and exogenous variables), and behavioral parameters.

This section briefly introduces these elements and presents the basic steps required in solving the model. It then presents the main features of the two types of simulation models typically used in trade policy analysis (partial equilibrium and computable general equilibrium models) with the modest goal of familiarizing the reader with the different concepts.

Required elements for applied trade policy modeling

A crucial element in a simulation model is that it should be based on solid *economic theory*. This is embodied in a series of mathematical representation of the different economic linkages, constraints, and behaviour assumptions of the model's economic agents (market structure, profit maximization, utility optimization, …) that the analyst wants to capture in the models. They will reflect the key assumptions that are used to simplify the reality into the model.

Next, for the model to be a useful empirical tool, the analyst needs to use good quality real world data. An ex-ante model starts with a series of observed variables which are assumed to represent an initial equilibrium state of the world. The system is then *shocked* by changing one (or a few) *exogenous* variable and solved until it produces a new equilibrium and new values for the *endogenous* variables of the model.[24] As will be discussed in greater details later, the choice of exogenous (vs. endogenous) variables determines the *general* or *partial* equilibrium nature of the model, in parallel with the model's *economic*

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[24] Stated differently, exogenous variables (also called shock or policy variables) are the variables that are taken as given and assumed to be unaffected by economic shock applied to the model while endogenous ones are those whose values respond to changes in the model.

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closure. The model closure is characterized by a set of assumption about some basic identities or constraints that have to hold for the model to reach equilibrium (such as market clearing conditions--demand equals supply, or income equals expenditures).

The final key elements required in conducting ex-ante trade policy modeling are the *behavioral parameters*. Those parameters reflect how economic agents respond to changes in their environment (e.g., price or income). They can include various price (and cross price) elasticities, income elasticities, substitution elasticities (among different goods or varieties of goods or factors), and others. These elasticities are generally taken from the existing literature or are estimated independently by the researchers outside the framework of the model (e.g., Kee, Nicita and Olarreaga (2004) and Donnelly, Johnson, Tsigas, and Ingersoll (2004) provide a set of very useful import and substitution elasticities, respectively).

Required steps for applied trade policy simulations

Prior to the actual policy experiment or simulation, an ex-ante model is generally benchmarked using the observed data and the behavioral parameters—that is, the model is initially calibrated so that its equilibrium replicates observed data. This process (also called *parameterization*, *initialization* or *calibration*) involves using the observed data and model parameters to determine the values of a number of unobserved variables (or the *calibration parameters*) in the model.[25] These variables are assumed to incorporate information that are not readily observable and are used as a fixed exogenous variable in the simulation steps.

Given the resulting calibration parameters, a policy experiment (or other experiments) can be conducted by first assuming that the parameterized model is in equilibrium. Then the value of an exogenous (policy) variable of interest is shocked to capture the questions that the analyst would like to address. And finally, the model is solved to reach a new equilibrium--by allowing prices to adjust to satisfy some predefined *equilibrium conditions*. Most trade-related simulation models rely on what is called the *comparative statics* methodology to evaluate the impact of a policy experiment: the effect of the shock is then computed by comparing the new equilibrium values to the observed data (the

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[25] For instance, if demand function is expressed as $\ln Q = A - b \ln P$, where $\ln Q$ is the demanded quantity, b is the price elasticity, and $\ln P$ is the price, the value of the intercept A is calibrated using the information on price, quantity, and elasticity, and is computed as $A = \ln Q / b \ln P$. The parameter A is the calibration parameter in this case.

initial equilibrium)—two equilibrium states of the world are compared.[26] The impact of the trade policy experiment on any given endogenous variable is then simply measured as the difference between the initial and the final equilibrium value of that variable.

4.1 Partial-equilibrium simulations (focused sectoral analysis)

In a partial equilibrium model, a particular commodity or market is studied, and the linkages with other sectors (income or substitution effects, or spillover) are ignored (i.e., they are assumed exogenous). Any trade policies deal with only this commodity or market. The condition for solving the model is simply to equate demand and supply in that particular market. This type of model can ideally be used when the effects on rest of the economy are small. That is, either the sector itself is small (limited income effects), or there is limited links with other parts of economy (limited backward and forward linkages).

This approach has a number of attractive features. The main advantage of the partial equilibrium approach to trade policy analysis is its minimal data requirement. Usually, it requires only a few trade flow and trade policy data for the sector being studied and a set of (price or substitution) elasticities which are usually pretty easy to collect from databases like COMTRADE or TRAINS. Also, due partly to the minimal data requirement, the analysis can be conducted at a pretty disaggregated or detailed sectoral level which solves a number of the aggregation biases discussed in previous sections. For example, it allows the study of the effects of the liberalization of "brown rice" imports by Madagascar, a level of aggregation that is neither convenient nor possible in the framework of a general equilibrium model. This also resolves a number of "aggregation biases." By the same logic, the partial equilibrium may allow the analysis of the likely impact of trade agreements like the Doha round more accurately, as the negotiations are conducted at a very disaggregated level. This approach also has the virtue of being transparent and relatively easy to implement and solve. In fact, a typical partial equilibrium model generally consists of a small number of equation equations representing the demand and supply sides, and solving the model simply entails allowing the price to adjust to equate demand and supply. Modeling is thus straightforward and results can usually be easily explained.

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[26] An alternative to the comparative statics approach (comparing two equilibrium states of the world) is a more dynamic approach, which involves either comparing two equilibrium (steady state) rates of growth, or tracking the adjustment process of given variables between two equilibrium states of the world. The latter usually involve relatively complicated assumptions on the behavior of the model's economic agents (in terms of saving and investment, capital accumulation, technological changes, for instance).

The partial equilibrium approach also has a number of disadvantages that have to be kept in mind while conducting any analysis. Since it is only a "partial" model of the economy, the analysis is only done on a pre-determined number of economic variables. This makes it very sensitive to a few (wrongly estimated) behavioral elasticities. Due to their simplicity also, partial equilibrium models may miss important interactions and feedbacks between various markets. In particular, the partial equilibrium approach tends to neglect the important inter-sectoral input/output (or upstream/downstream) linkages that are the basis of general equilibrium analyses. It also misses the existing constraints that apply to the various factors of production (e.g., labor, capital, land, …) and their movement across sectors.

Given limitations in the data and the abstract nature of such models, the user should interpret the results with caution. The numbers that come out of the simulations should only be used to give a sense of the order of magnitude that a change in policy can mean for economic welfare or trade. However, the model has detailed commodity and country coverage and for the comparison of various policy scenarios, it can be very helpful in indicating the relative magnitudes of the effects of policy changes on welfare, trade and prices.

Overview of SMART: A commonly used partial equilibrium

In the rest of this section, we provide as an illustration a brief overview of SMART, a simple and widely used partial equilibrium simulation tool that included in WITS (using COMTRADE and TRAINS databases). It allows the researcher to investigate the impact of unilateral/preferential/multilateral trade reforms at home or abroad on various variables including trade flows (import, exports, trade creation, trade diversion), world prices, tariff revenue, and economic welfare. It is based on a relatively simple demand and supply equilibrium for a given good.

On the (export) supply side, the setup in SMART is that different countries compete to supply the given good (export to) a given home market. The focus of the simulation exercise is on the composition and volume of imports into that market. Export supply of a given good (say banana) by a given country supplier (say Ecuador) is assumed to be related to the price that it fetches in the export

market and the degree of responsiveness of the supply of export to changes in the export price is given by the "*export supply elasticity*."[27]

On the demand side, SMART relies on the Armington assumption to model the behavior of the consumer. This assumes imperfect substitutions between different import sources (different varieties)—that is, goods (defined at the HS 6 digit level) imported from different countries, although similar, are imperfect substitutes (e.g., bananas from Ecuador are an imperfect substitute to bananas from Saint Lucia). Within the Armington assumption, the representative agent maximizes its welfare through a two-stage optimization process. First, given a general price index, she chooses the level of total spending/consumption on a "composite good," (say aggregate consumption of bananas). The relationship between changes in the price index and the impact on total spending is determined by a given "*demand elasticity*." Then, within this composite good, she allocates the chosen level of spending among the different "varieties" of the good, depending on the relative price of each variety (say, choose more bananas from Ecuador, and less from Saint Lucia). The extent of the between-variety allocative response to change in the relative price is determined by the "*Armington substitution elasticity*."

In the SMART modeling framework, a change in trade policy (say a preferential tariff liberalization) affects not only the price index/level of the composite good but also the relative prices of the different varieties. Through the export supply elasticity, the import demand elasticity, and the substitution elasticity, it will lead to changes in the chosen aggregate level of spending on that good, as well as, changes in the composition of the sourcing of that good. Both channels affect bilateral trade flows.

SMART reports the results of any trade policy shock on a number of variables. In particular, it reports the effects on trade flows (i.e., imports from the different sources). It also decomposes those trade effects in trade creation and trade diversion.[28] SMART also, it calculates the impact of the trade policy change on tariff revenue, which is computed simply as the (ad valorem) tariff rate multiplied by the value of the flow. Finally, the framework estimates the change

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[27] In the simplest version of SMART, the elasticity is assumed to be infinite—that is, the export supply curves are flat and the world prices of each variety (e.g., bananas from Ecuador) are exogenously given. The more complex version of SMART introduces upward sloping export supply functions (i.e., finite elasticity).

[28] Trade creation is defined as the direct increase in imports following a reduction on the tariff imposed on good k from country i. If the tariff reduction on good k from country i is a preferential tariff reduction (i.e., it does not apply to other countries), then imports of good k from country i are further going to increase due to the substitution away from imports of good g from other countries that becomes relatively more expensive. This is the definition of trade diversion in the SMART model.

in the welfare due to the policy experiment. This is computed as the sum of the change in the tariff revenue and the change in consumer surplus (or consumer welfare), which is broadly defined as the difference between the consumer's willingness to pay (marginal value) and the amount she actually pays.

4.2 Computable general equilibrium models[29]

Compared to the partial equilibrium approach, Computable General Equilibrium (CGE) models tend to be very complex and are usually not readily accessible to non-specialists. They capture complicated inter-sectoral vertical and horizontal, backward and forward economic linkages. Indeed, CGE models are based on the fact that the different markets in a given economy are linked and changes that take place in one market do have effects on other markets that should be documented as they can feed back to the original one. One of the key features distinguishing CGE from PE is the use of Social Accounting Matrix (SAM) to capture these various linkages.[30] Since they can take into account cross-sectoral reallocation of factors of production, CGE models are good tools for studying economywide impact and for identifying winners and losers under a policy change. This section briefly discusses the general structure and organization of trade-related CGE models.31

On the *production* side, most CGE models are characterized in terms of the outputs, the inputs (intermediate goods and factors of production), and the production technologies. The nature of the technology that transform the inputs into the final output is captured by a number of *fixed input-output coefficients* (or shares), as well as some *substitution elasticities* among inputs and factors of production. Firms maximize their profits using price information to decide how much of each good to produce, using how much of each input—this determines the supply of (final and intermediate) goods and the demand for inputs (including both intermediate goods and factors of production).[32]

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[29] Among the best known CGE trade models are the Michigan model (Deardorff and Stern, 1986), the McKibbin-Sachs Global model (McKibbin and Sachs, 1991), the G-Cubed model (McKibbin and Wilcoxen, 1992) , the SALTER model (Jomini et al., 1994), the Multi-regional Global Trade Model (Harrison, Rutherford and Tarr, 1996), and the Global Trade Analysis Project (GTAP) model (Hertel et al. 1997).
[30] The SAM helps account for all these interactions in a systematic and balanced way. It is built upon the circular flow conception of the economic system where each expenditure must be matched by a corresponding receipt or income.
[31] The interested non-expert reader is referred to Piermartini and The (2005) for an excellent detailed overview of CGE approaches for trade policy modelling.
[32] Revenue from sales of goods is used to pay for intermediate inputs and factors of production.

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On the *consumption* side, the majority of CGE models focus on a representative household, which is also assumed to be the owners of factors of production (land, labour and capital). The income that it receives from rent (land), wages (labor) and interest (capital) is spent on consumption of goods (and services), on taxes collected by the government, and/or on savings. The representative household maximizes it utility by allocating its (disposable) income among the goods and services available at the going market price. Assuming full employment, the household's endowments of factors of production are supplied to firms at the going factor market prices—this determines the supply of factors of production and the demand for goods and services.

Governments, in CGE models, collect taxes and tariffs, disburse subsidies and purchase goods and services. It's in this sector, using these policy instruments, that the policy experiments are usually triggered.

So far we have described the behavior of firms, consumers, and government in an economy in autarky. International trade is usually introduced in CGE models by liking the original economy with other countries with their own sets of firms, consumers, and governments. The substitutability between imports and domestic products is generally driven by the Armington assumption described earlier in the PE section: that is, goods imported from different sources, although similar, are different varieties that are imperfect substitutes. The choice of the representative consumer of how much to allocate to the purchase of each variety depends on the relative prices and the Armington substitution elasticity.

Just as it imports, a country also export differentiated product(s) to other countries. Each country is the unique supplier of its differentiated variety and the amount supplied depends on the prevailing world prices (which are in turn determined by some global trade balance condition between export supply and import demand). Under these assumptions, trade policy changes in a country can affect the world prices and the terms of trade (the ratio of a country's export and import prices) thus the welfare of all other countries.

The CGE model is solved by allowing the prices (including goods and factor prices) in the system to adjust so that all equilibrium conditions are satisfied: demand for goods equals their supply, demand for imports equals supply of exports, and demand for factors of production equals the available endowments. Given the new sets of prices, the new equilibrium level of different price-dependent variables can be determined: consumption, production, imports,

exports, factor allocation, tax revenues, etc. From those, in turn, some measure of the welfare impact of the trade policy experiment can be computed.[33]

 While very powerful and potentially very useful, CGE models have a number of limitations that needs to be kept in mind. First, unlike partial equilibrium, CGE models tend to be resource intensive, requiring a lot of information and computing power. They tend to be very complicated and inaccessible to non-experts. Their complexity can sometimes be overwhelming and their usefulness tend to be restricted when policymakers do not have a clear understanding of what they are are, what do they do, and how their results should be interpreted. To properly interpret the results, one needs to comprehend the economic assumptions and mechanisms underlying the model, and how sensitive the results are to those.

Most commonly used trade-CGE models are static in nature and fail to capture the effect of a trade policy change on the dynamic aspects of an economy. It has to be recognized though that a policy change such as the establishment of a FTA is likely to directly affect dynamic phenomena such as capital flows, demographics, and growth rates. An effort is currently being made in the GTAP network.

5. Conclusions

By now the reader will have had a "tour d'horizon" of some of the most widely used techniques in trade and trade-policy analysis. A last piece of advice: When embarking in the formal analysis of trade statistics, the beginning analyst should remember the following "good-habits" principles:

Always take a thorough look at the data to track mistakes, aberrations, missing values etc. This should start with simple procedures like Stata's "summarize" command, but also include plots of all sorts to verify that the data is what the analyst expects it to be. Failing to do this at the outset often means having to redo the analysis at a later point; using the carpenters' maxim, "measure twice, cut once".

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[33] The most widely used measure of welfare impact is the Equivalent Variation (EV) which is defined as the amount of income that would have to be given to (or taken away from) the economy before the policy change to leave the economy as well off as the economy would be after the policy change.

Indices, ratios and variables of interest should always be put in perspective. This means that they should be expressed in ways that make them comparable (e.g. purchasing power parity for cross-country comparisons) but also that parasite influences should be controlled for as much as possible (e.g. openness should not be assessed without controlling for income levels, geography etc.).

Robustness of results should be a constant worry. In ex post analysis, this means e.g. running the regression of interest with different estimation methods and trying various specifications; in ex ante analysis this means verifying how results vary when key parameters (elasticities etc.) vary.

Results should not be over-sold; as the experienced analyst gets to discover, numbers, however hazardous was the way in which they were arrived at, tend to take on a life of their own and do not need over-selling. As a matter of fact the media and even restricted policy circles tend to over-focus on eye-catching results, so caveats are never too many.

These are no more than common-sense pieces of advice. Together with judicious use of techniques such as those described in this paper, they nevertheless guarantee that the analysis' client will get a fair picture of what the numbers can say and what they cannot. If all policymakers could have access to statistical information processed in that way, thoroughly but honestly, policy decisions would be made in a better informational environment and many mistakes would be avoided.

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