TradeSim, the ITC Simulation Model of Bilateral Trade Potentials: Background Paper

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Introduction

As part of ITC's mandate to promote trade in developing countries and economies in transition, ITC has developed a variety of tools for strategic market research aimed at helping trade support institutions and the business sector in partner countries to identify new markets and assess competitive strengths and weaknesses.

These tools include the *TradeMap* programme, which renders national trade performance more transparent and identifies market diversification opportunities on the basis of product-specific international trade statistics. ITC's recently developed *Trade Performance Index* (TPI), which sheds light on the competitiveness profile of 178 countries in 14 different product sectors. This index is based on international trade statistics and results are presented in the form of rankings in a similar way to the UNDP's Human Development Index. For partner institutions which prefer to work directly with primary data, ITC produces jointly with the United Nations Statistics Division *PC-TAS*, which represents the world's largest trade database on CD-ROM. All of these three tools are based on international trade statistics. They derive indicators on future trade potential on the basis of past performance. This approach is useful for a number of product-specific applications for countries which have fairly diversified trade relations. It is, however, of limited use for assessing trade potential between countries that have traded little so far.

It is against this background, that ITC has developed *TradeSim*, an econometric model with the specific objective of estimating bilateral trade potential of developing and transition economies with any of their partner countries. Underpinning ITC's model is the theoretical foundations and empirical robustness of gravity models for the analysis of international trade. Although several gravity models are maintained by other institutions, none of them corresponds to the specific needs of ITC's partner countries, namely a model designed for developing and transition economies and that differentiates by major industrial sector.

The present paper is divided into four sections. The first section looks into the features, strengths and limitations of gravity models, in general. The second section provides the specifications of ITC's model. The third section describes the simulation outputs and how they can be used. A 4th section examines in depth the output for Senegal, chosen as an illustration. Whereas the first two sections are written for a technical audience, the last two sections summarise the outputs and applications of simulations for non-technical users. Appendices provide the technical material to the interested reader.

1. General features of gravity-type models

An important issue for trade promotion policies is that international trade is increasingly structured along natural trading regions and/or natural bilateral trade patterns.

It is important to tackle this issue at a rather aggregated level. While trade potential is the result of matched export capacities and import demands at the microeconomic level, on a more aggregated level of analysis, proximity in demand, in per capita income, in space, and in culture, are key macroeconomic determinants of export potentials. In total, trade flows are following the physical principles of gravity and two opposite forces determine the volume of bilateral trade between countries: the level of their economic activity and income, and the extent of impediments to trade. The latter include in particular transportation costs, trade policies, uncertainty, cultural differences, limited overlap in consumer preference schemes, various bottlenecks etc. National borders are among these impediments, even for industrialised countries. Intra-Canadian trade is much higher than US-Canadian trade (McCallum, 1995). In total, various combinations of macro-economic variables, such as gross domestic products and populations with geographic distance, are powerful predictors of trade potentials. Hence, gravity equations have extensively been used in the empirical literature on international trade. (Havrylyshin and Pritchett, 1991; Frankel and Wei, 1993; Bayoumi and Eichengreen, 1995). The related econometric models can also be used to predict trade patterns at the industry level (Bergstrand, 1989). In this case, the elasticities vary across industries for a given macro-economic variable; and these elasticities are those which help to predict future paths of specialisation.

1.1. A traditional tool recently updated

Initially, gravity models were developed on a mostly empirical basis, with researchers emphasising that country size and transportation costs between countries were good predictors of trade volumes[1]. And results were indeed positive, since such equations fit the data quite well. However, the lack of theoretical foundations rapidly led scholars to scepticism, and Anderson (1979), Helpman and Krugman (1985) and Bergstrand (1989) provided the missing theoretical basis. While Bergstrand built a general equilibrium model of world trade from which reduced equations may be derived, Helpman and Krugman showed that the combination of comparative advantages and monopolistic competition provided a coherent conceptual framework for empirical analysis.

[1] According to Hummels (1998), the leading determinant of bilateral trade is trade costs, defined as the combination of tariffs and distance. As trade barriers affect the sectoral prices and production or consumption patterns, using GDP-related variables in import equations will lead to biased results. Hence, simple indicators of exporter and importer (the so-called specific effects) may tentatively replace all macro-economic variables and sectoral variables. In this case, bilateral imports at the industry level can be considered as a function of the trade

On this basis, a large number of studies were undertaken. Within this mushrooming literature, gravity equations share a common design that can be customised for different purposes:

- First, a gravity equation is *bilateral*. It explains a trade-related dependent variable, by the combination of macroeconomic variables (size, income, exchange rates, prices etc.) for both countries. Indicators of transportation costs between the two countries and more generally market access variables are added.

- Second a gravity equation *may be used in order to estimate either determinants of the volume or determinants of the nature of trade flows*. In the latter case, the purpose is to use an index of intra-industry trade as dependent variable[2].

- Third, *theory* definitively *provides strong foundations to a modelling based on rough indicators*, which is quite useful when the purpose is to integrate a large number of countries in the sample or when the statistical background for (developing) countries is limited.

- Fourth, there is inevitably a discrepancy between the theoretical model and the « ideal » equation that would fit the data well. Border trade, seasonal trade, trade preferences or regional integration may be controlled for with specific effects by pair of country; such a solution however jeopardises any attempt to use the model for forecasting purposes[3]. This justifies the *introduction of cultural, historical or institutional determinants* in equations designed for an applied purpose.

- Lastly, given the type of variables under consideration, gravity-type econometric models are *estimated using rather aggregated data*. Numerous studies run equations on total exports. Studies considering more specifically developing countries disentangle at least food and manufactures. Bergstrand (1989) uses the single-digit level of SITC (9 industries) for 16 OECD countries. Using cross-sectional data, this leads to 240 observations per industry. In this case, in contrast to Box 1, we can no longer use the economic distance (the difference in income per capita) as an indicator of the intensity of comparative advantages: it is the direction of the comparative advantage we are interested in. Hence, exporters' and importers' incomes per capita must be introduced separately as independent variables. The sign of the respective parameter estimates will change according to industries. In a forthcoming paper,

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costs alone.

[2] While income per capita is a good indicator of demand and trade volumes, differences in per capita incomes reflect differences in factor proportions: rich countries are generally relatively well endowed in physical and human capital, in contrast to developing countries. Hence, large differences in per capita income will be associated with a lower share of intra-industry trade in bilateral trade.

[3] This is the solution suggested by Hummels and Levinsohn (1995). In contrast, Fontagné, Freudenberg and Pajot (1999) highlight the difficulty in applying these models to simulation purposes.

DIW (Deutsches Institut für Wirtschaftsforschung, German Institute for Economic Research) will classify industries in 3 different ways: i) by sector[4], ii) by determinants of competitiveness[5], iii) by labour qualification[6].

BOX 1: country size and trade patterns

In order to illustrate the logic behind gravity models, let us take a simple example addressing the issue of «country size » which is central in the so-called 'New International Trade Theory'.

The intuition is the following: consider two countries. While the product of their GDPs is a good predictor of the intensity of their bilateral trade, the difference in their GDPs may be interpreted as a proxy for differences in home market sizes.

Hence, using a monopolistic competition framework, we can build on the relationship between country size and the variety produced by countries[7]: a large country offers more variety. Since all varieties of a given product are consumed in each country, the larger country will be a net exporter of differentiated products. And the larger the difference in country sizes, the larger the trade imbalance for differentiated products, and the smaller the shares of intra-industry trade in bilateral trade.

In addition, if the size matters, larger countries will be the more advantaged in activities characterised by increasing returns –ceteris paribus. In total, a difference in GDPs may lead to deeper specialisation of the corresponding countries, inducing a larger share of inter-industry trade in bilateral trade.

References: Theory in Helpman and Krugman (1985); proof in Hummels and Levinsohn (1995) on OECD data; and in Fontagné, Freudenberg and Péridy (1999) on EU12 data.

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[4] Agriculture, mining and manufactures.

[5] Resource intensive, labour intensive, differentiated, scale intensive and technology intensive.

[6] High/low wages.

[7] This is exactly what dynamic export equations embodying differences in the growth of domestic and competitors manufactured output do: a manufactured output growing at a higher pace mirrors a larger share of world varieties being produced by the domestic economy, and hence an improved non-price related competitiveness.

1.2. The design of gravity models

The most common design is the following:

$$\textbf{[1]} \qquad X_{ij} = a_0 Y_i^{a_1} Y_j^{a_2} L_i^{a_3} L_j^{a_4} D_{ij}^{a_5} P_{ij}^{a_6} e^{u_{ij}}$$

With:
X_{ij} the total exports from *i* to *j*
Y_i, Y_j the countries' incomes
L_i, L_j the countries' population
D_{ij} the geographical distance between *i* and *j*
P_{ij} a preferential trade scheme dummy
u_{ij} the normal random error term

Such an equation can be alternatively written (Sanso et al. 1993):

$$\textbf{[2]} \qquad \begin{aligned} & X_{ij} = a_0 y_i^{a_1} y_j^{a_2} L_i^{a_{3*}} L_j^{a_{4*}} D_{ij}^{a_5} P_{ij}^{a_6} e^{u_{ij}} \\ & y = \frac{Y}{L}; a_3{*} = a_1 + a_3; a_4{*} = a_2 + a_4 \end{aligned}$$

or

$$\textbf{[3]} \qquad \begin{aligned} & X_{ij} = a_0 y_i^{a_1{*}} y_j^{a_2{*}} Y_i^{a_3{*}} Y_j^{a_4{*}} D_{ij}^{a_5} P_{ij}^{a_6} e^{u_{ij}} \\ & a_1{*} = -a_3; a_2{*} = -a_4; a_3{*} = a_1 + a_3; a_4{*} = a_2 + a_4 \end{aligned}$$

It is generally estimated in a log-linear form such as [4]. Such a specification provides elasticities of bilateral trade to income, country size and distance.

$$\textbf{[4]} \qquad \begin{aligned} & \log X_{ij} = a_0{*} + a_1{*}\log y_i + a_2{*}\log y_j + a_3{*}\log Y_i + a_4{*}\log Y_j + a_5 \log D_{ij} + a_6 P_{ij} + u_{ij} \\ & a_0{*} = \log a_0; P_{ij} = (1,0) \end{aligned}$$

Models generally use nominal incomes at current exchange rates. However, this may introduce a bias when developing countries or countries in transition are integrated in the sample. Using PPPs will give slightly different trade potentials for such countries. It is sometimes argued that PPPs would be much more appropriate to estimate trade potentials in the long run, an horizon in which all exchange rate adjustments towards equilibrium have taken place. In contrast, current income would be more appropriate to analyse short-term trade potentials. However, in our model, estimating trade equations using PPPs variables leads to unreliable and highly sensitive elasticities. Hence, the alternative solution adopted here is to estimate elasticities with current exchange rates, but using a sub-sample of developing countries trading will all their partners, developing or industrialised.

BOX 2: Alternative specifications of the basic gravity equation

An illustration of the relationship between equations 1 to 3 is given in the table below, neglecting the preferential trade dummy variable. This is estimated for 53 developing countries facing 75 partners in 1995-96. We consider total trade excluding minerals. The model is estimated in a log-linear form as in [4], providing elasticity of bilateral trade to income, country size and distance. A 1% increase in the size of the exporting country leads to a 1.3% in its exports, whereas a 1% increase in the size of the destination market leads to a 1% increase in exports. A 10% increase in GDP per capita in the exporting country leads to a 1.2% increase in it exports.

	Parameter	St error
intercept	-14.381	0.512
GNPi	1.329	0.022
GNPj	1.065	0.021
GNP/POPj	0.127	0.031
GNP/POPi	0.224	0.028
Distij	-1.439	0.042
AdjR2	0.699	
n	3921	

Trade theorists have validated these specifications, *ex post*. But the only reduced form to be based on a complete model embedding imperfect competition and traditional theories is equation [5] in Bergstrand (1989).

$$\textbf{[5]} \qquad X_{ij} = a_0 y_i^{a_1} y_j^{a_2} Y_i^{a_3} Y_j^{a_4} D_{ij}^{a_5} P_{ij}^{a_6} E_{ij}^{a_7} PR_i^{a_8} PR_j^{a_9} e^{u_{ij}}$$

In the latter equation, in accordance with the theoretical model, national incomes are taken as proxies for outputs, incomes per capita as proxies for factor endowments, D_{ij} as a proxy for transportation costs, while P_{ij} is a dummy for preferential tariff rates.

Since PR_i and PR_j are price indexes and E_{ij} is the bilateral nominal exchange rate index, the combination of these variables account for price competitiveness at the aggregated level.

Interestingly, the same equation can be estimated at the industry level (adding an industry subscript, *k*, to X_{ij}, PR_i and PR_j): Bergstrand uses a breakdown of total trade into the 9 sections of the SITC. In accordance with his theoretical framework, it would be necessary to introduce price indexes for each SITC section and for each country. Since such data sets were not available to the author, he used wholesale price indexes. The results are nevertheless interesting since parameter estimates vary according to industries (in magnitude but also in direction). Alternatively a pooling of industries could introduce specific effects on industries. The preference margin itself could be tabulated at the industry level (Fontagné and Péridy, 1995), and not using a dummy as in Bergstrand.

1.3. Applications and shortcomings of gravity models:

Gravity equations are one of the most popular tools in empirical studies addressing issues in international trade. Four categories of applications can be mentioned: estimating the cost of the border, explaining trade patterns, identifying effects related to regionalism and lastly tabulating trade potentials.

Cost of the border

If the presence of a common border facilitates bilateral trade between nations *i* and *j*, the same border is also an hindrance to trade. Hence, ceteris paribus, trade between regions of *i* should be more developed than trade between regions of *i* and regions *j*. This is the so called "border effect". Using data for inter-provincial trade, McCallum (1995) has shown that trade between Canadian provinces is 20 times larger than between these provinces and the United States. Wei (1996) relaxes the need for internal trade data. Country's trade with itself is simply the difference between its output and its aggregate exports to other nations. Using this type of definition, the border effect is 3 to 10 for OECD countries, according to specifications. In total, estimating an equation in which the imports of country from country *j* are divided by imports of country *i* (including internal imports) may identify the implicit protectionism of countries. Head and Mayer (1998) calculate such relative imports. The latter are explained using a gravity type equation disaggregated by industry. The border effect internal to the EU is 12 to 20 according to specifications. Crossing a border is equivalent to four times the average distance between national markets in the sample. To put it differently the average ad-valorem equivalent tariff of the borders in the single market is 37%.

Explaining trade patterns

Trade patterns have also been investigated using gravity-type equations. The trade overlap (i.e. two-way trade within industries) is examined in Bergstrand (1989) and Hummels and Levinsohn (1995): they tabulate bilateral indexes of intra-industry trade at the industry level. These indexes are then aggregated and their weighted average is explained using a gravity equation. Trade types, an alternative method used to disentangle trade in intra-industry versus inter-industry flows, are explained in Fontagné, Freudenberg and Péridy (1998). They calculate trade types at the 8-digit product level and aggregate the results at the industry level. These trade types are explained using equations integrating gravity-related variables. However, the three papers consider trade shares rather than trade volumes, which departs slightly from the bulk of work on gravity equations.

Trade creation versus trade diversion

Gravity equations have also been extensively used to address the issue of regionalism. Consider that our two countries *i* and *j* sign a regional agreement. Introduce two dummies: «both in» (*i* and *j* in the agreement) and «in out» (otherwise). If the parameter estimate for «both in» is positive and significant there is trade creation due to regionalism. In contrast, if the parameter estimate for «in out» is negative and significant, there is trade diversion. This exercise can be done in order to simulate trade potentials corresponding to any regional integration scheme between any grouping of countries.

Calculation of trade potentials

Lastly, the tabulation of trade potentials is certainly the line of research that has been studied the most extensively by economists. This methodology has been in particular used extensively for Central and Eastern European Countries, (Wang and Winters, 1991; Havrylyshyn and Pritchett, 1991; Baldwin, 1993; Gros and Gonciarz, 1995; Schumacher, 1995 and 1997; Festoc, 1996).

The first step consists of selecting the sample of countries between which trade is supposed to have reached its potential. Bilateral trade flows are considered between these countries, in a symmetric manner.[8] A gravity equation explaining bilateral exports within the sample is then estimated. This equation is used in simulation to obtain natural bilateral trade between any pair of countries, given that distance, GDPs and population are systematically available. Such simulated bilateral exports are compared with observed ones in order to infer bilateral export potentials. Such a methodology can be applied either at the aggregated or industry level, but has not yet been extensively implemented on an industry basis.

However, numerous difficulties appear systematically using such a methodology[9].

First, problems of **multicolinearity** are often faced. It is difficult to know whether existing studies do systematically tackle this issue since relevant statistical tests are generally not reported. However, when tackling this problem, authors generally use specific versions of the equation. For instance the Balassa-Bauwens transformation [6] has been extensively used (for example, see Fontagné, Freudenberg and Pajot, 1999).

[6]

$$DIFFY_{ij} = 1 + \frac{\left[w \log w + (1-w)\log(1-w)\right]}{\log 2}$$

$$w \equiv \frac{Y_i}{Y_i + Y_j}$$

[8] It is however technically possible to consider mirror statistics only for some non-reporting countries.
[9] The WIFO institute, in Austria, has conducted pioneering studies in this field (Egger, 1999; Breuss et Egger, 1997).

A related issue is how to introduce explanatory variables associated with **income**:

- individually, such as referred to above;
- transformed as in [6];
- in difference [7];
- as a ratio;
- as Hummels and Levinsohn do in [8];
- or in a multiplicative form (Bayoumi and Eichengreen 1995- Frankel and Wei, 1993). The latter solution must be chosen when bilateral trade is considered (X+M) since the share of bilateral trade in world trade is simply the product of the share of both countries in world trade or in world output (notwithstanding hindrances such as distance) [9].

$$\textbf{[7]} \qquad DIFFy_{ij} = \left| y_i - y_j \right|$$

$$\textbf{[8]} \qquad a_3 \min\left(\log y_i, \log y_j\right) + a_3' \max\left(\log y_i, \log y_j\right)$$

$$\textbf{[9]} \qquad \left(X_{ij} + X_{ji}\right) = a_0\left(y_i y_j\right)^{a_1}\left(Y_i Y_j\right)^{a_3} D_{ij}^{a_5} P_{ij}^{a_6} e^{u_{ij}}$$

The multiplicative form is finally nothing else than the estimate of the ratio of effective to potential bilateral trade. This feature is illustrated by equation [10]. If Y_i is changed into $T_{i\bullet}$ and Y_j into $T_{j\bullet}$, with the point used as the additive operator, then [11] can indifferently be estimated as in [12], after adding a scale, here the world trade. The dependent variable in [12] can be written as the ratio of the observed share of bilateral trade in world trade to the potential share. Hence, frictions such as transaction cost can explain any deviation from this ratio. (Freudenberg *et al.*, 1998).

$$\textbf{[10]} \qquad \begin{aligned} T_{ij} &= a_0\left(Y_i Y_j\right)^{a_1} D_{ij}^{a_2} e^{u_{ij}} \\ T_{ij} &\equiv X_{ij} + X_{ji} \end{aligned}$$

$$\textbf{[11]} \qquad T_{ij} = a_0\left(T_{i.} T_{j.}\right)^{a_1{}^*} D_{ij}^{a_2{}^*} e^{u_{ij}}$$

$$\textbf{[12]} \qquad \frac{T_{ij}}{T_{i.}T_{j.}} T_{..} = a_0 D_{ij}^{a_2{}^{**}} e^{u_{ij}} = \frac{T_{ij}}{T_{..}} \frac{T_{..}^2}{T_{i.}T_{j.}} = \frac{T_{ij} / T_{..}}{T_{i.}T_{j.} / T_{..}^2}$$

A third issue is whether the model has to be estimated in **first differences** in order to drop out measurement problems associated with distance, which differs from shipping costs (Bayoumi and Eichengreen 1995). The distance may however successfully be replaced by a weighted relative distance (using shares of partners in world trade or in output). Of course, these relative distances may vary over time.

Another issue is whether models have to be estimated using **cross section** or **panel data**. Matyas (1997, 1998) and Egger (1999) advocate that estimators are biased if one does not use panel estimates. Examining the integration of Eastern European countries to the international market, Fontagné, Freudenberg and Pajot (1999) demonstrate that potentials are under-estimated if one uses a cross-section for the final period, whereas a cross section for the initial period leads to a symmetric bias. However, this bias is not dramatic, even in extreme cases. In addition it is often difficult to collect data for a stable panel of developing countries and industries over a long period of time.

Lastly, they are non-linearities in the relationship, disqualifying any attempt to transpose elasticities obtained for developed countries to developing ones. This justifies the specific methodology used by ITC as referred to in the next sections. Accordingly, this methodology departs from the principle of estimating natural trade on a selection of a sample of countries between which trade is supposed to have reached its potential. Precisely, the related elasticities cannot be transposed. Hence, the sample includes developing countries trading with developing and developed countries, and the potential is *not* the difference between observed and simulated trade, as Equation [16] will highlight.

2. Design of *TradeSim*

The main purpose of using a gravity model at the Market Analysis Section (MAS) is to extend ITC's expertise in the following fields: bilateral trade potentials, regional (South-South) integration and dynamics of comparative advantages. An additional connection could be the simulation of changes in the environment of exporters, such as trade preferences and more generally trade negotiations, for specific sectors. At this stage, the latter is only an optional issue, since numerous studies – not to be replicated – are being undertaken elsewhere using alternative methodologies (WTO, World Bank and UNCTAD). It is also worth mentioning that the simulation of changes in the environment of exporters justifies to put emphasis on rather ignored topics such as transaction costs, security costs and cultural dimensions.

2.1. Purpose and general features

The constraint is to implement a simple tool that may be implemented in a systematic manner in order to scan international data. In doing this, a great concern has been i) to innovate rather than duplicate and ii) to build a tool matching the specificity of countries ITC that is interested in.

The basic set of equations in *TRADESIM* is the following:

- South-world model: a set of 53 exporting countries (the "South") has been selected to build this model (see Table 1). The selected countries are not member of the OECD (as of 31 December 1996), have not been affected by recent political instability, produce reliable data, are not of too small size (total exports excluding minerals are superior to US$ 0.5 billion) and their re-exports are not significant. The set of 75 importing countries (the "world") includes these 53 countries in addition to the 21 OECD countries and Hong Kong. Hong Kong has been excluded from the sample of exporting countries due to the size of its re-exports. However, it has been included in the set of importing countries.

- South-South model: for the exporting countries, the same sample is used. For the importing countries, OECD countries have been excluded.

- OECD-OECD model: estimated on the OECD countries sub-sample of reporting countries. The corresponding elasticities are used in the reverse market share analysis (see below).

The 1995-96 average is considered for all figures. Hence one uses cross-sectional estimates as a basis for simulation.

Trade is considered fuels and minerals excluded, but mono-exporters are not dropped out, provided that their trade is not too small having excluded fuels and minerals.

Bilateral export and import equations are estimated for trade as a whole and by industry clusters.

In total, *TradeSim* can be used for simulating:

- *Bilateral trade potentials*: As referred to previously the principle is to estimate an equation on a sample of countries and then use this equation for simulation purposes in order to derive theoretical (or natural) levels of trade. The comparison of simulations with observed flows enables to identify untapped trade potentials, provided that these potentials are not directly tabulated as the difference of observed and simulated flows.

- *Reverse Market Share Analysis*: Exports towards all partners are simulated separately for OECD and non-OECD countries, using two alternative sets of elasticities. In a second step, these simulations are merged. In a third step data is sorted by *importing* country. Lastly, observed and potential market shares of all competitors are compared for each market (a market is defined as the combination of a cluster and an importing country). The objective is to identify new suppliers that have neglected the import market under review.

- *Natural regions*: Such a set of equations may be useful in order to scan international trade data in order to identify "optimal trade areas". The principle is to identify major “natural trade partners” for each reporting country or region.

- *Dynamics of comparative advantages*: It is possible to address the dynamics of comparative advantage (Feenstra and Rose, 1997), given that scenarios of catching up for emerging countries can be considered, with an output in terms of changes in the specialisation.

2.2. The selection of industry clusters and estimation sample

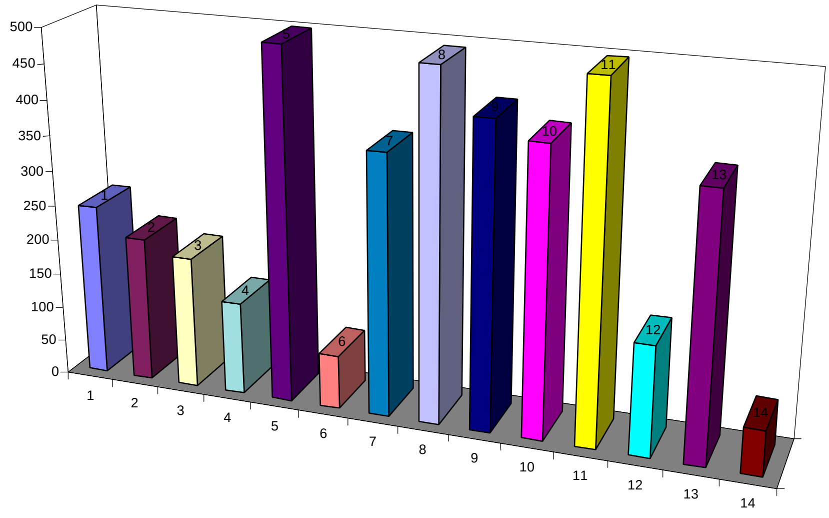
A total of 261 groups of products (defined at the 3 and 4 digit industries of the SITC) have been classified into 14 sectors, which represent total trade excluding minerals (fertilisers, ferrous waste, precious metal ores, coke, petroleum oil crude, etc.). The 14 sectors, corresponding to the classification used for the *Trade Performance Index*, are the following:

- Sector 1: Fresh food and agro-based products (live animals, vegetables, cotton etc.);
- Sector 2: Processed food and agro-based products (milk, cereal preparations, tobacco, manufactured, essential oils etc.);
- Sector 3: Wood, wood products and paper;
- Sector 4: Yarn, fabrics and textiles;

- Sector 5: Chemicals (rubber, chemical elements, medicaments, polymers, plastics, etc.);
- Sector 6: Leather and leather products (including footwear);
- Sector 7: Metal and other basic manufacturing (cement, pottery, glass, iron, steel, tools, etc.);
- Sector 8: Non-electric machinery (engines, tractors, machine-tools, pumps etc.);
- Sector 9: Computers, telecommunication equipment, consumer electronics;
- Sector 10: Electronic components;
- Sector 11: Transport equipment (motor vehicles, cycles, aircraft, ships etc.);
- Sector 12: Clothing;
- Sector 13: Miscellaneous manufacturing (sanitary equipment, measure instrument, watches, ammunition, musical instruments etc.);
- Sector 14: Petroleum products (excluding crude petroleum).

Taking the 1995-96 average, the breakdown of total trade of the 75 reporting countries within our database is given in Figure 1. Three sectors account for US$ 500 billion each: chemicals, non-electrical machinery and transport equipment. Four sectors range between $300 to $450 billion: metal and other basic manufacturing, computers, electronic components and miscellaneous manufacturing. Fresh food, processed food, wood and clothing, yarn, fabrics and textiles account each for $130 to $250 billion. The two "small" sectors are leather and shoes and petroleum products. We decided to distinguish the former from textile products, while the latter is isolated due to its specific nature and the possible perturbations introduced in the model by such products.

Figure 1: Breakdown of total trade by sectors within the sample (1995-96) (US$ billion)



Source: COMTRADE

The sample of countries used for the estimation phase is asymmetric. There are 75 countries in the sample, out of which only 53 are considered as exporters (to 74 markets) in the South-world specification. In this specification, we focus on developing countries exports to developing and developed countries. In the South-South specification, there are 52 exporting and 53 markets (Hong Kong being excluded from the sample of exporting countries).

Table 1: Country sample for *TRADESIM* estimates

Country	Exporter	Market	Code	Country	Exporter	Market	Code
Argentina	1	1	ARG	Korea	1	1	KOR
Australia		1	AUS	Latvia	1	1	LVA
Austria		1	AUT	Lithuania	1	1	LTU
Belgium		1	BEL	Madagascar	1	1	MDG
Bangladesh	1	1	BGD	Malaysia	1	1	MYS
Bolivia	1	1	BOL	Malta	1	1	MLT
Brazil	1	1	BRA	Mauritius	1	1	MUS
Canada		1	CAN	Mexico	1	1	MEX
Chile	1	1	CHL	Morocco	1	1	MAR
China	1	1	CHN	Netherlands		1	NLD
Colombia	1	1	COL	New Zealand		1	NZL
Cameroon	1	1	CMR	Nicaragua	1	1	NIC
Costa Rica	1	1	CRI	Norway		1	NOR
Cyprus	1	1	CYP	Pakistan	1	1	PAK
Czech Republic	1	1	CZE	Paraguay	1	1	PRY
Denmark		1	DNK	Peru	1	1	PER
Ecuador	1	1	ECU	Philippines	1	1	PHL
Egypt	1	1	EGY	Poland	1	1	POL
Estonia	1	1	EST	Portugal		1	PRT
Finland		1	FIN	Saudi Arabia	1	1	SAU
France		1	FRA	Singapore	1	1	SGP
Germany		1	DEU	El Salvador	1	1	SLV
Greece		1	GRC	Slovenia	1	1	SVN
Guatemala	1	1	GTM	South Africa	1	1	ZAF
Honduras	1	1	HND	Spain		1	ESP
Hong Kong		1	HKG	Sudan	1	1	SDN
Hungary	1	1	HUN	Sweden		1	SWE
Iceland	1	1	ISL	Switzerland		1	CHE
India	1	1	IND	Thailand	1	1	THA
Indonesia	1	1	IDN	Trinidad and Tob.	1	1	TTO
Ireland		1	IRL	Tunisia	1	1	TUN
Israel	1	1	ISR	Turkey	1	1	TUR
Italy		1	ITA	United States		1	USA
Côte d'Ivoire	1	1	CIV	United-Kingdom		1	GBR
Jamaica	1	1	JAM	Uruguay	1	1	URY
Japan		1	JPN	Venezuela	1	1	VEN
Jordan	1	1	JOR	Zimbabwe	1	1	ZWE
Kenya	1	1	KEN	Total	53	75	

2.3. Estimation results

Stepwise estimates have been extensively ran and all statistical tests performed, including multicolinearity diagnosis. Some variables, not reported here, have been dropped out given their low contribution. The set of equations on which elasticities used in the simulation phase are based (Table 2) is the following:

$$\log X_{ij} = a'_0 + a_1 \log y_i + a_2 \log y_j + a_3 \log Y_i + a_4 \log Y_j + a_5 \log D_{ij} + a_6 L_{ij} + \sum_z a_z Z_{zij} + u_{ij} \quad [13]$$

$$a'_0 = \log a_0$$

with Z a vector of dummies according to regional trading arrangements and L a dummy of common language between the two countries.

Table 2 : Elasticities used in the simulation phase

Sector	Yi	Yj	yi	yj	DijR
1	1.1675	1.0612	-0.5205	0.3163	-1.4843
2	1.2185	0.8359	0.2873	0.2886	-1.5701
3	1.0682	0.7895	0.2518	0.0924	-1.7887
4	1.5208	0.7529	-0.1437	0.1541	-1.4391
5	1.4533	0.8986	0.6464	-0.1418	-1.5704
6	1.2618	0.7371	-0.0711 **	0.3189	-1.2211
7	1.5553	0.8776	0.4226	(-0.0009)	-1.5635
8	1.3485	0.7996	0.6571	-0.0827	-1.4201
9	1.3044	0.6285	0.6792	0.2499	-1.0316
10	1.3372	0.6794	0.6669	0.1398	-1.2827
11	1.2674	0.6125	0.4334	0.1062	-1.4397
12	1.1306	0.6902	(-0.0059)	0.7106	-1.3080
13	1.3516	0.7582	0.4490	0.3423	-1.3097
14	0.5301	0.5362	0.2085	-0.0919	-1.8201
Total trade	1.3332	1.0534	0.2616	0.1866	-1.4046

Significance level
(-): Not significant at the 10% level
**: Significant at the 5% level only
Significant at the 1% level otherwise

3. Simulations Output

The basic output of a simulation exercise is a set of "normal" exports of a given reporting country to each of its elementary markets, according to its size, its income level, the distance from foreign markets, etc. One elementary market is the market for one cluster in one importing country. In a first stage, this exercise is made at the global level, considering all products as a whole. Then it is replicated for each sector. The definition of trade potentials differs according to the type of exercise considered, as detailed now.

3.1. Calculation of aggregated trade potentials

Consider for example China, which is a rather simple example to start with. The basic equation that has been estimated for *total* bilateral trade in our sample of 53 exporting countries competing on 75 markets is the following:

$$\begin{aligned}
&\log X_{ij} = -28.130 + 0.261\log y_i + 0.186\log y_j + 1.333\log Y_i + 1.053\log Y_j \\
&-1.404\log D_{ij} + 0.834\log L_{ij} \\
[14]\ &+1.604\log LOME + 1.490\log COMESA + 1.003\log ANDEAN + 2.823\log CACM + 5.688\log CARICOM \\
&n = 3921 \\
&AdjR^2 = 0.759 \\
&Cond.numb = 27
\end{aligned}$$

This equation can be used in simulation using values of these variables for China and for each of its 74 destination markets. The basic information obtained is thus a set of 74 simulated export values (Table 3). Chinese exports, as defined here, sum up to US$ 192,249 million. This is to be compared with the simulated value of US$ 191,619 million.

This difference is to be associated with residuals in the equation estimated and this deviation from the observed value of total exports has to be taken into account when tabulating potentials. However, since residuals are not distributed uniformly in the sample, deviations for large markets have to be excluded from the deviation accounted for when tabulating the correction. From a practical point of view, the tabulation of trade potentials is a two-step procedure.

First step: correction of simulated trade values for overall deviation

In this first step, we systematically exclude the residual associated with the destination market from the total residual, when tabulating the correction factor for this destination market. As a result, the adjusted simulated trade in the last column, does *not* sum up to the total simulated Chinese exports. More formally, the adjusted simulated trade for China (superscript star) differs from the simulated trade (superscript hat) as in equation 15.

[15] $$X_{ij}^{*} = \hat{X}_{ij} \cdot \frac{\sum_{k,k \neq j} X_{ik}}{\sum_{k,k \neq j} \hat{X}_{ik}}$$

$$X_{i}^{*} = \sum_{j} X_{ij}$$

This correction is applied to all partners in order to obtain potentials in the last column. In total, Chinese exports could be enhanced by roughly 50% if adjusted "natural" values of exports were reached on each individual market.

Turning to individual markets for Chinese exporters, the following results are obtained. Ceteris paribus, Chinese sales on the Japanese market could be 700% of their current value, given the size of these countries, their relative distance, their income per capita, and notwithstanding the facts that they do not belong to a common regional arrangement and do not speak a common language. Hence, Japan is the leading potential market for China. Such result is certainly biased by the re-exportation through Hong-Kong (see the outstanding result for Hong Kong). There is also a large potential for a percentage increase with Lithuania and Latvia, but for negligible values. Hence, it must not be considered. In contrast, the US$ 23,560 million potential with Korea highlights a second promising market for Chinese exports. India, Sweden, Israel, Venezuela, Switzerland, Finland and Austria are also promising.

At the opposite end of the spectrum, Chinese performances are outstanding on other markets, since they largely overwhelm their “natural” values. Considering markets larger than US$ 100 million, this is the case for Chile, Peru, New Zealand, Morocco, Egypt, South Africa, Bangladesh, Australia, Argentina, Canada, and the United States. In the latter case, the “normal” amount would be US$ 12 billion, to be compared with the observed US$ 41 billion. The figures obtained for Chinese exports to Hong Kong, already stressed, deserve much emphasis.

Lastly, the figures obtained for many European countries highlight a simulated pattern that is very similar to the observed one. This is the case for Denmark, Portugal, Italy, the UK and France.

Table 3: Tabulation of bilateral adjusted simulated Chinese exports (All products)

Importer	Observed	Simulated	Adjusted simulated	Importer	Observed	Simulated	Adjusted simulated
JPN	32583	113261	230783	BGD	429	121	121
KOR	6798	21600	23560	CZE	212	101	102
USA	41735	15025	12806	EGY	371	94	94
DEU	9436	7489	7435	HUN	233	85	86
HKG	57973	6321	4580	NZL	414	85	85
FRA	4253	4351	4368	COL	86	53	53
ITA	3202	3078	3086	VEN	36	50	50
GBR	3085	3068	3078	SVN	39	39	39
IND	610	1186	1194	CHL	446	37	37
ESP	1821	1145	1145	PER	171	33	33
NLD	2581	1116	1111	MAR	133	33	33
THA	1757	1052	1052	TUN	53	23	23
CAN	2806	1030	1024	CYP	59	21	21
CHE	766	932	936	ISL	16	16	16
MYS	1573	864	864	LTU	4	14	14
AUS	2514	795	791	JOR	90	10	10
BEL	1186	783	784	GTM	31	10	10
SWE	408	773	777	ECU	31	9	9
AUT	579	674	676	URY	45	9	9
IDN	1329	542	541	LVA	3	9	9
DNK	614	529	531	EST	12	8	8
SGP	3936	528	520	KEN	83	7	7
PHL	721	495	496	SDN	41	7	7
BRA	753	492	493	SLV	16	6	6
NOR	517	486	488	CIV	51	6	6
FIN	341	410	412	CRI	19	6	6
TUR	471	388	389	CMR	12	6	6
SAU	920	358	358	MLT	26	5	5
MEX	444	292	292	MUS	62	5	5
GRC	330	281	282	ZWE	21	5	5
POL	552	271	272	PRY	61	4	4
ISR	158	245	246	TTO	19	3	3
PAK	559	208	208	JAM	21	3	3
ARG	531	180	181	MDG	18	2	2
PRT	183	164	165	BOL	10	2	2
ZAF	555	145	145	HND	16	2	2
IRL	276	129	129	NIC	3	1	1
				TOTAL	192249	191619	307133

Source: Present trade figures are based on UN data (average over the 95-96 period). Simulations are based on *TradeSim*.

In total, the result of this exercise is three-dimensional: observed value, simulated value, and potential increase. Such tri-dimensional information is however difficult to handle when large samples of partners or clusters have to be considered. In addition, the adjustment process may lead to dramatic differences between unadjusted and adjusted simulated trade flows. The second step of the calculation tackles this issue.

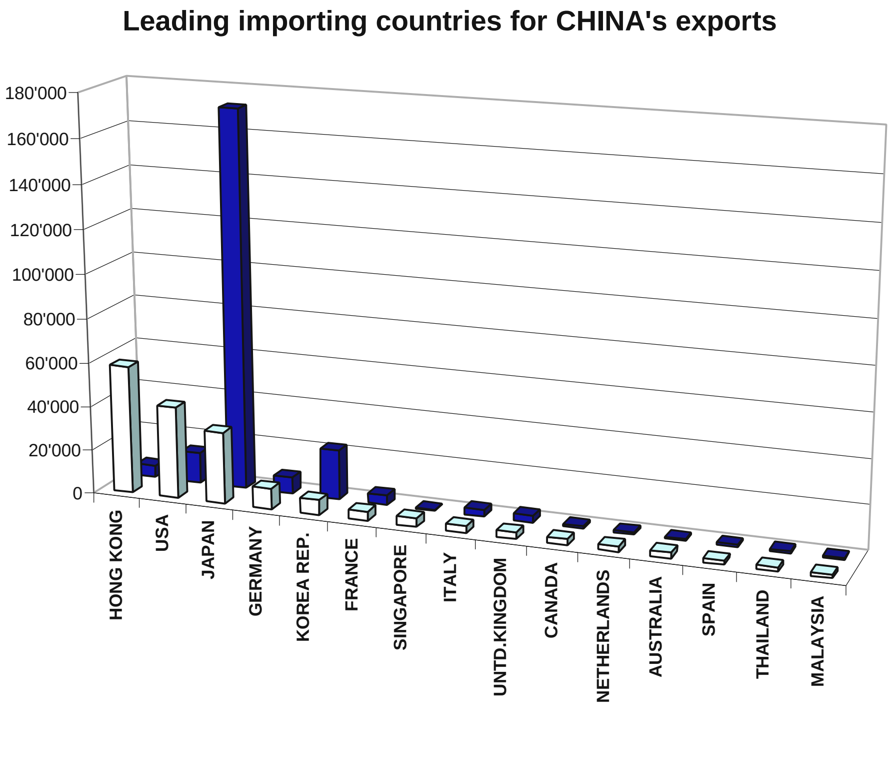
Second step: calculation of trade potentials

In order to tackle such multidimensional information and to smooth discrepancies between adjusted and unadjusted simulated exports, a simple normalised output, summarising all calculations ran so far, has been defined. It provides, for each reporting country, or by cluster, two values: the observed exports, and the average (superscript tilde) of the adjusted and unadjusted simulated bilateral export values (Equation [16]), here defined as *trade potentials*. Figure 2 below gives such information for China by plotting $\tilde{X}_{ij}$ and X_{ij} .

[16]

$$\tilde{X}_{ij} = (X^{*}_{ij} + \hat{X}_{ij}) / 2$$

Figure 2: Export potential for China, all products

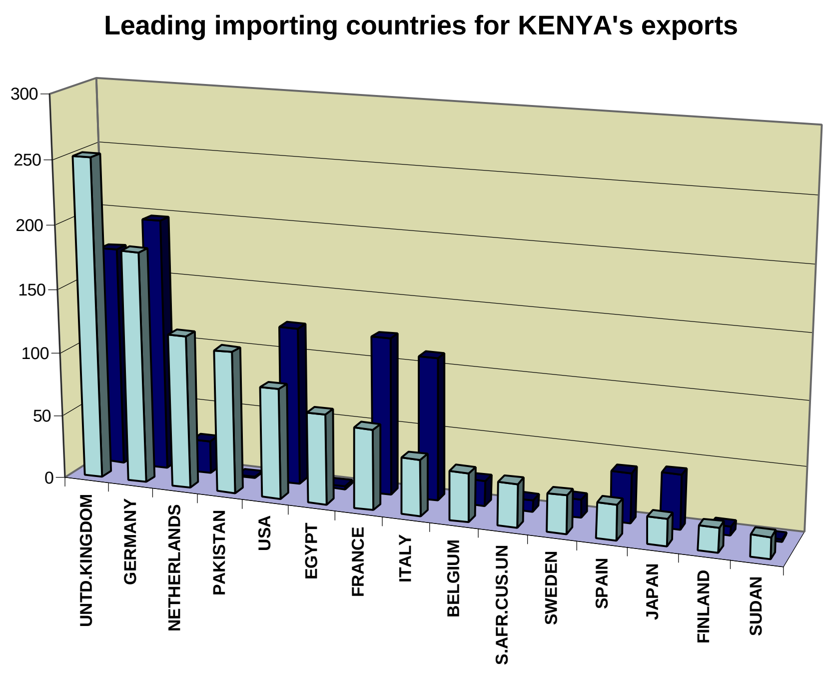


Legend: in white: current exports from China to the corresponding country ; in dark: export potentials to the country

Another example: Kenya

Kenya is an example of a rather small country for which the fit of the equation is necessarily worse than in the Chinese case, given its small weight in the country sample[10]. The observed total value of exports is US$ 1,324 million, to be compared with only 663 million simulated. Such spread between observed and simulated value must firstly be corrected, using the same assumptions and methods as for China. After correction the adjusted simulated trade reaches US$ 1,369 million. This leaves little scope for enhancing total exports. Consider the Japanese market for example. Observed exports reach US$ 20 million, to be compared with 27 million simulated. The ratio of these values is 1.3. However, since Kenya exports on the whole twice as much as the model simulates (before correction), the relative share of the Japanese market for Kenya is much higher and the relative potential increase factor is 2.7.

Figure 3: Export potential for Kenya, all products



Legend: in white: current exports from Kenya to the corresponding country ;in dark: export potentials to the country

The United Kingdom is actually the market absorbing the larger share of Kenyan exports, followed by Germany (Figure 3). However Kenyan exporters underscore on the German market which is their leading potential market. The United States, France and Italy are the markets offering the largest opportunities to Kenyan exporters. Notice however that Kenyan exports to Pakistan, Egypt the South

African Custom Union and to a lesser extent Sudan, are by far larger than expected.

3.2. *Calculation of disaggregated trade potentials*

In order to clarify the specificity of the methodology used for calculating trade potentials at the sector level, it is possible to run a full exercise for a *non-declaring* developing country, hence making use of mirror statistics. Senegal has been chosen. In 1997, the coverage of total trade by mirror statistics was roughly 80% for this country, taking into account the difference between CIF and FOB declarations. According to IMF estimates, mirror statistics give a CIF-total of US$ 360 million, to be compared with US$ 395 million in FOB terms.

Aggregated trade potentials

As far as total trade is concerned, the model fits the data well (Table 4, last row): the simulated exports ($463 million) match the observed ones ($469 million). In addition, the adjusted simulated trade (defined as in Equation [15]), is similar (here, equal in absence of decimals) to the observed trade, which leads to little scope for enhancing Senegalese exports as a whole. This is however the result obtained for estimates at the aggregated level.

Concerning the destination markets, the EU is by far the main market for Senegalese exporters, but a slight potential for increasing exports to the EU remains. Within the EU, the main partners of Senegal are France and Italy, both countries noticeably importing more than simulated. Spain is the third importer of Senegalese products, and has also exhausted its potential. As far as these countries are concerned, the potential of exports is exhausted, which justifies a prioritisation of other destination markets: Germany and the United Kingdom.

Exports towards the Netherlands and Belgium are also underachieved, notwithstanding the fact that Belgium (partly) and Senegal both speak French. In contrast, Portugal and Greece are markets on which Senegalese exporters outperform: in absolute terms, these markets are more important for Senegalese exporters than Belgium, Germany, the Netherlands, Sweden or Austria. This could be associated to preferences in consumption, Greece and Portugal purchasing large amounts of sea food products. It might also reflect the presence of Greek and Portuguese fishing boats in the Senegal territorial seas, since these countries import primarily fresh fish from Senegal. This latter phenomenon illustrates the limitation of an analysis based solely on macroeconomic determinants, especially for exporting countries specialised in a narrow range of products.

[10] Notwithstanding the fact that the model is log-linearised and under-weights large values.

Table 4: Observed and simulated Senegalese export markets

Importer	Observed	Simulated	Adjusted simulated
EU	366	391	383
FRANCE	181	139	119
ITALY	77	43	39
SPAIN	31	28	27
COTE D IVOIRE	18	0	0
UNTD.KINGDOM	16	40	42
GREECE	15	3	3
GERMANY	12	87	102
PORTUGAL	12	5	5
CAMEROON	12	0	0
JAPAN	10	9	9
INDIA	10	0	0
BRAZIL	9	3	3
NETHERLANDS	9	13	13
BELGIUM	9	22	22
HONG KONG	8	0	0
GABON	7	0	0
USA	5	36	38
INDONESIA	3	0	0
THAILAND	2	0	0
SWITZERLAND	2	6	6
DENMARK	2	5	4
TUNISIA	2	0	0
IRELAND	1	2	2
KOREA REP.	1	1	1
CHINA	1	1	1
MOROCCO	1	1	1
S.AFR.CUS.UN	1	0	0
CANADA	1	5	5
TURKEY	1	1	1
SWEDEN	1	5	5
AUSTRIA	0	7	7
FINLAND	0	2	2
Total	463	469	463

Source: Present trade figures are based on UN data (average over the 95-96 period). Simulations are based on TradeSim.

The tight relationship with France referred to above was expected given the historical and cultural links with Senegal. A comparison with the results obtained for other French-speaking sub-Saharan African countries, highlights that it is a general pattern with the exception of Congo (Table 5).

Table 5: Importance of the French market for selected African countries.

Exporting country	Observed exports 1995-96	Potential exports ($\tilde{X}_{ij}$)
CÔTE D'IVOIRE	839	714.5
CAMEROON	398	285.5
SENEGAL	181	129
GABON	164	166
DEM. REP. CONGO	35	144

Source: Present trade figures are based on UN data (average over the 95-96 period). Simulations are based on *TradeSim*.

Other markets in industrialised countries are not important in quantitative terms for Senegal. Japan is a polar case in comparison with France. With the exception of the size of Japan, all other determinants hinder trade. Hence, the model predicts only $9 million of Senegalese exports to this country. Even if this potential is already exhausted, a more qualitative analysis would indicate that given the Japanese consumption patterns (importance of sea food) it remains a potential of exports for such products in which Senegal generally outperforms. Noticeably, according to specialists, Senegal exports some rare species of molluscs that are highly appreciated in Japan.

According to the model, the potential for exports to the US remains large: the US market should represent roughly the Italian market for Senegal. However, the leading Senegalese products miss US distribution channels, do not match local preferences and face the competition of Canada and Alaska. As long as tariff and non-tariff barriers are maintained and criteria of quality are not matched, the econometric result cannot be interpreted in terms of real potential. What the model demonstrates, reciprocally, is that a larger diversification of Senegalese exports (towards clothing for example) could open more widely the US market to Senegalese exporters.

Disaggregated trade potentials

Turning to simulations sector by sector, it must be kept in mind that simulated trade flows by sector deserve adjustment, since residuals refer at least partially to comparative advantages. Using the notations referred to above, trade potentials are simply defined as $\hat{X}_{ijk}$ at the sectoral level. Hence, results must be handled cautiously: the sum of observed trade flows is by far larger than the simulated ones (Table 6). The structure has to be considered, rather than the absolute values.

In this example, such discrepancy is due to processed food for which Senegal outperforms given its macroeconomic characteristics; it is also the case for fresh food, to a lesser extent. The last outstanding performance is for chemicals. In the first column, we identify products within these sectors accounting for such performances: fish (smoked, salted fish, tuna), cotton, groundnut, fertilisers. Hence, it is worthwhile comparing present and simulated foreign trade structures, notwithstanding the systematic bias towards underestimation of performances of individual sectors. It appears that the relative share of processed food in Senegalese exports is 3 times larger than expected, whereas fresh food, despite its importance in absolute terms could account for an even larger share of Senegalese exports.

According to *TradeSim*, in addition to fish, Senegal could perform better for wood and paper, clothing and metal products. Concerning wood and paper, such outcome is however not realistic since Senegal is not well endowed in forestry resources. The only perspective would therefore be to export paper in the sub-region. In contrast, the clothing articles sector is certainly offering promising opportunities, given the domestic and regional crops of cotton (Benin, Burkina Faso) and given the low cost of labour: Asian countries having similar standards of living are large exporters of clothing. The low levels of exports and imports of clothing in Senegal confirm this. However since neighbouring countries do not report either, it is difficult to assess if a regional market for such products exists.

Table 6: Observed and simulated export structure by sector, Senegal 1995-96

Products	Sector	Observed trade (US$m.)	Simulated trade (US$m.)	Present structure (%)	Simulated structure (%)
Fish (fresh, frozen), crustaceans, cotton	Fresh food and agro-based products	251	102	54%	81%
Smoked, salted fish, groundnut oil fish prep. (conserves)	Processed food and agro-based processed products	158	12	34%	10%
	Wood, wood products and paper	1	2	0%	2%
	Yarn, fabrics and textiles	3	1	1%	1%
Manufactured fertilisers	Chemicals	28	1	6%	1%
	Leather and leather products	3	1	1%	0%
	Metal and other basic manufacturing	0	1	0%	1%
	Non-electric machinery	4	0	1%	0%
	Computers, telecomm;cons. Electronics	3	0	1%	0%
	Electronic components	1	0	0%	0%
	Transport equipment	1	0	0%	0%
	Clothing	1	3	0%	2%
	Misc. manufacturing	6	1	1%	1%
	Petroleum Products	4	0	1%	0%
	Sum of the clusters	464	126		
	Total trade (99)	463	469		

Source: Present trade figures are based on UN data (average over the 95-96 period). Simulations are based on *TradeSim*.

4. Concluding Remarks

TradeSim has been designed by ITC with the specific objective of estimating bilateral trade potential of developing and transition economies with any of their partner countries. The basic idea behind the model is that international trade is structured along natural trading regions and natural bilateral trade patterns. Hence, these patterns can be simulated for any pair of countries at the global or at the sectoral level.

It is worthwhile concluding by addressing a case in which the model is supposed to behave poorly, given its foundations. This will underscore shortcomings inherent to the methodology and stress the necessary cautiousness in interpreting the results.

From this point of view, Senegal appears at a first glance as a difficult case study: having a concentrated portfolio of exports, and exporting limited amounts as a whole, this non reporting country is a typical challenge for our modelling exercise. The results however are reinsuring, as highlighted by the following bi-dimensional analysis.

We have already noticed that France is the leading market for Senegalese exporters. The corresponding structure of exports replicates the one referred to above: fish and crustaceans, preserved fish and groundnut oil account for the bulk of these exports. What does *TradeSim* put forward in this case?

Given the absolute values provided in Table 7, France is clearly one of the leading markets for these products.

Table 7: Sectoral breakdown of observed and simulated Senegalese exports to France

Sector	Present trade (US$m.)	Present structure (% total)	Simulated structure (% total)
Fresh food and agro-based products	72	40%	81%
Processed food and agro-based proc.d products	98	54%	13%
Wood, wood products and paper	0	0%	2%
Yarn, fabrics and textiles	1	0%	1%
Chemicals	2	1%	0%
Leather and leather products	3	2%	0%
Clothing	0	0%	2%
Misc. manufacturing	3	2%	1%
Total trade	181		

Note: sectors with zero simulated trade and zero and observed trade are not shown.

Source: Present trade figures are based on UN data (average over the 95-96 period). Simulations are based on *TradeSim*.

For instance, Senegal exports $ 251 million of fresh food products, of which $ 72 million are exported to the French market. Concerning processed food, France accounts for $ 98 million of the $158 million exported to the world. In both cases export potentials are largely overwhelmed: the last column in Table 6, however, shows that processed food products have a much larger share in those exports than expected. In contrast, Senegal could develop its exports by diversifying towards textile products.

Another sensitive issue is related to South-South trade potentials. The model fails to identify any export opportunity associated with extra-regional South-South trade in the Senegalese case. Trade is larger than simulated for developing partners such as India, Brazil and Hong-Kong, Tunisia, Morocco and South Africa. Is there however any scope for regional trade in Western Africa, according to *TradeSim*?

Contrasting with the view of underdeveloped South-South Trade, we observe that the simulated exports to Côte d'Ivoire are very low (US$ 0.2 million) in comparison with the observed ones (US$ 18 million). Such result looks surprising but has been cautiously checked: the multiplicative form of the model, as long as two small countries are concerned, produces such outcome. The same remark can be applied to Cameroon and Gabon. Hence, in total, regional South-South trade is not underachieved in the region given the macroeconomic characteristics of the related countries.

Focusing on the relationship between Senegal and Côte d'Ivoire, one observes that these countries have similar levels of development and culture. However, they do not share any common border, and geographic distances between economic centers are important: the large Guinea is a natural hindrance to trade between these two countries if goods aren't shipped by sea. The economic theory considers that similarity in income per capita and economic size is a positive determinant of intra-industry trade (two-way trade within industries), while this type of trade increases more than proportionally with income per capita. If the simulated values are too small to be considered here, the simulated structure is highly interesting and confirms the scope for intra-industry trade (in a broad sense) on a regional basis (Table 8).

For numerous sectors, the simulated trade flows are larger than the observed ones, in relative terms: processed food, wood and paper, metal products, petroleum products. This must not be interpreted as large potentials remaining for these sectors: since Senegal does not export these products to the rest of the world, there is no scope for exporting them to Côte d'Ivoire either. In addition, we observe that these products are also those largely exported by Côte d'Ivoire: the latter country to Senegal potentially exports wood and petroleum products. However, such explanation cannot be checked in the absence of export statistics for Côte d'Ivoire in the *COMTRADE* database (only Côte d'Ivoire's import statistics are available).

Table 8: Simulated and observed Senegalese export structure on the Ivorian market

Sector	Present structure (% total)	Simulated structure (% total)
Fresh food and agro-based products	47%	33%
Agro-based processed products	2%	9%
Wood, wood products and paper	1%	7%
Yarn, fabrics and textiles	4%	7%
Chemicals	39%	12%
Leather and leather products	0%	2%
Metal and other basic manufacturing	0%	6%
Non-electric machinery	5%	4%
Computers, telecomm ;cons. Electronics	0%	1%
Electronic components	1%	2%
Transport equipment	0%	3%
Clothing	0%	2%
Misc. manufacturing	0%	4%
Petr. Products	1%	7%

Source: Present trade figures are based on UN data (average over the 95-96 period). Simulations are based on *TradeSim*.

In total, even in such a challenging case, *TradeSim* provides results making sense and leads to interesting insights in trade performance and trade potentials analysis, provided that figures are interpreted properly.

5. Appendix 1: description of the variables

Exports:

Exports are extracted from *COMTRADE*, using the clustering referred to below. Since there is a discrepancy between reporting country and partner declarations for a given trade flow, and according to the better quality of import declarations, we consider a weighted average of both declarations according to a "two-third-one-third" rule. For some countries, additional corrections have been introduced, according to Table 9, due to significant discrepancies or lack of data.

Table 9 : Correction of trade flows by country pairs

Correction	IMP	EXP	Correction	IMP	EXP	Correction	IMP	EXP
2/3 bis	ECU	AUS	2/3 bis	HND	FRA	2/3 bis	EGY	JPN
2/3 bis	LVA	AUS	2/3 bis	IND	FRA	2/3 bis	EST	JPN
2/3 bis	SVN	AUS	2/3 bis	JOR	FRA	2/3 bis	MAC	JPN
2/3 bis	HUN	AUT	2/3 bis	MAC	FRA	2/3 bis	POL	JPN
2/3 bis	JAM	AUT	2/3 bis	MAR	FRA	2/3 bis	SDN	JPN
2/3 bis	BOL	BEL	2/3 bis	MDG	FRA	2/3 bis	SVN	JPN
2/3 bis	LVA	BEL	2/3 bis	MUS	FRA	2/3 bis	TUN	JPN
2/3 bis	MAR	BEL	2/3 bis	PAK	FRA	2/3 bis	URY	JPN
2/3 bis	CHE	BOL	2/3 bis	URY	FRA	2/3 bis	CHN	MEX
2/3 bis	LTU	CAN	2/3 bis	VEN	FRA	2/3 bis	CHL	NLD
2/3 bis	SVN	CAN	2/3 bis	ECU	GBR	2/3 bis	DEU	NLD
2/3 bis	EST	CHE	2/3 bis	EGY	GBR	2/3 bis	HND	NLD
2/3 bis	KOR	CHE	2/3 bis	HND	GBR	2/3 bis	LVA	NLD
2/3 bis	ECU	CHN	2/3 bis	LVA	GBR	2/3 bis	GRC	NOR
2/3 bis	EGY	CHN	2/3 bis	MAC	GBR	2/3 bis	IDN	NOR
2/3 bis	GTM	CHN	2/3 bis	MAR	GBR	2/3 bis	IND	NOR
2/3 bis	HUN	CHN	2/3 bis	URY	GBR	2/3 bis	LVA	NOR
2/3 bis	KEN	CHN	2/3 bis	VEN	GBR	2/3 bis	MAR	NOR
2/3 bis	PRY	CHN	Export data	SGP	IDN	2/3 bis	MLT	NOR
2/3 bis	VEN	CHN	Import data	IDN	SGP	2/3 bis	SAU	NOR
2/3 bis	EGY	DEU	2/3 bis	ZAF	ISL	2/3 bis	TUN	NOR
2/3 bis	HUN	DEU	2/3 bis	CHL	ISR	2/3 bis	CZE	NZL
2/3 bis	MAR	DEU	2/3 bis	IDN	ISR	2/3 bis	ZWE	NZL
2/3 bis	EGY	DNK	2/3 bis	IND	ISR	2/3 bis	CHE	PER
2/3 bis	MAC	DNK	2/3 bis	JOR	ISR	2/3 bis	IDN	PRT
2/3 bis	PHL	DNK	2/3 bis	PER	ISR	2/3 bis	IND	PRT
2/3 bis	VEN	DNK	2/3 bis	EGY	ITA	2/3 bis	SGP	PRT
2/3 bis	EGY	ESP	2/3 bis	GTM	ITA	2/3 bis	VEN	SWE
2/3 bis	MLT	ESP	2/3 bis	JOR	ITA	2/3 bis	CYP	USA
2/3 bis	URY	ESP	2/3 bis	MLT	ITA	2/3 bis	EST	USA
2/3 bis	MAC	FIN	2/3 bis	PRY	ITA	2/3 bis	HND	USA
2/3 bis	PHL	FIN	2/3 bis	URY	ITA	2/3 bis	LVA	USA
2/3 bis	BGD	FRA	2/3 bis	VEN	ITA	2/3 bis	MUS	USA
2/3 bis	CRI	FRA	2/3 bis	CHN	JOR	2/3 bis	PRY	USA
2/3 bis	ECU	FRA	2/3 bis	BOL	JPN	2/3 bis	SDN	USA
2/3 bis	EGY	FRA	2/3 bis	CZE	JPN	2/3 bis	SVN	USA
						2/3 bis	CHN	ZAF

Legend: by default $X_{ij}' = (X_{ij} + 2\,M_{ji})/3$ (2/3 rule)

2/3 bis : $X_{ij}' = (2X_{ij} + M_{ji})/3$

Export data: $X_{ij}' = X_{ij}$

Import data: $X_{ij}' = M_{ji}$

Absolute distance

Dij: Distance: great circle distance between i an j capital (or main) cities (see Table 10). Having transformed the latitude j and the longitude l into radians $(\times\Pi / 360)$, the formula used to calculate the distance between the 146 countries and their 145 partners is [15]. The result can also be obtained using Pcglobe®.

$$\textbf{[15]} \quad \begin{aligned} &\Delta_{ij} \equiv l_j - l_i \\ &D_{ij} = Arc\cos\left[\sin j_i \sin j_j + \cos j_i \cos j_j \cos\Delta_{ij}\right] z \end{aligned}$$

with z= 6367 for km and 3956 for miles. We used km as a unit.

Relative distance

The average distance between a reporting country and all its partners weights the distance between a given reporting country and each partner. Hence, an isolated country will face shorter relative distance vis-à-vis a given partner. By construction, this indicator is asymmetric and aims to be so. For example, since Germany is narrow from all its partners, whereas Australia is not. The distance between Sidney and Köln is only 1.20 times the average distance between Australia and all its partners, whereas the distance between Köln and Sidney is 3.51 times the average distance between Germany and all its partners. We define 1.20 and 3.51 as the relative distances. Weights are defined as total imports of each partner normalised by total trade within the sample.

$$[\ 16] \qquad D_{ijt} = M_{..t} \frac{d_{ij}}{\sum_j M_{.jt} d_{ij}}$$

Table 10: Capitals/economic centers chosen for the calculation of Dij

Afghanistan	*Kabul*	Guinea	*Conakry*	Papua New Guinea	*Port Moresby*
Algeria	*Algiers*	Guinea Bissau	*Bissau*	Paraguay	*Asuncion*
Angola	*Luanda*	Guyana	*Georgetown*	Peru	*Lima*
Argentina	*Buenos-Aires*	Haiti	*Port au Prince*	Philippines	*Manila*
Australia	*Sydney*	Honduras	*Tegucigalpa*	Poland	*Warsaw*
Austria	*Vienna*	Hong Kong	*Victoria*	Portugal	*Lisbon*
Bahamas	*Nassau*	Hungary	*Budapest*	Qatar	*Doha*
Bahrain	*Al Manamah*	Iceland	*Reykjavik*	Romania	*Bucharest*
Bangladesh	*Dacca*	India	*New-Delhi*	Rwanda	*Kigali*
Barbados	*Bridgetown*	Indonesia	*Jakarta*	SACU	*Johannesburg*
Belgium - Luxembourg	*Brussels*	Iran	*Teheran*	Saudi Arabia	*Riyadh*
Belize	*Belmopan*	Iraq	*Baghdad*	Senegal	*Dakar*
Benin	*Cotonou*	Ireland	*Dublin*	Seychelles	*Port Victoria*
Bhutan	*Thimbu*	Israel	*Tel Aviv*	Sierra Leone	*Freetown*
Bolivia	*La Paz*	Italy	*Rome*	Singapore	*Singapore*
Brazil	*Brasilia*	Jamaica	*Kingston*	Slovenia	*Ljubljana*
Bulgaria	*Sofia*	Japan	*Tokyo*	Solomon Islands	*Honiara*
Burkina Faso	*Ouagadougou*	Jordan	*Amman*	Somalia	*Mogadishu*
Burundi	*Bujumbura*	Kenya	*Nairobi*	South Africa	*Cape Town*
Cameroon	*Yaoundé*	Korea R.(S)	*Seoul*	Spain	*Madrid*
Canada	*Ottawa*	Kuwait	*Kuwait*	Sri Lanka	*Colombo*
Central African Rep.	*Bangui*	Laos	*Vientiane*	Sudan	*Khartoum*
Chad	*N'djamena*	Latvia	*Riga*	Suriname	*Paramaribo*
Chile	*Santiago*	Lebanon	*Beirut*	Sweden	*Stockholm*
China	*Beijing*	Liberia	*Monrovia*	Switzerland	*Bern*
Colombia	*Bogota*	Lithuania	*Vilnius*	Syrian Arab Republic	*Damascus*
Comoros	*Moroni*	Macao	*Macao*	Taiwan	*Taipei*
Congo	*Brazzaville*	Madagascar	*Antananarivo*	Tanzania	*Dar es Salaam*
Costa Rica	*San Jose*	Malawi	*Lilongwe*	Thailand	*Bangkok*
Côte d'Ivoire	*Abidjan*	Malaysia	*Kuala-Lumpur*	Togo	*Lomé*
Cyprus	*Nicosia*	Mali	*Bamako*	Trinidad & Tobago	*Port of Spain*
Denmark	*Copenhagen*	Malta	*Valetta*	Tunisia	*Tunis*
Djibouti	*Djibouti*	Mauritania	*Nouakchott*	Turkey	*Ankara*
Dominican Republic	*Santo Domingo*	Mauritius	*Port Louis*	Uganda	*Kampala*
Ecuador	*Quito*	Mexico	*Mexico*	United Arab Emirates	*Abu-Dhabi*
Egypt	*Cairo*	Mongolia	*Ulan-Bator*	United Kingdom	*London*
El Salvador	*San Salvador*	Morocco	*Casablanca*	Uruguay	*Montevideo*
Estonia	*Tallinn*	Mozambique	*Maputo*	USA	*Washington DC*
Ethiopia	*Addis Ababa*	Myanmar	*Rangoon*	Russian Fed.	*Moscow*
Fiji	*Suva*	Nepal	*Katmandu*	Venezuela	*Caracas*
Finland	*Helsinki*	Netherlands	*Amsterdam*	Vietnam	*Hanoi*
France	*Paris*	New Zealand	*Wellington*	Yemen	*Sana*
Gabon	*Libreville*	Nicaragua	*Managua*	Yugoslavia	*Belgrade*
Gambia	*Banjul*	Niger	*Niamey*	Dem. Rep. of Congo	*Kinshasa*
Germany	*Cologne*	Nigeria	*Lagos*	Zambia	*Lusaka*
Ghana	*Accra*	Norway	*Oslo*	Zimbabwe	*Harare*
Greece	*Athens*	Oman	*Muscat*	Panama	*Panama*
Guatemala	*Guatemala*	Pakistan	*Islamabad*		

Note: notice that some of these countries were dropped out from the final sample.

GNP (GNP per capita) at current prices

GNP is the sum of value added by all resident producers plus any taxes (less subsidies) that are not included in the valuation of output plus net receipts of primary income (employee compensation and property income) from non resident sources. Data are in current billion US$ converted using the World Bank Atlas method.

We consider the average GNP for 1995 and 1996 in US$ (divided by the midyear population) taken from World Bank, World Development Indicators 1997. The exceptions are:

- Cyprus and Malta, GDP US$ taken from EIU Country Profile, 96/97 and 97/98.
- Sudan, GNP US$, Middle East Review, 98
- Belgium-Lux: simple average of GNP per capita of both.
- SACU: simple average of GNP per capita of the 5 countries.

Common language dummy variable

The “common language” dummy variable (see equation [13]) takes into account common national languages (official or not) as well as links established during the colonial period. The official languages were taken from *Exporters Encyclopedia 1998/99*. The following languages were considered: Arabic, Amerindian, Cantonese, Dutch, English, French, German, Irish, Greek, Italian, Japanese, Mandarin, Malay, Portuguese, Russian, Spanish, Swedish, Swahili.

For each country, one or two national languages were taken into account, provided that they are spoken by a high percentage of the population. For example, since French is spoken by a high share of the population in Belgium and Senegal, the dummy variable is equal to 1 for the trade between these two countries.

Free Trade Agreements

A distinction has been made between different types of agreements: Free Trade Zones and custom unions are grouped in a first category (FT) while other preferential schemes are considered separately (TA). Since a given country can belong to more than one preferential scheme, two variables are created (TA1 and TA2).

6. Appendix 2: SITC codes (rev.3) for the 14 industry clusters

Cluster 1- Fresh food and agro-based products

001 LIVE ANIMALS
011 BOVINE MEAT
012 OTHER MEAT, MEAT OFFAL
034 FISH,FRESH,CHILLED,FROZN
036 CRUSTACEANS,MOLLUSCS ETC
041 WHEAT, MESLIN, UNMILLED
0421 RICE
043 BARLEY, UNMILLED
044 MAIZE UNMILLED
045 OTHER CEREALS, UNMILLED
054 VEGETABLES
057 FRUIT,NUTS EXCL OIL NUTS
071 COFFEE,COFFEE SUBSTITUTE
072 COCOA
074 TEA AND MATE
075 SPICES
121 TOBACCO, UNMANUFACTURED
211 HIDES,SKINS(EX.FURS),RAW
212 FURSKINS, RAW
222 OILSEED(SFT.FIX VEG.OIL)
223 OILSEED(OTH.FIX.VEG.OIL)
231 NATURAL RUBBER, ETC.
261 SILK
263 COTTON
264 JUTE,OTH.TEXTL.BAST FIBR
265 VEGETABLE TEXTILE FIBRES
268 WOOL,OTHER ANIMAL HAIR
291 CRUDE ANIMAL MATERLS.NES
292 CRUDE VEG.MATERIALS, NES

Cluster 2- Processed food and agro-based products

016 MEAT,ED.OFFL,DRY,SLT,SMK
017 MEAT,OFFL.PRPD,PRSVD,NES
022 MILK AND CREAM
023 BUTTER,OTHER FAT OF MILK
024 CHEESE AND CURD
025 EGGS,BIRDS,YOLKS,ALBUMIN
035 FISH,DRIED,SALTED,SMOKED
037 FISH ETC.PREPD,PRSVD.NES
0422 RICE
0423 RICE
046 MEAL,FLOUR OF WHEAT,MSLN
047 OTHER CEREAL MEAL,FLOURS
048 CEREAL PREPARATIONS
056 VEGTABLES,PRPD,PRSVD,NES
058 FRUIT,PRESERVED,PREPARED
059 FRUIT, VEGETABLE JUICES
061 SUGARS,MOLASSES,HONEY
062 SUGAR CONFECTIONERY
073 CHOCOLATE,OTH.COCOA PREP
081 ANIMAL FEED STUFF
091 MARGARINE AND SHORTENING

098 EDIBLE PROD.PREPRTNS,NES
111 NON-ALCOHOL BEVERAGE,NES
112 ALCOHOLIC BEVERAGES
122 TOBACCO, MANUFACTURED
411 ANIMAL OILS AND FATS
421 FIXED VEG.FAT,OILS, SOFT
422 FIXED VEG.FAT,OILS,OTHER
431 ANIMAL,VEG.FATS,OILS,NES
551 ESSNTL.OIL,PERFUME,FLAVR

Cluster 3: Wood, wood products and paper

244 CORK,NATURAL,RAW WASTE
245 FUEL WOOD, WOOD CHARCOAL
246 WOOD IN CHIPS, PARTICLES
247 WOOD ROUGH,ROUGH SQUARED
248 WOOD, SIMPLY WORKED
251 PULP AND WASTE PAPER
633 CORK MANUFACTURES
634 VENEERS, PLYWOOD, ETC.
635 WOOD MANUFACTURES, NES
641 PAPER AND PAPERBOARD
642 PAPER, PAPERBOARD,CUT ETC
8215 Wooden furniture

Cluster 4 - Yarn, fabrics and textiles

651 TEXTILE YARN
652 COTTON FABRICS, WOVEN
653 FABRICS,MAN-MADE FIBRES
654 OTH.TEXTILE FABRIC,WOVEN
655 KNIT.CROCHET.FABRIC NES
656 TULLE, LACE,EMBROIDRY.ETC
657 SPECIAL YARN, TXTL.FABRIC
658 TEXTILE ARTICLES NES
659 FLOOR COVERINGS, ETC.

Cluster 5 : Chemicals

232 SYNTHETIC RUBBER, ETC.
266 SYNTHETIC FIBRES
267 OTHER MAN-MADE FIBRES
511 HYDROCARBONS,NES,DERIVTS
512 ALCOHOL,PHENOL,ETC.DERIV
513 CARBOXYLIC ACIDS,DERIVTS
514 NITROGEN-FUNCT.COMPOUNDS
515 ORGANO-INORGANIC COMPNDS
516 OTHER ORGANIC CHEMICALS
522 INORGANIC CHEM.ELEMENTS
523 METAL SALTS,INORGAN.ACID
524 OTHER CHEMICAL COMPOUNDS
525 RADIO-ACTIVE MATERIALS
531 SYNTH.COLOURS, LAKES,ETC.
532 DYEING, TANNING MATERIALS
533 PIGMENTS, PAINTS, ETC.
541 MEDICINES,ETC.EXC.GRP542
542 MEDICAMENTS
553 PERFUMERY,COSMETICS,ETC.
554 SOAP,CLEANERS,POLISH,ETC
562 FERTILIZER,EXCEPT GRP272

571 POLYMERS OF ETHYLENE
572 POLYMERS OF STYRENE
573 POLYMERS, VINYL CHLORIDE
574 POLYACETAL, POLYCARBONATE
575 OTH. PLASTIC, PRIMARY FORM
579 PLASTIC WASTE, SCRAP ETC
581 PLASTIC TUBE, PIPE, HOSE
582 PLASTIC PLATE, SHEETS, ETC
583 MONOFILAMENT OF PLASTICS
591 INSECTICIDES, ETC.
592 STARCHES, INULIN, ETC.
593 EXPLOSIVES, PYROTECHNICS
597 PREPRD ADDITIVES, LIQUIDS
598 MISC.CHEMICAL PRODTS.NES
621 MATERIALS OF RUBBER
625 RUBBER TYRES, TUBES, ETC.
629 ARTICLES OF RUBBER, NES

Cluster 6 - Leather and leather products

611 LEATHER
612 MANUFACT. LEATHER ETC.NES
613 FURSKINS, TANNED, DRESSED
831 TRUNK, SUIT-CASES, BAG, ETC
851 FOOTWEAR

Cluster 7 - Metal and other basic manufacturing

661 LIME, CEMENT, CONSTR. MATRL
662 CLAY, REFRCT. CONSTR. MATRL
663 MINERAL MANUFACTURES, NES
664 GLASS
665 GLASSWARE
666 POTTERY
670 REST OF 67 NOT DEFINED
671 PIG IRON, SPIEGELEISN, ETC
672 INGOTS ETC. IRON OR STEEL
673 FLAT-ROLLED IRON ETC.
674 FLAT-ROLLED PLATED IRON
675 FLAT-ROLLED, ALLOY STEEL
676 IRON, STL. BAR, SHAPES ETC.
677 RAILWAY TRACK IRON, STEEL
678 WIRE OF IRON OR STEEL
679 TUBES, PIPES, ETC. IRON, STL
681 SILVER, PLATINUM, ETC.
682 COPPER
683 NICKEL
684 ALUMINIUM
685 LEAD
686 ZINC
687 TIN
689 MISC.NON-FERR.BASE METAL
691 METALLIC STRUCTURES NES
692 CONTAINERS, STORAGE, TRNSP
693 WIRE PRODUCTS EXCL ELECT
694 NAILS, SCREWS, NUTS, ETC.
695 TOOLS
696 CUTLERY
697 HOUSEHOLD EQUIPMENT, NES

699 MANUFACTS.BASE METAL,NES
8213 Metal furniture nes

Cluster 8 - Non-electric machinery

711 STEAM GENER.BOILERS,ETC.
712 STEAM TURBINES
713 INTRNL COMBUS PSTN ENGIN
714 ENGINES,MOTORS NON-ELECT
716 ROTATING ELECTRIC PLANT
718 OTH.POWR.GENRTNG.MACHNRY
721 AGRIC.MACHINES,EX.TRACTR
722 TRACTORS
723 CIVIL ENGINEERING EQUIPT
724 TEXTILE, LEATHER MACHINES
725 PAPER, PULP MILL MACHINES
726 PRINTNG,BOOKBINDNG MACHS
727 FOOD-PROCESS.MCH.NONDOM
728 OTH.MACH,PTS,SPCL INDUST
731 METAL REMOVAL WORK TOOLS
733 MACH-TOOLS,METAL-WORKING
735 PARTS,NES,FOR MACH-TOOLS
737 METALWORKING MACHNRY NES
741 HEATNG,COOLNG EQUIP,PART
742 PUMPS FOR LIQUIDS,PARTS
743 PUMPS NES,CENTRIFUGS ETC
744 MECHANICAL HANDLNG EQUIP
745 OTH.NONELEC MCH,TOOL,NES
746 BALL OR ROLLER BEARINGS
747 TAPS,COCKS,VALVES,ETC.
748 TRANSMISSIONS SHAFTS ETC
749 NON-ELECT MACH.PARTS,ETC

Cluster 9 - Computers, telecommunications, consumer electronics

751 OFFICE MACHINES
752 AUTOMATC.DATA PROC.EQUIP
759 PARTS,FOR OFFICE MACHINS
761 TELEVISION RECEIVERS ETC
762 RADIO-BROADCAST RECEIVER
763 SOUND RECORDER,PHONOGRPH
764 TELECOMM.EQUIP.PARTS NES

Cluster 10 - Electronic components

771 ELECT POWER MACHNY.PARTS
772 ELEC.SWITCH.RELAY.CIRCUT
773 ELECTR DISTRIBT.EQPT NES
774 ELECTRO-MEDCL,XRAY EQUIP
775 DOM.ELEC,NON-ELEC.EQUIPT
776 TRANSISTORS,VALVES,ETC.
778 ELECTRIC.MACH.APPART.NES

Cluster 11 - Transport equipment

781 PASS.MOTOR VEHCLS.EX.BUS
782 GOODS,SPCL TRANSPORT VEH
783 ROAD MOTOR VEHICLES NES
784 PARTS,TRACTORS,MOTOR VEH
785 CYCLES,MOTORCYCLES ETC.
786 TRAILERS,SEMI-TRAILR,ETC

791 RAILWAY VEHICLES.EQUIPNT
792 AIRCRAFT,ASSOCTD.EQUIPNT
793 SHIP,BOAT,FLOAT.STRUCTRS

Cluster 12 - Clothing

841 MENS,BOYS CLOTHNG,X-KNIT
842 WOMEN,GIRL CLOTHNG,XKNIT
843 MENS,BOYS CLOTHING,KNIT
844 WOMEN,GIRLS CLOTHNG.KNIT
845 OTHR.TEXTILE APPAREL,NES
846 CLOTHING ACCESSRS,FABRIC
848 CLOTHNG,NONTXTL;HEADGEAR

Cluster 13 - Miscellaneous manufacturing

811 PREFABRICATED BUILDINGS
812 PLUMBNG,SANITRY,EQPT.ETC
813 LIGHTNG FIXTURES ETC.NES
871 OPTICAL INSTRUMENTS,NES
872 MEDICAL INSTRUMENTS NES
873 METERS,COUNTERS,NES
874 MEASURE,CONTROL INSTRMNT
881 PHOTOGRAPH APPAR.ETC.NES
882 PHOTO.CINEMATOGRPH.SUPPL
883 CINE.FILM EXPOSD.DEVELPD
884 OPTICAL GOODS NES
885 WATCHES AND CLOCKS
891 ARMS AND AMMUNITION
892 PRINTED MATTER
893 ARTICLES,NES,OF PLASTICS
894 BABY CARRIAGE,TOYS,GAMES
895 OFFICE,STATIONERY SUPPLS
896 WORKS OF ART,ANTIQUE ETC
897 GOLD,SILVERWARE,JEWL NES
898 MUSICAL INSTRUMENTS,ETC.
899 MISC MANUFCTRD GOODS NES
8211, 8212, 8217, 8218 Other furniture.

Cluster 14 Petroleum products

334 PETROLEUM PRODUCTS

EXCLUDED: Minerals

272 FERTILIZERS, CRUDE
273 STONE, SAND AND GRAVEL
274 SULPHUR,UNRSTD.IRON PYRS
277 NATURAL ABRASIVES, NES
278 OTHER CRUDE MINERALS
281 IRON ORE, CONCENTRATES
282 FERROUS WASTE AND SCRAP
283 COPPER ORES,CONCENTRATES
284 NICKEL ORES,CONCTR,MATTE
285 ALUMINIUM ORE,CONCTR.ETC
286 URANIUM,THORIUM ORES,ETC
287 ORE,CONCENTR.BASE METALS
288 NON-FERROUS WASTE,SCRAP
289 PREC.METAL ORES,CONCTRTS
321 COAL,NOT AGGLOMERATED
322 BRIQUETTES,LIGNITE,PEAT

325 COKE,SEMI-COKE,RET.CARBN
333 PETROLEUM OILS, CRUDE
335 RESIDUAL PETROL PRODUCTS
342 LIQUEFIED PROPANE,BUTANE
343 NATURAL GAS
344 PETROLEUM GASES, NES
345 COAL GAS,WATER GAS, ETC.
351 ELECTRIC CURRENT
667 PEARLS,PRECIOUS STONES
269 WORN CLOTHING,TEXTL.ARTL
911 MAIL NOT CLASSED BY KIND
931 SPEC.TRANSACT.NOT CLASSD
961 COIN NONGOLD NONCURRENT
971 GOLD,NONMONTRY EXCLORES

7. Appendix 3: parameter estimates for the 14 industry clusters

Cluster	Intercept	GNPi	GNPj	GNPHi	GNPHj	DijR	Lcij	LOME	COMESA	ANDEAN	CACM	CARICOM
1	-24.3389	1.1675	1.0612	-0.5205	0.3163	-1.4843	0.5312	1.2033	1.3580	(0.5734)	2.4792	4.2592
2	-29.3904	1.2185	0.8359	0.2873	0.2886	-1.5701	0.9231	1.9482	1.6453	2.2663	3.7397	6.8934
3	-26.2526	1.0682	0.7895	0.2518	0.0924	-1.7887	0.4231	1.1995	1.0271 *	1.1887 **	2.7776	5.4456
4	-27.6179	1.5208	0.7529	-0.1437	0.1541	-1.4391	0.8948	(0.0535)	1.8032	0.9510 *	2.7049	(1.3710)
5	-31.1900	1.4533	0.8986	0.6464	-0.1418	-1.5704	0.9271	-0.5694	1.4555	1.0311 **	3.6027	6.2426
6	-27.3513	1.2618	0.7371	-0.071 **	0.3189	-1.2211	0.5054	-1.1648	1.4149	0.8295 *	3.6272	4.4791
7	-31.7824	1.5553	0.8776	0.4226	(-0.0009)	-1.5635	0.7364	(-0.2532)	1.2757	1.9991	3.3901	5.9659
8	-30.5827	1.3485	0.7996	0.6571	-0.0827	-1.4201	0.7346	(0.0958)	1.2366	0.8900 *	2.3450	4.2193
9	-31.8165	1.3044	0.6285	0.6792	0.2499	-1.0316	0.6923	(-0.3347)	1.6664	(-0.6043)	1.9022	(1.0667)
10	-31.3286	1.3372	0.6794	0.6669	0.1398	-1.2827	0.7663	-1.0452	0.9985 *	(0.3481)	3.6519	5.9440
11	-28.1046	1.2674	0.6125	0.4334	0.1062	-1.4397	0.4482	-0.479 **	1.2285 **	1.0280 *	1.7604	(2.4137)
12	-29.0062	1.1306	0.6902	(-0.0059)	0.7106	-1.3080	0.7193	0.4682 *	1.4451	(0.5056)	2.2159	3.9141 **
13	-31.7240	1.3516	0.7582	0.4490	0.3423	-1.3097	1.1110	(0.0050)	1.6796	1.0136 **	3.4557	5.4234
14	-17.8206	0.5301	0.5362	0.2085	-0.0919	-1.8201	0.225 **	-0.497 **	(0.0393)	1.2644 **	(0.2323)	7.2128
99	-28.1310	1.3332	1.0534	0.2616	0.1866	-1.4046	0.8343	1.6043	1.4909	1.0037	2.8232	5.6887

Significance level
By default, all coefficients are significantly different from 0 at the 1% level
(~): Not significantly different from 0 at the 10% level
**: Significantly different from 0 at the 5% level
*: Significantly different from 0 at the 10% level

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