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The "sophistication indices" for the international agri-food trade analysis: the view point of imports

A. Carbone | University of Tuscia | Italy
R. Henke | CREA | Italy

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ABSTRACT

In this paper we look at a family of indicators originated around the concept of "sophistication" of traded goods. Usually the sophistication indices focus on export flows and are based on the relationship between the level of per capita GDP and the complexity of exports in terms of technological content, branding and packaging, quality features and so on. We use the same concept to explore import flows of agri-food products, assuming there is a relationship among the level of per-capita GDP of an importing country and the level of sophistication of its agri-food imports. We build and analyse two indices, one looking at the level of sophistication of imported goods (Consy) and one looking at the aggregated level of sophistication of an importing Country (Impy). The indices give a synthetic measure of the sophistication of the final market or, in other words, the kind of demand and competition that the product is going to face in the destination markets. With regards to this, the ranking produced by the two indices are relevant and consistent with the main world trade specialisation and the correlations with GDP confirm the assumption on which the indices are built.

Keywords: trade sophistication, agri-food export specialisation, agri-food import demand

PAPER

1. Introduction

The family of indices that move around the concept of "sophistication" is generally used in the trade literature to analysis the complexity of export flows and is based on the assumption that the higher the GDP of a country the more "complex" is its set of exports. The concept of sophistication includes the technological content, the branding and the packaging of the goods, the quality, and other features that add value to the products. These characteristics of the traded goods have increasingly importance in the international arena, becoming the ground for non-price competition, even in the food sector where, in order to meet a clear trend in the demand, producers and exporters have increasingly focused on product differentiation and quality attributes (Krugman, 1980; Helpmann, 1981; Schott, 2004; Fabrizio et al., 2007).

The sophistication of export flows is measured in the literature by two indices, respectively referred to the set of products exported and the countries exporting them (Lall et al., 2006; Hausmann et al. 2007).

The Prody index refers to a specific good and is given by the per-capita GDP (GDPpc) of all the countries exporting that good weighted by the specialisation of that country in the export of that product.

Similarly, the Expy index is referred to a single country and it is given by the sum of all the Prody indices of the goods exported by the country weighted by the share of the exports of any single good on the total exports of the country. This family of indices has been used for comprehensive studies analysing the entire set of exported items and a wide range of competing countries as well as for trade analysis of specific Countries and/or sectors (Rodrick, 2006: Minondo 2008; Di Maio and Tamagni, 2008). A stream of more recent literature has explored how the measure of export sophistication works when applied to the agri-food sector (Carbone and Henke, 2012; Carbone et al., 2015). In this case, especially for the primary basic goods, factors like climate, resources, conjunct productions, as well as policies, might influence significantly localisation and, hence, the export specialisation patterns. Nonetheless, different papers have shown that quality is a major export driver also in the agri-food sector, especially for processed food (Gehlhar and Pick, 2002; Fischer, 2010). In this paper we move from exports to imports, assuming there is a relationship among the level of per-capita income of an importing country and the level of sophistication of its agri-food imports. This approach is not entirely new, since other works have dealt with the shift from exports to imports[1].

1 See, for example, Marvasi (2013). In his paper, Marvasi builds an Impy index for China which is given by the Sum of the Prody indices of China exports weighted by the share of imports of China for each of the same products.

However, both the construction of specific indices and the analysis have been focused on the comparison of the level of sophistications of the export and import flows of a single country. In our work, we turn the attention to the construction of a new set of indices, defined as Consy and Impy, which are symmetrical to the Prody and the Expy. These indices look at the sophistication of the set of imports of a country, independently from its set of exports.

The Consy is defined as the sophistication index for imported goods: the higher is the role of high income countries in the imports of a good the more sophisticated will be the product. The income level of the destination markets for a product can be considered an indicator of the kind of competition that the product would likely meet.

In the same line of the measure of the export sophistication, the most interesting result is the ranking generated by the index and its time variation. In the same streamline of the Expy index, it is possible to build an Impy index, starting from Consy, that is given by the weighted values of the Consy vector of the whole set of imports of a country, where the weights are the shares of imports performed by the country per each product. We will discuss the following uses of the indices: 1) rank the sophistication of products as measured by the income level of importing Countries; 2) Compare the sophistication measures resulting from the Consy and that one measured by the Prody indices for agri-food items; 3) Show the overall sophistication of trading Countries considered as destination markets for agri-food products 5) compare between them the rankings of Countries obtained with Expy and Impy and among them and to the GDPpc.

The paper is organized as follows. Section 2 first presents and discusses the Consy and Prody indices and, second, shows the Expy and Impy indices. Results are presented in Section 3 while Section 4 concludes.

2. New indices of sophistication

In recent literature the use of the sophistication indices have been focusing especially on the export side, and in particular on the Prody index. More specifically, recent studies have associated this concept of sophistication to the level of prosperity of the exporting Countries, alias their level of GDPpc (Lall et al., 2006; Hausmann et al., 2007). The underlying idea is that, other things being equal, the more a country is specialised in producing and exporting high value products, the higher is the remuneration of inputs and, consequently, the higher the level of its GDP. The Prody index associated to each exported good is a synthetic indication of its level of sophistication and, at the same time, gives an idea of the type of countries exporting that good, so that it gives indirect information about the type of competition that the good in question has to deal with on the international markets (Lall et al., 2006). The core idea is that product sophistication is linked to the country productivity level and that it is important as an export driver. This is in line with Porter's view of the competitive advantages of locations and the strand of empirical literature that stemmed out from his seminal work (Porter, 1985; Ketels, 2006; Sterns and Spreen, 2010).

The sophistication of a given exported item is the result of the sum of the GDPpc of the countries exporting that item, each of them weighted with the trade specialisation of each country in that item. This measure is called Prody and, according to the version proposed by Lall et al. (2006) can be calculated as follows:

$$Prody = \Sigma_j s_{i,j} GDPpc_j$$

where $s_{i,j}$ is the weighting factor of the GDPpc of each country j exporting the i product and it is given by the share of product i on total exports:

$$X_{i,j} / X_i$$

where $X_{i,j}$ is the amount of the agri-food product i exported by the country j and X_i is the world agri-food export of product i.

it is worth noting that this index does not catch all the possible factors influencing the exporting performance of a good. Different localisation factors are at work, especially in the agri-food sector, where natural resources, transport costs and policy interventions, just to mentions some among the most relevant ones, are crucial in explaining the dynamics of export goods (Di Maio and Tamagni, 2008; Carbone et al., 2012). However, previous results showed that, especially for processed food exports, the relationship still stands and works quite well (Carbone and Henke, 2012; Carbone et al., 2015).

The main outcome of the application of the Prody index is a ranking of the products analysed according to their level of sophistication. Moreover, an interesting use of the Prody index and of the family of indices is their variation in time[2]. In this paper we look at the sophistication in a different perspective associating it also to imports rather than only exports.

This is based on the following considerations: i) looking at the destination markets, rather than the markets of origin, reduces significantly the influence of localization factors other than GDPpc; ii) destination markets are the actual competitive arena that products are going to meet, focusing on these seems valuable when the interest of the analysis is more on the competitive conditions relevant to the products rather than the growth effects of exports; iii) focusing on imports allows for narrowing the definition of the relevant markets and thus allows a more accurate analysis.

[2] Its variation in time, in fact, can be due to a change in the GDPpc of the countries exporting the good or as a consequence in the change of the export share, or, also for the change of the set of countries exporting it (new exporters entering in the competition game, or countries phasing out).

This approach can provide a complementary viewpoint to the one based on export analysis, thus bringing new insights and developments to the agri-food trade analysis. Economic literature provides wide theoretical rationale for a positive relationship between GDPpc and demand for diversification and quality (Gabszewicz, and Thisse, 1979; Kearney, 2010). Thus, the assumption the new sophistication indices would rely on (i.e. the sophistication level of demand/imports increase with the average GDPpc of the importing countries) seems based on solid grounds. The first index we consider here is the Consy. This is the sophistication index for imported good i, and it is defined as:

$$Consy_i = \Sigma_j GDPpc_j * c_{ij}$$

where GDPpc $_j$ is the per capita income of importing country j and c_{ij} is the share of total world imports of item i imported by country j:

$$M_{i,j}/M_i$$

where $M_{i,j}$ is the amount of the agri-food product i imported by the country j and M_i is the world agri-food import of product i.

The higher is the role of high income countries in the imports of a good the more sophisticated is the product. In other words, we posit that the income level of the destination markets for a product indicates the kind of competition that the product would likely meet. In the same line of the measure of the export sophistication, also in this case, the most interesting result is the ranking generated by the indices and their time trends.

This index works very well also in order to measure the sophistication level of a subgroup of importing countries. One could, in fact, compute a ConsyiA related to a group (A) of importing countries (lets' say the clients of an exporter under study). By confronting Consyi with ConsyiA it is possible to assess whether Country A (or Countries in group A) forms a more or less sophisticated market for product i with respect to the world markets. It is obviously also possible to do bilateral confrontations between the sophistication levels of destination markets of competing Countries.

In the same streamline of literature, the Prody index is often associated to the Expy index, which is referred to a single country. The Expy index for a country j is given by the sun of the Prody indices associated to the products exported by that country:

$$Expy_j = \Sigma x_i/X_j * Prody_i$$

This index provides a ranking of the countries analysed according to their ability to export "sophisticated" products. As in the case of the Prody index, also for the Expy it is interesting to see the variations in time of the country ranking, which can be due to the different components of the Expy.

As in the case of the Prody and Expy, starting from Consy it is possible to build a symmetric index (Impy) that is given by the weighted values of the Consy vector of the whole set of imports of a Country, where the weights are the shares of imports performed by the country per each product.

$$Impy_j = \Sigma M_{ij}/Mt_j * Consy_i$$

Where M_{ij}/M_{tj}, is the share of the import of the country j of the good i and M is the total import of the country j.

The Impy indices measure the overall level of sophistication of the imports of a given country, thus giving an idea of the kind of market an exporter may find in that country. Obviously, here also it is possible to build sectoral versions of the index that enable to make comparisons.

First empirical results on the rankings associated with indices as well as on the comparison with the results obtained with the export sophistication indices provide scope for discussion on their advantages and further understandings that may stem from the use of such a methodology.

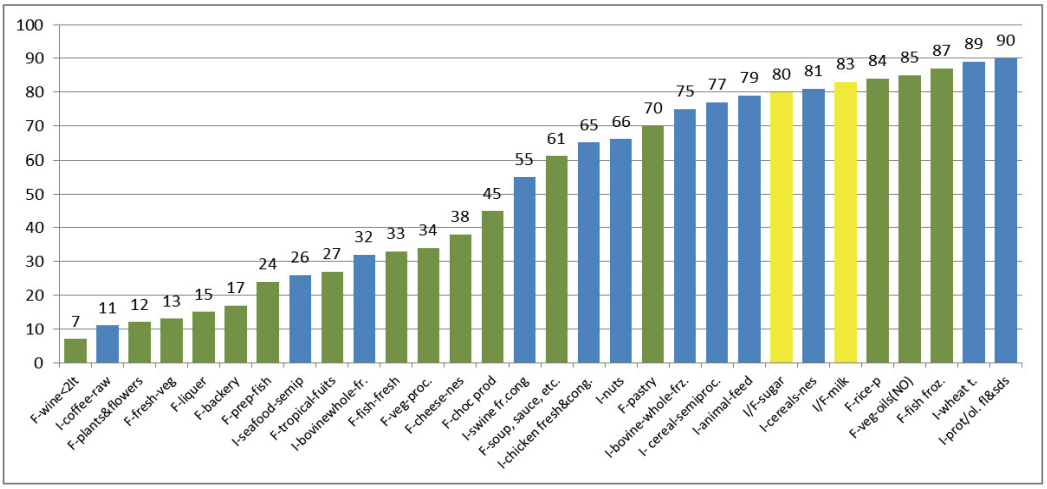
3. Preliminary results of the import sophistication indices

This Section presents and discusses some preliminary results obtained by the application of the indices of import sophistication to agri-food trade data[3]. Throughout the section, for clarity purposes, the comments are restricted to the thirty major items in terms of their shares in world trade, these are labelled in all figures; however, the analysis includes 92 items that represent the whole range of agri-food items. Figure 1 shows the import sophistication ranking of the selected items as measured by the Consy index. The prefix *F* denotes goods that are mainly for final consumption in the destination Country while prefix I stands for goods that are mainly used as inputs; a few items are labelled as *F*-I due to their double nature of intermediate and final goods. This specification is quite useful when comparing the values of the Consy and in particular its ranking. The top positions in the ranking include mainly goods for final consumption. These are complex processed goods, highly differentiated and with a high value added such as prepared fishes, wines (in bottles smaller than 2 litres), spirits and liqueurs, bakery products, processed veggies, cheeses, chocolate products, soups/condiments/sauces/etc. and so forth.

[3] The dataset includes 92 agri-food items aggregated starting from 700 Comtrade HS 1996 at 6-digit level and exchanged among 130 Countries that represent around 90% of all world trade exchanges.

Besides, also some fresh produces are ranked high according to the Consy values; again, these are differentiated and high value perishable products that require complex logistics functions and high transport costs like fresh veggies, tropical fruits, fresh fishes and plant and flowers. At the opposite end, the bottom of the ranking features mainly semi-processed goods, raw materials or commodities for final consumption. These are far more simple goods, non-significantly differentiated and for which competition is mainly performed at the price level. Among these there are wheat and other cereals, flours of cereals, flours/seeds of industrial plants, frozen swine, frozen bovines and frozen poultry, processed rice and vegetable oils (excl. olive oil).

Figure 1 - The sophistication level (ranking) of selected agri-food import items

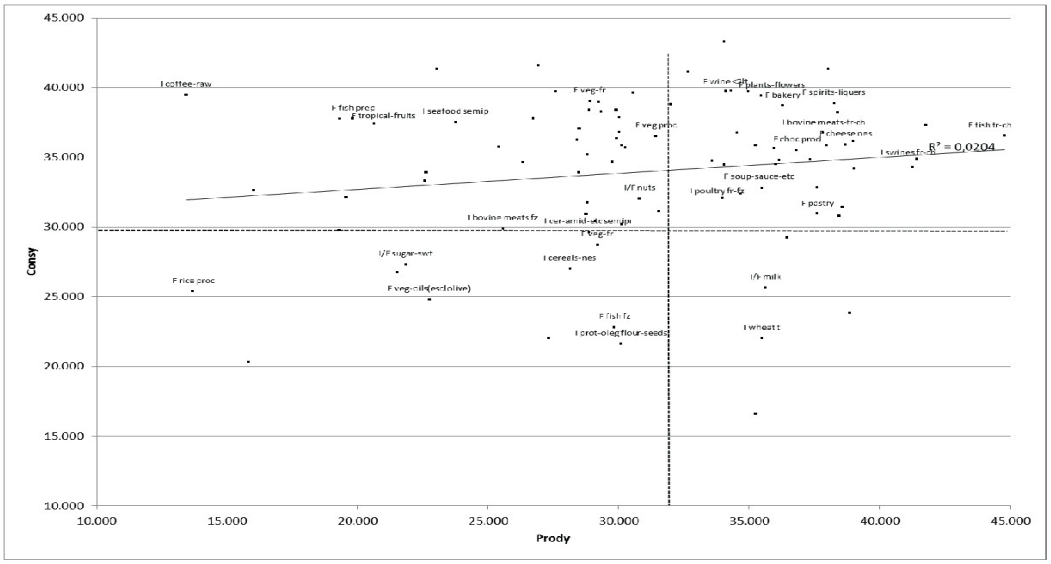


Note: (green bars: products for final consumption; blue bars: intermediate goods; yellow bars: double destination)

The values of the sophistication indices measured on the export and on the import side are compared in figure 2. As expected these two sets of values are not significantly correlated as factors influencing the localization of exports of a good and those affecting the geographical pattern of imports of the same good are different and widely unrelated(R2=0.025).

One additional evidence shown in figure 2 is the concentration of products in the up-right end of the graph; this is not surprising as it is the consequence of the major role played by richer Countries in international trade also in the agri-food sector.

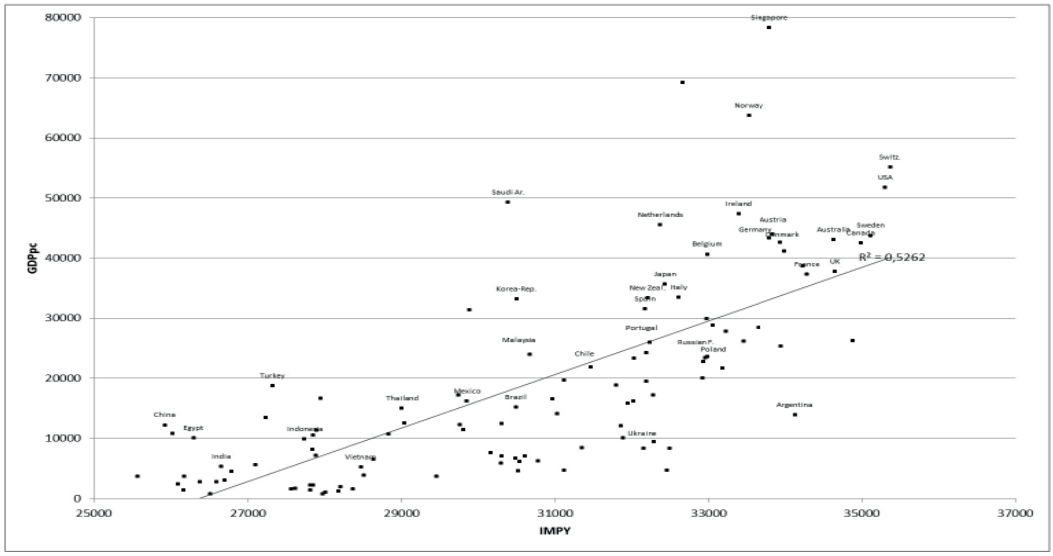
Figure 2 - The sophistication of selected agri-food traded items: a comparison between Prody and Consy.



The subdivision of the quadrant of the graph into 4 sub-regions helps to interpret the meaning of the position of the different products in this graph. In the top-right area we find products with a value of both the indices above the average of the group. This is the case for products whose production and consumption is mainly located in rich developed countries and are highly processed and incorporate a higher value added. In the top-left region of the graph we find coffee (raw), tropical fruit, and other products whose main characteristics is to be produced in specific parts of the world, generally, low to mid level of GDP, but heavily exported into developed countries. This justifies the fact that their Consy is

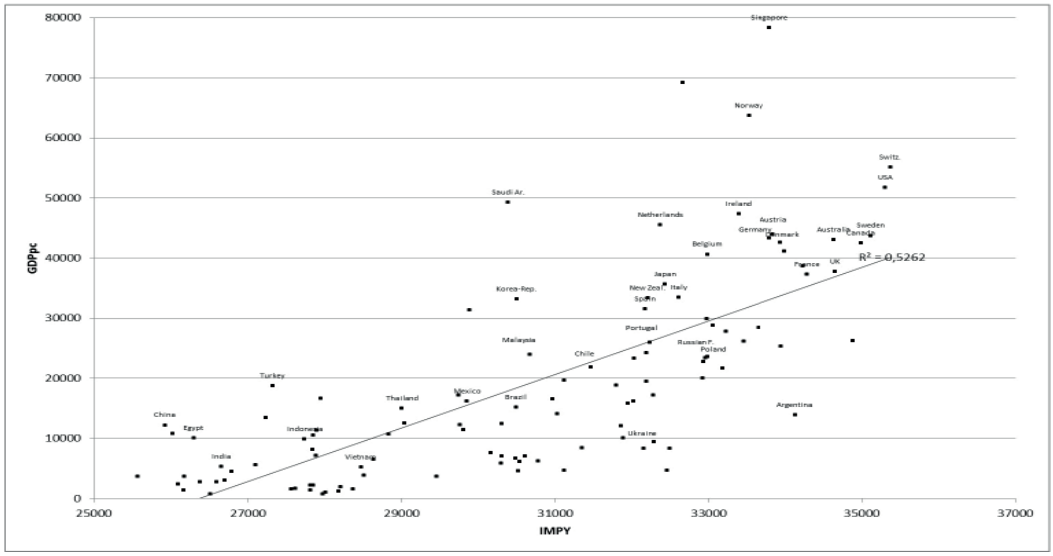
significantly higher than their Prody. In the bottom-right sub-quadrant we find fewer products that are also raw materials for the processing industry; however these are mainly exported by rich-developed countries that enjoys comparative advantages due to natural resources endowment (wheat, milk, and so on). In this case, the exporting countries are quite wealthy, while the buying markets are much more heterogeneous. Finally, the bottom-left area of the graph displays commodities or products that could be defined as "quasi-commodities" being semi-processed or semi-prepared which often are inputs for further stages of transformation. They features both Consy and Prody below the average values, but, with the only exception of the processed rice, are basically in the low-mid region of the ranking for both the indicators.

Figure 3 - The correlation between Impy and GDPpc



The Impy index shown in figure 3 is built on agri-food imports data. The graph opposes the import sophistication measure to the GDPpc. The figure displays data for 130 Countries while only the first 37 more important ones in terms of trade shares (either imports or exports of the Country shall be at least 1% of world total trade) are labelled. The first evidence shown by the graph is that there is a significant correlation between the Impy index and GDPpc (R^2=0.526), thus confirming the hypothesis on which the Impy is built and interpreted. At least for the limited case of the agri-food sector, we can affirm that, other things being equal, the more one country is well-off the more its imports basket include goods imported also by other rich countries, or, in other words, its imports are sophisticated. The distribution of the dots in figure 3 also shows, on one hand, that the relationship between GDPpc and Impy is tighter for higher income Countries and in particular for the European ones. On the other hand, relatively poorer Countries are more loosely located around the regression line. Ukraine and Argentine do not seem to follow the general rule as they are both Countries with a medium-low income level but their agri-food imports are relatively more sophisticated.

Figure 4 - A comparison between Impy and Expy for the agri-food trade



Finally, figure 4 explores whether Impy and Expy are associated to some extent. As always in this paper we limit to build Expy and Impy referred to agri-food trade. These are quite clearly correlated (R2=0.499),

thus indicating that both indices catch elements that are relevant in influencing the composition and quality of traded products.

Moreover, the degree of association of the two indices leaves room for other relevant issues to play a role in the localisation of production and consumption and, consequently, as determinants of trade directions. The dotted line in figure 4 helps visualising the countries that do not reflect the average correlation. As expected, Countries rich in natural resources enjoy a comparative advantage in producing agricultural raw materials and commodities and, thus, their Expy is higher compared to their Impy. This is the case, for example, of rich Countries such as USA, Canada, Australia, but also of middle-to-low income Countries such as Argentina, Malaysia, Vietnam and others. Differently, the figure shows also the case of countries whose imports are much less sophisticated than their exports. This is the case of Egypt, China, Tukey, among others. These seems to be Countries where both income distribution and economic policies play a role in fostering economic growth via pushing exports while taking under control consumption levels.

4. Concluding remarks

The paper discusses new indices for describing and understanding international trade. These belong to the family of the so-called sophistication indices introduced about ten years ago with respect to exports. The indices here proposed consider imports instead of exports, following the standard hypothesis on consumption that the basket of demanded product is highly driven by income level. Within the limits of our field of observation, we think that the outcomes of the exercise are interesting and encourage further exploration of the theme. The basic results we obtained can be summarized as follows:

i) Goods for final consumption for which quality is much relevant and whose markets tend to be highly segmented are high in the Consy ranking;

ii) together with the previous goods, the higher positions in the ranking are also occupied by goods whose production/transport/conservation/marketing are costly and/or require complex technologies;

iii) on the contrary, at the bottom of the ranking there are basically simpler unprocessed (less processed) products, commodities, agricultural raw materials;

iv) better-off Countries tend to import sophisticated goods, i.e. goods that are also imported by other richer Countries;

v) the hypothesis at the basis of the concept and measure of import sophistication seem compatible and complementary to that one underlying the concept and measure of export sophistication. Both rely on visions of trade determinants that seem to be able to explain at list part of the observed flows.

More insights will come from deepening the analysis, including focusing on specific agri-food products and filieres, observing the time dynamics of the indices, but also analysing more in depth the sophistication level of imports of different sets of Countries that are differently related to competing supplying Countries and so on. The floor is open to further research and to a more articulated and integrated use of this "new family" of rather promising indicators.

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