Trade Variety and the Economic Performance of Countries

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Abstract
There is considerable empirical evidence that the variety of the most developed economic systems has considerably increased since the time of the industrial revolution. Although strongly suggested by empirical evidence, this growth in variety has not been confirmed by adequate measures. In this paper we start to explore the relationships between the export and import variety of OECD countries and their economic performance. Growth in variety raises an even more important problem: is variety of an economic system at a given time only an effect or also a determinant of economic development? Our claims are that (i) the variety of economic system has grown, and, (ii) has to grow in order to allow the further development of the system, find a considerable, even if not definitive, support in previous literature. In the paper we first present our expectations about the evolution of variety and about its role in economic development, then we describe the technique and data we used for our measurements and finally we describe our results.

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TRADE VARIETY AND THE ECONOMIC PERFORMANCE OF COUNTRIES

INTRODUCTION.

There is considerable empirical evidence that the variety of the most developed economic systems has considerably increased since the time of the industrial revolution. The presence of many new objects, such as airplanes, computers, television, etc., of which no analogue was present in previous economic life and the fact that in general these new objects did not substitute any pre-existing ones, leads to a strong suspicion that the variety of the economic system has grown. Two mechanisms can have been responsible for this potential growth in variety:

(i) The creation of completely new products and services, non comparable to the pre-existing ones.
(ii) The progressive specialization of goods and services initially created in a more limited form, which raises the number of distinguishable economic species, which we can identify.

Although strongly suggested by empirical evidence, the growth in variety referred to above has not been confirmed by adequate measures. In fact, the most immediate way of confirming that output variety has effectively grown would require the use of output statistics. Data of this type are available, but not necessarily in a form useful for this purpose. The classifications on which output statistics are based are changed infrequently and do not necessarily reflect the true change in variety. On the other hand, trade statistics are available at a high level of disaggregation and in comparable form, at least for OECD countries. Thus, in this paper we start to explore the relationships between the export and import variety of OECD countries and their economic performance.

This observed, even if not finally confirmed, growth in variety raises an even more important problem: is variety of an economic system at a given time only an effect or also a determinant of future economic development? The answer to this question has some important theoretical and policy implications. If variety were only an effect of previous development economists could legitimately neglect it and leave it to industrial archaeologists. On the other hand, if variety is also a determinant of future economic development, to design the right composition of an economic system and to create favourable conditions for variety growth become important policy objectives.

The claims that (i) the variety of economic system has grown, and, (ii) has to grow in order to allow the further development of the system, find a considerable, even if not definitive, support in previous literature. Pasinetti (1981, 1993) showed how the emergence of new sectors, linked to innovations, can compensate for the falling ability of older sectors to create employment. Pasinetti’s work has been used by Saviotti (1996) to argue that variety growth is a necessary requirement for long-term economic development. Amongst recent endogenous growth models those by Romer (1990) contribute to the debate about variety by assuming that R&D activities create new types of capital goods which then accumulate in the economy. Although Romer does not use explicitly the concept of variety, in his models at least the variety of capital goods is bound to increase during the process of economic development. There is also a limited, although growing, amount of empirical evidence that export variety is correlated to economic wealth, and that variety in industrial sectors enhances urban and regional growth (Attaran, 1986; Gleaser et al., 1992; Frenken et al., 2004, 2006) contributes to the economic performance of OECD countries or of the regions of the Netherlands.
respectively. In what follows of this paper we first present our expectations about the evolution of variety and about its role in economic development, then we describe the technique and data we used for our measurements and finally we describe our results.

1) VARIETY AND ECONOMIC DEVELOPMENT

Economic development does not consist only in the creation of wealth but includes many other aspects. The multiple indicators of economic development that are used today, such as food, housing, education, health care, transports, communications etc. show the multiple dimensions of the phenomenon. This paper will be focused mainly on the wealth creating aspects of economic development, although wealth creation will not be considered here as the exclusive result of performing a constant set of activities with increasing efficiency. On the contrary, the most important aspect of economic development will be considered here the creation of new activities giving rise to qualitative change, and thus to change in the composition of the economic system. A more common way of describing the same situation is to say that the creation of new activities gives rise to structural change. Structural change is usually measured as the change in the number and relative weights of the sectors constituting an economic system. In a sense qualitative change is a broader phenomenon than structural change since (i) it can be present at lower levels of aggregation than sectors and (ii) it refers also to changes in the structure of institutions. Qualitative change takes place at several different levels. First, new objects are produced; second, generally the activities required to produce the new objects are different to those used for the pre-existing objects, although a one to one correspondence between objects and activities does not exist; third, the institutional infrastructure required for the production and utilisation of the new objects is often different from that required for the old objects. However, for the purposes of this paper the difference will not be stressed. Both qualitative and structural change affect the composition of the economic system, defined as the list of entities required to describe the economic system. In what follows we stress that both qualitative and structural change affect the composition of the economic system and thus contribute to economic development. In this sense economic development is not uniquely the result of growing efficiency in given activities, which in itself would not give rise to any change in composition, but also of a change in composition. To the extent that variety measures the change in composition of the economic system, we can say that efficiency and variety are two different, although related, forces contributing to economic development.

We have very few studies of variety at the national or regional level. Most of the evidence about changes in the composition of the economic systems comes from studies of structural change. Salter (1960) found that the scope for productivity advance differs markedly across industries, mainly due to different rates of technological progress. Industries with high rates of productivity growth were expected to increase their share of output and employment. Structural change would thus be as important a contributor to overall growth as increases in productivity within individual industries. Cornwall (1977) considered that manufacturing was the economy wide engine of economic growth. This would happen because the manufacturing sector displays dynamic scale economies through learning by doing. As production expands the scope for learning and productivity becomes larger. Furthermore, due to its strong backward linkages to other sectors, manufacturing influences, and presumably increases, the rate of output growth and possibly the rates of productivity growth in other sectors. Cornwall’s hypothesis was confirmed by empirical work for the years 1950s and 1960s. Recent empirical work by Fagerberg (2000) and by Fagerberg and Verspagen (1999) confirms the general importance of structural change but point to its changed role with respect to the
periods studied by Salter and by Cornwall. For the period 1973-1990 Fagerberg found that the overwhelming part of total productivity growth is accounted for by productivity growth within individual industries. According to Fagerberg this does not necessarily imply that structural change has become unimportant but that its role has changed. In particular, today’s leading industries are those related to ICT (Information and Communication Technologies) as opposed to chemicals, electricity, motor cars etc. Advances in productivity growth in ICT could have spilled over to other sectors, thus raising their rates of productivity growth. As a consequence rates of productivity growth might have been wrongly assigned to different sectors. Fagerberg and Verspagen (1999) tested Cornwall’s hypothesis for the period after the 1970s. They found that manufacturing still played the role of engine of growth for newly industrialising countries but not any more for industrialised countries. They explained this change by a type of structural change which was both internal to manufacturing itself and that could also cross the boundaries between manufacturing and services. From these studies we can draw the conclusions that a) structural and thus qualitative change are important components of economic development and that b) the use of highly aggregate and infrequently changed industrial classifications is not the ideal way to detect and study the role of qualitative change in economic development.

1.1) TWO HYPOTHESES

Variety is here defined as the number of actors, activities and objects required to describe the economic system. It must be pointed out that in this context variety can be used at a higher level of aggregation than the one traditionally used in much of the economic literature on the subject. While traditionally variety measured the degree of differentiation of a product group, in the present paper it is used to measure the degree of differentiation of economic systems at different level of aggregation starting from a firm or an individual product and ending with the world economy. In this paper then variety is a measure of the extent of differentiation of the economic system.

Two hypotheses link efficiency and variety to economic development:

**Hypothesis 1:** The growth in variety is a necessary requirement for long-term economic development.

**Hypothesis 2:** Variety growth, leading to new sectors, and productivity growth in pre-existing sectors, are complementary and not independent aspects of economic development.

These two hypotheses can be justified by the imbalance between productivity growth and demand growth (Pasinetti, 1981,1993). If productivity keeps increasing all the time while the demand for new goods and services reaches a saturation point, an imbalance arises. If the economy were constituted by a constant set of activities, in presence of growing productivity it would become possible to produce all demanded goods and services with a decreasing proportion of the resources used as inputs, including labour. This imbalance would then constitute a bottleneck for economic development. The addition of new goods and services to the economic system, that is a change in composition leading to a growth in variety, can be a form of compensation for the potential displacement of labour and of other resources. Variety growth is then required for the long term continuation of economic development. On the other hand, new goods and services can only be generated by means of search activities. The
resources required for these activities can only come from the increases in productivity in pre-existing sectors in a way similar to what happened during the process of industrialisation.

Then productivity growth in agriculture created the resources required for industrialisation (Kuznets, 1965). Similarly productivity growth in pre-existing sectors creates the resources required for search activities and thus for the generation of new products and services. In a Schumpeterian fashion, the growing productivity of the routines constituting the circular flow creates the resources required for innovation, without which economic development would come to a halt.

The approach adopted here is thus clearly Schumpeterian (Schumpeter, 1934), in the sense that the increasing efficiency with which a constant/pre-existing set of activities is performed in the course of time constitutes the circular flow while the new activities are created by innovations that are the true determinant of long term economic development. The consequence of the emergence of new activities is a qualitative change in the economic system, that is a change in the number and type of distinguishable objects produced by means of all the activities of the economic system. An activity means here any process that transforms a set of inputs into one or more outputs. The objects produced by these activities can be material objects or services. Thus, the following considerations, where it is not otherwise indicated, can refer equally well to the production of goods as to that of services. However, the use of variety in this paper requires some reconsideration of the Schumpeterian concept of creative destruction. In principle structural change could give rise to the emergence of a given number of new activities and to the extinction of the same number of older activities, thus making a zero contribution to net variety. Aghion (2005) stresses that it is precisely the substitution older innovations by new ones which constitutes the Schumpeterian character of their (Aghion and Howitt) endogenous growth models. We depart from this interpretation of creative destruction and maintain that the long run observed growth in variety simply implies that there is more creation than destruction. Often, though not always, older economic species survive alongside new ones. However, destruction is still a relevant feature of economic development because very often, though not necessarily in the majority of cases, older activities become extinct and are completely replaced by new ones. What always occurs, irrespective of the extinction of older activities, is the falling share of older activities in order to make room for the new ones. Thus, the reduction to zero of the output share of older activities (their extinction) is but a special case of their shrinking share of output to make room for newer ones. The changing composition of the economic system induced by innovation, not the one to one mapping of older and newer activities with the consequent extinction of the former, is the true Schumpeterian feature of economic development. As it turns out, the change in composition follows a particular arrow, leading to a growth in variety.

1.2) TRADE, GROWTH AND VARIETY

In this section we explain why we expect that when world variety grows individual countries, in order to keep their income per head approximately constant relative to other countries, need to raise their national variety in line with world variety. Furthermore, we refine our concept of variety and describe the relationships we expect between output and trade variety.

If we accept that growing variety is a necessary requirement for long term economic development, it follows that the income share of pre-existing sectors can be expected to fall gradually in the course of time. We can also expect that, however limited the extent of
specialisation of any country, its national output variety will be lower than the world output variety at a given time:

\[ V_j \leq V_w \quad (1) \]

If world output variety keeps increasing we can expect that, although individual countries tend to specialise, this specialisation cannot remain constant and must reflect the new goods and services emerging in the world economy. In general we expect national variety to increase when world variety increases. We stress that this condition applies only to the long run and that in the short to medium run deviations from it can occur. Thus, at a given time a country can specialise in a number of sector where its competitive advantage becomes so great that it more than compensates for the limited integration of new sectors. However, in the long run no country can completely neglect to incorporate new sectors without becoming impoverished. If countries aim at keeping an almost constant share of world income, or, in the case of developing or industrialising countries to catch up, then the ratio of national to world output must remain at least constant or increase in the case of catch-up. An approximate demonstration of this proposition is given in Saviotti (2003). There it is shown that developing countries have different catch up strategies, based on a mixture of specialisation, variety growth and entry into different niches. The success of these strategies can be expected to depend among other variables on the previous production structure of the country and on the time span over which the strategy is applied. At this point it is important to introduce the distinction between related and unrelated variety.

There is considerable evidence that at the level of the firm the diversification seems to lead to better results when it is related diversification (see for example Montgomery, 1982; Ramanujam and Varadarajan, 1989; Montgomery and Hariharan, 1991). In other words, a firm can more easily diversify by moving to products and services similar to those it was already producing than to completely different ones. In the case of firms this finding seems to confirm the idea that coherent firms are more likely to survive and to do well than unrelated or incoherent ones (Teece et al, 1994). We can expect something similar to apply to higher levels of aggregation; for example national or regional. If we interpret related variety as the one that countries or regions raise by introducing new products or services similar to those they were previously producing rather than completely unrelated ones, we can expect related variety to be more conducive to economic growth than unrelated variety, especially in the short run. This is exactly the result that Frenken et al. (2004, 2006) have obtained for different regions of the Netherlands. We can also expect related and unrelated variety to have intrinsically different time scales. Unrelated variety is likely to occur over longer periods than related variety. There are a number of reasons to believe the creation of completely different sectors to be a slower process than the differentiation of existing ones. Nevertheless, even unrelated variety needs to grow in the course of time and no country can completely neglect to incorporate at least some segments of new and important sectors. Thus, related and unrelated variety can be determinants of growth on different time scales, slower for unrelated and faster for related variety.

Variety can be measured for different subsets of the economic system, such as the output of the system, its production processes, its institutions, its trade etc. The importance of these distinctions is due to the fact that we cannot expect the variety of the different subsets to follow the same time path. Some subsets can have a growing variety while others have a falling one. The distinctions on which we will focus in this paper are the ones between output and trade variety and between related and unrelated variety.
We can in general expect export variety \((V_{\text{Exp}})\) to be lower than output variety \((V_{\text{Out}} < V_{\text{Exp}})\): there is hardly any country which exports all the goods and services that it produces. Equally, we can expect export variety to be lower than import variety \((V_{\text{Exp}} < V_{\text{Imp}})\).

Import variety can generally be expected to be higher than export variety. Various theories of international trade predict that countries should specialize, whether that be on the basis of natural resources or of some acquired comparative advantage, built for example by innovating in emerging sectors. On the other hand, all countries need a similar range of inputs, goods and services. This leads us to expect a greater similarity of import than of export variety. Furthermore, the imbalance between import and export variety is likely to vary with: (i) country level of economic development, (ii) country size (iii) propensity to export, etc. Countries at very low levels of economic development are likely to have a very low export variety. In the most extreme case the exports of very poor developing countries are based exclusively on raw materials. Thus, we can expect countries at very low levels of economic development to have an import variety much greater than export variety \((V_{\text{Imp}} >> V_{\text{Exp}})\). Also, in general export variety is likely to grow in relation to import variety when a country increases its (relative) level of economic development. For example, we can expect countries to raise their export variety in order to catch up. In fact, the rise in export variety is likely to be a necessary requirement in order for a country to develop.

Distinguishing between related variety (within sectors) and unrelated variety (between sectors), we expect countries that increase related variety to experience productivity growth, because a growth in related variety exploits economies of scope at the national level. In the following analysis, hypothesis 3 is tested:

**Hypothesis 3:** Related variety growth enhances productivity growth at the national level.

**2) RESEARCH DESIGN**

Following work on related and unrelated diversification, both at the firm level (Jacquemin and Berry, 1979) and the regional level (Attaran, 1986), we apply the entropy measure to indicate variety at different levels of sectoral aggregation. The main advantage of the entropy measure, and the reason for its use in the context of studies on variety/diversification, is that entropy can be decomposed at each sectoral digit level. The decomposable nature of entropy implies that variety at several digit levels can enter a regression analysis without necessarily causing collinearity (Jacquemin and Berry, 1979). In the following, we compute entropy using OECD trade data, which are available for OECD countries at the five-digit level from 1960 to 2003.

Unfortunately, there are many missing data especially at the 4 and 5 digit level. We therefore limit the analysis to the 3-digit level. For the same reasons, we also excluded the 1-digit sector “9” (commodities not elsewhere classified) and two-digit sector “35” (electricity). Furthermore, Israel and Austria are left out due to too many missing data as well as Germany after reunification (1989).

Following Frenken et al. (2004, 2006) we indicate *unrelated variety* per country by the entropy of the one-digit distribution, semi-related variety by the weighted sum of the entropy
at the two-digit level within each one-digit class, and related variety by the weighted sum of the entropy at the three-digit level within each two-digit class.

Formally, this decomposition procedure follows from the entropy formula. Let all sectors \( i \) at some level of aggregation fall exclusively under a sector \( S_g \) at some higher level of aggregation, where \( g=1,\ldots,G \). One can derive the shares \( P_g \) at the higher level of aggregation by summing the shares \( p_i \) at the lower level of aggregation

\[
P_g = \sum_{i \in S_g} p_i \tag{1}
\]

The entropy at the higher level is given by the entropy formula:

\[
UV = \sum_{g=1}^{G} P_g \log \left( \frac{1}{P_g} \right) \tag{2}
\]

and at the lower level by the weighted sum of entropy within each two-digit sector, is given by:

\[
RV = \sum_{g=1}^{G} P_g H_g \tag{3}
\]

where:

\[
H_g = \sum_{i \in S_g} \frac{P_i}{P_g} \log_2 \left( \frac{1}{P_i / P_g} \right) \tag{4}
\]

This procedure can be replicated at any level of aggregation. Having three level of aggregation (1-digit, 2-digit and 3-digit export flows), we indicate *unrelated variety* per country by the entropy of the one-digit distribution (equation 2), semi-related variety by the weighted sum of the entropy at the two-digit level within each one-digit class (equation 3 and 4 with \( g \) standing for one-digit classes), and related variety by the weighted sum of the entropy at the three-digit level within each two-digit class (equation 3 and 4, with \( g \) standing for two-digit classes).

It can be shown that entropy at the 3-digit level equals the sum of unrelated, semi-related and related variety. Thus, each country has a certain level of variety at the 3-digit level, which can be decomposed in unrelated, semi-related and related variety.

3) RESULTS

3.1) DESCRIPTIVE STATISTICS

In the Annex, we provide the entropy level for each country at the 3-digit level, which is decomposed in unrelated, semi-related and related variety. Clearly, countries that experiences rapid development in the period under consideration, including Finland, Greece, New Zealand and Turkey also experience rapid variety growth. By contrast, countries with higher levels of development initially, especially the USA, did not experience variety growth. Thus, already we have some descriptive evidence for our thesis.
Some countries show a rather deviant behaviour. In particular, Norway experience variety decline) due to specialisation in oil and fishery), while Ireland first experience variety growth, as expected, but suddenly experienced variety decline (due to specialisation on computers and pharmaceuticals).

Interestingly, the levels of import variety for all countries are roughly the same and more or less constant over time (figures not shown). 3-digit entropy of import is generally around 4.5, which is generally equal or higher then export variety, as expected.

3.2) Regression

To estimate the effect of different levels of variety (unrelated, semi-related and related), we used labour productivity data per hour work from the University of Groningen (www.ggdc.net). We divided the whole period into four 10-year periods starting from 1964-1973 to 1994-2003. We computed variety growth for each 10-year period in percentages\(^1\) as well as labour productivity growth per 10-year period in percentage. Data for Germany are valid only till 1990, so two period are missing. The total number of observations thus adds up to nineteen times 4 period plus one time 2 period (78 observations).

OLS estimation show that only related variety has significantly contributed to productivity growth. Table 1 shows that this positive effect is significant at the 5 percent level. This result, albeit without any control variables and not verified by changing the periods in which the data are subdivided, confirms our hypothesis that countries that increase related variety experience productivity growth, because a growth in related variety exploits economies of scope at the national level.

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>.291*</td>
<td>.026</td>
</tr>
<tr>
<td>UNRELATED VARIETY</td>
<td>.079</td>
<td>.203</td>
</tr>
<tr>
<td>SEMI-RELATED VARIETY</td>
<td>-.083</td>
<td>.241</td>
</tr>
<tr>
<td>RELATED VARIETY</td>
<td>.645*</td>
<td>.295</td>
</tr>
</tbody>
</table>

Dependent variable: labour productivity growth (\(N=78\))

4) Concluding Remarks

The results obtained in this paper constitute a partial, if important, confirmation of the role played by structural change in economic development. They show that related export variety is a determinant of productivity growth for OECD Countries for the period 1961-2003. Future research will aim to further validate this claim with additional econometric analyses and robustness tests.

\(^1\) Data for USA are missing for 2003 so we computed the annual growth rate in variety on the basis of four years in the final period.
A large number of questions arise as a consequence. First, what is the relationship between export and output variety? Second, is output variety a determinant of productivity growth? Third, is unrelated variety not a determinant of productivity growth or does it work over a longer time scale? Fourth, what are the determinants of output and of export variety? The last question has a large number of important policy implications. To say that the variety of an economic system has to grow to allow the long term continuation of economic development can have useful policy implications only if we know how to raise this variety. Of course, the introduction of new economic species always requires innovation. Today innovation generally requires R&D or at least search activities. Furthermore, there is reasonable evidence that the creation of appropriate institutions is required to allow the development of new technologies, a situation referred to as the co-evolution of technologies and institutions (Nelson, 1994). Thus, there are several possible determinants of variety growth. In future we plan to study all these questions and to achieve a fuller understanding of the role played by variety in economic development.

REFERENCES


Annex

Source: OECD trade databases

AUS is Australia
CAN is Canada
CHE is Switzerland
DEU is Germany
DNK is Denmark

ESP is Spain
FIN is Finland
FRA is France
GBR is Great Britain
GRC is Greece

IRL is Ireland
ITA is Italy
JPN is Japan
NLD is Netherlands
NOR is Norway

NZL is New Zealand
PRT is Portugal
SWE is Sweden
TUR is Turkey
USA is USA