Revealed Comparative Economies of Scope and Development Index

Shuhe Li and Changzhen Gong*

In this note, we attempt to construct some summary statistic to measure economic development and make comparisons across countries. A development index is defined in terms of both "scale" and "scope". "Scale" is measured by output per capita. "Scope" is measured by *revealed comparative economies of scope*, which in turn is measured by the ratio of the variety of exports over the variety of imports for a country. Using purchasing power parity and the Standard International Trade Classification, we have computed the development index for forty countries. (*JEL* Classifications: C43, O10)

Economists talk about "less developed economies" and "developed economies" daily. And yet to our best knowledge, there is no summary index to measure the degree of economic development and classify the economies in the world into the two groups. One may be tempted to use output per capita as the index of economic development. But then many oil-exporting countries become "developed", although they are quite "primitive" in many aspects such as technology. A more meaningful index is needed.

In this note, we attempt to construct some summary statistic to measure economic development and make comparisons across countries. This is by no means an easy task. We need to construct some statistic complicated enough to capture the key features of economic develop-

*Department of Economics and Finance, City University of Hong Kong, 83 Tat Chee Avenue Kowloon, Hong Kong, E-mail: efshuhe@cityu.edu.hk. Department of Economics, University Minnesota, Minneapolis, MN 55455, U.S.A.. We thank Lifang Sun for computational assistance, and an anonymous referee for helpful suggestions.

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ment, and at the same time, simple enough to be workable.

Economic development is a rich phenomenon, of which the changes of scale and scope are central (Chandler 1990). Growth and structure changes at the macro level are the consequences of the changes of scale and scope at the micro level. The creation of the mass production system (MPS) based on transfer lines at the turn of this century has tremendously increased economies of scale, which has resulted in a consistent rise of output per capita.

As output per capita increases, consumers' demand shifts from quantity to variety. In the 1960s and 1970s, the flexible manufacturing system (FMS) based on the combination of numerically controlled machines and transfer lines was invented (Maleki 1991). FMS has significantly increased economies of scope. The history of economic development is to a large degree the history of expansion of two dimensions—"scale"[1] and "scope", or the history of the increase of both output per capita and variety.

For illustration, consider Figure 1 below. The out-bowed curves are "production possibility frontiers" (PPFs). Given an economy with fixed population, PPF specifies what is the maximal total output[2] for each given total variety (i.e., the product space). (See Appendix A) Where *oa*, *ob*, and *oc* are, what we call, *minimum efficient varieties*, below (above) which output and variety are positively (negatively) correlated along the PPF.

Let us justify the shape of the PPF curve introduced above. (i) Different resources are not equally suited for producing a particular product, so it is more efficient to produce multi-products than to produce a single product. (ii) There exists complementarity among some different production factors, so more of one product may be needed to increase the production of another. For instance, to increase grain products, we may need to increase the production of fertilizers. (iii) There exists complementarity among some consumption goods and consumption may affect labor productivity. Therefore, to increase aggregate product, we may need to increase variety initially. Of course, as we reach a certain level of variety (minimum efficient variety), there will exist a trade-off between aggregate output and variety. This is

[1]The word "scale" here is related but does not mean scale economies; instead it means output per capita.

[2]Total output is the weighted sum of the quantities of different products and the weights are prices. For a small open economy, the prices are exogenously determined by the rest of the world.

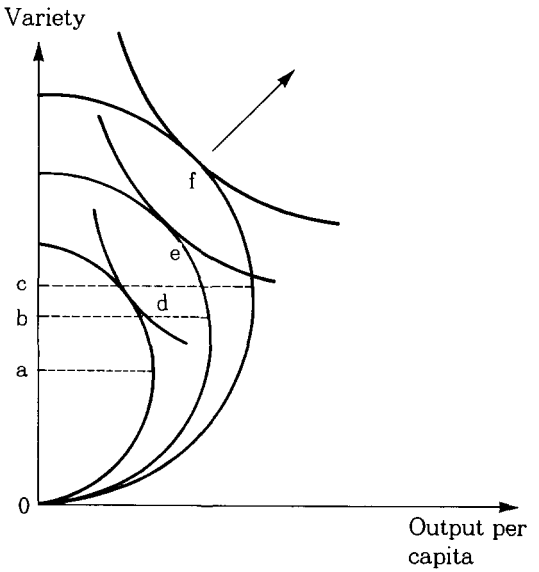


FIGURE 1
EXPANSION OF OUTPUT AND VARIETY

because if too many products are produced, then the production level of each product may become too low and far away from minimum efficient scale.

The curves that bow toward origin are "indifference curves" (see Appendix B). The tangent points *d*, *e*, *f* are optimal "bundles". The above analysis suggests that variety may grow faster than per capita output, which, of course, in reality depends how we measure variety.[3]

We are tempted to say that an economy at *e* is more developed than an economy at *d*, and an economy at *f* is more developed than an economy at *e*. However, there are three problems when we make comparisons across countries. First, different countries may have different (representative) preferences; i.e., some countries may put more weight on variety and others may put more weight on quantity. But this is not

[3]One way to measure variety is to estimate the stock of trademarks in use. For U.S. from 1930s to 1980s, per capita output grew about 2% annually, trademarks registered each year grew about 3%. Conceivably, the stock of trademarks in use grew more than 3% annually.

our concern in this note and let us assume preferences are the same across countries.

Second, the way of comparison made for d, e and f in Figure 1 above is a partial order; that is, one country with less variety and more output per capita and another country with more variety and less output per capita are not comparable. To make the comparison a total order, one way is to use lexicographic order. But this is too biased toward the primary variable which needs to be pined down. Suppose we agree output per capita is the primary variable. Then Saudi Arabia is more developed than Spain, which is against our sense. A more sound way is to take the product of variety and output per capita as the basis of comparison.

Third, variety in an economy is hard to measure and it is usually not recorded in any statistical sources. To classify variety of products is quire arbitrary. For cross-country comparisons, there are two additional problems. One is the non-overlapping of non-tradable goods. The other is country size effect; usually a larger country produces more variety. These problems are solved in this note by defining the *revealed comparative economies of scope* below and using the Standard International Trade Classification.

We now propose a measure: *relative development index* (RDI):

$$\text{RDI} = \text{ROPC} \times \text{RCES},$$

where ROPC is relative output per capita, and RCES is the *revealed comparative economies of scope*, and we let

$$\text{RCES} = \text{Variety of exports/Variety of imports.}^{4}$$

The relative output per capita of the leader country[5] is set to be 1, and the relative output per capita of each follower is its output per capita as percentage of that of the leader. Clearly, ROPC depends not only on scale economies but also on the endowments of natural resources and institutional arrangements among other things.

In our view, the degree of economies of scope in a country is positively correlated with its variety of exports, while negatively correlated with its variety of imports. This is because comparatively speaking, a country can efficiently produce the products it exports, but not efficiently produce these imported products. The latter indicates some lack of

[4]This way of definition connects trade to development.

[5]The leader country is the country with the highest output per capita.

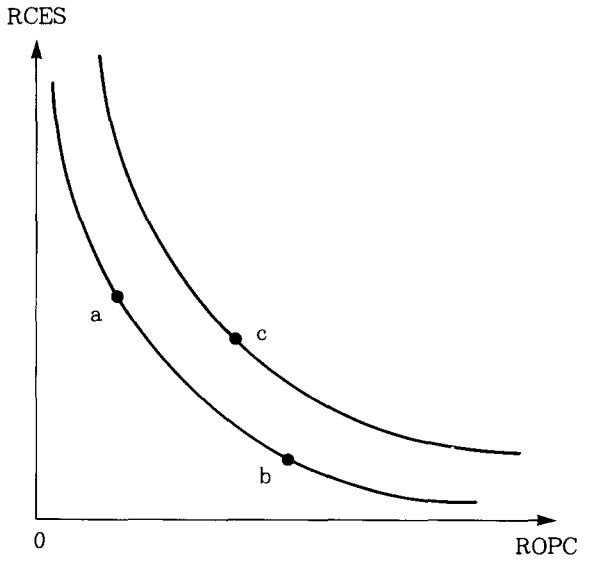


FIGURE 2
DEVELOPMENT INDEX

economies of scope. In order to compare the comparative economies of scope across countries, it is beneficial to use the ratio (rather than the difference) of the variety of exports to the variety of imports for a country to get rid of the country size effect.

Notice that Figure 1 can be extended to the case with trade. The idea is the same as extending the usual PPF to the case with international trade.

The idea of measuring development index is illustrated in Figure 2. The hypoberlas are "iso-developments." Point *a* and *b* correspond to the same development index. Point *c* corresponds to a higher development index.

Because of international labor divisions and individual country specialization, most countries export less varieties than they import, hence they have a RCES less than one. Some oil exporting countries have a RCES much less than one. To illustrate, Table 1 is computed based on simple count of the SITC 5 digits for forty countries in a single year. (To be precise, the variety computation should be based on some weighted averages and based on a certain time span.)

TABLE 1

COMPARISONS OF RDI, ROPC AND RCES OF 40 SELECTED COUNTRIES

Country	ROPC	RCES	RDI	Country	ROPC	RCES	RDI
Argentina	0.264	0.69	0.18	Mexico	0.263	0.61	0.16
Australia	0.711	0.61	0.43	Nigeria	0.072	0.08	0.01
Brazil	0.245	0.82	0.20	Netherlands	0.682	1.07	0.73
Canada	0.925	0.87	0.80	Pakistan	0.090	0.55	0.05
Chile	0.276	0.52	0.14	Peru	0.178	0.47	0.08
China	0.121	0.87	0.11	Philippines	0.107	0.80	0.09
Cote d'Ivoire	0.102	0.50	0.05	Poland	0.245	0.87	0.21
Egypt	0.158	0.45	0.07	Saudi Arabia	0.472	0.08	0.04
France	0.693	0.93	0.64	Singapore	0.726	0.96	0.70
Hong Kong	0.604	0.90	0.54	South Africa	0.283	0.44	0.12
Hungary	0.312	0.31	0.10	South Korea	0.243	0.87	0.21
India	0.047	0.71	0.03	Spain	0.46	0.93	0.43
Indonesia	0.094	0.52	0.05	Sri Lanka	0.117	0.63	0.07
Israel	0.521	0.96	0.50	Sweden	0.769	0.81	0.62
Italy	0.656	1.03	0.68	Switzerland	0.870	0.98	0.85
Japan	0.715	0.92	0.66	UK	0.661	0.93	0.61
Jordan	0.179	0.63	0.11	Uruguay	0.287	0.69	0.20
Kenya	0.052	0.54	0.03	US	1.00	0.96	0.96
Kuwait	0.786	0.72	0.57	Venezuela	0.244	0.20	0.05

Sources of basic data: (1) The Economist Book of Vital World Statistics, The Economist Book Ltd, 1990. (2). International Trade Statistics Yearbook, 1991, Part I. ROPC of each country is based on PPPs in 1988. RCES of a country is based on a year of 1985-90.

We also have Figure 3 to illustrate the results of Table 1 intuitively.

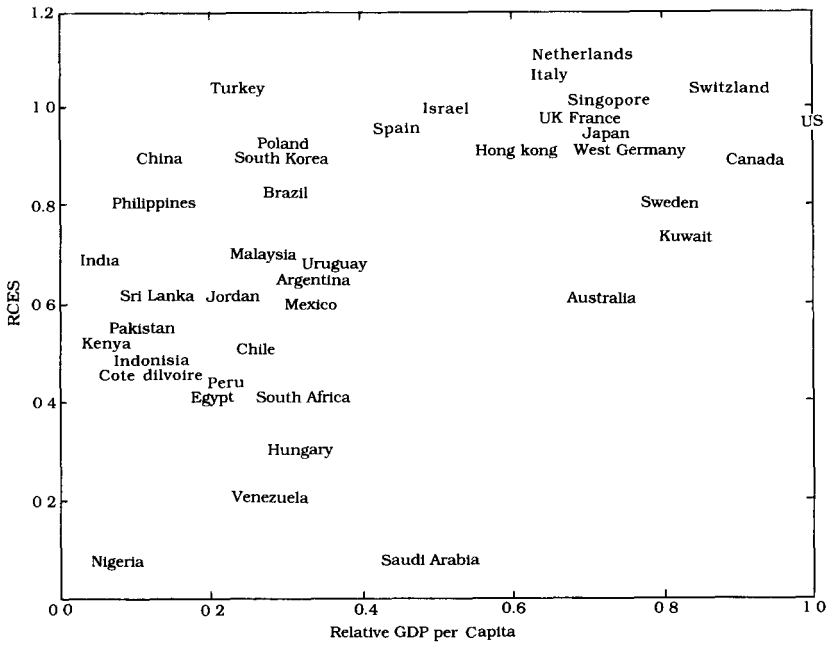
We observe that:

(i) There is a (very) weak positive correlation between output per capita and RCES. That is, a richer country tends to have larger revealed comparative economies of scope.

(ii) High output per capita is usually associated with high RCES and hence with a high development index. Economies with such indexes represent the developed countries (concentrated in the up right-hand corner in Figure 3). The rest are the developing countries.

(iii) Saudi Arabia has about the same output per capita as Spain, but its RCES (0.08) is well below Spain's RCES (0.93). Thus the development index of Saudi Arabia (0.04) is well below Spain's (0.43).

(iv) Among the forty selected countries, the US has the highest development index (0.96), Nigeria has the lowest (0.01). China has a very low development index (0.11) that is about the same as that of Jordan



PC and RCES for 40 Countries
Source of basic data: Table 1.

FIGURE 3
ROPC AND RCES FOR 40 COUNTRIES

and South Africa. China's RCES is fairly high (0.87); it is about the same as that of South Korea and Canada. But output per capita in China is very low; it is at about the same level as that of Sri Lanka and the Philippines.

We have constructed a summary statistic to measure economic development and made comparisons across countries. A development index is defined as the product of "scale" ad "scope". "Scale" is measured by output per capita. "Scope" is measured by revealed comparative economies of scope, which in turn is measured by the ratio of the variety of exports to the variety of imports for a country. Using purchasing power parity and the Standard International Trade Classification, we have computed and compared the development index and the revealed comparative economies of scope for forty countries.

In order to focus on the two central features of general economic development, our definition of development index omits many interest-

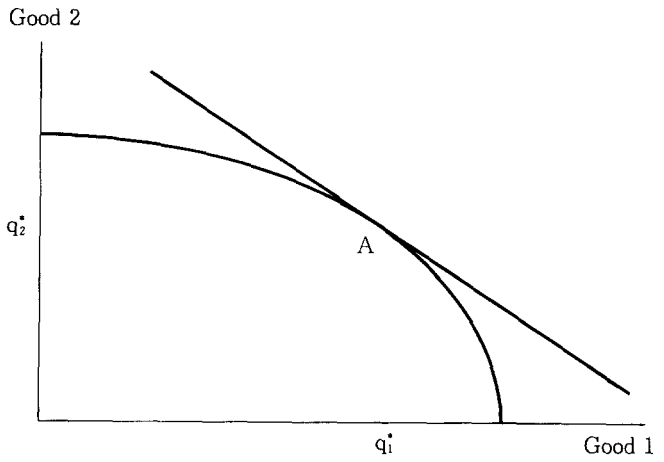


FIGURE 4

ing aspects of economic development. In particular, it does not directly capture technology advances, production structure changes and living standard improvement. The numbers of patents, the ratios of scientists/engineers to labor force or R & D expenditure-GDP ratios may be used to capture technology advances. The distribution (proportions) of the three industries (primary, secondary and tertiary industry) is a typical indicator of production structure changes. Living standard can be measured by life expectancy, child mortality rate and so on. One may want to add some of these indicators to our development index, depending on what questions he addresses. The problem is how to determine the "weight" for each individual indicator in the summary index. Clearly, further study is needed.

Appendix A. "Production Possibility Frontier" of Variety and Output

Suppose variety is given equal to 2. The production possibility frontier and an indifference curve in the usual sense are given in Figure 4. Point A is the Pareto optimal allocation and also the competitive equilibrium. Suppose the corresponding quantities and prices are q_1^*, q_2^*, and p_1^*, p_2^* respectively at A. Then the (maximal) total output will be $p_1^* q_1^* + p_2^* q_2^*$.

Appendix B. "Utility Function" of Variety and Output

For simplicity, consider a small open economy. The price vector is exogenously given (determined by the rest of the world). Suppose the variety is n and the total output is y.

Then define the "utility function" (of variety and output) v as

$$v(n, y) = \text{Max } u(q_1, q_2, \ldots, q_n)$$
$$\text{s.t. } p_1q_1 + p_2q_2 + \ldots + p_nq_n = y.$$

where u is the utility function in the usual sense, and $p_1, p_2, \ldots, p_n$ are prices.

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References

Chandler, Alfred D., Jr. *Scale and Scope: the Dynamics of Industrial Capitalism.* Harvard University Press, 1990.

Maleki, Reza A. *Flexible Manufacturing Systems: The Technology and Management.* Prentice Hall, 1991.