KEYWORDS

Free trade
Economic growth
Economic gap
Economic convergence
Mathematical models

The comparative advantage fallacy and a rule for convergence

Esteban Pérez Caldentey and Anesa Ali

The gains from trade argument is based on the principle of comparative advantage. However, this principle is predicated on "tacit" axioms, presenting an argument which supports a proposition different to the one it purports to prove. This paper presents an alternative treatment, using a leader-follower model to show that free trade can in fact accentuate differences and growth disparities between countries. More importantly, it argues that the follower economy can catch up with the leader economy only if the ratio between the income-elasticity of the follower country's exports to the rest of the world and the income-elasticity of its imports is greater than the ratio between the induced productivity of the leader and that of the follower country. This is our rule for convergence.

.

Esteban Pérez Caldentey
Economic Affairs Officer,
Development Studies Unit,
Economic Development Division,
ECLAC
esteban.perez@cepal.org

Anesa Ali
External Affairs Officer,
Division of Bilateral Relations,
Ministry of Foreign Affairs,
Trinidad and Tobago
anesa.ali.mfa@gmail.com

I
Introduction

This paper argues that the guiding principle behind free trade theory, comparative advantage, is only valid for barter economies characterized by full employment and absence of uncertainty where differences in size and development level do not affect the final outcome, which in point of fact is a Pareto optimum. However, this does not imply that comparative advantage, or for that matter Say's Law, can be applied to real-world economies.

This paper presents an alternative approach to the analysis of free trade using a leader-follower country model. The model is based on three pillars: cumulative causation, the technology gap, and the external constraint approach to growth. Using this framework, this paper presents a basic derivation of a rule for convergence.

This rule states that, given free trade, the follower economy can converge with the leader economy only if the ratio between the income-elasticity of demand for the follower country's exports in the rest of the world and the income-elasticity of its demand for imports is greater than the ratio between the leader and follower country's induced productivity.

The paper is structured in five sections. Following this introductory section, section II gives a brief presentation of the treatment of free trade in mainstream economic theory, including a summary explanation of the main theorems underpinning the idea of comparative advantage in international trade and the implications of these. Section III critically examines the principle of comparative advantage as underpinned by three tacit core axioms, namely the neutral money axiom, the gross substitution axiom and the ergodic axiom, discussing their meaning and examining their relevance.[1]

The fourth section presents our alternative model. In essence, this model states that convergence between the leader and follower economy can be modelled by the difference in Verdoorn-type equations. Their interaction is captured by the introduction of Thirlwall's Law and a technological spillover function.

Within the logic of our model, money is not neutral since monetary arrangements ultimately determine the framework within which real forces operate. It also gives primacy to income over substitution effects. In fact, the model presented here is explicitly different from other contributions to this type of approach in the literature because the role of relative prices is markedly absent from the analysis. Lastly, the model assumes away the existence of an ergodic environment where, by definition, ensemble, spatial and temporal statistical averages converge on the same mean.

☐ The opinions expressed herein are the authors' own and may not coincide with those of eclac or the Ministry of Foreign Affairs of Trinidad and Tobago. The authors are grateful for the comments of an anonymous referee. Comments are welcome and may be e-mailed to the authors.

[1] The critique of comparative advantage is undertaken in terms of the assumptions underpinning this basic foreign trade principle. According to Keynes (1973b, p. 21), Say's Law is the "classical theory's 'axiom of parallels.' Granted this all the rest follows… the unqualified advantages of laissez-faire in respect to foreign trade and much else which we have to question." As Davidson (1994 and 2002) explains, these three postulates (neutral money, gross substitution and the ergodic axiom) underlie Say's Law. "Granted these all the rest follows." The principle of comparative advantage is a special case of Say's Law. There are other critiques of Say's Law and comparative advantage based on internal consistency arguments or different methodological approaches. From the point of view of this paper's authors, the "tacit assumptions" critique is the most potent of all those levelled at the principle of comparative advantage and at neo-classical theory more generally.

II

The treatment of free trade in mainstream economic theory

According to mainstream economic theory, free trade creates welfare gains by allowing consumers and firms to purchase from the cheapest source of supply. This ensures that production is located according to comparative advantage. In other words, free trade allows the principle of comparative advantage to operate by suppressing discrimination between such sources of supply as may exist.

The properties of the standard mainstream free trade model based on comparative advantage, the Heckscher-Ohlin or Heckscher-Ohlin-Samuelson model,[2] are to be found in four well-known theorems: (i) the Heckscher-Ohlin theorem, (ii) the Stolper-Samuelson theorem, (iii) the Rybczynski theorem, and (iv) the factor-price equalization theorem.

The Heckscher-Ohlin theorem establishes a relationship between factor scarcity and factor embodiment in a commodity such that countries export the commodity which intensively uses the abundant factor. It provides the basis for the gains from trade argument, such gains consisting of the increase in output and real income for a given set of inputs or domestic resources resulting from trade.

The Stolper-Samuelson theorem complements the above theorem by stating that the intensive use of a factor of production for export (i.e., the abundant factor) raises its rate of return above that of all other factors. In turn, the consequent increase in the supply of that factor of production will lead to an increase in the output of the commodity that is intensive in that factor of production (the Rybczynski theorem). Lastly, the factor price-equalization theorem, stating that trade equalizes factor returns across countries, wraps up the case for free trade.[3]

The introduction of dynamic factors such as spillover effects does not alter the validity of the basic analysis. Indeed, it can be shown that if knowledge is freely mobile and equally accessible among countries, patterns of specialization are determined by comparative advantage.[4] That is, by construction in mainstream theory, static and dynamic trade theory are one and the same thing when free trade (implying *laissez-faire* and *laissez-passer*) prevails. There is absolutely no fundamental distinction between the two.

[2] The Heckscher-Ohlin (H-O) model was renamed Heckscher-Ohlin-Samuelson (H-O-S) after Samuelson formalized the basis properties of the H-O model.

[3] Under conditions of perfect competition, trade in goods acts as a substitute for factor mobility. Under conditions of imperfect competition, free trade does not result in the full equalization of commodity prices and factor returns across countries. However, free trade does reduce differentials and thus acts as a force for convergence.

[4] See Helpman (2004) and Grossman and Helpman (1996). The existence of economies of scale can lead to trade creation through production, consumption and cost reduction effects. The production effect allows the transfer of production to the lower-cost trading partner. The consumption effect refers to the gain in the consumer surplus due to lower prices. The cost reduction effect denotes a switch to cheaper sources of supply. Dunn and Muti (2000) identify three effects that can increase the efficiency of free trade: (i) a shift in output that increases its price by more than its average cost; (ii) a scale effect that reduces firms' average costs of production when output expands; (iii) an increase in trade permitting greater diversification of the final goods and intermediate inputs being traded.

III

Comparative advantage and its tacit axioms

The principle of comparative advantage and its purported benefits are based on three tacit axioms: neutral money, gross substitution and the ergodic axiom (Davidson, 1994, pp. 17-18; 2000, p. 171; 2002, pp. 43-44).[5]

A neutral economy is one where money is "*a neutral link among real transactions and the effects of monetary changes on real transactions is transitory*".[6] As a result, economic transactions taking place by virtue of each of these approaches are carried out in terms of physical goods and persons, whether consisting of trade in goods or factors of production and their remuneration, production processes involving a given level of technology, or the allocation of resources between alternative productive uses. Money does not in any way affect the economic process, which behaves like that of a barter economy.[7] Money is inessential and does not enter in any way into decision-making.[8]

The axiom of gross substitution means that any good can be substituted for by any other. Two goods are said to be gross substitutes when

$$z_1 / p_2 > 0 \text{ y } z_2 / p_1 > 0 \quad (1)$$

where *zi (p1, p2)* is an excess demand function and *p1* and *p2* are the money prices of goods 1 and 2.

The axiom of gross substitution implies that a price path follows a process of adjustment such that the rate of change in relative prices is proportional to the excess demand function. In other words, it converges towards equilibrium and is globally stable as a result. This is expressed formally as:

$$\lim_{t \to \infty} p(t) = p^* \quad (2)$$

where p* is a vector of equilibrium prices.

In the particular case of the Heckscher-Ohlin-Samuelson model, the axiom of gross substitution is strengthened by the fact that it assumes production functions and factor quality to be the same across countries. In other words, the rate of marginal substitution among factors is the same.

Ergodicity implies that ensemble, spatial and temporal averages converge to the same mean. In other words, a given system converges towards a *unique* globally stable equilibrium irrespective of the initial conditions or the trajectory followed. It also implies homogeneity, that is, that every member of a given ensemble possesses the same statistical behaviour as the whole ensemble. As a result, the statistical behaviour of an ensemble can be deduced from the behaviour of one sample function. The behaviour of the sample function is representative of that of the whole ensemble.

Turning to the core of mainstream trade theory, the axioms of neutrality, gross substitution and ergodicity are what underpin the operation and validity of the comparative advantage principle.

Expenditure is directed towards the cheapest commodity, leading to changes in relative commodity prices, production levels, the demand for factors and their respective real remuneration rates. The process leads to price equalization, full employment and net welfare gains for all trading partners. In other words, "free trade is best".

Moreover, the core axioms imply that initial conditions are irrelevant to the final outcome. That is, differences in the trading partners' size and development level do not affect the final outcome. Trade affects all countries alike and development level and size are a non-issue. As a result, there is no need and no room in trade theory and policy for any type of asymmetrical treatment whatsoever. Instead, the sole aim of trade

[5] Davidson (2000, p. 160) refers to open economy models of the 1960s which were developed using the core axioms above to "prove that free trade and optimum global economic growth required a laissez-faire approach".

[6] See Rymes (1989, pp. 47-49). Keynes (1979, p. 78) defined a neutral economy as one "in which the factors are hired by entrepreneurs for money but where there is a mechanism of some kind to ensure that the exchange value of the money incomes of the factors is always equal in the aggregate to the proportion of current output which would have been the factor's share in a co-operative economy".

[7] Schumpeter (1954) also distinguished between real analysis and monetary analysis. The former denotes that part of monetary thinking which views and understands economic relationships in real terms, that is, in barter terms.

[8] See, for example, the attempt by Samuelson (1976, p. 640) to introduce monetary factors into a standard neoclassical model of international trade. He writes: "..it is shown that the original Ohlin position was right in its contention that there would be a tendency for free trade in goods to serve as a partial substitute for factor mobility and thereby serve to reduce but not wipe out difference in factor prices". Hence money is an inessential addition to the mainstream framework.

policy should be to ensure the fluid operation of free market mechanisms.[9]

The purported benefits of the Heckscher-Ohlin-Samuelson model and regional integration theory follow logically from a set of premises that automatically guarantee full employment and welfare improvements irrespective of the trading partners' initial conditions and the strength of trade linkages between them. If the comparative advantage principle applies, free trade and "free trade areas" for that matter can only be "welfare improving areas", irrespective of geographical extent. It is actually all a matter of degree. The greater their geographical extent, the greater the improvement in welfare.[10]

However, this does not mean that comparative advantage is welfare-improving in a world more akin to the real world where the axioms of neutrality, gross substitution and ergodicity are not satisfied. Indeed, the application of orthodox trade principles to the "real world" raises the suspicion that the whole argument for free trade may fall prey to the fallacy of ignoratio elenchi, i.e., that of proving or supporting a proposition different to the one it is purporting to prove or support.[11] It is thus not surprising that, for example, empirical studies analysing the welfare effects of the formation of free trade areas find that the evidence is decidedly ambiguous.[12]

Changing the core premises and introducing non-neutral money, income rather than substitution effects and a non-ergodic environment can radically alter the conclusions of mainstream trade theory and regional integration theory. This is shown in the next section, which presents a simple model for two economies of different sizes and development levels.

IV

An alternative approach to free trade: a simple two-country model

The model is built on three approaches to economic growth. The first is encapsulated in Kaldor's notion of cumulative causation and its development in the work of McCombie and Thirlwall (1994) and McCombie, Pugno and Soro (2002). The second follows the balance-of-payments constraint approach to growth as developed by Thirlwall (1979) and McCombie and Thirlwall (1994).[13] Lastly, the third strand is the technological gap approach to growth.

[9] The current drive for bilateral trading arrangements in the Americas is squarely based on these tacit axioms.

[10] See footnote 3 above.

[11] *Ignoratio elenchi* was first identified by Aristotle in *On Sophistical Refutations*. It translates literally as ignorance of what constitutes a refutation and consists in proving an argument wholly different from the one purportedly being proved. Keynes (1973b, p. 259) mentions the fallacy. According to Carabelli (1991, p. 123) it belongs to the informal fallacy of relevance category. An informal fallacy of relevance establishes a relationship between the relevance/irrelevance of the premises of arguments and their conclusions. Irrelevance means that the premises and the conclusion are not connected. The fallacy is explained by the fact that the key assumptions of neoclassical theory (and indeed the core axioms) are tacit. Keynes (1973a, p. 79) argues that "…you will search in vain for any express statements of the simplifications which have been introduced or for the relationship of its [the neutral economy's] hypothetical conclusions to the facts of the real world". (The square brackets in the citation were introduced by the authors of this paper). See Keynes (1979, pp. 408-411) for a similar argument.

[12] Panagariya (2000) distinguishes two approaches to this issue. The first is based on some type of general equilibrium model whereby, starting from a base model with a given structure and parameters, tariff barriers among trading partners are removed. The second is based on gravity equation estimates. Panagariya (2000, p. 326) writes: "Consider first the simulation approach. It is relatively easy to manipulate the structure of the model, functional forms and parameter values in these models to obtain one's desired results." Regarding gravity equation estimates, the criticism focuses on the fact that the success of regional trade agreements is based on aggregate trade creation or diversion, when in fact the question is to identify whether trade creation has occurred at the sectoral level, and this requires a great deal of information that is difficult to obtain. Lastly, it is to be noted that the analytical exercise dealing with trade creation-trade diversion does not cover two aspects that are crucial for trade negotiations: trade in services, which is the main form of international trade for the smaller economies of the Caribbean, and the relationship between foreign direct investment and free trade areas.

[13] McCombie and Thirlwall (1994) and León-Ledesma (2002) extend the Kaldorian cumulative growth model to include the technological gap approach. For conceptual purposes, the cumulative and technological gap approach are treated as two different approaches to growth (see Castellacci, 2001).

The cumulative causation approach views growth as being internally generated. Technological innovation through the growth of embodied or disembodied productivity generates growth in demand which feeds back into productivity growth. The growth linkage between productivity and demand is explained by terms-of-trade effects, increased income and expenditure, and changes in income distribution. The linkage from demand to productivity is explained by returns to scale, specialization and market size, embodied technical progress and learning by doing (Castellacci, 2001). From this perspective, growth is generated internally through innovation activity.

This approach disparages the notion of equilibrium and thus of convergence and stability. However, it does not deal with technological spillovers between countries or the international diffusion that can occur through trade linkages, i.e., it does not address the issue of country interdependence. Such interdependence is one of the main hypotheses of the technological gap approach.

The technological gap approach asserts that a country's growth rate depends on its level of technological development. It also states that countries whose technological level is below the world innovation frontier can increase their rate of growth through a process of "catching up" or imitation. Lastly, the absorptive capacity of such countries depends on their "ability to mobilize resources for transforming social, institutional and economic structures" (Fagerberg and Verspagen, 2001, p. 11). The technological gap approach recognizes that all countries are not alike, that development levels are an important determinant of growth and welfare and that not all countries benefit to a similar extent from trade and the transmission of trade linkages.

The third approach, the balance-of-payments constraint approach, asserts that trade performance, trade linkages and growth cannot be understood or analysed in real or "barter" terms. Trade and growth are intimately linked to the architecture and workings of the existing international financial order, and these are the main constraint on economic growth and development.[14]

International trade is not carried out in real, "barter" terms but in money terms and more precisely in terms of the international reserve currency or currencies. Countries can build up their economic infrastructure and develop by importing capital, raw materials, inputs and technology only if they are able to acquire the reserve currency or currencies, which the great majority of countries cannot issue. As a result, countries' export potential must be commensurate with their import capacity.

Over the long run, consequently, countries must maintain equilibrium in the balance of payments or at least in the basic balance, since in the long run they can only grow at rates compatible with their external position. It is in this sense that countries are said to be balance-of-payments-constrained.[15]

Within this framework, money is not neutral. A process of technological "catch-up" through imitation derived from a process of cumulative causation cannot occur if economies do not have the means to obtain the reserve currency. More to the point, the extent to which countries can benefit from a "catch-up" process depends on the extent to which they can access international liquidity. Accordingly, in our approach, by contrast with mainstream theory, monetary factors provide the framework for the operation and development of real forces, such as innovation.

The model postulates the existence of two economies, one developed and the other developing. By definition, the developing economy is also the smaller economy. The developed economy is termed the leader (denoted by subscript $_l$) and the developing economy is the follower economy (denoted by subscript $_f$).

The leader has higher levels of productivity and is technologically more advanced. The follower economy is assumed at this stage to be closely linked to the leader economy. It is furthermore assumed that the leader economy issues the international reserve currency, which is by definition also used by the follower economy. As a result, the follower country is balance-of-payments-constrained while the leader country is not.

The model begins by defining the technology gap (G_p) between the leader and the follower economy (P_l and P_f, respectively) in logarithmic terms such that the rate of growth of the gap *(g)* can be expressed as the difference between the rates of productivity change in the leader and follower country (McCombie and Thirlwall, 1994; Targetti and Foti, 1997). That is,

$$G_p = Ln(P_l / P_f) \quad (3)$$

$$g = p_1 - p_f \quad (4)$$

[14] See Davidson (1992, pp. 93-96; 2002, pp. 158-161).

[15] Countries are balance-of-payments-constrained in the sense that "their performance in overseas markets, and the response of the world financial markets to this performance, constrains the rate of growth of the economy to a rate which is below that which internal conditions would warrant" (McCombie and Thirlwall, 1999, p. 49).

The rates of productivity growth in the leader and follower economies are equal to the sum of the rates of growth of autonomous (exogenous) and induced productivities. That is, they are modelled according to Verdoorn's Law.[16] The interpretation of the autonomous and induced coefficients adopted in this paper is that of Dixon and Thirlwall (1975) and McCombie and Thirlwall (1994).[17]

As stated by McCombie and Thirlwall (1994, p. 464), autonomous productivity depends on "*the autonomous rate of disembodied technical progress, the autonomous rate of capital accumulation, and the degree to which technical progress is embodied in capital accumulation*". For obvious reasons, the rate of autonomous productivity growth is higher in the leader economy than in the smaller country (i.e., $p_l > p_f$).

For its part, induced productivity is captured by the parameter λ, also known as the Verdoorn coefficient. Again as stated by McCombie and Thirlwall (1994), it is a function of "'*learning by doing*', *the degree to which capital accumulation is induced by economic growth (yl and yf for the leader and follower economies, respectively) and the extent to which technical progress is embodied in capital accumulation*".[18]

Formally,

$$p_l = p_{la} + \lambda_l y_l \quad (5)$$

$$p_f = p_{fa} + \lambda_f y_f \quad (6)$$

Note that, as formulated, equations (5) and (6) capture the presence of increasing returns due to the greater specialization induced by economic growth.[19] In turn, a greater degree of specialization entails a higher rate of growth, which permits the expansion of the potential for specialization. Hence, the process described by equations (5) and (6) is cumulative.

As stated earlier, the follower economy is balance-of-payments-constrained. That is, its rate of growth has to conform in the long run to the rate of growth consistent with balance-of-payments equilibrium. Such is not the case with the leader economy because it issues the international reserve currency.

In view of the ample empirical evidence corroborating balance-of-payments constraint models (Thirlwall and McCombie, 2004), the model postulates that income effects predominate over substitution effects and that the long-term growth rate of the follower economy (y_f) is determined by Thirlwall's Law. That is, the long-term growth rate of the follower economy (y_f) is determined by the long-term growth rate of the leader economy (y_l) multiplied by the income-elasticity ratio between the follower country's exports to the rest of the world (π) and the income-elasticity of its demand for imports (ξ). Formally,

$$y_f = y_l\ (\pi/\xi) \quad (7)$$

Successive substitution of equation (7) into equation (6) and of equations (5) and (6) into equation (4) yields the following expression for the rate of change in the productivity gap:

$$g = (p_{la}-p_{fa}) + \lambda_l y_l - \lambda_f\ (\pi y_l/\xi) \Leftrightarrow (p_{la}-p_{fa}) + y_l\ (\lambda_l - \lambda_f\ (\pi/\xi) \quad (8)$$

Equation (8) shows that the rate of change in the productivity gap over time will depend on the following factors: (i) the differences in autonomous productivities; (ii) the rate of growth in the leader economy; (iii) the difference between the Verdoorn coefficient in the leader country and that in the follower country, augmented by the ratio between the income-elasticities of the leader country's exports to the rest of the world and the income-elasticities of its imports. By contrast with other approaches found in the literature, relative prices do not play a role in the workings of Verdoorn's law.[20]

[16] Verdoorn's Law is a "statistical relationship between the long-run rate of growth of labour productivity and the rate of growth of output, usually in the industrial sector" (McCombie, Pugno and Soro, 2002, p. 1). This relationship was formulated by Verdoorn (1949) and restated as a law by Kaldor (1966).

[17] Soro (2002, pp. 45-53) considers three interpretations of Verdoorn's Law. The first two were suggested by Verdoorn and are based on complementarity and perfect substitutability of the factors of production. The third, which is the one adopted in this paper, follows the Kaldorian interpretation. A key component of Kaldor's interpretation is the existence of increasing returns to scale. Following Young (1928), Kaldor subscribed to a macroeconomic rather than microeconomic concept of increasing returns. See Soro (2002) and Chandra and Sandilands (2005).

[18] A value of $\lambda > 0.5$ indicates the presence of increasing returns.

[19] This means that increasing returns derive from specialization rather than scale. This is the position of Allyn Young and Nicholas Kaldor. See Young (1990).

[20] The approach adopted in this paper follows the post-Keynesian tradition in emphasizing income over substitution effects (Davidson, 1992, p. 22). On this view, relative prices do not play a role in determining the long-run gdp growth rate or the productivity gap. See Dixon and Thirlwall (1975) and León-Ledesma (2002) for a different approach in which the effect of Verdoorn's Law is captured through its effect on relative prices. Relative prices determine exports, which in turn determine the rate of output growth. If the price-elasticity of the export demand function is insignificant, then Verdoorn's Law plays no role whatsoever in determining this rate. In other words, increasing returns

According to equation (8), as long as $\pi < \xi$ then the rate of growth in the productivity gap will increase (mainly because $p_{la} > p_{fa}$ and $\lambda_l > \lambda_f$, leading to a process of divergence, and the follower country will not catch up with the leader economy. This finding holds for any given level of output growth in the leader economy.Moreover, equation (8) shows that when the leader economy's growth rate approximates to zero, the rate of growth in the productivity gap (g) is equal to the difference between the autonomous productivities. According to equation (8), lastly, positive growth rates in the leader economy (y_l) increase the growth rate of the follower economy (y_f). In other words, growth in the leader economy is a force for convergence. This follows from Thirlwall's Law (equation 7). But at the same time, growth in the leader economy increases the rate of growth of g, when $\pi > \xi$ (equation 8).[21] As a result, increases in y_l constitute an additional force for divergence in g. That is,

$$(9)\quad \partial_g/\partial y_l = (\lambda_l - \lambda_f(\pi/\xi) \text{ ya que } \lambda_l > \lambda_f \text{ y } (\pi/\xi) < 1$$

Within the framework provided by equation (8), there is no inherent mechanism for convergence. Rather, the initial conditions (i.e., higher productivity in the leader country and the higher value added of its exports relative to its imports), and thus the principle of absolute advantage, are what will determine the outcome of a free trade agreement between the leader and follower countries.

A closer approximation to a convergence mechanism can be arrived at by assuming that the difference in autonomous productivities between the leader and follower economies is equal to zero ($p_{la} - p_{fa} = 0$). Taking this hypothesis, it can be shown that the rate of change in the gap will increase, decrease or be equal to zero depending on whether the ratio of the Verdoorn coefficients between the leader and follower economies is greater than, less than or equal to the ratio between the income-elasticity of the follower country's exports to the rest of the world and the income-elasticity of its imports. That is,

$$(10)\quad \begin{array}{ccccc} >0 & & >0 & & > \\ g = 0 & \Leftrightarrow & y_l\,(\lambda_l - \lambda_f(\pi/\xi)) = 0 & \Leftrightarrow & \lambda_l/\lambda_f = \pi/\xi \\ <0 & & <0 & & < \end{array}$$

In other words, excluding discrete changes in the Verdoorn coefficients, closing the induced productivity gap requires that the difference in induced productivity between the leader and follower economy be offset by improved external performance in the latter (that is, must increase and/or π ξ must decrease). Changes in these parameters may reflect demand factors only or rather the effects of specialization, allocative efficiency and embodied technology.[22]

Up to this point the development of the model assumed that the Verdoorn equations, and more specifically the induced productivities of the leader and follower countries, were independent of one another. However, when countries trade and become more integrated, their performance is influenced by each other's level

and the process of cumulative causation are dependent on the workings of relative prices. Ultimately, therefore, these models rest the weight of the analysis on the validity of the gross substitution axiom.

[21] This result can be inferred from Thirlwall's Law. See, for example, Moreno and Pérez Caldentey (2003). As is shown here, this result presupposes that the autonomous and induced productivities in the leader economy surpass those of the follower economy.

[22] There are three competing hypotheses in the balance-of-payments-constrained literature regarding the determinants of the income-elasticities of imports and exports. The **first** follows from Prebisch and Singer and relates the size of the elasticity parameters to the manufacturing and technological content of the products exported and imported. According to this reasoning, the income-elasticity of exports increases as external sales move up the value-added chain from commodities to semiprocessed labour- and resource- intensive goods, then to manufactures with low, medium and high skill and technology content. In the case of developing economies, the income-elasticity of demand for their exports in the rest of the world is low and the income-elasticity of their demand for imports is high. Less developed countries exporting commodities subject to Engel's Law are usually in this category (Davidson, 1992). The main policy implication, following the logic of Thirlwall's Law, is that unless countries undergo a process of structural change that alters the elasticity parameters, the cleavage between developed and developing economies will widen over time and less developed countries are condemned to poverty. The **second hypothesis** states that while the income-elasticity of a country's demand for imports tends to remain more or less constant, the income-elasticity of its exports to the rest of the world varies over time with the level of development (Bairam, 1997). More specifically, the income-elasticity of demand for a country's exports in the rest of the world is inversely related to its level of development and tends to decline as this level rises. As a result, increases in external demand or expansionary phases in the global cycle (or that of the country's main trading partners) have a positive effect on developing countries' external position. The **third hypothesis** maintains that changes in the said income-elasticities are brought about by shifts in commercial policy or measures designed to transfer liquidity between countries, or both. Changes in commercial policy involve changes in trade barriers (tariffs and quotas). Measures to recycle liquidity comprise increases in surplus nations' imports and unilateral transfers from surplus to deficit nations (Davidson, 1992, p. 153). Thus far the empirical work shows that the income-elasticity of imports rises with trade liberalization and that the income-elasticity of exports depends on what the market and consumers and producers are demanding at a given time. Thus, while the income-elasticity of imports depends on institutional factors which include changes in commercial policy, as per the third hypothesis, there seems to be no clear core factor determining the income-elasticity of exports.

of economic development. That is, interdependence generates spillover effects between countries. One of the most important channels for the transmission of economic development is the diffusion of knowledge.[23]

Within the setting of our model, the spillover effects of knowledge are transmitted from the bigger, more developed economy (the leader) to the smaller, less developed one (the follower) via the absorptive or learning capacity of the latter. This capacity is limited by the extent of the productivity gap between the two economies.[24] The greater the absorptive capacity of the follower, the more powerful the knowledge spillover effect.[25]

Following Targetti and Foti (1997), induced productivity can be modelled as a non-linear function of the gap. Formally,

$$(11) \qquad \lambda_f = a\,(1/G_0)\,(e^{-G/\theta}) = a\varphi\,(e^{-G/\theta})$$

where

a = factor of proportionality.
φ = $(1/G_0)$ = inverse of the initial productivity gap and $0 < \varphi < 1$.
θ = parameter reflecting the adaptability or learning capacity of the follower economy.

According to equation (11), induced productivity in the follower country is proportional to the inverse of the initial productivity gap. That is, the greater (smaller) the initial productivity gap, the lower (higher) φ will be and, other things being equal, the weaker (stronger) the spillover effect.

Equation (11) is also a function of the extent to which the follower economy is able to acquire and incorporate knowledge from the leader economy (i.e., of the absorptive or learning capacity of the follower economy).[26] This is captured by $e^{-G/\theta}$ The basic mathematical properties of equation (11) are listed below and figure 1 plots the function.

$$(12) \qquad \lim_{\theta \to 0} \lambda_f = 0 \quad \text{y} \quad \lim_{\theta \to \infty} \lambda_f = a\,(1/G_0)$$
$$\lambda_f'(\theta) = a\,(1/G_0)\,(G/\theta^2)\,(e^{-G/\theta}) > 0 \text{ y}$$
$$\lim_{\theta \to 0} \lambda_f = \infty \quad \text{y} \quad \lim_{\theta \to \infty} \lambda_f = 0$$

Induced productivity is an increasing function of the parameter θ. However, as θ increases, induced productivity tends to the limit $(1/G_0)$. That is, the extent to which the follower country is able to use its learning capacity to catch up with the leader economy is bounded by the initial productivity gap (G_0). This is in fact the boundary of the country's learning capacity. The greater the initial productivity gap, the lower the "learning capacity boundary", as shown in figure 1 by the difference between the continuous straight line (corresponding to (G_0) and the dashed straight line (corresponding to G_{l_0} and $G_{l_0} > G_0$). Similarly, any increase in the actual gap, whatever its initial size, reduces the follower's induced productivity. This too is shown in figure 1, by the difference between the straight and dashed lines of induced productivities (λ_f and λ_{fl}, respectively), which correspond to different sizes of gap (G and G_l, respectively, where $G_l > G$).

Substituting equation (11) into equation (8) yields the following expression for the rate of change in the gap:

$$(13) \qquad g = (p_{la} - p_{fa}) + \lambda_f y_l - (a\varphi e^{-G/\theta} y_l\,(\pi/\xi))$$
$$\Leftrightarrow (p_{la} - p_{fa}) + y_l\,(\lambda_f - (a\varphi e^{-G/\theta}(\pi/\xi))$$

Equation (13) shows several important features of the "gap dynamics". First, for any given level of y_l and of (π/ξ), the direction of change in the gap will depend on the difference between the rate of growth in autonomous productivities, the induced productivity of the leader and the extent to which the follower country can benefit from the spillover effects, which basically depends on its adaptability or learning capacity (θ).

[23] See Helpman (2004, pp. 60-69) and Rogers (2004).

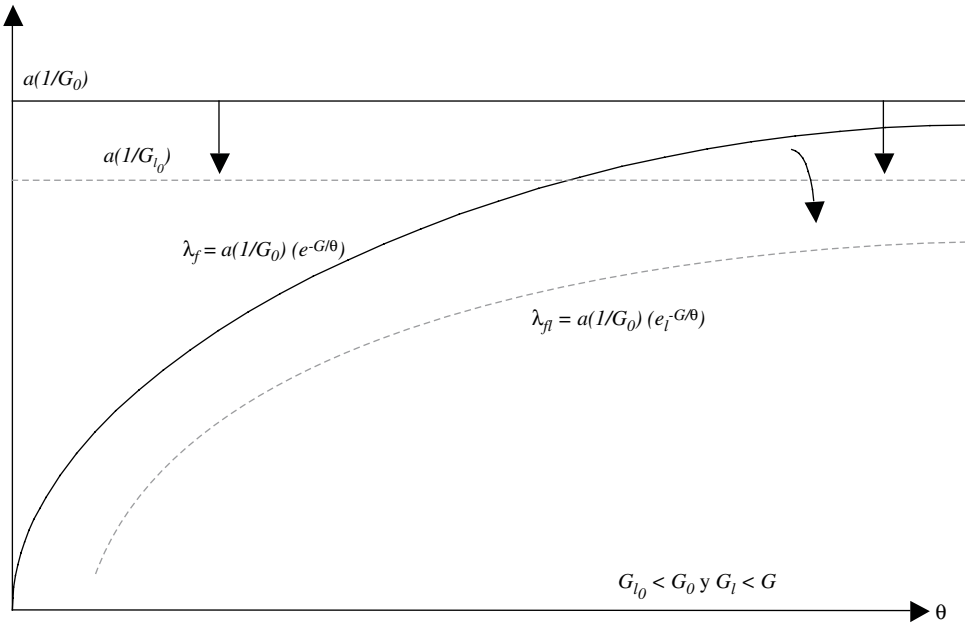
[24] See Nelson and Phelps (1966), Abramovitz (1986), Targetti and Foti (1997) and Rogers (2004).

[25] According to Abramovitz (1979, 1986 and 1995), countries can realize their catch-up potential if they exhibit "social capability" and "technological congruence" and possess natural resource endowments. The term "social capability" includes a wide variety of factors, including social attitudes and political institutions, educational attainment, organizational and commercial skills and adequate levels of infrastructure. The term "technological congruence" refers to the fact that technology in the leader economy may not always be appropriate for the follower economy (Verspagen and Los, 2002; Criscuolo and Narula, 2002).

[26] Absorptive capacity is defined by Dahlman and Nelson (1995) as "the ability to learn and implement the technologies and associated practices of already developed countries". It is a narrower concept than "social capability". According to Rogers (2004, p. 579), absorptive or learning capacity depends on "accessibility to overseas technology, learning ability, and the incentives or barriers to implementing new technologies".

FIGURE 1

Induced productivity of the follower country



Source: Prepared by the authors.

Second, an increase in the leader country's growth rate (y_l) will produce both divergent and convergent effects on the follower country's ability to catch up or narrow the gap. It will translate into an increase in the follower country's growth rate through the workings of Thirlwall's Law. The magnitude of the pull effect exerted by the leader on the follower country will depend on the ratio between the income-elasticities of the follower's exports to the rest of the world and the income-elasticity of its imports (π/ξ). In this way, growth in the leader country will narrow the gap, but at the same time it will widen it through its induced productivity effect ($y_l\lambda_l$). Formally, by taking the derivative of g with respect to y_l, it can be shown that the gap may be divergent, convergent or neutral. That is,

(14) $$\partial g/\partial y_l = \lambda_l - (a\varphi e^{-G/\theta}(\pi/\xi)$$

and

(15) $\partial g/\partial y_l > 0 \Rightarrow \lambda_l - (a\varphi e^{-G/q}(\pi/\xi)) > 0 \Leftrightarrow \lambda_l/(a\varphi e^{-G/q}) > (\pi/\xi)$: Divergent gap path.

$\partial g/\partial y_l = 0 \Rightarrow \lambda_l - (a\varphi e^{-G/q}(\pi/\xi)) = 0 \Leftrightarrow \lambda_l/(a\varphi e^{-G/q}) = (\pi/\xi)$: Neutral gap path.

$\partial g/\partial y_l < 0 \Rightarrow \lambda_l - (a\varphi e^{-G/q}(\pi/\xi)) < 0 \Leftrightarrow \lambda_l/(a\varphi e^{-G/q}) < (\pi/\xi)$: Convergent gap path.

According to the set of equations (15), growth in the leader economy (yl) will narrow (widen, not affect) the rate of growth in the gap only if the differences in the induced productivities of the leader and follower economies are smaller than (larger than, equal to) the difference between the income-elasticity of the follower country's exports and the income-elasticity of its demand for imports, i.e., $(\lambda_l/a\varphi\ e^{-G/\theta}) < (\pi/\xi)$; $(\lambda_l/a\varphi\ e^{-G/}) > (\pi/\xi)$; $(\lambda_l/a\varphi\ e^{-G/\theta}) = (\pi/\xi)$.

The same result (i.e., the same relationships and conclusion) holds in general terms when $y_l > 0$, assuming that for analytical purposes the difference in the rate of growth in autonomous productivities is equal to 0. Under these assumptions, equation (13) can provide a benchmark or criterion for convergence. That is,

(16) $$g = y_l\ (l_l - (a\ je^{-G/q}(\ /x))$$

and

(17) $g > 0 \Rightarrow \lambda_l - (a\varphi e^{-G/q}(\pi/\xi) > 0 \Leftrightarrow \lambda_l/(a\varphi e^{-G/q}) > (\pi/\xi)$: Divergent gap path.

$g = 0 \Rightarrow \lambda_l - (a\varphi e^{-G/q}(\ /\xi) = 0 \Leftrightarrow \lambda_l/(a\varphi e^{-G/q}) = (\pi/\xi)$: Neutral gap path.

$g < 0 \Rightarrow \lambda_l - (a\varphi e^{-G/q}(\pi/\xi)\ 0 \Leftrightarrow \lambda_l/(a\varphi e^{-G/q}) < (\pi/\xi)$: Convergent gap path.

Both sets of equations, (15) and (17), point to the fact that no parameter (whether it be learning capacity θ or the elasticity of exports or imports), and no policy aimed at a single objective, can guarantee convergence. As an example, policies to increase the relative elasticity of the leader country's income-elasticity of exports (say, policies to encourage the production of goods with high income-elasticity)[27] may prove unsuccessful unless induced productivity differences can be offset (because complementary policies are in place to improve learning capacity or because the policies themselves have a positive effect on learning capacity in the follower country).

V
Conclusion

The principle of comparative advantage is the cornerstone of mainstream trade theory. It is held to ensure the realization of welfare gains by allowing consumers and firms to purchase from the cheapest source of supply.

Comparative advantage forms the basis for the argument that free trade is best and that the gains from trade can only be realized under a laissez-faire regime. However, its underlying assumptions (the axioms of neutral money, gross substitution and ergodicity) make the entire argument prey to the *ignoratio elenchi* fallacy.

This paper presents an alternative framework for analysing the effects of free trade, exemplified at this stage of our work in progress by a two-country model consisting of a leader and a follower. The leader is more developed and also issues the international reserve currency.

Our framework is based on three approaches to economic growth: cumulative causation, the technological gap and balance-of-payments constraint.

Cumulative causation departs from the notion of equilibrium and convergence: differences in productivity and growth can persist and widen over time. According to this approach, the impetus for growth and the interrelationship between growth and productivity are generated internally. The technological gap formula addresses the issue of country interdependence and is a vehicle for analysing the spillovers from trade. The third approach complements the other two by providing the monetary context within which they operate.

According to the model presented, there is no mechanism that can guarantee the optimality of free trade, convergence between countries or indeed any predictable outcome. The final outcome of free trade may depend on a variety of parameters and variables. It may even be shaped by history, critical decisions and unforeseen events.

The model suggests that the growth impetus of the leader economy has both a convergent and a divergent effect on the follower country. The convergent effect works through two channels: adaptive capacity and Thirlwall's Law. The divergent effect works through the induced productivity and cumulative causation mechanisms.

In addition, it asserts that all the follower country can do is to take advantage (through spillover effects) of the productivity gains of the leader country. The extent to which the follower country can profit from spillovers depends on its adaptability (i.e., its learning capacity and its ability to earn reserve currency) and its initial conditions, including its stock of currency. As a result, monetary policies that soften the balance-of-payments constraint can be as important as educational policies aimed at improving human capital.

Lastly, the model states that the follower can narrow the gap with the leader country only if the difference in the elasticities ratio is greater than the difference in the induced productivity coefficients. Countries gain nothing in terms of convergence by improving their net export potential unless it offsets the induced productivity differential. This is a rule of convergence proposed and upheld in this article, and it should provide a benchmark and guideline for economic policy design.

(Original: English)

[27] These may well be efficiency improvement policies.

Bibliography

Abramovitz, M. (1979): Rapid growth potential and its realisation: the experience of capitalist economies in the postwar period, in E. Malinvaud (ed.), *Economic Growth and Resources: The Major Issues*, London, Macmillan.

_____ (1986): Catching up, forging ahead, and falling behind, *Journal of Economic History*, vol. 46, No. 2, New York, Cambridge University Press, June.

_____ (1995): The elements of social capability, in D.H. Perkins and B.H. Koo (eds.), *Social Capability and Long-Term Growth*, Basingstoke, Macmillan Press.

Bairam, E.I. (1997): Levels of economic development and appropriate specification of the Harrod foreign-trade multiplier, *Journal of Post Keynesian Economics*, vol. 19, No. 3, New York, M.E. Sharpe.

Carabelli, A. (1991): The methodology of the critique of the classical theory: Keynes on organic interdependence, in J. Davis (ed.), *Keynes and Philosophy*, Aldershot, Edward Elgar.

Castellacci, F. (2001): A "technology-gap approach to cumulative growth": toward an integrated model. Empirical evidence for Spain, 1960-1997, document presented at the Druid Academy Winter Conference (Copenhagen, 18-20 January).

Chandra, R. and R.J. Sandilands (2005): Does modern endogenous growth theory adequately represent Allyn Young?, *Cambridge Journal of Economics*, vol. 29, No. 3, Oxford, Oxford University Press, May.

Criscuolo, P. and R. Narula (2002): *A Novel Approach to National Technological Accumulation and Absorptive Capacity: Aggregating Cohen and Levinthal*, Research Memoranda, No. 18, Maastricht, Maastricht Economic Research Institute on Innovation and Technology.

Dahlman, C. and R. Nelson (1995): Social absorption capability, national innovation systems and economic development, in D.H. Perkins and B.H. Koo (eds.), *Social Capability and Long-Term Growth*, Basingstoke, Macmillan Press.

Davidson, P. (1992): *International Money and the Real World*, New York, St. Martin's Press.

_____ (1994): *Post Keynesian Macroeconomic Theory*, Northampton, Edward Elgar.

_____ (2000): Commitment to full employment in a global economy, in A.W. Warner, in M. Forstater and S.M. Rosen (eds.), *The Economics and Social Policy of Williams S. Vickrey*, New York, M.E. Sharpe.

_____ (2002): *Financial Markets, Money and the Real World*, Northampton, Edward Elgar.

Dixon, R.J. and A.P. Thirlwall (1975): A model of regional growth rate differences on Kaldorian lines, *Oxford Economic Papers*, vol. 27, Oxford, Oxford University Press.

Dunn, R.M. and J.H. Muti (2000): *International Economics*, London, Routledge.

Fagerberg, J. and B. Verspagen (2001): *Technology-Gaps, Innovation-Diffusion and Transformation: An Evolutionary Interpretation*, TIK Working Paper, No. 11/01, Oslo, Centre for Technology, Innovation and Culture (TIK).

Grossman, G.M. and E. Helpman (1994): *Technology and Trade*, NBER Working Paper, No. 4926, Cambridge, Massachusetts, National Bureau of Economic Research.

Helpman, E. (2004): *The Mystery of Economic Growth*, Cambridge, The Belknap Press of Harvard University Press.

Kaldor, N. (1966): *Causes of the Slow Rate of Economic Growth of the United Kingdom. An Inaugural Lecture*, Cambridge, Cambridge University Press.

Keynes, J.M. (1973a): *The Collected Writings of John Maynard Keynes*, vol. 13, New York, Cambridge University Press.

_____ (1973b): *The Collected Writings of John Maynard Keynes*, vol. 7, New York, Macmillan Press.

_____ (1979): *The Collected Writings of John Maynard Keynes*, vol. 19, New York, Cambridge University Press.

León-Ledesma, M.A. (2002): Accumulation, innovation and catching-up: an extended cumulative growth model, *Cambridge Journal of Economics*, vol. 26, No. 2, Oxford, Oxford University Press.

McCombie, J.S.L., M. Pugno and B. Soro (2002): *Productivity Growth and Economic Performance. Essays on Verdoorn's Law*, New York, Palgrave Macmillan.

McCombie, J.S.L. and A.P. Thirlwall (1994): *Economic Growth and the Balance-of-Payments Constraint*, New York, St. Martin's Press.

_____ (1999): Growth in an international context: a post Keynesian view, in J. Deprez and J.T. Harvey (eds.), *Foundations of International Economics. Post Keynesian Perspectives*, New York, Routledge.

Moreno, J.C. and E. Pérez Caldentey (2003): Trade liberalization and economic growth in Central America, *CEPAL Review*, No. 81, LC/G.2216-P, Santiago, Chile, December.

Nelson, R.R. and E.S. Phelps (1966): Investment in humans, technological diffusion and economic growth, *American Economic Review*, vol. 56, No. 2, Nashville, Tennessee, American Economic Association.

Panagariya, A. (2000): Preferential trade liberalization: the traditional theory and new developments, *Journal of Economic Literature*, vol. 38, No. 2, Nashville, Tennessee, American Economic Association.

Rogers, M. (2004): Absorptive capability and economic growth: how do countries catch-up?, *Cambridge Journal of Economics*, vol. 28, No. 4, Oxford, Oxford University Press.

Rymes, T.K. (1989): *Keynes's Lectures, 1932-35. Notes of a Representative Student*, Ann Arbor, The University of Michigan Press.

Samuelson, P.A. (1976): An exact Hume-Ricardo-Marshall model of international trade, in G.G. Judge and T. Takashi Takayama (eds.), Studies in Economic Planning over Space and Time, vol. 2, New York, North Holland Publishing Company.

Schumpeter, J. (1954): *History of Economic Analysis*, New York, Oxford University Press.

Soro, B. (2002): Fattori che regolano lo sviluppo della produttività del lavoro: fifty years on, in J. McCombie, M. Pugno and B. Soro (eds.), *Productivity Growth and Economic Performance. Essays on Verdoorn's Law*, New York, Palgrave Macmillan.

Targetti, F. and A. Foti (1997): Growth and productivity: a model of cumulative growth and catching-up, *Cambridge Journal of Economics*, vol. 21, No. 1, Oxford, Oxford University Press.

Thirlwall, A.P. (1979): The Balance-of-Payments Constraint as an Explanation of International Growth Rate Differences, *Banca Nazionale del Lavoro Quarterly Review*, vol. 32, Rome, Banca Nazionale del Lavoro.

Thirlwall, T. and J.S.L. McCombie (2004): *Essays on Balance of Payments Constrained Growth: Theory and Evidence*, London, Routledge.

Verdoorn, P.J. (1949): Fattori che regolano lo sviluppo della produttivita del lavoro, L'industria, vol. 1. Translated by A.P. Thirlwall in D. Ironmonger, J. Perkins and T. Hoa (eds.), *National Income and Economic Progress: Essays in Honour of Colin Clark*, London, Macmillan, 1988.

Verspagen, B. and B. Los (2002): The Evolution of Productivity Gaps and Specialization Patterns, unpublished.

Young, A. (1928): Increasing returns and economic progress, *Economic Journal*, vol. 38, No. 152, Oxford, Royal Economic Society.

_____ (1990): Nicholas Kaldor's notes on Allyn Young's LSE lectures 1927-29, *Journal of Economic Studies*, vol. 17, No. 3/4, Bradford, United Kingdom, Emerald