How well the cumulative causation and export-led approaches predict actual growth of the EU(15) countries[1].

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Abstract

This paper uses the cumulative causation approach to predict actual growth in the EU (15) countries over the period 1981-2004. The cumulative causation principle underlines the importance of demand factors as the driving forces of growth and assumes that productive factors are endogenous to the growth process, challenging therefore, the neoclassical theory of exogenous growth. A special characteristic of the cumulative growth approach is the presence of increasing returns to scale properties that turn the process of growth circular and self-sustained. In the same line of thought, an export-led growth approach is also employed to predict growth in the EU(15) countries which takes into account the balance of payments performance. In this framework, exports are the most potent element of demand that drive growth, and international trade elasticities are the key parameters determining the rate of growth. This model is extended to include the productivity gap as important factor in determining export competitiveness. The empirical analysis uses panel estimation techniques to predict actual growth. Our evidence shows that both, the cumulative causation and export-led approaches, accurately predict actual growth in the EU(15) countries, and that exports and productivity (through technological progress) are the driving forces of growth.

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Keywords: cumulative causation growth, export-led growth, increasing returns to scale, productivity gap, panel regressions.

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1. Introduction

This paper uses the cumulative causation principle to predict actual growth in the EU(15) member countries. This approach is associated with Myrdal (1957) who earlier tried to explain the backwardness of the developing countries, arguing that leading economies have the capability to explore, sustain, reinforce and augment their initial advantages in sectors with increasing returns to scale characteristics, making difficult for less advanced countries to compete at the same activities. According to the cumulative causation process and the hypothesis of the endogeneity of factor inputs, a concentration of industrial activity will occur in regions with comparative advantages, causing a higher specialization and better reallocation of productive resources. In the same line of thought, Kaldor (1966)[2] explained that is the mechanism based on increasing returns to scale (known as Verdoorn's Law)[3] that generates the cumulative causation tendencies in the context of the polarization process. Kaldor attributed to industry and manufacturing the role of the engine of growth, as being the only sectors generating increasing returns to scale and producing mostly tradable commodities. Exports are the most potent component of exogenous demand with a higher multiplier effect on national income, lower import content and higher saving propensity. Technology is transferred through international trade and exports are responsible for higher efficiency in production generating growth with circular and cumulative tendencies.

Based on the same principles, Thirlwall (1979) developed an export-led model that determines a country's growth rate consistent with the balance of payments equilibrium. Thirlwall argues that the position of the balance of payments in current account is important for growth and that a disproportionate deficit can constrain demand, and therefore growth, unless the economy is able to finance the external deficit by international capital flows. The equilibrium growth rate is determined by a simple rule (known as Thirlwall´s Law) given by the ratio of exports growth over the income elasticity of the demand for imports. The key parameters in this approach are the income elasticities of the demand for imports and exports that capture the supply characteristics of the goods produced and traded. An income elasticity of the demand of

[2] See in Targetti and Thirlwall (1989).
[3] Verdoorn´s Law relates the labour productivity growth to the growth of the industrial output, and this is a dynamic relationship that captures increasing returns to scales properties due to technological progress. For more details and the controversy on Verdoorn´s Law, see McCombie and Thirlwall (1994).

imports higher than that of exports shows a structural problem. The goods which are produced in the domestic market are not competitive (desirable) neither in the domestic nor in foreign markets. In this case, an effort must be made to reallocate productive recourses to tradable sectors producing commodities with higher quality and high elasticity of demand in international markets. The most effective solution is to improve the non-price competitiveness of exports through industrial policies which focus on research and development and training activities.

This paper implements both approaches to predict actual growth in the EU(15) countries over the period 1981-2004, by using panel data estimation techniques. Revisiting these earlier approaches and implementing new estimation techniques to predict actual growth are the main contributions of the present study. The remainder of the paper is divided in the following sections. Section 2 explains the cumulative causation principle and the mechanism that makes growth circular and self-sustained. Section 3, implements the cumulative causation model to a sample of 15 European countries and tests its predictive capacity in explaining actual growth in these countries. Section 4 develops an augmented export-led model based on Thirlwall's Law, introducing a technological factor (through the productivity gap) that can better explain export non-price competitiveness. The predictive capacity of this model is also tested for the same sample of countries. The last section summarises the main findings.

2. The Cumulative Causation Principle.

Myrdal´s (1957) explanation of the development gap and divergence among regions or countries is based on the dualistic structure of the economies and the functioning of the cumulative causation principle. The hypothesis of geographic dualism[4] helps to understand the differences between North and South or between the centre and the periphery, the former being more industrialized, the latter primary producing, and this leads to a structure that creates unequal exchange and unequal pace of development between regions of the same nation or between countries. Under the conditions of labour migration, capital movements and trade, the existence of dualism can retard the

[4] The term "dualism" has different interpretations, but mainly it refers to economic and social divisions in an economy, such as differences in the level of technology and productivity, differences in the degree of geographic development, and differences in social customs and attitudes (Thirlwall, 2006).

development of backward economies through the process of circular and cumulative causation growth.

This process can be described as follows. Consider a country where all regions have attained the same stage of development (same per capita income, similar levels of productivity and technology, similar wages). Assuming an exogenous shock, due for instance to an increase in exports demand, will produce a disequilibrium situation with development proceeding more rapidly in the regions where the demand for their exports has increased in the expense of the other less competitive regions. This disequilibrium in development will be reinforced by a type of multiplier-accelerator mechanism producing increasing returns in the favoured regions turning them more competitive. The productive means, capital, labour and entrepreneurship will all move to the more competitive regions where the prospective returns and demand are higher. The impact of immigration into the expanding regions will induce higher demand and improvements in infrastructures (transport, communications, education, and health facilities), higher efficiency and productivity fostering further the competitive advantages of the favoured regions. The less competitive regions will experience the opposite tendencies due to the emigration of labour and other means of production. The forces of demand and supply interact in such a way that produces cumulative movements towards divergence. The tendency of cumulative expansion in the favoured regions will create *"backwash*" effects on other less competitive regions, causing development differences to persist or even widen.

Myrdal recognised also that *"spread"* effects can be emanated from the expanding regions that might have favourable repercussions on the backward regions. These *"spread"* effects can represent an increased demand for the backwards regions´ products and the diffusion of technology and knowledge. Although Myrdal recognises a kind of externalities, he argues that the *"spread"* effects are weaker than the *"backwash"* effects and that if the interest is to narrow regional disparities a state policy is needed to protect the lagging regions. The alternative is to let the process take its natural course till the time arrives, when increasing costs in the expanding region owing to higher costs of living or to external diseconomies due to congestion, will halt expansion. Hirschman (1958) also recognised the persistence of the *"backwash"* effects, and in order to offset them, he suggested a state policy that imposes a kind of sovereignty, such as a separate tax system and protection in certain activities. Policies must be implemented in a way to reduce the polarization effects responsible for

interregional differences and to strengthen the *"spread"* effects[5] that have favourable repercussions on backward regions.

The process of circular and cumulative causation is also used by Myrdal to explain international differences in the level of development between countries. Labour migrates from poor to rich countries in the perspective of better remuneration and better employment opportunities, fostering demand and growth in the destination country. Capital migrates to the developed countries where risk is lower, tax incentives are generous, skilled labour is available and profit perspectives are higher. Trade is unfavourable to the developing countries, producing mainly primary commodities with inelastic demand and low value added. Trade is more advantageous to the developed countries, specializing in increasing returns to scale activities with high elasticity of demand, and high value added. Efficiency-wage[6] has the tendency to fall faster in faster-growing countries as a result of gains in productivity. Therefore, developed countries gain a cumulative competitive advantage, especially in manufacturing commodities. Spread effects that would have favourable repercussions on the backward countries are weaker at the international level than within nations, making international differences in development to persist or even widen.

Kaldor (1957, 1966) developed his growth theory using many ideas of Myrdal and criticised the neo-classical approach of exogenous growth as unrealistic and unable to explain differences in growth rates between countries or regions. In contrast to the neo-classical doctrine of constant returns to scale of the reproducible factors, Kaldor attributed to industry and manufacturing the exclusive role of generating increasing returns to scales through the workings of the Verdoorn´s Law. Once a region obtains a growth advantage (mainly in exports) it will tend to sustain it at the expense of other regions, because faster growth leads to faster productivity growth through the Verdoorn´s effect. Higher productivity in turn reduces efficiency-wages and prices turning the region more competitive, and the growth process continues to expand in a circular and cumulative manner. At the heart of the cumulative growth process stands the hypothesis of increasing returns to scales associated to the Verdoorn Law, reflecting some kind of technological progress. For Kaldor the competitive industry is responsible for the polarization phenomenon and the poles of economic activities are industrial poles. On the other hand, exports that are mainly produced in the industrial sector are

[5] Hirschman uses the term "trickle down" effects instead of "spread" effects.
[6] Efficiency- wage is defined as the ratio of money wage to productivity.

the most potent element of exogenous demand (world demand) with higher multiplier effects on national income. Exports are the most important element of exogenous demand for several reasons:

- exports are the component of demand with the highest multiplier effect on national income through the Harrodian foreign trade multiplier;
- exports are the component of demand with the highest saving propensity, since profits have to be reinvested to renew the products, implement new technologies and innovate;
- exports are the component of demand with the lowest import content, comparing to consumption, investment, government spending, etc.;
- exports allow for higher imports in equipment goods, raw materials, technology, that are all necessary for further economic development;
- exports lead to higher growth without incurring balance of payments problems;
- exports can relieve the demand constraints on growth and therefore permit faster growth if factor supplies are available to be utilised;
- technology is transferred through external trade, facilitating the diffusion of technology and knowledge;
- exports are mainly produced in the industrial sector with increasing returns to scale characteristics and higher gains in productivity;
- exports induce innovation and higher efficiency in domestic production;
- exports are responsible for generating higher growth with cumulative causation characteristics.

Kaldor's ideas of the cumulative causation growth were formalised by Dixon and Thirlwall (1975) in a system of dynamic equations described as follows:

(i) The Growth equation:

$$g_t = \gamma(x)_t , \quad \gamma > 0 \tag{1}$$

The first equation of the system relates the growth of total output (g) to the growth of exports (x) expressing the idea that exports are the engine of growth, with γ being the export elasticity with respect to output growth. This relationship is strong not simply in a definitional sense in that exports are a component of total output, but for fundamental reasons associated to the characteristics of exports as the most potent autonomous

component of aggregate demand and from the perspective of a strong causality that runs from exports growth to output growth.

(ii) The Demand for Exports equation:

$$x_t = \eta(pd)_t + \delta(pf)_t + \varepsilon(z)_t\,,\ \eta < 0, \delta > 0, \varepsilon > 0 \qquad (2)$$

The second equation explains the price and non-price determinants that influence export competitiveness. Accordingly, export demand growth is inversely related to the growth of domestic prices (p_d), and positively related to the growth of foreign prices (p_f) and the growth of the world income (z). In this equation, η and δ are the domestic and foreign price elasticities of demand for exports, respectively, and ε the world income elasticity of demand for exports. The world income elasticity of demand for a country's exports captures the supply characteristics of the goods produced, such as quality, design, durability, resistance, post–sale services, etc.

(iii) The Domestic Price equation:

$$(pd)_t = (w)_t - (r)_t + (l)_t \qquad (3)$$

Relation (3) is an identity explaining how domestic prices are determined. The growth of domestic prices is determined by the growth of efficiency-wages (the growth of money wages (w) minus the growth of labour productivity (r)) and the mark-up growth on unit labour costs (l)[7].

(iv) The Productivity equation:

$$r_t = r_a + \lambda(g)_t\,, \quad 0 < \lambda < 1\,, \qquad (4)$$

Equation (4) is responsible for generating the cumulative causation and self-sustained growth, known as the Verdoorn Law. This Law relates the growth of labour productivity (r) to the growth of output (industrial and manufacturing output for Kaldor) and this relationship reflects some kind of technical progress: (r_a) is the growth of autonomous productivity and λ the elasticity of labour productivity growth with respect to output growth, known as the Verdoorn's coefficient. According to Kaldor, a faster growth of output *causes* a faster growth of productivity, and a statistically significant

[7] This is derived from the usual Kaleckian mark-up relationship, given as, $P_t=(W/R)_tT_t$, where W is the level of money wages, R is the average product of labour, and T is one plus a percentage mark-up on unit labour costs.

relationship between labour productivity and output growth with a positive elasticity and less than unity can be taken as evidence of substantial economies of scale[8]. Verdoorn Law is a dynamic relationship reflecting the change of productivity and output because technical progress enters into it, both in static and dynamic forms. Static increasing returns relate to the size and scale of production and dynamic increasing returns refer to technical progress, increased specialisation, learning by doing, and externalities in production.

(v) The Equilibrium Growth Rate:

$$g_t = \gamma \frac{\left[\eta(w_t - r_a + l_t) + \delta(pf)_t + \varepsilon(z)_t\right]}{1 + \gamma\eta\lambda} \tag{5}$$

Equation (5) is the reduced form of the system obtained by combining equations (1) to (4) and solving with respect to domestic output growth. This relation determines a country's equilibrium growth rate, positively related to factors such as, the growth of world income, the income elasticity of demand for exports, autonomous productivity, the growth of foreign prices, and inversely related to the growth of money wages and mark-up growth, since $\eta < 0$. The effect of the Verdoorn coefficient λ is also positive on growth since η (the domestic price elasticity with respect to exports) is negative. The same is true with γ, the elasticity of exports with respect to total output growth.

In this system, the Verdoorn's relation makes the model circular and cumulative and once a region (country) gains a growth advantage (specializing in activities with increasing returns to scale or producing goods with a high income elasticity of demand) it will tend to keep it or even reinforce it. According to this mechanism, the higher the rate of growth of output, the faster the rate of growth in productivity (equation 4), the lower the rate of increase in unit labour costs and domestic prices (equation 3), the faster the rate of growth of exports (equation 2), and hence the faster the growth of total

[8] Kaldor (1975) argues that if there are constant returns to scale (the neoclassical hypothesis) this would imply that an increase in output *(g)* will be associated with a proportionate increase in the growth of labour *(e)*. In this case, since $r = g - e$ there would not be any association between r and g and the Verdoorn coefficient λ would not be statistically different from zero. Alternatively, the regression of e on g should have an elasticity not different significantly from unity if constant returns to scale occur or less than unity when increasing returns to scale prevail. Kaldor uses alternatively the regression e on g to avoid a spurious correlation than can occur in the original Verdoorn Law (equation 4) when e grows at low rate or is constant. For empirical evidence see Fingleton and McCombie (1998).

output (equation 1), and the process starts again. The process develops in a virtuous cycle favouring the economy with the initial competitive advantage and making difficult for other economies to establish the same activities. This is the essence of the theory of cumulative causation growth, that explains the phenomenon of divergence between the centre and the periphery or between industrial and agricultural economies, and hence between developed or developing regions (countries)[9]. Developing or less developed economies (countries or regions) have not the ability to explore activities with increasing returns to scale properties and to generate a cumulative process of expanding growth. Trade openness will benefit economies that have the ability to explore activities with substantial economies to scale and produce competitive commodities. The message which can be drown from Kaldor´s model of cumulative causation is that higher growth can be obtained by making the economy (region or country) more competitive and/or altering the industrial structure in a way to produce products with higher income elasticities of demand and obtaining higher gains of productivity reflected in the Verdoorn coefficient.

Few studies attempted to test empirically the validity of the cumulative growth model, among them, Amable (1993), Atesoglou (1994), Pini (1996), Targeti and Foti (1997), de Benedictis (1998), and recently Leon Ledesma (2002).

Targetti and Foti (1997) developed and estimated a cumulative growth model trying to explain the convergence process of the backward economies toward the more advanced countries through the diffusion of technical progress. They are critical to the neo-classical doctrine of convergence and catching-up as being unable to explain the development gap observed among countries. They are in line with Abramovitz´s (1986) concept of "social capability" as a necessary condition for lagging countries to successfully exploit the technologies invented by the leaders, in order to converge. In their multi-equation model output growth is determined by the demand for exports, and the rate of growth of productivity is endogenously determined by the growth of output as in Kaldor´s model. An additional factor that determines the growth rate of productivity of a country is the gap between the country's productivity level and that of the leader, introducing with this way the catching-up hypothesis in productivity. Another factor which determines productivity growth is the investment ratio (as percentage of GDP) used as a proxy for capital accumulation embodying new capital

[9] A critical view of the cumulative causation model is given in Soukiazis (2001).

goods, new technology and knowledge. Export growth is determined by the growth of world demand and relative productivity growth (the difference between country's productivity growth and the world productivity growth). The model was estimated by 3SLS method for a sample of 9 OECD countries (1950-88), 9 Latin American countries (1960-88), and 7 selected East Asian countries (1960-88). The estimated results give support to the cumulative growth process which depends upon the degree of the economies to scale (the Verdoorn coefficient), the dynamic foreign trade multiplier (income elasticity of demand for exports), the elasticity of exports with respect to productivity growth differential, and capital accumulation. The authors finally conclude that there is a strong process of convergence in productivity in the OECD and East Asian groupings, but not clear evidence of convergence in the less developed Latin American countries.

Another study is by Leon Ledesma (2002) who developed a more complete model of cumulative growth in which the effects of innovation, capital accumulation, learning by doing, human capital and catching-up are considered. Innovation is another source of cumulative growth and important determinant of international competitiveness. Catching-up and convergence in productivity is the result of diffusion of technology. Ledesma shows, that cumulative models, far from being old fashioned, allow for the introduction of new ideas of growth and explain fairly well the growth performance of the developed countries. His model involves five equations that explain cumulative growth. The first relates the growth of output to the growth of exports as in Kaldor´s model. The second explains the growth of a country's exports, depended on the usual factors, such as, the growth of relative prices, and the world income growth. In addition, he introduced two more factors, the investment-output ratio as a proxy for capital accumulation and a technology or innovation variable able to explain the non-price competitiveness of exports related to product differentiation and quality characteristics. A country's ability to differentiate and compete in quality will depend crucially on the degree of innovation and technical progress embodied in the investment-output ratio. The third equation defines the growth of domestic prices as function of the growth of efficiency-wages (the difference between the growth of money wages and productivity growth) assuming that mark-up is constant. The fourth relation of the dynamic system is an extended Verdoorn´s equation, where growth in productivity is explained by the growth of output (the major determinant), and additionally, the investment-output ratio, innovation activity and the productivity gap as

a potential catch-up factor. The idea is that the existence of productivity differences between the leading economy and the followers opens up the possibility for imitation and diffusion of new technologies developed by the leader. The final equation of the system explains the determinants of innovation activity. The first factor is a demand factor expressed by the growth of output. The second is the rate of growth of the cumulative sum of real output, as a proxy for the effect of learning by doing[10] and accumulated experience. The third element explaining innovation activity comes from the level of education of the working population, not only from the perspective that more qualified human capital is responsible for raising the capacity to innovate, but also because it raises the ability to assimilate new technologies and facilitates the diffusion of technology process. The final determinant of innovation activity is the productivity gap with a negative effect, since the less developed is a country, fewer resources are allocated to R&D and patenting activities. The whole model is structured in a way, that both forces of divergence and convergence interact to determine the final outcome on the cumulative growth process. The dynamic system of cumulative growth has been tested empirically using 3SLS, considering a sample of 17 OECD countries, for the period 1965-1994. The estimated equations performed satisfactory in terms of statistical significance and the expected effects of the variables, being able to explain differences in growth performance. Cumulative growth is explained by the Verdoorn´s effect and also from the induced effect that growth has on innovation and non-price competitiveness.

In the following section the cumulative growth framework will be used to predict actual growth in the EU(15) countries.

3. Predicting actual growth through the cumulative causation approach.

In this section we consider a cumulative growth model integrating the basic ideas of the demand orientated approach. The model is used to predict actual growth rate in 15 European Union countries over the period 1981-2004. Panel data is used to estimate the equations of the dynamic system. The model can be described as follows:

$$g_t = \alpha + \beta(x)_t\,,\ \beta > 0\,, \qquad \text{growth equation} \qquad (6)$$

[10] This concept was originally formulated by Arrow (1962).

This first relation of the system is the usual growth equation as in Kaldor´s model where exports are the most potent element of autonomous demand with direct multiplier effects on the growth of total output. In this relation β is the elasticity of output growth (*g)* with respect to exports growth (*x*) showing the sensitivity of output when the demand for a country's exports is growing.

$$r_t = \delta + \gamma(g)_t + \mu(gap)_t\,,\ \mu,\delta > 0\,,\ 0 < \gamma < 1\,,\quad \text{productivity equation} \qquad (7)$$

The second relation is the productivity equation where the growth of labour productivity (*r)* depends not only on the growth of total output (the Verdoorn Law) but also on the productivity gap *(gap)* given by the growth of relative productivity between the EU countries (the followers) and the USA (the leader). As in Leon Ledesma (2002) the productivity gap variable can be assumed as a potential catch-up factor, in the sense that productivity grows faster in the lagging countries as a result of higher diffusion of technology and knowledge. In this equation, δ is the growth of autonomous productivity, γ is the Verdoorn coefficient reflecting returns to scale properties, and μ the productivity growth elasticity with respect to technological gap between the followers and the leading country. As we explained before, for Kaldor, the Verdoorn´s relationship is crucial for a cumulative growth process to start operating.

$$x_t = \zeta + \pi(r)_t + \rho(wp)_t + \sigma(z)_t\,,\quad \rho < 0, \zeta, \pi, \sigma > 0\,, \text{ export equation} \qquad (8)$$

The third equation of the system describes a country's exports performance. The competitiveness of exports depends highly on domestic and foreign productivity, and the demand for a country's exports increases as foreign income expands. It is expected that the higher the growth of domestic productivity *(r)* the higher the demand for a country's exports and the higher the growth of foreign productivity *(wp)* the lower the demand for a country's exports since productivity grows faster abroad.. On the other hand, as foreign demand *(z)* grows faster the chances for a country to export more in the international markets are higher. In this equation, π and ρ are the export elasticities with respect to domestic and foreign productivity growth, respectively, and σ is the export elasticity with respect to income growth abroad.

Combining equations (6), (7), and (8) we can derive the equilibrium condition that determines the growth rate of the domestic output given by:

$$g_t = \frac{\alpha + \beta\left[\xi + \pi(\delta + \mu(gap)_t) + \rho(wp)_t + \sigma(z)_t\right]}{1 - \beta\pi\gamma} \qquad (9)$$

Equations (6), (7) and (8) are estimated by using panel data referred to the earlier group of 15 European Union countries for a period that spans from 1981 to 2004. The usual panel data estimation techniques are employed, namely, the fixed effects approach assuming that differences in structures between countries are controlled for by the specific country-dummies (which is known as the Least Squares Dummy Variables approach), and alternatively the random effects GLS approach, where differences in structures are assumed to be random. The Hausman test will help us to select the most appropriate estimation approach. The purpose of estimating the above equations is to obtain the key parameters that determine the equilibrium growth rate of the countries in the sample as defined in equation (9). The results from the estimations can be summarized as follows:

(i) Table 1, reports the results obtained from the estimation of the growth equation (6).

Table 1. Output growth equation, EU (15), 1981-2004

Estimated equation : $g_{i,t} = \alpha_i + \beta(x)_{i,t}$					
	Const.	**β**	**R^2**	**D.F.**	**S.E.E.**
Fixed Effects LSDV	**	0.1893 (9.3203)*	0.3307	344	1.8567
Random Effects GLS	1.4232 (6.163)*	0.1984 (9.905)*	0.3505	358	1.8289
Hausman Test	8.973863 [0.0027387]				

Notes: g is annual growth of real output; x is annual growth of real exports; figures in parenthesis are t-ratios; * stands for statistical significance at 1% level; ** indicates that all *country-dummies* are statistically significant at 5% level; D.F. are degrees of freedom; and SEE is the standard error of estimate.
Data Source: Statistical Annex of European Economy, Spring 2004.

As it can be observed, there are no substantial differences between the two methods of estimation, but the Hausman test favours the regression with fixed effects. The appropriateness of the fixed effects approach is reinforced from the fact that all specific country-dummies are statistically significant, capturing with this way differences in structures across countries. The elasticity of output with respect to exports shows that every percentage increase in real exports is responsible for 0.19 percentage

increase in real output. On the other hand, as the goodness of fit shows, 33% of the variation in output growth in the EU(15) is attributable to export growth. These are sufficient evidence supporting Kaldor´s ideas that exports are a potential element of growth.

(ii) The results from the estimation of the Verdoorn´s Law are given in Table 2 and are similar in both methods of estimation, although the Hausman test selects the random effects regression as the most appropriate. The Verdoorn coefficient reveals that every percentage increase in real output raises labour productivity by 0.21 percentage points and according to Kaldor this is evidence of the presence of increasing returns to scale properties[11]. The technological gap variable has its expected positive effect on the growth of productivity, revealing that the higher the productivity gap between the follower and the leader the higher the growth of productivity in the lagging country as a result of higher diffusion of technology and knowledge. This evidence is in line with the catching-up hypothesis in productivity.

Table 2. Productivity growth equation, EU (15), 1981-2004

Estimated equation : $r_{i,t} = \delta_i + \gamma(g)_{i,t} + \mu(gap)_{i,t}$						
	Const.	**γ**	**μ**	**R^2**	**D.F.**	**S.E.E.**
Fixed Effects LSDV	**	0.2105 (7.268)*	0.4353 (16.696)*	0.6445	343	0.9998
Random Effects GLS	1.2438 (12.633)*	0.2095 (7.664)*	0.4433 (17.202) *	0.6508	357	0.9908
Hausman Test	5.881359 [0.05282981]					

Notes: r is the growth rate of productivity; g is the growth rate of real output; *gap* is the technological *gap* measured as the difference in productivity growth between each EU (15) country and the leader economy USA; figures in parenthesis are t-ratios; * stands for statistical significance at 1% level; ** indicates that all *country-dummies* are statistically significant at 5% level; D.F. are degrees of freedom; SEE is the standard error of estimate.
Data Source: Statistical Annex of European Economy, Spring 2004.

(iii) Table 3 reports the results obtained from the estimation of the export equation (8). Although the Hausman test favours the estimation with random effects, the results are similar in both regressions. As it can be seen, domestic productivity growth has a positive and significant effect on the growth of exports, but growth productivity abroad is not a relevant factor. Every one percentage point increase in domestic

[11] The returns to scale are given by the relation $1/(1-\gamma) = 1.27$.

productivity (other things remaining constant) is responsible for 0.94 percentage increase in real exports. Another relevant (statistically significant) factor determining countries export growth is the expansion of external demand. The income elasticity of the demand for exports is greater than unity revealing that exports are income elastic. It is shown that every percentage increase in external demand (average growth of GDP of the remaining 14 EU countries) induces 1.38 percentage increase in the demand for exports. The income elasticity of the demand for exports, as we explained before, captures the supply characteristics of the goods produced, related to quality which are more important in international competition.

Table 3. Export growth equation, EU (15), 1981-2004

Estimated equation : $x_{i,t} = \xi_i + \pi(r)_{i,t} + \rho(wp)_{i,t} + \sigma(z)_{i,t}$							
	Const.	**π**	**ρ**	**σ**	**R^2**	**D.F.**	**S.E.E.**
Fixed Effects LSDV	n	0.8623 (5.819)*	0.1572 (0.406) n	1.3944 (6.872)*	0.3172	342	4.1982
Random Effects GLS	0.2394 (0.349)n	0.9412 (6.575)*	0.0974 (0.254) n	1.3757 (6.813)*	0.3338	356	4.1468
Hausman Test	5.881359 [0.11752720]						

Notes: x is the growth rate of real exports; r is the growth rate of domestic productivity; wp is average growth rate of productivity of the 15 EU countries; z is average growth rate of real GDP of the remaining 14 EU countries; figures in parenthesis are t-ratios; n indicates that the estimated coefficient is not statistically significant at the 5% significance level; * stands for statistical significance at 1% level; D.F. are degrees of freedom; SEE, is the standard error of estimate.
Data Source: Statistical Annex of European Economy, Spring 2004.

(iv) Estimating the dynamic equations of the cumulative causation model we have obtained the key parameters which can be used to predict the actual growth of the 15 EU countries constituting our sample. Substituting all the relevant values into equation (9) we predict an average rate of growth of real output equivalent to 2.531 % per annum. Analytically:

$$g_t = \frac{\alpha + \beta[\xi + \pi(\delta + \mu(gap)_t) + \rho(WP)_t + \sigma(z)_t]}{1 - \beta\pi\gamma}$$

$$g_t = \frac{1.474 + 0.189\,[0.239 + 0.941\,(1.244 + 0.443\,(0.067)) + 0.097\,(1.804) + 1.376\,(2.53)]}{1 - 0.189\,(0.941)0.2095}$$

$g_t = 2.531$ (Predicted growth rate)

Comparing the predicted by the model annual growth rate 2.531% with the average actual growth rate 2.534% observed over the period 1981-2004, we can assert that the cumulative causation growth model used predicts very accurately the actual growth that really occurred in the EU(15) countries. Therefore, the cumulative causation principle and the key parameters that characterize this process are useful instruments to predict with great precision the countries growth rate and in terms of policy allows to identify the structural parameters which must be improved in order to achieve higher growth.

4. Predicting actual growth through the export-led approach.

Kaldor´s cumulative causation growth model considers that the rate of growth of exports governs the long-run rate of growth of output but ignores the imports side of the economy. Thirlwall (1979) formalized Kaldor's ideas and developed an alternative export-led model where the position of the balance of payments (in current account) matters for the long term growth. According to Thirlwall a balance of payment deficit can constrain demand and retard growth. Thirlwall established a simple rule that determines the rate of growth of domestic output consistent with the balance of payments equilibrium. This simple rule (known as Thirwall´s Law) asserts that a country's balance of payment equilibrium growth rate is given by the ratio of exports growth over the income elasticity of demand for imports. Thirlwall has shown that his simple growth rule is equivalent to the Harrod foreign trade multiplier when it is expressed in a dynamic form[12].

The export-led model we use to predict actual growth in the EU(15) countries is an augmented version of Thirlwall´s Law[13], since in the export function we introduce a technological factor expressed by the productivity gap that aims to capture the non-price competitiveness of exports. The model can be described as follows:

The rate of growth of the demand for imports is given by the following expression:

$$m_t = \psi\left(pm_t + e_t - px_t\right) + \pi y_t \qquad (10)$$

In this equation m_t denotes the growth of imports, pm_t and px_t the growth of import and export prices, respectively, e_t is the exchange rate variation, y_t is the growth of domestic income, ψ is the relative price elasticity of demand for imports (with an expected

[12] For more details on this issue see McCombie and Thirlwall (1994), p.237.
[13] Some more empirical evidence is given in Soukiazis and Cardoso (2005).

negative sign), and π is the income elasticity of demand for imports (with an expected positive sign). Accordingly, the demand of imports is negatively related to the relative price of imports and positively related to domestic income and the magnitude of the impact is given by the respective price and income elasticities.

Analogically, the rate of growth of the demand for exports may be expressed as follows:

$$x_t = \eta(px_t - pm_t - e_t) + \varepsilon z_t + \delta(gap)_t \qquad (11)$$

In this equation x_t stands for the growth of exports, z_t is the growth of foreign income, *gap* is the difference in productivity growth between the EU(15) countries and the USA, η is the price elasticity of demand for exports (with an expected negative sign), ε is the income elasticity of demand for exports (with an expected positive sign), and δ is the elasticity of exports with respect to productivity *gap* (with an expected positive sign[14]). In view of that, the demand for a country's exports is negatively related to the relative price of exports and positively related to foreign income and the productivity gap. The magnitude of the impact is given by the respective price, foreign income and productivity gap elasticities.

The model assumes that the Balance of Payments is in equilibrium from the point of view of the current account. This implies that the value of exports of goods and services is equal to the value of imports expressed in a common currency. The equilibrium condition in balance of payments with variables expressed in growth rates is therefore given by:

$$px_t + x_t = pm_t + m_t + e_t \qquad (12)$$

Substituting equations (10) and (11) into the balance of payments equilibrium condition (12) and solving for domestic income we get:

$$y_{BP} = \frac{(1+\eta+\psi)(px_t - pm_t - e_t) + \varepsilon(z)_t + \delta(gap)_t}{\pi} \qquad (13)$$

Equation (13) determines the rate of growth of domestic income consistent with the balance of payments equilibrium (in current account) denoted by y_{BP}. This equation expresses several economic propositions, among them; the Marshall-Lerner condition $|\eta+\psi| > 1$ for a successful devaluation; the inverse impact on domestic growth when

[14] The idea here is that as far as the growth in productivity of the EU counties approaches to the USA level, the EU countries become more competitive in export markets.

inflation in the home country *(px)* is higher than abroad *(pm)*; the positive effect on the growth of domestic income due to the growing external demand *(z)*; the inverse impact on growth due to a higher import penetration, through *(π)*; and the positive impact on domestic growth when productivity in the home country (relative to the leader) improves.

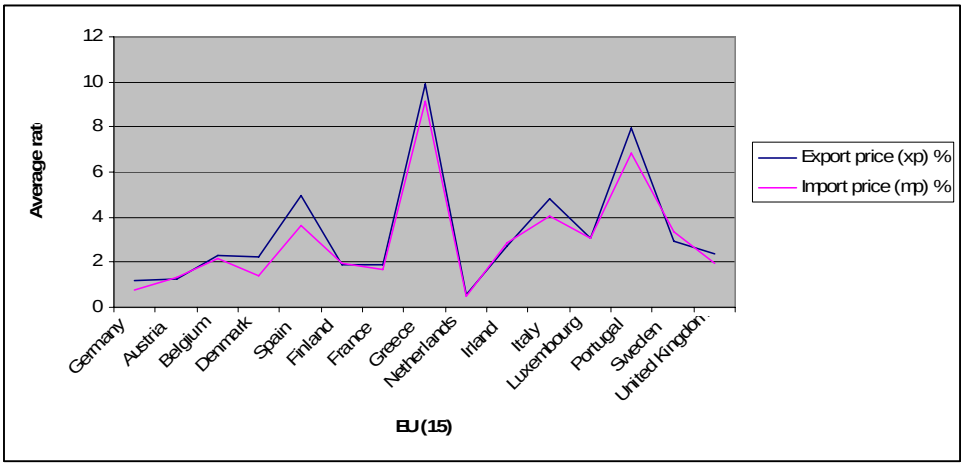
Equation (13) can farther be simplified if the assumption is made, that relative prices measured in a common currency do not change over the long run. This assumption is particularly realistic for the EU countries after the effort made to achieve nominal convergence implying similar levels of inflation among members and exchange rate stability. Table (4) and Figure 1 show this development, reporting the average growth rates of import and export prices, respectively.

Table 4. Average annual growth rates of export and import prices, EU (15), 1981-2004.

Country	**Average (1981-2004)**		**Relative price growth rates px-pm**
	Export price growth rates px	**Import price growth rates pm**	
Germany	1.204	0.742	0.462
Austria	1.275	1.317	-0.042
Belgium	2.325	2.163	0.162
Denmark	2.233	1.421	0.812
Spain	4.971	3.604	1.367
Finland	1.875	1.942	-0.067
France	1,896	1.654	0.242
Greece	9.892	9.108	0.784
Netherlands	0.554	0.496	0.058
Ireland	2.725	2.854	-0.129
Italy	4.829	4.071	0.758
Luxembourg	3.092	3.096	-0.004
Portugal	7.983	6.842	1.141
Sweden	2.900	3.383	-0.483
United Kingdom	2.379	1.938	0,441
Average			0.3668

Notes: px and mp show the average annual growth rates of export and import prices, respectively, for each of the EU(15) countries, over the period 1981-2004. Import and export prices are measured at the same currency. The last column gives the average growth rate of relative prices.
Data Source: Statistical Annex of European Economy, Spring 2004

Figure 1. Average growth rates of export and import price, UE (15), 1981-2004



Data Source: Statistical Annex of European Economy, Spring 2004.

As it can be observed differences in the growth rates between the export and import prices are not significant over time, therefore the hypothesis that relative prices remain constant over time, that is $(px_t - pm_t - e_t = 0)$, is very plausible in the context of the EU(15) countries. This evidence also reinforces the idea that non-price characteristics of the products are more important in international competition. Assuming relative prices constant in the long run, equation (13) reduces to:

$$y_{BP} = \frac{\varepsilon z + \delta(gap)}{\pi} \qquad (14)$$

Equation (14) is the extended form of Thirlwall's Law[15]. According to this expression a country will grow faster if its income elasticity of demand for exports is higher than its income elasticity of demand for imports (ε>π); if foreign income expands; and as long as the productivity growth of the respective country approaches to the leader. Investing in technology and innovation is essential in order to improve productivity and consequently the competitiveness of exports in international markets.

The import equation (10) is estimated by the usual panel estimation techniques and the results are reported in Table 5.

[15] The original expression of Thirlwall´s Law is given by $y_{BP} = \frac{\varepsilon z}{\pi}$ or alternatively $y_{BP} = \frac{x}{\pi}$.

Table 5. Import growth equation, EU (15), 1981-2004

Estimated equation $m_{i,t} = \chi_i + \psi(pm)_{i,t} + \tau(px)_{i,t} + \pi y_{i,t}$							
	Const.	**ψ**	**τ**	**π**	**R²**	**D.F.**	**S.E.E.**
Fixed Effects LSDV	#	-0.3156 (-3.91)*	0.2751 (2.81)**	1.7823 (17.65)*	0.5146	342	3.8334
Random Effects GLS	0.9734 (2.25)**	-0.3499 (-4.41)*	0,3273 (3.48)*	1.7176 (17.97)*	0.5257	356	3.7891
Hausman Test	12.969505 [0.00470302]						

Notes: m is the rate of growth of real imports; pm and px are the rates of growth of import and export prices, respectively; y is the rate of growth of real GDP; figures in parenthesis are t-ratios; * and ** stand for statistical significance at 1% and 5% level, respectively; # indicates that the majority of *country-dummies* has no statistical significance; D.F., are degrees of freedom; SEE, is the standard error of estimate.
Data Source: Statistical Annex of European Economy, Spring 2004.

As it can be seen both estimations are similar but the Hausman test selects the fixed effects specification as the most appropriate. It can be observed that imports are elastic with respect to domestic income (elasticity higher than unity), revealing that every percentage increase in real GDP induces 1.78 percentage increase in the demand for imports, everything else being constant. On the other hand, the import-price elasticity is negative and domestic-price elasticity with respect to imports is positive, as expected, showing that as imports become more expensive its demand falls and as domestic products become more expensive the demand for imports increases. Considering the magnitude of the price elasticities (less than unity in absolute terms) we can assert that demand of imports is price inelastic. These two price elasticities capture the price competitiveness of the commodities traded in international markets, in contrast to the income elasticity that depicts the non-price competitiveness. All elasticities are statistically significant and the goodness of fit is reasonable.

The estimated results of the export equation (11) are illustrated in Table 6. Through the Hausman test, the fixed effects regression is elected to be more appropriate. The income elasticity of demand for exports reveals that exports are income elastic, and that every percentage increase in foreign income causes 1.69 percentage increase in the demand for exports. The price elasticities carry their expected signs with values less than unity (in absolute terms) revealing that the demand for exports is price inelastic. When exports become more expensive it is expected that its demand falls and when prices increase abroad it is expected an increase in exports since the price-competitiveness abroad deteriorates. On the other hand, the elasticity of exports with respect to productivity gap is positive as expected, showing that when

productivity growth in the EU(15) approaches to the leader, exports become more competitive and its demand increases.

Table 6. Export growth equation with productivity gap, EU (15), 1981-2004

Estimated equation $x_{i,t} = \tau_i + \eta(px)_{i,t} + \nu(pm)_{i,t} + \varepsilon(z)_{i,t} + \delta(gap)_{i,t}$								
	Const.	**η**	**ν**	**ε**	**δ**	**R^2**	**D. F.**	**S.E.E.**
Fixed Effects LSDV	#	-0.377 (-3.58)*	0.4890 (5.66)*	1.7173 (10.07)*	0.3573 (3.67)*	0.353	341	4.086
Random Effects GLS	1.1307 (1.79) [n]	-0.393 (-3.86)*	0.4961 (5.84)*	1.6886 (9.99)*	0.3943 (4.11)*	0.372	355	4.027
Hausman Test	11.628033 [0.02034266]							

Notes: x is the rate of growth of real exports; px and pm are the rates of growth of export and import prices, respectively; z is the average growth rate of real GDP of the remaining 14 EU countries; *gap* is the technological *gap* measured as the difference in productivity growth between each EU (15) country and the leader economy USA; figures in parenthesis are t-ratios; ; [n] indicates that the estimated coefficient is not statistically significant at the 5% significance level; * stands for statistical significance at 1% level; [#] indicates that the majority of *country-dummies* has no statistical significance; D.F. are degrees of freedom; SEE is the standard error of estimate.
Data Source: Statistical Annex of European Economy, Spring 2004.

The scope of estimating the import and export demand functions is to obtain the key parameters that can be used to test the validity of the extended form of Thirlwall`s Law, given by equation (14). All the values needed to predict the average growth rate of the EU(15) countries, over the period 1981-2004, consistent with the balance of payment equilibrium, are given in Table 7. As it can be seen, the predicted by the model growth rate 2.45% is fairly close to the actual growth occurred 2.53%. The fact that actual growth appears to be slightly higher than that predicted by Thirlwall´s Law may suggest that the EU(15) countries, in average, grew a little faster than the balance of payments equilibrium condition allows. Another interesting finding is that the income elasticity of demand of imports (1.78) is slightly higher than the income elasticity of demand for exports (1.72) indicating, therefore a higher import penetration than exports. Combining these two facts, and in line with the propositions of the model, we would suggest that an effort must be made to increase farther the income elasticity of the demand of exports relatively to imports in order to obtain higher rates of growth without occurring balance of payments problems. This can be done by improving the non-price characteristics of the products produced and traded through technological advances and innovation activities.

Table 7. Predicted growth rate consistent with the balance of payments equilibrium. Thirlwall's extended model, EU (15), 1981-2004

ε [(a)]	z [(c)]	π [(b)]	x [(c)]	δ [(a)]	gap [(c)]	$y_{BP}=[\varepsilon.z+\delta(gap)]/\pi$
1.7173	2.53	1.7823	5.5997	0.3573	0.067	2.45

Notes: ε is the income elasticity of demand of exports; z is the average growth rate of real GDP of the EU(15) countries over the period 1981-2004; π is the income elasticity of demand of imports; x is the average growth of real exports over the period 1981-2004; *gap* is the average growth of the productivity *gap* (difference in productivity growth between each EU (15) country and the leader economy the USA; [(a)] value taken from Table 6; [(b)] value taken from Table 5, [(c)] own calculations.
Data Source: Statistical Annex of European Economy, Spring 2004.

5. Summary and main conclusions

Trough this study an attempt has been made to show that old fashioned models of the demand oriented approach are still able to predict with high accuracy the actual growth rate occurred in the EU(15) countries, over the period 1981-2004. In doing so, we employed two main models, the first based on the cumulative causation principle and the second on the export-led growth framework.

As we have shown, the cumulative causation growth model predicts pretty well actual growth in Europe. The predicted by the model average annual growth rate equal to 2.531% is very close to the rate of growth that really occurred 2.534%. As we have explained, what makes the model circular and cumulative is the presence of increasing returns to scales and these properties have confirmed in the estimation of the Verdoorn´s Law. It is also shown, that productivity gap is a relevant catching-up factor of productivity growth, showing that the higher the distance between the follower and the leader the higher the growth of productivity in the lagging country as a result of higher diffusion of technology and knowledge. In addition, domestic productivity and foreign income are the major determinants of export growth, capturing non-price characteristics of the products competing in export markets.

The export-led model based on Thirlwall´s Law predicts also fairly well the actual growth observed in the EU(15) countries. The average annual growth rate predicted from this model equivalent to 2.45% is slightly lower than the actual one 2.53%, showing that the EU(15) countries grew in average little faster than the rate of growth suggested by the balance of payments equilibrium condition. The fact that income elasticity of the demand for imports is found to be slightly higher than the income elasticity of the demand for exports can be taken as sign of preoccupation. This

fact reveals a higher penetration of imports than exports in the EU(15) countries and if this tendency continues balance of payments problems can occur able to restrict demand and therefore growth. The solution to reverse this tendency is to develop policies related to technical progress and innovation activities, able to improve the non-price competitiveness of the goods produced and traded in export markets.

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