Tipo de documento: Working Paper N°19
ISSN: 0327-9588

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Fecha de publicación: Junio 1995

ISSN 0327-9588

UNIVERSIDAD TORCUATO DI TELLA

WORKING PAPER No 19

THE EXPORT-LED GROWTH HYPOTHESIS REVISITED: THEORY AND EVIDENCE*

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June 1995

ABSTRACT:
Exports have been often singled out as a key determinants of fast and sustainable rise in per capita income. In this paper we revisit this export-led growth hypothesis (ELGH). From an empirical point of view we study this phenomenon applying Granger-type tests on panel data. The results seem to confirm that, for the sample of countries and the period under study, exports did behave as the "engine of growth" as they Granger-caused investment, output growth and imports. To capture these empirical features, in the theoretical analysis, we reformulate the ELGH standard model in terms of recent models of endogenous growth.

Export-led growth, Endogenous growth, export-output causality.

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* This work has been greatly motivated by a previous study: "Economic Growth, Openness and Exports" which has been awarded by the ARCOR Foundation; we thank the support received from this Institution. Also, in the preparation of this version of the paper the authors benefited from useful conversations with H. Ennis y J.P. Nicolini. The usual disclaim applies.

1. Introduction.

Since the mid-80s several Latin American countries have undertaken major economic reforms. Among the many measures that were taken, trade liberalization occupied a central place, breaking a long tradition (almost four decades) of import substitution policies in the region. One of the main reasons for the change in attitude was probably the view that economic openness contribute to growth[1]. In this regard, it is widely agreed that import substitution policies did not help to close the income gap between the countries of the region and the developed world. On the contrary, on average, growth in Latin America has been erratic and modest.

This evidence sharply contrasts with that of East Asian's countries. As it is well documented[2], the outward-oriented trade policies followed by those nations have been associated with an impressive growth in exports and in GDP. Thus, for many observers, export growth has become a key feature of an overall strategy to obtain a rapid and sustainable increase in per capita income. The move toward liberalization in Latin America could then be understood as a way of adopting an "Asian-type", export-led, growth pattern[3].

But, what are the reasons for exports to have a role (independent of factor accumulation)) in this process?. Moreover, beyond the case of four or five Asian countries, how strong, widespread and robust is the evidence that shows a positive, long term relationship between exports and growth in GDP?. And, even if we identify such a positive relationship, how can we be sure that a strong GDP growth is a

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[1] For a detailed discussion of economic reform in Latin America see Rodrick (1993) and Banco Mundial (1993a).

[2] See, for example, Banco Mundial (1993b) and Thomas and Wang (1993).

[3]There has been a long and still ongoing controversy regarding trade policy --and public policy in general-- in East-Asia. The key issue is that government intervention in those countries is much more pervasive than what people initially thought. On this issue see Edwards (1993), Banco Mundial (1993b), Rodrick (1993) (1994), King K. and Leipziger (1993).

consequence of an increase in exports and not the other way round?.

The purpose of the paper is to address these questions both from an empirical and a theoretical perspective. From an empirical view, there are many studies based on cross-section data which include trade indicators but few of them takes care of the "robustness" of their results. Moreover, regressing one variable on others says nothing about the exogeneity of the regressors, although this is a critical question to understand which factors sustain growth. The literature that controls for robustness suggests that trade -broadly defined- , investment and output growth are positively related. Notwithstanding, the issue of "exogeneity" is left open. With the purpose of clarifying this last issue we perform Granger causality tests applied to panel data. The analysis is developed distinguishing exports from imports behavior. Panel data estimation allows to study the time series relationship between trade and growth for a wide range of countries. This approach permits to evaluate the "exogenous" role of exports, as far as Granger causality is concerned. The result of this empirical analysis shows that for the sample considered (which includes a set of developed and developing countries from the 70's to the early 90's) exports appear as Granger causing both investment and per capita output. Instead, this result is not found when trade is measured using imports.

Can these "facts" be understood with the available theoretical models?. A pioneer work in this field is Feder (1982) which can be considered as the "classic" export-led growth model (ELGM). In this model the role of exports as the "engine" of growth is based on the assumptions of "cross-sector externalities" plus a "productivity differential". Nevertheless, as it is shown below, there are some difficulties with this formulation to explain a long term relationship between exports and growth. We reframe the ELGM in terms of the modern theory of endogenous growth. This reformulation allows a better understanding of the role that externalities and productivity differentials play in economic growth. Contrary to what is derived from the simple ELGM analysis, the existence of positive externalities is neither a necessary nor a sufficient condition for exports to have a positive, lasting effect on capital accumulation. Similar to Lucas (1988) analysis for the case of human capital, in our model a key condition to obtain sustained growth is that productivity of capital in the exportable sector is not subject to diminishing returns, while in the nontradable sector the marginal productivity of capital is decreasing. Still, this condition can be understood as the "productivity differential" (between the exportable and non-exportable sectors) proposition which appears as an argument in the ELGM literature.

The rest of the paper is organized as follows. Section 2 revises previous literature empirical on the subject and presents the Granger causality tests using panel data. Section 3 discusses the standard ELMG model. In section 4 we rewrite this model in terms of the endogenous growth theory. Finally, section 5 concludes.

2. Empirical analysis: causality tests in Panel Data.

In recent years there has been an explosion of empirical studies that try to asses the determinants of the long term pattern of growth in per capita income[4]. In most cases these studies perform cross country regression where the average rate of growth in per capita income is regressed on investment and other variables. Many of these regressions include foreign trade indicators as explanatory variables. Two recent papers, Levine and Renelt (1991)(1992) try to asses the robustness of these cross-country empirical analyses. Following the "Specification Searches" methodology developed by Leamer (1978), they run a sensitivity analysis in order to identify which correlations are maintained when the list of regressors are modified[5] . They show that many results are not robust. However, directly related to the issue of growth and exports, they found the following: (i) a positive and robust correlation between average growth rate of per capita income and investment-output ratio; (ii) a

[4] See for example the papers of Barro (1991), Mankiw et al (1992), Feliz (1992), Gould and Ruffin (1993), Edwards (1992), Roubini and Sala-i-Martin (1991).

[5] See also Fuentes (1992).

positive and robust correlation between investment-output ratio and the ratio of exports, imports or total trade to GDP.

The empirical evidence then suggest that trade (i.e. exports and imports), investment and growth in GDP per capita are robustly related. Nevertheless, such a positive correlation say nothing about the nature of these relationship. Different authors have suggested different directions in which these variables interact with each other. Feder (1982) postulates an effect that goes from exports to GDP. On the other hand, Esphasany (1991) and Lee (1993) suggests that total imports is the variable that takes the leading role in affecting exports and GDP performance. Furthermore, increases in exports and imports can be a consequence of GDP growth.

To clarify these questions we empirically analyze the relationship between exports, imports, investment and growth applying "Granger-Causality Tests" to a pooling of (cross section- time series) data[6]. The approach followed is similar to that applied by Carroll and Weil (1994) to study the relationship between growth and savings. It should be emphasized that this kind of analysis is not aimed at finding "structural" relationships. At most, it allows detecting "time-anticipations" of a variable[7]. A well-known limitation of the methodology is that -when causality is analyzed between two variables- a third one may be "causing" both. Granger causality holds in this context when the past of a variable (say X_{t-1}) helps to predict the other variable (say Y_t) in addition to its own past (Y_{t-1}); then X Granger-causes Y. (The analysis may be symmetrically applied for X on Y).

Similarly to Carroll and Weil, we transformed the original data set into non- overlapping four years averages computed for a sample of 27

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[6] See Harvey (1981) for definitions and methodology of Granger Causality for time series.

[7] It should be note that Granger Non-causality is neither necessary nor sufficient for "weak exogeneity" as defined by Engle et al (1983). (Both weak and Granger non-causality are necessary for "strong exogeneity").

developed and less-developed countries during the 1971-1991 period[8]. These averages allow to isolate long-run effects from short-term (cyclical) movements. Both OLS and instrumental variables estimations (IVE) were performed (see annex for details). The variables were defined as differences (of logs) assuming that fixed (countries) effects were given only in the levels of such variables. Dummy variables were also included for time-specific effects. Then (bivariate) causality was analyzed for dy_t, dx_t, dm_t and di_t, which denote the (average) growth of per capita GDP, exports, imports and fixed investment, respectively, all in constant prices. All the data was taken from World Bank's World Tables. Results are presented in tables 1 to 8.

It is clear that, for the sample analyzed, the previous behavior of exports (measured as 4-year averages of log differences) has been positive related to that of growth. This result stands whether estimation is done using OLS or IVE (see table 1a and 2a). Such anticipation of export variations also appears in the case of investment and imports (tables 3a and 5a for OLS and 4a and 6a for IVE). Thus, exports are leading the growth process (anticipate GDP growth and investment) and, given that in the long run we should have balanced trade, exports anticipate imports.

The reverse direction of causality between these variables (see table 7 and 8) is more difficult to assess for this information set due to either non-significant "t" statistics or residual autocorrelation, at traditional significance levels. Only some feedback of investment to exports may be found (see table 7b).

Another critical result for this sample, is that imports, quite different from exports, have no positive effect either on GDP or on investment (see table 1b and 3b for OLS estimation and 2b and 4b for IVE estimation). Therefore, in terms of its growth effect, it makes

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[8] Carroll and Weil use five years average and their sample contains 22 countries. Our 27-country sample contains Argentina, Algeria, Australia, Bolivia, Brazil, Canada, Chile, Cote d' Ivoire, Colombia, Costa Rica, Germany, Spain., France, India, Israel, Italy, Japan, Korea, Sri Lanka, Mexico, Malaysia, Netherlands, Sweden, Thailand, Tunisia, Uruguay and USA.

a difference how "trade" is defined.

In addition we found that GDP growth anticipates that of investment (table 3c (OLS) and table 4c (IVE)), whereas the reverse direction cannot be proved for this sample (see table 1c and 2c)). This is a result in line to the analysis of King and Levine (1994) and similar to that of Carroll and Weil (1994) for the case of saving.

In summary the results obtained from performing Granger causality test to panel data indicate that exports, and not imports, leads the growth process since they anticipate the behavior of both, investment and per capita GDP. In the next sections we discuss and reframe the export-led theoretical literature so as to make it consistent with this evidence.

3. Exports and GDP growth: the standard export-led growth model.

The idea that foreign trade and, in particular, exports have growth implications has often been emphasized in the development literature[9]. Factors like externalities, economies of scale, technological improvement, learning, etc. have been mentioned as being encouraged by trade liberalization and by the increase in the exchange of goods and services in the world markets.

Nevertheless, it was not until Feders' work (see Feder (1982)) that some of those intuitive ideas were put into a formal setup, constituting what we call the export-led growth model (ELGM). In this model, exports have a positive effect on GDP growth due to the following two reasons. First, the exportable sector generates positive externalities on the other sectors of the economy through technological spill-overs and also through the transmission of new management techniques. Second, it is assumed that factor productivity is higher in the exportable sector compared to the non-exportable. Thus any trade liberalization policies that induces a reallocation of factors of production into exportables, and out of the other sectors of the economy, will have a positive effect on aggregate GDP.

More formally, the model assumes that the economy is divided into

[9]For early work on the relationship between trade policies, foreign trade and growth see Little et al (1970), Balassa (1971), Kruegner (1978) y Bhagwati (1978).

two sectors: exportables (X) and nontradables (N). The production functions have the usual neoclassical properties,

$$N = F(K_X, L_N, X) \qquad (1)$$

$$X = G(K_X, L_X) \qquad (2)$$

where K_i, L_i denotes the quantity of capital and labor used in each sector. The inclusion of the exportable output into the nontradable production function (where $F_X > 0$) captures the externality effect mentioned above. On the other hand, the assumption of a factor productivity differential is represented by the following condition,

$$\frac{G_K}{F_K}=\frac{G_L}{F_L}=1+\gamma \qquad (3)$$

where G_K , F_L denotes the marginal productivities of capital in both sectors and G_L, F_L does the same for the case of labor. The positive constant γ indicates to what extent factor productivities in the exportable sector are higher compared to the non tradable sector. This may reflect a disequilibrium situation where static gains can be achieved by reallocating resources from one activity to the other or, alternatively, the existence of taxes or other intersectoral distortions that negatively affect exportable goods. Total output is just the sum of production in both activities[10],

$$Y = X + N \qquad (4)$$

Differentiating (4) and using (1)-(3), the following expression representing aggregate GDP growth is obtained,

$$\frac{\dot{Y}}{Y}=\alpha\frac{I}{Y}+\beta\frac{\dot{L}}{L}+[F_X+\frac{\gamma}{1+\gamma}]\frac{X}{Y}\frac{\dot{X}}{X} \qquad (5)$$

where I/Y is the investment-output ratio, $\dot{L}/L$ the growth rate of employment and X/Y the export-output ratio[11] .The presence of the growth rate of exports in expression (5) distinguishes this model

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[10]The assumption of unit relative prices has been relaxed in an improved version of the Feder model developed by Bilinsay and Khan (1994).

[11]The α and β coefficients should be interpreted as indicative of the marginal product of capital and labor in the non-tradable sector, not those of the economy as a whole. See Feder (1982) for details.

from the standard growth accounting equation. Thus, due to intersectoral spillovers and productivity differentials, exports appear as an independent factor that pushes the rate of growth of output beyond what is determined by the accumulation of capital and labor.

Equation (5) has been profusely used in empirical work[12]. Nevertheless, from a theoretical point of view, there are some limitations which undermine its ability to provide a justification for a long-run relationship between exports and GDP growth. First, even if we initially assume a disequilibrium state where marginal productivities are not equalized across sectors, it is difficult to see why such a differential will not be reduced, and eventually eliminated, as exports increase. Once we allow for the overall level of investment and population growth, the increase in exports is signaling a reallocation of resources towards the exportable sector. But of course this reallocation will reduce the marginal productivity of factors in that sector making the productivity differential smaller. And, at some point, the differential will vanish.

Second, if, instead, the initial situation is one of equilibrium, where the productivity differential is due to taxes and other inter-sectoral distortions, there will be no reallocation of factors of productions. So exports, as production of nontradable goods, will expand at the rate that factor accumulation dictates, having no independent role in economic growth. We conclude then that productivity differentials imply only a static welfare gain that, within the context of the model, would not have any growth effect.

With respect to the cross-sector externality, we would arrive at the same conclusion as before if the elasticity of non tradable ouput with respect to exports ($F_x X/(Y-X)$) declines with X. The positive effect of exports on GDP growth will decline as this elasticity gets smaller and smaller as the export share increases[13]. On the other

[12]Beyond Feder (1982) several authors have estimated equation (5) or slight variations of it. See for example Moscho (1989), Esfhasany (1991), Dollar (1992) and Bilgnsoy and Khan (1994).

[13]Belginsey and Khan (1994) extended the original Feder model incorporating variable (diminishing) elasticity .

hand, if a constant elasticity of nontradable output with respect to exports is assumed --as in Feder (1982)-- then the intersectoral externality may have growth consequences even in the long-run. But, then, the question is, why exports will continue to grow in the first place. Why will investment and output in the exportable sector keep rising if capital is subject to diminishing marginal returns?. Of course, these questions are beyond the scope of the original ELGM literature as these studies take exports growth as exogenous. Nevertheless, these questions have to be addressed if we want to understand under what circumstances exports can perform as the "engine" of economic growth. But to do this we need to reframe the ELGM in terms of an explicit growth theory. This is done in the next section.

3. Exports and Growth: An endogenous growth model.

The formalization of the relationship between trade liberalization, exports (and imports) and growth has not been easy even within the context of explicit models of economic growth. The traditional neoclassical growth model (Solow (1958), Koopman (1965)) predicts that, in the long run, these policies have only level effects. Sustainable increases in per capita income is then only possible by the exogenous improvement in technology[14].

The theory of endogenous growth came out in part as a solution to this problem (see Lucas (1988), Romer (1986), Rebelo (1991)). With a slight modification in the traditional neoclassical production function, these models can successfully obtain equilibria where per-capita income grows continuously without requiring an exogenous increase in total factor productivity. The key assumption is to postulate a lower bound (greater than zero) for the value of the

[14]This does not preclude that trade policies, and public policies in general, can have growth effects in the transitional period, before reaching the steady state. This avenue of research has been explored by some authors with some success (see, for example, Barro (1991), Jong-Wha Lee (1993), Mankiw et al (1992), Gould and Ruffin (1993)).

marginal productivity of physical (human) capital[15]. With this purpose we assume a production technology where output is a function of an aggregate measure of capital (human and physical) times a constant (the Ak-Rebelo's specification)[16].

In what follows we study the relationship between trade policies, exports, imports and economic growth in the context of a Rebelo-type, endogenous-growth model. We consider the case of an open economy with three sectors: exportable, importable and non-tradable. To simplify the analysis we assume that residents of this economy consume only the exportable and the non-tradable goods, while the importable good is an input of production (capital). Also, locally, only the exportable and the nontradable goods are produced. All the importable goods (capital) are then imported. The production functions corresponding to the non-tradable (N) and exportable (X) sectors are given by the following expressions,

$$Q_N = A K_N^{\alpha} L_N^{1-\alpha} Q_X^{\eta} \qquad (6)$$

$$Q_X = B K_X \qquad (7)$$

where Q_i i=X,N denotes the quantity produced of each good. We assume nontradables are produced using a constant return to scale thecnology that employs both capital (K_N) and (raw) labor (L_N). In addition, as in the ELGM model, the exportable sector generates a positive externality on the production of non tradable (Q_X is included as an arguments in Q_N). Again, this assumption captures the existence of technology spill-overs as well as the transmission of managerial skills, training etc. Exportable output is produced with a technology that uses only capital (K_X) which is not subject to dismninishing marginal returns; the marginal product of capital in that sector is

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[15]It should be mentioned that there is another branch of the endogenous growth literature that also obtains equilibria with sustained growth but, in this case, the emphasis is placed on the "endogenous" process of technological development (se Romer (1990), Grossman y Helpman (1991) (1993)).

[16]A lower positive bound for the marginal productivity of capital is also obtained with a CES specification.

constant and equal to B[17]. Instead, the production of nontradable goods is subject to diminishing returns, specially when the marginal productivity of capital is evaluated from a decentralized point of view.

As indicated above, this specification of the production functions constitutes a key assumption assuring the existence of an equilibrium with a positive, steady-state growth rate of per capita output. At the same time, it is a way of "recreating" the productivity differential assumption of the early ELGM literature. For simplicity we assume total population L stays constant and we normalize it to one.

Consumers in this economy have time separable preferences, represented by the following intertemporal utility function,

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[17] Rebelo himself (see Rebelo (1991) and Barro and Sala-i-Martin (1995)) has shown that this production function can be derived from a more general one where ouput depends both on physical and human capital. Suppose, for example, that instead of equation (7), the production of exportables is determined by the following expression,

$$Q_X = BK_X^{\beta} H_X^{(1-\beta)} \qquad (a.1)$$

where H_X denotes the amount of human capital used in the production of exportables. Rearranging,

$$Q_X = BK_X \left(\frac{H_X}{K_X}\right)^{(1-\alpha)} \qquad (a.2)$$

In equilibrium the marginal productivities (net of depreciation) of human and physical capital will be equal. This gives a constant value for the ratio H_X/K_X. Thus, (a.2) can be rewitten as,

$$Q_X = B'K_X \ ; \quad B' = B\left(\frac{H_X}{K_X}\right)^{(1-\beta)} \qquad (a.3)$$

Then the non-diminishing return assumption in the exportable sector can be understood as a consequence of physical and human capital being used in the production of this good. And, as the two factors can be accumulated, the marginal productivity of physical capital does not declines as output rises.

$$\int_0^\infty \frac{e^{\rho t}(c_X^\alpha c_N^{1-\alpha})^{1-\gamma}}{1-\gamma}dt \qquad (8)$$

where c_X and c_N denote consumption of exportable and non-tradable goods. We assume all markets are always in equilibria. Then,

$$Q_X=C_X+X \qquad (9)$$

$$Q_N=C_N \qquad (10)$$

where X indicates total exports. As we are interested in the steady state solution -where countries cannot accumulate positive (or negative) debt-, we postulate that the trade account is in balance period after period,

$$M=p_X X \qquad (11)$$

where M represents total imports and p_X indicates the relative price of exports in terms of imports (the terms of trade) which, given the assumption of a small open economy, is constant. In this economy the accumulation of capital ($K = K_X+K_N$) is determined by the volume of imports. But, given the balanced trade assumption, this is, in turn, equal to total exports. Using equations (9) and (11), the expression that describes the law of motion of capital is then equal to,

$$\dot{K}=p_X(BK_X-C_X) \qquad (12)$$

We solve the model assuming home-production (we do not deal explicitly with the behavior of firms and of factor markets). The present value hamiltonian that summarizes the dynamic problem faced by the representative family is,

$$H(.)=e^{-\rho t}\frac{(c_X^\alpha c_N^{1-\alpha})^{1-\gamma}}{1-\gamma}+\lambda[p_X(Bk_X-c_X)]+\phi[Ak_N^\alpha k_X^\eta B^\eta-c_N] \qquad (13)$$

Where λ is the standard dynamic multiplier indicating the shadow price of a unit exportable good. It captures the fact that if not consumed, this product can be exported, allowing more imports, more capital and more future consumption. ϕ is the multiplier corresponding to the nontradable market equilibrium condition. This multiplier represents the equilibrium price of nontradable in terms of importable (in present value terms) taken as given by the representative family. For the decentralized case, where C_X and C_N are controls and K_X and K_N are state variables, the first order conditions can be summarized in the following two equations,

$$\frac{\alpha}{1-\alpha}\frac{c_N}{c_X}=\frac{\lambda p_X}{\phi} \qquad (14)$$

$$\frac{\lambda p_X}{\phi}=\frac{A\alpha k_N^{\alpha-1}k_X^{\eta}B^{\eta}}{B} \qquad (15)$$

Equation (14) indicates that an optimal allocation of consumption between the two goods should satisfied the standard condition that the ratio of marginal utilities be equal to the ratio of prices . On the other hand, expression (15) establishes that the condition for efficiency in production: the ratio of prices has to be equal to the marginal rate of transformation.

Making (14) and (15) equal, applying natural log and differentiating we arrive at,

$$\frac{\dot{c}_N}{c_N}=g_{c_N}=g_{c_X}+(\alpha-1)\frac{\dot{k}_N}{k_N}+\eta\frac{\dot{k}_X}{k_X} \qquad (16)$$

To solve for the rate of growth of capital in both sectors we divide (12) by k,

$$\frac{\dot{k}}{k}=p_X\left(B\frac{k_X}{k}-\frac{c_X}{k}\right) \qquad (17)$$

A steady state solution requires that $\dot{k}/k=g$, where g is a constant. But then, using (17) we conclude that $\dot{k}_x/k_x=\dot{k}/k=g$ and $\dot{c}_x/c_x=\dot{k}/k=g$. Moreover $g=g_{cx}$. In addition, as $k=k_x+k_n$, k_n should also grow at the rate g_{cx} [18]. Then replacing these results in (16) we get the following relationship between g_{CN} and g_{CX},

$$g_{c_N}=g_{c_X}(\alpha+\eta) \qquad (18)$$

A second expression relating both rates of growth is found by differentiating the first order condition corresponding to exportable consumption with respect to time,

$$\frac{\dot{C}_X}{C_X}=g_{c_X}=\frac{p_X B+(1-\gamma)(1-\alpha)\frac{\dot{C}_N}{C_N}-\rho}{1-\alpha(1-\gamma)} \qquad (19)$$

Together with (18) equation (19) serves to determine the rate of growth of consumption (and of output) in both sectors. In particular,

$$g_{cx}=\frac{p_X B-\rho}{h} \qquad (20)$$

with

$$h=[1-\alpha(1-\gamma)]-[(1-\gamma)(1-\alpha)(\alpha+\eta)]>0$$

Notice that in the general case where $\alpha+\eta=1$ the model displays an unbalanced growth path. In particular, if $\alpha+\eta<1$, exportable output grows at a higher rate than that of nontradable. This result will, in turn, be associated with a long-term secular fall in the relative price of exportable goods in term of nontradable; that is, an equilibrium real exchange appreciation[19]. On the other hand, in the special case where the externality effect is high enough so as to make $\alpha+\eta=1$, then both sectors grow at the same rate, equal to,

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[18] In addition, given the production functions (6) and (7), it is easy to see that output will grow at g_{cx}, for the case of exportable goods, and at g_{cx} $(\alpha+\eta)$ in the case of the non-tradable sector.

[19] Differentiating equation (20) we find,

$$\frac{\dot{\phi}}{\phi}=\frac{\dot{\lambda}}{\lambda}+(1-(\alpha+\eta))\,g_{cx}$$

Thus if $\alpha+\eta<1$ the price of nontradable goods ϕ grows at a higher rate than the price of exportable λp_x, where both prices are expressed in present-value terms.

$$g_{cx}=g_{cn}=\frac{P_X B-\rho}{\gamma} \qquad (21)$$

This last result resembles that found in one sector, Rebelo-type models where the steady state rate of growth of the economy equals the (constant) marginal productivity of capital minus the rate of time preference, both terms multiplied by the elasticity of substitution ($1/\gamma$ in our case)[20].

Within the context of this model it is clear that exports are the "engine" of economic growth. This sector sustains the continuing increase in per capita income through two channels. On one hand, there is the key assumption that (human and physical) capital in this sector is not subject to diminishing returns. As a consequence, incentives to save do not vanish and so capital accumulation continues for ever; in other words, exports sustain investment and, as capital goods are imported, it also lead to higher import demand.

Secondly, the exportable sector generates positive externalities on the rest of the economy. Though this factor is not a necessary (nor a sufficient) condition to have sustained growth (as in Lucas (1988))[21], it helps to push upward the growth rate of nontradable output, thus, making balanced growth possible.

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[20] It is easy to extend the model for the case where imports are charged with an import tax. Assuming T is the tariff, equation (11) can be rewritten as,

$$M(1+T) = p_x X$$

Solving the model as we did before and assuming the special case where $\alpha+\eta=1$, we arrive at,

$$g_X=g_N=g=\frac{\frac{p_X}{(1+T)}B-\rho}{\gamma}$$

where $dg/dT < 0$ and $dg/dp_x > 0$. The intuition of these results is clear. A raise of T or a decline in P_x makes importable goods (capital) more expensive in term of exportable products. Then a given amount of exports implies less imports and then, less capital accumulation in the steady state.

[21]See also Sala-i- Martin (1991).

5. Concluding Remarks.

Trade liberalization has occupied a central place in recent structural reforms programs pursued by many developing countries. Governments hope that, as it happened in East Asia, this policy will encourage export performance and GDP growth. In this paper we review this export-led growth hypothesis both from an empirical and a theoretical perspective.

From the empirical point of view, we discuss the literature which show a robust relationship between trade, growth and investment. Then we try to empirically study the interaction between these variable performing Granger causality test to panel data. The results indicate that exports, and not imports, Granger-cause growth of both, per capita GDP and investment. Moreover exports causes imports flows. Then the evidence suggest that, for the sample of countries chosen and the considered period, exports behave as the "engine of growth".

On the theoretical side, we reframe the traditional export-led growth model (ELGM) (Feder (1982)) in terms of the modern theory of endogenous growth. This makes theory more consistent with the evidence just described. In addition, it helps to overcome some difficulties that the original ELGM approach has in order to provide a theoretical rationale for a long-term, positive association between exports and growth in per capita income. In particular, the existence of non-diminishing returns -as opposed to a productivity differential- in the exportable sector is a sufficient condition for exports to have a positive, long-term effect on the economy growth rate.

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TABLE 1
GRANGER CAUSALITY TEST: dy_t
OLS

(108 observations)

a) dx_{t-1} ---> dy_t

	dy_{t-1}	dx_{t-1}	time effects			
Estimated coefficient	0.25	0.19	.003	.01	-.02	.01
"t" (absolute value)	(2.48)	(3.30)	(0.60)	(1.67)	(3.91)	(1.75)
R^2=.34 F(5,101)=10.59[.00] σ=.023 DW=2.1 AR(1,101)=0.62[.43] N(2)=1.89						

b) dm_{t-1} ---> dy_t

	dy_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	0.47	-.052	.01	.01	-.02	-.01
"t" (absolute value)	(3.46)	(.93)	(2.4)	(1.49)	(3.2)	(1.2)
R^2=.28 F(5,102)=7.84[.00] σ=.024 DW=2.1 AR(1,101)=1.21[.27] N(2)=1.74						

c) di_{t-1} ---> dy_t

	dy_{t-1}	di_{t-1}	time effects			
Estimated coefficient	0.50	-0.06	.01	.01	-.02	.01
"t" (absolute value)	(3.3)	(1.04)	(1.9)	(1.6)	(3.1)	(1.4)
R^2=.28 F(5,102)=7.90[.00] σ=.024 DW=2.1 AR(1,101)=1.57[.21] N(2)=1.46						

The symbols dy,dx,dm,di stands for first log-differences in per capita GDP, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variables and t-1 the same average for the previous four years. The sample includes 27 countries and the time period goes from 1971 to 1991 (4 non-overlapping averages were computed). The numbers under the time effects columns are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er time observations. The estimation method is OLS. F stands for the F (joint significance) test and σ denotes the standard error of regression. AR (1,..) is the first order autocorrelation F-statistics (Harvey (1981) and N ( ) is the Jarque-Bera (1980) $\chi 2$ statistics under the normality assumption.

TABLE 2

GRANGER CAUSALITY TEST: dy_t

IVE

(108 observations)

a) dx_{t-1} ---> dy_t

	dy_{t-1}	dx_{t-1}	time effects			
Estimated coefficient	0.35	0.17	.002	.01	-.02	.01
"t" (absolute value)	(2.74)	(2.78)	(0.43)	(1.57)	(3.98)	(1.94)
σ=.023 DW=2.3 ARχ^2(1)=2.46 N(2)=1.89						

b) dm_{t-1} ---> dy_t

	dy_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	0.62	-.095	.01	.01	-.02	-.01
"t" (absolute value)	(3.56)	(.01)	(2.71)	(1.3)	(3.2)	(1.2)
σ=.024 DW=2.3 ARχ^2(1)=3.39 N(2)=1.80						

c) di_{t-1} ---> dy_t

	dy_{t-1}	di_{t-1}	time effects			
Estimated coefficient	0.81	-0.14	.005	.01	-.02	.01
"t" (absolute value)	(3.34)	(1.87)	(0.8)	(1.6)	(2.9)	(1.7)
σ=.023 DW=2.1 ARχ^2(1)=5.73 N(2)=3.88						

The symbols dy,dx,dm,di stands for first log-differences in per capita GDP, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variable and t-1 is the same average for the previous four years. The sample includes 27-country sample and goes from 1971 to 1991 (4 non-overlapping averages were computed). The numbers under the time effects columns are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er time observations. The estimation method is Instrumental Variables (IVE). σ denotes the standard error of regression . AR χ^2 (1) is the first order autocorrelation χ^2 statistics (for IVE) . N ( ) is the Jarque-Bera (1980) χ2 statistics under the normality assumption.

TABLE 3

GRANGER CAUSALITY TEST: di_t

OLS

(108 observations)

a) dx_{t-1} ---> di_t

	di_{t-1}	dx_{t-1}	time effects			
Estimated coefficient	0.02	0.51	.01	.02	-.08	-.01
"t" (absolute value)	(0.02)	(2.99)	(0.8)	(1.3)	(3.8)	(0.40)
R^2=.25 F(5,102)=6.71[.00] σ=.071 DW=2.0 AR(1,101)=0.01[.91] N(2)=3.06						

b) dm_{t-1} ---> di_t

	di_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	0.12	-.03	.04	.01	-.07	-.02
"t" (absolute value)	(0.7)	(.2)	(2.58)	(1.2)	(3.28)	(0.85)
R^2=.18 F(5,102)=4.53[.00] σ=.07 DW=1.9 AR(1,101)=0.13[.72] N(2)=4.6						

c) dy_{t-1} ---> di_t

	di_{t-1}	dy_{t-1}	time effects			
Estimated coefficient	-0.26	1.33	.02	.02	-.07	-.01
"t" (absolute value)	(1.6)	(2.85)	(1.7)	(1.2)	(3.3)	(0.32)
R^2=.24 F(5,102)=6.51[.00] σ=.072 DW=2.1 AR(1,98)=0.84[.36] N(2)=0.91						

The symbols dy,dx,dm,di stands for first log-differences in per capita GDP, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variable along the 27-country sample. The time period considered goes between 1971 to 1992 (4 non-overlapping averages were computed). The numbers under the lags column are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er lags. The estimation method is Ordinary Least Squares (OLS). F stands for the F (joint significance) test and σ denotes the average estimation error. AR (1,..) is the first order autocorrelation statistics (Harvey (1981). N ( ) is the $\chi 2$ Jarque-Bera (1980) statistic under the normality assumption.

TABLE 4

GRANGER CAUSALITY TEST: di_t

IVE

(108 observations)

a) dx_{t-1} ---> di_t

	di_{t-1}	dx_{t-1}	time effects			
Estimated coefficient	-0.16	0.58	.01	.03	-.07	-.01
"t" (absolute value)	(1.13)	(3.28)	(0.7)	(1.4)	(3.3)	(0.69)
σ=.073 DW=1.7 ARχ^2(1)=2.88 N(2)=4.58						

b) dm_{t-1} ---> di_t

	di_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	-0.15	0.22	.03	.03	-.07	-.02
"t" (absolute value)	(0.7)	(0.9)	(2.1)	(1.5)	(3.04)	(0.7)
σ=.076 DW=1.8 ARχ^2(1)=2.09 N(2)=5.73						

c) dy_{t-1} ---> di_t

	di_{t-1}	dy_{t-1}	time effects			
Estimated coefficient	-0.59	2.06	.01	.03	-.06	-.01
"t" (absolute value)	(2.3)	(3.2)	(0.7)	(1.4)	(2.7)	(0.3)
σ=.071 DW=1.97 ARχ^2(1)=0.02 N(2)=0.58						

The symbols dy,dx,dm,di stands for first log-differences in per capita GDP, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variable along the 27-country sample. The time period considered goes between 1971 to 1992 (4 non-overlapping averages were computed). The numbers under the lags column are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er lags. The estimation method is Instrumental Variables (IVE). σ denotes the average estimation error. AR χ^2 (1) is the first order autocorrelation statistics (for IVE estimation) . N ( ) is the $\chi 2$ Jarque-Bera (1980) statistics under the normality assumption.

TABLE 5

GRANGER CAUSALITY TEST: dm_t

OLS

(108 observations)

a) dx_{t-1} ---> dm_t

	dm_{t-1}	dx_{t-1}	time effects			
Estimated coefficient	-0.13	0.30	.06	.02	-.08	-.02
"t" (absolute value)	(1.3)	(2.18)	(4.0)	(1.2)	(4.7)	(1.1)
R^2=.31 F(5,102)=9.06[.00] σ=.057 DW=1.8 AR(1,101)=1.84[.18] N(2)=1.09						

b) dm_{t-1} ---> dy_t

	dy_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	-0.14	.06	.07	.02	-.07	-.02
"t" (absolute value)	(0.9)	(.42)	(5.7)	(1.1)	(4.34)	(1.35)
R^2=.28 F(5,102)=7.8[.00] σ=.058 DW=1.7 AR(1,101)=3.35[0.07] N(2)=2.58						

c) dy_{t-1} ---> dm_t

	dm_{t-1}	dy_{t-1}	time effects			
Estimated coefficient	-0.20	0.39	.06	.02	-.07	-.02
"t" (absolute value)	(1.44)	(1.20)	(5.42)	(1.0)	(4.36)	(1.24)
R^2=.29 F(5,102)=8.14[.00] σ=.058 DW=1.8 AR(1,101)=2.2[.14] N(2)=2.78						

The symbols dy,dx,dm,di stands for first log-differences in per capita GDP, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variable along the 27-country sample. The time period considered goes between 1971 to 1992 (4 non-overlapping averages were computed). The numbers under the lags column are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er lags. The estimation method is Ordinary Least Squares (OLS). F stands for the F (joint significance) test and σ denotes the average estimation error. AR (1,..) is the first order autocorrelation statistics (Harvey (1981). N ( ) is the $\chi 2$ Jarque-Bera (1980) statistic under the normality assumption.

TABLE 6

GRANGER CAUSALITY TEST: dm_t

IVE

(108 observations)

a) dx_{t-1} ---> dm_t

	dm_{t-1}	dx_{t-1}	time effects			
Estimated coefficient	-0.23	0.32	.06	.02	-.07	-.02
"t" (absolute value)	(1.5)	(2.3)	(4.1)	(1.2)	(4.4)	(1.3)
σ=.057 DW=1.7 ARχ^2(1)=2.24 N(2)=1.2						

b) di_{t-1} ---> dm_t

	di_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	-0.40	0.23	.08	.01	-.07	-.03
"t" (absolute value)	(0.8)	(.67)	(3.9)	(0.8)	(4.16)	(1.39)
σ=.059 DW=1.7 ARχ^2(1)=2.16 N(2)=4.9						

c) dy_{t-1} ---> dm_t

	dm_{t-1}	dy_{t-1}	time effects			
Estimated coefficient	-0.37	.68	.07	.01	-.07	-.02
"t" (absolute value)	(1.26)	(1.26)	(5.36)	(.92)	(3.95)	(1.39)
σ=.59 DW=1.71 ARχ^2(1)=1.68 N(2)=3.9						

The symbols dy,dx,dm,di stands for first log-differences in per capita GDP, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variable along the 27-country sample. The time period considered goes between 1971 to 1992 (4 non-overlapping averages were computed). The numbers under the lags column are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er lags. The estimation method is Instrumental Variables (IVE). σ denotes the average estimation error. AR χ^2 (1) is the first order autocorrelation statistics (for IVE estimation) . N ( ) is the χ2 Jarque-Bera (1980) statistics under the normality assumption.

TABLE 7

GRANGER CAUSALITY TEST: dx_t

OLS

(108 observations)

a) dm_{t-1} ---> dx_t

	dx_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	0.17	0.13	.05	.01	-.04	-.002
"t" (absolute value)	(1.78)	(1.84)	(5.5)	(.78)	(3.9)	(0.02)
R^2=.21 F(5,102)=5.5[.00] σ=.040 DW=2.3 AR(1,101)=6.70[.01] N(2)=2.43						

b) di_{t-1} ---> dx_t

	dx_{t-1}	di_{t-1}	time effects			
Estimated coefficient	0.16	.12	.06	.01	-.05	-.002
"t" (absolute value)	(1.69)	(2.1)	(6.1)	(0.5)	(4.0)	(0.21)
R^2=.22 F(5,102)=5.7[.00] σ=.04 DW=2.2 AR(1,101)=4.29[0.04] N(2)=2.5						

c) dy_{t-1} ---> dx_t

	dx_{t-1}	dy_{t-1}	time effects			
Estimated coefficient	0.13	0.37	.05	.01	-.04	-.01
"t" (absolute value)	(1.28)	(2.04)	(5.7)	(0.6)	(3.82)	(0.11)
R^2=.22 F(5,102)=5.69[.00] σ=.040 DW=2.2 AR(1,101)=5.2[.02] N(2)=3.72						

The symbols dy,dx,dm,di stands for first log-differences in GDP per capita, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variable along the 27-country sample. The time period considered goes between 1971 to 1992 (4 non-overlapping averages were computed). The numbers under the lags column are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er lags. The estimation method is Ordinary Least Squares (OLS). F stands for the F (joint significance) test and σ denotes the average estimation error. AR (1,..) is the first order autocorrelation statistics (Harvey (1981). N ( ) is the $\chi 2$ Jarque-Bera (1980) statistic under the normality assumption.

TABLE 8

GRANGER CAUSALITY TEST: dx_t

IVE

(108 observations)

a) dm_{t-1} ---> dx_t

	dx_{t-1}	dm_{t-1}	time effects			
Estimated coefficient	0.20	0.12	.05	.01	-.04	-.002
"t" (absolute value)	(1.7)	(1.73)	(5.8)	(0.53)	(3.8)	(0.02)
σ=.040 DW=2.3 ARχ^2(1)=2.11 N(2)=2.12						

b) di_{t-1} ---> dx_t

	di_{t-1}	dm_{t-1}	time effects			
Estimaded coefficient	0.20	0.12	.05	.01	-.05	.002
"t" (absolute value)	(1.67)	(1.97)	(5.4)	(0.5)	(4.0)	(0.14)
σ=.040 DW=2.3 ARχ^2(1)=3.47 N(2)=2.21						

c) dy_{t-1} ---> dx_t

	dx_{t-1}	dy_{t-1}	time effects			
Estimated coefficient	0.17	.33	.05	.01	-.04	-.001
"t" (absolute value)	(1.34)	(1.78)	(5.14)	(.6)	(3.86)	(0.1)
σ=.040 DW=2.3 ARχ^2(1)=4.0 N(2)=3.3						

The symbols dy,dx,dm,di stands for first log-differences in per capita GDP, exports, imports and gross fixed investment. The sub-index t indicates non-overlapping 4-year-averages for the corresponding variable along the 27-country sample. The time period considered goes between 1971 to 1992 (4 non-overlapping averages were computed). The numbers under the lags column are the estimated coefficients for the constant and dummy variables corresponding to the 1rst, 2nd and 3er lags. The estimation method is Instrumental Variables (IVE). σ denotes the average estimation error. AR χ^2 (1) is the first order autocorrelation statistics (for IVE estimation) . N ( ) is the χ2 Jarque-Bera (1980) statistics under the normality assumption.

ANNEX.

Granger Causality using Panel Data.

Caroll and Weill (1994) apply "causality" tests to a sample that includes both time series and cross-section observations (panel data). Their approach can be framed by noting that they estimate a regression which is encompassed by the next one,

$$(1)\ y_{ti} = \mu + y_{t-ji}'\beta + x_{t-ji}'\gamma + w_t'\delta + \alpha_i + u_{ti}\ ;\quad t=1...T \quad i=1...N$$

where j and l (j, l > 0) denote appropriate lags such that u_{ti} results as innovation (given the information set).

Regarding eq.(1), the variable x (does not) Granger-causes y if the hypothesis H_0: $\gamma = 0$ can (cannot) be rejected. A symmetrical approach would test the causality of y on x.

Caroll and Weill analyze the causality between the average propensity to save and growth for a sample of different countries (i), and take the time observations (t) as nonoverlapping averages of k years. In this work, k=5, in order to isolate long run effects from cyclical(shorter) movements; moreover, taking nonoverlapping averages assume a lag effect of k years (on average). They also assume l=j=1 in eq. (1) and restrict the time effects, w_t', to dummy variables.

When an equation like (1) is estimated, two questions arise: i) the inclusion of "country specific effects" , α_i ;and ii) the estimation of a dynamic model since lagged explained variables are include as regressors. These problems are interrelated as we will show. They are also more critical when the panel has a short number of time observations (small T) - as it is often found in practice- for i), and many cross-section observations (large N) for ii), since there are also many α_i parameters to be estimated (for example, including country specific dummies).(See Hsiao, 1986)

An approach often suggested for static models to tackle ii) is to reformulate the model in differences thus eliminating α_i. However, when this approach is applied to dynamic model like (1) OLS are not appropriate. Assuming j=1 in (1) and taking first differences,it becomes,

$$(2)\ \Delta y_{ti} = \beta_1\,\Delta y_{t-1i} + \gamma_1\,\Delta x_{t-1i} + w^{*}_t{}'\,\delta^{*} + v_{ti}$$

where $w^{*}_t{}'\,\delta^{*}$ now include the time-effects for the model in differences. Since $v_{ti} = u_{ti} - u_{t-1i}$, then $E(u_{t-1i},\Delta y_{t-1i}) \neq 0$, and OLS estimators are biased. Therefore, instrumental variables estimators(IVE) are suggested; and appropriate IV are Δy_{t-2i} o y_{t-2i}.(See,Hsiao 1986). Both, OLS and IVE are presented by Caroll and Weil.

The approach of section 2 can be summarized as follows: a) the variables were defined as first differences of nonoverlapping averages of k years,and b) country specific effects α_i are assumed only in the levels of the variables (e.g. in the level in the per capita GDP), thus the equations estimated are of the following kind,:

$$(3)\ \Delta y_{ti}^{k} = \beta_k\, \Delta y_{t-1i}^{k} + \gamma_k\, \Delta x_{t-1i}^{k} + w^{**}_t{}'\, \delta^{**} + \varepsilon_{ti}$$

where $\varepsilon_{ti} = u_{ti} - u_{t-ki}$ and

$$\Delta y_{ti}^{k} = (y_{ti} - y_{t-ki})/k$$

$$\Delta y_{t-1i}^{k} = (y_{t-ki} - y_{t-2ki})/k$$

$$\Delta x_{t-1i}^{k} = (x_{t-ki} - x_{t-2ki})/k$$

An instrumental variable for Δy_{t-1i}^{k} is,

$$\Delta y_{t-1i}^{kIV} = (y_{t-(k+1)i} - y_{t-(2k+1)i})/k$$

Thus $E[\Delta y_{t-1i}^{kIV}, \varepsilon_{ti}] = 0$ (if not autocorrelation is present) and estimating (3) by IV give unbiased estimators of the coefficients which can be used to perform "causality" test.

Finally, it is worth noting that determining k may result somewhat arbitrary (when nonoverlapping averages of (fixed) k periods are used), in addition to the selection of k in practice. However, this question is mostly related to the probability of type II error (not reject H_0 when it is false, here not detect "causalities") due to inappropriate k. Instead, it is not critical when "causalities" are found in a particular sample, whichever the value k has fixed. The problem of generalizing results to other countries and other periods is not exclusive of this approach.