A Growth Theory and Competitiveness Gains Measure Linkage

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5. October 2006

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Abstract

This work provides a macroeconomic approach and a sound conceptual foundation for the notion of "competitiveness gains", so prone to multiple interpretations, and to make it fit for empirical analyses. Instead of "competitiveness" is "competitiveness gains" the relevant concept, defined as a situation where the economy experiences a higher growth rate of TFP than its competitors. We present a theoretical model of competitiveness that provides a rationale for the variations of competitiveness, associated to the behavior of related variables; then we carry out an empirical exercise which shows that our formalization supports a measurable approximation to competitiveness gains.

Keywords: competitiveness, competitiveness gains measurement, total factor productivity, trade and growth

JEL Classification: F43 – O41 – O47 – B41

1 Introduction

The absence of agreement about the sense of the notion "international competitiveness" has influenced negatively to some theorists who have repudiated the terminology or have denied his relevance. Nevertheless, the way taken by the applied economists and political analysts has been exactly the opposite one. Some of the approaches that emphasize the use of indicators do not offer a clear connection between these and a model that explains the phenomenon that apparently the indicators describes. The result is that often they confuse consequences with causes and it is not very sure on what they measure. For example, some authors associate the competitiveness to a "good" commercial

*We wish to thank the people whose comments, feedback and discussions habe contributed to improving our work. We have further benefited from careful comments by Fernando Navajas, Carlos Dabús, Fernando Tohmé, Alberto Herrou-Aragón and Julio Berlinski. We also acknowledge the financial support of the CONICET Doctoral Fellowship. Responsibility for errors remains with the author. E-mail: ghgonza@criba.edu.ar

performance, therefore, a quantitative expression would be a "good" participation of market. Whereas others think about the efficiency of the social systems to organize and to maintain cooperation links, then its expression could be any socioeconomic indicator of cooperation without any precision.[3]

The core of this work is to provide a macroeconomic approach and a sound conceptual foundation for the notion of “competitiveness gains”, so prone to multiple interpretations, and to make it fit for empirical analyses -this means that it is possible to measure it in effective form and to make an interpretation of the result without ambiguity.

This approach offers a direct relationship between competitiveness and the idea of ability to compete of an economy (or sector) that results from a profile or set of characteristics. Interaction between this and competitors' profiles determines the trade performance. In this way, instead of “competitiveness” is “competitiveness gains” the relevant concept, defined as a situation where economy (or sector) experiences a higher growth rate of TFP than its opponents. Then, intrinsic relativity of the notion became explicit -it compares economic structures at a same moment. Increases in levels of productivity of the competitors could be translated in degradation of its position in the international market and in substitution of domestic goods by imported ones inside domestic market. Our approach would allow us to include these situations in the same theoretical frame and from a common conceptual structure. In addition, it offers an operationable concept.

Finally, the concept of competitiveness gains is effectively operational if it fulfills the following condition: its measure must be *natural* [8], objective and continue. The *naturalness* definition establishes that it is a necessary condition the existence of a suitable or approximately true causal model with respect to real situations -that is, that all the important factors for the measurement of the concept have been considered in the model and the *causal powers* that the model attributes were those that are observed in the reality- in conjunction with a justified procedure of measurement[1].

The outline of the paper is as follows. The next section lays out a simple competitiveness model that is built by the equilibrium solution of a bisectoral growth model with intertemporal optimization, and two economies that competes for a third market. Therefrom, we expose a positive relationship between long-run trade performance and the measure of competitiveness gains. Section 3 presents the empirical specification, the generalization of the measure of competitiveness gains for a panel of economies, and a description of the data used in the empirical work. Section 4 reports the results of the estimation of growth rate of TFP, the computation of competitiveness gains measure and the test of the theoretical relationship mentioned before. Final considerations are discussed in the fifth section.

[1] For more discussion, [3]

2 The Model

We want to find a relationship between long-run trade performance and the measure of competitiveness gains. We consider two competing economies, D and F, which export consumption goods to and import capital goods from a third market, R. Economy R determines the price and absorbs totally their tradable supply. Hence, in spite of competing in price or quality, they do it in volume, and the competitiveness sources are reduced to consider technological causes, specifically, total factor productivity (TFP) and factor endowments.

To simplify the analysis, we consider each competing economy with two sectors. One of them produce exportable consumption goods, the other nontradable consumption goods. The production functions corresponding to the nontradable (N) and exportable tradable (T) producer sectors are given by the following expressions,

$$Y_{Nj} = A_j K_{Nj}^{\gamma_{Nj}} \qquad \text{and} \qquad Y_{Tj} = B_j K_{Tj}^{\gamma_{Tj}}$$

where Y_{ij} and K_{ij}, $i = N, T$ denote the quantity produced of each goods and the capital employed in that production in economy j, $j = D, F$, and $\gamma_{ij} > 0$ are constant. Labor is assumed constant and unitary in each sector, therewith those expressions could be considered in per-worker terms. Variables $A_j > 0$ and $B_j > 0$ represent the technological state and efficiency level in each sector, and a positive variation is interpreted as "an umbrella covering real cost reductions of all kinds" [4] Thus, we elude to specify a function that explain the total productivity behavior. Nevertheless, we assume that their growth rates are endogenous to the optimization process. This means that growth rates of TFP and capital are mutually determined in steady state[2].

We suppose that infinitely-lived families in each economies have preferences represented by the following intertemporal utility function,

$$\int_0^{\infty} e^{\rho t} \frac{\left(c_{Tj}^{\alpha} c_{Nj}^{1-\alpha}\right)^{1-\theta}}{1-\theta} dt$$

where α is a constant, $0 < \alpha < 1$, and represents the distribution of consumption between tradable and nontradable goods. c_{ij} denote the individual consume (quantity) of good i in economy j, with $i = N, T$ and $j = D, F$. Parameters $\rho > 0$ and $\theta > 0$ are the rate of time preference and inverse of the intertemporal elasticity of substitution, respectively.

All markets are always in equilibria. Then,

$$Y_{Tj} = C_{Tj} + X_{Tj}; \qquad Y_{Nj} = C_{Nj}; \qquad \dot{K}_j = \frac{p_{Tj}}{p_R} X_{Tj}.$$

[2] We remark mutually determination between this variables instead of one-way direction causal effect becouse the mathematical resolutions of the optimization problem are different. Whereas in the first case the relationship emerge as a result of equilibria, the assumption of directional causality require a parametrical function of TFP growth. Examples for this last approach [2] and [6].

The first to the left represents the tradable domestic market equilibria in economy j, therefrom we obtain X_{Tj} the quantity exported to economy R. The next is the nontradable domestic market equilibrium, and the last is the trade balance where $\dot{K}_j$represents the imports of capital and p_{Tj}/p_R indicates the terms of trade. Since these economies do not compete in price, we simplify the model assuming that p_{Tj} and p_{T-j} grows at the same rate that p_R. Hence, by assuming balanced trade we obtain that the growth rates of capital and exports are equal.

From the equilibrium conditions of tradable domestic market and trade account, and production function of tradable goods, the expression that describes the law of motion of total capital is

$$\dot{K}_j = \frac{p_{Tj}}{p_R} B_j K_{Tj}^{\gamma_{Tj}} - \frac{p_{Tj}}{p_R} C_{Tj}$$

Since structural and behavioral assumptions are identical in both economies, the optimization processes and results are identical. Henceforth, the subindex of origin are suppressed.

Assuming home-production, the current-value augmented Hamiltonian that summarizes the dynamic problem faced by the representative family is

$$H = \frac{\left(c_T^{\alpha} c_N^{1-\alpha}\right)^{1-\theta}}{1-\theta} + \lambda \left(\frac{p_T}{p_R} B k_T^{\gamma_T} - \frac{p_T}{p_R} c_T \right) + \phi \left(A k_N^{\gamma_N} - c_N \right)$$

where $H = \hat{H} e^{\rho t}$ and $\lambda = \hat{\lambda} e^{\rho t}$ The multipliers or co-state variables, λ and ϕ, can be interpreted as the shadow prices of a unit of capital (expressed in utility units), and the shadow prices of a extra unit of capital assigned to tradable sector (expressed in utility units), respectively. The first one captures the fact that if a unit of tradable good is not consumed, the surplus augments and this allows to import more capital goods and, hence, to increase future consumption. In this sense, the second one captures the fact that each unit of nontradable good that is not consumed represents less requirements of capital, and consequently, more capital available in order to realize more tradable goods.

The Pontryagin conditions are given by

$$(i-ii)\ H_{c_T}, H_{c_N} = 0;\ (iii)\ -H_{k_T} = \dot{\lambda} - \rho\lambda;\ (iv)\ -H_{k_N} = \dot{\phi} - \rho\phi;$$

$$(v-vi) \lim_{t \longrightarrow \infty} e^{-\rho t} k_{Tt} \lambda_t = \lim_{t \longrightarrow \infty} e^{-\rho t} k_{Nt} \phi_t = 0.$$

Equations (i) and (ii) can be consolidated into a new expression that represent the equality between the marginal rate of substitution in consumption and the ratio between nontradable and tradable goods prices. From equations (iii) and (iv) we obtain the condition for efficiency in production, i.e. the equality between ratio of prices and the marginal rate of transformation. Making both results equal, applying natural log and differentiating with respect to time we arrive at

$$(1) \qquad d\ln c_N - d\ln c_T = d\ln A + (\gamma_N - 1)\, d\ln k_N - d\ln B - (d\ln k_T)\,.$$

This expression relates the rates of growth of the control and state variables. To solve the growth rate of capital in both sectors we begin from the fact that the stock of total capital is equal to the sum of the stocks used in each sector. Thereby the growth rate of the first one must be equal to the sum of the growth rate of k_T and k_N, weighted for the participation of each one in total capital, k, and equal to a constant g_k ($\equiv d\ln k$) in steady state. Then, it is possible to verify that in steady state the growth rate of k_T ($g_{k_T} \equiv d\ln k_T$) and k_N ($g_{k_N} \equiv d\ln k_N$) are equal to g_k.

From the equation of motion of total capital we specify the growth rate of total capital. Applying natural log and differentiating with respect to time, we obtain a first approximation to the steady state growth rate of consumption of tradable good,

$$(2) \qquad d\ln c_T = g_k\left[1 - \frac{y_T}{c_T}(1-\gamma_T)\right] + \frac{y_T}{c_T} d\ln B$$

Applying natural log and differentiating with respect to time the nontradable market equilibrium condition, we reach other expression of the same rate,

$$(3) \qquad d\ln c_T = \gamma_T g_k + d\ln B$$

Finally, making (2) and (3) equal we get the following relationship between the growth rate of capital and growth rate of TFP,

$$(4) \qquad g_B \equiv d\ln B = (1-\gamma_T)g_k.$$

Equation (4) is a steady state condition and make evident that growth rate of TFP is endogenous to the process of capital accumulation. It indicates that a steady state solution with $g_k > 0$ requires $g_B < 0$ if capital factor have increasing returns, and $g_B > 0$ if capital factor have decreasing returns. If it is the case, g_B must be greater (lesser) with high (low) g_k and low (high) γ_T. Finally, if capital have constant returns, this condition do not be reached. However, it is possible to show that steady state exist when either g_B is null or X_T is null at initial moment. Relevant cases in long-run show both g_k and g_B positive, therefore, the analysis is centered in the case that the tradable sector produce using a technology with nonincreasing return to capital.

Using (3) and (4) we show that in steady state $g_{c_T} \equiv d\ln c_T = g_k$. Together with (1) and previous results, we arrive at $g_{c_N} \equiv d\ln c_N = \gamma_N g_k + g_A$ where $g_A \equiv d\ln A$. Notice that in steady state both sectors growth at the same rate (balanced growth path) if $g_A = (1-\gamma_N)\, g_k = g_B\,(1-\gamma_N)\,/\,(1-\gamma_T)$.

Expression of g_k is reached in term of the parameters from the first order condition (i) and the growth rate of λ multiplier that is obtained from condition (iii). Then, supposing balanced growth and replacing the rates of growth of consumption, the growth rate of capital in steady state is

$$(5) \qquad g_k = g = \frac{(p_T/p_R)\,\gamma_T B k_T^{\gamma_T - 1} - \rho}{\theta}.$$

Expression (5) indicates that growth rate of capital in steady state is equal to the return rate of capital (value of marginal productivity) minus the rate of discount, both terms multiplied by the intertemporal elasticity of substitution. Like in models *à la* Ramsey-Cass-Koopman, this means that ρ is the agent's impatience measure and the return rate of capital, $f'(k_T)$, is the compensation for reducing present consumption. The greater is the impatience, lesser is the desire of reducing present consumption and, hence, lesser are the surplus**,** the imported capital and the growth rate. These effects are stronger if θ is low, in other words, when future consumption is not a good substitute of present consumption. On the contrary, the greater is the return rate of capital, the greater is the recompense for interchange present for future consumption, consequently, greater are the surplus, the imported capital and the growth rate.

Within the context of this model it is clear that it is more significant the stock assigned to tradable sector than the magnitude of total capital stock. Supposing two economies with $\gamma_T < 1$ and all the same but initial value of stock of capital of tradable sector, the model predicts greater growth rate in the economy with lesser stock of capital. Nevertheless, as the technological development follows the process of capital accumulation -expressed in (4)-, then controlling for technological level, multiple results emerge. Economies with higher stocks of capital assigned to tradable sector grow faster if B_T is high enough to counteract the decreasing returns to capital.

Thus far we have got the optimal solution to the intertemporal assignment of recourses, however have not set up the relationship between the steady state growth rate of TFP and trade performance in long-run. In the way to overtake a model of international competitiveness, we have supposed that economy R purchases all surplus of tradable consumption good produced in competing economies, D and F, and its decisions are optimal. Now, we define the measure of trade performance like it is usual by export market share of economy,

$$(6) \qquad S_j \equiv \frac{X_j}{X_j + X_{-j}}$$

with $j = D, F$. Applying natural log and differentiating with respect to time both sides of the expression (6), and operating on the results, we obtain

$$(7) \qquad g_{S_j} = S_{-j}\left(g_{x_j} - g_{x_{-j}}\right)$$

where g_{S_j} and g_{x_j} represent the growth rate of export market share and the growth rate of exports, respectively, in economy j. Variable S_{-j} denote the initial export market share of competitor and since expression (7) it follow that the greater is S_{-j}, the greater is g_{S_j} if the difference between the exports growth rate is positive. That growth effect could be interpreted like a "prize for effort" obtained after a better productive performance or a "punishment" in contrary case.

Finally, equations (4) and (7) determine a positive theoretical relationship between a measure of competitiveness gains -expressed by difference between the growth rate of TFP of each competing economy- and long-run trade performance

-this last expressed by the steady state growth rate of export market share-, as follows

$$(8) \quad g_{S_j} = \zeta S_{-j} G_{j,-j}$$

where $\zeta = 1/(1-\gamma_T) > 0$ and $G_{j,-j} = g_{B_j} - g_{B_{-j}}$. According to our approach, and using Harberger's terminology, the greater is the "reduction of real costs" of domestic economy respect to the competitor, the greater is the long-run growth rate of export market share. Variable S_{-j} is interpreted as before. ζ is interpreted as sensitivity parameter of long-run export performance to competitiveness gains. The lesser is the elasticity of product respect to capital, γ_T, the lesser is the effect of competitiveness gains, $G_{j,-j}$, on long-run export performance. As we have assuming that both economies are similar, their growth rates of TFP are similar. Hence, there is not competitiveness gains for none. In this case, the export market shares remain unchanged and equal. Moreover, there is not an external constraint for domestic economy since we have supposed a perfectly elastic demand. However, if economy R reduces its absorption rate or if competitor achieves unilaterally a change in production conditions the chain of effects could be described by expressions (4), (5) and (8).

If R reduces its demand, competing economies adjust their processes of production to availability of capital. Expression (5) indicates that to support the steady state this behavior implying to adjust downwards the TFP, this means "destruction of technology" (in a wide meaning), and/or discapitalization or "destruction of capital". The intuition is that noticing the negative unexpected change and believing that it is permanent, the agents are not incentives to make an efficient use of technology and, moreover, they are persuade to reduce their installed capacity of production.

Assuming identical competing economies, the adjust is identical and neither competitiveness gain emerge nor market shares change -although, growth rate of steady state is lesser than the previous-to-adjustement one. Pass over the identicalness assumption[3], one of them could experience a higher rate of growth than the other and, consequently, from (4) and (8) it follows that there is a positive change in growth rates of TFP and market share. In that situation, the economy that is the least flexible -this means, to have a delay in adjustment of TFP and capital-, gains competitiveness and its market share grows at the expenses to the competitor. If since a beginning economies are different in the value of parameters, their exported volumes are different and, therefrom, the same occurs with their initial market shares. However, the effects of a reduction in demand of R are equivalent to the explained case.

In the event of a competitor achieves unilaterally, and exceptionally, a change in production conditions due to exogenous shocks (v.g. foreign contribution of capital). From (5) and (4) it follows that there is a rise in its growth rate of TFP and competitiveness gains. Finally, from (8) competitiveness gains produce a higher growth rate of export market share. Economy R absorbs the increase in

[3]If we consider that TFP is defined by institutional relations, interaction networks, technological capabilities, etc., the economies could be not totally flexible or could have different rates of adjustment.

output of consumption good and responses with a increase in output of capital good directed toward the competitor that gains competitiveness.

3 Empirical Specification

Preceding model sets up a positive causal relationship from competitiveness gains towards long-run growth rate of export market share. Henceforth we present some evidence that could give empirical support to this result. In order that, we presents three stages. First, a panel of annual growth rate of TFP for J economies and T years is constructed from an econometric specification of growth accounting. In second stage, variable $Gj,-j$ is computed using that TFP panel. Finally, growth rate of export market share is regressed using $Gj,-j$ as explanatory variable.

Below we expose the specification of growth accounting and the estimation procedure of TFP growth rate, the generalizing of G measure to J economies, and finally the description of data and sources.

3.1 Growth accounting

To begin, we assume that total output is a geometric index of sectorial components as follows[4],

$$(9) \qquad Y = Y_T^{\tau_T} Y_N^{\tau_N}$$

where Y_i measures the output of i sector $(i = T, N)$[5]. Hence, growth rate of total output is equal to the sum of the growth rate of output in each sectors, weighted for its respective exponent, τ_i. Then, sum of τ_i is equal to one and we define them to be the output share $(i.e., Y_i/Y)$, without any loss of generality. Also asumme that Y and Y_i emerges from a Cobb-Douglas production technology given as follows,

$$(10) \qquad Y_i = TFP_i K_i^{\gamma_i} L_i^{\beta_i}$$

Using (10) in (9), we obtain

$$(11) \qquad Y = TFPK^{\gamma} L^{\beta}$$

with

$$\begin{aligned} TFP &= TFP_T^{\tau_T} TFP_N^{\tau_N}, \\ K^{\gamma} &= K_T^{\gamma_T \tau_T} K_N^{\gamma_N \tau_N}, \\ L^{\beta} &= L_T^{\beta_T \tau_T} L_N^{\beta_N \tau_N}. \end{aligned}$$

This means that TFP, K and L are geometric indexes of TFP_i, K_i and L_i, respectively. Replacing sectorial TFP in previous expression by A $(= TFP_N)$

[4] [1] present a similar growth accounting model with other objectives and specification.

[5] Sectorial components T and N could be interpreted as geometic indexes of outputs with similar characteristics.

and B $(= TFP_T)$, applying natural log and differentiating with respect to time, we arrive at

$$(12) \quad d\ln Y = \tau_T d\ln B + \tau_N d\ln A + \gamma d\ln K + \beta d\ln L.$$

Assuming that long-run growth rates of total capital and labor are constant, it is possible to verify that sectorial growth rate are equal to aggregate ones. Then, supposing balanced growth[6], parameters γ and β are constant and equal to $\tau_T\gamma_T+\tau_N\gamma_N$ and $\tau_T\beta_T+\tau_N\beta_N$, respectively, and $d\ln A$ is expressed in terms of $d\ln B$. Thus, from (12) and reexpressing the result in per-worker terms,

$$(13) \quad d\ln y = d\ln B + \gamma_T d\ln k + (\beta_T + \gamma_T - 1)d\ln L$$

where θ $(\equiv \beta_T + \gamma_T - 1)$ take positive, null or negative values and denotes increasing, constant or decreasing returns to scale, respectively. Expression (13) typically accounts the contributions of increases in the factors of production and the residual on total output growth rate, however the parameters concern to export sector. Therefore, this expression forms the basis of first stage of our empirical specification. Finally, for J economies and T periods, the empirical expression is

$$(14) \quad \triangle \ln y_{jt} = \gamma_T \triangle \ln k_{jt} + \theta \triangle \ln L_{jt} + \lambda + \varepsilon_j + \varsigma_t + \xi_{jt}$$

with $j = 1, ..., J$ and $t = 1, ..., T$. Terms λ, ε, ς and ξ added denote the TFP growth rate of export sector. The first one is a common fixed effect term while ε and ς are a country specific and time specific error terms and ξ is a common i.i.d. error terms.

Then, TFP growth rate of tradable sector is given by

$$(15) \quad \triangle \ln B_{jt} = \triangle \ln y_{jt} - \hat{\gamma} \triangle \ln k_{jt} - \hat{\theta} \triangle \ln L_{jt}$$

3.2 Generalization of G measure to J economies

Theoretical model presents a G measure defined as the difference between the TFP growth rates of domestic economy and the competitor. Nevertheless, empirical specification requires a generalized G measure. Beginning from export market share definition for J economies,

$$(16) \quad S_i = \frac{X_i}{X_1 + ... + X_i + ... + X_J} = \frac{X_i}{X_i + \sum_{j\neq i}^{J} X_j}.$$

Then, applying natural log and differentiating with respect to time and op-

[6]Balanced growth assumption means that tradable and nontradable sectors grows at the same rate, although there could be intrasectoral differences in growth rates.

erating on the result, we have

$$(17)\quad d\ln S_i = d\ln X_i - \frac{dX_i + d\sum_{j\neq i}^{J} X_j}{X_i + \sum_{j\neq i}^{J} X_j}$$
$$= \left(1 - \frac{X_i}{X_i + \sum_{j\neq i}^{J} X_j}\right) d\ln X_i - \frac{\sum_{j\neq i}^{J} X_j}{X_i + \sum_{j\neq i}^{J} X_j}\frac{d\sum_{j\neq i}^{J} X_j}{\sum_{j\neq i}^{J} X_j}$$
$$= \frac{\sum_{j\neq i}^{J} X_j}{X_i + \sum_{j\neq i}^{J} X_j}\left(d\ln X_i - \frac{d\sum_{j\neq i}^{J} X_j}{\sum_{j\neq i}^{J} X_j}\right)$$
$$= S_{-i}\left(d\ln X_i - \sum_{j\neq i}^{J} S_j d\ln X_j\right)$$

with

$$S_{-i} = \frac{\sum_{j\neq i}^{J} X_j}{X_i + \sum_{j\neq i}^{J} X_j}; \qquad S_j = \frac{X_j}{\sum_{j\neq i}^{J} X_j}.$$

S_{-i} is exports market share of competing economies taken as whole, and S_j is the share of each economy on total exports of the set of competing economies.

According to the theoretical model, in steady state the growth rate of exports is equal to the TFP growth rate of tradable sector multiplied by $\zeta = 1/(1-\gamma_T) > 0$. Using that in final expression of (17), we obtain

$$(18)\quad d\ln S_i = \frac{S_{-i}}{1-\gamma_T} d\ln B_i - S_{-i}\sum_{j\neq i}^{J} \frac{S_{-i}S_j}{1-\gamma_T} d\ln B_j.$$

Assuming that all economies own the same value of γ_T, expression (18) represents a generalizing of theoretical expression (8). This means,

$$(19)\quad g_{S_i} = \zeta S_{-i} G_{i,-i}^{J}$$

where

$$(20)\quad G_{i,-i}^{J} = g_{B_i} - \sum_{j\neq i}^{J} S_j g_{B_j}$$

with the same interpretation as before. Now, $G_{i,-i}^{J}$ is competitiveness gains measure of economy i with respect to all remaining economies competing in international market. To reach expression (19) is crucial the identicalness suppose. Alternatively, if we allow differences between groups of countries but similarity inside each group about the value of γ_T, using (17) we arrive at expression (19) that summarize the relationship between long-run export performance and differences between TFP growth rate of competing economies but now competitiveness gains is denoted by the following expression,

$$(21)\quad G_{i,-i}^{J*} = g_{B_i} - \sum_{m=1}^{M} \zeta_M \sum_{n\neq i}^{N} S_n g_{B_n}$$

where m $(= 1, ..., M)$ is a subset of economies that have similar parameter γ_T, and n $(= 1, ..., N)$ is the competing economy that belong to subset

m. S_n denote the share of economy n on total exports of the subset of competing economies. $\zeta_M = \left(1-\gamma_{T_i}\right) / \left(1-\gamma_{T_M}\right)$ is a sensitivity parameter of competitiveness gains of economy i to productivity performance of the subset M. Values of sensitivity parameters are approximated to actual ones using the product elasticities estimated for each subset of economies through the growth accounting model. This approach have at least one limitation that is the dependency of estimated value of G with respect to the definition of the set of economies. Then we will come back with this problem.

In following sections, we use two empirical specifications of expression (19). The first one is

$$(22) \qquad \triangle \ln S_{j\tau} = \varphi G^{adj}_{j\tau} + \psi_{j\tau}$$

with $j = 1, ..., J$ and $\tau = 1, ..., T$. $G^{adj}_{j\tau} = S_{-j\tau} G^{J}_{j\tau}$ is competitiveness gains measure adjusted by the "prize for effort" proxy, and ψ is a error term composed for a country specific effect, a time specific effect and i.i.d. error terms. One limitation of the specification (22) is that it is impossible to insolate the effect of competitiveness gains and the scale effect of S_{-i}. Therefor a second empirical specification of expression (19) is

$$(23) \qquad \triangle \ln S_{j\tau} = \varpi S_{-j\tau} + \pi G^{J}_{j\tau} + \psi_{j\tau}$$

In any case, we use both versions of G^J expressed, respectively, by (20) and (21).

3.3 The data

The raw data were taken from King et al. data set [7], PENN World Tables [6] and World Development Indicators 2005 (WDI). The result is a panel of 114 advanced and developing countries with observations from 1960 through 1988, with the following distribution according to the 1988 World Bank classification: 27 high income countries, 51 middle income countries (15 upper middle and 36 lower middle ones) and 36 low income countries[7]. Taken as a whole, the sample represents the annual average of 86 percent of world exports. Data limitations restrict the cover in time from 25 through 28 observations for country.

[7] High income group: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany West, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Kuwait, Luxembourg, Netherlands, New Zealand, Norway, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, United Kindom, U.S.A. Upper middle income group: Algeria, Argentina, Barbados, Gabon, Greece, Iran, Iraq, Malta, Portugal, South Africa, South Korea, Suriname, Trinidad & Tobago, Uruguay, Venezuela. Lower middle countries: Angola, Bolivia, Botswana, Brazil, Cameroon, Chile, Colombia, Congo, Costa Rica, Dominican Rep., Ecuador, Egypt, El Salvador, Fiji, Guatemala, Honduras, Ivory Coast, Jamaica, Jordan, Malaysia, Mauritius, Mexico, Morocco, Nicaragua, Panama, Papua N. Guinea, Paraguay, Peru, Philippines, Senegal, Swaziland, Syria, Thailand, Tunisia, Turkey, Zimbabwe. Low income group: Afghanistan, Bangladesh, Benin, Burma (Myanmar), Burundi, Central Afr.R., Chad, Ethiopia, Gambia, Ghana, Guinea-Bissau, Guyana, Haiti, India, Indonesia, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Nepal, Niger, Nigeria, Pakistan, Rwanda, Sierra Leone, Somalia, Sri Lanka, Tanzania, Togo, Uganda, Zaire (Congo D.R.), Zambia.

We computed real GDP (US$, 1985 international prices) through a panel of annual data on capital stock per capita and capital-output ratio that come from [7]. Labor were approximated by taking population between 15 and 64 years old (in percentages) published by WDI and total population that come from [6], except Afghanistan for what we used WDI data set.

We estimated the growth accounting model expressed in (14) for the total sample and for the three income groups -low, middle, and high income countries- using fixed effects estimation techniques due to we are not able to assure that country specific and time specific effects are uncorrelated with the included regressors.

Then, the estimates of TFP growth were used to constructing the G measure panel data using equation (21) and G^* using equation (22). In this last case, we use the output elasticities that were obtained from income groups estimations of growth accounting model. Tabla 1 displays the values of sensibility parameters used for computing G^*. Correlation coefficient between cross-country average of both indexes is equal to 0.86. Hence, the analysis of data use preferably the first one because its simple computing and it avoid grouping problems.

Table 1 Values of sensibility parameters

	$n \in H$	$n \in M$	$n \in L$
$i \in H$	1.0000	3.5261	1.3613
$i \in M$	.2836	1.0000	.3861
$i \in L$	.7346	2.5902	1.0000

H, M, L denote high, middle and low income group, respectively.
Sources: see text.

Finally, values of merchandise exports (US$, current prices) come from UNCTAD Handbook of Statistics. In any case, growth rates were approximated by taking the logarithmic differences. Empirical specifications (22) and (23) are estimated by using fixed effects estimation techniques too, due to previously mentioned reasons.

4 Estimation results

Table 2 displays the estimation results of equation (14) that summarize the growth accounting model. As may be seen, in every regression the coefficient of $d \ln K$ is positive and significant at the 5% level. Column one gives the estimate for the total sample. The coefficient of $d \ln L$, negative and significant, indicates that the production function exhibits decreasing returns to scale. The coefficient of $d \ln K$ assigns a value of 0.5905 to the elasticity of output with respect to the physical capital stock. These two coefficients combine to generate the implied elasticity of output with respect to the labor force of 0.2085. Thus, after accounting for country-specific and time-specific effects, the output elasticities with respect to labor and physical capital sum to a value of 0.7990.

Table 2 Growth accounting regressions

	all	*H*	$M^{(1)}$	*L*
Countries	114	27	51	36
Observations	3118	748	1395	975
$d \ln k$	.5905	.2700	.7930	.4638
	(20.4)	(5.33)	(18.31)	(8.65)
$d \ln L$	-.2010	-.5089		-.4228
	(-2.14)	(-2.52)		(-2.11)
const	.0050	.0234	-.0038	.0074
	(1.96)	(6.31)	(-1.82)	(1.34)
F-statistic	213.73	16.83	335.14	43.06

H, M, L denote high, middle and low income group, respectively. Each row corresponds to a growth accounting regression using a different data sample. The numbers in parentheses are t-statistics

$^{(1)}$Output elasticities were restricted to add up to one. For details see text.

Columns two to four report the estimated results for the countries classified by income groups. In the cases of high and low income countries samples, the coefficients of $d \ln L$ are again negative and significant, and assign a value of 0.2211 and 0.1134, respectively, to the elasticity of output with respect to labor force. Again, the output elasticity with respect to labor and physical capital sum a value lower than unity -i.e. 0.4911 in high income countries and 0.5732 in low income country sample.

However, the middle income countries regression reports a coefficient of $\ln L$ that is insignificant at conventional levels -i.e. t-statistic=-0.40 at the 5% level with p-value=0.69. Even though we subdivide the sample in upper middle and lower middle income countries, in any case the value of the coefficient θ is insignificant. Therefrom output elasticities were restricted to add up to one only for that group. Now, the output elasticity with respect to physical capital and labor are 0.7930 and 0.2070, respectively.

Those elasticities were employed to produce four TFP growth estimations for each country over time using equation (15).All-period average values show the best performance for high income countries, while the worst one for the middle income countries. Table 3 shows four-years-period average rate of TFP growth for total sample and for each income group of countries. Note that all has experienced a similar behavior -i.e. a slowdown from 1960-63 period through beginning 1984-87 period and a recuperation from there.

Table 3 Average TFP growth

	all	*H*	*M*	*L*
1960-63	.018	.040	.017	.010
1964-68	.014	.034	.006	.015
1969-73	.010	.028	.000	.014
1974-78	-.004	.015	-.015	.000
1979-83	-.012	.005	-.024	-.006
1984-87	.008	.021	-.001	.016

H, M, L denote high, middle and low income group, respectively. Each row corresponds to a four-years average of TFP growth.
Sources: see text.

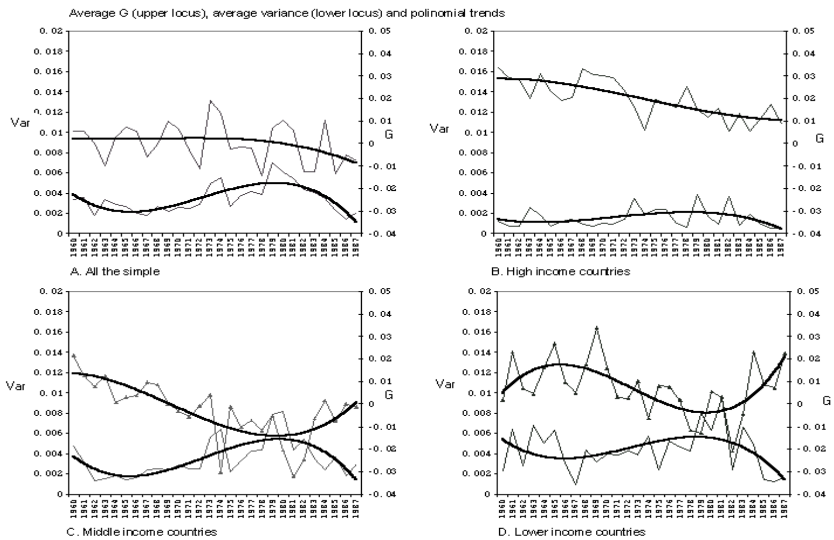
Table 4 displays the four-years-period average of G measure -computed from (21)- and the average variability. Note that the productivity slowdown have affected the average G and it has followed a similar trend. A slowdown in average G with a tendency to zero in considered period could be interpreted like a trend towards a steady state where no economy experienced a change in its market share. However, the higher average variability inside the group suggests a situation where the required effort to gain competitiveness by anyone of the economies is smaller every time.

Table 4 G measure

	Average G measure				Average variance of G			
	all	*H*	*M*	*L*	*all*	*H*	*M*	*L*
1960-63	.000	.028	.014	.009	.003	.001	.003	.005
1964-68	.002	.025	.005	.015	.002	.001	.002	.004
1969-73	.004	.026	-.001	.013	.003	.002	.003	.004
1974-78	-.001	.017	-.012	.000	.004	.002	.004	.004
1979-83	.000	.012	-.018	-.006	.005	.002	.006	.007
1984-87	-.004	.011	-.002	.015	.002	.001	.003	.002

H, M, L denote high, middle and low income group, respectively. Each row corresponds to a four-years average of G measure and its variance.
Sources: see text.

Figure 1 plots the annual average G behavior for all sample and income groups and show that there could be evidence to think in the same sense that last appreciation. If we compare total sample with income group average G behaviors, we see that in spite of generalized productivity slowdown and differences in scale, high income countries have lost competitiveness with respect to middle and -principally- low income groups in the last years of the sample.



Inside high income group Hong Kong , Singapore, Cyprus, Israel and Japan are the countries with the best long-run performance. However, taking total sample estimations some of them have lower values of G measure than developing countries -v.g. Uganda and Kenya. Middle income group show the worst values of G and a downward trend for average G from 1960 decade.

Finally, G measure panel has been used to test empirically the theoretical relationship between export performance and competitiveness gains expressed in (22) and (23). Table 5 and 6 contain the basic results from regressions. As may be seen, in all cases the coefficient of two versions of G measure is positive, and all but low income group is significant at conventional levels. This last result seems to contrast with the previous analysis of low-income average G measure, however it is not enough evidence to refute the relationship.

Table 5 Competitiveness gains regressions

	all			
Countries	113			
Observations	3090			
	(a)	(b)	(a)	(b)
G^{adj}	.4361			
	(6.66)			
G		.4183		
		(6.41)		
G^{*adj}			.3913	
			(5.94)	
G^{*}				.3755
				(5.72)
S_{-i}		3.5082		3.6125
		(3.73)		(3.83)
const	-.0151	-3.4917	-.0170	-3.5970
	(-4.02)	(-3.74)	(-4.51)	(-3.85)
F-statistic	44.36	29.44	35.27	25.24

Each row corresponds to a competitiveness gains regression.
(a) and (b) correspond to empirical specification (22) and (23), respectively. G measure is computed by (20) and G^* by (21). G^{adj} and G^{*adj} are previous G measures multiplied by S_{-i}. See text for more details. The numbers in parentheses are t-statistics

Table 6 Competitiveness gains regressions

	H		M		L	
Countries	26		51		36	
Observations	720		1395		975	
	(a)	(b)	(a)	(b)	(a)	(b)
G^{adj}	.8633		.6638		.0238	
	(8.57)		(8.30)		(0.17)	
G		.7953		.6378		.0191
		(7.95)		(8.13)		(0.13)
S_{-i}		1.4475		17.7707		19.5989
		(3.07)		(6.80)		(2.20)
const	-.0230	-1.4128	-.0060	-17.7284	-.0393	-19.6161
	(-2.97)	(-3.10)	(-1.28)	(-6.80)	(-4.16)	(-2.21)
F-statistic	73.48	41.89	68.87	58.18	.03	2.44

H, M, L denote high, middle and low income group,respectively.
Each row corresponds to a competitiveness gains regression.
(a) and (b) correspond to empirical specification (22) and (23), respectively. G measure is computed by (20) and G^{adj} is previous G measures multiplied by S_{-i}. See text for more details.
The numbers in parentheses are t-statistics

A second important result is that the constant of the regression could be interpreted as a critical value for growth rate of export market share. Note in first regression of Table 5 that if G value is null -that means there is no competitiveness gain for economy j with respect to remaining economies- then, it is result in a loss of market share -i.e. a negative long-run growth rate-. Then, a threshold for G is computed using the regression results. In fact, from first regression values,

$$G_{j,-j}^{th(reshold)} = \frac{0.0151}{0.4361 \times S_{-j}} = 0.0346 \frac{1}{S_{-j}}.$$

For example, if economy j have a initial market share of 1 per cent, G^{th} is equal to 0.0349. Considering expression (20) of G measure, this mean that economy j has lost market share if its growth rate of TFP has been under $g_{B_i}^{th} = 0.0349 + \sum_{j \neq i}^{J} S_j g_{B_j}$. In fact, the weighted average of estimated TFP growth rate for all sample in 1961 was 0.0157, consequently, the required TFP growth rate was over 5 per cent.

5 Conclusions

Empirical works on competitiveness have not often a theoretical foundation. Some of them offer a variety of competitiveness measures without a clear sense about what they mean or, on a contrary, confuse competitiveness with market performance when the more useful approach is consider these like cause and effect, respectively. The aim of this paper was to propose a long-run macroeconomic approach and a operative concept of competitiveness gains. To fulfill with *operationality* condition, it has been presented a formal frame, a measurement procedure, and we have tested the external consistency of the model.

Our theoretical model is based in a equilibrium solution of a bisectoral growth model, and display a relationship between competitiveness gains and export market performance. Competitiveness gains measure emerges from there as the difference between the TFP growth rates of domestic economy and competitor. In case of a market with J economies, the growth rate of TFP taking for the last is the weighted average of growth rates of TFP with the initial market share as the weight. Moreover, if it is possible to divide competitors between groups of similar economies, then it is possible to define a competitiveness gains measure that look at the effects of the intragroup differences in the competitive performance of the domestic economy.

Then, our empirical exercise confronts the theoretical relationship with the data and show, firstly, evidence in favor of this approach. In all but low income group of countries results suggests that economies with better performance in terms of productivity growth with respect to the competitors will tend to experience faster growth of its export market shares. In second place, it is possible to compute a threshold of G measure and, hence, a threshold of TFP growth, with a strictly positive values.

Despite of previous finds, issues related to causality are still somewhat open, and will require a more complex empirical work what transcends the objectives of present paper. Other issues are somewhat open, some related with measurement procedure, i.e. the use of aggregate data in spite of sectorial one to produce estimated growth rate of TFP, the value of G measure computed after controlling intragroup similarity and intergroup differences of countries is sensible to grouping criterion, and the empirical work could be been affected for omitted variables. The later could be a possible trend to puzzle out the low income group behavior.

Nevertheless, we do believe that these results are persuasive and, principally, auspices. Our approach introduces a formal frame to discuss macroeconomic issues of competitiveness and a justified measurement procedure with possibility to improve. In this sense, further understanding on the source of competitiveness require to connect deeply our theoretical G measure with the principal components of the set of characteristics that define the ability to compete. Thus far this set was represented or resumed by total factor productivity, henceforth we consider necessary to move forward linking competitiveness gains with a theory of total factor productivity.

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