TARIFFS ON IMPORTS AND GROWTH IN DEVELOPING ECONOMIES: A U-SHAPED LINK?

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1. Introduction

The impact of trade policy on growth remains a central issue in development economics. After the disappointing results of the import-substitution policies pursued in many developing economies, the prevailing view in academic circles and major international organizations is that a progressive reduction of trade barriers should be a typical component of political reforms aimed to strengthen the growth process. Unfortunately, while globalization and its influence on welfare and development lie at the centre of the political and economic debate, empirical evidence seems not to offer clear conclusions about the merits or dangers of trade liberalization policies. A large number of contributions claim that lower trade barriers are associated to higher growth rates[1]. However, a more skeptic view has recently emerged: Harrison and Hanson (1999) and Rodriguez and Rodrik (2000) critically discuss the empirical literature and affirm that the existence of a relationship between trade barriers and development is far from being clearly established, as the openness variables commonly used in econometric either have no robust relationship with growth or cannot be interpreted as trade policy indicators. Results contained in contributions specifically devoted to developing economies (which are the focus of this paper) appear controversial as well; to mention a few contributions, according to Dollar (1992) and Edwards (1992) growth is clearly higher in less protectionist countries, in Greenaway *et al.* (2002) the effect of trade liberalization is still positive but

[1]. To give just a few references, Lee (1995) finds that higher trade distortions negatively affect long run growth; in a well-known paper Sachs and Warner (1995) use different variables in order to build a general "openness" indicator which turns out to be positively and significantly related to growth; in Sala-I-Martin (1997) the Sachs and Warner's dummy variable itself is the only openness indicator passing a severe robustness test; Edwards (1998) considers separately a wide range of indicators and similarly concludes that more open economies experience better growth performances.

substantially modest, while Yanikkaya (2003) finds that higher growth is associated to higher trade barriers.

Differences in samples and estimation methods as well as the lack of good quality and internationally comparable data partly explain the inconclusiveness of the empirical literature. An alternative explanation, which will be tested here, is that commonly specified regressions suffer from a serious misspecification bias: the lack of robust results may derive, in particular, from the common and inappropriate imposition of a linear (or log-linear) relationship between trade policy and growth, whereas theory suggests that such a link may be non-linear and (more importantly) even non-monotonic. In the model studied by Rivera-Batiz and Romer (1991) the balanced path growth rate depends in a non-monotonic (U-shaped) way on the level of an "*ad valorem*" tariff on the imports of a set of intermediated goods. In a similar theoretical framework Baldwin and Forslid (1999) show that the growth impact of both "*ad valorem*" and specific tariffs affecting the imports of intermediated goods is again non-monotonic (but U-shaped in the former case and bell-shaped in the latter). Rodriguez and Rodrik (2000) sketch a simple two-sector growth model, where the relationship between the level of trade barriers and growth is again non-monotonic (but do not consider the potential role of non-linearities in the empirical part of their paper).

Though these models usually rely on strong simplifying assumptions (equally developed economies, symmetric levels of trade protections, etc.) and have to be developed further, their implications for empirical work might be serious: regressions not taking into account the possible influence of non-monotonic effects of tariffs on growth are likely to be misspecified and to suggest misleading conclusions. The empirical relevance of the non-monotonicity result is tested here considering a trade policy indicator which is widely used in recent econometric work but seems to exert no influence on growth: the "*ad valorem*" tariffs on imported intermediate and capital goods taken from the Barro-Lee database[2]. It will be shown in this paper that, once non-linearities and certain technical aspects of the regressions have been taken in due account (such as an appropriate choice of the period over which

[2]. Edwards (1998) notes that regressors introduced to capture possible non-linear effects of trade policy may be significant but does not develop this issue further. To my knowledge, Baldwin and Sbergami (2000) have been the first to investigate explicitly the issue of non-linearities in the trade and growth link. They find that, for a certain number of openness indicators usually considered in the recent literature, taking into account non-linear effects allows to detect significant relationships that would not appear in purely linear fits; however, not differently from earlier contributions, they do not find any significant link between growth and two of the most direct trade policy measures they consider: the "*ad valorem*" tariffs and quotas (on the imports of intermediate and capital goods) taken from the Barro-Lee database.

growth rates are computed and a careful treatment of outliers), a significant link actually emerges between the tariff rate and the growth performance of a sample of developing economies; this link, coherently with what suggested by theory, is non-monotonic and U-shaped.

The paper is organized as follows. Section 2 recalls the theoretical framework which is the basis of the specified regressions; Section 3 presents data and contains econometric results for a sample of developing countries, while Section 4 briefly summarizes and concludes.

2. The theoretical framework

In Baldwin and Forslid's (1999) paper, which will be taken as the underlying theoretical basis for the empirical part of the present paper, the long run equilibrium growth rate g is shown to be[3]:

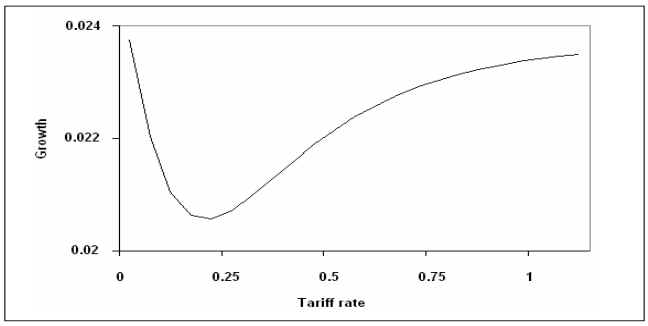
$$[1] \qquad g = \frac{2\alpha M(L/a) - \rho[1 - \alpha(\eta + M)]}{(1 \quad)}$$

where L is the total labour force (supposed to coincide with total population), a is an inverse measure of the efficiency of labour employed in the research sector, α and ρ are parameters describing respectively technology and preferences, and finally η and M are (non-monotonic) functions of the tariff rate (on the imports of a set of intermediate goods), such that the general link between the tariff rate and growth is U-shaped (provided that only "*ad valorem*" tariffs are imposed). The intuition behind the non-monotonicity outcome is that (reciprocal) reductions in the tariff rate have opposite effects on domestic and foreign sales; as a consequence the impact upon profits and thus the returns from the investment in the research sector (which, expanding the set of available intermediate goods, is the engine of the growth process) depends on the initial protection level. A symmetric increase in the tariff rate on the one hand affects positively local sales, while on the other hand reduces both foreign sales and the profit margin on exports for any given of foreign sales. If the initial tariff rate is sufficiently high, the positive effects on local sales prevails, as foreign sales are not quantitatively important; the opposite happens at low protection levels.

[3]. There is a slight difference respect to the growth equation actually obtained in Baldwin and Forslid (1999); this difference is discussed in Appendix 1, which contains a short description of the model.

Fig. 1 is based on a numerical solution of the long run growth rate derived in Eq.[1] for a given set of parameters[4]. The turning point of the curve linking tariffs and growth is affected by the size of the elasticity of substitution.

Fig. 1 – Non-linearities in the tariff-growth link



For $\sigma = 8$ (as in Fig. 1) the critical tariff rate corresponds to about 19%; this is, contrary to what found in Rivera-Batiz and Romer (1991), a completely plausible value. Obviously, it remains an open issue to understand which assumptions on parameters are more realistic; nevertheless this numerical exercise suggests that the possibility of a non-monotonic relationship really deserves more attention and should not be discarded *a priori*[5].

3. Data and econometric results

[4]. The chosen parameter values are: $\alpha = 0.3; L/a = 0.8; \rho = 0.05; \sigma = 8.$ It is easy to show that the growth minimizing tariff rate is the solution to the (non-linear) equation: $\tau M(\sigma - 1) = 1.$

[5]. A possible reason explaining why the non-monotonicity outcome does not seem to have received great attention in the empirical work of the 1990s is that Rivera-Batiz and Romer (1991) themselves thought that it has no practical relevance: according to their numerical solution of the model, the critical tariff rate beyond which trade protection could have a growth promoting effect is too high and not plausible, while for realistic tariff rates growth is monotonically decreasing in the level of trade protection.

In order to estimate Eq.[1], the following growth regression is specified:

(I) $LGNP15 = a_0 + a_1 LGNP + a_2 LIFEXP + a_3 LPOP + a_4 LTTAR + + a_5 LTTAR2 + a_6 X + \text{error term}$

where LGNP15 is the average annual per-capita income growth rate between 1980 and 1995; LIFEXP, life expectancy at birth in 1980, is the proxy for human capital which should positively affect the efficiency of the research sector and then the growth rate; LPOP is the population level in 1980, to test the presence of the scale effect implied by the model. The variable LTTAR is defined as log(100**t*), that is the logarithm of the percentage tariff rate *t* on imported intermediate and capital goods, while LTTAR2 is simply its square value; as in Baldwin and Sbergami (2000), this quadratic term is introduced to capture the non-linear and non-monotonic effect of tariffs on growth. In practice, with respect to the equilibrium growth rate reported in Eq.[1], LIFEXP and LPOP capture the effect of the term *L/a*, LTTAR and LTTAR2 represent the influence of the tariff rate, while parameters α and ρ are implicitly supposed to be country invariant. The specified regression contains also the variable LGNP, the per-capita income level in 1980 (to test for the presence of conditional convergence) and X, a set of control variables. Control variables include LBMPA, the black market premium averaged over the 1980s (an index of macroeconomic distortions which should negatively affect growth), as well as EASTASIA and LATAM, the same two geographical dummy variables for East Asia and Latin America already considered in the mentioned empirical work by Harrison and Hanson (1999) and Rodriguez and Rodrik (2000).

Data about LGNP, LGNP15 and LIFEXP come from the World Bank's "*World Development Indicators 2000*", while I take statistics about tariffs on imported intermediates and the black market premium from the Barro-Lee (1994) database. The availability of data for these variables is such that the total sample is composed by 56 countries. The complete list of countries and details about data are contained respectively in Appendix 2 and Appendix 3.

The period over which the income growth rate has been computed is 1980-95, the implicit assumption being that the tariffs from the Barro-Lee (1994) database (which refer to the years 1985-88)[6] are a good proxy of the average international differences in trade protection over that period. This seems a less strong assumption than that made in Baldwin and Sbergami (2000), where the growth rate is related to the period 1960-89. Harrison and Hanson (1999) raise the same criticism discussing the paper by Sachs and Warner (1995) and

[6]. See Sachs and Warner (1995) for details.

noting that: «*Sachs and Warner use end-of-period averages to test average period growth rates*» which could mean that differences in trade policy barriers have not been adequately measured; Rodriguez and Rodrik (2000) discuss the same point and choose to compute the growth rate over the period 1980-94.

Before commenting regression results, it is very important to take a look at data on tariffs through usual sample statistics (reported in Tab. 1).

Tab. 1 – Univariate statistics

	N = 56 (India included)				**N = 55 (India excluded)**			
	Mean	**Std.Dev.**	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Tariff rate	0.228	0.188	0.013	1.319	0.209	0.116	0.013	0.482

These reveal that the protection rate of India is extremely far from the mean: its reported level of average tariffs on intermediates is 1.319, whereas the mean and the standard deviation of the tariff rate are 0.228 and 0.188 (or, respectively, 0.209 and 0.116, if India is excluded from the sample); none of the other countries in the sample has a tariff rate higher than 50% (as a matter of fact, the second highest tariff rate level is that of Burkina Faso, 0.482, and the lowest that of Oman, 0.013). As such an anomalous value might significantly affect estimates; regressions have been estimated both including and excluding India from the sample. Further, I systematically check for the possible influence of other outliers, excluding countries whose residuals in the base regression are "excessively" large.

I start in Tab. 2 from the estimate of the growth model for the general sample of 56 countries, including LTTAR but not the quadratic term LTTAR2 (regression [2.1*a*]); this is the usual OLS specification common to most empirical papers which does not allow for non-monotonic effects.

Tab. 2 – Tariffs and growth in developing countries. Dependent variable: LGNP15 (average per-capita income growth 1980-95)

Regr. n.	**[2.1*a*]**	**[2.1*b*]**	**[2.1*c*]**	**[2.2*a*]**	**[2.2*b*]**	**[2.2*c*]**

C	-1.416	-1.376	-1.279	-1.234	-1.304	-1.264
	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]
LGNP	-0.011	-0.011	-0.009	-0.011	-0.014	-0.013
	[.019]	[.004]	[.004]	[.007]	[.000]	[.000]
LIFEXP	0.136	0.130	0.120	0.125	0.131	0.127
	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]
EASTASIA	0.023	0.034	0.027	0.028	0.027	0.027
	[.063]	[.000]	[.001]	[.014]	[.000]	[.000]
LATAM	-0.017	-0.015	-0.017	-0.011	-0.011	-0.012
	[.007]	[.011]	[.003]	[.092]	[.082]	[.050]
LPOP	0.001	0.002	0.002	0.000	0.001	0.001
	[.639]	[.261]	[.209]	[.909]	[.585]	[.665]
LBMPA	-0.009	-0.008	-0.010	-0.007	-0.008	-0.007
	[.004]	[.002]	[.000]	[.005]	[.002]	[.002]
LTTAR	-0.003	0.001	0.000	-0.034	-0.032	-0.033
	[.663]	[.849]	[.976]	[.004]	[.003]	[.002]
LTTAR2				0.006	0.006	0.006
				[.006]	[.005]	[.003]
N. obs.	56	53	50	56	53	52
R^2 (adj.)	0.487	0.694	0.702	0.560	0.696	0.717
JB test	19.142	0.953	1.603	15.425	1.603	1.107
	[.000]	[.621]	[.449]	[.000]	[.449]	[.575]
Ramsey test	1.076	0.855	1.983	0.433	0.635	0.764
	[.300]	[.355]	[.159]	[0.511]	[0.425]	[0.382]
Estimated critical tariff rate				0.139	0.181	0.178

(1) OLS estimates. "P-values" reported below coefficients and test values are based on heteroskedastic-consistent standard errors. *(2)* The Jarque-Bera (JB) test, distributed as a χ^2 with 2 d.f., tests for the null hp. of normally distributed residuals. *(3)* The Ramsey test, distributed as a χ^2 with 1 d.f., tests for correct functional form.

The coefficients have generally the expected sign: income growth over the period is negatively related to the initial income level, to the black market premium and to the tariff rate level, while it is positively correlated to life expectancy at birth and to population size; also, the growth performance over the considered period has been higher than the average for

East Asia, while the opposite holds for Latin American economies. However, the Jarque-Bera test clearly rejects the null hypothesis of normally distributed residuals, which makes inferences unreliable. It turns out that this is mainly due to some influential observations. In particular, I define as outliers (and exclude) those observations whose residual is larger than 2 or, alternatively, 1.5 times the estimated standard error of regression [2.1*a*]; the results obtained excluding these units correspond respectively to regressions [2.1*b*] and [2.1*c*] (the list of countries excluded from each regression is reported in Appendix 4). As it may be seen, the Jarque-Bera test does not reject any more the null of normally distributed residuals in regressions [2.1*b*] and [2.1*c*], so that the usual inference tests provide now reliable information. It may also be seen that removing outliers considerably increases the explanatory power of the regression (the adjusted R^2 jumps from about 0.49 in regression [2.1*a*] to 0.7 in regressions [2.1*b*] and [2.1*c*]). The results of regressions [2.1*b*] and [2.1*c*] are qualitatively similar. Respect to regression [2.1*a*], the coefficient of LTTAR is now positive but completely far from statistical significance, implying the absence of any link between tariffs and growth. The coefficients of the other regressors have again the expected sign and reach standard levels of significance (the only exception is the coefficient of LPOP, which may be interpreted as evidence against the presence of scale effects).

The main conclusion of this first group of regressions is that tariffs on imports intermediates and capital goods seem to exert no impact upon growth, which is coherent with previous empirical literature considering the same trade policy indicator. Though the Ramsey test in regressions [2.1*a*] to [2.1*c*] never rejects the null hypothesis of correct functional form[7], theory suggests that the preceding regression might be misspecified, as it does not allow for non-monotonic effects in the tariffs and growth relationship. In order to check whether this is the case, the quadratic term LTTAR2 is introduced into the second group of regressions ([2.2*a*] to [2.2*c*]).

In regression [2.2*a*] usual significance test are again not informative, as residuals are drawn from a not normal distribution; however, once outliers have been excluded according to the procedure outlined above, the Jarque-Bera test is no more significant. It is straightforward to see that the signs of the estimated coefficients of LTTAR and LTTAR2 are coherent with the theoretical prediction of a non-monotonic U-shaped relationship between tariff rates and growth and reach a strong statistical significance level (while the results for the other regressors do not change qualitatively). So the inclusion of the quadratic term implies completely different conclusions about

[7]. Note however that it is not far from statistical significance in regression [2.1*c*].

the existence of a link between trade policy and growth, with protection harmful to growth at low tariff rate levels, but resulting growth enhancing beyond some "critical" point (a tariff rate of about 18% according to these estimates), which is exactly what the simple theoretical model predicted.

In order to check whether these results are driven from the extremely high tariff rate level of India (which is never individuated as an outlier in the regressions of Tab. 2), I replicated the same estimation procedure excluding India from the starting sample (which is now composed by 55 countries). The results are presented in Tab. 3 and are absolutely coherent with those of Tab. 2: a statistically significant (and non-monotonic) link between tariffs and growth emerges only once a quadratic term has been introduced into the regressions, implying that trade policy actually exerts an influence on growth and that the size and the sign of this impact depend on the protection level itself (in this case the estimated critical tariff rate is a bit lower than before and approximately equal to 15%). The results concerning the other coefficients are similar to the preceding ones, the only exception being represented by the dummy variable for Latin America which loses significance.

Fig. 2*a* and Fig. 2*b* report the scatter diagrams of the observed tariff rate levels and "unexplained" growth (that is, the residual of a first stage regression in which growth is regressed on all the regressors but the tariff rate). Fig. 2*a* makes immediately clear how anomalous the reported tariff rate of India is (India is represented by the isolated point at the right of the Fig.); the possible existence of a non-linear relationship between tariffs and growth seems a bit clearer in Fig. 2*b*, which has been obtained after having excluded India from the sample.

Tab. 3 – Tariffs and growth in developing countries (India excluded from the sample). Dependent variable: LGNP15 (average per-capita income growth 1980-95)

Regr. n.	**[3.1*a*]**	**[3.1*b*]**	**[3.1*c*]**	**[3.2*a*]**	**[3.2*b*]**	**[3.2*c*]**

C	-1.377	-1.439	-1.259	-1.236	-1.305	-1.196
	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]
LGNP	-0.011	-0.013	-0.009	-0.011	-0.014	-0.014
	[.019]	[.004]	[.004]	[.006]	[.000]	[.000]
LIFEXP	0.134	0.139	0.119	0.125	0.131	0.120
	[.000]	[.000]	[.000]	[.000]	[.000]	[.000]
EASTASIA	0.024	0.029	0.028	0.028	0.027	0.029
	[.047]	[.004]	[.001]	[.015]	[.000]	[.000]
LATAM	-0.016	-0.017	-0.017	-0.010	-0.010	-0.006
	[.009]	[.009]	[.003]	[.132]	[.118]	[.324]
LPOP	0.000	0.002	0.001	0.000	0.001	0.002
	[.875]	[.285]	[.337]	[.920]	[.414]	[.234]
LBMPA	-0.008	-0.009	-0.009	-0.008	-0.008	-0.008
	[.008]	[.004]	[.001]	[.002]	[.001]	[.001]
LTTAR	-0.003	-0.005	-0.001	-0.041	-0.039	-0.045
	[.591]	[.335]	[.864]	[.002]	[.000]	[.000]
LTTAR2				0.008	0.007	0.008
				[.004]	[.001]	[.000]
N. obs.	55	52	49	55	52	51
R^2 (adj.)	0.485	0.650	0.696	0.558	0.700	0.726
JB test	16.434	1.055	1.640	15.527	1.976	2.892
	[.000]	[.590]	[.440]	[.000]	[.372]	[.236]
Ramsey test	1.244	0.730	1.919	0.791	1.460	1.660
	[.265]	[.393]	[0.166]	[0.374]	[0.227]	[0.198]
Estimated critical tariff rate				0.127	0.153	0.144

(1) OLS estimates. "P-values" reported below coefficients and test values are based on heteroskedastic-consistent standard errors. *(2)* The Jarque-Bera (JB) test, distributed as a χ^2 with 2 d.f., tests for the null hp. of normally distributed residuals. *(3)* The Ramsey test, distributed as a χ^2 with 1 d.f., tests for correct functional form.

Fig. 2a – Tariffs and growth (India included)

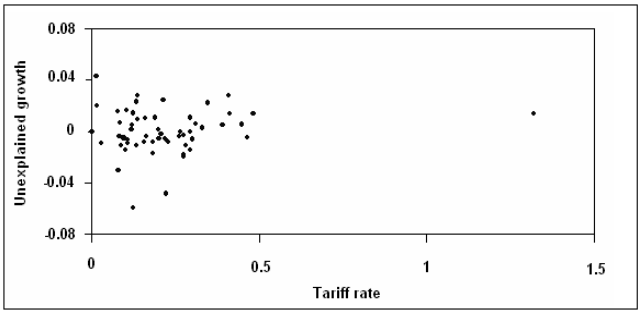
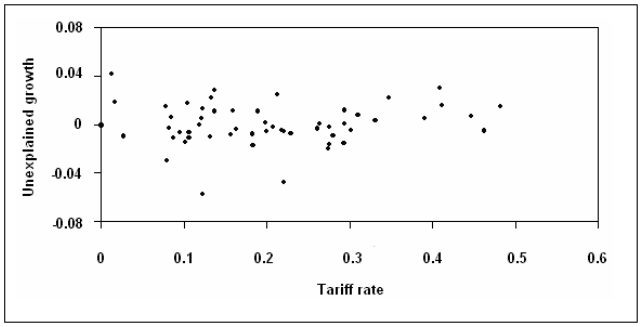


Fig. 2b – Tariffs and growth (India excluded)



The results concerning the black market premium, LBMPA, deserve some last comments. The choice to introduce this regressor is strictly related to the recent debate on openness and growth. Much of the criticism raised by Harrison and Hanson (1999) and Rodriguez and Rodrik (2000) about the Sachs and Warner's (1995) results concerns the fact that the partition between "open" and "closed" economies implied by the Sachs and Warner's dummy variable is substantially driven by the black market premium, which should be considered more appropriately as a variable reflecting macroeconomic distortions not necessarily related to trade policy choices; in Harrison and Hanson (1999) and Rodriguez and Rodrik (2000), once the black market premium is introduced into the regressions separately from the other trade policy indicators (including the tariff rates on imported capital goods), the latter cease to exert a significant impact upon growth. Results of Tab. 2 and Tab. 3 reveal that this is not the case, provided that the possibility of non-monotonic effects in the trade and growth link is accounted for[8].

[8]. Furthermore, results (not reported here) clearly indicate that the exclusion of the black market premium from the regression would not change the general result that the impact of tariff rates upon growth is significant and non-monotonic.

4. Summary and conclusions

Relatively recent contributions on trade and (endogenous) growth show that the link between openness and growth may be non-monotonic, and in particular U-shaped, if openness is measured by the "*ad valorem*" tariff rate on the imports of a set of intermediate goods. This could be a possible explanation of the empirical trade and growth puzzle, namely the absence of a significant and robust relationship between trade policy measures and growth. In this paper I discussed the empirical relevance of the theoretical non-monotonicity result on the basis of econometric estimates for a sample of developing economies.

The results of the empirical analysis conducted are actually coherent with the theoretical insights, indicating the existence of a U-shaped relationship between "*ad valorem*" tariff rates and growth rates, so that, provided that the tariff rate is sufficiently high, trade protection may even have a growth promoting effect. So the fragility of the available empirical estimates of the impact of trade policy on growth would be due to serious misspecification problems: the imposition of a linear fit to a non-linear and non-monotonic relationship.

Before definitive conclusions may be drawn, the robustness of these results should obviously be tested using new datasets on trade policy (possibly disaggregated by economic sector and available for many years). Nevertheless the results of this paper clearly indicate that future empirical research will have to take into account the possible existence of non-linear effects and in general to devote more attention to the specification of correctly and theoretically founded regressions linking growth to trade policy.

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Appendix 1. – The trade and growth model

Baldwin and Forslid consider a symmetric two country-model in which a final good Z is produced in a perfectly competitive market according to a Cobb-Douglas technology $Q_z = a_z L_z^{1-\alpha} Q_x^{\alpha}$, where L_z is labour, Q_x is a CES composite of a set of differentiated intermediate goods (supplied in a Dixit-Stiglitz monopolistic competition setting) with a constant elasticity of substitution σ. As in Romer (1990) and Grossman and Helpman (1991), a part L_I of the total labour force L is employed in a research (*I*-) sector, which has the task of discovering new varieties of differentiated (*X*-) goods; denoting by K and K^* respectively already existing home and foreign varieties of differentiated goods, it is assumed that:

$$\dot{K} = L_I/a_I$$

where $a_I \equiv a/(K + K^*)$ is the number of labour units required in the *I*-sector to introduce a new variety (and $a>L$), bearing a cost $F = wa_I$ (w, the wage rate, is also the numeraire, so that $w = 1$).

It follows that under symmetry ($K = K^*$) the growth rate is $g \equiv \dot{K}/K = 2L_I/a$. Differentiated goods in the *X*-sector are produced using labour (one unit of labour per unit of output) and their exports are subject to an "*ad valorem*" tariff rate *t*. Given preceding assumptions, Baldwin and Forslid show that nominal expenditures (which are time invariant due to the choice of the numeraire) are equal to:

$$E = (L - L_I)/\left[1 - \alpha(\eta + M)\right]$$

where:

$$M \equiv (1+\tau^{-\sigma})/\left[\sigma(1+\tau^{1-\sigma})\right] \;\; ; \;\; \eta \equiv (\tau^{1-\sigma} - \tau^{-\sigma})/(1+\tau^{1-\sigma}) \;\; ; \;\; \tau \equiv 1+t$$

and operating profits in the *X*-sector are $\pi = \alpha ME/K$. As the preferences of the representative consumer are represented by:

$$U = \int \log(c_t) e^{-\rho t} dt$$

where ρ is the individual discount rate and c_t represents consumption at time *t*, it then follows that the present value *V* of one unit of capital in the equilibrium is given by $V = \pi/(\rho + g)$. If P_K denotes the replacement cost of capital, equilibrium investment, according to the Tobin-q approach, is characterized by the condition $V=P_K$; in this context P_K is nothing but *F*, so the equilibrium condition is:

$$\frac{\alpha ME}{(\quad)K} = \frac{a}{2K}$$

so that in the long run we have:

$$L_I = \frac{2\alpha ML - \rho a\left[1 - \alpha(\eta + M)\right]}{2(\quad)}$$

and the growth rate is given by Eq.[1] in the text. The only implicit difference of these equations respect to Baldwin and Forslid (1999) is that they do not consider the constant term *a* (or, in other terms, they assume: $a = 1$); its inclusion, however, seems important for two reasons: on the one hand it is easy to see that the term *L/a*

has to be less than 1, in order to bound growth to reasonable values; on the other hand this constant, which measures the efficiency of the research sector, is probably not country invariant and should be explicitly modelled in the regression specification.

Appendix 2. – Data

Variable	Source	Definition
EASTASIA		Dummy var. equal to 1 for East Asian countries and to 0 otherwise
LATAM		Dummy var. equal to 1 for Latin American countries and to 0 otherwise
LBMPA	(b)	Black market premium averaged over the 1980s
LTTAR	(b)	Average tariffs on imported intermediates and capital goods
LTTAR2	(b)	Average tariffs on imported intermediates and capital goods (quadratic term)
LGNP	(a)	Per-capita GNP level in 1980
LGNP15	(a)	Average per-capita GNP growth (1980-1995)
LIFEXP	(a)	Life expectancy at birth in 1980
LPOP	(a)	Population size in 1980

All variables are in logs.
(a) World Bank, *World Development Indicators 1997*.
(b) Barro-Lee (1994).
LBMPA is actually the (log of the) simple average of the variables bmp5 and bmp6 of the Barro-Lee database.
LTTAR is referred to the period 1985-88; LTTAR2 is defined as (LTTAR)^2.

Appendix 3. – Countries (N = 56; Barro-Lee country codes)

1 Algeria	46 Zambia	81 Bangladesh
3 Benin	47 Zimbabwe	85 India
5 Burkina Faso	49 Barbados	86 Indonesia
6 Burundi	51 Costa Rica	87 Iran
7 Cameroon	54 El Salvador	92 Korea
9 Central African Rep.	56 Guatemala	93 Kuwait
12 Congo	57 Haiti	94 Malaysia

17 Ghana	59 Jamaica	95 Nepal
21 Kenya	60 Mexico	96 Oman
25 Malawi	65 Trinidad and Tobago	97 Pakistan
28 Mauritius	67 Argentina	98 Philippines
29 Morocco	69 Brazil	99 Saudi Arabia
32 Nigeria	70 Chile	100 Singapore
33 Rwanda	71 Colombia	101 Sri Lanka
34 Senegal	72 Ecuador	102 Syria
36 Sierra Leone	73 Guyana	104 Thailand
39 Sudan	74 Paraguay	109 Cyprus
43 Tunisia	77 Uruguay	134 Papua New Guinea
45 Congo DR (ex Zaire)	78 Venezuela	

Appendix 4. – Outliers excluded from regressions

Regr. n.	Congo DR	Chile	Bangladesh	India	Korea Rep.	Oman	Philipp.	Saudi Arabia	Cyprus
[2.1*a*]									
[2.1*b*]	*					*	*		
[2.1*c*]	*		*		*	*	*	*	
[2.2*a*]									
[2.2*b*]	*				*		*		
[2.2c]	*	*			*		*		
[3.1*a*]				*					
[3.1*b*]	*			*			*		
[3.1*c*]	*		*	*	*	*	*	*	
[3.2*a*]				*					
[3.2*b*]	*			*	*		*		
[3.2*c*]	*			*	*		*		*

Note: An asterisk indicates that a given country has been excluded from the regression corresponding to that column.