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Productivity and Economic Growth: The Case of Chile

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I Introduction

The crises that swept through Asia in late 1997 brought Chile's economic boom to an abrupt halt. Having grown at an average rate of 7.3% per year in 1984-97, the Chilean economy has expanded by under 3% a year since then. So what happened?

One answer, often put forward by the authorities, posits significantly worse external conditions as the basic explanation. As Chile is a small open economy, when the world economy slows the demand for its exports declines, leading to lower export prices and volumes. If the price of oil rises at the same time, this small open economy, which imports nearly all the oil it consumes, will suffer even more. Things will become still worse if net capital flows to emerging economies suddenly dry up.

Figure 1 plots the basic external variables affecting the Chilean economy for the period 1980-2001. Panel A shows world GDP growth using IMF data. Although a sharp economic slowdown is predicted for 2001, it is fair to say that the previous few years (particularly 1999 and 2000) were years of high growth for the world economy as a whole. Panel B shows Chile's terms of trade, defined as the price of its exports divided by the price of its imports, using data from the Central Bank of Chile. Although there has been a sharp decline in 2001, the terms of trade over the previous few years (1998-2000) were around their average level for the whole period. Net private capital flows to emerging markets are shown in panel C. These have clearly dropped off very sharply, badly hurting economies that are heavily dependent on external financing. This aspect of the situation is similar to most of the 1980s. Lastly, panel D shows the path of the international interest rate[1] over the last 20 years. This is a key variable since it affects the burden of the external debt; and also the cost of new borrowing in the case of countries with access to international capital markets (including Chile). As this panel shows, interest rates are at their lowest level for the whole period. Although not much attention is

[1] The 180-day US dollar LIBOR is used here.

paid to this variable, it is clearly moving in the opposite direction to the other variables mentioned, for lower interest rates are positive for a country like Chile.

The external scenario is clearly important in an emerging open economy like Chile. However, it is difficult to blame all the slowdown in Chilean economic growth over the last few years on this factor, for the following reasons: (i) The deterioration in external conditions came after Chile's economic slowdown had already begun. In fact, 1998-2000 were not bad years for the world economy, yet Chile grew by under 3% per year.[2] Average growth in the world economy for these three years was above the average for the last two decades. The same can be said about Chile's terms of trade: in 1998-2000 they were less than 1% below the average for the last 20 years. (ii) Although it is true that net private capital flows to emerging economies declined sharply as from 1996-1997 and were almost non-existent during the last couple of years, it can be argued that for any given country there is a degree of endogeneity in this variable. Chilean firms have been able to obtain financing abroad at relatively low interest rates during this period, and the government has issued new debt that has been readily accepted on the world capital market. Chile would thus appear to have access to the international capital market. Moreover, the most significant feature of the balance of payments in recent years has been a huge increase in capital outflows, as Chileans have increased their investments abroad. It could be argued that this has occurred because domestic interest rates (adjusted for country risk and expectations of devaluation) have been relatively low, or simply because there are not many investment projects in the country at the present time.

The final external variable, the international interest rate, has been quite favorable in recent years, with both nominal and real rates below their average for the 1980s and 1990s. The short-term rate has recently fallen to levels not seen in decades.

Of course, the second half of 2001 may turn out really bad for the world economy in the wake of September 11, particularly affecting the external conditions facing the

[2] In 2000 the world economy expanded faster than at any time since 1988.

Chilean economy. But even if this proves to be the case (we still do not know for sure), it will have nothing to do with the relatively poor performance of the Chilean economy over the last four years.

In short, although external conditions have clearly worsened, this provides only a partial explanation for the weak performance of the Chilean economy. Our impression is that the slowdown in economic growth can at least partially be reversed. This paper argues that the way to do this is by increasing the growth in total factor productivity (TFP). Chile’s golden age in terms of economic growth was explained by a strong expansion in TFP. This, in turn, is explained by the productivity effects of the reforms implemented in the 1980s and early 1990s. To some extent they have now been exhausted. Accordingly, what Chile now needs to reinvigorate economic growth is a new wave of reforms in areas were it has fallen behind — areas relating mainly to the “microeconomic foundations” of growth, namely institutions and the efficiency and efficacy with which they function. Another way to put it would be to say that new microeconomic reforms are needed to enhance the efficiency with which available resources are used.

If we view economic growth not as a linear process but rather as one marked by sporadic productivity shocks that lead to high growth for a period, before fading in convergence until the next productivity boost, then Chile would currently be in a phase in which the most recent productivity shock is contributing its last ammunition. If this is the case, the country needs a new shock to kick-start a new period of rapid economic growth. Of course this new boost could be luck — discovery of oil or a significant positive terms-of-trade shock, for instance. But, as luck is random we prefer to consider a new productivity shock arising from economic policy initiatives aimed at improving economic efficiency. We argue that improvements in these areas are likely to produce a new surge in economic growth in Chile. Furthermore, the deterioration in external conditions increases the need for policies to boost the country’s currently sluggish growth rate.

The paper is organized as follows. Section II presents some stylized facts on the Chilean economy, firstly analyzing the behavior of total factor productivity over the last several years. The conclusion is that we are currently going through a significant productivity slowdown. We then present a number of indicators of microeconomic efficiency for Chile, showing that while the country is highly ranked in many areas, elsewhere it is well below the average for countries of similar per-capita income levels. There is clearly room for upgrading Chile’s institutions, and doing so could generate a new productivity boom.

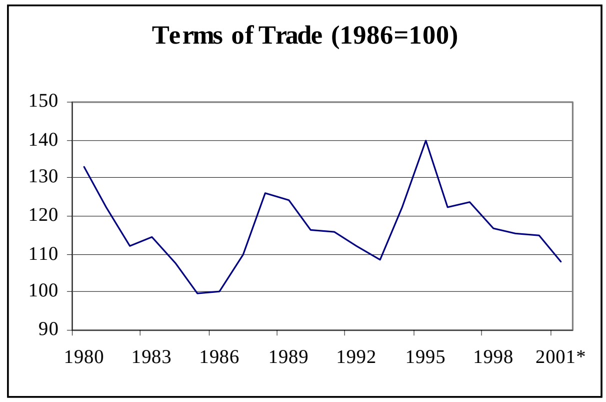
Section III develops a basic model along these lines, showing how TFP can surge when institutions are upgraded. In section IV we run cross-section growth regressions with TFP as the dependent variable. We construct several indicators of efficiency in institutions and examine their effect on growth, and we consider the potential effect on TFP in a country like Chile. Finally, section V presents conclusions.

Figure 1
External conditions facing the Chilean Economy

(a)

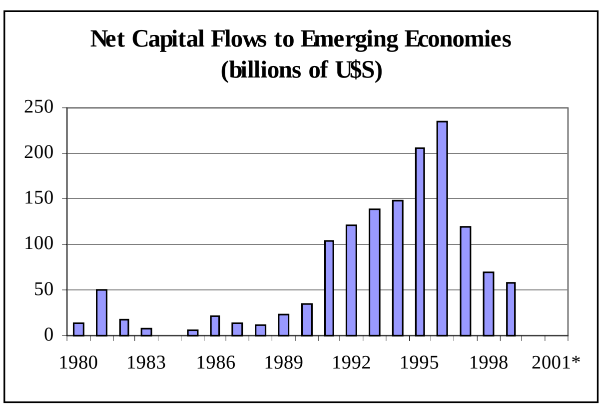
***** Estimated
Source: IMF

(b)



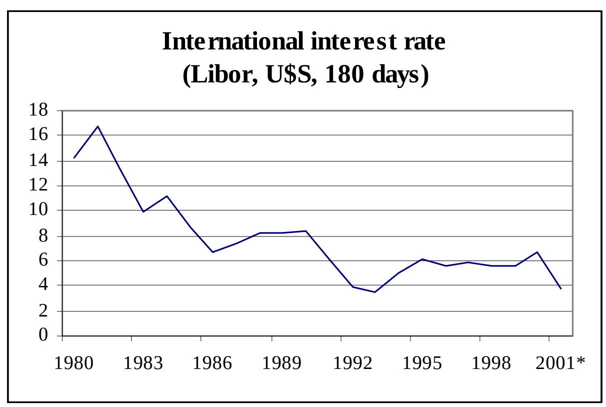
***** Estimated
Source: Central Bank of Chile

(c)



***** Estimated
Source: IMF

(d)



***** Estimated
Source: Central Bank of Chile

II TFP and microeconomic efficiency in Chile: some stylized facts

The central hypothesis of this paper is that Chile needs to upgrade its institutions if it wants another decade of high growth. Of course it could be argued that the country has already made all necessary reforms and has extracted all the benefits from them. This view would imply that Chile now has to get used to lower growth rates (say 4% per year); provided the country maintains its current level of institutions and pursues a prudent macroeconomic policy it could aspire to this level of economic growth. There are at least three problems with this argument. Firstly, while it is true that Chile's institutions function remarkably well in many respects, this is not the case across the board. There is significant room for improvement in many areas, as documented below. This makes it plausible to envisage a new wave of reforms to modernize the country's institutions and boost economic growth. Secondly, periods of high economic growth in many recent success stories[3] have lasted longer than in Chile. The fact that Chile enjoyed nearly a decade and a half of rapid economic growth in the 1980s and early 1990s is certainly remarkable; but there are several other countries — in Europe, Asia and elsewhere in Latin America — that have enjoyed two, three and even four decades of rapid GDP growth. Moreover, Chile's per capita GDP does not make it one of the leading economies in the world, so there is no reason to invoke a natural tendency towards slower growth rates. Finally, as we show below rich countries are able to keep reasonable rates of productivity growth in spite of their high levels of income per capita suggesting that good economic policies and good institutions are able to introduce some continuity in the growth in TFP.

According to most international rankings, Chile already has institutions that are efficient in an aggregate sense given the country's per-capita income.[4] But this does not mean that those institutions cannot be improved, especially if growth has come to a

[3] See, for instance, Maddison (2001)

[4] See, for example, the Global Competitiveness Report (2001) or the Index of Economic Freedom (2000).

relative standstill. Moreover, the same rankings show that Chile has not progressed in recent years but has stayed more or less in the same place. Most of these indicators have to be understand dynamically in the sense that once a specific place in the ranking has been achieved it doesn't give the country assurance of remaining in that place. The country will keep the place only if there is a continuous "lifting" of their policies and institutions. Therefore, it is possible to see a slowdown in productivity growth even in the absence of "absolute" deterioration in the institutional quality.

Total Factor Productivity

Table 1 presents data on TFP growth for Chile over the last two and a half decades. TFP is measured as the residual GDP growth that is not explained by labor or by capital accumulation. There are no input quality adjustments. A productivity boom occurred in the second half of the 1970s in the wake of the first wave of structural reforms; this was followed by the crisis of the early 1980s. Recovery began in the mid-1980s, when there was a second productivity boom (associated with a second wave of reforms) which reached its peak in the first half of the 1990s. In the second half of that decade, productivity growth slowed down once more, and over the last four years (1998-2001) TFP growth has been nil.

These calculations clearly show that the key difference between this latest period (1998-2001) and the previous fourteen years of high economic growth (1984-1997) is TFP growth. As Table 1 shows, capital's contribution to growth has been around 2.5 percentage points since the mid-1980s (1986-2000) and has not changed in recent years. On the other hand, labor's contribution to growth averages 1.3 points but has accounted for a declining share in recent years. This is explained by a significant increase in unemployment since 1998. Finally, as mentioned above, TFP rose from two to three percentage points before falling back to a figure close to zero.

Table 1
Chile: Components of Economic Growth

	GDP growth	Contribution of:		
		TFP	Labor	Capital
1976-1980	6.8	3.2	2.4	1.2
1981-1985	-0.1	-2.3	1.2	1.0
1986-1990	6.5	2.2	2.0	2.2
1991-1995	7.5	3.3	1.4	2.8
1996-2000	4.6	1.6	0.5	2.5
1998-2001*	2.9	0.4	0.1	2.4

*For 2001 the data are estimated.
Source: Roldós (1997) and own estimations for the last period.

Microeconomic efficiency

Several different variables have been used in the literature to capture a country's degree of microeconomic efficiency. In some of these indices, Chile is comparatively well placed compared to other developing countries, albeit well behind developed countries. In other indices, however, it lags behind countries of similar development level.

Djankov *et al.* (2000) present a data set on the time and cost involved in starting up a new firm. In terms of time, the process takes in Chile 78 days, ranking it 55th out of 75 countries — far behind countries like Canada (2 days), United States (7 days), or even South Africa (30 days). On this measure Chile is in a worse position that most countries of similar per-capita income. In terms of monetary costs (in relation to per-capita GDP) Chile ranks 25th at 12% of per capita GDP. This is good compared to a country such as Israel (20%) but much higher than in the US or Canada (1%), Australia and Norway (2%), or even Turkey (3%).

The Current Competitiveness Index published in the Global Competitiveness Report (2001) also provides information on microeconomic efficiency. This is an aggregate index intended to capture "an economy's effective utilization of its current stock of resources". The index is constructed from several variables, such as the number of permits needed and days taken to start up a new firm, bureaucratic red tape, and so forth. In terms of days taken to start up a new firm, Chile has more or less the same position as in the previous index (54th among 75 countries). In terms of permits, Chile ranks 35th with 5 permits, which is more than the UK (2), New Zealand (3) or the US (4), but less than Brazil (7) or Mexico (10).

Evans and Rauch (1999) study the effects of State bureaucracy on growth, considering in particular salary structure and policy, along with the procedures used for hiring top managers in public administration. They find that the more that public managers are hired on merit, and the more attractive their salaries, the higher the economic growth of the country concerned. Valdés (2001) uses the coefficients obtained by Evans and Rauch and finds that if the quality of Chile’s public administration had been equal to that of Hong Kong in 1970-1990, its growth rate would have been as much as 1.5 percentage points higher per year.

Kaufmann *et al.* (1999) construct a database with a number of variables on governance, including the regulatory framework. Here Chile ranks 18th among 145 countries, which puts it above most other countries of similar per-capita income, but well behind countries such as the US, the UK and New Zealand. Corruption is a variable that undermines the proper functioning of institutions. These authors also construct an index of corruption control, in which Chile is again well ranked (24 among 136) but still far behind the leaders. The index goes from +2.5 (the less corrupted) to –2.5 (the more corrupted). Chile has 1.03, which well above the mean but behind countries such as New Zealand (2.1), Canada (2.1) or the US (1.4).

Government spending

A somewhat different way to see this problem would be to assess the efficiency of government spending. During the 1990s there has been significant increase in government expenditure in Chile. While in 1990 the general government spending represented 22% of GDP, by the end of the decade the figure had climbed to 26.4%. The question that arises is whether higher government spending has resulted in more and better government services.

A recent study of the public health system by Rodríguez and Tokman (2000) shows that the growth of government spending has not generated a corresponding increase in the services produced in this sector. While government spending on health has risen by 190%, total services have increased by only 22%. This means that the productivity of expenditure has fallen by over 50%. Beyer (2001) calculates that if productivity were at its 1990 level, the public health system today could provide additional services worth about 1.5% of GDP.

Education

Human capital is one of the variables to have attracted most attention in the economic growth literature.[5] Barro (1999) applies his cross-section growth regressions to the Chilean case, and estimates that if the quality of education in this country were at a level compatible with its per-capita income, growth would be as much as two percentage points higher per year. Barro uses scores achieved in an international science test to measure education quality.[6] Although education is not one of the focus variables in this article, we are convinced that is one of the major forces behind economic growth. Moreover, measuring education quality through international examination scores clearly reveals this as an area in which Chile performs well below its development level. This suggests that growth could be significantly accelerated if education quality were improved. We return to this point in section 4.

The education budget grew from 2.5% of GDP in 1990 to 4.2% in 2000, but there have been no clear signs of any improvement in education quality. It is true that education is a long-run issue, but the emphasis seems to have been on throwing additional resources at this sector, rather than focusing on how to actually improve educational outcomes.[7]

[5] See Lucas (1988); Barro and Sala-i-Martin (1995); Barro (1991).
[6] See Barro R. and J.W. Lee (1997 and 2000).
[7] See Eyzaguirre and Fontaine (2001).

III The theoretical setup

This paper inserts itself in the tradition of endogenous growth. However we want to look a the process of economic growth from a slightly different perspective. We would like to focus our analysis mainly on TFP growth. In general, early growth studies started by considering an aggregate Cobb-Douglas production function with technological change so that growth in output could be expressed as a function of capital accumulation and labor accumulation. Under the assumption of perfect competition, the weights of the inputs were their respective shares. The resulting difference between output growth and the weighted input accumulation was called the residual.

These studies found that the unexplained part of output growth, the residual, was the most important element in explaining the growth rate of different countries. For example, Solow (1957) found that TFP explained a 52% of the growth rate of the US between 1909-1949. Denison (1967) estimated that for the period 1950-62, TFP explains 40% of the growth rate in the US, while in the case of a group of countries of Europe it contributed on average a 62%. These high rates of growth in TFP were immediately a source of debate in the profession. On the one hand, some pointed out that these early studies failed to recognize the heterogeneity of the different inputs (for example, Jorgenson and Griliches, 1971.) New estimates of TFP were carried out. Inputs were categorized by type, so that the growth of capital and labor became a weighted average of the growth of the different input types. The weights were the income shares of the different types of labor and capital in total labor and capital compensation, respectively. Hence, this procedure corrected by marginal productivity of the different input types. Using this corrected methodology, Jorgenson (1995) found that TFP accounted for only 21.6% of the growth rate of the US in the period 1947-85. Capital accumulation was the most important factor in explaining growth.

A second line of thought uses the evidence coming from these early studies to argue that there was something wrong with the neoclassical theory of growth. Economists argued that if the main source of economic growth was left unexplained, then we had no satisfactory theory of growth (for example, Romer, 1986). New models of growth were developed that were trying to deal with this problem. It was the origin of the endogenous growth literature. In Romer (1986) and Lucas (1988) the basic idea is that individuals do not internalize the externalities associated to the accumulation of knowledge. These so called AK (where K is broadly defined) models have strong implications. Among them that differences in savings rates among countries or in population growth may result in permanent differences in rates of economic growth which has the strong implication of no convergence in income per capita among countries. On a different issue these models although they have endogeneized growth rely on exogenous accumulation of knowledge.

The constant marginal product of capital and the (conditional) divergence in income per capita is however not possible to sustain empirically. Although the empirical growth literature (for a revision see Barro and Sala-i-Martin, 1995) tends to support the endogenous growth theory, it also shows that there is conditional convergence and diminishing returns to capital. The failure of the AK models to predict adequately these facts have lead to a revision of these early endogenous models. The augmented Solow model of Mankiw, Romer and Weil (1992) fits more adequately the data. The basic model is augmented to include human capital. Their empirical results are consistent with decreasing returns to capital and a slow convergence to the steady state. Moreover the model is able to reconcile large differences in output per capita once differences in savings rate and population growth are accounted for: a clear improvement on the basic Solow model.

Although the augmented Solow model does a much better work in fitting the actual data that the basic model and the AK models, it has an evident shortcoming. In the steady state the growth rate in income per capita is defined by the rate of technological change which is exogenously determined and therefore unexplained. An important amount of effort has been put in trying to understand the forces behind the rate of technological progress. The most successful in this line of research have been those linked to the

Schumpeterian tradition of growth through creative destruction. In the basic model (see Aghion and Howitt, 1992) succeeding vintages of intermediate goods embody quality improvements which render their predecessor obsolete. These quality improvements are a source of economic growth but they are the result of an uncertain research process leading to a stochastic growth. The possibility of monopoly profits introduce incentives to hire labor for research instead of hiring it for the manufacturing of the latest generation of intermediate goods. In the steady state equilibrium the division of labor between research and manufacturing remains unchanged although given the nature of research activities growth is stochastic. The average growth rate in this steady state equilibrium depends on the propensity to save, the productivity of the research technology and the degree of market power enjoyed by a successful innovator.

These models are complementary in nature and allow us to build a general framework to approach the discussion we are interested in. Conceptually and following closely Mankiw et. al. (1992). We can think of the level of GDP as determined by:

$$Y(t) = K_t^{\alpha} H_t^{\beta} (A_t L)^{1-\alpha-\beta}$$

where K, H, and L represent physical capital, human capital, and basic labor respectively. As usual α is the partial elasticity of output with respect to K, and β is the partial elasticity of output with respect to H. A(t) will be assumed to have two components: the level of economic efficiency (E(t)) that depends on the quality of economic policies and institutions, and the level of technological progress $\Phi(t)$. We further assume that E(t) can be written as a log linear function of economic policies and institutions, and that $\Phi(t)$ grows at an exogenous rate g(t)[8]. Making the usual assumptions about the dynamics of K and L we have the following system:

[8] This rate of technological growth could eventually be "endogeneized" by assuming, for example, that it is the result of intentional investment in R&D of profit seeking firms. These firms invest in R&D to capture "monopoly rents" associated to a product innovation.

$$
\begin{aligned}
&\dot{K}(t) = s_K Y(t), \\
&H(t) = s_H Y(t), \\
&\dot{L}(t) = nL(t), \\
&A(t) = E(t)\Phi(t), \\
&\ln E(t) = \lambda_o + \textstyle\sum_i p_i \ln I_i(t), \\
&\dot{\Phi}(t) = g(t)\Phi(t).
\end{aligned}
$$

where the I_i stand for the different policies we are interested in. Defining k, h, and y as K/ΦL, H/ΦL, and Y/ΦL, respectively, we can write the first two equations of the former system as follows:

$$
\begin{aligned}
\dot{k}(t) &= s_k E(t)^{1-\alpha-\beta} k(t)^{\alpha} h(t)^{\beta} - (n+g)k(t) \\
\dot{h}(t) &= s_h E(t)^{1-\alpha-\beta} k(t)^{\alpha} h(t)^{\beta} - (n+g)h(t)
\end{aligned}
$$

Solving for the steady state values of physical capital and human capital we get the following expressions:

$$
\begin{aligned}
\ln k^* &= \frac{1-\beta}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h + \ln E(t) - \frac{1}{1-\alpha-\beta}\ln(n+g) \\
\ln h^* &= \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{1-\alpha}{1-\alpha-\beta}\ln s_h + \ln E(t) - \frac{1}{1-\alpha-\beta}\ln(n+g)
\end{aligned}
$$

The level of income per capita in this steady equilibrium is as follows:

$$
\ln y^* = \ln E + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g)
$$

Note that the level of income per capita in the steady state equilibrium is influenced by the quality of economic policies and institutions[9]. Of course, this last specification would be valid only if countries are in their steady state. Since this is not the case the

[9]We have dropped the time subscript from the variable associated to the quality of economic policies and institutions which indicates that we are assuming that they do not change persistently in the long run.

dynamics ha to be modeled explicitly. If we consider the production function defined earlier and the equations of motion for k and h, it is possible to take log linear first order Taylor approximation around ln k* and ln h* (i.e. the steady state values of h and k) to obtain the following balance growth path:

$$\frac{d[\ln y(t)]}{dt} = -(1-\alpha-\beta)(n+g)[\ln y(t) - \ln y^*]$$

which shows that y converges to y* at rate (1-α-β)(n+g). This is a differential equation with the following solution

$$\ln y(t) - \ln y^* = e^{-(1-\alpha-\beta)(n+g)}[\ln y(0) - \ln y^*]$$

which implies that y approaches y* exponentially. To find an expression for the growth in income per capita we add ln y* - ln y(0) to both sides producing the following growth equation:

$$\ln y(t) - \ln y(0) = (1-e^{-(1-\alpha-\beta)(n+g)t}) \cdot \ln y^* - (1-e^{-(1-\alpha-\beta)(n+g)t}) \ln y(0)$$

where $(1-\alpha-\beta)\cdot(n+g)$ determines the speed of convergence and indicates how rapidly an economy's output per capita, y, approaches its steady-state value, y*. The starting level of income per capita is given by y(0). Since we got before an expression for ln y* we can substitute it in the previous equation to obtain the following equation.

$$\begin{aligned} \ln y(t) - \ln y(0) = {} & (1-e^{-(1-\alpha-\beta)(n+g)t}) \cdot (\lambda_o + \textstyle\sum_i p_i \ln I_i(t)) + (1-e^{-(1-\alpha-\beta)(n+g)t}) \frac{\alpha}{1-\alpha-\beta} s_k \\ & + (1-e^{-(1-\alpha-\beta)(n+g)t}) \frac{\beta}{1-\alpha-\beta} s_h - (1-e^{-(1-\alpha-\beta)(n+g)t}) \frac{\alpha+\beta}{1-\alpha-\beta} \ln(n+g) \\ & - (1-e^{-(1-\alpha-\beta)(n+g)t}) \ln y(0) \end{aligned}$$

Eventually this function could be empirically estimated. We choose however a different approach. We are specifically interested in the growth of total factor productivity. The growth in TFP is a more natural framework to think about economic policies and institutions. The argument behind is that the contribution to economic growth of similar rates of accumulation in physical capital or human capital accumulation will differ across countries if their economic policies and institutions also differ. In the early empirical studies of growth the effect of these variables were captured in the so called residual. Researchers were aware of the fact that this residual was the result of omitted factor influencing the growth process. Indeed they knew that exogenous technological progress was a convenient way of expressing the output growth due to factors unrelated with the accumulation of inputs. For example, Denison (1967), broke down the residual obtained in his growth estimation in several components. Among them, advances in knowledge, improved allocation of resources and economies of scale. These concepts are fully integrated in the modern endogenous growth models. As Solow (1994) points out “the idea of technological progress was never far below the surface.”

The lack of formal models and adequate data to test them were important factors behind the slow move towards an endogenous theory of economic growth. We may add to the picture the widespread impression that the residual was the outcome of several factors none of them most important than the other. As Harberger (1990) puts it: the residual is better understood in terms of reduction in real costs. In this definition almost anything fits.

This theoretical debate has increased the interest in the empirical studies on economic growth. Our study is no exception in that trend. But it does relate only indirectly to a theoretical framework like the one described above. Since we concentrate our efforts in explaining the differences in rates of growth in TFP among countries a more appropriate framework is growth accounting. Once we choose this option we do not pretend to satisfy a specific theory of economic growth and we work very loosely with different concepts. Our main goal is to look at policy efforts that may have an impact on TFP growth and through this channel in economic growth. It is true however that growth accounting may be useful in stimulating the development of new theories of growth.

Recent studies build on the idea that TFP is not an important source of growth (for example, Young, 1995). In our opinion, whether TFP calculations are large or small is not a relevant issue for growth theory, unless we have a satisfactory theory of what makes TFP large or small. We know of the importance of input accumulation for growth. We have quiet satisfactory theories of how input accumulation occur. Differences in growth due to differences in capital accumulation are easily understand by the profession. We have a lot of insights of why investment rates differ across countries. However, we don't have many insights of why TFP rates differ across countries. And as this paper shows the differences can be large.

In accordance with the theory of economic growth and hence compatible with the framework developed above we think of TFP as influenced by a wide mix of economic policies and institutions. Keeping it very simple we can think about the growth process in a very decentralized way as follows

$$\sum_{i=1}^{n} p_i y_i = \sum_{i=1}^{n} w_i l_i + \sum_{i=1}^{n} \rho_i k_i \, .$$

This equation represent the well-known identity that total value added for an economy equals payments to productive factors where the subscripts stand for the different industries (or firms) of the economy. These factors are defined without a loss of generality as capital and labor. If the former equation holds so does the following:

$$\sum_{i=1}^{n} p_i \Delta y_i + \sum_{i=1}^{n} y_i \Delta p_i = \sum_{i=1}^{n} w_i \Delta l_i + \sum_{i=1}^{n} l_i \Delta w_i + \sum_{i=1}^{n} \rho_i \Delta k_i + \sum_{i=1}^{n} k_i \Delta \rho_i$$

Rearranging we get an expression for the residual R:

$$\sum_{i=1}^{n} p_i \Delta y_i - \sum_{i=1}^{n} w_i \Delta l_i - \sum_{i=1}^{n} \rho_i \Delta k_i = R = \sum_{i=1}^{n} l_i \Delta w_i + \sum_{i=1}^{n} k_i \Delta \rho_i - \sum_{i=1}^{n} y_i \Delta p_i$$

The left hand side of this last equation reflects the traditional measure of the residual. The right hand side of this expression can be understood as its "dual". A more careful look at this expression is useful. It help us to disentangle what the residual is all about. Specifically, it shows that the residual will be positive if there are efficiency gains. Why? The expression is positive only if the rewards to the existing production factors increase (decrease) by more (less) than the increase (decrease) in revenues associated to the increase (decrease) in prices of a given output. This is only possible if some efficiency gains occur along the productive process. This expression doesn't mean necessarily that it is possible to increase efficiency by keeping output and inputs constant. The productive process is very dynamic and of course some rearrangements will take place in the process of increasing efficiency.

This situation is perhaps better illustrated through an example that suits this idea of efficiency gains (or reduction in real costs) well. If there are economies of scales not fully utilized in a firm, a rearrangement in production (probably an increase) will satisfy the "dual" in a natural way. The reduction in average costs associated to a complete utilization of economies of scale makes room to a possible increase of the rewards to the existing productive factor without an increase in output prices. So if the residual, or total factor productivity (TFP), is an important element in the process of growth, as we expect to show in these pages, it is natural to think of the growth process as a very decentralized process that occurs at the level of individual firms. In such a scenario the relevant policy questions are related to the general question of how to facilitate this process of efficiency gains to the individual firms.

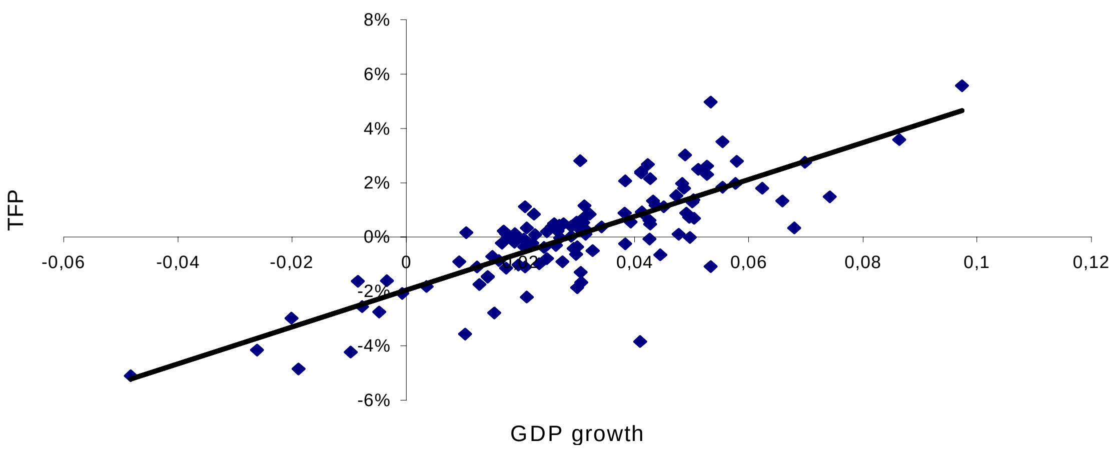
The first step is precisely to build reasonable estimates of TFP. To do so we worked out a very simple exercise in growth accounting for the period 1980-2000. This consist in estimating the unexplained rate of GDP growth after controlling for investment and increases in employment. We used the data of the IMF collected in the International Financial Statistics. We take the labor share in GDP to be 0.6. Assuming a stock of capital that is 2.5 times output and a depreciation rate of 5%, this implies an average rate of return of capital of 11%, a reasonable return for the entire physical capital stock. Since we do not have consistent data on employment for our sample we use population data. TFP is the result of calculating the following equation:

$$TFP_t = \hat{Y}_t - (r + \delta)I_t - s_L \hat{L}$$

meaning that TFP is the result of subtracting from the rate of growth in GDP net investment weighted by the gross rate of return of capital (δ is the depreciation rate) and the rate of growth of labor weighted by the labor's share in GDP.

There is no doubt of the importance of TFP as an explanation for growth. Figure 2 draws the relationship between TFP and the rate of economic growth for the period between 1980 and 2000. It is clear from the figure that there is a strong and positive correlation between both variables. Indeed two thirds of the variance in growth rates is explained by variations in the rate of TFP growth. Of course this observation doesn't mean that factor accumulations do not play a role in explaining the differences in economic growth among countries only that it is rather limited. Since our estimations do not correct for human capital it could be argued that our calculations for TFP exaggerate its actual importance[10]. However it would be surprising if the inclusion of human capital reduced significantly the importance of TFP[11].

Figure 2
TFP and growth: average growth in 1980 2000



[10]In our empirical estimations we try to correct for human capital.
[11]Indeed for a smaller sample and the period 1970-1991, Beyer (1997) corrects for human capital accumulation finding that on average TFP felt 0.48 percentage points ranging from 0.04 to 1.01 percentage points.

That TFP is very important in economic growth is illustrated more clearly in table 1. Since we were able to build TFP for 107 countries in the period 1980 –2000 we take 10 years average growth in TFP for each country. This allows us to analyze 214 periods. We select the top 10% and bottom 10% of the periods in terms of economic performance and compare the importance of TFP in explaining the differences in the rate of growth of GDP.

Table 1
The Sources of Growth

		Output	Factor Accumulation	TFP
10% Highest growth rates	Mean	7.55	3.88	3.67
10% Lowest growth rates	Mean	-1.19	2.29	-3.48
Difference in Mean		8.74	1.59	7.15

The differences among in the rate of growth in GDP countries is to a great extent explained by the differences in the rate of growth in TFP. It is important to notice that differences in factor accumulation are only a small part of the story. The extent to which TFP could differ from period to period and country to country is so significant that a better understanding of the causes behind the huge differences is worth pursuing.

That TFP is an important source of economic growth for every country is confirmed if we concentrate our results in specific groups of countries. To show this we do the following exercise. We rank the 107 countries according to its level of GDP per capita in 1980 (the first year of our analysis). To do so we use the Penn Tables. Then for the group of countries whose GDP per capita is in the top quartile of the ranking we select the periods with the highest rate of economic growth and those with the lowest rate of economic growth. In both cases we consider a 25% of the whole sample. The time spans are 1981-1990 and 1990-2000. The next step is to compare the average rates of economic growth across the two groups. These calculations are presented in Table 2. In table 3 we do the same exercise but now for the countries whose GDP per capita is in the bottom quartile of the GDP per capita ranking.

Table 2
The Sources of Growth: countries with highest GDP per capita

		Output	Factor Accumulation	TFP
Highest periodic growth rates	Mean	4.57	3.48	1.09
Lowest periodic Growth rates	Mean	0.50	2.79	-2.29
Difference in Mean		4.07	0.69	3.38

Table 3
The Sources of Growth: Countries with lowest GDP per capita

		Output	Factor accumulation	TFP
Highest periodic growth rates	Mean	6.22	3.10	3.12
Lowest periodic Growth rates	Mean	-0.21	2.08	-2.29
Difference in Mean		6.43	1.02	5.41

The rates of growth among “similar” countries may differ substantially from one period to the other or from one country to the other. Moreover we can hardly find in the differences in capital accumulation a consistent explanation for these significant variations. The important discrepancies in the rate of economic growth have to be linked to the differences in the rate of growth of TFP. Indeed in periods of low growth both in rich and poor countries the rate of factor accumulation is quite high but it is the rate of TFP growth that defines if there will be a bad or good period of economic growth. We have to remember here that this tables are built on 10 years averages so we are not talking here about cyclical downturns in the economy.

Therefore in order to keep high rates of economic growth the key is the performance of TFP. Otherwise countries with respectable rates of accumulation of productive factors will be unable to grow at high rates. Then, a significant challenge for middle and low-income countries is the capacity to sustain positive rates of TFP. If they are unable to do so the possibility of catching up with rich countries is greatly reduced. Indeed both in periods of high and low growth the rates of factor accumulation between rich and poor countries do not differ much. However TFP may grow faster among poor countries. The key then is to favor economic policies and institutions that may assure high rates of economic growth.

IV TFP, Policies and Institutions

There is a large body of literature (for example, Easterly, 1993, and Krueger, 1990) that points out that bad economic policies may affect economic performance heavily. A related literature targets the role that institutions play in the process of economic growth (for example North, 1990). At the same time the discrepancies in levels of income and rates of economic growth among countries are far beyond the differences in factor accumulation. Therefore, it is worthwhile to explore in more detail the links between the rate of growth of TFP and economic policies and institutions. Of particular interest is the role that microeconomic policies play in this story. The simple hypothesis that we are considering is that differences in the quality of these policies play a significant role in the rate of growth of TFP.

In the previous sections we showed that countries that are unable to grow tend to exhibit negative rates of growth in TFP. The differences in factor accumulation play a minor role in the variation of growth rates across countries. On the other hand it is easy to verify that countries differ significantly in their economic policies and institutions.

Moreover these differences tend to persist in time. For example, changes in the effectiveness of government, in the legal system or in the quality of educational systems take a very long time to be put in effect and they remain broadly similar over considerable periods of time.

The positive or negative effect of policies and institutions on TFP may last also for very long periods of time. An inefficient government bureaucracy, for example, may hinder permanently efficiency gains. On the other hand, a state reform that improves substantially the efficiency of the state bureaucracy may generate an increase in the economic efficiency of an economy almost continuously if there is entry of new economic activities. The same thing can be said of an once and for all improvement in the quality of education. The increases in productivity associated to the entering of the “new” school graduates to the labor force will last until their is a complete replacement of the “old” labor force. This may occur even if the schooling level of the new labor is the same as the one leaving the labor force.

One of the problems faced by the empirical work in this subject is the lack of data on much of the economic policies and institutions we are interested in. However in the last two decades there have been a systematic effort of different institutions trying to collect reliable data on the quality of economic policies and institutions. One problem is that much of the data relies on subjective measures of the quality of institutions. Another problem is that different indicators tend to be highly correlated within each data set. Probably this is not surprising since most of the high quality policies and institutions come in a package. So a country with a good regulatory framework probably has simultaneously a highly qualified bureaucracy and at the same times low levels of corruption. The reverse is true in the case of countries with a bad regulatory framework. In our empirical analysis we try to use data from a wide variety of sources in order to avoid this kind of problems.

Our empirical strategy takes the rate of growth in TFP as a dependent variables and tries to explain its variation across countries appealing to a series of institutional and policy variables. Specifically we take as dependent variable the average growth in TFP in the period 1980-2000[12]. Although from the theoretical discussion we can't be sure that TFP will grow at a smaller pace among rich countries than among poor countries tables 2 and 3 suggest however that this is an open possibility. In periods of high growth the increase in TFP is lower in rich countries that in poor countries. To control for this possibility we include as a control the log of income per capita in 1980.

Also as an initial control we decide to include a measure of human capital. We argued before that our estimates of TFP could be biased (although modestly) since we excluded from its calculation a measure of human capital. To correct for this omission we include the initial level of education of the different countries. Note that the model developed before (which relies heavily on Mankiw et. al., 1992) suggests that the correct variable to include in the estimation is the investment rate in human capital. The problem is the difficulty to find an appropriate measure of this investment rate[13]. Moreover Benhabib and Spiegel (1994) find that the investment rate in human capital does not enter significantly in a growth equation. At the same time they argued that the initial level of education in a country is an important determinant of future productivity growth. The first column in table 4 shows the result of regressing TFP on the log of GDP per capita in 1980 and the total years of secondary education of the population age 15 and more. The first variable is from the Penn Tables. The second comes from Barro and Lee (2000).

[12] For some countries the period ends in 1999.

Table 4
The determinants of the rate of growth of TFP
Dependent variable: rate of growth of TFP: 1980-2000

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	0.04868**	0.08068*	0.09599*	0.13657*	0.15386*	0.13772*
	(2.362)	(3.724)	(4.420)	(4.993)	(5.275)	(5.274)
Ln GDP PC	-0.00655**	-0.01378*	-0.01565*	-0.02019*	-0.02181*	-0.02226*
	(-2.293)	(-4.664)	(-5.329)	(-5.629)	(-5.791)	(-5.775)
Secondary	0.00486**	0.00272	0.00192	0.00270	0.00018	0.00025
	(1.981)	(1.265)	(0.921)	(1.422)	(0.079)	(0.102)
Ed. Quality		0.07832*	0.07048*	0.06879*	0.05611**	0.06196**
		(3.362)	(3.124)	(3.129)	(2.418)	(2.378)
Regulatory Burden			0.00994**	0.01137**	0.01241**	0.01691**
			(2.394)	(2.020)	(2.021)	(2.013)
Bureaucracy				-0.00812**	-0.00818**	-0.00884**
				(-2.271)	(-2.181)	(-2.234)
R & D					0.00557**	0.00560**
					(2.021)	(1.998)
Open						0.00498
						(0.820)
Free						0.00613
						(0.933)
Adj. R2	0.04	0.30	0.36	0.44	0.48	0.48
N	88	57	57	46	42	41

Test – t in parentheses. *Significant at the 1% level; **Significant at the 5% level.

Both variables are significant. However they are unable to explain the variation in TFP across countries. As expected the coefficient on the initial level of secondary education is positive suggesting that it affect positively the future growth in productivity. In the case of the level of GDP per capita we find a negative coefficient which to some extent was expected given the results obtained in tables 2 and 3.

Keeping these controls we go ahead to test the impact on TFP of institutions and economic policies. We start by introducing the quality of education. To do so we take the Barro and Lee (2000) data on educational quality. Specifically we take the data on

[13] Mankiw et. al. (1992) used the proportion of the working age population that is in secondary education.

achievements in international tests of mathematics to include in our regression. In the cases where no mathematics test was available we choose the achievement in the science test. If none of them was available we choose the achievements in reading. We took the last observation available. In some cases the only tests available were in the early 70. Since educational institutions do not change rapidly we don't think that we are making a serious mistake. We upgrade the Barro and Lee data with the results of the 1999 TIMSS and the "Laboratorio Latinoamericano de Educación". In this last case we use the fact that both Colombia and Chile took part not only in the "Laboratorio" but also in the TIMSS to convert the achievements in this last test to the scale reported by the TIMSS. Following Barro and Lee we uniformed all the different tests on a 0 to 100 % scale.

In Column 2 of Table 4 we present the results of regressing TFP on the Log of GDP per capita in 1980, initial level of secondary education and our indicator of educational quality. This last variable enters very strongly in our regression suggesting that a good educational system influences significantly productivity growth. At the same time the initial level of secondary education looses significance implying that increases in the level of schooling in economies with bad educational systems may not improve the growth perspectives of those economies greatly.

Model 3 adds to our regression a measure of the regulatory burden faced by the different economies. The data comes from Kaufmann et. al. (1999). These authors aggregate different measures of governance originated from various sources of information in six robust indicators. "Voice and Accountability" (VA) measures the extent to which citizens of a country are able to participate in the selection of governments; "Political Instability and Violence" (PIV) measures the perceptions of the likelihood that the government will be destabilized; "Government Effectiveness" (GE) attempts to capture the quality of government by combining among other indicators the perceptions of the quality of public services, the independence and competence of the civil service; "Regulatory Burden" (RB) tries to capture the extent to which there are market unfriendly policies in a country as well as perceptions of the burdens imposed by excessive regulation; "Rule of Law" (RL) includes several indicators which measure the extent to which agents have confidence in and abide by the rules of society, and finally "Graft" (CP) measures perception of corruption. The choice of units of governance assures that the estimates of governance have a mean of zero, a standard deviation of one, and range from around –2.5 to around 2.5. Higher values correspond to better outcomes.

One of the problems with these indicators are that they are for the years 1997-98. Some of them are less time invariant than others. For example, political systems have changed substantially in some countries in the last two decades which may affect substantially VA and PIV. RL and CP may also be influenced heavily by such changes. GE and RB are probably less sensible to changes in political systems. Since our dependent variable covers the period 1980-2000 these are the candidates to include in our regression. However these indicators are highly correlated with partial correlations ranging from 0.68 to 0.93[14]. GE and RB have a correlation of 0.85 in our subsample. Since we have an alternative measure for government effectiveness we include in our regression RB as an independent variable. As expected the coefficient for this variable is positive. A market friendly regulatory environment contributes positively to the growth of TFP.

Governments play an important role. They not only allocate an important amount of the resources available in a economy but they also supervise the allocation of resources of the private sector. Therefore the government's efficiency may affect the overall performance of an economy. For this reason we try to include a measure of government effectiveness in our analysis. Djankov et. al. (2000) trying to look at regulations to entry across countries built a database that includes the monetary cost of establishing a new firm and the number of days it takes to go over the different procedures to establish a firm. We aggregate their information in one variable by assuming that the value of the time lost following the different procedures for establishing a new firm is proportional to the income per capita of the country. Since the income per capita is measured for one

[14] In our subsample the degree of correlation increases.

year, the natural indicator is the number of days divided by 365. We add this calculation to the monetary cost as a proportion of income per capita informed by Djankov et. al. to get a unique measure[15]. The higher the value of this indicator the less efficient is the government. In column 4 we show the results of the regression that includes this variable in the list of regressors. Not surprisingly the coefficient of this variable is negative. It is also statistically significant. The less efficient the government the lower the rate of growth of TFP.

Finally in model (5) we try to move our analysis to a more precise measure of the impact of technology on growth. The claim of most endogenous growth theorist is that their every reason to believe that the growth of technology depends on economic decisions at least as much a does factor accumulation. We implicitly have identified this growth in technology with the quality of institutions and economic policies but the ability of the various countries to innovate and catch up will be affected not only, for example, by the quality of the human capital but also by their direct efforts in doing those innovations and adaptations. The investment in R & D may be a good approximation to those efforts. We include the expenditures in R & D as a percentage of GDP averaged for the years 1984 to 1997 in our regression. The data comes from the World Bank. The estimated parameter is positive and statistically significant suggesting that increases in R & D may boost the rate of growth of TFP.

To do a minimum check of the robustness of our results we run our model with two additional variables. The first one is an indicator of openness. We use the one built by Sachs and Warner (1995). Their indicator takes the value of 1 if the economy is open and the value of 0 if the economy is closed for each of the years between 1950 to 1992. We use as independent variable the proportion of years that the economies are open between

[15]These probably underestimate the true costs for the different firms since their opportunity cost is probably much larger that the one reflected by the income per capita. Also, surely it differs from one firm to the other. In absence of a better alternative we keep this one but remain aware that this variable has to be improved. On the other hand, and in spite of these caveats we think that the variable remains a good indication of the efficiency of governments. It is really this dimension that we would like to capture.

1980 and 1992[16]. The other independent variable uses the Index of Economic Freedom. We average the different indexes available since 1993. None of these variables enters significantly in model (6). Most important our other independent variables remain practically unchanged both in terms of magnitude and significance.

The implications of these results for Chile are important. If we take column 5 as our departure model several interesting conclusions arise about the impact that feasible reforms may have on the rate of TFP growth and therefore on the overall performance of the Chilean economy. If Chile were to increase their results in international tests like the TIMSS to the average country achievement our results suggest that the rate of growth of TFP could increase by 0.6 percentage points. An average achievement will put a country like Chile at the level of Thailand or Lithuania, and slightly below countries like Latvia, Malaysia or Bulgaria. None of these countries have a GDP per capita higher than Chile at PPP levels. One of the main factors behind the underachievement of Chilean students is that schools are rarely held accountable for their performance (Eyzaguirre and Fontaine, 2001). If this is the case it is urgent to reform educational institutions in order to assure accountability among schools. A key aspect in this direction is the reform of the teachers' labor statue that protects teachers heavily without clear obligations.

Another avenue to improve productivity is by increasing government efficiency. For establishing a firm in Chile 78 days are required. This is well above the median of 55 days and the OECD average of 24 days. If Chile were to have an efficient government that among other things is able to reduce the days required to establish a firm TFP could grow at an additional 0.2 percentage points. The small number is a little bit disappointing. There are two interpretations for this result. Firstly it could be argued that ours is too narrow an indicator of government effectiveness. Secondly that an ineffective governments influences the performance of an economy much more through its policies than through the functioning of the civil service. So a highly efficient bureaucracy in a

[16] Of course, ideally we should have extended their data until the year 2000.

highly distorted economic environment will have no impact on TFP or in economic growth.

These arguments suggest that the regulatory burden may be of greater importance than the quality of bureaucracy in determining a country's economic performance. Indeed there is almost a one to one relationship between the quality of the regulatory burden and the growth in TFP. The value of this indicator for Chile is relatively high (0.89 versus a maximum of 1.25) but notwithstanding there is a lot of room to improve in this dimension. The maximum value that this indicator takes is 2.5. Indeed in other dimensions of the governance indicators built by Kaufmann et. al. Chile gets higher values than the one obtained in the regulatory dimension. The good performance of the Chilean economy in the last 15 years is surely linked to a relatively good governance structure. However a lot more can be achieved if this structure is upgraded.

Finally there is a potential for a modest productivity boost if the investment in R&D is increased. The country invested in the last years 0.68 % of GDP in R&D well below the average of 0.95% of GDP for the whole sample of countries for which we have data. Rising our investment in R&D to the world's average may increase growth in 0.15 percent points.

V Conclusions

We have argued that the rate at which economies may grow is not only constrained by their level of resources and technology but also by the structure of incentives embodied in its institutions and economic policies. In particular, Chile's economic success in the last years is associated to the application of sensible economic policies and the existence of a sound institutional environment. If the country is able to keep and improve these policies and institutions an additional period of high growth may be assured. The mayor gains in economic growth for a country like Chile may come from an improvement in its educational systems. Reasonable and reachable improvements may increase the rate of growth in Chile in 0.6 percent points. Further gains are possible if the country's regulatory framework is improved. Although the country's policies are market friendly they are less than optimal. Increasing government efficiency and more investment in R&D may produce additional although modest gains in economic growth. Taking our results together it is possible to conclude that modest changes in the country's policies and institutions may increase Chile's rate of growth in 1 to 1.5 percent points.

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