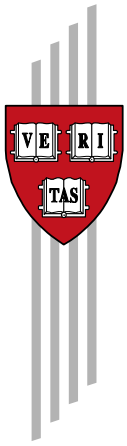
Doing Growth Diagnostics in Practice: A 'Mindbook'

Ricardo Hausmann, Bailey Klinger, Rodrigo Wagner

CID Working Paper No. 177
September 2008

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Working Papers

Center for International Development
at Harvard University

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Abstract: This paper systematizes the implementation of the Growth Diagnostics framework. It aims to give the meta-steps that a persuasive growth diagnosis should have, and elaborates on the strategies and methods that may be used. Rather than a step-by-step instruction manual or handbook, this paper is meant to be a 'mindbook', suggesting how to think about the problem of identifying a country's constraints to growth.

Keywords: growth diagnostics

JEL Codes: A11, B41, O10, O20

Doing Growth Diagnostics in Practice: A 'Mindbook'

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September 8, 2008

This manuscript has benefitted from the experiences and insights of numerous researchers who have been doing growth diagnostics over the past few years. We acknowledge first and foremost the original growth diagnostics authors Dani Rodrik and Andres Velasco, as well as Philippe Aghion, Abhijit Banerjee, Jeff Frankel, Robert Lawrence, James Levinsohn, Lant Pritchett, Roberto Rigobon, Francisco Rodriguez and Federico Sturzenegger. Other lessons were learned from either contributors or commentators of individual country diagnostics in which we have been involved in the past four years. These include Andres Echeverry, Jaime Frias, Martin Hommes, Felipe Kast, Jose Roberto López-Calix, Dougal Martin, Sandro Parodi, Indhira Santos, Matthew Shearer, Alfie Ulloa, Reinier Schliesser, and Andres Zahler. Important lessons have also been learned from growth diagnostic teams at the World Bank lead by Roberto Zagha, at the Inter-American Development Bank lead by Eduardo Fernandez-Arias, Fidel Jaramillo and Ernesto Stein, at the Asian Development Bank lead by Jesús Felipe and at the UK Department for International Development lead by Anthony Venables and Alan Winters as well as from HKS students of PED 130, PED 309, and the HKS-CID Executive Education course on Growth and Development. Excellent research assistance was provided by Max Perez and Carla Mejia. All errors and omissions are our own.

I think the major issue is how broad the evidence is on which you rest your case.
Some of the modern approaches involve mining and exploring a single body of evidence within itself. When you try to apply statistical tests of significance, you never know how many degrees of freedom you have because you're taking the best out of many tries.

I believe that you have a more secure basis if, instead of relying on extremely sophisticated analysis of a small fixed body of data, you rely on cruder analysis of a much broader and wider body of data, which will include widely different circumstances. The natural experiments that come up over a wide range provide a source of evidence that is stronger and more reliable than any single very limited body of data.

Milton Friedman[1]

Preface

Economists have been dissatisfied with the set of tools they have had to diagnose the growth challenges faced by individual countries. Much of the research on growth focuses on what causes growth in general, rather than on the potential obstacles to growth in particular settings. That may be why the growth diagnostic approach proposed in Hausmann, Rodrik and Velasco (2005) (HRV from now on) has received significant attention in economic analysis and policy discussions. Yet that paper left many open questions about how to proceed in practice.

This paper systematizes the implementation of the Growth Diagnostics framework. It aims to give the meta-steps that a persuasive growth diagnosis should have, and elaborates on the strategies and methods that may be used. Rather than a step-by-step instruction manual or handbook, this paper is meant to be a 'mindbook', suggesting how to think about the problem of identifying a country's constraints to growth. Analyzing constraints does not necessarily make Growth Diagnostics an advocate of economic growth. Countries should find the trade offs, if any, between growth and other goals through an appropriate political process. This work only intends to identify which levers are more likely to deliver growth

This synthesis is the result of three years of attempts by many economists – including the authors – to perform these diagnoses. It also responds to the useful critiques made by colleagues (Rodriguez, 2005; Dixit, 2007; Aghion and Durlaf, 2007; Leipziger and Zagha, 2006; Pritchett, 2006; Fernandez –Arias, 2007; Felipe and Usui, 2008).

Section 1 discusses the growth diagnostic approach and contrasts it to the techniques used most frequently in the past. Section 2 reviews the key principles of a differential diagnostic, which are then applied in Section 3 which discusses the steps of performing growth diagnostics in practice. Section 4 introduces some issues on the transition from diagnosis to therapeutics. The final section concludes.

[1] *From "An Interview with Milton Friedman", Macroeconomic Dynamics, 5, 2001, 101-131, Cambridge University Press.*

Preface 2
1: Identifying the Constraints to Growth 4
The Three Workhorses of Current Practice 5
Cross-Country Panel Growth Regressions 5
Growth Accounting 8
International Benchmarking 11
Growth Diagnostics 16
Theoretical Considerations 18
Growth Diagnostics and the HRV Model 21
Criticisms 23
Other Notes of Caution 25
Bayesian Approach 26
2: Principles of a Differential Diagnosis 32
1) The (Shadow) Price of the Constraint is High 32
2) Movements in the Constraint Should Produce Significant Movements in the Objective 40
3) Agents in the Economy Should be Attempting to Overcome or Bypass the Constraint 42
4) Agents Less Intensive in a Binding Constraint Should be More Likely to Survive and Thrive, and Vice Versa 43
3: Growth Diagnostics in Practice 49
Describing the Growth Process 49
Univariate Analysis of Growth. 49
Other Correlates of Growth 53
What is the Right Question? 57
Going Down the Decision Tree 57
First Decision Node 57
The Right-Hand Side of the Tree: Financial Stories 61
The Left Branch of the Tree: Low Expected Private Returns 71
A Matrix of Tests 80
4: From Symptoms to Syndromes (and back again) 83
5: From diagnostics to Therapeutics 91
6: Conclusion 96
7: References 98

1: Identifying the Constraints to Growth

The growth diagnostic approach is based on the idea that there may be many reasons why an economy does not grow, but each reason generates a distinctive set of symptoms. These symptoms can become the basis of a differential diagnostic in which the analyst tries to distinguish among potential explanations for the observed growth rate of the economy.

There is a fundamental difference between growth diagnostics and growth theory and empirics. In the former, the subject is a particular country. In the latter, it is a general economic phenomenon in which individual countries are examples. This is not unlike the relationship between research and practice in medicine. A typical medical researcher asks questions such as: does factor X affect the level of variable Y for the average person of a certain population? For example, X could be salt and Y could be blood pressure. The typical medical doctor asks the question: is a high-salt diet the cause of high blood pressure for this particular patient? The two questions are not totally unrelated, but they are quite distinct because the causes of maladies among patients is usually heterogeneous since it depends on a potentially unknowable set of complex interactions between many aspects of the individual patient and of his environment. So, while researchers may pin down what happens on average in a sample of patients of a certain population, it is never clear whether the case of the patient in front of us is comparable. That is why clinical trials try to distinguish by age, gender, ethnic origin, and other variables, but the potential list of intervening factors and interactions is too large for reasonable samples to be able to control for, forcing medical doctors to interpret the relevance of such evidence for their patient with great care.

Similarly, an economic researcher asks the question: “does variable X affect the rate of growth of a typical economy chosen at random from a certain population?” X could be the level of inflation, the average tariff rate, the level of spending in schools or the independence of the central bank. An economic advisor would ask the

question: for this particular country, at this particular time, what is preventing the country from achieving higher sustained and shared growth? Again, the two questions are not completely independent, but neither are they the same question.

The Three Workhorses of Current Practice

Much of the empirical research and country-level diagnostics on growth has been based on three basic workhorses: cross country growth regressions, growth accounting and international benchmarks. We will briefly discuss some of the aspects that limit the effectiveness of each for the purpose of achieving a convincing diagnosis.

Cross-Country Panel Growth Regressions

Cross country growth regressions (initiated by Barro, 1991) ask what variables are causally associated with growth *in the average country*. The basic equation regresses the growth rate for a sample of country-period observations on the log of the initial level of income and a vector of explanatory factors.

$$g_t = \hat{\alpha} \log(y_{t-1}) + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + .. + \hat{\beta}_N x_N$$

The equation estimates the marginal contribution to growth β of each causal factor, assuming that the contribution is the same for all countries in all sub-periods of the sample.

There have been literally millions of such regressions run with all sorts of explanatory variables (Sala-i-Martin 1997), including geographic, institutional, demographic and policy variables of many sorts.

Let us consider taking one of those estimated regressions and use it to design a growth strategy for a country. Suppose the equation has some explanatory variables that are hard to change, such as geographic latitude and the average age of the

population. So, you disregard them and focus on those that seem more amenable to be influenced by policy. You might find credit to the private sector as a share of GDP and secondary school enrollment as two variables that appear to be statistically and economically significant and potentially amenable to policy change. Why not base a growth strategy on an education plus finance mix of policies?

There are two reasons that may give you pause. The first is that governments do not directly decide either how much credit the private sector will get from private banks or how many kids stick around until they finish high school, so the right-hand-side variables are not really policy instruments, but instead are endogenous outcomes of some process. Credit may be low because banks do not have enough resources to lend or because firms do not want to borrow. School attainment may be low because there are no schools or because households do not find them useful.

The second reason is that while in the average country it may be true that a higher level of credit to the private sector may be associated with higher growth, there is no certainty that any given country is an average country in this particular respect. Similarly, while aspirin may relieve pain for the average patient, you may think twice before giving it to your particular patient if he suffers from stomach ulcers.

So, should you expect your country to be average in terms of its reaction to credit easing or educational improvements? One quick test might be to see whether your country's low private credit ratio is related to low supply of or low demand for credit. You can tell one from the other by looking at the interest rate. If supply (demand) was limited, you would expect to see a high (low) interest rate. If education was an important limitation on growth you would expect to see a high return to schooling, as estimated, for example, through a Mincer regression[2]. The cross country regression assumes that the estimated parameter, say on education or credit, is the same for all countries in the sample, but the parameter may well be very heterogeneous and

[2] Mincer (1953) runs a regression of the log of wages on years of schooling with other controls. The estimated coefficient represents the percentage return in terms of wages of an additional year of schooling. For a survey see Heckman, Lochner and Todd (2003).

dependent on a set of other variables. Prices contain information regarding the marginal return to more education or credit, but this information is disregarded by the typical equation.

This is clearly unfortunate. Economics is about prices and quantities, but the typical cross country regression uses almost no prices, which implies that important information is disregarded. Also, the regression framework requires one to have all the variables for all the countries in the sample. But one can get a lot more information about an individual country than what one can get in a standardized form for 130 countries. So the approach inevitably waists potentially useful information.

Moreover, in a typical regression the assumption is that the parameter to be estimated is the same for all countries in the sample. But this is an assumption, not a result. As we argued above, this parameter may well be heterogeneous. For example, suppose a drug is effective only on patients that have a certain allele or gene. The researcher is unaware of this and runs a clinical trial. He will find that there is a statistically significant effect of the drug on the population, but in fact, the result is heterogeneous depending on the presence or absence of the allele in each patient.

Aghion and Durlauf (2007a) argue that by adding enough interactions to the regression one can solve the problem. Suppose you believe that R&D expenditures are important for growth only for relatively rich countries. Then you can interact the level of R&D expenditure with the level of income and that will allow you to estimate a differential impact of R&D expenditure on growth. Obviously, more flexibility in the specification of the equation to be estimated is always better. But there are three problems with this approach. The first is that you need to know what interactions are in the data generating process, which we typically do not. Secondly, you must know the functional form of that interaction. Finally, in a typical cross country regression framework as you add these interactions you run out of degrees of freedom because the sample size is not big enough. As argued in Aghion and Durlauf (2007b), there is econometric specification uncertainty, measurement uncertainty and theory

uncertainty. In fact, Rodriguez (2007) uses a non-parametric approach to show that there is evidence that interaction effects are important but that they cannot be adequately explored with existing datasets because of sample size. Moreover, as you add more variables to the regression, there is no guarantee that the omitted variable bias will decline[3].

Another deep critique has to do with the pro-activeness of government policy. Naïve interpretations of growth regressions implicitly assume a random assignment of policies. That depicts governments as non strategic agents, which clearly is a very bad assumption. We know that traffic cops tend to be assigned to areas where there is a lot of traffic. Hence a regression between the volume of traffic and the number of cops would give a positive coefficient, blaming cops for the traffic, even though cops may be optimally allocated. Rodrik (2006) concludes: "*When government policy responds systematically to economic or political objectives, the standard growth regression in which economic growth (or any other performance indicator) is regressed on policy tells us nothing about the effectiveness of policy*".

Finally, Easterly (2007) finds that if you take instances of very bad policy outcomes out of a standard growth regression, the statistical significance of policies on growth disappears, both individually and jointly. This is consistent with the idea that policies matter if they hit a binding constraint, but their effects otherwise are highly heterogeneous.

Growth Accounting

The second workhorse of the empirical growth literature is growth accounting. It involves decomposing the economic growth of a country in terms of the amounts

[3] A more promising and less assumption intensive avenue is to use niche regressions to estimate the response to a policy in countries that are "comparable" to the one under discussion. It is almost a non-parametric approach that involves running a "local" regression. If the problem is the impact of health expenditures on growth in Africa, adding Luxembourg would not make the estimate more precise because we do not expect the coefficient to be the same in both countries. Adding GDP per capita or country fixed effects does not solve this because there is parameter heterogeneity. In any case, making comparisons based on "matching" countries is much less persuasive than in Labor Economics, where it is much easier to find an observationally equivalent matches among individuals.

contributed by the accumulation of different factors of production – e.g. physical capital of various sorts, human capital of different kinds and labor – and a Solow residual that is often referred to by the glamorous name of total factor productivity (TFP) but that Moses Abramovitz referred more aptly as 'the measure of our ignorance'.

The technique is based on two assumptions: (i) a production function with constant returns to scale; (ii) perfect competition (i.e. no distortions) so that each factor is paid its marginal product. Together they imply that growth can be decomposed into the part contributed by the accumulation of factors of production and a part contributed by productivity. The contribution of a factor to growth is its rate of growth weighted by the share of national income accruing to that factor[4]. Productivity is measured as the residual between the observed growth and the fraction explained by factor accumulation. To perform the calculation one needs to have the rate of growth of output and the rate of accumulation and the share in national income of each of the included factors. TFP is calculated as a residual.

As a result one obtains a decomposition of growth into a part that can be accounted for by the accumulation of each factor and a part which cannot be explained by factor accumulation. There are plenty of theoretical and practical reasons that make this calculation problematic.

On the theoretical front, the assumption of constant returns to scale goes against all endogenous growth models which are based on some form of increasing returns. As argued in Barro (1998), the main implication is that one cannot use the income shares to weigh the contribution of each factor and there is no clear way of deciding which weights to use.

[4] This uses the assumption of constant returns to scale and perfect competition. Under these conditions, the share of income accruing to a factor is equal to the elasticity of output to that factor.

Secondly, as pointed out by Hsieh (1998), we can look at the evolution of returns instead of the accumulation of factors – the so-called dual approach[5] – but these often give very different results. Contrary to Young (1995) who argued that during the East Asian Miracle TFP had made very little contribution to growth, Hseih finds that the dual approach gives very high upward corrections, especially for Singapore and Taiwan.

Third, as pointed out by Pritchett (2000), the way capital is measured is by calculating the cumulated, depreciated investment effort, but this may have very little to do with the actual capital that is on the ground, as many investments may be either inefficient, wasteful or become obsolete at rates that are very different from the assumed depreciation rates. Fourth, the decomposition is dependent on the factors that are considered. Is capital decomposed between residential and non-residential? Is human capital only decomposed into primary, secondary and tertiary schooling? What about the use and depletion of natural resources? For countries with an important use of its resource base, say an oil or mineral exporter, the contribution of this factor will appear as part of TFP unless it is explicitly accounted for. Finally, all these quantities are measured with great imprecision and these errors get accumulated in the residual. This means that it is very hard to trust the quality of the results.

More fundamentally, Felipe and Adams (2005) remind us of a point made *inter alia* by Samuelson (1979) and Simon (1979), that the parameters that come out the estimation of an aggregate production function may be a reflection of the accounting identity that states that value added is the sum of wages plus profits and would be recovered even if the production function was completely different or was not well defined.

Closer to our discussion, a major problem with the growth accounting approach is that it does not map into a diagnostic. To begin with, the individual components into

[5] He uses the equality $Y = RK + wL$ to derive an estimate, which only depends on the constant returns to scale assumption and uses changes in returns rather than the quantities of capital and labor.

which growth is decomposed are not independent from each other. For example, in the basic Solow model, the rate of growth of the any form of capital stock *k* in the steady state is a function of the rate of growth of TFP:

$$\frac{dk_{ss}}{k_{ss}} = \frac{1}{1-\alpha}\frac{dA}{A}$$

Where A is TFP and α is the income share of capital in national income[6]. So the component parts are not independent of each other. Therefore one cannot interpret the decomposition as signaling whether the problem is one of accumulation or one of productivity because the two are linked. Low investment may be caused by low productivity.

Moreover, suppose one finds that capital accumulation is low. What kind of constraint would explain this? Is it lack of savings? Is it a problem of poor financial intermediation? Is it instead caused by concerns about the appropriability of returns? Or is the problem associated with a constrained supply of complementary factors such as public investment? And if TFP growth is low, how does this help identify its causes?

These critiques to growth accounting are not aimed at abolishing its use. But the exercise provides some numbers that can only be interpreted with great care and in a broader context. Growth diagnostics is one way to provide that context.

International Benchmarking

Another tool that is becoming increasingly popular is the use of international rankings. Many organizations with different objectives- like Freedom House, the World Economic Forum, Transparency International and the World Bank - create indices to assess the relative importance of countries in a widening set of dimensions.

[6] Assuming a Cobb Douglas production function.

Table 1 provides a list of the main international surveys and brief description of their character.

Table 1
Some International Surveys that can be used, carefully…

Name	Website	Description
World Bank Enterprise Surveys	www.enterprisesurveys.org	Firm surveys in over 100 developing countries. A mix of subjective indicators (e.g. raking of constraints) and objective indicators (e.g. how many power outages last year). Summary reports and country-firm level data is available.
World Bank Doing Business Indicators	www.doingbusiness.org	Data on the efficiency and costs of business regulations in over 170 developing countries based on standardized pre-selected transactions.
Global Competitiveness Report	www.gcr.weforum.org	Based primarily on surveys of business leaders, with data on 131 developing and developed countries, spanning health and education, institutions, infrastructure, and market efficiency.
Transparency International Corruption Perceptions Index	www.transparency.org	A ranking of 180 countries on perceptions of corruption
World Bank Worldwide Governance Indicators	www.govindicators.org	Survey-based indicators of voice and accountability, political stability, rule of law, regulatory quality, control of corruption, and government effectiveness.

The idea of measuring performance in a comparative manner is in principle very useful, as it provides feedback to a society about its performance relative to what seems feasible. As such, it can trigger a social conversation around the topic at hand. Moreover, if properly interpreted and used, it can contribute evidence to a diagnostic effort. However, there are important aspects that condition its usefulness.

First, there are issues with the soundness of indicators. By definition an indicator is a one dimensional measure of something. But many of the underlying phenomena the indicator tries to quantify, such as competitiveness, institutional quality or investment climate, are very high dimensional. Consider for example the Global Competitiveness

Index of the World Economic Forum. It considers that competitiveness is related to 12 areas or pillars.

Table 2
The 12 pillars of competitiveness. Global Competitiveness Report 2007-2008

• institutions	• labor market efficiency
• infrastructure	• financial market sophistication
• macroeconomic stability	• technological readiness
• health and primary education	• market size
• higher education and training	• business sophistication
• goods market efficiency	• innovation

Each of these areas is in itself a complex sub-area with many different aspects. For example, the quality of the institutional environment is measured with the 18 indicators described in Table 3.

Table 3
Components of the Institutions pillar of the Global Competitiveness Index

• intellectual property	• diversion of public funds
• protection of property rights	• strength of auditing and reporting standards
• transparency of government policymaking	• business costs of terrorism
• judicial independence	• efficacy of corporate boards
• efficiency of legal framework	• ethical behavior of firms
• favoritism in decisions of government officials	• business costs of crime and violence
• presence of organized crime	• wastefulness of government spending
• protection of minority shareholders' interests	• reliability of police services
• public trust of politicians	• burden of government regulation.

Note how different each item on the list is from each other. Take for example public trust in politicians, business costs of crime and violence and burden of government regulation. These are complex systemic outcomes which are themselves caused by a very large set of factors.

The construction of the index involves projecting this complexity into a lower dimensional space. This makes them easier to understand and, if reduced even further to a ranking, akin to a sports competition. However, this reduction necessarily implies a loss of information, and depending on the manner in which it is done it can do more harm than good.

A common method to reduce dimensionality to simply take averages of disparate components. This approach implicitly involves the assumption of linearity and separability in the construction of indexes. Linearity makes all the dimensions of the index into substitutes. Judicial independence is averaged with presence of organized crime and ethical behavior of firms. The weights used in these averages are usually arbitrary. Moreover, according to this methodology, if you under-perform on one you can make it up by over-performing on the others. In real life, these elements are more likely to be complements than substitutes: one license can stop all investments in a sector; it is not compensated by performance along other dimensions.

Separability means that the effect of improving things in one dimension is independent of the state of the other dimensions. The implicit assumption is that the mapping between each dimension and performance is monotonically increasing in all dimensions, all the time. This is highly unlikely to be the case. Second-best interactions are bound to be very important. The benefit of having fewer licenses has to be traded off against the benefit of assuring consumers that products are safe and banks are sound. The benefit of having low license fees must be traded off against the cost of having licensing offices that are cash strapped because, in the absence of adequate fees, they depend on a weak central government budget. Low labor taxes in the US go with little public provision of health services leaving more of the burden of health insurance on corporate balance sheets while making labor mobility riskier for workers, as they typically lose their health insurance when they lose their jobs.

A more serious issue is the use of the index in terms of identifying problem areas or binding constraints. One typical approach is to focus the attention on areas where a country performs poorly. For example, the Global Competitiveness Index classifies as assets each area where a country performs better than its average and as liabilities those areas where it underperforms[7]. The idea is to focus on areas of relative weakness. However, poor performance of a country in an area can be an indication of an inadequate supply, and hence a problem, or just low demand for that particular factor given the country's structure. Countries for example may differ in the importance and effectiveness of R&D expenditures for their pattern of growth. One country may be spending more than another, and yet be under-spending more *vis a vis* its optimal allocation. The quality of the contracting environment may be more important for growth in some countries than in others and consequently, more attention might have been paid to it despite it's a good ranking.

Some surveys directly ask people their opinion regarding the relative importance of a problem or constraint. For example, the Global Competitiveness Report and the Investment Climate Assessment Surveys ask interviewees to rank a closed list of potential obstacles. There are several problems regarding the interpretation of these results. First, there are the standard doubts about truth telling. Second, a sample of existing firms is a biased sample of the firms that *would have existed if the relevant constraints were removed*. The surviving firms may be politically well connected, form part of financial conglomerates, or are exempt from taxation because of some specific provision, making them less sensitive to problems of governance, finance or taxation, respectively. In addition, comparing hedonic scales across individuals and countries is rife with cultural issues: what is outrageous corruption in Sweden may not raise too many eyebrows elsewhere[8].

[7] See http://www.gcr.weforum.org/

[8] Here normalizing and making a within country ranking of constraints may be useful. But still there can be a huge sector specific heterogeneity, so it is advisable to explore that heterogeneity splitting the sample between sectors.

Nevertheless, in spite of problems in the construction and use of international rankings, they are becoming a new and useful source of information that a good growth diagnostic exercise can make good use of, provided they are well used.

In sum, the three workhorses of recent growth analysis – Barro-style growth regressions, growth accounting and international rankings – can contribute pieces of the puzzle, but they fall short in terms of an approach to effectively diagnose and identify the problems that may be affecting a specific country.

Growth Diagnostics

Anna Karenina starts with the famous line: "Happy families are all alike; every unhappy family is unhappy in its own way." Paraphrasing Tolstoy, each poor country may be held back by very different things. The point of the growth diagnostic approach is to find out what these things are.

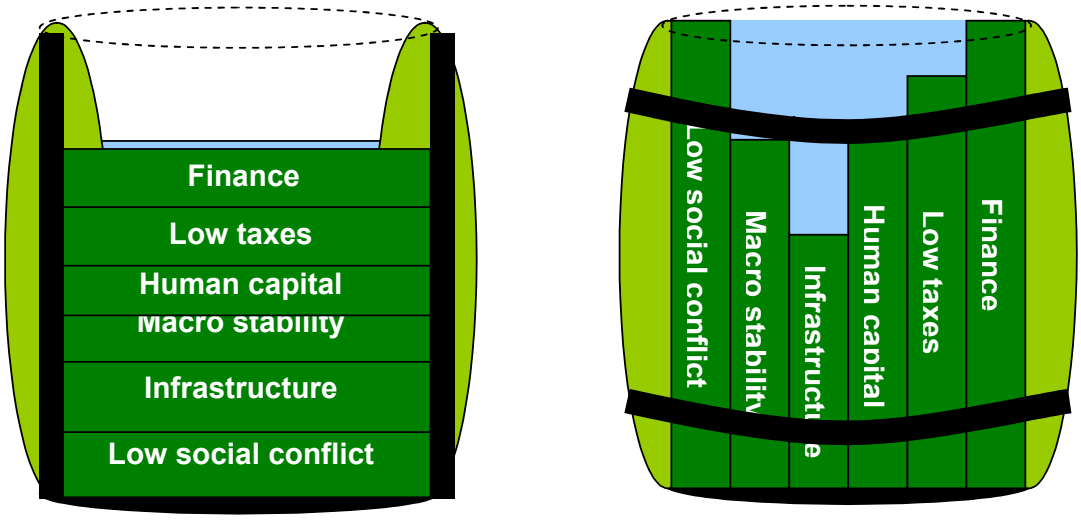
Implicitly both cross-country regressions and international rankings, by adding up different right-hand-side variables, assume linearity and separability. This implies that the variables considered are substitutes; poor performance in one are can always be compensated with over-performance in another area. Moreover, the impact of any policy on growth is independent of the level of the other variables[9]. At the limit, no diagnostic is really needed because action in any front is going to have an equal effect on the outcome in all countries, whether one improves the trade regime, the educational system, property rights or the level of trust in politicians.

The growth diagnostic approach gives greater weight to the possibility that the determinants of growth are complements rather than substitutes. The contrast can best

[9] In principle, one can put interaction terms, which would cause the impact of one variable to depend on the level of another. However, there are so many potential interaction terms that the degrees of freedom of the estimation collapses very rapidly. See Rodriguez (2007).

illustrated by looking at the structure of the two barrels in Figure 1[10]. The left hand barrel has horizontal wood slabs, while the right hand side barrel has vertical slabs. The volume in the first barrel depends on the *sum* of the *width* of all slabs. Increasing the width of any slab will increase the volume of the barrel. So a strategy based on improving anything you can, when you can, while you can, would be effective.

Figure 1
How much liquid will the barrel hold?



The volume in the second barrel is determined by the *length* of the *shortest* slab. Two implications of the second barrel are that the impact of a change in a slab on the volume of the barrel depends on whether it is the binding constraint or not. If not, the impact is zero. If it is the binding constraint, the impact will depend on the distance between the shortest slab and the next shortest slab. In other words, the impact of a relaxation of the binding constraint is not just some estimated coefficient times the magnitude of the change. If the change is large enough, the distance to the next binding constraint will matter too.

[10] The figure on the right is known as Liebig's Barrel. What in economics is called a Leontief production function was first formulated by Karl Philipp Sprengel in the early 1800s. Given the fact that plant nutrients enter in relatively fixed proportions he proposed that total production depends on the scarcest nutrient. Later, Justus von Liebig, , "father of the fertilizer industry", popularized the concept with the analogy of a broken barrel (Liebig's barrel) that contains as much output as the shortest stave.

It is tempting to think that in a poor country, everything is binding because everything is in poor shape. But it is unwarranted to think that all dimensions are binding at the same time. Yes, infrastructure is lousy, banks are not Swiss and schools leave a lot to be desired. However, education may be lousy but other things may be so much worse that high-skilled individuals are either leaving the country or driving taxis. The banking system may be small, but banks may be full of liquidity and desperate to find sound customers to lend money to at very sensible interest rates. Why there are so few takers may be the question to ask.

In practice, the world is somewhere in between the two extreme representations of Figure 1. This implies that there are some constraints that would have minimal effects because something else is preventing their relevance, but more than one constraint may be restricting growth at the same time.

So, if all possible constraints are not equally binding, the questions becomes which ones might be binding disproportionately? Which one, if relaxed, will deliver the biggest bang for the effort? This becomes the central question of growth diagnostics, as it permits the setting of strategies and priorities in a more disciplined manner.

Theoretical Considerations

First, the most binding constraint is not necessarily the one that exhibits the highest distortion, measured as the wedge between private and social returns. For example, while an import tariff is a distortion because it creates a wedge between social and private returns of a factor, the importance of that wedge will depend on the impact of the factor. A very high import tariff on an exportable or on a good that has many substitutes does not have much social impact. So the question really is about the area of the implied Harberger triangle and not just its height. If the height of the triangle is

the tax rate, then the base will depend on the way the system responds to the distortion[11].

A second issue is that normally we cannot manipulate the binding constraint directly. The metaphor of a barrel was developed originally for the fertilizer industry. In that case, if nitrogen is missing, you just need to add it[12]. However, intervening in an economy is more complex. On the one hand there are implementation problems which make it difficult in practice to affect some constraints. This is the case when government has no levers to move that constraint, or when that lever is not really cost effective.

On the other hand, a policy can impact many constrained factors at the same time. For example, if infrastructure is seen as the binding for a country, then increased investment may be the solution. But how the government finances this effort may impact the tightness, or shadow price, of other constraints such as macro risks or availability of finance. If something is the binding constraint, relaxing it may or may not have very large direct benefits that may overwhelm the indirect effects on other aspects of the economy.

While slightly more complicated, this corollary is just an application of the second best theorem (Lipsey and Lancaster, 1956-57). It says that in an economy with many distortions, eliminating one distortion is not necessarily welfare improving.
In principle, as argued in HRV, focusing on the constraint that has the biggest direct effect increases the chances that the overall effect would still be beneficial. However, this is a presumption that should be considered more directly in the diagnostic. Clearly, if something is the binding constraint it may not be that easy to remove. Otherwise, political entrepreneurs might have already done it given the expected

[11] In HRV this is shown to depend on the shadow price of the constraint in the optimization problem and not on the tax rate per se.
[12] A reader well informed about Soil and Plant Science will recognize that the nutrients in the soil are not so easy to manipulate either.

returns. So, it may be hard to affect and hence may not necessarily constitute the best way forward. This is a question of therapeutics, the topic of section 4.

Moreover, even if two countries have the same most binding constraint, the optimal policies to deal with them might be different. This is so because, inter alia, the level of all the other distortions affect the impact of any change. If infrastructure is the problem, countries with different amounts of fiscal space may go about things very differently.

At the center of the growth diagnostic problem is the fact that we do not know what is the right growth model of the economy we are working on. Hence, the diagnostic process should generate some idea of the possible constraints on growth in a particular economy and affect the probability we assign to different alternative hypotheses. But at the end of the day the objective is to have a rational prioritization of interventions. In this respect, it is similar in spirit to the literature on *decision making under ambiguity*. Although much less formally, it follows Manski (2001) and Brock, Durlauf and West (2003), in that it looks for a way to move forward without reneging on the uncertainty about what is the right model of the economy.

Growth diagnostics goes from a very aggregate outcome, such as the growth rate of an economy, to its potential causes. As such, it is a top-down approach. The alternative bottom-up approach is the classic cost-benefit analysis of individual projects and policy initiatives. Cost benefit analysis assumes that there exists such a thing as "a proposal" – a plan for action – which just requires a quantification of its potential effects. That would be an excellent way to do growth policy if we had access to all the potential proposals in the world, including all potential combinations of projects. However, there is sample selection, because only some (and not necessarily the most relevant) proposals reach the cost-benefit evaluation stage.

Growth Diagnostics, by taking a more top down approach, tries to unveil the areas where there might be high payoff projects in terms of growth. It is a natural complement of cost-benefit analysis in this grid search for better policy alternatives.

Growth Diagnostics and the HRV Model

Implicit in a discussion of the constraints to growth in a country is a particular model of the economy. It is important to note that many of the methodological principles in doing growth diagnostics discussed below are not dependent on the precise nature of the model. Indeed, these principles can be applied to economic issues other than growth, such as the causes of low levels of education, rampant informality or high inequality. Our focus here on growth is not because we suggest that it is the *only* issue that is important. Nevertheless, it is important enough to warrant detailed study.

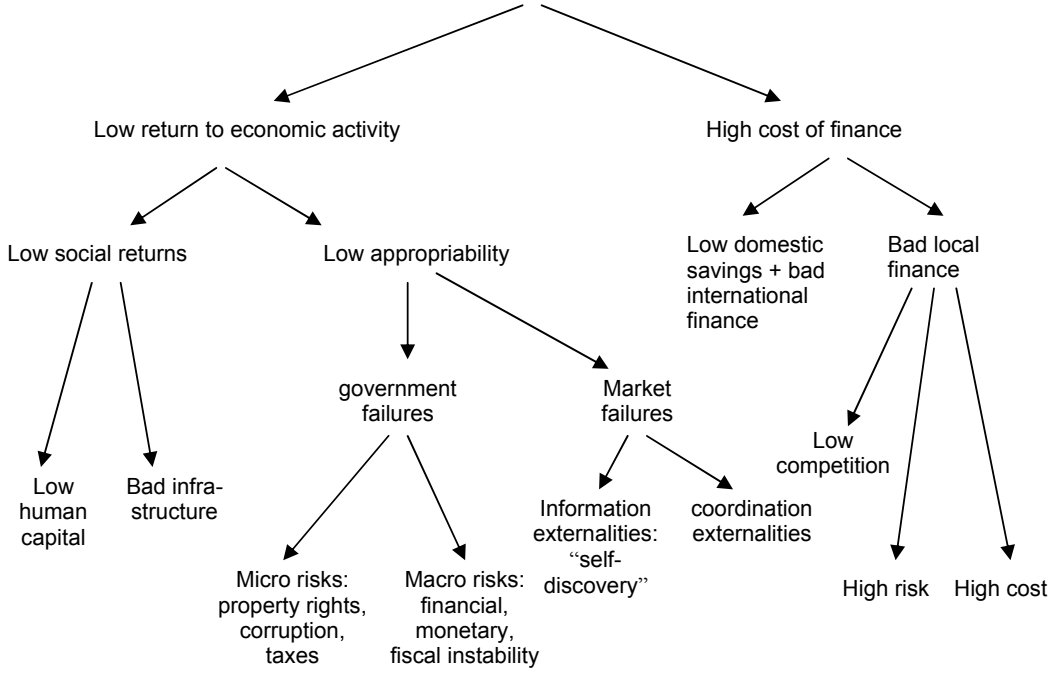
As a starting point for a diagnostic, HRV present a decision tree (Figure 2) motivated by a simplified growth model that allows for several types of distortions. An important property of many growth models, including HRV, is that in a balanced growth path, the rate at which the economy grows (which equals the rate at which assets are accumulated) is a function of the difference between the expected return to asset accumulation and the cost of those assets as seen by the private agents which are accumulating those assets. The greater the gap between the expected return to asset accumulation and acquisition cost, the greater the investment effort. This can be seen in the following expression:

$$g = \frac{\dot{c}_t}{c_t} = \frac{\dot{k}_t}{k_t} = \sigma\left[r(1-\tau) - \rho\right]$$

Where g is the rate of growth of the economy, c and k are the levels of consumption and capital per capita, r is the expected social return to investment, $(1-\tau)$ is the proportion of r that is privately appropriable and ρ is the opportunity cost of funds. The greater the gap, the bigger the incentive to accumulate and the higher the growth rate.

This model leads to a very clear first cut at the potential nature of constraints: countries might not be growing either because the expected private return of asset accumulation $r(1-\tau)$ is low or because the cost of funds ρ is high. It is this condition that begins the HRV decision tree. It implies two potential scenarios: those in which there are plenty of privately profitable investment opportunities but few financial resources to carry them out (high ρ) or those in which private expected return rates to carrying them out are low (low $r(1-\tau)$). This first distinction can then be further decomposed into more precisely refined constraints: is the low return problem one of low social returns r or one of low expected appropriability $(1-\tau)$? One could then decompose further and ponder what could be the cause of each. Equally, on the right hand side of the decision tree, one could ask, what lies behind the high cost of finance? Is it a lack of aggregate savings because of low domestic savings and lack of additional access to foreign savings or is it one of poor intermediation? This is not unlike the Ishikawa diagrams used in Industrial Quality Management, where the idea is to identify the factors behind poor performance by asking a series of *nested* questions.

Figure 2
A Growth Diagnostics decision tree
Problem: Low levels of private investment and entrepreneurship



Criticisms

This seminal HRV Growth Diagnostics paper received several criticisms, mostly related to the implementation of growth diagnostics. These criticisms have allowed the methodology to be extended and improved. Here are a few of the most relevant, which we address below.

- *It's not really a tree.* As Dixit (2007) points out, one should not take at face value the idea of a decision tree which would imply that moving down one branch excludes all others from consideration. Indeed, after a few rounds of argumentation it is obvious that branches cross each other because there may be complex interactions between the different potential constraints. Many economic problems cannot be easily classified in the mutually exclusive categories shown in the HRV paper. As argued by Dixit, the proper framing for argumentation should Bayesian. But the tree is quite helpful in organizing

and disciplining the analysis in its early stages, and a useful tool in communicating results.

- *What to do with coordination problems.* Focusing only on shadow prices and one constraint at a time can be leaving out possibilities where there is no demand and no supply of a given factor because of a coordination failure (Rodriguez, 2005; Dixit, 2007; Aghion and Durlauf, 2007a).

- *Investment is not always growth.* The original HRV paper puts investment at the top of the decision tree as the variable to explain. However, in some cases, aggregate investment may seem adequate but it may be hiding a strong misallocation (Fernandez –Arias, 2008). This critique misses an important point: in HRV asset accumulation is seen as an interesting area to search for symptoms of a problem because problems get reflected in investment behavior, independent of the relative importance of such behavior for growth. More practically, there are very few cases of countries where distortions are such that private investment is too high. The typical examples used to argue against capital fundamentalism – Tanzania and the USSR – did not involve private investment. The most common distortions such as poor property rights protection, macroeconomic instability, inadequate infrastructure, corruption, etc. have the effect of lowering private investment below optimal levels.

- *Investment is not necessarily productivity.* This is a key misunderstanding of the methodology. The level of investment in this model is determined by the returns to such investment. The entire left-hand side of the decision tree is about the determinants of productivity that would increase the demand for investment. Therefore, productivity is implicitly the central focus.

- *There is no one single binding constraint.* Yes, but the opposite is not true: not all poorly provided inputs are important constraints, as they do not all bind at the same time. If agents find expected returns to be dismal, changing the

availability of finance may do little to investment. The HRV paper suggested focusing on the constraints that have the highest direct effect in order to increase the chances that the impact would overwhelm potentially negative second-best interactions. There may be more than one that either fits these conditions or that one cannot discard as potentially fitting them.

Other Notes of Caution

The iterative elimination of potential constraints is not a process free from controversy. For example, a potential robustness check consists of changing the order of elimination and seeing whether it leads to the same place. Or in the case of coordination problems, one may want to look at both at the demand and supply side of a constraint.

Also, it is important to try to achieve a level playing field between alternative hypotheses and let the process guide the outcome. The burden of proof should be equally hard for all the potential alternatives. It is much less persuasive when the "survivor of iterative elimination" is reported as a binding constraint just because there are no good tests to reject it.

In some cases, the lack of level playing field is the result of availability bias. For example, it is easier to get financial data, so it is easier to accept or reject finance as a binding constraint. But, for infrastructure and productive diversification the available data tend to be worse and tests are less precise. However, it is important that this not bias the outcome in favor or against such hypotheses. In other cases, there might be agency problems. Both the analysts and the organizations asking for growth diagnostics have their pet hypotheses, which may result in less effort in rejecting them.

Finally, after going over this tree, one needs to build a coherent story of the economy. Here, one can "stand on the shoulders of giants", by asking how the country's data match with existing models of economic growth, and how the empirics can tell apart

one model from the other in a particular country, as suggested by Aghion and Durlauf (2007a). Nevertheless, one should not force a country to fit a particular *existing* model. Maybe the best model for that country still needs to be written, and Growth Diagnostics should be viewed as the process of unveiling that model through an iterative process of deduction and induction, data and theory; but contextual to the country.

Bayesian Approach [13]

A key challenge of growth diagnostics is integrating diverse and at times disjointed pieces of evidence from a variety of sources, including cross-country datasets, microeconomic surveys, and the popular press. As discussed above, the "state of the art" – growth regressions, growth accounting and international rankings – are less than perfect instruments and throw away a lot of interesting and relevant information due to their data requirements. It restricts the types of questions that can be asked and the kind of evidence that can be used to advance the search. How does the analyst go about assembling such evidence? This is a situation that is ideal for Bayesian analysis.

How does it work? Suppose you are working with a team of analysts pondering what the binding constraint of a particular problem might be, say why country C grows so slowly. There are several hypotheses in the group and each member assigns a subjective probability to what the cause is.

The Bayesian approach implies that as new symptoms of the country are identified, members update their convictions following Bayes' rule:

$$\Pr(H_X \mid S_i) = \frac{\Pr(S_i \mid H_X)\Pr(H_X)}{\Pr(S_i)}$$

[13] A more complete discussion is in Dixit (2007).

To build intuition on this rule we will use the example of trying to identify a terrorist (hypothesis, H_x) when one has access to different signals (in this case, S_i is a bomb).

Note that the denominator is the unconditional probability of a bomb, Pr(S_i), which is very low because we very rarely see people carrying bombs. A low denominator naturally raises the posterior probability Pr($H_X \mid S_i$). However, the proportion of terrorists in the population, Pr(H_X), is also low. Terrorists are infrequent, so it reduces *ceteris paribus* the likelihood of the terrorist hypothesis.

But, we also have the conditional probability that somebody is a terrorist if he is carrying a bomb, Pr($S_i \mid H_X$). Given that this is orders of magnitude higher than the unconditional probability (a normal person carrying a bomb) the posterior probability turns out to be very high.

This is a case when the signal is very informative, because it is very infrequent unconditionally, but very likely conditional on the hypothesis, i.e. on being a terrorist. An uninformative signal, on the other hand, could be the presence of a beard. Many terrorists may have beards, but so do many non-terrorists, so observing a beard should have a very small impact on changing one's priors.

In general, tests in a growth diagnostic are less informative than observing a bomb, but still more informative than a beard. Many tests have some potential to update our beliefs.

Significantly, there is nothing that the method requires about prior probabilities except that they be logically consistent. The greater the implication of the symptom, given the hypothesis and the more unexpected the symptom, the greater the power of the symptom to change prior beliefs.

Let's try to operationalize this. When talking about growth, it is useful to consider the fact that people may start with some set of beliefs based on known characteristics of the country. For example, the country might be in the tropics and resource-poor with high fertility and mortality rates, low educational attainment, low savings rate, mostly rural, with relatively good governance indicators and low ethno-linguistic fragmentation.

Suppose that one considers the hypothesis that the cause of low growth is a low savings rate. The hypothesis then implies that entrepreneurs have good projects, but they cannot find enough savings to do all the projects they have identified. If this is the case, then the credit market should balance at a very high real interest rate, reflective of the high marginal product of capital. Now, countries with the characteristics previously mentioned may well tend to have high real interest rates for other reasons. Therefore, one could calculate the denominator of the equation above as the probability that a country *with similar characteristics* has a real interest rate above a certain threshold. Given these characteristics, one would expect to find relatively high real interest rates, meaning that the unconditional probability of finding low real interest rates is relatively low. The conditional probability that the interest rate is low given the hypothesis is true (i.e. that the binding constraint is lack of savings) should be low. So if we actually do find a low real interest rate in this particular country, it would have a large effect in changing prior beliefs that the problem was one of insufficient savings.

This gives a role for international benchmarking: to establish the unconditional probability that symptom *j* is observed. We need to work on the conditional probability that the symptom would be observed if the hypothesis is true. In many cases, one observes that infrastructure quality is low, but it is expectedly low given the country's characteristics. Then observing low infrastructure does not greatly change one's priors.

In theory, the Bayesian approach follows from a simple table of conditional and marginal probabilities. In the simplest case, it looks like the following example. Let's assume we know three pieces of information, two from some kind of evidence and one prior.

1. The probability of observing a positive test in the population is 60%. This is not a completely uncontroversial fact, because it is not always obvious what the relevant population is, but it is still something we may be able to observe.

2. An econometric estimate tells us that 80% of countries that are constrained by the factor under study get a positive result in this test.

3. The prior (before the test) probability of this constraint being binding is 50%.

With these pieces we are able to build Table 4, where for simplicity the three pieces of information are highlighted in **bold**:

Table 4
A simple example of probabilities

		Hypothesis		
		Constraint 1 binds	Constraint 1 does NOT bind	Unconditional on hypothesis
Signal	Test = 1	**40%**	20 %	**60 %**
	Test = 0	10%	30 %	40 %
	Unconditional on signal	**50%**	50 %	100 %

This is not a very powerful test. While 80% (40% out of 50%) of countries bounded by this constraint get a positive test, so do 40% (20% out of 50%) of those where this constraint is not binding. But using Bayes' formula gives us our answer: the after-test probability that this constraint is binding.

$$\Pr(Const1 = binds \mid Test = 1) = \frac{\Pr(Test = 1 \mid Const1 = binds)\Pr(Const1 = binds)}{\Pr(Test = 1)}$$

$$= \frac{\left[\frac{40\%}{50\%}\right][50\%]}{60\%} = \frac{40\%}{60\%} = 1/3 \approx 66\%$$

So the updated probability of the hypothesis increased 16 percentage points, from 50% to 66%. As we see, a *single* weak test is not going to make a persuasive diagnostic by itself. A powerful test us one that is very likely to give a positive results if the constraint is binding and very unlikely to be positive if it is not binding.

The example above highlights three more issues. First, the change in the posterior probability is linearly proportional to the prior[14]. For example, if the prior probability of the constraint being binding is 10% rather than 50%, then the posterior would have been 13.3%, an increase of only 3.33 percentage points rather than the 16.66 points increased in the baseline example. So evidence helps, but its impact depends on the strength of the priors: strong priors of policymakers are harder to change than weak priors, requiring more powerful evidence to effect a similar change. At the limit, if people have priors of probability zero (or one) for a hypothesis, no test can affect their beliefs.

Second, the true and complete matrix is unmanageably large. Moving to a practical implementation, we have potentially hundreds of tests we could run. Moreover, the number of rows in this matrix should also include all the possible interactions between signals. Similarly, we have many possible binding constraints as columns. As a result, we end in a curse of dimensionality.

Thus, to apply the Bayesian framework in practice we need to make some assumptions. One such assumption is that every decision of signal / constraint is

[14] Note that the combination facts (1) and (2) is only consistent with priors in the range from zero to 75%. Priors beyond that point are not logically consistent because all probabilities in the table should be between zero and 100%.

separable[15]. For example a test about crime is uninformative about the hypothesis of access to finance being a binding constraint. In this case, this assumption seems reasonable and it certainly helps to reduce the dimensionality of the matrix, gaining tractability and practical relevance. In other cases this exclusion is much more controversial. In any case, it is always better to make explicit that the true matrix is more complex and in a growth diagnostic exercise we are simplifying it.

Third, in reality we do not know the conditional probabilities in the matrix. While usual econometrics can tell us something about the probability of a signal given the hypothesis, many of the additional tests we observe for the country are omitted from the regression. Maybe in the future something like a complete matrix of symptoms and hypothesis may be published, but up to now spending all the time filling every cell in that matrix is probably not the most cost effective way to understand why countries do not grow. Therefore, applying Bayesian logic to update ones priors on the likelihood that a particular constraint is binding is an implicit, rather than explicit, exercise. The Bayesian approach is something the analyst needs to have in the back of their mind when analyzing tests and constructing arguments.

The following Section uses these Bayesian principles in the four key identification strategies used in a differential diagnostic, which are explained with examples, and then are applied to the growth diagnostics decision tree in Section 4.

[15] The matrix then would be diagonal by blocks.

2: Principles of a Differential Diagnosis

With this Bayesian framework we can posit four general properties that a constraint should exhibit for it to be potentially binding (Table 5). We will discuss them in order. No single test or symptom is clearly definitive: any test implied by these guidelines may have limited value to discriminate among potential binding constraints on its own. A differential diagnostic requires the application of several tests, which are collected and aggregated in the proper Bayesian framework. The result of a battery of tests will be stronger a posterior probability that a particular constraint, or set of constraints, is binding, thus incorporating the richest set of information available.

Table 5
Principles of a Differential Diagnosis

If a constraint is binding, then

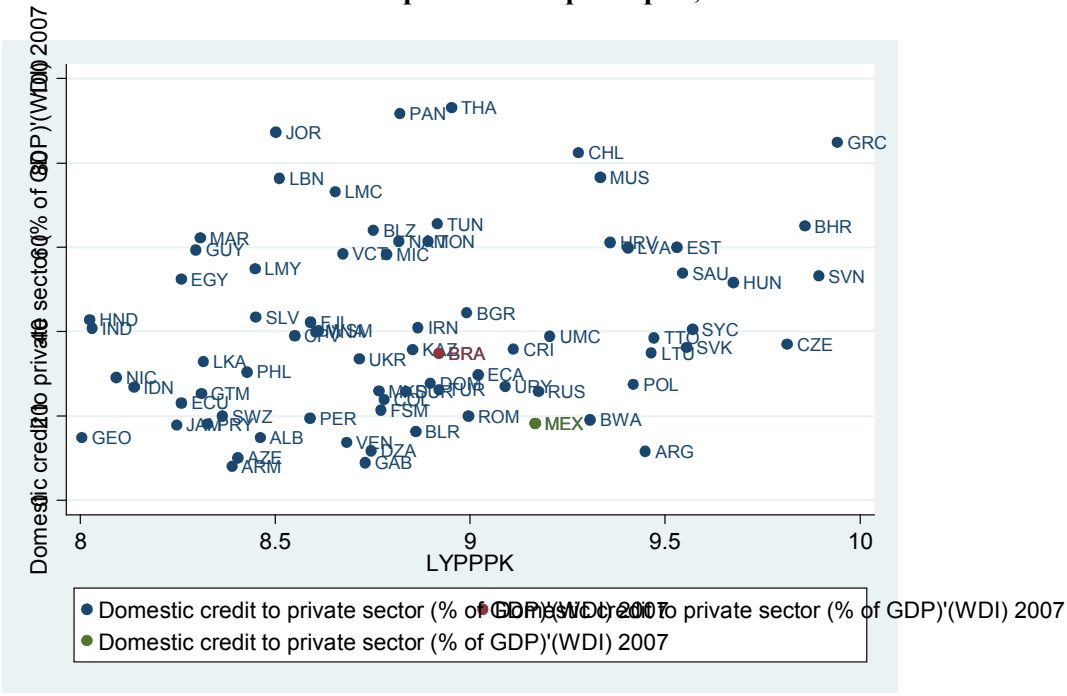
1) The (shadow) price of the constraint should be high
2) Movements in the constraint should produce significant movements in the objective function
3) Agents in the economy should be attempting to overcome or bypass the constraint
4) Agents less intensive in that constraint should be more likely to survive and thrive, and vice versa

1) The (Shadow) Price of the Constraint is High

This is the fundamental principle for identifying binding constraints to growth put forward in the original growth diagnostics paper: the degree to which a constraint is binding is indicated by its shadow price. A shadow price is the change in the objective function due to an increase in the supply of one of the constrained inputs, and a high shadow price indicates that relieving that constraint would have a large impact. While we don't always observe such shadow prices directly, they are often signaled by actual or implied market prices, or other symptoms of un-met demand.

Let us take for example the hypothesis that the problem in a particular country is the availability of credit to the private sector. A popular measure is the amount of credit to the private sector as a share of GDP. This is a quantity measure, not a price measure and is popular in cross-country growth regressions. Figure 3 shows this variable for a set of middle income countries.

Figure 3
Financial depth vs. GDP per capita, 2005



Source: EIU.

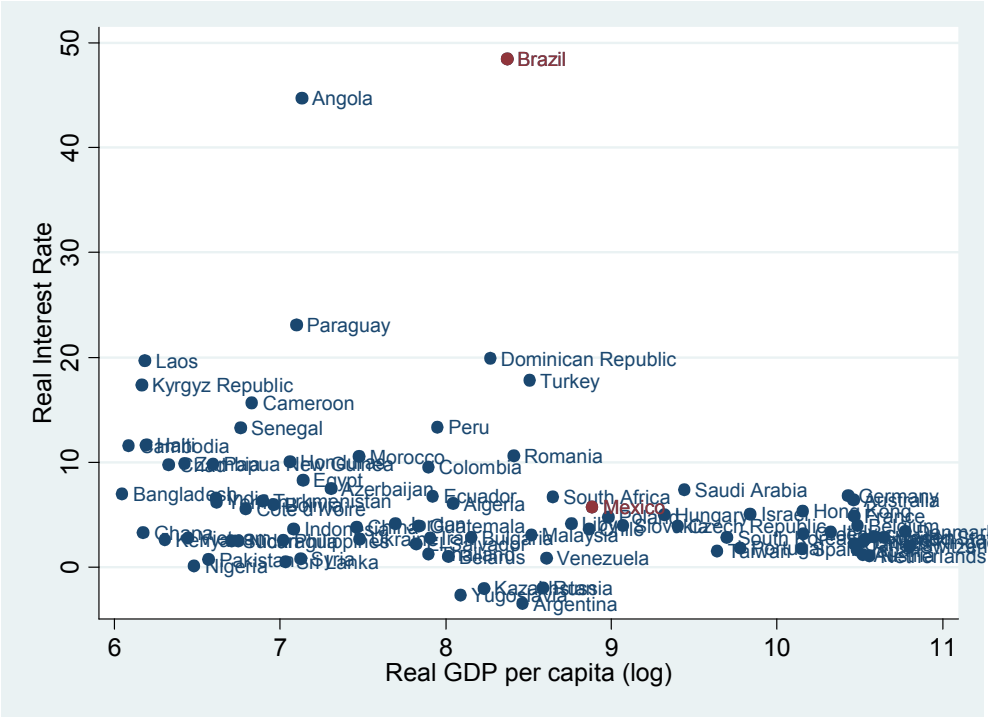
This graph suggests that the financial depth in Brazil is significantly higher than in Mexico. Does this mean that finance is less likely to be a binding constraint in Brazil than in Mexico?

The key error in this reasoning is that a low quantity is not necessarily a signal of scarcity of the factor. The quantity of finance supplied in an economy may be low because of scarce supply, in which case it would be a binding constraint, but it may simply be low because of low demand, in which case it is not a binding constraint.

The way to distinguish between one case and the other is the price: low quantity and a high price indicate scarcity of supply relative to demand. In the case of finance, the 'price' is the real interest rate. This is shown below, where we see that the price of finance in Brazil is actually among the highest in the world, whereas that in Mexico is quite low. This suggests that the conclusion based on quantities is incorrect, and if anything the opposite is true: the very high price of finance in Brazil and low price of finance in Mexico are strong signals that access to finance is a binding constraint in the former and not in the latter.

Here we use international comparisons as a way of inferring what real interest rate to expect unconditionally given the known country characteristic of the country, like its level of development. Such comparisons give us some sense not just of the average level of a certain price in a sample of countries, but also of its variance. If the standard deviation of real interest rates is very large relative to the distance of the country from the mean, it will be hard for the test to change the analyst's priors. In this particular case, the observation for Brazil is so stark because it is several standard deviations outside the expected range. So it provides a particularly powerful signal in favor of a financial constraint story.

Figure 4
Real Interest Rate vs. GDP per capita, 2005



Source: EIU. Real interest rate is taken as the lending interest rate minus inflation (change in consumer prices).

It is important to try to get as good a price of a constraint as possible. In this case, the economy-wide 'lending interest rate' may not reflect the actual marginal price charged for financial capital. We know that bank lending rates vary a lot depending on the amount of collateral, the type of borrower, the amounts, tenor, and so on. The average lending rate used in this example may or may not be appropriate.

Moreover, we know that all financial markets are distorted because of moral hazard and willingness to pay problems. There is bound to be credit rationing in all financial markets for reasons discussed in the literature since Stiglitz and Weiss (1981): as the probability of default goes up with the interest rate, there are classes of risk that are simply rationed out because the required interest rate to cover the risk would trigger a default. Rationing is a common feature of many markets and we will return to it shortly.

Other factors have implicit prices that can be inferred with a bit more work, for example using hedonic regressions that help us to get a sense of the price of each characteristic of a good. The returns to human capital can be approximated using a Mincer (1958) style estimation, which involves a regression of the log of wages on the years of schooling and other controls such as experience, gender, type of employment, sector of activity, location, and so on.. These estimations are not perfect, among other things because we have reason to believe that there is an important omitted variable bias[16] and potentially there may be positive externalities associated with education, as many endogenous growth models assume (e.g. Lucas, 1988). However, researchers have yet to find convincing evidence of the an important education externality (e.g. Acemoglu and Angrist, 2000).

[16] The returns to schooling are dependent on a person's unobserved characteristics, such as ability, which may be correlated with the decision to stay in school for a longer period of time, given higher expected returns. Hence years of schooling and ability may be positively correlated and this would bias the estimated returns to schooling upwards, as the estimation would attribute to schooling what it is fact a return to ability. This problem has been addressed in the US with independent measures of ability for some samples and the estimated corrections are not large (Heckman, Lochner and Todd 2003). However, this bias can be mitigated by comparing a country internationally, since the bias is bound to affect all countries in a more or less similar fashion, at least to a first approximation, so the estimated differences in returns across countries can be informative.

Figure 5
Mincerian returns to education vs. years of schooling of the labor force, 2001



Source: Own calculations based on country household surveys collected by the Inter-American Development Bank.

Figure 5 shows the Mincerian returns to schooling vs. the average years of schooling of the labor force. It suggests that while the average level of schooling in El Salvador, Bolivia or Venezuela is rather low, the returns to schooling are also quite low suggesting that society is unwilling to pay for a greater supply of the education that is being delivered.

There are situations where one presumes the presence of externalities and distortions so the shadow price may be significantly distorted *vis a vis* the market price. A method to get at this was proposed by Klenow and Rodriguez-Clare (2005) and used by Rodriguez-Clare to assess R&D externalities and by Velasco (2005) to assess distortions in human and physical capital markets. It is based on calibrating a neo-classical growth model with distortions and deriving the notional returns that should be observed under the assumptions of the model given the country's factor endowment. These notional returns are then compared to the observed returns to calculate the magnitude of the wedge between social and private returns. The main

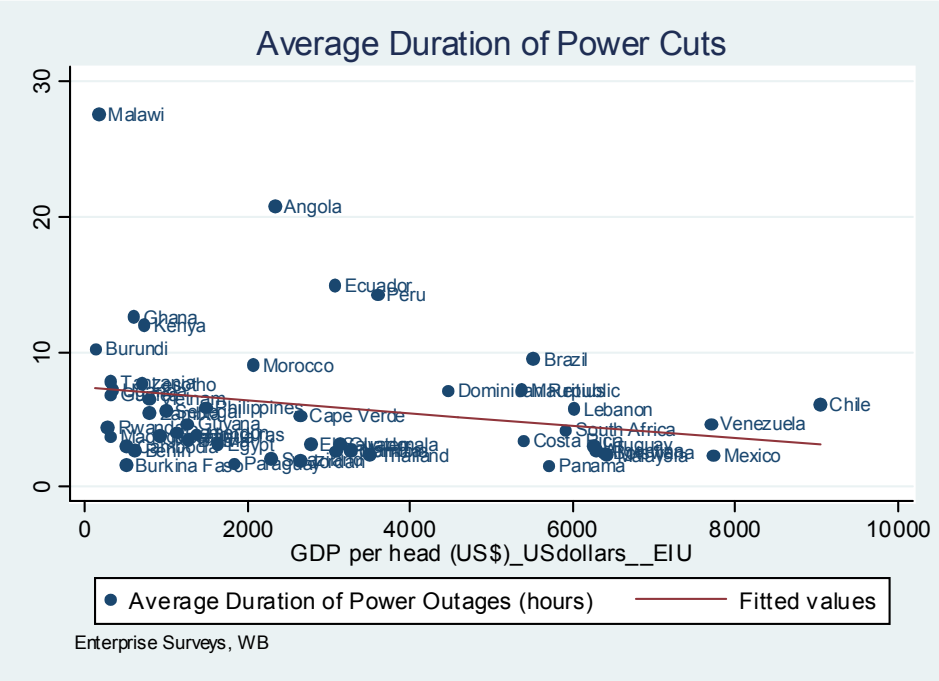
drawback is that the wedge is calculated as a residual of an assumption-laden structural model and where variables such as physical and human capital are poorly measured.

Rationing is another case in which market prices differ from shadow prices. It involves a situation where agents would be willing to supply or demand more at the current price but are unable to. It typically affects the credit, labor and infrastructure markets. In the credit market, borrowers would be willing to obtain loans at current lending rates but are prevented from doing so. In the labor market, unemployment or informality may reflect the inability of workers to access formal employment at the going wage rate. In infrastructure, congestion may affect the transportation system while poor quality or lack of provision may affect the power, water and telecommunications sectors.

In some instances, the presence of congestion in one market can be inferred from its effect in another market. For example, road congestion affects the cost of cargo, so estimates of the cost per container-mile may be indicative of the problem. In the case of education we might observe significant investment in and high prices for non-state training academies and technical schools.

The most common approach to obtain estimates of rationing have been based on enterprise surveys such as the World Bank's Investment Climate Assessments and the World Economic Forum's Global Competitiveness Surveys. Questions typically include the average frequency and duration of power outages, the time to obtain telephone service, hedonic valuation of the importance of a certain problem, etc. Figure 6 shows an example of such a statistic for power outages.

Figure 6
Average duration of power outages, circa 2006



In the credit market, surveys ask firms to rank the importance of the problem and also ask whether they asked for a loan, whether they obtained it, why they did not ask for credit or why they were denied, and so on. Interpreting the results always requires care. In principle, one would expect that in a developing country, small and medium enterprises will have difficulty obtaining credit, but assessing its relative importance is more difficult. Some survey questions are also hard to interpret. Firms, for example, do not request a loan if they do not expect to obtain it, so rates of denial of loans are hard to interpret. In addition, all surveys suffer from survivor bias: the companies that exist are the ones that were somehow able to cope with the problems that affect the companies that could have existed but don't[17].

Any diagnostic is always performed with imperfect data. The only way forward is to take such shortcomings into account when considering the degree to which the signal

[17] For a careful use of the Investment Climate Assessment data to assess credit rationing see Benhassine and Schmidt (2002).

updates the analysts' priors, and to triangulate constraints with the greatest number of diagnostic tests possible. This is the message of the epigraph by Milton Friedman.

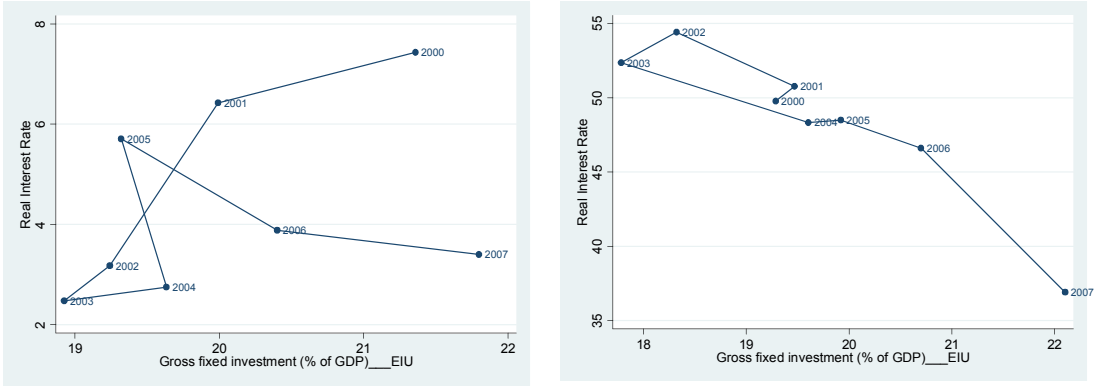
2) Movements in the Constraint Should Produce Significant Movements in the Objective

By definition, if a binding constraint is relaxed then this will increase the value of the objective function. In the context of growth diagnostics, if a particular constraint is relaxed, then this should have a payoff for growth, investment, job creation, or whatever the specific economic objective is. Otherwise, it is difficult to argue that that constraint was binding at that time.

For example, if the hypothesis is that access to finance is the binding constraint, then increases in the availability of finance through a reduction in interest rates should have a positive impact on the investment rate of the country, and vice versa. Is this observed in the data?

The figures below show real interest rates versus investment for Mexico and Brazil. Clearly in Brazil, we do observe that when the real interest rate rises, investment falls, and when rates fall, investment rises. This suggests that we are observing shocks to the supply of credit and the negative relationship indicates movements along the demand curve. In Mexico, on the other hand, investment fell from 2000 to 2003 in the context of falling real interest rates, and rose from 2003 onwards in the context of a moderate increase in interest rates. This is a signal that it is the demand for investment that explains the movement, not the cost of finance. So a financial story is again more likely for Brazil than for Mexico.

Figure 7
Investment vs. Real Interest rates, Mexico (left) and Brazil (right)



Source: EIU

These simple graphs seem persuasive, but have some important limitations. First, when countries recover or accelerate many good things happen at the same time. Thus, we have an identification problem. For example, the interest rate may be going down, but so are other risks related to the return of projects. To check the robustness of the bivariate relationship, one should carefully explore the alternative explanations.

Related to this is what is called the 'fan belt effect'. The fan belt is a simple component of an automobile that if broken can cause the engine to overheat and seize. So the fan belt breaking can be the cause of a car failing, but once this happens, simply replacing the belt will not fix the car, and the major problem is now a seized engine. The original cause of failure leads to subsequent damage, and may no longer be the binding constraint.

Similarly, a constraint to growth that is binding today may have been triggered by another constraint, rather than being the initial constraint itself that occurred when growth declined. For example, social unrest in El Salvador caused a growth collapse, and went on to cause significant damage to infrastructure (Rodriguez 2005). Although a peace agreement was reached in the country, the negative consequences of the conflict on infrastructure remain. Therefore, it would be a mistake to observe that since the decline in growth occurred before much of the infrastructure was damaged,

or because the original constraint that caused the growth collapse has since been relaxed, that infrastructure could not be the binding constraint to growth today.

Bivariate figures can be interpreted as causal stories only if one assumes that changes in the constraint were exogenous to growth. As such, these movements have to be interpreted carefully, and given greater context. Moreover, analysts must keep in mind how comparable previous periods are to the present day, as past dynamics could have been driven by constraints since relieved. In fact, the solution to a binding constraint yesterday could even negatively affect growth today. One possible example could be the Korean conglomerates - *chaebols* -, which played a crucial role in economic take-off in the 1960s and 1970s. They solved both coordination and finance problems which were binding on growth at that time, but some argue that during the nineties these *chaebols* might have generated negative externalities to the finance of non conglomerated firms, especially small and medium enterprises (Almeida and Wolfenzon, 2006). The government has since "*been exerting pressure on the chaebols to slim their empires."* As a consequence, *"with the chaebol no longer dominating access to South Korea's huge pool of savings, credit began to flow to small- and medium-sized firms*" (Economist, 2003, cited by Almeida and Wolfenzon, 2006).

With these considerations in mind, comparing the dynamics of the potential constraints to growth offers potential areas to test hypotheses.

3) Agents in the Economy Should be Attempting to Overcome or Bypass the Constraint

Private sector actors are all too aware of the constraints holding back their economic progress, and are likely responding in a wide variety of ways. There are many examples, some of which are listed below.

For example, when analyzing the economy of India one tends to observe significant anecdotal evidence of firms investing heavily in self-generation of electricity because

of frequent outages on the public grid. This anecdotal evidence is further supported by figures on the country's investment climate assessment, which indicated firms are investing a great deal more in their own power generators than in comparator countries. Similarly, in Malawi a new uranium mine (Paladin) had to invest in its own power generation because the state provider could not meet their basic requirements (Agar 2007), even though self-generation is much more expensive.

Table 6
Private responses to constraints

If this constraint is binding…	then we might expect to see:
Labor market regulations	Higher than normal levels of informal employment
Contract enforcement	The emergence of extra-legal contract enforcement mechanisms like trading within social groups or organized mafias enforcing contracts (Dixit 2005)
Electricity infrastructure	Many businesses investing in their own generators
Crime and security	Large outlays for private security guards
Uncertainty of monetary stability	Dollarization, use of inflation indexed contracts.
Coordination failures in the discovery of new activities	Vertical integration in new successful business. Efforts for industry groups to share costs in feasibility studies for new sectors and markets
Low appropriability due to high taxes	Greater use of cash for business transactions

As shown by this example, some of the evidence of agents bypassing binding constraints can be found in hard data sources, but many examples will be qualitative and anecdotal, gleaned from in-country research and interviews, as well as stories in the popular press. The idea is to incorporate the widest and most varied set of indicators and signals possible, while always remembering what a reasonable counter-factual might be.

4) Agents Less Intensive in a Binding Constraint Should be More Likely to Survive and Thrive, and Vice Versa

Consider the following metaphor. Suppose you were asking: what is the binding constraint to animals thriving in the Sahara desert? This is not unlike the question of what limits economic growth in a country. However, in the Sahara, it is instructive to

note that of those few animals that do thrive in that environment, a very large proportion are camels and a very small proportion are hippopotamus. The fact that the animals most intensive in the use of water, hippopotamus, are scarce while the animals least intensive in the use of water, camels, are thriving suggests that the supply of water may be a binding constraint to the spread of animals in the Sahara.

In general, the idea is that looking at the nature of the most successful parts of the economy can be informative of the constraints that affect others. We would expect to observe that those who are either structurally less intensive in the constrained factor, or at least more able to bypass it, will be doing comparatively well. Conversely, those sectors most intensive in the constraint will be doing relatively poorly.

This principle can be in two different directions. First, the analyst can scan the economy, identify which sectors are doing surprisingly well and which are doing surprisingly poorly, and then look for the common constraints which are less intensive for the former and more intensive for the latter. The other possibility is to start with the constraint, determine the relative intensity of the sectors and then consider their relative performance. The first direction is akin to moving from the camels and hippos to the water, and the second is akin to moving from the water to the camels and hippos.

This approach can be used informally by looking qualitatively at the nature of the growing sectors and their structure. For example, Pritchett (2003) reports that the growing firms in Indonesia had very cozy relationships with President Suharto and his family, suggesting that governance might be a problem for others. When the health of the President became an issue, investment in the privileged groups collapsed.

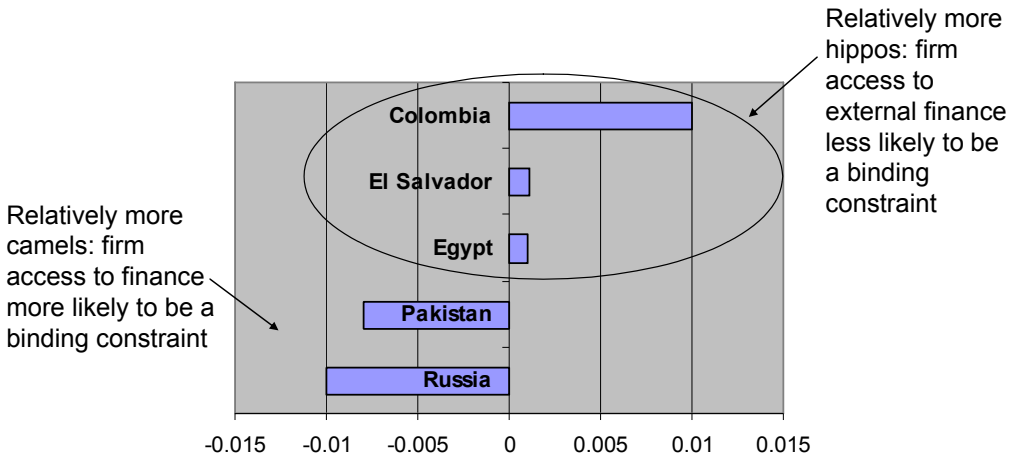
One way to formalize this methodology is by following the work of Rajan and Zingales (1998), which examines the effects of financial constraints across countries. In that paper, the authors use the heterogeneity of external finance requirements

among industry in combination with comparative performance across countries to measure the impact of financial development. Their industry-level measure of dependency on external finance comes from US data, which is assumed to be a financially unconstrained economy. In that data, industries like tobacco and apparel are relatively un-intensive in external finance, as investors can finance operations more easily through cash flows. If finance is the water, these industries are the camels. Textiles and plastic products, on the other hand, are the hippos. These industries are highly dependent on funds external to the firm, such as debt.

Rajan and Zingales show that in countries with less developed financial markets, industries intensive in external finance develop more slowly. Thus, one way to assess whether finance is the binding constraint to growth is to look at the relative performance of sectors according to their dependence in external finance. In short, for diagnostic purposes we are reversing the question asked by Rajan and Zingales.

This type of analysis could be done using the UNIDO INDSTAT database. With the industry's share of value added in country *C* as the dependent variable, one can regress this on industry dummies, industry dummies interacted with GDP (to roughly capture differing patterns of production across levels of development), and country dummies interacted with the measure of the industry's level of dependency on external finance. This interaction is the variable of interest: a positive and significant coefficient for the country of interest indicates that, controlling for typical patterns of production and their variation with the level of development, this particular country has a relatively larger share of its value added in industries that are dependent on external finance. In other words, it has more hippos. A negative coefficient indicates the opposite. The results for a sample year are shown below, for illustrative purposes.

Figure 8



Source: Authors' calculations using UNIDO INDSTAT and Rajan & Zingales (1998).

A similar exercise can be performed using any other industry-level measures of intensity in a constraint. For example, Nunn (2006) estimates the sensitivity of industries to the contract enforcement environment, proxied by the fraction of inputs that are not referenced priced or sold on organized exchanges, meaning that they require relationship-specific contracts. Just as with Rajan and Zingales' measure of dependency on external finance, Nunn's industry-level measure of contract intensity can be used by the analyst to determine if contract-intensive sectors in the country of interest are doing surprisingly well or surprisingly poorly compared to non contract-intensive sectors. The latter would be a signal that fears of appropriability due to poor contract enforcement could be a binding constraint to growth.

In some cases, an industry-level indicator of structural dependency on the constraint of interest may not be available. In such cases, one approach would be to infer it using the World Bank Investment Climate Assessments (ICAs). A core set of questions is included in the ICAs of most surveyed countries. The resulting international dataset gives firm-level data including country, industry, and the degree to which a set of constraints are seen by the respondent as a problem for business growth. Using this international dataset, one can construct a sectoral indicator of activities sensitivity to a constraint. For example, the agro-industrial sector is the one

that most complains about crime. Note that this is after controlling for country characteristics such as income, so it is not simply that poorer countries are more likely to have security problems and also more likely to specialize in agriculture. The analyst can then perform the second stage as above, to determine if the sectors more intensive in the constraint are performing worse than otherwise expected. Hausmann and Klinger (2008) used this approach to assess whether crime was a binding constraint to growth in Mexico.

Instead of variation across industries, the analyst could also exploit variation across sub-national regions to identify binding constraints. Heterogeneous performance across regions may relate to constraints that are more present in one area and less present in the other. An example of this technique in practice is Townsend (2008), who attempted to measure financial restrictions on entrepreneurship through inter-regional variation in Thailand.

As with all other types of tests, these are not absolute indicators but rather signals that can update the analysts priors to varying degrees. And with this approach in particular, there are important assumptions that must be kept in mind. Sensitivity measures such as Rajan and Zingales (1998) or Nunn (2006) assume that industry sensitivity is constant across countries. But we know, for example, that the pharmaceutical industry in Vietnam is not engaged in R&D to the extent that US firms are, and therefore would be less sensitive to the availability of long-term financing than US firms in the same industry.

In addition, a constraint's intensity in a country, and particularly across regions, could very well be endogenous to returns. For example, consider the following argument: areas in the country that benefited from a government road improvement project enjoyed much larger agricultural growth than other areas that did not benefit from the program. Is this evidence that roads are a binding constraint? This could very well be true, but it is also quite possible that the government identified the beneficiary areas based on their agricultural potential, so it is not that the road program caused

agricultural growth, but instead that agricultural productivity caused the road program to target that region. This possibility would have to be considered.

Moreover, it must be kept in mind that agents chose to locate where they located. The distribution of activities observed is an equilibrium given the current structure of the economy, so the explanation for it must account for why agents decide to stay where constraints are particularly harsh.

This illustrates that with this, and indeed any principle of a differential diagnosis, analysts must continually ask themselves why the outcome is an equilibrium given the incentives acting on firms and government.

3: Growth Diagnostics in Practice

Armed with these principles, we can engage in a growth diagnostic exercise. A diagnostic technology is one able to tell us what factor(s) are likely to be binding in a country at a particular point in time. As we have argued, growth diagnostics has to be pragmatic with respect to the kind of evidence used in the quest for binding constraint(s). It can be a regression, a survey, hard price data, hedonic or shadow prices, electoral results, a focus group or anecdotal information. The important thing is to smartly aggregate the evidence in a coherent and causal story able to update the priors of policymakers.

To set up an appropriate growth diagnostic exercise, it is useful to follow the following five step process:

i. Describe the growth process and determine a relevant question.
ii. Go through a differential diagnosis
iii. Posit a syndrome
iv. Test further implications, corroborate evidence of the syndrome
v. Iterate on (iii) and (iv) until you converge.

Each will be discussed in turn.

Describing the Growth Process

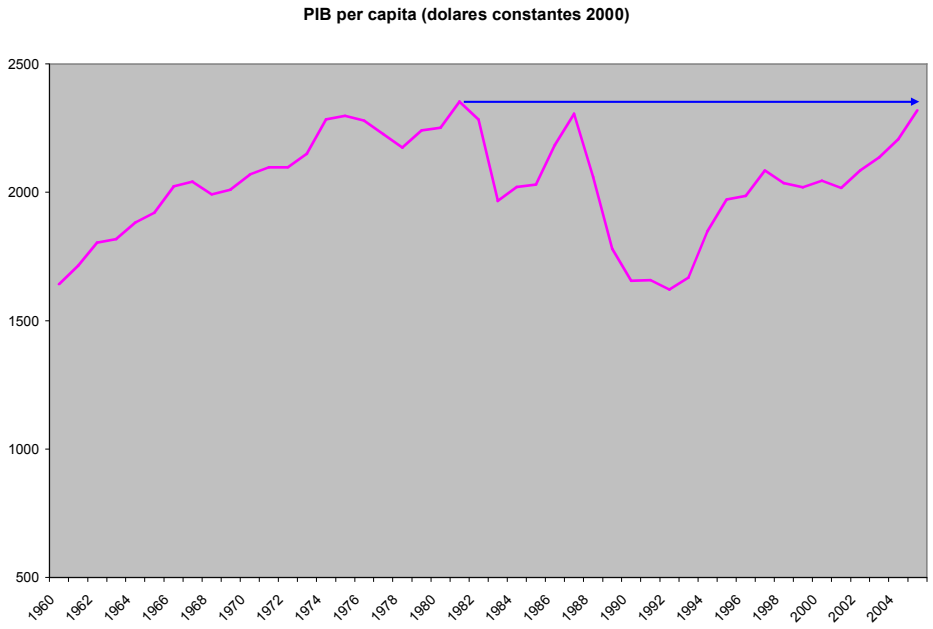
It is important to start a diagnostic exercise by framing the question in a particular country in the context of its growth history. There are several dimensions that are worth considering.

Univariate Analysis of Growth.

Here it is important to get a long run sense of the growth experience of the country. For example, one may be prima facie surprised to see the incredible growth that Peru had in the last 15 years. However, a broader look to the economy's history shows that

this was a recovery from a growth collapse. So, one should ask why an average worker in 1979, without either internet, cell phones, personal computers or even fax machines, was as productive as an average worker today. In addition, the graph begs the question of the cause behind the repeated booms and busts and the causes behind such a protracted growth collapse. In fact, the phenomenon of growth collapses is very common in developing countries and should be kept in mind when looking at countries undergoing relatively rapid current growth, which may be not more than a recovery from a previous collapse.

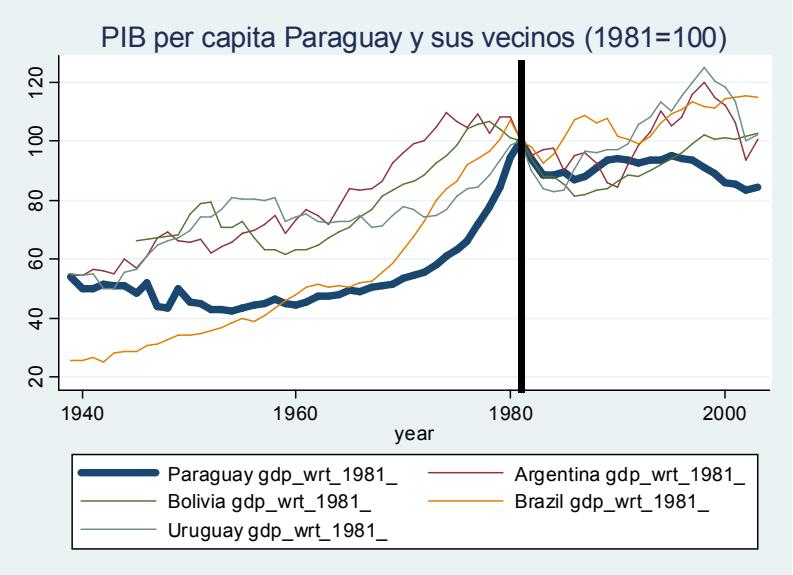
Figure 9
Peru: GDP per capita 1960-2005



Moreover, it should be remembered that the world did not start in 1960, when the World Development Indicators or the Penn World Tables begin their statistics. Going back further is often very useful to get a sense of the whole evolution of growth, stagnation and crisis. Doing so with other relevant comparators is often enlightening. For example, Figure 10 shows the long run evolution of Paraguay's GDP per capita that also includes its neighbors. The graph shows that from the late 1930s to the

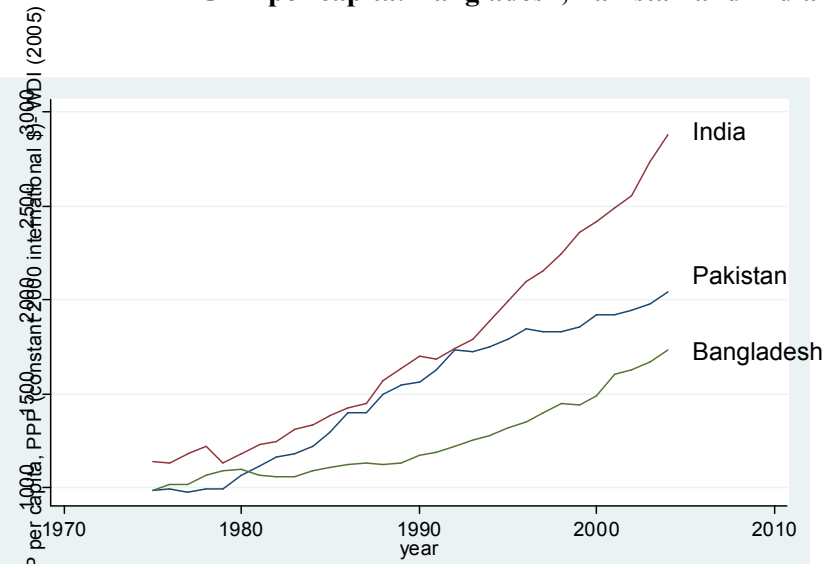
present, Paraguay really had only a single period of significant growth, between the late 1960s and 1981. It did worse than all its neighbors before and after that period.

Figure 10
GDP per capita: Bangladesh, Pakistan and India



In other instances, while growth may appear adequate itself, the country may lag behind other important comparator countries. This is the case of Pakistan, which used to be part of the same political entity with India until 1948, and with Bangladesh, until 1970. The country did better than the others until 1990, but has since fallen behind (Figure 11).

Figure 11
GDP per capita: Bangladesh, Pakistan and India



Another way to characterize growth is to benchmark it against neighboring sub-national units. For a country like Paraguay, with large neighbors, this is very informative about how much of the growth puzzle comes from the general neighborhood and how much is country-specific. For instance, in the period 1990-2000 Paraguay was the worst performer in its local neighborhood. It tells us that aggregate shocks in the area cannot fully account for this low growth in Paraguay, unless we assume Paraguay is differentially sensitive to those shocks.

Table 7
Comparing Economic Growth in Paraguay against different provinces (states) of Brazil, Argentina and Uruguay

Province / Country	Growth 1990-2000	Rank
Mato Grosso do Sul	2.1%	34
Misiones	1.9%	38
Formosa	1.0%	52
Paraná	0.8%	55
Salta	0.5%	57
Corrientes	0.3%	60
Chaco	-0.3%	64
Paraguay Total	**-0.5%**	**65**

In the table we show only the sub-national units of other countries that are directly neighboring Paraguay. Source: Authors' calculation using sub-national level data kindly shared by Juan Blyde.

Other Correlates of Growth

The transition from Malthusian stagnation to modern growth (Galor and Weil 1999, 2000, Lucas 2003, Parente and Prescott 1993, Clark 2007) involved historically a very significant set of inter-related changes that accelerated productivity growth, inverted the historically positive relation between income and fertility and increased education and urbanization. Most models suggest that the decline in fertility, the increase in female labor force participation and in the educational efforts of families and governments are reflective of a broad increase in the returns to human capital that is associated with the Industrial Revolution. Since this process started earlier in some countries than in others, today we observe a strong relationship between GDP per capita and such variables as educational attainment, fertility and urbanization.

While looking at a country's income per capita in the long run is informative of when the transition to modern growth took place, looking at the relative position of a country in each of these relationships is informative of the relative extent to which the different dimensions of the transformation have occured. Figure 12 shows the birth rate and the log of GDP per capita, while Figure 13 shows the rate of secondary schooling. Clearly, the former communist countries have undergone the demographic transition and the universalization of secondary education, but do not have the income level that normally accompanies those transformations. Many African countries are in a different position.

Figure 12
Crude Birth Rate and log of GDP per capita (2005)

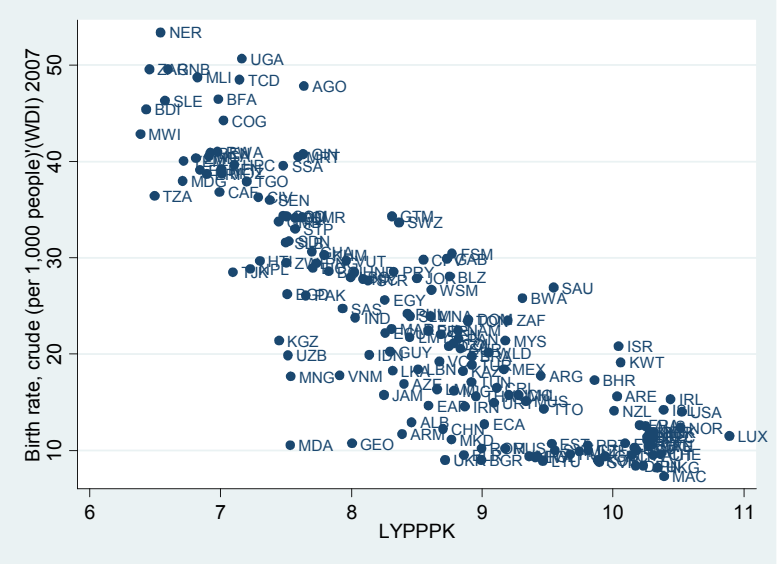
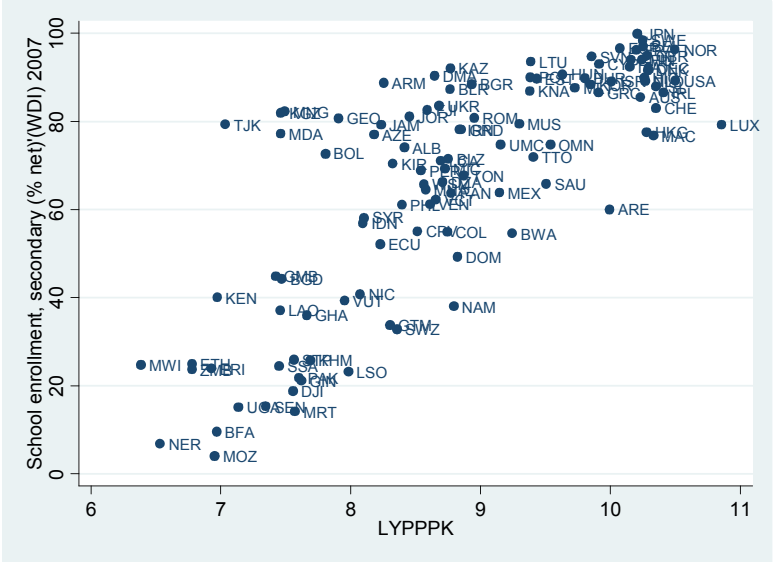


Figure 13
Secondary school enrollment and log of GDP per capita (2004)



It is therefore useful to look at the position of countries in these dimensions. To continue with our comparison of Pakistan with India and Bangladesh, Figures 14, 15 and 16 show the fertility rate, the rate of population growth and the secondary school enrollment rate. The figures show a consistent story: Pakistan, was similar to India

and Bangladesh in these dimensions in the 1960s, but has since diverged, showing a much slower demographic transition and improvements in education.

Figure 14
Fertility rates: Pakistan, India and Bangladesh

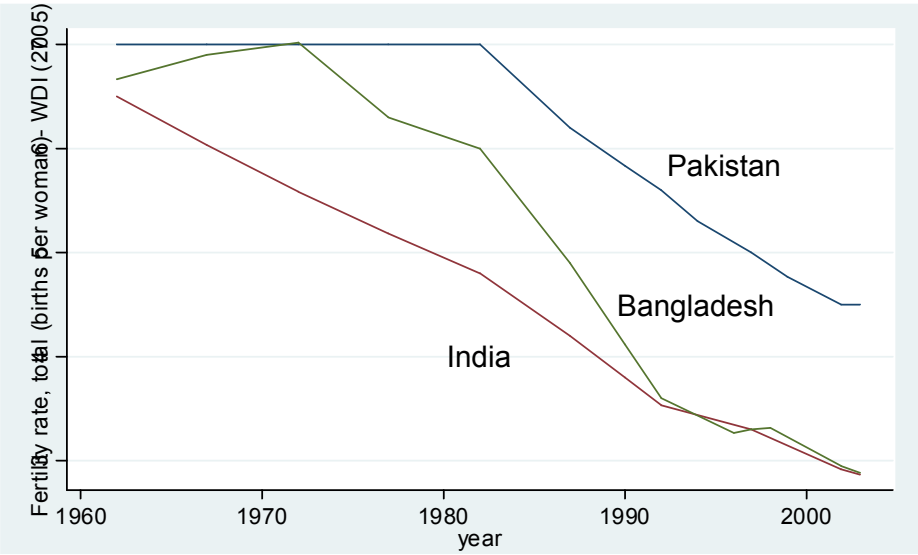


Figure 15
Population growth: Pakistan, India and Bangladesh

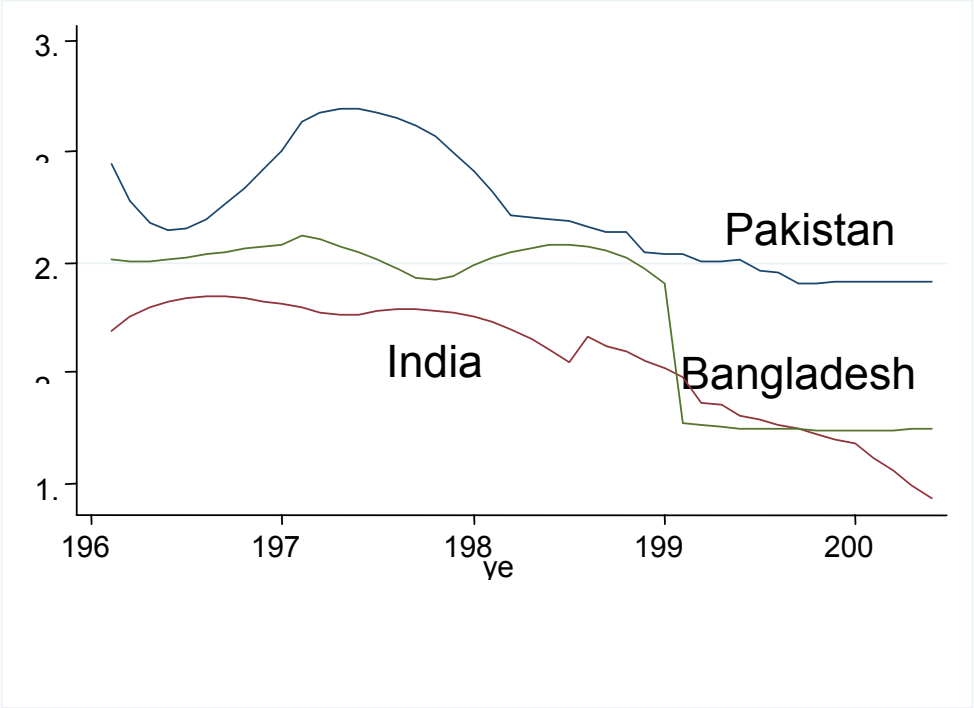
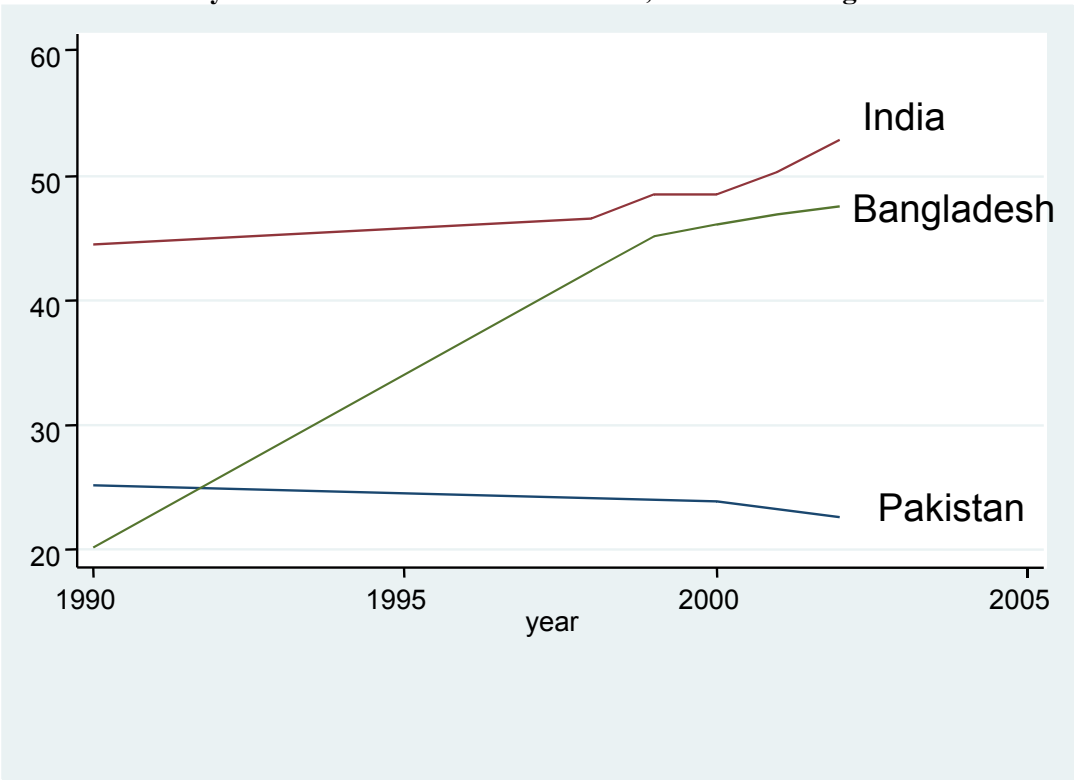


Figure 16
Secondary school enrollment rate: Pakistan, India and Bangladesh



Other important dimensions are urbanization and structural transformation, whether in the composition of output or of exports. For example, there is nothing particularly slow about Pakistan's urbanization process while its productivity growth in agriculture exceeds that of the other two countries. So this calls for an answer to the relative under-performance of Pakistan that is urban, not rural. This does not add up to a diagnostic, but it establishes important stylized facts that a potential diagnosis will have to account for.

Other interesting aspects to describe involve the evolution of investment rates and the level of consumption, the sub-national variation of growth and the level and evolution of income distribution. It is also important to be aware of the country's macroeconomic history and performance, as many of the problems of the past as well as the constraints for future action are affected by macro concerns.

What is the Right Question?

In many cases the puzzles of growth are not always obvious, neither for the analyst nor for policy makers. For countries that are growing rapidly, the analysis needs to specify its focus. Maybe the issue should shift from accelerating growth to just sustaining it by looking at potential constraints that may become binding (Rodrik, 2007; Felipe and Usui, 2008). Maybe, as in the case of Peru, it would be about why, in spite of the growth in overall GDP, did growth not show up in median household income and in the poorest regions. In other cases, the interesting question would be at a sub-national level. For example, why is the Chinese province of Guizhou so poor in spite of the overall country growth?

The end result of this first step should be a clear understanding of the country's growth history, and the specification of the key growth question to be answered by the diagnostic.

Going Down the Decision Tree

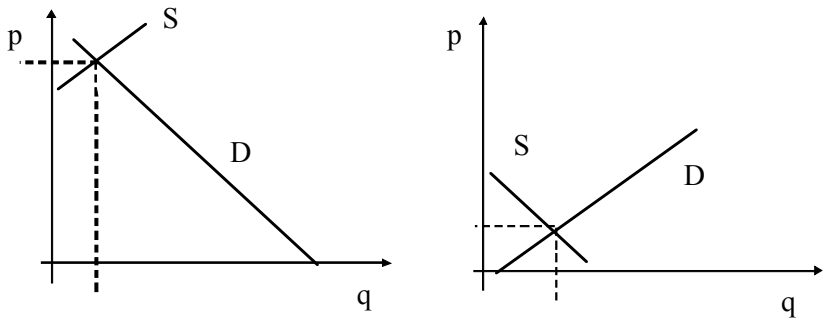
In this section we describe how to go through the decision tree presented in Figure 2. As discussed above, it is important to remember that this decision tree is a heuristic device and should not be taken as either definitive or fundamental; it is a first argumentative scaffolding. It starts with a certain problem and a theoretical approach to organize the potential explanations. A similar approach could be used to analyze many other possible problems such as high unemployment or low school attainment. Keep in mind that this is a root cause analysis diagram, and as such should be read from top to bottom, and not side to side or from the bottom up.

First Decision Node

The first question in any economic diagnosis when you are observing a low outcome: is it a supply problem or a demand problem? Figure 17 describes analytically the main difference between the two pathologies. Two countries may have a similarly

low level of a certain activity or factor. However, this may emerge either from low supply (left) or low demand (right). What tells them apart is the price.

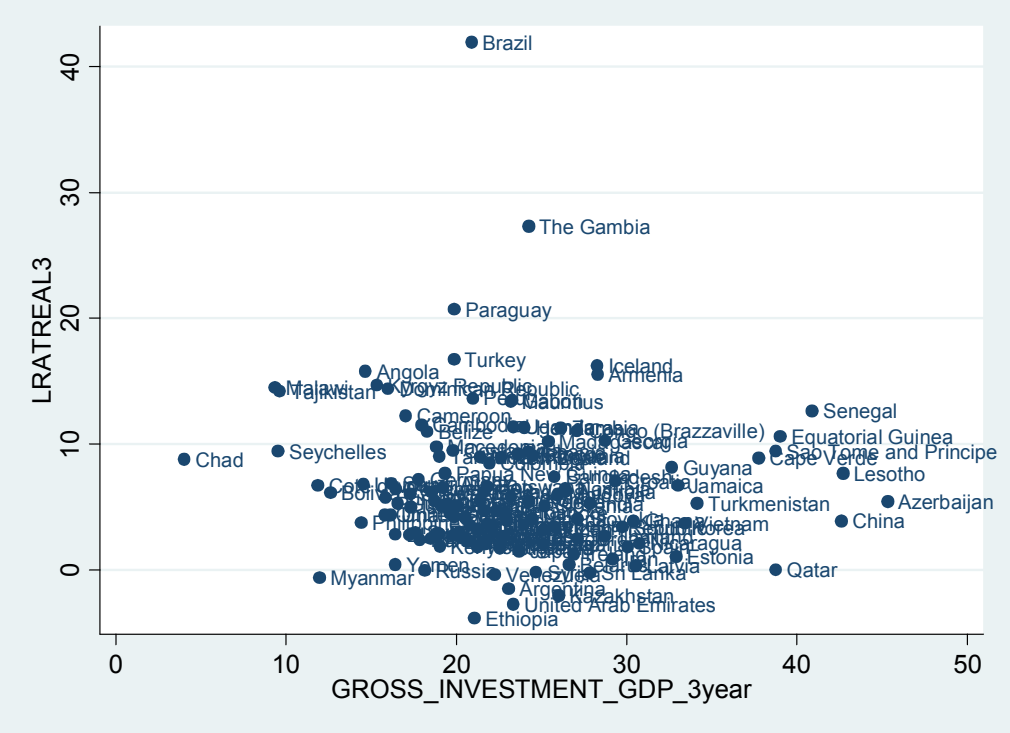
Figure 17
Is it a demand or a supply problem?



This first node is the key question for any adaptation of the growth diagnostics methodology to any growth model or non-growth issue, such as education. In the case of the HRV decision tree, the question is what is constraining private investment and entrepreneurship. The idea is that if the country was growing faster than it is at present, there would be more private investment and entrepreneurship. Why are we not seeing it? The first node in the decision tree tries to differentiate between stories based on low investment demand – lack of projects that can pay a reasonable private rate of return – from problems associated with the inability to acquire the financial resources to invest in such projects at a reasonable rate. Here we should apply the four principles of a differential diagnostic: is the shadow price of finance very high? Do movements in the financial constraint map into changes in investment and growth? Are agents trying to avoid the constraint? Are the growing sectors less intensive in the binding constraint?

Figure 18 shows the data for the real lending rate and the investment ratio averaged for the years 2005-2007. It shows a great diversity of cases:

Figure 18
Real Lending Rates and Investment Ratio 2005-2007



Countries like Venezuela and Argentina have a similar investment ratio to that of Brazil, but radically different real interest rates. To make sense of this, one must posit very different investment demand curves. For Brazil this means that, to the extent that there is significant borrowing for investment at this lending interest rate, firms must be expecting a return at least as large as that rate, which shows that expected private returns are very high. Conversely, Venezuela and Argentina must be on a much lower investment demand curve.

It is also important to know what the interest rates is at which firms can invest their cash flow. Firms that are cash rich will require from their projects an interest rate at least as high as the one they can obtain in the market. So if this rate is high then even the firms that do not require borrowing will demand a very high return from their investments.

It is useful in this context to ask hypothetical questions either introspectively or to relevant local agents: "Let's imagine that you are an entrepreneur with 20 million dollars to invest in the country, so access to finance is not a constraint. In what kinds of project would you invest, if any?" As discussed in Hausmann and Rodrik (2005), Salvadorian businessmen could not come up with many examples, indicating that expected returns to investment – absent a financial constraint – were not very enticing[18]. Venezuelan investors are clearly worried about the appropriability of expected returns, given recent nationalizations and changes to property rights, which may explain why they are relatively unresponsive to negative real interest rates.

Johnson, McMillan and Woodruff (2002) study whether access to finance or expected returns was the problem in post-communist countries by examining how firms used their collateral and retained earnings. Their main argument is that funds internal to the firm (i.e. retained earnings) are a cheaper source of finance than bank loans. Thus, they should be depleted first in case a profitable investment is available. Their results indicate that low investment in their sample of firms cannot be explained neither by lack of internal funds (reinvestment of profits was reported as low) nor from lack of access to external funds (a great majority of firms had enough collateral to get a loan, but did not use it). While the authors recognize that this is just a sample of existing firms that can't tell us about future firms or about firms that closed, they interpret this evidence as lack of private returns to investment.

It is also useful to do a 'camels and hippos' analysis of the successful agents in the economy and look at the way agents have organized to overcome the binding constraint. For example, in Brazil the National Economic and Social Development Bank BNDES funds itself with involuntary savings from workers, through the Workers Welfare Fund, that are paid a below market return and on-lends these resources to investors at rates well below those of the market. This constitutes a significant tax on workers and allows some firms and local governments to avoid the

[18] An alternative explanation is that the entrepreneurs did come up with ideas were not revealing the information they had because of multiple reasons (revelation problems).

financial constraint. But since this mechanism is not big enough – the stock of loans represents barely 25 percent of one year's private investment – at the margin others need to pay the high market rate. The fact that the mechanism exists is in itself suggestive of the political economy forces unleashed by the constraint (Hausmann, 2008).

In other instances, market interest rates may be low but there may be significant credit rationing to some sectors of the economy. Rationing is to be expected in the credit markets of all developing countries. However, if the returns to investment are high, one would expect companies that do have access to become conglomerates to exploit those opportunities. By doing so, they limit the economic costs of rationing. Moreover, large firms need small and medium enterprises as suppliers or customers, so they stand to benefit from sharing their credit access with the rationed firms. So, one would expect to see significant flows of trade credit from large firms to rationed firms[19]. This is an example of the principle that agents should be engaging in efforts to bypass a binding constraint. If these symptoms are not present in a significant fashion, it is hard to argue that a situation of low market interest rates is compatible with high expected returns to private investment.

The Right-Hand Side of the Tree: Financial Stories

So, suppose we are convinced that the country has plenty of investment opportunities that are privately profitable but that finance is constrained. The question now is to determine why. There are in essence two classes of stories here. One has to do with inadequate access to savings, while the other has to do with problems mobilizing those savings, i.e. an inefficient process of financial intermediation.

[19] For example, manufacturers can sell their merchandize to retailers on credit, given that they have the possibility, unavailable to banks, of cutting off future supplies of they default. Supermarket chains can give financial advances for their purchases from SMEs, knowing that access to such a distribution channel is very valuable to any supplier.

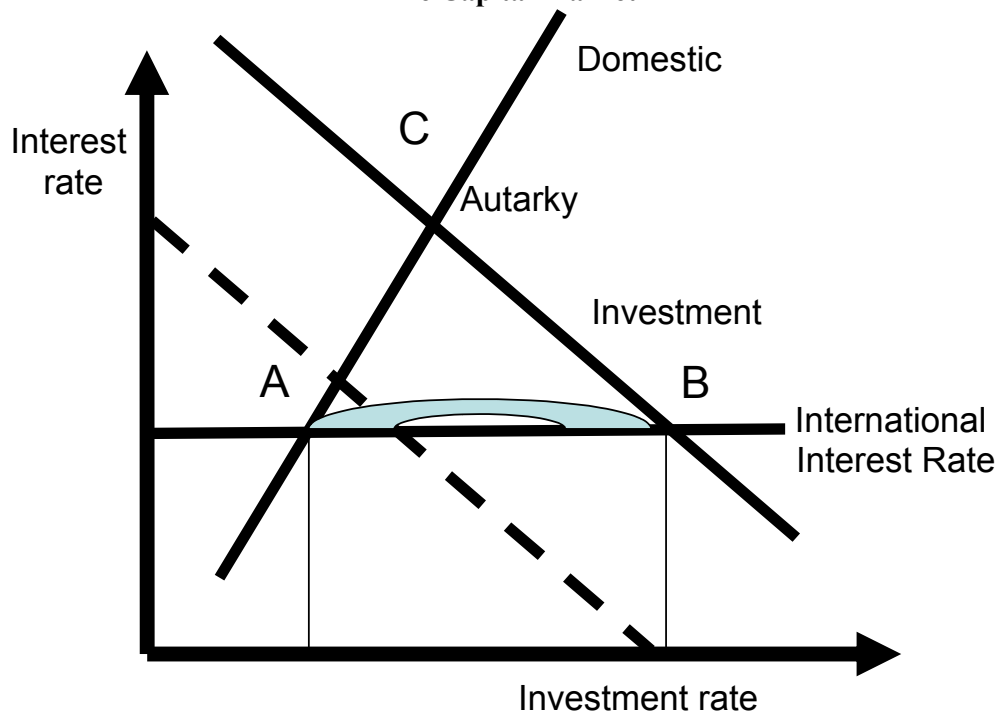
Savings Stories

A savings story needs several symptoms to be present. First and foremost, society must be willing to remunerate savings at a high interest rate. If the government or banks are able to capture savings without coercion at low interest rates it is hard to see how access to savings could be importantly binding. By contrast, if governments and banks find themselves in a position where they must remunerate savers at a high real rate, it means that anybody else in the society will have an even harder time to access savings.

Second, access to foreign borrowing must be restricted. Savings can in theory move internationally. If capital mobility was perfect, one would expect to see the same interest rate in all countries. This is illustrated in Figure 19, where investment and savings are compatible with the international interest rate (points A and B), while the difference is be borrowed (as shown) or invested abroad. In contrast, if a country has no access to international loans, supply and demand will have to balance locally and hence the interest rate would have to adjust to a point such as C.

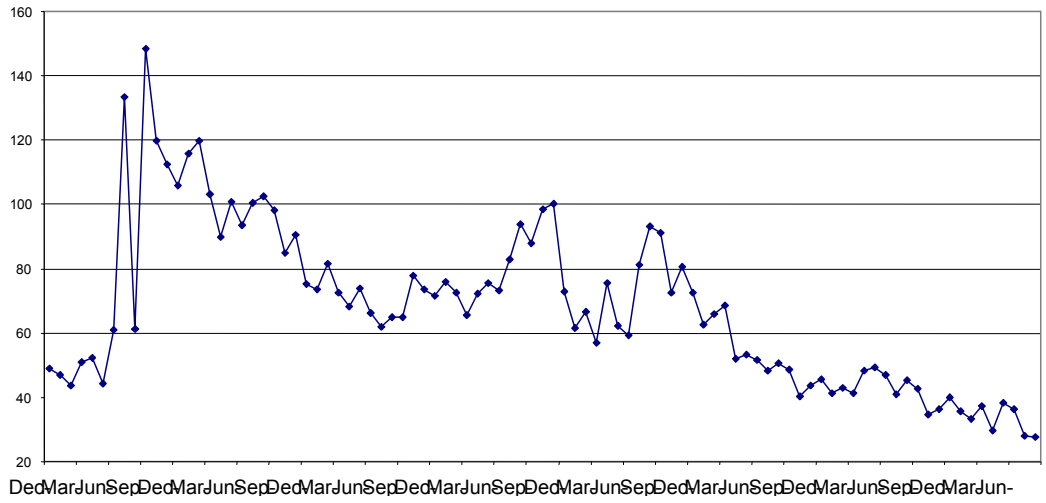
Therefore, to argue that a country has a savings problem, one needs to prove the joint hypothesis that access to foreign borrowing is restricted or very expensive and that domestic savings are somehow limited.

Figure 19
The Capital Market



One symptom of costly access to foreign savings is a country's sovereign risk or credit rating. It reflects the cost and kind of access that the government and large firms have to foreign savings. Access to international finance has been rather volatile. For most of the last 20 years, developing countries with access to international markets – so-called emerging markets – numbered at most 32 countries and their access was rather unstable. This can be seen in Figure 20 which shows the spread between the Emerging Market 32 country Bond Index (EMBI-Global) yields and US Treasuries.

Figure 20
Spread between the EMBI-Global (32 countries) and US Treasuries (1998-2005)



The graph shows that the average spread has been very large, for most of the period above 6 percentage points (600 basis points). It peaked at over 14 percentage points and moved below 4 percent only after 2005. These are quite hefty spreads for a group of elite emerging market countries. Others simply have had no access. Moreover, the volatility in access is quite large suggesting that if this was the binding constraint, it would present many opportunities to observe its dynamic effects as market conditions change. The sudden curtailment of access to foreign savings, dubbed in the literature as sudden stops (Calvo, 1998), has been also an endemic characteristic of many developing countries.

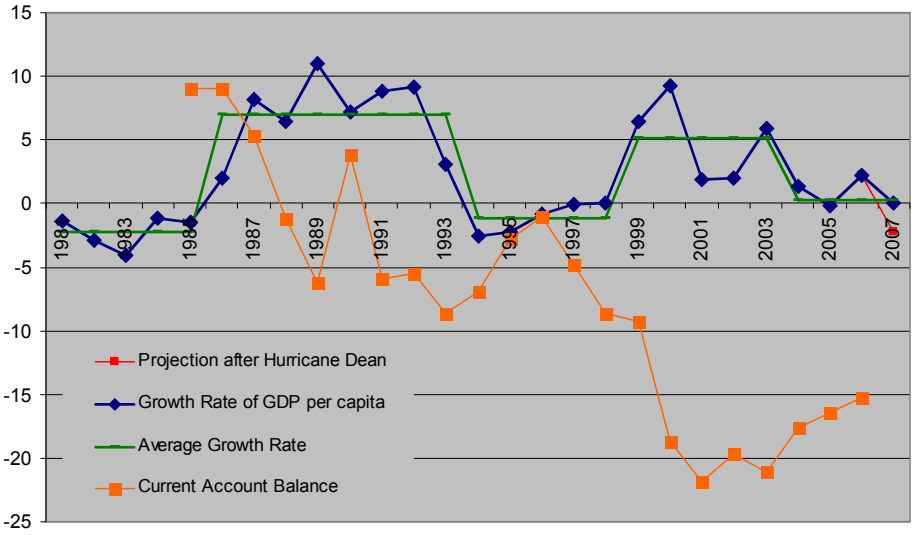
In some instances, access to foreign borrowing is restricted not because of international reasons but just because there exist domestic capital controls that prevent capital from moving in, perhaps because the government wants to prevent excessive reliance on capital inflows. However, as China shows, the presence of capital controls does not imply that savings are constrained: China has exhibited a hefty current account surplus in spite of having one of the highest investment rates ever recorded, indicating that domestic savings are ample in spite of high investment.

A high country risk cum low credit rating is usually the result of an excessive debt accumulation that occurred in the past and hence may reflect the fact that domestic savings had been insufficient and thus the country tapped its access to foreign savings until it hit its credit ceiling[20]. Reviewing the history of foreign debt problems is useful. But beyond not having access to foreign savings, the level of domestic savings should be low relative to the level of investment that would if the country had easy access to foreign savings. Otherwise, the country may run a current account surplus, given the paucity of investment demand. Presumably, this is not the case, since we have already documented the high domestic real interest rate in the first node of the decision tree.

There are limits to the amount that foreign savings can contribute fund domestic investment. First, clearly is the fact that as the foreign debt accumulates, concerns over either ability or willingness to pay causes the cost of foreign borrowing to go up or be shut down completely. This happened in Brazil as recently as 2002-2003. In Belize, we observe that growth accelerates whenever access to foreign savings can be relied upon. But when the current account deficit becomes no longer sustainable, access to international savings is cut off and growth stops until the cycle repeats itself. This can be clearly observed in the patterns of growth acceleration and recession over the past 20 years, and is suggestive of a savings story in Belize.

[20] A credit ceiling emerges in equilibrium when there are willingness to pay problems that are proportional to the amount of the debt. Lenders would not be willing to extend credit beyond a point where borrowers have an incentive to default. See Eaton, Gersovitz and Stiglitz (1986).

Figure 21
Growth and the Current Account, Belize



Source: 1981-2005, World Bank WDI. 2006 value using Government of Belize data, 2007 value using Government of Belize estimate. 2007 value incorporating the effects of hurricane Dean (red) using IDB (2007).

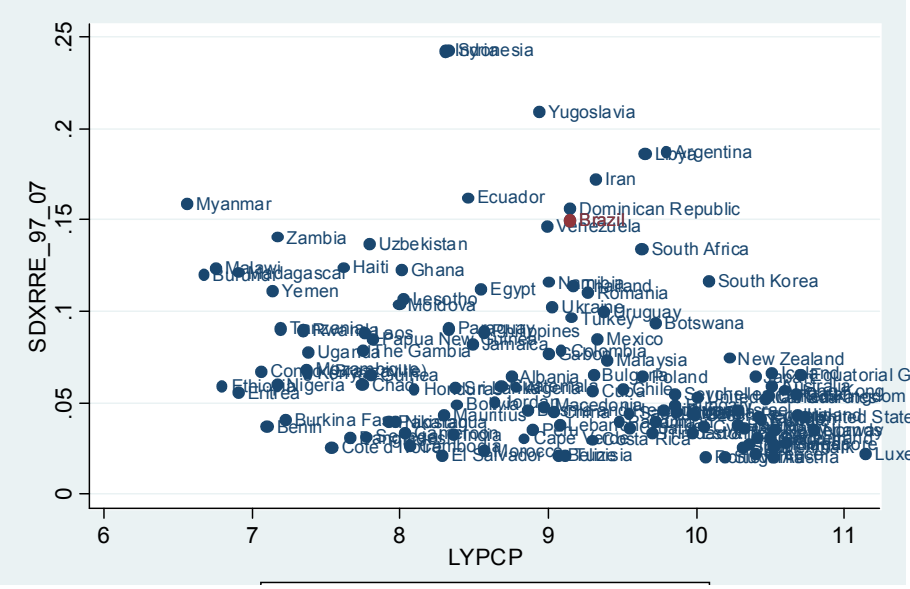
A second limitation to foreign savings comes from the fact they can fund the increase in demand for all goods, but can only directly improve the supply of tradable goods, since in the end they fund imports. This means that foreign savings increases the relative supply of tradables causing their relative price to fall, (i.e. the real exchange rate to appreciate) potentially lowering expected returns to investment. Reliance on foreign savings, by appreciating the real exchange rate may limit growth, by lowering expected returns[21].

In addition, changes in the relative tightness of the savings constraint reflect themselves in a volatile real exchange rate. Figure 22 shows the average volatility of the real exchange rate in the decade to 2007 and the log of GDP per capita. Instability in the access to foreign savings may be an important source of exchange

[21] There is a growing literature that relates the level of the real exchange rate with the rate of growth of the economy, and finds an important channel through domestic savings. See for example Rodrik (2007), Levy-Yeyati and Sturzenegger (2007) and Montiel and Serven (2008).

rate volatility in many developing countries: Argentina, Brazil, Ecuador and Indonesia all suffered sudden stops in the period analyzed in Figure 22.

Figure 22
Real exchange rate volatility 1997-2007 vs. log of GDP per capita



Source: Economist Intelligence Unit.

A low domestic savings rate should also call for an additional explanation. Why would a country's savings rate be particularly distorted? Is it a poverty trap? Is it a situation where, as argued by Hausmann (2008) for Brazil, the government extracts a very high tax burden and generates negative savings through its own consumption and pension payments? This is why the next step of a growth diagnostic must the formulation of a syndrome, as we will discuss below.

Financial Intermediation Stories

The alternative hypothesis to a savings problem is a financial intermediation problem. Here the first signal is a wide spread between deposit and lending rates.

In principle, spreads may be high for four reasons: high costs, high (implicit) taxation of financial intermediation, high risks or high profits. Banking systems usually have readily available data on operating costs and reserve requirements, so this can be

easily documented. Separating risks from profits is a bit trickier. Banks tend to be accused of having excess profits only to collapse a few years later in a major systemic crisis. One way to look at whether the problem is one of risks or monopoly profits is by looking at the price-earnings (P/E) ratios of banks. If the earnings are high but the P/E ratio is low, it means that profits are not expected to last, suggesting a high risk story. By contrast, if banks have a safe monopoly, price-earnings ratios should be high.

If the general rate of interest in the economy is high, maybe because of a savings constraint, one should expect to also find high margins, but these are the consequence of whatever is keeping interest rates high and not the cause of the problem. A simple model is useful to bring the issue to light. Assume that bank balance sheets are composed of loans (L) and reserves (R) on the asset side and deposit (D) and capital (K) on the liability side:

$$L + R = D + K$$

Reserves, either for liquidity demand reasons or because of regulatory requirements, must be a fraction ε of deposits. For capital adequacy reasons, K must be a fraction κ of loans.

$$R = \varepsilon D$$
$$K = \kappa L$$

Let the lending and deposit rates be respectively r_L and r_D and the spread s be just the difference:

$$s = r_L - r_D$$

Let us assume that operating costs are a proportion c of the deposit base. Under perfect competition, economic profits would be driven down to zero. We assume for

simplicity that capital requires the same rate of return as the lending rate and that reserve requirements are not remunerated. We therefore have that:

$$r_L L - r_D D - r_L K - cD = 0$$

Substituting and solving for the spread as a function of the lending rate or the deposit rate we obtain:

$$r_L(1-(\varepsilon+c)) = r_D$$
$$s = (\varepsilon+c)r_L = \frac{\varepsilon+c}{(1-(\varepsilon+c))} r_D$$

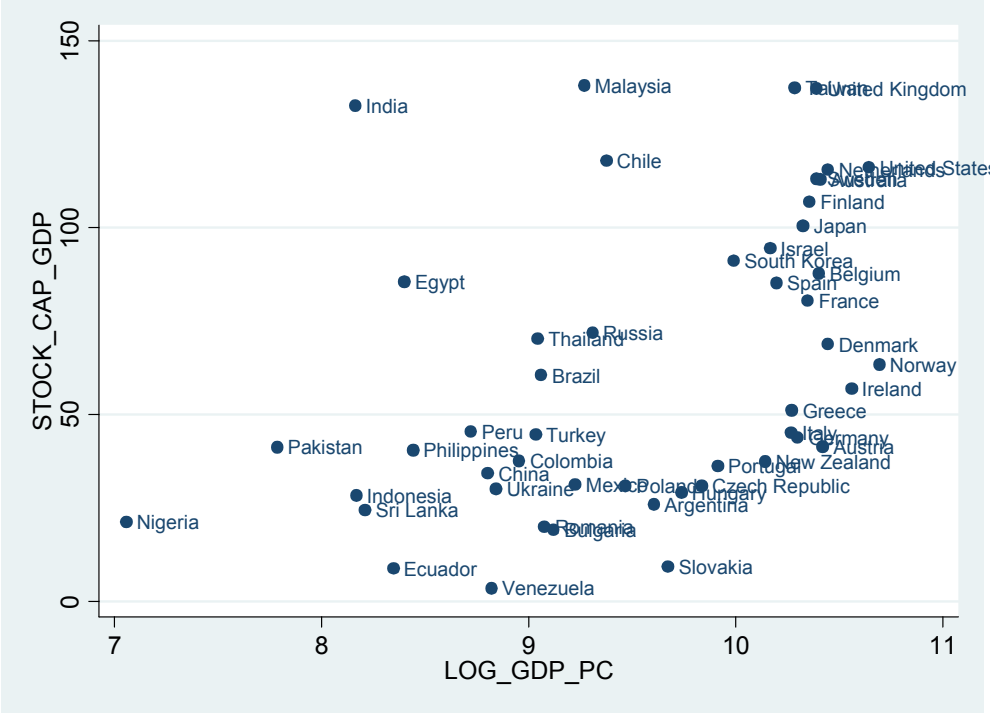
So, the size of the spread is proportional to the effective reserve requirement on banks, to the costs of the banking system and either to the lending or the deposit rate. Large spreads can be thus accounted for by either high reserve requirements, which constitute a tax on financial intermediation, a high cost structure of the banking system *c* and a high deposit rate. This means that we should expect to find high margins, even if the intermediation is not too bad. The real criteria should be the term $(\varepsilon+c)$[22].

[22] Two assumptions are easily relaxed. The cost of financial intermediation may not be purely proportional to the deposit base but may incorporate a fixed cost. The returns to bankers may exceed the lending rate and cause a greater spread.

BOX 1

Beyond banks there are capital markets, where bonds, equities, commodities and other derivatives may trade. There is enormous variation of the relative size of these markets across both developed and developing countries, as shown in Figure 23. Beyond any other argument, the fact that the variation is so large means that almost no number appears to be outside what would be expected in the absence of the hypothesis. Instead, the variation reflects the fact that property is held differently across equally developed countries.

Figure 23
Stock Market Capitalization as a share of GDP vs. Log of GDP per Capita, 2005



Note: excludes Hong Kong and Switzerland. Source: Economist Intelligence Unit.

In some countries, large firms are foreign-owned and trade as parts of other companies in foreign exchanges. In others, restrictions on the banking system have stimulated the capital market. In the end, the relative development of alternative financial modalities emerges from a process where actors are trying to minimize costs. Capital markets, by requiring broadcasting of information and the protection of minority shareholders create transaction costs that private equity can avoid.

The important question from a diagnostic point of view is whether what is constraining growth is the inability to combine high return entrepreneurial initiatives with financial resources. Stock markets seldom play this role, even in advanced countries.

At the core of a financial story must be an institutional problem of one sort or another. After all, at the core of finance is an exchange of complex, contingent property rights that are affected by the number of participants, or the liquidity of markets. A financial story must explain what the nature of that failure is and why it is an equilibrium of some sort. Again, this is something that requires positing a syndrome in the third step of the diagnostic process.

The Left Branch of the Tree: Low Expected Private Returns

Let us go back to the top of the decision tree in Figure 2 and assume that we have convinced ourselves that the problem is not one of costly finance. Therefore it must be one of low demand for investment due to low *expected private* returns. However, one would like to confirm that this is the case with evidence. Answers to the hypothetical question: "what activities would you invest in if you had US$ 20 million?" is an interesting starting point. There are institutions – such as private equity funds – whose business is precisely to answer these questions. It is often very illuminating to get a sense of the projects they have considered and the reasons for undertaking them or not, their experience with previous investments, and so on.

Now, what could explain these low returns? We can split the search into two broad kinds of answers: either the overall social returns to projects are low or the proportion of those returns that can be privately appropriated is low. The idea is to determine if there are clear investment ideas that would be executed if participants could be assured that the returns are going to be there and are not going to be dissipated by others through planned or surprise hold-up problems.

Appropriability

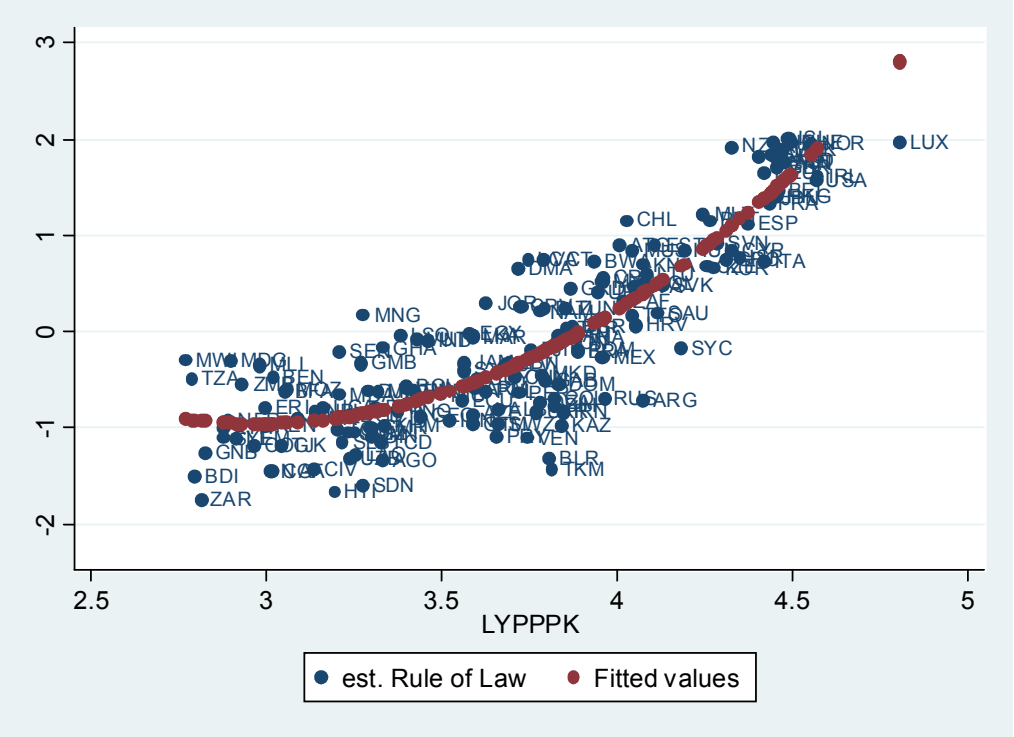
Problems of appropriability can be of different sorts. There are microeconomic hold-up problems that may involve corruption by government officials, hold-up problems with suppliers, customers or labor unions, etc. There may be fears of a major shift in macroeconomic conditions. Formally, these concerns may reflect uncertainty over the

social returns of the project, as would happen for example if aggregate demand were to collapse causing low returns to the project, or because macroeconomic problems are bound to end in some form of expropriation, either through inflation, debt default or a banking crisis. These fears may actually translate in a lower expected social return or in a return that is not appropriable.

There are an increasing number of indicators of appropriability risk, although all have the problems we discussed in Chapter 2. The World Bank publishes 6 indicators of institutional quality that may map into appropriability problems, although not in a precise way. These are rule of law, voice and accountability, political stability, government effectiveness, regulatory quality and control of corruption. The main drawback of these indicators is that their relationship with income per capita is quite flat at the level of income of most developing countries: Argentina and Tanzania, or Guinea-Bissau and Venezuela have similar rule of law indicators even though their income per capita differs by a factor of 2.

Hence, if it were the case that all countries have the same sensitivity to rule of law, this particular indicator has trouble causing a significant updating of the priors about how binding is appropriability to development in a particular country. To construct a potential story around this constraint, the analyst would have to argue that the country under study is more sensitive than others to poor performance in this indicator. Hence, even a simple graph can restrict the type of argument the analyst can make.

Figure 24
Rule of Law and Log of Income per Capita, 2006



The Economist Intelligence Unit publishes a large set of risk indicators. Listed in Table 8, these indicators can help the analyst asses the kind of fears investors may have.

Table 8
Risk Indicators. Economist Intelligence Unit

Banking: Economic policy risk	Overall risk rating
Banking: Economic structure risk	Overall risk score
Banking: Liquidity risk	Overall: Economic policy risk
Banking: Overall risk score	Overall: Economic structure risk
Banking: Political risk	Overall: Liquidity risk
Currency: Economic policy risk	Overall: Political risk
Currency: Economic structure risk	Political efficacy risk
Currency: Liquidity risk	Political stability risk
Currency: Overall risk score	Risk of armed conflict
Currency: Political risk	Risk of social unrest
Expropriation risk	Security risk
Financial risk	Sovereign: Economic policy risk
Foreign trade & payments risk	Sovereign: Economic structure risk
Infrastructure risk	Sovereign: Liquidity risk
Labor market risk	Sovereign: Overall risk score
Legal & regulatory risk	Sovereign: Political risk
Macroeconomic risk	Tax policy risk

It is important to get a sense of the margins on which the appropriability problems are operating in a particular country. For example, in Argentina, Bolivia, Ecuador and Venezuela, there is an abundance of identified natural resources that are not being developed either because the legal regime prevents investment or because of recent expropriations. So, clearly there are high return projects that are not being developed because of property rights issues.

Another tool is the World Bank Investment Climate Assessments. These surveys ask existing firms about their perceptions of various potential appropriability problems, as well as quantitative indicators that give some indication of their magnitude. But as with all of these indicators, they must be used carefully. The degree to which certain values update the analysts' priors depends on putting the numbers in context with relevant comparators. Moreover, high or low values can be consistent with a variety of potential constraints.

International rankings and surveys aren't the only source of information on appropriability problems. In order to estimate the impact of labor market rigidities on appropriability through unionization in South Africa, Banerjee et al. (2006) use

household survey data to estimate the union wage premium: the difference in wages between unionized and non-unionized workers controlling for personal, regional, and industry characteristics. The authors find that the union wage premium increased by 10 to 20 percentage points over the past decade, suggesting that unions may have had an increasing capacity to affect wages and limit appropriability in the sectors of the economy where they are strong (e.g. mining, manufacturing, utilities, and medical, educational, and legal services) during that period. One could then use this result in a 'camels and hippos'-type analysis, keeping in mind that unionization is endogenous.

In another example from South Africa, Aghion, Braun and Fedderke (2006) examine the hypothesis that monopoly power is harming appropriability by examining mark-up rates among South African manufacturing firms. The authors show that mark-ups are consistently higher in South Africa than in corresponding industries worldwide. High mark-ups should trigger entry and an eventual reduction in profit margins, but the authors document that mark-ups show no declining trend over time, signaling that there may be problems of monopoly power and a lack of competition constraining investment in South Africa. They run panel regressions to show that mark-ups are negatively associated with growth.

Other telling signals are the location decisions taken by companies that cater to a regional market, be they the regional headquarters of large multinational corporations or companies with a more local base. Since these cater to a regional market, they can decide where to locate and those decisions are telling about the perception of the investment climate.

Low Social Returns

The alternative explanation for low expected returns is that the actual returns are just low, even if they were appropriable. Causes for low social returns are potentially many, but they typically involve some missing complementary factors or inputs that an individual investor cannot provide. For example, key infrastructure like roads, power, water, and telecommunications may be missing or unreliable, causing low

returns for projects that require them. Human resources with the right set of skills may be in short supply or harder to hire, making them either too expensive or just not available and thus causing low expected returns.

We can use the diagnostic techniques to assess the tightness of constraints such as infrastructure or human capital. We can look at measures of their shadow price, look at movements over time, ponder about the way the faster growing activities cope with this constraint and document the attempts people make to overcome the constraint.

But the analyst must continually dig deeper into the observed signals. For example, in South Africa one can observe high returns to tertiary education in the formal sector, suggesting that there is a skills shortage in the economy (Banerjee et al. 2006). Yet Rodrik (2006) shows that the fast growing sectors in the economy are precisely those that are intensive in human capital. With a very high unemployment rate of unskilled workers and slow growth in less skill intensive tradable activities including manufacturing, Rodrik argues against human capital as the binding constraint to growth in South Africa.

Things are a bit more complex when the issue arises from coordination and other forms of market failure. In general, any economic activity requires many inputs of one sort or another. These may be tradable, such as raw materials or equipment, or non-tradable, such as labor, infrastructure and other services. Presumably, tradable inputs should be less of a headache, provided that transportation and transaction costs are not too high, as they often are when trade is impeded by poor infrastructure, hard-to-cross borders and a poor trade facilitation environment. The problem of the non-tradable inputs is more serious in the sense that if they are not available, productive activities that require them as inputs cannot take place or can do so only at very low levels of efficiency.

Non-tradable inputs or capabilities give rise to two important distortions that may limit growth: coordination failures and self-discovery externalities. Products cannot

be made unless their non-tradable inputs are present, be they human skills, services or some other input. But nobody would like to specialize in a non-tradable input for which there is no demand. This is the classical 'chicken and egg', or coordination, problem. It becomes more serious the more specific the input is to a certain activity. Moreover, to get it started, there are bound to be few people on either side of the market, which will exacerbate hold-up problems until the market becomes thicker.

In practice countries address this problem by moving to goods that require inputs similar to those they already have. But as we shall see, countries differ in the number of such products and hence in the severity of these coordination problems.

The fact that non-tradable inputs may be specific and may or may not exist means that innovators need to figure out how to adapt the production of a certain product given the set of existing country capabilities. So, while a product may in essence be very similar to one that already exists in the world, an innovator still needs to incur costs to find out whether, given the countries capabilities, it will be profitable. This process, which Hausmann and Rodrik (2003) called self-discovery, suffers from informational externalities as the innovator incurs some costs on which imitators can free ride.

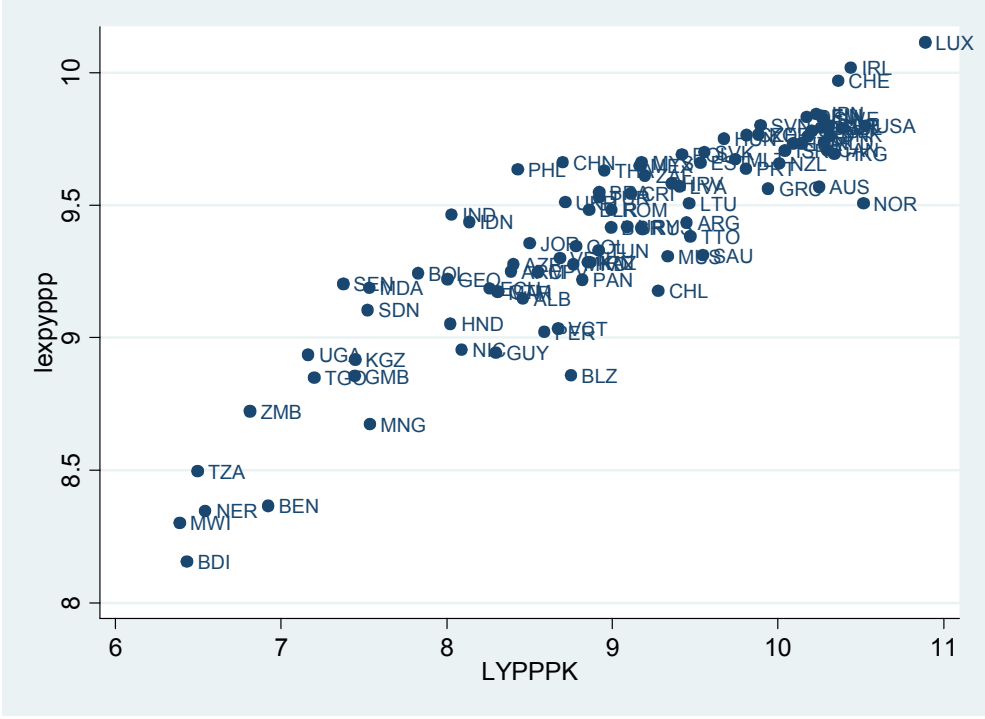
In short, coordination failures and information externalities may limit the existence of profitable projects.

It is possible to have a sense of how serious these problems might be in a given context by noting that the supply of non-tradable inputs determines the areas in which a country can express its comparative advantage. Countries with a limited set of these inputs or capabilities will have comparative advantage in few, relatively simple products exported by other poor countries (Hidalgo and Hausmann, 2008). By contrast, if a country has an ample set of these non-tradable inputs, it will have comparative advantage in more complex products. One possible measure of the sophistication of a country's comparative advantage is the GDP per capita of its

competitors on a product-by-product basis. This measure, proposed in Hausmann, Hwang and Rodrik (2007) (called EXPY) calculates the weighted average of the GDP per capita of a product's exporters and then averages it for the export basket of a country. The paper shows that a country's GDP per capita tends to converge towards its EXPY. Countries with a low EXPY for its level of income tend to grow more slowly.

Figure 25 shows the EXPY for a set of countries. Countries with a high EXPY for their level of income such as China, India and the Philippines should face less of a problem than countries like Honduras, Nicaragua, or Peru.

Figure 25
Export sophistication and Log of GDP per capita (2005)

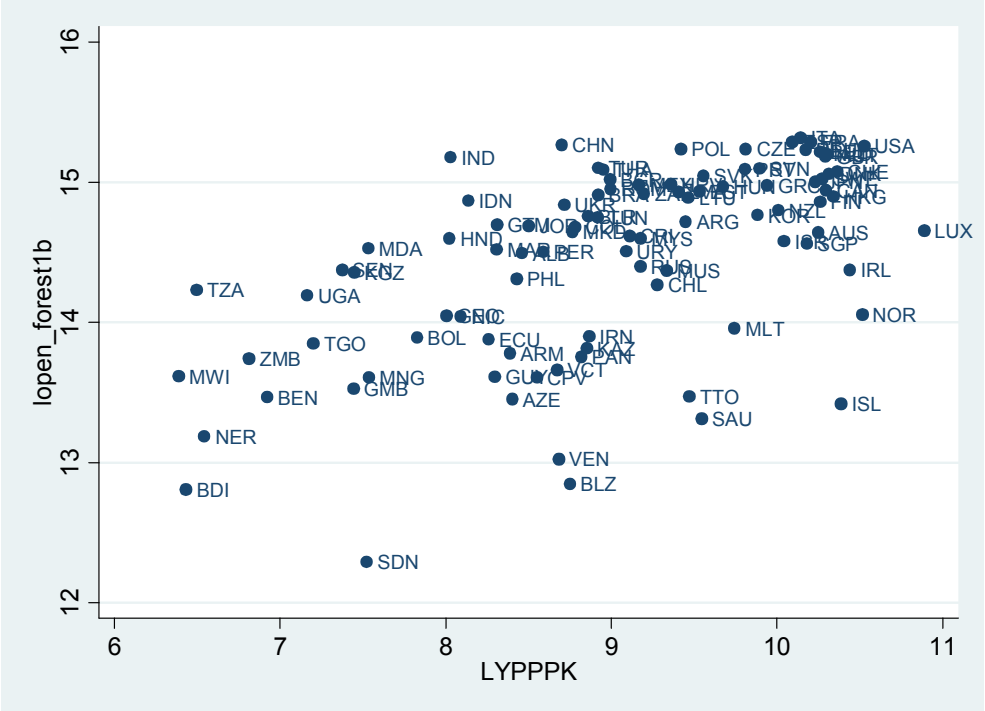


This indicator can be taken as a measure of existing capabilities. But as argued in Hausmann and Klinger (2006) and Hidalgo et al (2007), countries tend to move from their current areas of comparative advantage to other "nearby" goods in the sense that

these are goods that tend to be jointly exported by other countries. This is because goods that are nearby would tend to use similar inputs to those already existing in the economy, reducing the aforementioned coordination problems in the emergence of new activities.

However, not all products have a similar number of "nearby" goods. Hausmann and Klinger (2006) propose a measure of the position of a country in the "product space", which can be seen as the option value to move towards other goods, weighted by how "far" they are. The resulting measure, which they call open forest, predicts the capacity of a country to upgrade its exports and grow. It can be taken as an indicator of the degree to which the country is exposed to coordination and self-discovery failures in the movement to new export activities.

Figure 26
Log of Open Forest and GDP per capita (2005)



As Figure 26 shows, countries differ greatly in the presence of "nearby" goods to move to, that is, goods that face relatively low coordination problems.

Another measure that can be used is to study whether, given a country's options, it has made good use of them. One way to evaluate this is to ask whether the frequency of transitions to new products is unusual, after controlling for a country's position in the product space.

A Matrix of Tests

As a practical matter, it is easy to get lost with so many tests and alternative explanations. It is therefore useful to make a structured list of the kinds of tests that help discriminate between different hypotheses. Table 9 provides a prototype of such a table, which can be used as a starting point for matching symptoms to the relative tightness of constraints. Each column shows a constraint and each row represents a symptom. The set of columns and rows is not meant to be exhaustive. Some tests help distinguish between families of constraints – groups of columns – while others can tell apart more finely between those hypotheses.

So, for example, financial stories become more plausible when there is high real lending rate, when the country has limited access to external finance and when the country's growth responds to reductions in the real interest rate. Also, it is interesting to know if banks, in net terms, are lending or collecting payments from previous operations[23]. When credit is booming, then building a financial story requires other ingredients to make it persuasive.

[23] One can define the net cash flow from banks as the percentage change in credit to the private sector minus the interest rate.

Table 9

Binding Finance		Binding social returns					
		Lack of complementary factors		Low appropriability			Coordination
				Government failure			Market fail.
				Ex ante	Ex post		
Low aggregate Savings	Bad finance	Human Capital	Infrastructure & public goods (geography ?)	Ex ante risks	Tax	Low property rights, crime & corruption	Low R&D Low Self discovery
High lending interest rate		Low lending interest rate					
Low net cash flow from banks		High net cash flow from banks (dC/C - i)					
Investment elastic to interest rate		Lack of investment response to interest rate change					
Access to external finance (EMBI, Default risk, CAD, Unsustainable debt)			Low infrastructure wrt comparable countries	High static markups & low entry; in industries with entry costs	Monopoly power, high markups. Regulated entry	Expropriation	Low sophystication (EXPY) and few new industries
Short loan duration, credit rationing		Inward migration high skills	Shocks to infrastructure (hurricane, war)	Political risk, social risk		Social unrest	Growth responds to new indus
High deposit interest rate	High spread	High returns to education		Tax policy risk	High taxes: Top marginal tax rate, corporate tax, VAT	Open conflict	Few products "nearby" to move (openforest low)
Negative relation between growth and current account.	If it's high risk, then low profits	Procyclical mincerian returns	Growth elastic to infrastruct. Change	Labor market risks	Restrictive labor regulations	Corruption (illegal tax rate) (Kaufman)	
	High operating expens /assets	Low tertiary for level of development	Congestion	History of expropriation	Inflation tax	High protection costs (ICA)	High correlation of growth with TOT
	Monopoly powers: high (P/E) ratio of banks	Returns decrease as education grows	Port quality. High losses in transport (ICA)	High expectation of losing future profits	Cost of doing business		High returns to coordination activities

But these tests do not distinguish between a savings story and a financial intermediation story within the overall family of financial stories. This is why in this table we put them crossing both columns of financial constraints. To tell these possibilities apart we may want to know how costly is financial intermediation and whether these costs reflect operational inefficiency, high taxation of financial intermediation, high risks or monopoly profits. So we look at operating costs, profit rates and price earning ratios to tell them apart.

When the problem is in aggregate savings, we would expect to observe a high deposit rate because money is scarce. We would also expect that growth accelerates only in periods in which either the terms of trade improve or foreign lending becomes available.

Low return hypotheses all involve a situation in which lending is available and cheap but does not trigger much investment. This is in the right hand side of Table 9. Telling appropriability from low social returns requires looking into other symptoms.

This is an indicative and incomplete list of tests. It should not be used mechanically because nothing substitutes careful economic reasoning. However, the list may allow a more systemic view of the evidence. Analysts should feel free to modify and extend this table. The key principle is to always strive to extensively explore the hypothesis space.

Once these and other tests are conducted using the widest range of evidence possible, the analyst should have some well-supported hypothesis as to what constraint or constraints are binding on growth. But the existence of these constraints must be themselves explained in a clear and consistent causal story. Deriving and testing such a story is the next step of the analysis, taken up in the following section.

4: From Symptoms to Syndromes (and back again)

In the previous steps we assessed the tightness of different constraints on growth. However, we did not propose a theory or an explanation for the existence of those particular constraints. A diagnosis should include a logically consistent causal chain that accounts, as much as possible, for the facts we observe. We refer to this causal story as a syndrome. Once we posit it, we must check its soundness by deriving other symptoms that should be present if the proposed syndrome is true. This process should be repeated until the diagnostic has settled on a well-supported identification of what the binding constraints to growth are and why they are present.

Economists dislike stories based on people acting stupidly. We presume that if agents could individually change their actions and be better off, they would do it. We like to think that what we observe is a Nash equilibrium outcome of a game, so unilateral deviations are not profitable. So the proposed syndrome should have this equilibrium feature.

To argue that an economy suffers from a certain greatly constrained factor, we need to understand where that constraint comes from. If markets were perfect, the shortage of a factor would generate incentives to increase its supply. So, why does the constraint not self-correct? A satisfying answer would have to involve what departures from perfect competition we think are involved. Suppose, for example, that the requisite factor is a publicly provided good, such as law and order or infrastructure. If the political system is competitive, and if people sense the tightness of the constraint, one would imagine a political entrepreneur acting to provide the missing input. If this does not happen, we need to make *explicit* what friction(s) explain the limited provision of this scarce factor by the political system, and why not providing it is sensible for the agents involved.

Thus, the analyst needs a hypothesis that rationalizes why the empirical regularity emerges as an equilibrium outcome. That is the role of the syndrome. It would be

dangerous to jump to policy prescriptions without some understanding of the root causes of the constraint.

Furthermore, the syndrome proposed as the ultimate cause of the evidence observed should have other testable implications. Are those symptoms in the data? Does the story help explain other facts on the ground?

There are limits to how sure the analyst can become about the story. In an academic setting, if a paper does not pass a certain threshold, it is not published. For decision makers, not acting is in itself a decision that may be inferior to acting with significant uncertainty. Thus, there is a trade off for the analyst between getting the perfect diagnosis with all the experiments in a wish list and getting a diagnosis that can add value to decision making. Decisions will likely be taken anyways, so not proposing a tentative conclusion for lack of perfect evidence is not innocuous. In fact, the selection of policy interventions should reflect these uncertainties.

For the purpose of illustration, we propose a list of potential syndromes that may account for a country's binding constraint. The list is indicative, not exhaustive. The list of potential ailments afflicting the human body is long and expanding. Our list of economic ailments is shorter, but the more we learn, the longer the list of ailments will become.

Table 10 shows the list of potential syndromes. The first four are related to government failure. Governments face very difficult problems: they need to aggregate preferences from a heterogeneous population that is affected very differently by public decisions. They need to solve common-pool problems that arise from the fact that public spending is funded collectively but many of its benefits accrue to individuals. They need to make credible inter-temporal commitments so that people can plan their lives. And they need to address serious agency problems, so that public officials asked to do the people's work don't find ways to put their own interests first.

Table 10
A first list of syndromes

•The over-borrowing state
•The over-taxing state
•The under-investing state
•The under-protecting state
•Disruptions to the export sector
•Barriers to entry

A common consequence of these challenges is an overburdened state. However, the form that excess burden might take may differ markedly between countries. The government may overtax, may under-invest or may over-borrow. Too high a tax rate, by lowering expected private returns, may discourage investment leading to low investment demand. In this scenario, lending interest rates should be low reflecting the low marginal returns to additional investment. Too low a public investment effort may cause bottlenecks leading to low private investment demand despite low interest rates. Alternatively, too high a fiscal deficit may lead to crowding out in the financial markets causing low private investment but with a high interest rate.

India is an interesting case. It has a very high fiscal deficit and public debt. And yet, interest rates on long term government debt are fairly low, so it is hard to argue that there is crowding out. The government has very significant subsidies and transfers, while infrastructure is very poorly provided. Let us suppose that the binding constraint is infrastructure. Why is it an equilibrium? What is the syndrome?

One possible explanation is that the highest return public investments are in urban areas, where new non-agricultural activities show very promising returns. But, given that 70 percent of the population lives in rural areas, the median voter may care little for urban infrastructure. So it is difficult to get a political coalition to allocate the funds, since the benefits do not accrue to the median voter. One testable implication is that politicians who do allocate the funds to urban infrastructure achieve high growth but are voted out. This actually happened in the 2005 elections in the state of Andhra Pradesh, where Hyderabad, the capital city, was perceived as the best run city in

India, showing spectacular growth, but the countryside voted massively against the government. So the syndrome would be that of an under-investing state[24]. To check the story one may want to find evidence of a strong crowding in effect of public investment. Policy solutions would require thinking about the political obstacles to the requisite allocations.

Brazil is in a rather different situation. The government is over-burdened with obligations which emanate in part from the great social and regional differences that characterize the country and from the 1985 constitution (which *inter alia* tried to address them). The government has one of the highest tax revenues as a share of GDP of any developing country. In spite of this, it has negative public savings and among the lowest public investment rates of any country in the world. High taxes and poor infrastructure should cause low private returns to investment. And yet, interest rates are sky high indicating that the marginal private return to investment is quite high. In fact, to prevent the economy from over-heating, the Central Bank is forced to set the highest real overnight interest rate in the world. This is consistent with the hypothesis of an over-borrowing state.

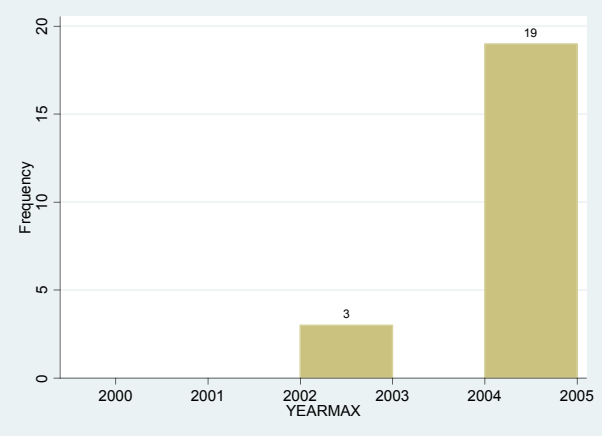
The distinction between India and Brazil highlights the importance of the binding constraint approach. While the underlying state weaknesses may be similar, the precise manner in which growth is affected can be very different so that policy improvements need to have a very different character. In India, infrastructure investments would receive the first priority, even at the cost of a larger deficit. In Brazil, greater public savings would be at the top, even at the cost of high taxes or lower infrastructure investment.

In other cases, the syndrome must explain a growth collapse. Unfortunately, many countries have been suffering from such collapses. Figure 27 shows the dates at

[24] By this we mean a government that does not provide the complementary public investment causing private returns to be low. An"under investing state" should not be confused with the overall symptom of under investment in the country.

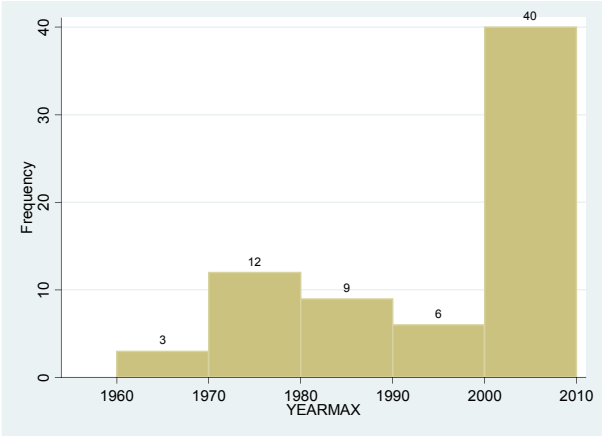
which countries reached its peak GDP per capita to date[25]. If growth were positive in every single year, the last observation would be the maximum of the series. The farther back the peak, the longer the period of cumulative negative growth. While all industrial countries had their peak after the year 2000, 30 out of 70 developing countries reached their peak before that date. In fact, most of these reached it in the 1970s and 1980s, when mobile phones and the internet were not available and when both life expectancy and educational attainment was lower than at present. Hausmann, Rodriguez and Wagner (2008) find that a large proportion of these growth collapses are triggered by adverse shocks to the export earnings of a country. But they find that the depth and length of the ensuing growth collapse depends on the country's availability of nearby goods to move to. Here the binding constraint may well be the inability of the country to move to alternative products because the coordination and self-discovery obstacles are just too great. These difficulties become binding because the traditional export sector is in trouble making the shadow price of new exports very high.

Figure 27
When did countries reach their peak GDP per capita?
(a) Industrialized countries



[25] We use World Development Indicators (2007) and include only countries with GDP per capita data since 1961. The last year with data is 2005.

(b) Developing countries



Source: World Development Indicators (2007).

Take, for example, the case of Peru. The country's current growth spurt is actually a recovery from a protracted growth collapse. While this collapse featured a financial crises, currency meltdown, political violence, and infrastructure deterioration, it was all precipitated by a strong terms of trade collapse. Moreover, although much of the resulting collateral damage was repaired in the 1990s, the significant recovery from the collapse did not occur until the underlying terms of trade reversed and prices rose for Peru's principal exports: minerals and energy. When one looks at the sectors that fueled the growth and export collapse and recovery, they are (with few exceptions) the exact same sectors that had previously collapsed. In the face of the terms of trade shock, Peru was not able to adjust its export offering and move to any alternative export sectors. Instead, output simply collapsed until world demand for those sectors recovered.

Why would optimizing agents not move to new export activities when traditional activities face headwinds and the real exchange rate depreciates massively? As discussed in the previous section, individuals may not be able to coordinate movements to new activities when they are radically dissimilar to the current productive structure and can not adapt existing non-tradable inputs. And the data for Peru shows that at the time of the export collapse, there were very few alternative activities nearby. Hence, a potential syndrome for Peru is that it suffered a syndrome

of disruptions to the export sector while being isolated in the product space. A similar story can be said of Zambia, where the decline of copper prices in 1975 lead to a protracted growth collapse with no response from other export products until the recovery of copper in the early years of this decade.

However, this may not be the whole story. During the export collapse, Peru actually lost market share in international markets. So this fact needs explaining: before the terms of trade collapsed in the early 1980s, Peru had recently nationalized all its major export industries such as fishing, mining and hydrocarbons and had done an agrarian reform that wiped out its traditional agricultural exports. So, the problem might have involved not only obstacles to productive transformation but also poor protection of property rights. The recovery only happened after mining and hydrocarbons were opened again to private investment on very favorable terms that may be politically unsustainable in the future.

Bates (2008) proposes an alternative explanation for the growth collapses of Africa. The reduction in export revenue diminished the resources the government had to maintain order and triggered civil wars, generating an under-protecting state where law and order collapses.

Other syndromes might be based on barriers to entry. Economic activity may be reserved for some incumbents. Entry by other groups is actively restricted as these may erode rents or create alternative sources of economic and political power. In market economies there are anecdotal cases of sectors being restricted for individual economic groups with good political connections. The argument has been made about the telecom sector in Mexico and South Africa or the fertilizer market in El Salvador. It is an open question whether these examples may rise up to become a major constraint to the overall rate of growth of the economy. In regimes with communist or non-market tendencies this problem can easily become the dominant barrier to growth. Entrepreneurial activity is either outlawed or severely restricted in many key sectors of the economy and private property is actively discouraged and persecuted.

In such regimes, there are no invisible hands working to react to imbalances and the system ends up being characterized by what Janos Kornai defined as the Economics of Shortage (1980).

These are just illustrative cases that give a causal story behind a particular binding constraint or set of constraints. Hopefully, as more growth diagnostics are done across the world, our palate of potential syndromes will increase. However, the analyst should not force the country or region under study to fit these stories: they are here for the purpose of illustration. What is important is to try to formulate stories that fit the facts, are internally consistent and fit further evidence. With such a diagnostic it is much easier and safer to move to therapeutics.

5: From diagnostics to Therapeutics

Up to now we have been discussing how to diagnose the constraints to growth in a country. However, the subsequent question of interest for policymaking is what to do about it. We need to move from diagnostics to therapeutics. Now, clearly this is quite a different type of problem. Discovering that the Koch bacillus causes tuberculosis is very different from inventing penicillin. Sometimes, a cure is found for an ailment by chance, without a clear idea of how it works. However, as pointed out by Mokyr (2002), technology evolves more rapidly when there is an epistemic understanding of the nature of the problem, since this makes the search for solutions easier and provides an understanding of why a particular approach might work. That is, good diagnostics facilitate better therapeutics.

So far we have been worried about the effect of constraints on growth, $\frac{\partial\, Growth}{\partial\, Constraint_i}$, and ideally we have wanted to identify the most binding: $\max_{i \in I}\left\{\frac{\partial\, Growth}{\partial\, Constraint_i}\right\}$. Now we need to think of policies that move those constraints or reduce their negative growth impact. In our approach, we see growth as a function:

$$Growth(\ Constraint_1\ ,...Constraint_i\ ,...,Constraint_I\ )\ .$$

Then policy P_j affects growth through its impact on these constraints. In particular, its *marginal* effect would be:

$$\frac{\partial\, Growth}{\partial\, Policy_j} = \sum_{i=1}^{I} \frac{\partial\, Growth}{\partial\, Constraint_i} \frac{\partial\, Constraint_i}{\partial\, Policy_j}$$

This equation highlights some important points. The first issue regards implementation, represented by the effect of a policy on a constraint $\frac{\partial\, Constraint_i}{\partial\, Policy_j}$.

Given that we cannot move constraints directly, we need to find out policies that do so, in a politically feasible and cost effective way. While we will not be explicit about how to make these policies, the intuition for the analyst is that we want to maximize the overall effect on growth for every unit of either fiscal or political budget. Thus, what matters is the *product* of how binding is the constraint, $\frac{\partial\, Growth}{\partial\, Constraint_i}$, times the cost effectiveness of changing that constraint with the best set of policy levers. Nonetheless, no matter how efficient the lever, by definition moving non binding constraints cannot have an impact on growth.

On the other hand a policy may impact more than one constraint. It may relax some and worsen others. These second-best interactions require a careful policy design and choice.

The role of growth therapeutics is to come up with a policy or a set of policy interventions that accelerate growth, given the understanding of the factors that are constraining growth in a particular economy. This is very different from an agenda emerging from a straightforward use of a cross country regression, where $\partial Growth / \partial Policy$ is assumed to be the same for all countries. It is also different from a "best practice" agenda, typically based on international rankings, where all areas of policy are reviewed against a benchmark and actions are taken to move each area towards that benchmark, or prioritizing the areas that are relatively ranked worse, with no other evidence of their tightness.

Now, it is important to note that the policy space is quite big. Any country has hundreds of thousands of pages of legislation managed by hundreds of public entities. This legislation is constantly being rewritten, extended and amended while public

agencies are in a permanent state of redesign. This occurs in part as a reflection of changing information, knowledge, needs, preferences, opportunities and obstacles.

This means that there are quite a few degrees of freedom in policy design and it is important to think of policies in terms of their effectiveness in addressing constraints that are seen as important, while minimizing the adverse impact on other constraints. Moreover, this means that context is particularly important for this final step, placing a premium on local knowledge and input.

Take for example the typical debate around free trade. The traditional way the debate is carried out is through a universal discussion about whether free trade, on average, has been good for the world, using both theory and international evidence.

Presumably, if the argument is won in favor of free trade, a country should engage in a process of tariff reduction and trade liberalization. Probably, the tariff reduction will have benefits to consumers, may reduce output in import competing sectors and would most likely lower tax revenues, which would have to be compensated for somehow. But since the international evidence says that the policy is good, let's do it.

The alternative approach would start from the identification of a certain constraint on growth and its general relevance to the economy. Let us say that we have identified a mediocre rate of export growth which we associate with the lack of a competitive input market that acts as a tax on potential exporters. Free trade would allow potential exporters the chance to buy their inputs anywhere in the world and hence would reduce the anti-export bias of the system. However, this may be achieved with a special regime for exporters rather than a generalized reduction in tariffs. Such a policy may limit the negative effects on import competing employment and on the national budget while relaxing the constraint where it is perceived to be most binding. In fact, this has been the policy followed in many countries. It tries to achieve the expected benefits from trade liberalization while minimizing adverse second best interactions.

Rodrik (2002) highlights the way in which Chinese reforms were designed to reduce the constraints where they were most severe while limiting second best interactions. The two-tier price system for farmers allowed the regime to improve supply incentives in agriculture without the fiscal and redistributive effects of a generalized price liberalization. The Household Responsibility System and the Township and Village Enterprises were reforms that created enough assurance to economic agents so that they could engage in investment activities, without creating a credible system of property rights which would not have been feasible.

Big constraints on growth are there for a deep reason and they are not always easy to affect, even when they are clearly identified. Vested interests may be present and the political economy of change may be difficult. Suppose we identify violence in a particular country to be the binding constraint on growth. This may make security policy an integral part of a growth strategy. But progress may not be easy to achieve. Disregarding the binding constraint and focusing on some other constraint, such as infrastructure, may not have a significant crowding in effect because of the security situation. However, there may be ways of implementing the security policy so as to relax the impact of the constraint on growth even if the overall security situation of the country does not improve dramatically (e.g. by securing some areas for manufacturing or tourism through a special police force).

In other cases, there may be series of constraints that are perceived as being quite tight without a clear ranking and with some that are much easier to affect than others. In that case, it may be reasonable to go for the constraints that are more easily relaxed in the expectation that as they deliver their pay-off and things improve, the other constraints may become easier to deal with.

In some instances, decisions cannot be made gradually so marginal calculations may not be appropriate. Sometimes it is impossible to move a constraint "just a little bit", like in the case of legal systems. In other situations, non-linearities may favor a big

push rather than a more modest change. For example, the decision to decentralize health or education services and to make the fiscal reforms necessary to transfer the requisite resources to local governments is not a marginal change. It involves $\frac{\Delta Growth}{\Delta Policy_i}$ rather than $\frac{\partial Growth}{\partial Policy_i}$. Consequently, the analyst should provide some explicit story of the second best interactions that may emerge after this big jump.

Also, we must remember the Lucas critique, which says that the observed reduced-form relationships may not remain stable after a policy change because agents will rationally change their behavior accordingly. The ideal solution to this problem is to estimate the deep parameters of the economy and not rely on reduced-form estimates. Unfortunately, in many instances this is no feasible. Nonetheless, at the moment of moving into policy, it is important to ponder the degree to which the behavioral properties of the system might change as a consequence of the policy adopted.

6: Conclusion

The goals of academic research and those of the world of practice are naturally different but those differences have not been fully understood in terms of methods and standards of evidence. Growth diagnostics resembles more the case of a civil suit while academic research uses the standards of a criminal case. In the former, the decision criterion is "the preponderance of the evidence". In the latter, it is "beyond reasonable doubt". A policymaker cannot avoid making decisions and she will have to do so with the best available information and analysis, even if she would have wished to have more certainty than what can be provided. Economic analysis in the real world seldom provides enough information to quench all doubts. Cogent arguments may exist for an alternative story and it may be hard to tell stories apart. The role of the responsible analyst is neither to hide the doubts so as to create a wrong sense of infallibility nor to go into a nihilist attitude and avoid decisions. Instead, they should state the most plausible story, describe the alternative stories that may account for the known facts, and try to think through the strategies that could tell them apart. In addition, the analyst could think of policy interventions that are expected to be appropriate for each scenario and ideally find a strategy that may work under all the possible stories.

The goal of a diagnostic is to come up with a coherent story that can account for the growth performance of a particular country in the here and now, a story that can be the basis for a consideration of therapeutic strategies. The diagnostic should help find a focus to the strategy and help set priorities. This is an important tool to avoid the temptation to try to fix more than is feasible or even convenient. Here it is important to avoid the temptation to say that everything bad is binding, or to say that each constraint that is associated with an important stakeholder is important. Don't reduce the set of candidates more than is possible given the evidence, but strive to take it as far as possible.

Be sure your syndrome is a coherent causal story. Whatever story you have identified should be compatible with rational individual behavior: we presume that agents are trying to do what they like most given the incentives and constraints under which they are operating. The syndrome should reflect this rather than fall back on explaining constraints with either stupid behavior or the typical villains like a corrupt or inept government and a rapacious group of private sector incumbents.

Recognize that any growth diagnostic is a work in progress. The analyst can continually respond 'why' to every answer the diagnostic proposes, further decomposing the causal story. Moreover, new data and evidence is always becoming available, and the underlying features of the economy in question are themselves always changing. Therefore, a growth diagnostic should not be viewed as a conclusive and finished work, but rather a working hypothesis that is to be continuously prodded, challenged, and extended by the analyst and subsequent researchers.

Finally, it is important to recognize that growth diagnostics itself is also a work in progress. The methodology has been substantially clarified, revised, and expanded since its original presentation in HRV. Analysts that have implemented the methodology have continuously identified new tests, data sources, and diagnostic techniques. The list of syndromes is ever-expanding, and many researchers have made substantial contributions to the core methodology. This process should continue.

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