RAPID

Rethinking African Paths to Industrial Development

Diagnostics for Industrialization

Growth, Sectoral Selection, and Constraints on Firms

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Abstract

This paper reviews methods that have been put forth by the development literature on diagnostics. We sub-divide the variety of diagnostics into three types: revealing the most binding constraints to economy-wide growth, selecting sectors in which to diversify, and identifying sources of sectoral underperformance. Each diagnostic method is judged as to whether it provides a structured way of performing diagnostics, directs analysts towards the right questions, and is parsimonious in the use of data and resources. After reviewing a variety of methods, we argue that with respect to growth diagnostics, the best approach is to combine Hausmann's, Rodrik and Velasco's "Growth Diagnostics" with more encompassing and forward-looking methods. In sectoral selection, Hausmann and Hidalgo's "Product Space Analysis" can serve as an adequate base for choosing sectors in which to diversify, but this method must be tempered by a much more diverse set of indicators that matter for sectoral choice. Finally, diagnostics at the sectoral level can be performed through a sequence of methods: starting from easily-collectable perceptions data and progressing to more data-heavy techniques, depending on the time and resources available.

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1. Introduction

The importance of diagnostics is increasingly recognized in the development policy literature as a way of helping in the design of context-specific policy solutions (Rodrik 2010). Diagnostics can be performed at different levels and in different policy areas, but this review focuses on those that are relevant for the design of industrial policy. Therefore, we discuss three kinds of diagnostics, associated with three separate functions: revealing the most binding constraints to economy-wide growth, selecting sectors in which to diversify, and identifying sources of sectoral underperformance. Each type of diagnostic is discussed in sequence. In each section, we first describe various diagnostic methods and then assess the relative value of each one of them according to whether they provide a structured way of performing diagnostics, direct analysts towards the right questions, and are parsimonious in the use of data and resources. This requires a both a discussion of each method's theoretical underpinnings and of the practicality of putting it in practice, which follow the descriptive section.

2. Growth Diagnostics

2.1 Traditional Methods of Growth Diagnostics

Hausmann, Rodrik and Velasco (2005) (henceforth HRV) is a seminal paper in the literature on diagnostics that introduces a structured framework for identifying the most binding constraints on a country's growth. These authors saw their framework as a response to the shortcomings of methods previously used in the academic and policy literatures. One common method used in the 1990's, starting with the work of Robert Barro (1991), consisted of performing cross-country growth regressions.[1] These regressions try to explain growth as a function of the initial level of income and a number of explanatory variables, measuring each variable's contribution to the growth rate. Based on the results of these regressions, analysts can see which policy variables have the greatest impact on economic growth and design growth policies accordingly.

Hausmann et al. (2008) mention growth accounting as a second method for diagnostics. However, growth accounting lacks clear policy implications, so we do

[1] We base our discussion of traditional diagnostic methods on Hausmann et al. (2008). See their paper for a more in-depth account.

not discuss it here. This leaves us with international benchmarking as the third standard way of doing diagnostic work. While cross-country growth regressions lost most of their empirical credibility since the early 2000's, as discussed below, international benchmarking is still very common in the policy world. The method consists of comparing a number of economic and policy indicators with peer countries (as measured by the level of development) and aspirational peers (ie. slightly ahead of the country in question). These comparisons can show in which policy areas a country is lacking and suggest ways to improve its economic performance. In addition to standard data on the macro economy or on policy areas such as education, international benchmarking frequently involves comparisons of indices constructed from surveys such as the World Bank Doing Business Indicators, the Global Competitiveness Report, or the Transparency International Corruption Perceptions Index. The advantage of these indices is that they allow a more systematic comparison of the institutional environment for doing business, which would otherwise be too subjective.

2.2 HRV's Growth Diagnostics

HRV's Growth Diagnostics framework is based on the result from a standard endogenous growth model according to which economic growth depends on the returns to factor accumulation, their private appropriability, and the cost of financing accumulation. The diagnostic begins by finding which of these factors carries the greatest weight in reducing the growth rate. One must then identify the distortion responsible for this; once the distortion has been identified, its causes must be understood in greater detail, until it becomes possible to devise targeted policies to correct it. HRV describe this exercise as moving down a decision tree. At each node, a judicious use of available data should guide one's choice of the most likely explanation for a particular distortion. In the original Growth Diagnostics paper, HRV give examples of applications of the framework to El Salvador, Brazil and the Dominican Republic, but do not explicitly outline exactly how one is to adjudicate between different explanations at each node of the decision tree.

In a more detailed paper, Hausmann, Klinger and Wagner (2008) elaborate on this matter. Responding to the challenge of "integrating diverse and at times disjointed pieces of evidence from a variety of sources, including cross-country datasets, microeconomic surveys, and the popular press", they choose to frame their approach in terms of a Bayesian analysis. This allows analysts to combine prior beliefs on the probability that a constraint afflicting an economy is binding (ie. the probability that it has a 'syndrome') with international benchmarking (the unconditional probability that the syndrome is present) and empirical evidence on the probability that countries suffering from a given syndrome manifest a particular symptom. With this information at hand, it is possible to use Bayes' formula to compute the probability that the chosen constraint is binding in light of the information available. In practice, HRV's Growth Diagnostics do not directly involve computation of probabilities, but the Bayesian framing serves to demonstrate its underlying logic. According to this logic, a constraint is likely to be binding if:

1. Its shadow price is high.
2. Movements in the constraint produce significant movements in the objective function.
3. Agents in the economy are attempting to bypass the constraint.
4. Agents less intensive in the constraint are more likely to thrive.

All of these conditions can be judged using a mix of evidence, including regressions, surveys, price data, electoral results and even anecdotal information, as long as it can be used to form a coherent causal story.

The description above illustrates the core tenets of the Growth Diagnostics approach, but Hausmann and co-authors give further guidelines on the production of diagnostic reports. The diagnostic itself should be preceded by a description of a country's growth process, which allows the selection of a question to be explained by the diagnostic. Based on this, a syndrome is to be posited, and further implications of the syndrome tested, repeating this process until one is satisfied with the story reached. Finally the same logic of the diagnostic underlies their recommendations concerning policy: it should target the most binding constraint, while still being attentive to second-order interactions with other elements of the policy environment.

2.3 DFID's Inclusive Growth Diagnostics

HRV's Growth Diagnostics has been very influential and it has inspired policy analysts to diagnose countries' economic performance in a more structured way. However, even if its authors mention that the framework can be used to analyze other questions, it has been noted that the framework privileges economic growth over other socially desirable goals. Moreover, by prioritizing short-term growth, it ignores binding constraints that might arise later in the development process. Therefore, other frameworks have incorporated elements of the HRV framework into a broader diagnostic exercise that acknowledges the long-term strategy for the economy, as well as issues of inclusiveness and environmental sustainability.

DFID's Inclusive Growth Diagnostics is a good example. Under this framework, the first stage of the diagnosis consists of mapping a country's economic structure and the drivers of its recent growth pattern. The second stage involves looking at the sectors of the economy – divided into agriculture, export industry and services, domestic industry and services for the domestic market, and extractives – with two objectives in mind: 'transformational' growth and 'holding-pattern' growth. The former concerns opportunities for the reallocation of resources into more productive activities, seen as a catalyst of longer-term inclusive development, while the latter is focused on supporting the livelihoods of the poor until transformational growth touches them. The third stage consists of the diagnostic proper, identifying the factors that constrain private investment, divided into cross-cutting factors, which affect all sectors of the economy, and sector-specific issues. Finally, the diagnostic framework looks at political economy issues, including the overall political settlement and the specific interests of stakeholders affecting the constraints singled out by the analysis.[2]

Compared to HRV, DFID's diagnostic approach is less specific as to the way evidence should be used to identify opportunities and constraints. For instance, the section on sectoral opportunities for inclusive growth does not specify how opportunities in agriculture, extractives or activities geared towards the domestic market are to be identified. Only on export-oriented activities does the framework refer to other tools frequently used in the literature, including HRV's Growth Diagnostics (more on the selection of activities below). Similarly, when identifying cross-cutting and sector-specific constraints, there are no guidelines for deciding which constraint is the most binding, and there is a greater range of questions deemed relevant. Overall, DFID's Inclusive Growth Diagnostic looks at development policy from a more encompassing point of view than HRV's single-minded focus on binding constraints to short-term growth. In this respect, it resembles other diagnostic frameworks used by international institutions, such as the World Bank's Systematic Country Diagnostics (SCD). The next section compares the value of different approaches to growth diagnostics.

3. Assessing Growth Diagnostics

Growth diagnostics work by taking a model of economic growth and translating it into a framework for generating policy insights. Therefore, the task of adjudicating between different methods of growth diagnostics can be divided into two components. Firstly, the plausibility of the growth model must be assessed. We must then check whether the proposed diagnostic framework is useful from a practical

[2] The framework also includes a section on DFID's current engagement, but this is not relevant for the present review.

point of view; that is, for a given set of data, can it maximize the quality of the policy insights generated using a reasonable amount of resources?

3.1 Growth Models

The neoclassical growth model constitutes the basis for most empirical work on growth (Durlauf et al. 2005). In cross-country growth regressions, the variables that enter the neoclassical model are log-linearized so as to be amenable to statistical testing applying Ordinary Least Squares (OLS) to observable variables. Assuming the OLS assumptions hold, the coefficient on a policy variable in the regression represents the effect of that variable on growth. The underlying logic of empirical growth regressions raises two sets of questions on which the validity of the policy prescriptions thus generated will depend. The first involves judging whether a log-linearization of the neoclassical growth model can adequately capture the growth process in developing countries. Secondly, the validity of the specific statistical model used must be assessed. We briefly discuss these issues below.

Cross-country growth regression implicitly assume both linearity and separability (Rodriguez 2006; Hausmann et al. 2008). This implies that the impact of (the logged value of) a variable on growth is independent of the level of other variables, and that a lower value for one of the variables can be compensated by a higher value in another one. Moreover, it is assumed that the growth effects of changing a variable are the same in all countries. Although few people would agree with the idea that the determinants of economic growth really are linear and separable, log-linearization is not necessarily a problem if we believe that the data-generating process for growth can be reasonably approximated with a first-order Taylor series. Much of the controversy in the literature revolves around this issue. For instance, Romer (2001) claims that the first-order approximation is in fact reasonable if an economy is in the vicinity of a balanced growth path. Aghion and Durlauf (2009), while recognizing the limitations of a first-order Taylor approximation, see the solution as finding ways of developing "richer conceptions of interactions" rather than outright dismissing such approximations. Interactive and non-linear terms are in fact used in many contributions to the empirical growth literature (eg. Barro 1996; Banerjee and Duflo 2003), but their use clearly begets a discussion on issues of functional form.

For Rodriguez (2006), the inclusion of non-linear terms is insufficient to avoid the problem of functional form misspecification if one assumes linearity in the remaining regressors. Performing a number of tests on commonly used growth datasets, he finds that if the function form of the non-linearity is unknown, a linear regression, even if including non-linear and interactive terms, will produce biases and inconsistent OLS and IV (Instrumental Variables) estimators, due to the limited sample size of most growth datasets. Based on these results, he claims that the policy prescriptions derived from growth regressions are not warranted, and that the only conclusion that can be drawn from them is that the effects of policy on growth are inherently context-dependent. Other econometric issues with cross-country growth regressions have been identified elsewhere in the literature, including problems of endogeneity, parameter heterogeneity, outliers, omitted variables and measurement error (Rodrik 2012; Temple 1999; Durlauf et al. 2005; Easterly 2005), further raising doubts on the utility of such regressions.

Rodriguez's results are echoed in a series of papers by Hausmann and Rodrik. The context-dependence of the effects of policy implies that there is no one best practice for economic policy and that growth strategies will be diverse (Rodrik 2005). Moreover, it is unlikely that one can judge ex ante the full extent of a policy's impact on the economic environment given the complexity of the economic system and the myriad interactions between its different components (Hausmann 2008). Therefore, economic policy is to be guided by two principles: it must put in place institutions that allow information on required public inputs to be processed in a decentralized manner (Rodrik 2004; Hausmann 2008), and it must adopt an experimental mindset, acknowledging the limitations of top-down planning (Rodrik 2008). These views on the recipes for growth are reflected in the Growth Diagnostics framework. Hausmann, Pritchett and Rodrik (2005) find that the drivers of 'growth accelerations' (episodes of significant increases in per capita GDP growth) are highly idiosyncratic and unrelated to measures usually prescribed by the policy consensus. The finding lends support to ideas about the context-dependence of policy and the search for binding constraints, embodied in practice in HRV's Growth Diagnostics.

3.2 Assessing HRV

The Growth Diagnostics approach has not been immune to criticism. Aghion and Durlauf (2009) note that the framework is unable to address situations in which both supply and demand for a factor are lacking. Moreover, Felipe and Usui (2008) criticize the approach for always assuming that increasing investment is the key to economic growth, and point to the 'Growth Accelerations' paper itself as showing that increased investment is not a predictor of higher growth. They argue that while increasing investment is a necessary condition for growth in the long-run, this is not the case in the short run, where it might rather involve increasing the efficiency of investment (as had been previously argued by Easterly and Levine 2001) or of better allocating the investment (Agosin et al. 2009). In practice, therefore, the Growth Diagnostics framework is likely to be more useful for igniting growth in stagnant economies than for optimizing the performance of high-growth economies (although Leipziger and Zagha 2006 disagree with this assertion). For the latter, it might be more important to prepare for binding constraints that appear later in the development process, something that the Growth Diagnostics, and arguably any approach, is not equipped to predict. This is an important point that will come up later when we compare HRV's Growth Diagnostics with the DFID approach.

Other commentators fall short of disagreeing with HRV, but suggest a number of 'tweaks' to the framework. Rodriguez (2005) asks why must one necessarily tackle one full constraint at a time, rather than, for instance, halving two constraints simultaneously. In fact, growth diagnostic reports produced by the authors of the framework themselves often prescribe the targeting of multiple constraints (eg. Hausmann and Klinger 2008; Hausmann et al. 2015). Another modification of the HRV framework is suggested by Dixit (2007), who notes that the idea of "diagnosis" requires some background knowledge from which to draw. Hence, he recommends that academic research engage in establishing the probabilities that different outcomes will occur in the presence of various syndromes. In this way, it is possible to construct a table of causes, prior probabilities and effects that would facilitate the application of a Bayesian approach to diagnostics. From a theoretical point of view, this would be preferable to a tree, a point conceded by Hausmann et al. (2008) who, however, insist on the use of the tree due to its greater ease of comprehension.

3.3 Comparing HRV with other methods

The great innovation of HRV is the creation of a structured framework for diagnostics in a field where it was historically absent. Their structure facilitates the prioritization of policy measures which, given political economy constraints, are likely to be more manageable than a more broad-based developmental effort. However, if one truly were preoccupied with intervening in different policy areas, tackling multiple constraints, then HRV's standard approach might not be the best option. This, in fact, is the procedure followed by DFID's Inclusive Growth Diagnostics, which instruct analysts to examine a number of possible constraints in virtually all policy areas. Of course, it is still possible to advocate the application of HRV's Growth Diagnostics to these more disaggregated policy areas, but one can argue that a more fundamental divergence is at play here. Both approaches look at different aspects of the economic environment, but while HRV recommend checking whether a constraint is binding before trying to uncover its causes, DFID's Inclusive Growth Diagnostics is more information-intensive, in that it requires an analyst to come to grips with constraints and opportunities in every sector, in addition to cross-cutting policy areas.

Beyond the differences in costs and labour requirements between the two approaches, it is clear that DFID departs from the 'Chinese' strategy espoused by Rodrik, in which governments deal with only one constraint at a time. As mentioned above, in practice, no government has the privilege of saving itself for only one constraint at a time, but this characterization can still allow us to build two 'ideal types' of diagnostic framework to be placed at opposite ends of a continuum: on one end, the prioritizing, experimentalist approach of HRV; and on the other, the more encompassing approach of DFID and other international institutions, such as the World Bank's SCD (which ironically is the least systematic of them all). The divergences between these frameworks, and our choice amongst them, fundamentally depends on our a priori view on how complex the economy is, and on to what extent the data available – analyzed through our preferred framework – can yield the correct policy implications. In this respect, it seems clear that the model of the economy underlying cross-country approaches is too simplified, but it is harder to adjudicate between the HRV's Growth Diagnostics and DFID's Inclusive Growth Diagnostics.

At times, Hausmann, Rodrik and co-authors give the impression of overestimating the difficulty of making economic predictions, and their radical, decentralizing approaches to economic policy are rarely borne out in practice. However, particularly in an African context, one must be aware that the paucity and lack of quality of data might create obstacles for more encompassing approaches, especially when they require judgment of a sector's or a firm's potential. In practice, the most promising approach might be a mix of the two: on one hand, tackling the most binding constraints to growth in order to unlock the fiscal resources, the political support and the aggregate demand to facilitate policies directed at structural change; on the other hand, having a general sense of where future opportunities for productive transformation may lie. But discovering such opportunities requires knowledge of an adequate method for producing sectoral diagnostics, which we move on to in the next section.

4. Methods for Identifying the Most Promising Sectors and Activities

Sectoral selection is perhaps the most controversial issue in industrial policy, as the mantra on states' inability to pick winners became conventional knowledge in the heyday of the Washington Consensus. Still, there is a rising consensus in the policy literature that selectivity of some sorts is inevitable in the conduit of industrial policy (eg. Lin 2012; Crespi et al. 2014). Nonetheless, there is no agreement on exactly how activities and sectors are to be selected. This section outlines different methods put forward in the literature and briefly discusses the advantages and drawbacks of each.[3]

4.1 Domestic Resource Cost Analysis

Domestic Resource Cost Analysis (DRC) is a methodology used most frequently in agricultural economics. However, its use is not necessarily limited to agriculture, and in USAID's Inclusive Growth Diagnostic (Garber 2012) it is mentioned as a method that can be used as part of the process of sector selection. DRC seeks to identify the products in which a country has comparative advantage, understood as the ability to use inputs most efficiently to generate the greatest social value. Hence, it requires a comparison between many goods that could potentially be produced. Importantly, DRC tries to identify the underlying comparative advantage and thus tries to account for policy distortions.

As outlined by Morris (1990), DRC analysis follows five steps:

1. Developing enterprise budgets, accounting for all of a firm's inputs and outputs.
2. Classifying inputs and outputs as either tradables or non-tradables.
3. Determining shadow prices, a measure of the 'true' economic value of inputs and outputs. For non-tradables, these are to be assessed based on their opportunity cost value (ie. their returns in the next best alternative use). The economic value of tradables is their price in world trade.
4. Calculating net social profitability, which is a straightforward subtraction of the economic value of inputs from the economic value of outputs.
5. Calculating resource cost ratios (RCR), which is the ratio of the shadow value of non-tradable inputs to the tradable value added. A value of the RCR between 0 and 1 indicates that there is a comparative advantage in the production of that good.
6. Conducting an analysis of the sensitivity of the results to changes in the coefficients used to construct budgets.

Once we are confident that the results are not sensitive to the parameters chosen, it is possible to select goods for production among those possessing a comparative

[3] For a more in-depth and theoretical discussion on selectivity in industrial policy, see Dercon, Lippolis and Peel (2018).

advantage, with a positive RCR value closer to zero indicating a good with higher social value.

4.2 Growth Identification and Facilitation Framework

A relatively straightforward methodology for identifying sectors and activities in which to specialize is spelled out in Justin Lin's (2012) Growth Identification and Facilitation Framework (GIFF). The underlying idea of his framework is that countries must specialize in the production of goods according to their 'latent comparative advantage', which naturally calls for a comparison with similarly endowed countries. For a given country, the GIFF prescribes identifying the tradeable goods and services produced in the past two decades in fast-growing countries with similar endowment structures and per capita incomes between twice and four times as large. Governments must pay particular attention to sectors that have experienced spontaneous market entry. Applying the framework to Nigeria, he also searches among the list of imports for those with low fixed costs and limited economies of scale, which can more easily be produced domestically.

4.3 Product Space Analysis

A more systematic approach to sector selection is elaborated by Ricardo Hausmann and Cesar Hidalgo in a series of publications. Hausmann and Hidalgo (2011) find that there is a systematic relationship between the number of different products a country makes and the number of other countries that on average make those products (ie. the ubiquity of the product). Developed countries tend to export products that are less ubiquitous, while developing countries' exports are more ubiquitous. They explain this finding by assuming that more ubiquitous products require a larger number of capabilities (ie. are more complex) and that countries differ in the amounts of capabilities they have. This allows them to build an 'Economic Complexity Index' (ECI), which measures the complexity of the product mix made by a country. Hausmann et al. (2011) show that the ECI is correlated with a country's income level, as well as with how fast it grows in the future. Complementing this strand of research, Hidalgo et al. (2007) develop the idea of the 'product space', a map showing the proximity of different goods to each other, as measured by the conditional likelihood that a country exporting one of the goods will also export the other. They show that new export products tend to emerge close to existing areas of the product space, implying that diversification is easier for countries located in denser parts of the product space.

Combining these findings, Hausmann and Hidalgo develop a guiding framework for the selection of goods and sectors. The framework uses the concepts of 'distance' and 'opportunity value' – ie. the degree to which producing a certain good allows a country to move closer to more complex goods in the product space – to rank goods. In general, when examining the options for diversification in poor countries, there is a trade-off between the distance and opportunity value of goods. The Product Space brings these trade-offs to light and allows sectoral selection to be guided by an assessment of the difficulty of moving into the production of a good, as well as the likely pay-offs from producing it. A good example of these tools in action are policy reports on Uganda (Hausmann et al. 2014) and Rwanda (Hausmann and Chauvin 2015). After placing all goods on a two-dimensional chart showing the distance and opportunity value relative to currently produced goods, they exclude goods with an opportunity value of zero, a distance greater than average, and those with low complexity. They then evaluate options for diversification based on their distance and opportunity value.

4.4 Sectoral Selection in Practice

Although product space analysis offers the most sophisticated and disciplined framework for selecting paths of specialization, policy reports on sectoral selection also incorporate other considerations when coming up with recommendations. For instance, Hausmann and Chauvin's report on export diversification in Rwanda looks at the pattern of trade in the country and in its neighbours to identify markets in which it can sell more sophisticated goods. It also considers goods' transport costs, a highly important factor in view of the country's landlocked position.

More generally, methods of sector selection share with Growth Diagnostics the feature of being more of a 'disciplined art' than a science (in the words of Nobel prize-winner Mike Spence). Beyond the indicators constructed by Hausmann and co-authors, there is a wide range of criteria that can potentially be used to assess opportunities for diversification. For example, in addition to Justin Lin's GIFF and Hausmann/Hidalgo product space analysis, an ODI report on economic transformation in Nigeria (Te Velde et al. 2016) mentions revealed comparative advantage (RCA) analysis and analysis of firm level productivity as possible methods for identifying promising sectors and products. RCA consists of comparing the share of a good in a country's export basket to its share in world trade and noting where the former exceeds the latter, while firm level productivity analysis requires comparing total factor productivity in various industries with comparator countries, in this case Kenya and Indonesia. Balchin et al. (2016) go even further and list 17 criteria for sector selection, including low-skilled employment potential, whether world demand is growing, market size, value chain length, and availability of resources.

A further example of methods of sectoral selection comes from Chile, where BCG was hired to analyse the issue (Crespi et al. 2014). The criteria used by them were a sector's high growth potential on a 25-year horizon, assessed using their market intelligence, and a comparison of the capabilities required to become competitive in any given product with the capabilities possessed at the time by Chile, where the relevant capabilities consisted of 77 resource or input variables. A weighing of distance against growth potential was also conducted there, and ultimately eight priority sectors were identified.

4.5 Discussion

DRC analysis is a good baseline from which to assess the utility of other methods for the selection of sectors and activities, but the method itself suffers from severe limitations. On the practical side, calculating the resource cost ratio of one good is a very data-intensive process, and there are substantial difficulties in calculating the value of the many of the variables that go into the model, such as the shadow prices of land, labour and capital, the equilibrium exchange rate, and in constructing a budget for the production of a good, particularly those goods which are not produced yet and for which there is substitutability in the factors of production. In sectoral selection, the problem gets compounded by the fact that the RCR must be calculated for every good that can be possibly produced, rendering the overall procedure incredibly data-intensive.

Due to the data-intensiveness of DRC analysis, Garber (2012) recommends that it be preceded by a product space analysis in order to narrow down the range of possible goods. However, a combination of DRC with product space risks theoretical incongruence. DRC analysis is based on the idea of 'comparative advantage', according to which countries must specialize in goods they can produce relatively more efficiently. In contrast, product space analysis sees development as being driven by the production of more complex goods, which requires the accumulation of productive capabilities (Hausmann and Hidalgo 2011). In product space analysis, the return from specializing in a good does not only, or even primarily, depend on the immediate monetary benefits it provides, but on its economy-wide dynamic effects. These two opposing principles combined to guide sectoral selection would result in choices with unclear rationales, making us further question the utility of DRC analysis.

The greatest virtue of product space analysis is the introduction of a more systematic element to address the difficulty of 'picking winners', once deemed the biggest pitfall of industrial policy. The diffusion of the methodology within the policy world testifies to its value. However, it is not devoid of limitations. Lederman and Maloney (2012) harness the relevant trade literature to provide an in-depth discussion of the idea that “what you export matters”. They point to problems with Hausmann and Hidalgo’s framework. These include:

- The lack of an adequate empirical basis for the idea that producing goods produced by rich countries is good for growth.
- There are substantial variations in quality, and thus price, within even narrowly defined product categories. Therefore, growth benefits of particular goods might be attributable to their longer ‘quality ladders’ allowing unit values to convergence with those of richer countries.
- For any given good, advanced economies experience faster convergence in unit values than developing countries, perhaps reflecting the role of better institutions.
- An exclusive focus on goods as the unit of analysis masks the heterogeneity in the technologies used to produce the same good in different countries, with consequent differences in potential for externalities. They argue that this finding, together with the increased global fragmentation of production, calls for greater attention to tasks rather than goods.

Lederman and Maloney make very convincing theoretical and empirical arguments against product space analysis, but it is possible that they overstate their policy implications. Although they admit that the presence of quality ladders suggests that specializing in some goods rather than others can have more positive implications for growth, they claim this does not imply countries should defy ‘comparative advantage’ and seek to change their export mix since “there is no obvious externality that the market cannot see and which must be corrected.” (Ibid. p. 75) This argument is questionable on several fronts: for example, there are a number of conceptual and theoretical shortcomings in the concept of ‘comparative advantage’, and it is by no means clear that there is a set of factors that uniquely determine what a country is able to produce. Nevertheless, their findings are not necessarily incompatible with the main tenets of product space analysis, including the idea that there is a role for policy in directing economic diversification.

Throughout Lederman and Maloney’s book advances the thesis that the technology of production and the quality of the good are more important than the specific category under which it gets classified. The transition of Volvo from a logging company to a leading car manufacturer is said to be illustrative of precisely that principle. However, it could well be the case that Volvo is an exception coming from a country with a very good endowment of institutions and human capital, and is not representative of the accumulation of productive capabilities in the modal developing economy. A more instructive history is that of industrialization in East Asia, which started with simple products produced in simple ways, but evolved as firms gained greater experience in production, largely spurred by their exposure to export markets (Hobday 1995). More generally, few would disagree with the observation that the production of manufactures for export markets is more likely to incentivize producers to develop the requisite technological and organizational skills than the production of undifferentiated commodities. Indeed, this idea has empirical support: although none of these studies explicitly compares the benefits of exporting manufactures with those provided by other kinds of export, there is substantial evidence that the export of manufactures in developing countries leads to the augmentation of technological and organizational capabilities (see Harrison and Rodriguez-Clare 2010 for a list of such studies).

These observations allow us to render Lederman and Maloney's findings compatible with some of the ideas espoused by Hausmann and Hidalgo. For the latter, shifting the productive structure towards more complex goods facilitates the accumulation of capabilities that can later be used to further diversify, while the former claim that the presence of these capabilities, independent of the productive structure, is what matters for growth. Once we recognize that the production of certain goods for export can spur the development of requisite capabilities, allowing producers to both move up along the quality ladder and to start producing goods with longer quality ladders (Hwang 2007; Khandelwal 2010, Henn et al. 2013), it is possible to reconcile the two views. So Lederman and Maloney's argument comes to complement Hausmann and Hidalgo, rather than contradict them, and product space analysis retains it utility.

Still, product space analysis cannot be the only diagnostic tool at the disposal of policymakers. As the previous section showed, there are a variety of possible motivations for sectoral choice, including the provision of jobs, which are not adequately captured by the product space's exclusive focus on the accumulation of capabilities. Demand conditions, value chain characteristics and market access are clearly important for sectoral choice, and other characteristics of goods besides the capabilities required to produce them, such as transport costs, are important. It is also useful to make comparisons with similarly endowed countries at a higher level of development, as suggested by Lin, since emulation of successful development experiences has historically helped countries form their development strategies (Amsden 2001). There are also theoretical problems in presupposing an exact mapping from goods to capabilities, as many accounts decompose capability into quality and productivity, and note that these can vary immensely within the same product class (Schott 2008; Sutton 2012; Sutton and Trefler 2016). Therefore, the ECI can only be an imperfect measure of the process of capability accumulation that drives development. Ultimately, there might not be any clear-cut formula for choosing sectors; instead, a policymaker must weigh the information provided by different indicators, and make a judgment call. The use of product space analysis, tempered by the additional considerations highlighted above, seems like the most practical way of doing this.

5. Diagnosing Constraints to Sectoral Productivity

This section discusses different methods of diagnosing the binding constraints to growth (in either employment or productivity) in any given industrial sector. There are two sets of questions on this topic that could be of relevance. The first concerns the policy variables that constrain increases in existing firms' productivity. Additionally, one can examine the factors that are preventing more firms, especially those of foreign origin, from entering a sector. Here we only examine the former question, as we were unable to find sufficient research output on the latter.[4]

5.1 Perceptions Data

The standard method for diagnosing the constraints on productivity growth at a sectoral level are similar to those used at a country level. Fafchamps and Quinn (2012) is an example of the use of perceptions data. They survey manufacturing firms in Ethiopia, Tanzania, Zambia, China and Vietnam, comparing the firms and their business environment along several dimensions, so as to understand the reasons behind China's success, and where Africa may be lagging behind. Despite their use of a custom-made dataset, the most commonly used tool for benchmarking is the World Enterprise Survey (WES), regularly conducted by the World Bank, which surveys over 122,000 firms in 124 countries. The WES is the most complete survey of its kind and asks firm managers a range of questions on the macroeconomic framework, governance issues facing the firm, and infrastructure (Xu 2011). Firm managers are also asked to assess the severity of different business climate constraints on a 5-point scale. Aggregating the responses of different firms, it is possible to rank the constraints. Alternatively, firm managers are asked which constraints are the most serious. The fact that the WES is conducted at a firm-level, as opposed to the country-level assessment of other indices such as the Doing Business Indicators, also allows us

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[4] In development policy, there is a relatively large literature on FDI attraction, but it is either discussed at a country level, focuses on the design of investment promotion agencies, or performs econometric assessments of different theories of firms' decisions to locate The most relevant report were able to find is IMF (2003), which has an interesting section on the locational determinants of FDI, based on an investor survey. We were not able to find further pieces discussing the decision to invest in a particular sector. On the other hand, business studies have produced research on the determinants of multinationals' decisions to invest abroad, but it is largely based on case studies and focused on firm's internal dynamics.

to look at these constraints at a more granular level. For instance, Dinh et al. (2012) look at how reported constraints vary according to a firm's size, age, sector and region.

5.2 Regressions

Although benchmarking or looking at managers' responses to questions on constraints can be a good preliminary way of looking at the data, the most common approach in the literature remains regression analysis. There is a large literature investigating the effects of infrastructure, competition, regulation, financial constraints, corruption, and crime on firm outcomes (see Dethier et al. 2011 and Xu 2011 for surveys). However, most of this literature does not attempt to identify *the* most binding constraint to firm growth. Dinh et al. (2012) is an exception to this pattern, as they explicitly try to identify *the* most binding constraint to employment growth in their analysis, interpreted as the statistically significant variable with the highest coefficient in all models. Using subjective indicators (ie. managers' perceptions) they find that access to finance is the most binding constraint. They then proceed to assessing the impact of objective financial access variables on employment growth using another set of regressions, followed by an examination of the determinants of financial access. Finally they investigate how the effects of the different financial access variables vary according to firm size and firm age.

Gelb et al. (2007) is another paper that follow a regression-based approach to identify the most binding constraint to firm growth according to different characteristics. However, in both cases, as in most of the business climate literature, their aim is not to provide diagnostics in the strict sense of the term – if we think of a diagnostic as a way of gathering information on specific cases – but instead aims to provide generalizable evidence on the effects of the variables of interest on firm performance. An exploration of the literature seems to indicate that the only two frameworks that strictly follow the idea of 'diagnostics' are USAID's 'Disaggregated Growth Diagnostic' (DGD) and value chain analysis (VCA). Below we discuss each one in turn.

5.3 Disaggregated Growth Diagnostics

USAID's DGD is the diagnostic framework that most closely incorporates the main tenets of HRV's Growth Diagnostics when seeking to identify priority policy areas at a sectoral level. USAID's concept note (Garber 2012) lists the steps for conducting a DGD, but for our purposes it is most relevant to focus on their guidelines for finding binding constraints on sectoral growth. They build a decision tree almost identical to HRV's original one, but intended for sectoral analysis, with the question of "what constrains private investments" at the top. Although the concept note does not fully explain how one is to move down the tree, USAID and DFID's Inclusive Growth Diagnostic on Bangladesh (Davidson et al. 2014) is a practical example of the methodology's application. It basically follows Hausmann et al.'s (2008) prescriptions, characterizing a constraint as binding if it fulfills the same four conditions. These questions are dealt with in a similar way to HRV's Growth Diagnostics. The main difference is in the first step of the process, where to judge whether movements in the constraint produce significant movements in the objective, Davidson et al. (2014) make use of an econometric methodology first developed by Escribano et al. (2008). This consists of testing the contribution of different components of the investment climate to total factor productivity, using data from World Enterprise Surveys. To assess whether the shadow price of the constraint is high, they compare quantitative indicators of the presumed constraint with other countries. For instance, after identifying electricity as an important constraint to the garment sector in Bangladesh, they compare the frequency and cost of power outages with other Asian countries. For the next step, looking at economic agents' efforts to bypass the constraint, they report figures on generator ownership, noting electricity generated in this way is significantly more expensive. Finally, to ascertain whether agents less intensive electricity are more likely to survive and thrive, they look at generator ownership differences between small, medium and large firms.

5.4 Value Chain Analysis

Unlike other diagnostic methods reviewed in this piece, there is no unified methodology bearing the name 'value chain analysis', but a family of procedures sharing some similarities. The most obvious similarity between these approaches is close scrutiny of each element of a good's value chain, benchmarking it against the same industry in countries where it has been more successful. Below we outline some varieties of VCA revealed by a literature search, preceded by a brief summary of the ideas behind Michael Porter's original coinage of the term.

Porter introduced the term 'value chain' in his 1985 book *Competitive Advantage* as an analytic device allowing one to disaggregate a firm's action into the set of discrete activities it performs, such as design, production, marketing and distribution of its products. In each of these activities, a firm can obtain 'competitive advantage' over its rivals either on the basis of product differentiation or of cost advantage. Porter also develops the idea of a 'value system', consisting of the collection of value chains of a firm's suppliers, channels and buyers. This framework is then used to analyze different strategies for a firm to succeed in an industry. Importantly, Porter emphasizes the diversity of value chains, noting that even in the same industry, no two firms share the same value chain, and that there are a variety of ways in which value chains can differ. This point on the diversity of value chains comes up again later when we discuss the use of VCA in sectoral diagnostics.

Porter's framework was originally developed with the aim of helping firms make strategic decisions. For this reason, it has to be adapted when using it in sectoral diagnosis for industrial policy. A recent World Bank report on "Light Manufacturing in Africa" (Dinh et al. 2012) uses such an adaptation of VCA to assess the determinants of the differences in productivity between the apparel, leather products, agribusiness, wood, and metal products industries in Ethiopia, Tanzania, Zambia, China and Vietnam. While in Porter's version of VCA the major sub-divisions of a value chain are inbound logistics, operations, outbound logistics, marketing and sales, and service, the VCA performed by Global Development Solutions decomposes each good's production process into measures of wage costs, labour productivity, input costs, and trade logistics costs. So, technically speaking, the VCA does not look at activities, but at a breakdown of a firm's costs. The data is obtained by means of interviews with over 300 medium-sized firms in each country. The analysis reveals the specific areas in which firms in each country outperform or underperform those in the benchmark countries (China and Vietnam), thus revealing priority policy actions.

Although Global Development Solutions does not explicitly outline its methodology for conducting VCA, and although their report is somewhat confusing, a reading of the report accompanying the Light Manufacturing publication reveals the following steps:

1. Selecting a specific product, within the broader sector, on which to focus the analysis (eg. polo shirts and underwear in the apparel sector). In the case of the Light Manufacturing report, these were chosen based on them having a low capital intensity, low skill requirements and already having a revealed comparative advantage.
2. Analysis of current structure and trends in the industry, in the world at large and within Africa.
3. Sector profiles in all the comparator countries. Data shown here include production and trade statistics, employment data, regulations and policies, and some of the main features of the sector, including its history and peculiarities.
4. A specification of the market structure and the institutional support structure in each country, including a diagram. At this stage some of the main problems with the industry, as revealed by interviews, are reported.

5. A 'road map' diagram detailing the structure of the supply chain.
6. A detailed breakdown of all the costs involved in production. This involves computing the domestic resource cost of a good (as explained in the section on sector selection), comparing it with the price of an equivalent imported good.
7. Projections of the DRC ratio under different projections for productivity growth and renminbi appreciation, noting whether domestic production would be efficient, and thus able to compete with Chinese imports.
8. The 'core' of the VCA, consisting of a breakdown of costs at every stage of the supply chain for each country, as well as information on the ratio of skilled to unskilled workers.
9. Benchmarking exercise of key variables for the production of polo shirts including: spoilage and rejection rates; waste and losses; electricity, water and fuel costs; labour productivity; electricity, water and fuel usage; transport requirements; installed capacity and capacity utilization; the labour absenteeism rate; average salaries of skilled and unskilled workers; days of operation per month and working hours per day; the average age of major equipment; percentage of production exported directly and indirectly; channels for direct and indirect sales; overall unit production costs, average VAT rebates, and average selling prices.
10. Finally, the analysis reveals other factors contributing to differences in competitiveness, such as the timeliness of product delivery, and the general organization of the sector.

The steps detailed above show that VCA is a relatively data-intensive process, and consequently requires a relatively high commitment of resources, but is able to deliver actionable policy recommendations, backed by quantitative data.

Sutton (2000) provides another variety of sectoral analysis. He conducts a benchmarking study of the Indian machine-tool industry, comparing it to the same industries in Japan and Taiwan. The report is divided into two parts, one dealing with productivity and the other with quality. In this respect, it differs from the VCA described above, which does not examine quality. To obtain measures of productivity, he compares basic machine-tools with similar specifications, a strategy also followed in the VCA report described above, looking at a simple measure of number of machines produced per year per employee. He finds that there is a wide dispersion in productivity levels between Indian firms, but the most productive Indian firm only achieves half the productivity level of a comparable Taiwanese firm. Lower wages more than offset the productivity disadvantage of the best Indian firm, but given that in-house wages only comprise 15% of production costs, he argues that even if productivity were doubled, there would be a small effect on the machine-tool's price, which can be easily offset by modest changes in quality. Therefore, understanding the sources of differences in quality is more important. To analyze the differences in quality, he identifies firms that use both Indian and foreign machines and asks them about general satisfaction with each machine, as well as the aspects which they felt each firm was better in. After finding that Indian firms scored better in service and foreign firms scored better in reliability and accuracy, he asks more specific questions on each of these dimensions, concluding that the priority areas for intervention among Indian firms should be improvements in design and a tighter control of production processes. Moreover, given the importance of high volumes for the industry, he suggests ways of promoting industry concentration.

While not consisting of VCA strictly speaking, and not following any specific methodology, Sutton's approach differs from VCA in that he looks at both productivity and quality, and follows a piecemeal approach of asking increasingly specific questions. In the next section, we compare the approaches outlined here, based on the criteria described in the introduction.

6. Discussion

6.1 Perceptions Data

Gelb et al. (2007) discuss some of the issues surrounding the use of perceptions data to infer constraints on sectoral development. On the matter of comparing questions that use ratings to those that use rankings, they note that it is a complex question, but argue for ways of combining both, allowing us to both assess the severity of constraints and to discriminate between them. Still, this is of no use if we believe that perceptions data do not offer useful information about firms' actual constraints. Gelb and co-authors show that response to questions on constraints follow patterns according to countries' levels of GDP per capita: poorer countries are more concerned with basic issues such as electricity provision and macroeconomic stability, countries in the middle of the African income range give greater importance to governance constraints, and policy-dependent constraints such as labour regulations and a shortage of skills are deemed most acute by the richest African countries. Importantly, these reported constraints co-vary with objective indicators, suggesting that their responses do reflect their experiences. A similar conclusion is reached by Hallward-Driemeier and Alterido (2009).

Despite this suggestive evidence about the relevance of perceptions data, Clark (2011) lists a number of reasons why one should be skeptical. He mentions evidence suggesting that responses to questions on specific areas of the investment climate do not just reflect perceptions on that area of the business climate, but also overall business confidence. Aggregating perceptions across firms also raises many issues, as it is not clear how ordinal responses should be combined, and what weight should be given to responses from different firms where they rank the severity of constraints. Moreover, such surveys suffer from the so-called "camel and hippo problem" (Hausmann and Velasco 2005): we only ever observe the responses of firms that exist given the existing investment climate, but do not know what are the constraints on potential new entrants, or on firms that are intensive in a constrained factor. Finally, it is possible that managers' views do not accurately reflect problems facing the economy as a whole, since they might call for policy interventions that might benefit them but have negative consequences for society as a whole (eg. a cut in electricity tariffs). This does not invalidate the use of perceptions data in diagnostics, but shows that we must be careful when interpreting the results of such surveys. Despite its limitations, such data retains some advantages, such as for example allowing a comparison of the importance of different constraints, which would be difficult to do if using variable-specific units (Carlin et al. 2006; Dethier et al. 2011). In any case, perceptions data can never by themselves serve as a diagnostic, and they must be complemented by other methods, as discussed below.

6.2 Regressions

Regression-based analyses of sectoral data rely on many of the same theoretical assumptions as growth regressions. However, it can plausibly be claimed that the problem of dimensionality is less serious due to the greater level of disaggregation. If this is the case, then thinking about a first- or second-order Taylor approximation may justify the use of linear regressions. However, leaving this issue aside, even at a more disaggregated level, empirical work is fraught with econometric issues. In addition to the "camels and hippos" problem, which also besieges econometric approaches, Dethier et al. (2011) mention the common problem of collinearity in investment climate data, since so many of the regressors are usually correlated with each other. This results in imprecise regression coefficients, which might vary according to which other variables are included in the model, making it difficult to interpret regressions results. Endogeneity is an additional – and potentially more serious – problem. It can arise If relevant explanatory variables are not included in the regressions, or if firms report better investment climate indicators because of their inherent ability to overcome constraints, resulting in reverse causality from firms to the investment climate. In this case, regression coefficients will be biased and will not yield helpful policy implications. Dethier and co-authors also discuss the question of what variable to use as dependent variable. Although analysts are normally interested in studying productivity (TFP), calculating it is by no means straightforward, and their construction process might generate a number of biases.

Clark (2011) also discusses econometric issues affecting regression-based approaches, but emphasizes the key issue of heterogeneity. Reviewing the relevant literature, he finds that investment climate variables affect different aspects of firm performance (such as labour productivity, sales growth, employment growth, export share and investment share) in different ways, and most only affect a few of these aspects. Moreover there is considerable heterogeneity with regards to how these variables affect firm performance according to size, sector, firm age, technological intensity and region. Importantly for the topic of diagnostics, "there is almost no evidence on how different aspects of the investment climate affect firms in narrow sub-sectors of manufacturing (eg. with breakdowns at the 4-digit or even 2-digit ISIC level)". He argues that a major constraint is the small sample size for most sub-sectors of manufacturing in African Enterprise Surveys, which do not allow for statistical inference. But even if one were to obtain data from the universe of firms in a particular sub-sector, the small size of most African manufacturing sectors would also hamper attempts to perform regression-based diagnostics, especially given the large number of variables that are potentially important for firm performance. If we add considerations on intra-sector heterogeneity, then the power of regression-based approaches becomes severely limited. For instance, McKenzie (2011) notes in both Tanzania and Uganda only about 100 manufacturing firms have more than 100 employees.

6.3 Disaggregated Growth Diagnostics

The DGD approach naturally brings with it many of the advantages of HRV's Growth Diagnostics, particularly the structure it gives to the analysis. However, adapting Growth Diagnostics to the firm level means that in the first step of the analysis one cannot use time series data and must instead rely on regressions using cross-sectional data, with all the problems it implies, as discussed above. Another problem with the approach is that often the data required to address the four steps of the diagnostic are not available. In fact, reading Davidson et al. (2014), one often gets the impression that the authors are inferring a little too much relative to the data available. Unfortunately, we were not able to find examples of other reports using the same methodology, so it is hard to tell whether this is an intrinsic property of the methodology or just of one particular application. Finally, this approach also fails to take firm heterogeneity into account. The literature on productivity dispersion (Hsieh and Klenow 2009) and on African firms' capabilities (Sutton and Kellow 2010) suggests that the largest firms have substantially higher capabilities and a higher potential for productivity growth. Because DGD focuses on constraints to the average firm in a sector, it is unable to account for the qualitative differences between these industry leaders and the rest, and cannot identify the constraints that are most important to them.

6.4 Value Chain Analysis

The varieties of VCA are the most data-intensive diagnostic method, because they require the collection of data in the field. The great advantage of VCA is that it does not rely on statistics, but on direct observation of production processes. As a result, it avoids some of the pitfalls of other approaches that try to make causal claims. Moreover, VCA allows one to focus on the firms perceived as having the greatest potential, and generally to disaggregate the analysis as desired. Of course, this comes at a significant cost in terms of data and resources expended. Sutton's (2000) study of supply chains is more economical in the use of data, but it only looks at in-factory productivity, and does not examine factors external to the firm, or the rest of the supply chain, as done in the VCA conducted for the report on Light Manufacturing in Africa. Sutton (2004) does look at supply chains, but again does not aim at identifying policy-amenable variables, and instead benchmarks productivity at different points of the Chinese and Indian auto-component supply chains. Thus, it seems that if one wants to obtain policy recommendations from VCA, there is little alternative but to follow the approach implemented by Global Development Solutions.

Despite its advantages compared to the other methods, VCA is not a panacea. An important limitation is that it does not account for product quality, except insofar as it is measurable in terms of defective units. Although this might not be a problem for standardized, simple goods, there is a substantial body of evidence (reviewed in the section on sector selection) indicating that in order for a country to develop, it has to upgrade product quality. VCA cannot tell them how to do that.

6.5 Conclusion

Analysts interested in performing diagnostics face a number of tradeoffs in the choice of the most appropriate method. Although it would be quite comfortable to be able to simply use WES data, the discussion on the use of perceptions data and regressions show this is not enough. DGDs are also a relatively cheap method to use, since in principle they can be performed using only downloadable data, but again we have seen that this method, by itself, cannot be trusted to provide adequate policy recommendations.

Ultimately, it seems like a combination of methods, culminating in a VCA, is probably the best strategy. This is the approach followed by the World Bank's report on Light Manufacturing in Africa, which is arguably the best available example of sectoral diagnostic. The report uses data obtained through quantitative and qualitative surveys, comparative value chain and feasibility analysis, and a study of the impact of Kaizen managerial trainings for owners of SMEs, as well as WES data, to reach its policy prescriptions. The production of the report clearly required an amount of resources that is by no means replicable in routine diagnostic exercises, but part of this is probably due to its aim of being a flagship report.

Nevertheless, the underlying philosophy of combining the evidence obtained in different ways is still valid. For instance, Gelb et al. (2007) suggest using perceptions data as a starting point for identifying binding constraints, with quantitative methods later leading to more specific conclusions. We might want to add some form of VCA to the mix, but the key conclusion that can be reached is that the development of an adequate sectoral diagnostic requires the combination of different kinds of evidence, probably using the methods surveyed, within a unified, structured framework.

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