THE IMPACT OF INSTITUTIONS ON ECONOMIC PERFORMANCE

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TO MY PARENTS,

FOR MAKING THE LAST THIRTY YEARS POSSIBLE AND

TO KAROLIN,

FOR MAKING THE LAST THREE THE BEST.

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[1]This chapter is based on joint work with Theo Eicher, University of Washington.

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Preface

> "[the country] had probably long ago acquired that full complement of riches which is consistent with the nature of its **laws and institutions**. But this complement may be much inferior to what, with **other laws and institutions**, the nature of its soil, climate and situation might admit of."
>
> Adam Smith, Wealth of Nations[2]

"Why are We so Rich and They so Poor?"[3] What explains modern economic growth and the marked differences in income per capita levels around the world? For example, why is Luxembourg with a purchasing power parity adjusted income per capita of 46,000 US Dollars nearly a 100 times richer than Tanzania with its 500 US Dollars?[4] Why did Germany and Japan catch up with world leaders in income levels after the second World War? Why did the growth process accelerate in some nations like China and India while others, like most in Sub-Saharan Africa, stagnate? How did South Korea and Taiwan achieve doubling their income in a decade or less? As Robert Lucas (1988) famously put it:

> "The consequences for human welfare involved in questions like these are simply staggering: Once one starts to think about them it is hard to think of anything else."

This dissertation analyzes the importance of institutions for economic performance, trying to make a modest contribution to explain why some countries remain poor, while others prosper. It was written at the Munich Graduate School of Economics from 2002 to 2005 and consists of three chapters that can be read independently. The first two chapters assess the importance of institutions empirically, while the last one provides

[2] Adam Smith (1937, p. 95), emphasis added.

[3] Landes (1990)

[4] These income data are from the Penn World Tables 6.1. Units are PPP in terms of trade adjusted 1996 US Dollars.

a dynamic model of institutional change. Given the paramount role of institutions for economic development established in the first chapters and, more importantly, in prominent recent contributions to the literature, this last chapter tries to answers the question why countries trying to improve their institutional framework may fail.

While an entire school of thought, the "New Institutional Economics" (NIE), concerns itself with them, institutions, until recently, did not receive particular attention in main-stream, neoclassical economics.[5] According to Nobel Laureate Douglass North (1990) a widely accepted broad definition of institutions is that they are *"humanly devised constraints that structure human interaction"*. However, the institutional framework under which agents operate was implicitly taken as given in theoretical models and the concept of institutions hard to grasp empirically.

Starting with an important contribution by Mauro (1995) on the effects of corruption on economic growth, institutions have received considerable more attention in empirical studies in recent years and their causal effect on economic performance has been well established. Profiting from greater data availability for institutional variables, Hall and Jones (1999) show that accumulation in human and physical capital cannot adequately explain differences in income per worker across countries. Instead, they stipulate that the quality of institutions influences both factor accumulation and the efficiency of production and thus explains long run economic performance. They use a broad index of social infrastructure to proxy for institutions that includes the rule of law, bureaucratic quality, corruption, risk of expropriation, government repudiation of contracts and openness to trade. Acemoglu, Johnson and Robinson (2001, 2002, 2005) focus on the security of private property and the risk of being expropriated by the state and conclude that institutions are the *"fundamental cause of long run economic growth"*.

The importance of these particular institutions, that are usually categorized as *economic institutions*, had been acknowledged by classical economists. Adam Smith (1937) for example specifies the institutions from the introductory quote:[6]

> "Commerce and manufactures [..] flourish [..with] a regular administration of justice, possession of their property, [..] faith of contracts [...]".

[5] The NIE cannot be done justice by surveying it in this short preface. For important contributions see North and Thomas (1973), North (1990), North (1994) or Williamson (2000).

[6] Very recently, Acemoglu and Johnson (2005) have attempted to further 'unbundle' these economic institutions into *contracting* and *property rights* institutions.

Only a few formal theoretical models exist that endogenize property rights institutions. Grossman and Kim (1996) and Tornell (1997) determine the security of property as a result of individual defense spending. Zak (2002) allows for a role of the state in levying taxes to protect property. Eicher and Penalosa (2004) endogenize the strength of intellectual property rights in an endogenous growth model.

A somewhat distinct set of institutions is analyzed by Persson (2004, 2005) and Persson and Tabellini (2003). They show what effects *constitutional* or *political institutions* have on economic outcomes. In particular their focus is on how the form of democracies (presidential or majoritarian systems) influence economic policies and national income. Theoretical models in this area concentrate on the transition to the 'institution' of democracy (Acemoglu and Robinson, 2000, 2001) or what type of constitution (voting rules required to block legislation) results from agents' bargaining in the process of writing it (Aghion, Alesina and Trebbi 2004).

The connection between these two types of institutions is made by Williamson (2000), Acemoglu, Johnson and Robinson (2005), Acemoglu and Johnson (2005) and Roland (2004), who all posit a *hierarchy of institutions.* The basic argument is that the constitutional institutions / political rules set the stage for the economic institutions, since they set the incentive for legislators and policymakers that shape economic institutions and regulations.[7]

The recent thorough analysis of institutions in the academic literature is met by increased attention towards them in more policy related fields. For example the World Bank dedicated its 2002 World Development Report (World Bank, 2002) to "Building Institutions for Markets", followed a year later by the International Monetary Fund's (IMF, 2003) focus on "Growth and Institutions" in its World Economic Outlook.

In this dissertation, the primary focus of the first two chapters is on the empirical relevance of economic institutions. Chapter 1 shows that they are robust determinants of economic growth in a global sample of countries over a 35-year period, even if one controls for a large number of other variables that have been suggested in the literature. Chapter 2 provides evidence that these economic institutions are important determinants of income per capita even in the more developed OECD countries which one might not have expected. To do so, the *hierarchy of institutions hypothesis* is utilized to show that political institutions can serve as valid instruments for economic ones. The use of instrumental variables is necessary to establish unbiased, causal

[7]Empirical validation for such a hierarchy is given by Persson (2004, 2005) and Eicher and Schreiber (2005) and is analyzed in detail in chapter 2.

effects in income level regressions because the quality of economic institutions might be endogenous to income.[8]

In chapter 3, a further differentiation of institutions - aside from the dichotomy of economic and political ones mentioned above - is considered to explain the failure of large scale institutional reform or *institutions transplantation*.[9] Most notably, North (1990) argues that institutions may be of *formal* (constitutions, laws and regulations) or *informal nature* (norms, codes of conduct, established ways of doing business and informal conflict resolution procedures). Institutional reforms will fail if only the formal institutional framework is changed, while people do not decide to *"Develop norms of behavior that will support and legitimize new [formal] rules."* The last chapter of this dissertation analyzes in detail why agents might rationally choose not to adapt their informal institutions after a change in the formal ones. Since norms and the like are an inherently social phenomenon it is shown how sufficiently strong interpersonal interdependencies in their creation lead to critical threshold levels of informal institutional quality. Since this informal quality is context specific to the prevailing formal institutional framework, disruptions of the institutional equilibrium that are too large will result in a situation in which agents do not adjust to changes in the formal institutions and thus can lead to dismal outcomes of large scale reforms. The next few paragraphs briefly summarize the methodology and preview the results of the three chapters in more detail.

Chapter 1 pays particular attention to the role of *model uncertainty* in cross country growth regressions and uses the *Bayesian model averaging* (BMA) methodology to account for it. The concept of *model uncertainty* explicitly acknowledges that in economic theory competing models exist to explain the same phenomenon and that it is not clear that only one model is the correct one.[10] In the context of growth models and growth econometrics, Durlauf (2001) and coauthors argue that modern growth theories are fundamentally *open-ended*: one growth theory typically has no bearing on the empirical relevance of another. The researcher is not sure which theory is the correct one and hence what exact model should be specified to be tested empirically

[8] Richer Countries might be able to afford better institutions because enforcing property rights and to establish a well functioning judicial system is costly.

[9] Taking the institutional framework of successful western economies and 'transplant' it to poorer nations.

[10] The pioneering work of Hansen and Sargent (2001a,b, 2005) on robust control models this uncertainty in the context of monetary policy. An empirical test of their theories using simple model averaging has recently been proposed by Levin and Williams (2003).

and which covariates should be included in it.[11]

The number of potential regressors to be included in growth regressions is large and one cannot simply run a regression with all theories let alone all variables used to proxy for these theories in the literature.[12] This has typically lead researchers to engage in empirical variable selection strategies and report results only for one preferred model and a limited amount of other specifications to establish robust results. This subset of results can of course be criticized for potentially not being selected randomly. Furthermore, in the reported results uncertainty is understated: When a model selection method such as *general to specific* or a stepwise procedure is used, the single model obtained is assumed to be the correct model. All future inferences and predictions that are made with the model do not account for the uncertainty involved in the selection process. Alternatively, the *Bayesian model averaging* methodology does incorporate the variance component associated with the uncertainty of model building. The basic idea of BMA - dating back to Leamer (1978) - is that, instead of using just one model and discarding all information from other, potentially good models, to average estimates of quantities of interest over all models with a reasonable datafit, using weights proportional to this fit. This methodology has been applied in the context of cross-country growth studies by Brock and Durlauf (2001), Fernandez, Ley and Steel (2001a), and Sala-i-Martin, Doppelhofer and Miller (2004).[13] In chapter 1, a number of measures of institutional quality and a variable that proxies for the degree of financial development, that had not been considered in these studies, are included in a BMA analysis. The importance of institutions has been discussed above and is the main topic of this dissertation. Levine, Loayza and Beck (2000), Levine (2005) and Aghion, Howitt and Mayer-Foulkes (2005) provide substantial evidence for an important role of finance for economic development. Categorizing over 30 variables according to the seven most important growth theories chapter 1 sets out to discover whether finance or institutions or something else are decisive factors shaping the growth performances of different countries. The results confirm an important role for institutions, while financial intermediation does not seem to play a role, once institutional characteristics and, perhaps surprisingly, the public health environment are controlled for. Institutions and health are also shown to significantly influence the rate of convergence in income

[11] Cf. Brock and Durlauf (2001), Durlauf (2001), Brock, Durlauf and West (2003) and Durlauf, Johnson and Temple (2005).

[12] In the most recent survey on the topic the count of variables used in different growth regressions is up to over 140 (Durlauf, Johnson and Temple, 2005).

[13] Other economic application include Finance (Avramov, 2002), Returns to Schooling (Tobias and Li, 2004) and Forecasting of inflation and exchange rates (Garratt, Lee, Pesaran and Shin, 2003, Wright, 2003a,b and Jacobson and Karlsson, 2005).

levels for countries.

In chapter 2, another important problem of cross sectional regressions is addressed: *Parameter heterogeneity*. As Brock and Durlauf (2001) assess, it seems questionable that certain institutional indices can reasonably be expected to exhibit parameter homogeneity across *"complex heterogeneous objects such as countries"*. Specifically, the question asked in this chapter is, whether the economic institutions that have plaid a paramount role in the global sample of Hall and Jones (1999) or in the sample of developing countries of Acemoglu, Johnson and Robinson (2001, 2002) can also contribute to explaining differences in income per capita levels across the more advanced OECD countries. It might be expected that these institutions vary substantially less across this group of countries and that other factors or more specific institutions (like labor and financial market regulations) are more important here. Surprisingly, it is found that, while the coefficients on institutions is about half as big for the OECD sample compared to the global one, it is nevertheless highly significant and economically important, explaining up the 60 percent of the up to eight fold differences in income per worker for advanced nations. Since the quality of institutions might be endogenous to income levels, as establishing and maintaining this quality is costly, one needs to instrument the economic institutions in income level regressions. The instruments that are well established in the literature pertain to the degree of Western European historical influence.[14] These instruments are inadequate for OECD countries, since they were for the most part the *source* of that influence. In a first step, it is shown in chapter 2 that these instruments indeed do not perform well once the global sample is splitted into OECD and Non-OECD members. Surprisingly the instruments of Hall and Jones (1999) fail even in the Non-OECD sample. Next, the *hierarchy of institutions hypothesis* is employed in search of instruments that are valid across all subsamples. While economic institutions determine economic performance, they are themselves influenced by political institutions. Persson (2004, 2005) and Eicher and Schreiber (2005) report empirical evidence for the hierarchy of institutions, by employing specific political/constitutional variables as instruments for economic institutions. The same method is followed in chapter 2. The instruments perform well because they are slow moving and because they have a negligible direct impact on output. As a prac-

[14] Hall and Jones (1999) use English, French, German, Portuguese, and Spanish languages and Latitude as their main instruments and refer to Western Europe's discovery of "the ideas of Adam Smith, the importance of property rights, and the system of checks and balances in government." Acemoglu, Johnson, and Robinson (2001, 2002, 2005) use the mortality rates that European settlers faced, arguing that the settlers established good institutions only in those areas where they actually settled - and survived - in large numbers.

tical matter, this is established in the regressions results of that chapter. Glaeser et al. (2004) also argue forcefully against a direct link between output and political institutions. The strategy employed to establish the validity of these new instruments is to first show that they perform at least as well as the established ones in the global sample and to then verify, that they pass all relevant statistical tests in the subsamples. After substantial robustness analysis which examines different estimation methods, time periods, datasets and samples, chapter 2 concludes that a common set of economically important institutions does indeed exist among advanced and developing nations. The impact of these institutions does vary substantially across samples; it is about three times higher in developing countries than in the OECD.

Given the importance of institutions for economic development and welfare established in the first chapters, chapter 3 analyzes why large scale institutional change might fail. After all, what seems to be implied by the empirical results is that poor nations only need to improve their institutional framework in order to prosper. Why then, do large regions of the world remain submerged in utter poverty?

One explanation is, that due to conflicting and vested interests no attempts to improve matters are made because the entrenched elites stand to loose from these changes. Even in a democracy, ex-ante uncertainty about who might gain and who might loose under a new institutional framework could lead to the rejection of institutional reform, even though a majority would have benefitted ex-post (Fernandez and Rodrik, 1991).

However, if political economy arguments were the only reason, one could not explain another fact about institutions and economic performance that is observed in reality: even countries that did indeed set out on the path of institutional reform do not uniformly perform well. Some succeeded and others failed, even though most of them were trying to implement institutional reforms that were generally seen to be efficiency enhancing. In fact, in many cases of transition economies the reforms had been prescribed by western advisors.[15]

Chapter 3 analyzes the dynamics of large scale institutional change to answer that question. It incorporates the New Institutional Economics' distinction between *formal* and *informal* institutions in a formal theoretical model and analyzes their interaction in a dynamic framework. The failure of *institutions transplantation* is often ascribed to the fact that the imposed formal framework does not fit well to the informal one. What has not been analyzed so far, is why agents would not adjust these informal

[15] For a detailed discussion on the experience of China relative to Latin America or Russia compared to other more succesfull transition economies see for example Rodrik (2005).

institutions, as that should clearly be in their economic interest. This chapter combines two well established notions from distinct strands of literature to answer that question: i) institutions are context specific and ii) informal institutions are a social phenomenon with externalities and network effects in their creation. By changing the formal institutions the government influences the quality of the informal ones: they are initially less valuable in the new context. People would need to adjust them. As informal institutions are viewed to exist in a social context it is shown how sufficiently strong interpersonal interdependencies in the creation of norms lead to critical threshold values for the informal institutional quality. If a reform lowers this value by a too large extent, it leads to a non-adjustment trap and thus explains why large scale institutional change my fail, even in the long run.

The model economy is populated by a large number of infinitely lived, representative agents. Their productivity is linked to the overall institutional quality, much as it seems to be suggested by the empirical studies cited above. This overall quality is in turn made up of the interplay of formal and informal institutions.[16] While agents decide to accumulate informal institutional 'capital', the government decides on the formal institutions. To model the question at hand, it is assumed, that it has a one time chance to alter the formal framework. The government is assumed to be what might be considered a 'benevolent dictator' who knows what the best formal institutions are and changes them for the better (i.e. it is assumed that they can be ordinally ranked).

This change does not come without a cost, however, as informal institutions are context specific. They had been adapted to the old formal institutional setting. Agents have to decide whether to expend precious effort to "Developing norms of behavior that will support and legitimize new [formal] rules".[17] Since norms are an inherently social phenomenon, how high the individual effort is rewarded in terms of improved informal and thus overall institutional quality depends on how much effort the other agents are exerting.

Thus an externality similar to the one analyzed by Azariadis and Drazen (1990) in the context of human capital accumulation may lead to critical threshold levels of informal institutional quality. The interesting feature of the model is that the government actually influences the starting value of that quality in the agents' optimization

[16] Indeed the importance of something akin to the concept of informal institutions had been discussed by J.S. Mill who wrote: *"much of the security of person and property in modern nations is the effect of manners and opinion [..and of] the fear of exposure rather [than] the direct operation of the law and the courts of justice."*

[17] North (1990).

problem.[18] If this value is lowered by too much (and large scale formal institutional reforms naturally lead to greater 'depreciation' of the informal ones), the economy may become trapped in a situation in which agents rationally choose not to adapt. Due to the externality, the pay off to engaging in trying to improve the informal institutions is very low and is thus not worthwhile the agents effort. Since this outcome is more likely the larger the reform is, the model offers an explanation why institutions transplantation or very large scaled reforms may fail, even in the long run. One might think of a country like Liberia, that for a number of years, de jure shared the formal institutions and constitution with the United States but de facto was submerged in what could be described as informal institutional anarchy.

[18] Nothing actually happens to the informal institutions themselves. They are just initially less valuable in the new formal context, and agents need to learn about the new rules and find out what works best under the new conditions.

Chapter 1

Finance, Institutions and Growth - Accounting for Model Uncertainty

There are more things in heaven and earth, Horatio,
Than are dreamt of in your philosophy.

William Shakespeare, Hamlet, act 1, scene 5

1.1 Introduction

Two questions have been at the forefront of empirical growth research recently. What are the deep and robust determinants of economic growth and how can the differing convergence experiences of different countries be explained?

This chapter aims to find out whether two concepts suggested by distinct strands of literatures, financial intermediation and institutions, or rather some other variables may help to answer these questions. The aim is to treat regressors categorized according to the most important growth theories on an equal footing and to properly account for the *model uncertainty* that is particularly severe in empirical growth regressions due to the many potential regressors.

The last 15 years have witnessed a noticeable revival of growth theories and the development of many different growth models initiated by the seminal work of Romer (1986) and Lucas (1988). The abundance of models is met by an even greater cornucopia of variables that have been used in the empirical field to proxy for some aspects of these growth theories and to test their relevance.

A good overview of the current state of the literature is the Handbook of Economic Growth (Aghion and Durlauf, forthcoming). The interested reader finds theories and evidence linking education, health and human capital (chapter 13), trade openness, liberalization and good macroeconomic policies (chapters 15, 23) and sociopolitical stability and conflicts (chapter 25) to economic performance. A further important question in the literature on the deep determinants of economic growth is the Institutions versus Geography debate in which some authors argue for a direct effect of geography (Sachs, 2003) while others asses that "Institutions Rule" (Rodrik, Subramanian and Trebbi, 2004) and are the "Fundamental Causes of Long Run Growth" (Acemoglu, Johnson and Robinson, 2005).

Somewhat distinct from the deep determinants debate has been a strand of the literature arguing for an important influence of financial intermediation on growth.[1] It has perhaps not been considered as a deep determinant because finance is clearly

[1] For an excellent survey, see Levine (2005).

endogenous to even short and medium run growth and thus causal and unbiased effects are hard to establish. In a recent paper, however, Levine, Loayza and Beck (2000) use legal origins as instruments for financial development and show that the exogenous component of finance exerts a strong influence on economic performance.

The basic question relating to convergence is why only some poor countries do catch up to richer nations given that all should equally enjoy Gerschenkron's (1962) famous "advantage of backwardness". In particular the poorest less developed nations should be able to benefit the most from technological and capital transfer from more advanced nations and positive international externalities.

Following the seminal paper by Nelson and Phelps (1966) the common answer to this question is a version of "Barriers to Technology Adoption" (Parente and Prescott, 1994). The basic idea is that the rate at which the gap to the technological frontier is closed depends on the capacity of a country to absorb the new technologies, usually exemplified in the level of human capital. In a very recent contribution Aghion, Howitt and Mayer-Foulkes (2005) argue that rate of technological diffusion is linked to the level of financial intermediation rather than education.

This dependence of the implementation of new technologies on the levels of certain variables are empirically tested through specifications that include a term interacting the stock of human capital or finance with backwardness, measured as a country's distance from the technological leader in terms of initial GDP per capita.

The many regressors suggested by the literature and the possibility of differential convergence rates due to the different levels of some regressors point to an important problem in empirical growth research: *Model uncertainty*. What does the "true" model look like, how should it be empirically specified and what covariates be included?

As argued by Steve Durlauf and coauthors (Brock and Durlauf, 2001; Brock, Durlauf and West, 2003; Durlauf, 2001 and Durlauf, Johnson and Temple, 2005), modern growth theories are fundamentally *open-ended*. One growth theory typically has no bearing on the empirical relevance of another. The researcher is not sure which theory is the correct one and hence what exact model should be specified in order to be tested empirically. Given that according to the most recent survey article (Durlauf, Johnson and Temple, 2005) well over 140 different regressors have been used in the literature, researchers have naturally only considered a limited subset and engaged in empirical variable selection strategies. Usually, results for one preferred model and a limited number of other specifications are reported. This subset of results can of course be criticized for potentially not being selected randomly. Furthermore, in the reported

results uncertainty is understated: When a model selection method such as general to specific or a stepwise procedure is used, the single model obtained is assumed to be the correct model. All future inferences and predictions that are made with the model do not account for the uncertainty involved in the selection process.

Bayesian model averaging (BMA) has emerged as a solution to the problem of model uncertainty that is soundly founded in statistical and decision theory that includes the variance component associated with model building in the presented results. The basic idea is that instead of using just one model and discarding all information from other, potentially good models, to average estimates of quantities of interest over all models with a reasonable datafit, using weights proportional to this fit.

The BMA methodology has recently been applied in the context of cross-country growth studies by Brock and Durlauf (2001), Fernandez, Ley, and Steel (2001a), and Sala-i-Martin, Doppelhofer and Miller (2004). While a limited number of institutional variables have been included in these contributions, proxies for the level of financial intermediation were not considered due to their potential endogeneity.[2] Furthermore, these papers focused on the deep determinants of economic growth in linear regression specifications and did not address non-linear effects, in particular issues of barriers to technology adaption and differing convergence rates.

This chapter aims to fill that gap. It introduces in a Bayesian model averaging analysis a wider range of proxies for institutional variables and especially includes the exogenous component of finance that has been used by Levine, Loayza and Beck (2000) and Aghion, Howitt and Mayer-Foulkes (2005) alongside variables suggested by most other important theories of economic growth. It also allows for an interaction of those variables for which this might be suggested by theory (human capital, health, finance, institutions, liberalization and good, stable macroeconomic policies) with the initial output gap to find out which variables might indeed influence the technological diffusion and thus rates of convergence. In doing so it also the first contribution to scrutinize the effects of financial development by a very comprehensive robustness analysis.

In a first step the results show that in a simple linear specification, institutions and surprisingly the public health of a country influence the growth rate while finance does not. There is also substantial evidence for convergence. In a next step, we find that

[2]Institutional variables include political rights, civil liberties, the rule of law and the degree of capitalism. Variables measuring the security of private property or bureaucratic quality that have been found important elsewhere were not included.

the level of institutional quality and health influence the speed of convergence. There is also some weak evidence linking the rate of technological diffusion to the level of human capital, while such an effect is not corroborated for financial development.

The remainder of the chapter is organized as follows: section 1.2 briefly reviews the growth theories and variables proxying for them used in the BMA analysis in more detail. Section 1.3 gives an overview of the statistical theory and methodology of *Bayesian model averaging* for the problem at hand, before section 1.4 presents the results first for a simple linear setup and then adding the threshold terms with a special focus on finance. Robustness to different priors, endogeneity and multicollinearity concerns are analyzed in part 1.5 until section 1.6 finally offers some concluding remarks and an outlook for further research.

1.2 Growth Theories and the Data

Given the large number of theoretical contributions on the topic of economic growth and possible variables suggested in the literature to measure some aspects of these theories, Durlauf and Quah (1999) conclude that there are *"as many potential regressors as countries"*. Indeed in the most recent survey on the topic the count is up to over 140 (Durlauf, Johnson and Temple, 2005). The most prominent strands of theories can be broadly summarized under the following categories: (i) Human capital and schooling, (ii) geography, (iii) health, (iv) good macroeconomic policies and openness to trade, (v) social conflict and sociopolitical stability, (vi) institutions and finally (vii) financial intermediation.

Human Capital figures prominently in the augmented Solow Model (Mankiw, Romer and Weil, 1992) and the new endogenous growth theories (Romer, 1986 and Lucas, 1988). Following Aghion, Howitt and Mayer-Foulkes (2005) and Levine, Loayza and Beck (2000) in this chapter, we use Barro and Lee's (1996) measures of average years of schooling and secondary schooling relative to a 60-year working life in the population in 1960 as a proxy for the fraction of time devoted to accumulating more human capital. We also utilize the human capital to output ratios constructed by Klenow and Rodriguez-Clare (1997). To account for the dynamic aspects, like Aghion, Howitt and Mayer-Foulkes (2005), we use the growth rates of these variables, which are available for the average years of schooling and the human capital ratio.[3]

[3] From 1960-1995 and 1960-1985 respectivly.

There is an intense debate in the literature about the direct effects of geography on economic outcomes. The idea was put forward in the economics literature by Nobel Laureate Gunnar Myrdal, who wrote:

"a serious study of the problems of underdevelopment ... should take into account the climate and its impacts on soil, vegetation, animals, humans and physical assets–in short, on living conditions in economic development" (1968, volume 3, p.2121).

Following the work by Jared Diamond (1997) many authors have tried to validate (Sachs, 2001, 2003; Gallup, Sachs and Mellinger, 1999 and Masters and McMillan, 2001) or debunk (Rodrik, Subramanian and Trebbi, 2004, Easterly and Levine, 2003 and Acemoglu, Johnson and Robinson, 2001, 2002) the direct effect of geography and climate on growth empirically. The geography debate also shows how growth theories are *open-ended* and interrelated: some authors argue for example that geography exerts its influence manly through its effect on other variables such as transportation costs and trade possibilities (Frankel and Romer, 1999; Sachs and Warner, 1995) or on the disease environment (Bloom and Sachs, 1998) or its effects on institutions (Hall and Jones, 1999). Variables for all of these possible channels through which geography might influence development are included and to preview some results we indeed find no strong direct effect for it. Following most of the literature we include a dummy for Africa, the absolute latitude, the percentage of the population within a 100 km of an ice free coast (to proxy for obstacles to trade) and the percentage of the population living in the geographical tropics.

How healthy people are, may of course influence the quality of human capital (Schultz, 2002), individual productivity (Miguel and Kremer, 2004 and Strauss and Thomas, 1998) and the growth rate of the labour force (Kalemli-Ozcan, 2002).[4] To capture these ideas and the possible effect of geography through the disease environment, we follow Aghion, Howitt and Mayer-Foulkes (2005) and include the average life expectancy at birth, the average child mortality and a variable measuring the malaria ecology.[5]

The degree of trade openness is seen as essential in models of technology diffusion. The importance of trade has already been alluded to (also see Alcalà and Ciccone, 2004 among many others). Openness is part of a set of good macroeconomic policies that have been suggested (most notably by the so called Washington Consensus) to

[4] In two very recent papers, Weil (2005) argues for an effect of health on growth using micro level evidence and Acemoglu and Johnson (2005b) using macro data argue against it.

[5] See Kiszewski et al (forthcoming) for details. This variable is constructed with exogenous variables based on temperature, mosquito abundance and type of mosquito prevelance.

be essential for less developed countries to achieve satisfactory and sustained growth. For example, the key components of the Enhanced Structural Adjustment Facility - the centerpiece of the IMF's strategy from 1987 to 1999 to aid poor countries and promote long run growth - were prudent macroeconomic policies and the liberalization of markets. Growth, it was hoped, would follow automatically.[6] Given this practical relevance of macro policies and the academic discussion on their merits (for example Acemoglu et al., 2003), we include in the BMA analysis, the trade volume and a black market exchange rate premium as proxies for openness, the fiscal policy variable of government spending as a percentage of GDP, the average inflation rate from 1960-1995 and an index of state owned enterprises to cover most of the policies usually used in the literature.[7]

Building on work by Persson and Tabellini (1994) and others, some researchers have attributed under-development to the multiplicity of population subgroups, defined by differences in sociocultural factors such as racial features and languages which might result in social conflicts over redistribution and other vital questions.[8] We include direct measures of the occurrences of conflicts like the number of revolutions and coups over a time span of 30 years (Barro, 1991; Barro and Lee, 1993; Sala-i-Martin et al, 2004) and the number of assassinations per 1000 inhabitants (Aghion, Howitt and Mayer-Foulkes, 2005 and Levine, Loayza and Beck, 2000). Furthermore a measure of ethnolinguistic fragmentation is used, since it is believed that higher social fragmentation could make conflicts more likely (Easterly and Levine, 1997).

There is a substantial, well established literature seeing "Institutions as the Fundamental Cause of Long-Run Growth" (Acemoglu et al., 2005, 2001, 2002; Hall and Jones, 1999 and Rodrik et al., 2004 to name but a few). Since institutions shape economic and political incentives they influence investment decisions in human and physical capital and the efficiency of the organization of production, research and trade. The causal effect of institutions has been established in income levels regressions using sophisticated instrumental variables, but in cross country growth regression they have failed to show up very robustly (Sala-i-Martin, Doppelhofer and Miller, 2004 and Fernandez, Ley and Steel, 2001a). In the present analysis we include a broad range of variables spanning the institutional continuum from business regulations, the quality of the bureaucracy and corruption over the prevalence of the rule of law, security of property rights and

[6] See Azariadis and Starchurski (2005).

[7] Compare Aghion, Howitt and Mayer-Foulkes (2005) and Levine, Loyaza and Beck (2000) for examples of these so-called policy conditioning sets.

[8] See among others: Tornell and Velasco (1992), Benhabib and Rustichini (1996), Alesina et al. (1999) and Rodrik (1999).

the expropriation risk to broader indices like civil liberties, and statehistory, an *"index of in-depth experience with state-level institutions"* that has recently been introduced by Bockstette et al (2002).

A causal effect of the exogenous component of financial intermediation on growth on the other hand has found in the important contribution of Levine, Loayza and Beck (2000). Much more theory and evidence about finance and growth is summarized in Levine (2005). Financial intermediation is seen to help (i) production of ex ante information about possible investments, (ii) monitoring of investments and implementation of corporate governance, (iii) trading, diversification, and management of risk, (iv) mobilization and pooling of savings, and (v) exchange of goods and services.

To test the theory of a role for finance we use the exogenous component of the ratio of private credit to GDP that has emerged as the preferred proxy for financial intermediation in the literature. Since finance is potentially endogenous even to short run growth it is instrumented by legal origins, which have been shown to be valid instruments by Levine, Loayza and Beck (2000), Aghion, Howitt and Mayer-Foulkes (2005) and Levine (2005).

A summary explaining the variables used and their sources as well as their descriptive statistics are given in Tables 1.A1 and 1.A2 in the appendix respectively. Thus, this chapter is the first to introduce such a broad range of theories including finance and many aspects of institutions into a *Bayesian model averaging* exercise. But it does not stop short there, but also allows for nonlinearities in the variables, particularly interactions of some regressors with the initial output gap, also a novelty in BMA analyses about economic growth.

Nelson and Phleps (1966) were the first to formalize Gerschenkron's (1962) catch-up hypothesis. Firstly the growth of the technology frontier reflects the rate at which new discoveries are made and the growth of total factor productivity depends on the implementation of these discoveries, and varies positively with the distance between the technology frontier and the level of current productivity. Secondly they stipulate that the rate at which the gap between the technology frontier and the current level of productivity is closed depends on the level of human capital. This was a break with the view that human capital is an input into the production process. Early empirical support for this hypothesis is offered by Welch (1975), Bartel and Lichtenberg (1987) and Foster and Rosenzweig (1995).

Benhabib and Spiegel (1994) characterize the dependence of implementation of new technologies on human capital levels through a specification that includes a term

interacting the stock of human capital with backwardness, measured as a country's distance from the technological leader. Aghion, Howitt and Mayer-Foulkes (2005) use the same methodology to test their somewhat modified but closely related theory: in their model it is financial intermediation that needs to surpass a critical threshold level. Indeed, in all of their empirical specifications an interaction term of finance with the initial output gap is strongly significant and negatively correlated with growth. To document robustness they interact each variable in their conditioning set with the initial output gap and then run a regression including that term and the financial interaction term for each of these variables separately.[9] This robustness exercise appears somewhat arbitrary especially in the light of *model uncertainty* and *theory open-endedness*. It could well be that more than one or two theories about economic growth are valid or even interacting.

While there are the theories mentioned about barriers to technological diffusion in human capital, education and finance and Parente and Presscot (1994) actually put forward the idea that these barriers might be linked to institutions, it is hard to think of a theory that would call for an interaction term with geographical variables, like the African dummy. The coefficient on such a term would be even harder to interpret: one can not overcome a threshold of being a little African. That is why we only use interactions with finance, institutions, policies and human capital and health variables in our base specification but not for geography. Given that including the interaction terms we consider 56 right hand side variables, *model uncertainty* is substantial in this context and the next section spells out how BMA may be used to deal with it in this context.

1.3 Accounting for Model Uncertainty

The workhorse for cross country growth regression has become a simple linear framework based on the contributions of Barro (1991) and Mankiw, Romer and Weil (1992). The growth rate is regressed on a set of potential regressors suggested by the various growth theories mentioned above.

$$g = \beta_0 + \sum_{j=1}^{k} \beta_j z_j + \varepsilon = Z\beta + \varepsilon, \tag{1.1}$$

[9] Basically we use all the variables that they used in our analysis below.

where g is the average growth rate of per capita GDP over a certain time period, β_0 is a constant term and Z is a vector of k potential covariates including the initial output gap. As Brock and Durlauf (2001, p. 234) put it, the *"fundamental problem with growth regressions is determining what variables to include in"* the vector Z. Growth theories are *open-ended* in the sense that *"the validity of one causal theory of growth does not imply the falsity of another".* Furthermore, even if one agrees on a set of theories, there have been well over 140 (Durlauf, Johnson and Temple, 2005) different variables suggested to proxy for different aspects of these theories. Given that there are only so many countries in the world that make up the set of observations the researcher has to make a choice as to which variables are going to be in- and excluded. She has to decide on a specific model. The incertitude associated with the process of selecting regressors is known as *model uncertainty* and a Bayesian solution to it was first proposed by Leamer (1978).

If, following Nelson and Phelps (1966), only one possible form of nonlinearities in the growth process is accounted for, the problem is even more severe because the number of regressors is basically doubled as pointed out above. For example, exactly like Benhabib and Spiegel (1994) did for human capital, Aghion, Howitt and Mayer-Foulkes (2005) test their theory of thresholds in financial intermediation by including a proxy for financial intermediation interacted with the initial output gap relative to the technological leader (taken to be the US) in a standard cross-sectional growth regression.

$$g_i - g_1 = \beta_0 + \beta_y(y_i - y_1) + \beta_f F_i + \beta_{fy} F_i(y_i - y_1) + X_i\beta_x + \varepsilon_i, \tag{1.2}$$

where index 1 stands for the leader country and i for any other, g is the average growth rate of per capita GDP, y is its initial level of it, F_i is the average level of financial intermediation and X_i is a vector of other country specific regressors.[10] A significant negative influence of the interaction term on growth (more precisely on the growth differential relative to the leader) is taken as evidence of the non-linearity in the variable under scrutiny, be that human capital (Benhabib and Spiegel, 1994) or finance like in this example from Aghion, Howitt and Mayer-Foulkes (2005).

In fact, Aghion, Howitt and Mayer-Foulkes (2005) first use some regressors without interacting them as a conditioning set X_i. In their robustness analysis they take one potential other regressor at a time, interact it with the initial gap and include the regressor, its interaction as well as the interaction term of financial development in

[10] Compare their equation (13) on page 191.

the regression. These alternative regressors are meant to cover most other competing theories of economic development. Their results show that the only significant coefficient in this particular exercise turns out to be β_{fy} the one for the interaction term of financial development and the initial output gap.[11] But of course they only consider a small subset of all possible models in doing so. Given that g_1 can be taken to be constant only affecting the intercept and that financial intermediation is just another regressor we can write the growth regression as a linear regression model on k potential covariates z like in equation (1.1) above and potentially $k-s$ interaction terms of these regressors with the initial output gap:[12]

$$g = \beta_0 + \sum_{j=1}^{k} \beta_j z_j + \sum_{j=1}^{k-s} \beta_{zy} z_i (y_i - y_1) + \varepsilon. \tag{1.3}$$

A consequence of the additional source of uncertainty in the process of selecting which regressors and their interaction terms to include in (1.3) is that basing inference on a single model and thus ignoring *model uncertainty* may result in underestimating the uncertainty about quantities of interest (Raftery, Madigan and Hoeting, 1997). This uncertainty can be substantial as there are now $R = 2^{k(k-s)}$ potential different models.

For example, in the literature on economic growth up to 67 variables have been used in a single paper at once (Sala-i-Martin, Doppelhofer and Miller, 2004) and the importance of *model uncertainty* is acknowledged to be particularly severe (see, e.g. Temple, 1999; Brock and Durlauf, 2001; Durlauf, 2001). Levine and Renelt (1992) address the issue of *model uncertainty* by employing a version of the *extreme bounds analysis* pioneered by Leamer (1983) and basically find only the initial income to be robustly related to growth.[13] Sala-i-Martin (1997), using a less restrictive test, identifies a relatively large number of variables to which he assigns some level of confidence for inclusion in growth regressions.

These two methods have been criticized for lack of a sound statistical and decision theoretic foundation and the first one for being far too restrictive, as the model on which the rejection of robustness of a variable is based might be fitting the data extremely poorly. *Bayesian model averaging* has emerged as a theoretically sound solution to

[11] Financial indermediation and its interaction with the initial GDP gap are here instrumented by Levine, Loayza and Beck (2000) legal origin variables to adress potential endogeneity issues. All other variables are not instrumented.

[12] Where k - s is the number of variables for which an interaction term is suggested by theories of technological diffusion.

[13] Robust refers to the question of whether the coefficient associated with the variable never changes sign and retains at least a five percent significance across all possible model specifcations.

account for model uncertainty and will be discussed below. The simple robustness analysis carried out by Aghion, Howitt and Mayer-Foulkes (2005) only takes into account a fraction of the potential models and bases inferences on them, thus completely ignoring models that include more than one additional potential determinant of growth apart from their simple conditioning sets.

1.3.1 Bayesian Model Averaging

Leamer (1978) formalized the idea to account for model uncertainty by simply basing inference about quantities of interest on weighted averages over all possible models, instead of focusing on a single one. As weights he proposed a measure that is proportional to the quality of the model relative to the other models, more formally the posterior model probability, which will be derived below. Apart from accurately accounting for model uncertainty, BMA has been shown to have a number of advantages (for details see Raftery and Zheng, 2003): (i) It is soundly based on statistical and decision theory; (ii) Jeffreys (1939) proofed that model selection using Bayes factors (on which BMA is based) minimizes the *Total Error Rate;*[14] (iii) a point estimate based on BMA about a quantity of interest that has a common interpretation across all models, minimizes the *Mean Squared Error* (MSE) among point estimators and the average length of the confidence interval is consistently shorter than the standard confidence interval; (iv) it selects the 'true' model (with sufficient data), if the true model is contained in the set of competing models even if that true model is the null or full model;[15] (v) it builds in penalties for model complexity; (vi) theoretically, the BMA predictive distribution is optimal under Good's (1952) *Logarithmic Scoring Criterion* and (vii) the superior predictive performance of BMA, relative to selecting a single model, has been confirmed in various simulation exercises and assessments of out of sample predictions.[16]

The last results intuitively underlines the appeal of model averaging in the following sense: BMA allows to use more information that is contained in the data than by just using a single model and discarding information contained in any other model. BMA is superior to the full model because models get weighted according to their data-fit such that very bad models will receive a negligible weight and statistical relevance of variables is not attenuated by the inclusion of irrelevant regressors.

[14] With Total Error Rate=Type I error rate + Type II error rate. This is true for nested models, if the practical distribution is equal to the prior distribution over the parameters.

[15] Cf. Raftery, Madigan and Hoeting (1997).

[16] Cf. Raftery, Madigan and Hoeting (1997), Hoeting et al (1999), Raftery (1995), Raftery Madigan and Volinsky (1995) and Fernadez, Ley and Steel (2001a, 2001b).

Bayesian estimation in general expresses all uncertainty, including uncertainty about the unknown parameters of a model, in terms of probability and views unknown parameters as random variables. All results follow directly from elementary probability theory, notably the definition of conditional probability, Bayes' theorem and the law of total probability.[17] A simple probability model for the data D is specified by a vector of d unknown parameters $\theta = (\theta_1, ..., \theta_d)$. In case of the linear regression model of (1.1) these parameters simply are $(\beta_0, ..., \beta_k, \sigma^2)$. An important Bayesian concept is the prior probability density (or prior) $p(\theta)$ which incorporates any information the researcher may posses about θ prior to observing the data. The probability model is then defined by the likelihood $p(D|\theta)$, which is the probability of observing the data D given that θ is the true parameter vector.[18] The fundamental question that econometricians are trying to answer is what the data has to say about a certain quantity of interest. Using Bayes' rule we can formulate the posterior distribution of θ as the conditional probability of θ, given the data and the prior

$$p(\theta|D) = \frac{p(D|\theta)p(\theta)}{p(D)}. \tag{1.4}$$

Since $p(D)$ does not involve θ we can ignore it and state that the posterior distribution is proportional to the likelihood times the prior:

$$p(\theta|D) \propto p(D|\theta)p(\theta). \tag{1.5}$$

This equation can be thought of as an updating rule where the data allows us to update our prior beliefs about parameters in θ. The resulting posterior distribution combines both data and non-data (i.e.: the researchers priors) information.

Usually the researcher is faced with situations where there is more than one potential model. In our application to economic growth, we noted that there might be a large number R of different models. Then it also needs to be specified on which model, M_r for $r = 1, ...R$, the posterior is conditioned on:

$$p(\theta^r|D, M_r) = \frac{p(D|\theta^r, M_r)p(\theta^r|M_r)}{p(D|M_r)}. \tag{1.6}$$

The Bayesian logic behind equation (1.4) of expressing uncertainty in terms of

[17] Compare for this and the following for example Raftery (1995) and Koop (2003).

[18] In case of the classical linear regression model with a normal error distribution this will be a normal density which depends upon the parameters.

conditional probability may be easily extended to the level of model uncertainty. The posterior probability that model M_r is the correct model (posterior model probability) by Bayes rule is given by:

$$p(M_r|D) = \frac{p(D|M_r)p(M_r)}{\sum_{s=1}^{R} p(D|M_s)p(M_s)}, \tag{1.7}$$

where $p(M_r)$ is the prior model probability of a model[19] and $p(D|M_s)$ is the marginal likelihood of model r. Sometimes also referred to as the integrated likelihood it is calculated by integrating both sides of (1.6) over θ^r and using the fact the LHS integrates to one as:

$$p(D|M_r) = \int p(D|\theta^r, M_r)p(\theta^r|M_r)d\theta^r. \tag{1.8}$$

Then, following Leamer (1978), we can base inference about any quantity of interest Δ (i.e. coefficients or predictions) on its posterior distribution, which by the law of total probability is

$$p(\Delta|D) = \sum_{r=1}^{R} p(\Delta|D, M_r)p(M_r|D). \tag{1.9}$$

This formula is the essence of BMA: it provides information about the full posterior distribution of Δ, which is a weighted average of its posterior distributions under each possible model with weights equal to the posterior model probabilities. Intuitively, if we are for example interested in the point estimate of the mean of a particular coefficient β_j in the linear regression model (1.1), then it is simply the average of the estimates of the mean of β_j in each model (in models where it is excluded that will simply be zero), where each model is weighted by how well it fits the data compared to the other models (i.e. the posterior model probability):

$$E(\beta_j|D) = \sum_{r=1}^{R} E(\beta_j|D, M_r)p(M_r|D). \tag{1.10}$$

The posterior standard deviation may also be computed in this spirit as the sum of the weighted average of the variance in each model and the variance of β_j across

[19] Most commonly this is assumed to be a uniform prior across the model space, meaning that ex ante each model is assumed to be equally likely with $p(M_r) = 1/R = 1/2^k$. A notable exception is Sala-i-Martin, Doppelhofer and Miller (2004) who somewhat arbitrarily assume that models that include 7 regressors are most likely. In the robustness section we experiment with different priors.

models:

$$var(\beta_j|D) = \sum_{r=1}^{R} var(\beta_j|D, M_r)p(M_r|D) + \sum_{r=1}^{R}[E(\beta_j|D, M_r) - E(\beta_j|D)]^2 p(M_r|D). \tag{1.11}$$

The first term on the RHS is equivalent to the calculation of the posterior mean and reflects the within model variance of β_j for each model. The second term captures the fact that the models themselves are very different and with them the possible estimated values for the mean of β_j. It is not determined by the model-specific variance calculations and thus captures how model uncertainty can increase the variance associated with a parameter estimate relative to conventional models.[20]

With these posterior point estimates and standard errors it is of course easily possible to construct posterior t-values and other significance statistics. In BMA however, inference about the importance of variables is not primarily based on posterior t-values, but rather on the cumulative posterior probability of the models that contain the variable of interest. This is defined as the *posterior inclusion probability* of regressor x_j in terms of its coefficient β_j:

$$\Pr(\beta_j \neq 0|D) = \sum_{A_1} p(M_r|D), \tag{1.12}$$

where $A_1 = \left\{M_r : r = 1, ..., R; \beta_j \neq 0\right\}$ is the set of models that include x_j. Simply put, a regressor is the more significant the more often it shows up in models that are well supported by the data. If a uniform prior on the model space is specified (i.e. each model is equally likely ex ante with $p(M_r) = 1/R$, which implies a prior inclusion probability of 1/2 for each individual regressor), Raftery (1995) suggests the following interpretation of the posterior inclusion probabilities: $\Pr(\beta_j \neq 0|D) > 50\%$ suggests that the data provides weak evidence that the regressor is an important one, $p > 75\%$ implies positive evidence and $p > 95$ and 99% provide strong and very strong evidence for a regressor respectively. As a rule of thumb any variable that has a posterior inclusion probability that is greater than the prior inclusion probability is at least weakly supported by the data. For model priors that favor smaller models like in Sala-i-Martin, Doppelhofer and Miller (2004), this prior regressor inclusion probability can be smaller than 1/2 (0.11 in their baseline case), thus implying that generally regressors with a posterior inclusion probability sufficiently greater than the prior one may be flagged as important. An inclusion probability close to one signals in any event,

[20] Compare Leamer (1978) and Brock, Durlauf and West (2003).

that the particular regressor is included in almost all of the very good models and thus contributes prominently to explaining the dependent variable even in the presence of a high degree of model uncertainty.

What is left to do in order to undertake an BMA analysis is to specify priors, which do not unduly influence the posterior estimates but are uninformative and let the data speak. For the prior on the model size it is common to assume a uniform prior on the model space, i.e. each model is equally likely ex ante such that $p(M_r) = 1/R = 1/2^k$ for each r.[21] For the prior on the regressors we follow Raftery (1995) in implicitly using the *unit information prior* by approximating the log of the likelihood $p(M_r|D)$ with the BIC (*Bayesian Information Criterion*) in all of the above equations. The unit information prior is seen as a conservative prior in not assuming much prior information and is sufficiently spread out over the relevant parameter values and reasonably flat over the area where the likelihood is substantial. For inference about the significance of a particular coefficient β its mean is usually centered at zero a priori, corresponding to the classical null hypothesis in frequentist econometrics that a regressor has no effect on the outcome.[22]

1.4 BMA Results

Our BMA analysis proceeds in three steps: First we scrutinize the results of Levine, Loayza and Beck (2000) and those summarized by Levine (2005) of the importance of financial development on growth by including all the variables mentioned in section 1.2 in a linear way. Secondly, we consider the nonlinear effect of finance on growth suggested by Aghion, Howitt and Mayer-Foulkes (2005), by just including the other regressors linearly, only to find that the claimed robustness of their results already vanishes at this point. Finally, we perform the most comprehensive BMA analysis by allowing interactions with the initial output gap for those variables for which it might be suggested by theories of technological diffusion.

[21] See for example, Brock, Durlauf and West (2003), Raftery (1995) and Fernandez, Ley and Steel (2001a).

[22] For more details see Raftery (1999). Implicitly Sala-i-Martin et al (2004) also use the BIC (see Raftery, 2005).

1.4.1 Finance or Something Else?

To incorporate the effect of the exogenous component of financial intermediation along with the other potential theories mentioned in section (1.2) in a linear growth regression, we follow Levine, Loayza and Beck (2000) and Aghion, Howitt and Mayer-Foulkes (2005) in instrumenting their preferred proxy, the ratio of private credit to GDP[23], with legal origin variables. We use the predicted values from the first stages for the following BMA analysis. All other variables are directly taken from the Aghion, Howitt and Mayer-Foulkes (2005) dataset.[24] Table 1.1 presents the results.

The first column reports the posterior probability that a variable is included in the models as given by equation (1.12). The next 3 columns provide the posterior coefficient estimate, the posterior standard deviation over all models considered as in (1.10) and (1.11) and the BMA equivalent to a t-value following from these. The last five columns present the five models which receive the highest support by the data. They present the best models selected from the model space according to the *Bayesian information criterion* (BIC).[25] The variables are sorted according to their posterior inclusion probabilities in descending order. Figure 1.A1 in the appendix provides a graphical assessment of what the over a 100 best models look like and their relative support by the data. The models are depicted on the horizontal axis, where the width assigned to them is proportional to their datafit according to the BIC. Which variables enter in which model and what sign the posterior coefficient has (green for positive and red for negative) is shown on the vertical axis. Variables that have a very low posterior inclusion probability obviously never make it into any good models.

The rows at the bottom of Table 1.1 introduce the value of the BIC (lower values indicate a better datafit) and very importantly the posterior model probability. This number very nicely illustrates the importance of *model uncertainty*: Even the best model is only correct with a probability of under one percent. Thus, one could say that a researcher who bases inferences on this model exclusively would use a model which might be incorrect in over 99 percent of the time.

The variable most strongly supported by the data is the initial output gap relative

[23] The other variables they use are liquid liabilities, bank assets and the ratio of comercial banks' assets to total (central bank plus comercial bank) assets. As was the case for Levine, Loyaza and Beck (2000) and Aghion, Hewitt and Mayer-Foulkes (2005) our results are not greatly altered when using these alternative measures.

[24] We thank Aghion, Hewitt and Mayer-Foulkes (2005) for making the data publicly available at Mayer-Foulkes' website.

[25] For the BIC, lower values mean a better model fit (cf. Raftery, 1995).

Table 1.1
BMA* Results For Linear Specifications

Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value	Best BMA 1	Best BMA 2	Best BMA 3	Best BMA 4	Best BMA 5
Intercept	100	-12.5400	2.787	-4.499	-13.165	-12.980	-14.363	-10.818	-13.237
gap60	100	-1.9160	0.315	-6.090	-2.094	-2.017	-2.027	-1.885	-2.033
me	99.5	-0.1162	0.032	-3.641	-0.118	-0.105	-0.126	-0.101	-0.120
avgexpect	97.3	0.0913	0.034	2.724	0.096	0.102	0.101	0.078	0.095
expriskB	86.8	0.5616	0.273	2.060	0.600	0.719	0.676	0.688	0.663
f_prop97	54.5	0.1854	0.213	0.869	0.355	.	0.346	.	0.381
lat_abst	47.3	-0.8833	1.138	-0.776	.	.	.	.	-1.003
civil	43.3	0.1111	0.157	0.706	.	.	0.151	.	.
statehist	39.8	0.4118	0.620	0.664	.	.	.	.	.
rulelawB	30.4	0.0980	0.178	0.549	.	.	.	.	.
avgmort	23.4	-0.0008	0.002	-0.449	.	.	.	-0.003	.
gschool	16.5	-0.0523	0.136	-0.386	.	.	.	.	.
ghy	16	0.0832	0.225	0.369	.	.	.	.	.
bureauB	14.6	0.0798	0.206	0.387	.	.	.	.	.
hy	14.3	0.2428	0.761	0.319	.	.	.	.	.
afr	12.8	-0.1754	0.505	-0.348	.	.	.	.	.
troppop	5.3	0.0279	0.148	0.189	.	.	.	.	.
infra	4.5	0.0345	0.243	0.142	.	.	.	.	.
school60	4.3	-0.0115	0.062	-0.184	.	.	.	.	.
soe	3.9	-0.0029	0.017	-0.164	.	.	.	.	.
bmp	3.8	0.0002	0.001	0.167	.	.	.	.	.
pi	3.1	0.0002	0.002	0.136	.	.	.	.	.
corruptB	1.8	-0.0044	0.040	-0.109	.	.	.	.	.
revc	1.7	-0.0154	0.143	-0.107	.	.	.	.	.
assass	0.9	0.0029	0.036	0.079	.	.	.	.	.
f_regu97	0.7	-0.0020	0.029	-0.069	.	.	.	.	.
sec	0.3	-0.0003	0.009	-0.029	.	.	.	.	.
gov	0.3	0.0001	0.002	0.040	.	.	.	.	.
privohat	**0**	**0.000000001**	**0.000003**	**0.000**	**.**	**.**	**.**	**.**	**.**
pop100cr	0	-0.00001560	0.004	-0.004	.	.	.	.	.
trade	0	0.000001	0.0001	0.009	.	.	.	.	.
avelf	0	-0.00000003	0.0003	0.000	.	.	.	.	.
nVar					5	4	6	5	6
r2					0.799	0.780	0.807	0.791	0.805
BIC					-63.580	-62.965	-61.761	-61.651	-61.417
post. Model prob.					0.079	0.058	0.032	0.030	0.027
Observations					53	53	53	53	53

*Notes: Results obtained with R-BMA BIC.reg software provided by A. Raftery (1995)
Dependent variable is average GDP per capita growth rate 1960-1995
Privohat is the predicted value from a regression of private credit on legal origins

to the leader. It has a posterior inclusion probability of 100 percent and as is visible from Figure 1.A1 enters in every reasonable model with the expected negative sign. This result is in line with the *extreme bound analysis* of Levine and Renelt (1992) and with the *Bayesian model averaging* exercises of Sala-i-Martin, Doppelhofer and Miller (2004) and Fernandez, Ley and Steel (2001a) and indicates support for the conditional convergence hypothesis.

Apart from initial income only 4 variables that pertain to theories relating health and institutions to growth have a posterior inclusion probability higher than the prior one. Theories of geography, policies and trade openness, sociopolitical stability and in particular finance are not supported by the data once the former variables are controlled for and model uncertainty is taken into account. The second and third best variables are two health variables. Malaria ecology and the average life expectancy. A variable measuring the malaria prevalence was also included in Sala-i-Martin, Doppelhofer and Miller (2004) and ranked as 7 out of 68 followed by the life expectancy in 1960, insofar our results are mirrored in theirs. Life expectancy was even ranked third in Fernandez, Ley and Steel (2001a) who did not include any other health variables. Thus finding health variables high on the list is not peculiar and these results are further reinforced by the recent micro-level study of Weil (2005).

Next in line - strongly supported by the data with 86 percent inclusion probability and showing up in almost all good models as Figure 1.A1 suggests - is the risk of expropriation. Apart from the initial income gap this variable also has one of the highest posterior coefficients with 0.56, indicating that improvements in this aspect of institutional quality could have sizable effects on economic growth. This particular variable has been found extremely important in the income level regression work of Acemoglu, Johnson and Robinson (2001, 2002, 2005). Thus our results reinforce their research that focused on long run growth - by looking at how the exogenous component of the expropriation risk impacts income levels - even for the medium run by looking at growth rates of income over 35 years. This variable has not been included in other BMA exercises as have been very few institutional variables: Sala-i-Martin, Doppelhofer and Miller (2004) only use civil and political liberties which turn out not to be robustly related to growth. In addition to these two, Fernandez, Ley and Steel (2001a) introduce the rule of law and rank it 7 out of 41 with mild support by the data with an inclusion probability of 52 percent. In our analysis these variables have only a 43 and 30 percent posterior chance of inclusion respectively, but that is because we also include risk of expropriation and property rights which prove to be more important. The security of property variable is the last of the five variables that receive at least weak support

from the data in our analysis.

Of course, one might be concerned with the endogeneity of institutional variables in our growth regressions. However, institutions are usually seen to be quite persistent such that they should be influenced a lot less by growth rates of income than by the income level itself.[26] Furthermore, they may also be measured with error which would lead to a downward attenuation bias of their coefficient, while the endogeneity problem would lead to an upward one. It is usually found in the income levels regressions with instrumented institutions that the Instrumental Variable coefficient is larger than the OLS estimate such that measurement error appears to be the more severe problem of the two and our estimates on institutions should be if anything conservative.[27] Nevertheless, in the robustness section we report results for instrumenting the dominant component of the institutions vector instead of private credit which reaffirms our results here.

Recapitulating, our findings suggest that once other important theories of economic growth are analyzed on an equal footing with the exogenous component of finance, the claimed robust effect of finance on growth vanishes. Typically, studies finding such an effect do not take model uncertainty into account because they ignore variables suggested by other plausible growth theories.[28] Paramount appear to be health conditions and institutions. Higher life expectancy at birth, a lower risk of malaria infection and securely defined and enforced property rights foster economic growth. The theories about the effect of geography on growth are only corroborated inasmuch as they postulate an indirect effect through their influence on the disease environment.

Taken together with the fact the another predetermined variable namely ethnolinguistic fragmentation is also not important, this suggests a more optimistic perspective on the prospects of achieving higher growth in a number of countries than the geographic determinism view. In line with Acemoglu et al. (2003) we find that once health and especially institutional conditions are controlled for, bad macroeconomic policy variables are merely the *"symptoms"* but not the cause of slow growth. Given the pessimistic outlook for finance we now turn to see if it might not play an important

[26] The argument made about their endogeneity usually is that richer countries might be able to afford better institutions not the faster growing ones. If anything the value of institutional quality at the end of the period should be of great concern, but we use period averages for most variables.

[27] Compare for example Hall and Jones (1999) and Bockstette et al. (2002, p. 360).

[28] Levine, Loayza and Beck (2000) for example, only allow for initial income, average schooling, governemt size, inflation, the black market premium and openness to trade, thus allowing for two additional theories: human capital and policies. Performing BMA on this set of regressors and the instrumented financial intermediation variable indeed provides finance with a posterior inclusion probability of 98 percent.

role as a barrier to technological adaption as Aghion, Howitt and Mayer-Foulkes (2005) find.

1.4.2 Finance as a Barrier to Adaption?

Given that in reality there seems to be substantial evidence not only of conditional convergence but also divergence in income rates - for example Quah's (1996, 1997) "*Twin peaks*" - one would like to be able explain this phenomenon. Aghion, Howitt and Mayer-Foulkes (2005)'s model offers just that. In fact, after estimating a simple form of it they are able to divide the countries into the ones that are most likely to converge and the ones to most likely diverge in income levels (table II, p. 197). Aghion, Howitt and Mayer-Foulkes (2005) first test their theory of a financial threshold variable by running a regression as specified in equation (1.2). However like Levine, Loayza and Beck (2000), they ignore a number of growth theories in their main specifications when conditioning only on initial income, average schooling, government size, inflation, the black market premium, openness to trade, indicators of revolution and coups, assassinations and ethnolinguistic fragmentation. Their decision to only include those regressors from the entire set of variables at their disposal (which are all the variables we use here and are described in Table 1.A1 in the appendix) appears somewhat arbitrary and is not explained in their text.

Perhaps one reason is that including many irrelevant variables in a model inflates all standard errors and thus pushes the statistical significance of all regressors downward. Hence, it is difficult to include all potential regressors in a simple OLS analysis without running the risk of rendering all variables insignificant. Nevertheless, the results of doing just that are telling. The last two columns of Table 1.2 provide results for the full model where we include all the variables mentioned in section 1.2 alongside the interaction term of finance with initial income.

While the interaction term of finance with the initial output gap is insignificant, a number of other variables exhibit statistical significance. In particular the initial output gap has a sizable negative coefficient lending support to conditional convergence even after the Aghion, Howitt and Mayer-Foulkes' (2005) barrier in finance is allowed for. Further important variables are institutional and human capital ones.

However, basing inference on just one model, especially the full one, is not adequate firstly, because the inclusion of irrelevant regressors inflates the standard errors of all variables and secondly, because ignoring *model uncertainty* leads to an underestimation

Table 1.2
Interacted Finance Variables versus Levels of the Rest

Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value	Best BMA 1	Best BMA 2	Best BMA 3	Best BMA 4	Best BMA 5	Full Model Coeff.	Full Model t-value
Intercept	100	-12.500	2.802	-4.460	-13.165	-12.980	-14.363	-10.818	-13.237	-8.540	-1.66
gap60	100	-1.905	0.320	-5.950	-2.094	-2.017	-2.027	-1.885	-2.033	-1.501	-2.11
me	99.6	-0.116	0.032	-3.600	-0.118	-0.105	-0.126	-0.101	-0.120	-0.097	-1.7
avgexpect	97.3	0.091	0.033	2.720	0.096	0.102	0.101	0.078	0.095	0.070	1.31
expriskb	86.5	0.559	0.274	2.040	0.600	0.719	0.676	0.688	0.663	-0.211	-0.52
f_prop97	54	0.184	0.213	0.863	0.355	.	0.346	.	0.381	0.114	0.41
lat_abst	46.9	-0.873	1.133	-0.770	.	.	.	.	-1.003	-1.900	-1.1
civil	43.5	0.112	0.157	0.709	.	.	0.151	.	.	0.510	2.79
statehist	39.3	0.405	0.616	0.657	.	.	.	.	.	0.835	1
rulelawb	30.6	0.099	0.179	0.553	.	.	.	.	.	0.512	1.86
avgmort	24.1	-0.001	0.002	-0.458	.	.	.	-0.003	.	-0.001	-0.34
ghy	15.6	0.081	0.223	0.364	.	.	.	.	.	0.204	0.48
gschool	15.5	-0.053	0.140	-0.381	.	.	.	.	.	-0.706	-3.08
bureaub	14.9	0.080	0.205	0.392	.	.	.	.	.	0.620	1.99
hy	13.4	0.255	0.799	0.319	.	.	.	.	.	3.462	1.76
afr	13.1	-0.184	0.523	-0.352	.	.	.	.	.	-2.346	-1.96
troppop	5.2	0.028	0.147	0.188	.	.	.	.	.	-0.393	-0.61
infra	4.7	0.041	0.253	0.160	.	.	.	.	.	1.307	1.01
school60	4.6	-0.014	0.070	-0.196	.	.	.	.	.	-0.288	-1.44
soe	4.5	-0.004	0.021	-0.182	.	.	.	.	.	-0.133	-1.45
Privohat_gap	**4.3**	**-0.001**	**0.004**	**-0.149**	**.**	**.**	**.**	**.**	**.**	**-0.018**	**-0.88**
bmp	3.4	0.000	0.001	0.158	.	.	.	.	.	0.006	1.3
pi	3	0.000	0.002	0.135	.	.	.	.	.	-0.002	-0.17
corruptb	1.8	-0.004	0.040	-0.108	.	.	.	.	.	-0.074	-0.26
revc	1.6	-0.015	0.141	-0.104	.	.	.	.	.	-1.542	-1.32
assass	0.8	0.003	0.036	0.077	.	.	.	.	.	0.522	1.5
f_regu97	0.6	-0.002	0.028	-0.066	.	.	.	.	.	-0.102	-0.29
sec	0.3	0.000	0.009	-0.031	.	.	.	.	.	-0.125	-0.67
gov	0.2	0.000	0.002	0.032	.	.	.	.	.	0.012	0.32
avelf	0.2	0.001	0.037	0.032	.	.	.	.	.	-0.284	-0.31
trade	0.1	0.000	0.000	0.021	.	.	.	.	.	0.008	1.07
pop100cr	0.1	0.000	0.012	-0.016	.	.	.	.	.	-0.374	-0.62
privohat	**0**	**0.000**	**0.000**	**0.000**	**.**	**.**	**.**	**.**	**.**	**-0.001**	**-0.05**
nVar					5	4	6	5	6	all	
r2					0.799	0.78	0.807	0.791	0.805	0.92	
BIC					-63.58	-62.965	-61.761	-61.651	-61.417	.	
post. Model prob.					0.079	0.058	0.032	0.03	0.027	.	
Observations					53	53	53	53	53	53	

*Notes: Results obtained with R-BMA BIC.reg software provided by A. Raftery (1995)
Dependent variable is average GDP per capita growth rate 1960-1995
Privohat is the predicted value from a regression of private credit on legal origins
Privohat_gap is the predicted from regressing privo*gap60 on legal origins and
legal origins interacted with the gap60

of the uncertainty associated with quantities of interest (Raftery, Madigan and Hoeting, 1997). These two points are nicely illustrated when contrasting results from the full model in the last two columns of Table 1.2 with the more appropriate *Bayesian model averaging* results in the first 9 columns of that table. On the one hand, the best BMA regressors gain in significance in terms of posterior t-values relative to the full model which is due to the inflation of the standard errors by the inclusion of irrelevant regressors in the saturated model. On the other hand, civil liberties, the rule of law, bureaucratic quality, the growth rate of years of schooling and the African dummy loose their statistical and economic significance.[29] This is due to the fact that model uncertainty is now accounted for and thus alleviates the problem of underestimating the uncertainty about quantities of interest. The full model fits the data a lot less well than the best BMA model and most variables included in the full model do not show up in many of the good models. Figure 1.A2 in the appendix, which depicts the best models for Table 1.2, illustrates this point; only very few variables are included in all good models. Thus BMA nicely allows to address both of these issues mentioned above at once.

Comparing the results of Table 1.2 to Table 1.1 shows that including the finance interaction term does not change the results for the other variables by much. The same regressors remain relevant with almost identical posterior inclusion probabilities, posterior coefficients and t-values.

The use of the comprehensive conditioning set does lend support to theories of conditional convergence, particularly the ones based on institutional, health and human capital variables. But it does not seem to support the hypothesis of a critical threshold level of financial development necessary to join a convergence club since the coefficient on the interaction term of finance and the initial output gap is not statistically different from zero in both the full model and the BMA results. Thus, the financial barrier to convergence that Aghion, Howitt and Mayer-Foulkes (2005) find in their base line specifications is not robust to the consideration of other theories that had not been included in their conditioning sets.

Since divergence in growth rates is observed in reality, one may wonder whether the data does not provide any evidence of what causes it. In fact, a first hint is contained in Table 1.A3 in the appendix: the square of the initial output gap is added to the set of regressors and the coefficient on that squared initial output gap is highly significant

[29] Note that according to equation (1.11) this may be due to the fact that the variance within the good models is higher than for the full model or (more likely) because the poinst estimate between models differs greatly for these variables.

and negative. As Aghion, Howitt and Mayer-Foulkes (2005) (p. 203) argue:

"If this term were to have a significant negative coefficient [..] it might indicate that what keeps poor countries from joining the convergence club is just being poor to start with, or something other than finance that is correlated with being poor to start with."

As will be shown in the next subsection, we can indeed find variables for which the interaction term with the initial output gap is highly significant. In particular, these are health and institutional factors which might be correlated with "being poor to start with".

1.4.3 Institutions and Health as Facilitators of Technological Diffusion

We now allow all regressors in the comprehensive conditioning set for which this might be suggested by a theory of barriers to technology adoption to be interacted with the initial output gap. It might be institutions (Parente and Prescott, 1994), human capital (Nelson and Phleps, 1966 or Benhabib and Spiegel 1994) health variables or lack of a sufficiently good macroeconomic policies or sociopolitical stability that keep countries from converging fast. Table 1.3 shows that for a number of variables convergence is significantly faster the higher they are.

In this table the variables are ranked according to their posterior inclusion probabilities and it is evident that the interaction terms make up the bulk (6 out of 9) of the regressors that have an inclusion probability of greater 0.5 and have BMA t-values greater one. Again, health and an institutional variable receive the strongest support from the data: the average child mortality rate and the *"index of in-depth experience with state-level institutions* (statehistory) of Bockstette et al. (2002).[30] The rest of the variables influencing the rate of convergence are two institutional (bureaucratic quality and civil liberties) indices, human capital and also the policy variable of government spending. This effect might be interpreted in the light of growth models with productive government spending. Surprisingly, once we allow for these nonlinearities the African dummy reclaims the significance it has found in many other cross sectional growth studies.

The predominance of institutional variables (3 interacted ones and the rule of law entering linearly) among the 9 identified as robustly correlated with growth is in line

[30] The child mortality rate of course is measured as higher meaning worse performace such that a positive associated interaction term indicates that lower mortality means faster convergence.

Table 1.3
Barriers to Technology Diffusion in Health and Institutions

Rank	Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value
1	Avgmort_Gap	0.978	0.007	0.003	2.828
2	afr	0.969	-2.266	0.992	-2.285
3	Statehist_Gap	0.911	-1.029	0.525	-1.961
4	Gov_Gap	0.767	-0.033	0.026	-1.274
5	Bureaub_Gap	0.725	-0.231	0.197	-1.170
6	Civil_Gap	0.712	-0.111	0.108	-1.030
7	rulelawb	0.633	0.237	0.271	0.875
8	Hy_Gap	0.565	-0.820	1.012	-0.810
9	pop100cr	0.555	-0.380	0.457	-0.831
10	Rulelaw_Gap	0.493	-0.124	0.213	-0.582
11	bureaub	0.481	0.200	0.289	0.691
12	f_regu97	0.457	-0.122	0.193	-0.632
13	revc	0.442	-0.415	0.675	-0.615
14	Fprop97_Gap	0.434	0.068	0.114	0.593
15	School60_Gap	0.430	0.069	0.117	0.588
16	corruptb	0.422	-0.128	0.220	-0.579
17	Gschool_Gap	0.409	0.043	0.091	0.474
18	hy	0.408	0.490	0.933	0.526
19	me	0.407	0.129	0.233	0.554
20	gschool	0.405	-0.092	0.186	-0.491
21	Me_Gap	0.398	0.049	0.089	0.547
22	Assass_Gap	0.384	-0.089	0.178	-0.501
23	Avelf_Gap	0.375	-0.183	0.384	-0.476
24	Sec_Gap	0.375	-0.069	0.129	-0.532
25	Fregu97_GAP	0.348	0.056	0.118	0.469
26	Exprisk_Gap	0.343	0.061	0.133	0.458
27	assass	0.294	0.023	0.241	0.096
28	gov	0.290	0.008	0.023	0.337
29	civil	0.268	0.002	0.145	0.014
30	Corrupt_Gap	0.268	-0.003	0.123	-0.021
31	Pi_Gap	0.257	-0.001	0.005	-0.225
32	**Privohat_Gap**	0.255	-0.003	0.007	-0.350
33	Avgexpect_Gap	0.252	0.001	0.012	0.067
34	Revc_Gap	0.245	0.094	0.294	0.320
35	Ghy_Gap	0.243	-0.018	0.125	-0.142
36	Trade_Gap	0.242	-0.001	0.003	-0.302
37	trade	0.237	-0.001	0.004	-0.350
38	avgexpec	0.234	-0.006	0.025	-0.225
39	Soe_Gap	0.230	0.006	0.028	0.234
40	pi	0.228	-0.002	0.007	-0.264
41	statehis	0.228	0.113	0.414	0.273
42	bmp	0.223	-0.001	0.003	-0.220
43	f_prop97	0.218	0.012	0.144	0.082
44	sec	0.207	0.022	0.075	0.293
45	Gap_Gap	0.205	0.016	0.160	0.103
46	avgmort	0.203	0.000	0.001	-0.214
47	avelf	0.202	-0.016	0.483	-0.034
48	school60	0.199	-0.011	0.062	-0.169
49	Bmp_Gap	0.195	0.000	0.001	-0.052
50	expriskb	0.190	0.007	0.135	0.053
51	gap60	0.186	-0.061	0.804	-0.076
52	soe	0.180	-0.003	0.030	-0.088
53	lat_abst	0.177	-0.022	0.411	-0.054
54	troppop	0.158	-0.025	0.139	-0.179
55	ghy	0.144	0.007	0.116	0.064
56	**privohat**	0.134	0.000	0.002	0.077

Notes: Sala-i-Martin et al (2004) Gauss software BACE was used to generate these results. PrCredit(IV) and XprCredit(IV)_gap are the predicetd values of an OLS regression of Private Credit and (Private Credit)*Gap on AHM's legal origins and legal origins interacted with the initial gap. X_Gap is the variable x*gap60
The Gauss software BACE needs to be used because BIC.reg is limited to 45 variables.
BACE does not allow to select best models or calculate BICs. 53 observation

with Aghion, Howitt and Mayer-Foulkes' (2005) observation that there is a *"possibility that what matters for convergence is some unspecified combination of financial development and institutions"*,except that institutions appear to be the dominant factor.

We would be inclined to interpret our results further in the tradition of the literature of the effects of institutions on long run growth: institutions ultimately determine factor allocations, productivity and savings as Hall and Jones (1999) and Acemoglu, Johnson, and Robinson (2001, 2002) pointed out. It seems hard to imagine that, given the possibilities of technological transfer, a country with great investment opportunities, an educated and healthy work force and a sufficient level of infrastructure provided by the state (productive government spending) would not attract FDI as a substitute for domestic credit in order to finance that transfer. What could, however, lead to the absence of foreign capital flows into a country is the absence of security of these investments, the rule of law, corrupt officials and the risk of expropriation or the lack of a productive workforce.

1.5 Robustness

1.5.1 Robustness to Different Priors

One concern in Bayesian Econometrics is the robustness to different prior specifications. It has been pointed out by Sala-i-Martin, Doppelhofer and Miller (2004) that choosing a prior inclusion probability of 0.5 for each regressor might be to high as that would favor relatively large models.[31] They suggest a smaller probability of 0.11 which is the ratio of the number of regressors they considered (68) and their preferred prior model size of 7.[32] Given that we consider a smaller set of 30 regressors here, we re-estimated our results with a prior on the inclusion probability of $7/30 = 0.23$. Tables 1.4 and 1.5 replicate tables 1.1 and 1.2 with the Sala-i-Martin, Doppelhofer and Miller (2004) prior model size of 7. Results are very robust to this change in the priors. The same variables pass the threshold of significance which is now defined as having a posterior inclusion probability greater 0.23 and neither the private credit variables in Table 1.4 nor its interaction term in Table 1.5 are significant.

[31] Note, however that the BIC already has a built in penalty for complexity (compare Raftery, 1995, 1999)

[32] By setting the prior inclusion probability to 0.5 one implictly assumes a prior model size of k/2, where k is the number of potential regressors.

Table 1.4
Robustness of Linear Specification to Prior Model Size 7

Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value	Best BMA 1	Best BMA 2	Best BMA 3	Best BMA 4	Best BMA 5
Intercept	100	-12.5300	2.545	-4.920	-13.165	-12.980	-14.363	-10.818	-13.237
gap60	100	-1.9910	0.281	-7.090	-2.094	-2.017	-2.027	-1.885	-2.033
expriskb	98.9	0.6776	0.159100	4.260	0.600	0.719	0.676	0.688	0.663
me	96.6	-0.1071	0.035	-3.060	-0.118	-0.105	-0.126	-0.101	-0.120
avgexpect	94	0.0932	0.036	2.580	0.096	0.102	0.101	0.078	0.095
f_prop97	26.8	0.0943	0.180	0.523	0.355	.	0.346	.	0.381
avgmort	12.1	-0.0005	0.002	-0.315	.	.	.	-0.003	.
civil	7.3	0.012280	0.0538	0.228	.	.	0.151	.	.
lat_abst	5.6	-0.0627	0.339	-0.185	.	.	.	.	-1.003
rulelawb	4.7	0.0100	0.061	0.163	.	.	.	.	.
statehist	4.7	0.02889000	0.1764	0.164	.	.	.	.	.
infra	4.2	0.03818000	0.246	0.155	.	.	.	.	.
ghy	3.9	0.0098	0.068	0.145	.	.	.	.	.
hy	3.6	0.0321	0.237	0.135	.	.	.	.	.
afr	2.6	-0.0390	0.256	-0.152	.	.	.	.	.
gschool	2.3	-0.0026	0.025	-0.104	.	.	.	.	.
troppop	1.3	0.0053	0.063	0.085	.	.	.	.	.
pi	1.2	0.0001	0.001	0.081	.	.	.	.	.
bureaub	0.9	0.0052	0.055	0.096	.	.	.	.	.
privohat	0	0.0000	0.000	0.000	.	.	.	.	.
school60	0	0.0000	0.000	-0.002	.	.	.	.	.
sec	0	0.0000	0.000	-0.001	.	.	.	.	.
pop100cr	0	0.0000	0.000	0.000	.	.	.	.	.
trade	0	0.0000	0.000	0.000	.	.	.	.	.
f_regu97	0	0.0000	0.000	0.000	.	.	.	.	.
gov	0	0.0000	0.000	0.000	.	.	.	.	.
omp	0	0.0000	0.000	0.001	.	.	.	.	.
soe	0	0.0000	0.000	-0.002	.	.	.	.	.
avelf	0	0.0000	0.000	0.000	.	.	.	.	.
evc	0	0.0000	0.001	-0.001	.	.	.	.	.
assass	0	0.0000	0.000	0.000	.	.	.	.	.
corruptb	0	0.0000	0.001	0.000	.	.	.	.	.
nVar					5	4	6	5	6
2					0.799	0.780	0.807	0.791	0.805
BIC					-63.580	-62.965	-61.761	-61.651	-61.417
post					0.141	0.036	0.017	0.015	0.014
Observations					53	53	53	53	53

*Notes: Results obtained with R-BMA BIC.reg software provided by A. Raftery (1995)
Dependent variable is average GDP per capita growth rate 1960-1995
Privohat is the predicted value from a regression of private credit on legal origins
Assumed prior inclusion probability=0.23 which is equivalent to BACE prior model size = 7.

Table 1.5
Robustness of Table 1.2 to Prior Model Size 7

Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value	Best BMA 1	Best BMA 2	Best BMA 3	Best BMA 4	Best BMA 5
Intercept	100	-12.520	2.550	-4.910	-13.165	-12.980	-14.363	-10.818	-13.237
gap60	100	-1.983	0.283	-7.000	-2.094	-2.017	-2.027	-1.885	-2.033
expriskb	98.8	0.678	0.159	4.250	0.600	0.719	0.676	0.688	0.663
me	96.5	-0.107	0.035	-3.040	-0.118	-0.105	-0.126	-0.101	-0.120
avgexpect	93.8	0.093	0.036	2.560	0.096	0.102	0.101	0.078	0.095
f_prop97	25.8	0.091	0.178	0.511	0.355	.	0.346	.	0.381
avgmort	12	0.000	0.002	-0.314	.	.	.	-0.003	.
civil	7	0.012	0.053	0.223	.	.	0.151	.	.
lat_abst	5.3	-0.058	0.326	-0.179	.	.	.	.	-1.003
rulelawb	4.5	0.010	0.060	0.160	.	.	.	.	.
statehist	4.5	0.027	0.171	0.159	.	.	.	.	.
infra	4.1	0.037	0.244	0.153	.	.	.	.	.
ghy	3.8	0.010	0.067	0.143	.	.	.	.	.
Privohat_Gap	**3.2**	**0.000**	**0.003**	**-0.124**	.	.	.	.	.
hy	2.8	0.027	0.217	0.125	.	.	.	.	.
afr	2.6	-0.040	0.259	-0.154	.	.	.	.	.
troppop	1.2	0.005	0.061	0.081	.	.	.	.	.
pi	1.1	0.000	0.001	0.079	.	.	.	.	.
bureaub	1	0.005	0.055	0.097	.	.	.	.	.
privohat	**0**	**0.000**	**0.000**	**0.000**	.	.	.	.	.
school60	0	0.000	0.000	-0.002	.	.	.	.	.
sec	0	0.000	0.000	0.000	.	.	.	.	.
gschool	0	0.000	0.003	-0.010	.	.	.	.	.
pop100cr	0	0.000	0.000	0.000	.	.	.	.	.
trade	0	0.000	0.000	0.000	.	.	.	.	.
f_regu97	0	0.000	0.000	0.000	.	.	.	.	.
gov	0	0.000	0.000	0.000	.	.	.	.	.
bmp	0	0.000	0.000	0.001	.	.	.	.	.
soe	0	0.000	0.000	-0.002	.	.	.	.	.
avelf	0	0.000	0.000	0.000	.	.	.	.	.
revc	0	0.000	0.001	-0.001	.	.	.	.	.
assass	0	0.000	0.000	0.000	.	.	.	.	.
corruptb	0	0.000	0.001	0.001	.	.	.	.	.
nVar					5.000	4.000	6.000	5.000	6.000
r2					0.799	0.780	0.807	0.791	0.805
BIC					-63.580	-62.965	-61.761	-61.651	-61.417
post. Model prob.					0.139	0.064	0.016	0.013	0.013
Observations					53	53	53	53	53

*Notes: Results obtained with R-BMA BIC.reg software provided by A. Raftery (1995)
Dependent variable is average GDP per capita growth rate 1960-1995
Privohat is the predicted value from a regression of private credit on legal origins
Privohat_gap is the predicted from regressing privo*gap60 on legal origins and
legal origins interacted with the gap60
Assumed prior inclusion probability=0.23 which is equivalent to BACE prior model size = 7.

For the case of interactions in all variables, the picture is very similar. The core results are not altered by changing the priors either. Table 1.6 shows results with the same prior inclusion probability of 0.23 used above such that the assumed prior model size is 13. However given that Sala-i-Martin, Doppelhofer and Miller (2004) emphasize the prior model size of 7, apparently regardless of the number of regressors under consideration, we also estimated the interaction results with a prior inclusion of 0.125 in table 1.7.

Table 1.6
Robustness of Table 1.3 to Prior Model Size 13

Rank	Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value
1	Avgmort_GAP	0.995	0.007	0.002	4.609
2	Statehist_GAP	0.912	-1.061	0.487	-2.177
3	afr	0.823	-1.468	0.885	-1.659
4	rulelawb	0.680	0.267	0.222	1.202
5	Gov_GAP	0.622	-0.026	0.024	-1.080
6	Bureaub_GAP	0.620	-0.185	0.168	-1.100
7	Civil_GAP	0.542	-0.071	0.082	-0.865
8	bureaub	0.367	0.154	0.240	0.643
9	f_regu97	0.367	-0.121	0.186	-0.651
10	Rulelaw_GAP	0.341	-0.054	0.125	-0.433
11	pop100cr	0.244	-0.147	0.310	-0.474
12	Hy_GAP	0.217	-0.280	0.652	-0.430
13	hy	0.210	0.263	0.636	0.414
14	Fregu97_GAP	0.205	0.036	0.090	0.397
15	corruptb	0.194	-0.049	0.126	-0.390
16	Corrupt_GAP	0.193	0.030	0.084	0.351
17	gov	0.186	0.007	0.019	0.343
18	civil	0.173	0.010	0.087	0.117
19	Me_GAP	0.138	0.006	0.029	0.216
20	Gap_GAP	0.135	0.031	0.112	0.278
21	Gschool_GAP	0.128	0.007	0.033	0.207
22	gschool	0.124	-0.020	0.075	-0.272
23	me	0.123	0.007	0.070	0.095
24	expriskb	0.122	0.030	0.108	0.280
25	gap60	0.120	-0.107	0.466	-0.230
26	Avelf_GAP	0.118	-0.036	0.135	-0.268
27	revc	0.110	-0.064	0.246	-0.260
28	avgexpec	0.108	-0.004	0.017	-0.252
29	Exprisk_GAP	0.105	-0.005	0.041	-0.124
30	statehis	0.103	0.059	0.286	0.207
31	bmp	0.095	0.000	0.001	-0.215
32	avelf	0.090	0.042	0.209	0.200
33	Ghy_GAP	0.089	-0.011	0.067	-0.167
34	Revc_GAP	0.089	0.022	0.121	0.181
35	sec	0.087	0.009	0.044	0.216
36	Bmp_GAP	0.084	0.000	0.001	0.162
37	trade	0.083	0.000	0.002	-0.183
38	Fprop97_GAP	0.083	0.007	0.038	0.194
39	Avgexpect_GAP	0.081	0.001	0.006	0.090
40	Pi_GAP	0.079	0.000	0.002	-0.151
41	School60_GAP	0.079	0.004	0.028	0.128
42	f_prop97	0.076	-0.003	0.056	-0.057
43	Soe_GAP	0.074	-0.001	0.009	-0.103
44	Aassass_GAP	0.064	-0.005	0.039	-0.136
45	pi	0.064	0.000	0.003	-0.066
46	ghy	0.061	0.009	0.070	0.131
47	lat_abst	0.061	-0.029	0.213	-0.135
48	**Privohat_GAP**	0.059	0.000	0.002	-0.035
49	Trade_GAP	0.059	0.000	0.001	-0.048
50	avgmort	0.059	0.000	0.001	-0.104
51	Sec_GAP	0.059	-0.004	0.034	-0.114
52	assass	0.054	0.004	0.051	0.069
53	school60	0.054	-0.001	0.022	-0.029
54	soe	0.053	0.001	0.012	0.063
55	**privohat**	0.049	0.000	0.001	0.006
56	troppop	0.047	0.000	0.061	-0.008

Notes: Sala-i-Martin et al (2004) Gauss software BACE was used to generate these results
PrCredit(IV) and XprCredit(IV)_gap are the predicetd values of an OLS regression of
Private Credit and (Private Credit)*Gap on AHM's legal origins and legal origins interacted with the initial gap.
For clarity of exposition names for regressor interacted with the initial output gap start with an 'X'
The Gauss software BACE needs to be used because BIC.reg is limited to 45 variables.
BACE does not allow to select best models or calculate BICs 53 observation
Prior inclusion probability is 0.23, prior model size = 13

Table 1.7
Robustness of Table 1.3 to Prior Model Size 7

Rank	Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value
1	Avgmort_GAP	0.994	0.007	0.002	4.270
2	Statehist_GAP	0.872	-1.064	0.551	-1.930
3	rulelawb	0.702	0.291	0.223	1.304
4	afr	0.642	-1.154	1.007	-1.146
5	Bureaub_GAP	0.535	-0.158	0.165	-0.953
6	Gov_GAP	0.440	-0.018	0.024	-0.780
7	Civil_GAP	0.432	-0.056	0.074	-0.763
8	bureaub	0.226	0.086	0.181	0.474
9	Rulelaw_GAP	0.209	-0.035	0.097	-0.367
10	Gap_GAP	0.199	0.076	0.174	0.438
11	pop100cr	0.184	-0.133	0.321	-0.414
12	Hy_GAP	0.168	-0.261	0.685	-0.380
13	f_regu97	0.167	-0.052	0.134	-0.390
14	expriskb	0.162	0.061	0.155	0.391
15	Me_GAP	0.136	0.004	0.019	0.240
16	gov	0.135	0.005	0.016	0.317
17	gap60	0.128	-0.120	0.481	-0.249
18	Corrupt_GAP	0.118	0.020	0.069	0.291
19	Fregu97_GAP	0.113	0.020	0.067	0.293
20	Bmp_GAP	0.096	0.000	0.001	0.255
21	Exprisk_GAP	0.089	-0.010	0.044	-0.232
22	me	0.087	0.000	0.044	-0.011
23	corruptb	0.080	-0.019	0.083	-0.232
24	civil	0.070	0.005	0.054	0.084
25	avgexpec	0.069	-0.003	0.014	-0.201
26	hy	0.066	0.074	0.361	0.205
27	f_prop97	0.062	-0.005	0.043	-0.110
28	avelf	0.062	0.027	0.172	0.155
29	bmp	0.060	0.000	0.001	-0.195
30	Revc_GAP	0.058	0.019	0.108	0.178
31	Avelf_GAP	0.058	-0.016	0.095	-0.172
32	statehis	0.056	0.033	0.214	0.154
33	gschool	0.055	-0.007	0.040	-0.175
34	Avgexpect_GAP	0.054	0.000	0.005	-0.009
35	Pi_GAP	0.052	0.000	0.002	-0.145
36	revc	0.049	-0.027	0.162	-0.169
37	Gschool_GAP	0.043	0.002	0.016	0.124
38	sec	0.041	0.005	0.032	0.147
39	Ghy_GAP	0.039	-0.004	0.041	-0.106
40	pi	0.037	0.000	0.002	-0.033
41	avgmort	0.034	0.000	0.000	-0.110
42	trade	0.033	0.000	0.001	-0.117
43	Soe_GAP	0.033	-0.001	0.006	-0.080
44	ghy	0.032	0.005	0.049	0.097
45	Fprop97_GAP	0.032	0.002	0.020	0.091
46	Sec_GAP	0.030	-0.002	0.023	-0.080
47	**privohat**	0.029	0.000	0.001	-0.014
48	school60	0.029	0.001	0.014	0.062
49	School60_GAP	0.028	0.000	0.014	0.001
50	assass	0.028	0.000	0.031	-0.005
51	Trade_GAP	0.027	0.000	0.001	-0.004
52	lat_abst	0.027	-0.009	0.134	-0.068
53	soe	0.027	0.000	0.009	0.037
54	**Privohat_GAP**	0.025	0.000	0.002	-0.046
55	Assass_GAP	0.024	-0.001	0.020	-0.026
56	troppop	0.023	0.000	0.042	-0.006

Notes: Sala-i-Martin et al (2004) Gauss software BACE was used to generate these results
PrCredit(IV) and XprCredit(IV)_gap are the predicetd values of an OLS regression of
Private Credit and (Private Credit)*Gap on AHM's legal origins and legal origins interacted with the initial gap.
For clarity of exposition names for regressor interacted with the initial output gap start with an 'X'
The Gauss software BACE needs to be used because BIC.reg is limited to 45 variables.
BACE does not allow to select best models or calculate BICs 53 observation
Prior inclusion probability is 0.125 implying prior model size = 7

While there seems to be a slight tendency that the number of regressors that have a posterior inclusion greater than the prior one is increased a bit by lowering the prior model size, the most important regressors remain the same, especially in terms of their significance in terms of BMA t-values. Given these results, one can be quite confident that the findings presented in the main section are very robust to different prior specifications.

1.5.2 Robustness to Instrumentation and Dilution

One might have further concerns regarding the instrumentation of the private credit variable. Using the predicted value is actually not a proper instrumental variable regression as that would imply to include all other regressors used in the second stage also in the first stage alongside the instruments. Obviously this is not feasible with the very many different models considered here. Given that both the private credit variable and its interaction term never show up in any reasonable model, one probably need not be too concerned about this point. Another objection might be that one unfairly biases results against the financial intermediation terms by using predicted values from regressions on legal origins and thus maybe taking away some variation from it compared to the other regressors. That is why we re-estimated all our results by using the actual and not the predicted values, i.e. not instrumenting private credit. Since the results were virtually unchanged, especially in that the financial terms never reached any significance and rather health and institutional variables are important we do not report those results here to conserve space. We will report one specification where we do not instrument finance below in the switched regressions.

A great concern in traditional econometrics are biases due to multicollinearity. This is especially the case for large datasets with many different variables such as the present one. In BMA however, this *dilution* that arises in regressions when independent variables are highly correlated is only a problem when the correlated regressors measure the same underlying concept. When they correspond to substantially different mechanism one need not worry (compare Hoeting et al, 1999, pp. 413-414). In our dataset the problem of dilution might then be acute especially for the institutional variables, but also geographical ones, schooling and health. The policy variables on the other hand, certainly measure very different types of policies. To inspect whether our results are unduly influenced by this effect, we performed factor analysis on the highly correlated institutional, health, schooling and geographical variables.[33] The correlation matrices

[33] Given that the variable statehistory measures something quite distinct from the other institutions,

for these variables in Table 1.A4 in the appendix show that multicollinearity might indeed be a problem. In all cases only one factor is dominant (eigenvalue substantially greater than one). We label these newly created variables institution1, health1, school1 and geography1 respectively. Table 1.8 shows that when we use these factors instead of the correlated variables, our basic results go through. Here, we directly introduce the specification where we allow for interactions with the initial output gap for all variables for which that is implied by the barriers to adaption theories.

Again what matters are institutional and health parameters but not finance. There clearly two variables that influence the rate of convergence. The health factor and in the institutional experience variable state history.[34] The institutional factor alone exhibits a strong positive effect. Interestingly, the initial output gap reclaims its significance such that one might conclude that its effect was tarnished by the inclusion of correlated regressors.[35] The results for Table 1.8 are illustrated in Figure 1.A3 in the appendix and show that indeed only variables or factors for theories that have been important in the main specification appear in many good models.

A last concern might be that institutions might be endogenous. As mentioned above, this should not be a great concern here since institutions are generally seen to be influenced by output levels not growth rates and we use period averages and not end of period values. Nevertheless, as a final robustness experiment we employ what Aghion, Howitt and Mayer-Foulkes (2005) call switched regressions: instead of instrumenting finance with legal origins, we instrument the institutional factor. This is now possible because we have only one potentially endogenous institutional variable since statehistory is by construction exogenous to growth rates. That legal origins can serve as valid instruments for institutions has been recently demonstrated by Levine (forthcoming). Table 1.9 shows that even in this specification financial intermediation does not gain an important role.

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namely the long term stability of a state and the in depth experience with institutions, we leave this variable in the regression as it is. (it is also not very highly correlated with the other institutional variables and certainly not endogenous). For the same reason the African Dummy is retained. The Sociopolitical stability variables are not very highly correlated with one another.

[34] Unlike the mortality variable that proofed important in the main section, the health factor is coded such that higher values mean better health conditions.

[35] Furthermore, we now include less interaction terms that are by their nature correlated with the gap.

Table 1.8
Robustness to Multicollinearity

Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value	Best BMA 1	Best BMA 2	Best BMA 3	Best BMA 4	Best BMA 5
Intercept	100	-0.009	0.517	-0.017	-0.124	-0.369	0.225	-0.542	-0.077
Inst1	100	1.073	0.189	5.690	1.090	1.020	0.799	0.996	1.010
Health2_GAP	100	-0.772	0.099	-7.790	-0.814	-0.791	-0.743	-0.811	-0.801
Statehist_GAP	99.9	-1.235	0.311	-3.980	-1.258	-1.282	-1.635	-1.317	-1.347
gap60	73.4	-0.652	0.478	-1.370	-0.928	-1.071	.	-0.916	-0.596
afr	41.9	-0.381	0.566	-0.672	.	.	.	.	.
gov_gap	34.8	-0.011	0.017	-0.609	.	.	-0.041	.	-0.021
avelf_gap	22.1	-0.093	0.210	-0.441	.	.	.	.	.
trade_gap	19.3	-0.002	0.005	-0.445	.	.	.	.	.
trade	19	-0.003	0.007	-0.440	.	.	.	.	.
avelf	16.3	0.127	0.351	0.362	.	.	.	.	.
soe_gap	11.3	-0.006	0.023	-0.253	.	.	.	.	.
school1	10.6	0.024	0.089	0.273	.	0.245	.	.	.
gov	10.4	0.003	0.011	0.250	.	.	.	0.029	.
soe	3.5	-0.005	0.031	-0.170	.	.	.	.	.
school1_gap	3.4	-0.004	0.032	-0.123	.	.	.	.	.
health2	3	0.010	0.086	0.121	.	.	.	.	.
bmp_gap	2.4	0.000	0.000	0.098	.	.	.	.	.
pi_gap	2.4	0.000	0.001	-0.111	.	.	.	.	.
assass_gap	1.1	0.001	0.016	0.077	.	.	.	.	.
revc	1	-0.004	0.072	-0.062	.	.	.	.	.
pi	0.7	0.000	0.001	0.049	.	.	.	.	.
assass	0.2	0.000	0.011	-0.032	.	.	.	.	.
statehist	0.1	0.000	0.031	0.009	.	.	.	.	.
revc_gap	0.1	0.000	0.020	-0.018	.	.	.	.	.
privohat	0	0.000	0.000	0.003	.	.	.	.	.
privohat_gap	0	0.000	0.000	0.000	.	.	.	.	.
bmp	0	0.000	0.000	0.000	.	.	.	.	.
Inst1_gap	0	0.000	0.007	-0.014	.	.	.	.	.
geo1	0	0.000	0.000	0.000	.	.	.	.	.
nVar					5	4	6	5	6
r2					0.799	0.78	0.807	0.791	0.805
BIC					-63.5796	-62.9651	-61.7605	-61.6507	-61.4173
post. Model prob.					0.079	0.058	0.032	0.03	0.027
Observations					53	53	53	53	53

*Notes: Results obtained with R-BMA BIC.reg software provided by A. Raftery (1995)
Dependent variable is average GDP per capita growth rate 1960-1995
Prior inclusion probability is 0.5
Health2, school1, Inst1 and Geo1 are the first factors from factor analysis on the variables specified in the correlation matrix 1.A4 in the appendix
Private Credit and its interaction term are instrumented with legal origins

Table 1.9
Switched Regression- Controling for the Endogeneity of Institutions

	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value	Best BMA 1	Best BMA 2	Best BMA 3	Best BMA 4	Best BMA 5
Intercept	100	-0.208	0.372	-0.560	-0.275	-0.262	-0.150	0.127	-0.497
statehist_gap	100	-1.555	0.363	-4.284	-1.775	-1.536	-1.704	-1.614	-1.516
health2	100	1.537	0.227	6.768	1.534	1.490	1.240	1.628	1.644
inst3_gap	84.7	-0.395	0.241	-1.643	-0.389	-0.314	-0.394	-0.460	-0.500
gov_gap	71.9	-0.035	0.026	-1.311	-0.056	-0.044	-0.057	-0.067	-0.042
privo_gap	29.2	-0.003	0.005	-0.528	.	-0.007	.	.	.
gap60	25.8	-0.274	0.525	-0.523	.	.	.	.	-0.469
bmp	22.3	-0.001	0.003	-0.444	.	.	.	.	.
assass	14.5	-0.044	0.132	-0.330	.	.	.	.	.
pi_gap	13.7	-0.003	0.009	-0.352	.	.	.	.	.
pi	13.1	-0.004	0.012	-0.344	.	.	.	.	.
assass_gap	12.2	0.026	0.083	0.315	.	.	.	.	.
bmp_gap	10.3	0.000	0.001	0.295	.	.	.	.	.
gov	6.1	-0.001	0.011	-0.125	.	.	.	-0.034	.
health2_gap	5.6	-0.009	0.054	-0.174	.	.	-0.167	.	.
trade_gap	3.9	0.000	0.002	-0.161	.	.	.	.	.
statehist	3.1	-0.015	0.134	-0.113	.	.	.	.	.
soe_gap	2.6	-0.001	0.006	-0.106	.	.	.	.	.
geo1	2.5	-0.003	0.032	-0.097	.	.	.	.	.
trade	2	0.000	0.002	-0.127	.	.	.	.	.
afr	1.8	-0.010	0.104	-0.097	.	.	.	.	.
inst3	1.5	0.004	0.043	0.099	.	.	.	.	.
revc	0.8	-0.004	0.063	-0.063	.	.	.	.	.
avelf	0.7	0.002	0.049	0.049	.	.	.	.	.
school1_gap	0.3	0.001	0.023	0.045	.	.	.	.	.
school1	0.2	0.001	0.024	0.034	.	.	.	.	.
revc_gap	0.1	0.000	0.011	0.018	.	.	.	.	.
privo	0	0.000	0.000	0.000	.	.	.	.	.
soe	0	0.000	0.000	0.000	.	.	.	.	.
avelf_gap	0	0.000	0.004	-0.006	.	.	.	.	.
nVar					5	4	6	5	6
r2					0.799	0.78	0.807	0.791	0.805
BIC					-63.5796	-62.9651	-61.7605	-61.6507	-61.4173
post. Model prob.					0.079	0.058	0.032	0.03	0.027
Observations					53	53	53	53	53

*Notes: Results obtained with R-BMA BIC.reg software provided by A. Raftery (1995)
Dependent variable is average GDP per capita growth rate 1960-1995
Private Credit and its interaction term are not instrumented
Institution3 is the instrumented first factor from factor analysis on
f_regu97 bureauB corruptB rulelawB f_prop97 expriskB civil
Instrumented with LLB's Legal Origins
Health2, school1 and Geo1 are the first factors from factor analysis on the
variables specified in the correlation matrix 1.A4 in the appendix

The instrumented institution and the health factor trade places with regard to displaying the threshold and statehistory continues to play a paramount role as a threshold. By using the not instrumented financial intermediation variable its interaction term does at least make it into the 5th best model. As Figure 1.A4 in the appendix shows it now indeed does show up in the occasional good model but these occasional appearances to not help to gain a significant posterior inclusion probability or posterior t-value. Given that a variable like private credit is a lot more likely to be influenced

by growth rates than institutions the light gain in importance of finance is maybe not surprising as endogeneity leads to upward biases of OLS estimates.[36]

All in all, we can conclude that results of finance being unimportant once institutional quality, and the health environment are controlled for are quite robust to different priors and different specifications.

1.6 Conclusion

Are theories of finance and growth robust to the inclusion of variables implied by other growth theories? Our results of a simple *Bayesian model averaging* analysis of a linear growth model that properly accounts for model uncertainty and includes variables from many theories including the exogenous component of finance that has received broad attention in the literature suggest that this is not the case. The variables that are robustly related to growth are measuring institutional and health quality.

Since this type of simple linear regression analysis cannot capture nonlinearities it can only explain conditional convergence. However, one might be interested in digging deeper into the question of why some countries do not catch up given that there should be what Gerschenkron (1962) famously called the *"advantage of backwardness"* in imitating foreign technology and in enjoying positive spillovers from other countries and to find out what explains the differing convergence rates observed in reality. The ideas of barriers to technological adaption have been put forward by a numbers of authors to answer these questions. Aghion, Howitt and Mayer-Foulkes (2005) offer an interesting model that characterizes critical thresholds in the financial development of a country. Some financing is needed in order to successfully benefit from technological spillovers. The empirical test used to verify this theory largely ignores *theory open-endedness* and *model uncertainty*. Properly taking account of these factors by means of *Bayesian model averaging*, one can show that it seem to be rather institutional and health factors that are at the heart of the non-convergence phenomenon. Aghion, Howitt and Mayer-Foulkes' (2005) theory might be adapted to incorporate these findings: given that it can easily be generalized by replacing F for finance with an I for institutions or H for "healthy human capital", one can take that theory together with the empirical evidence derived here to strongly argue for a theory of barriers to adaption in institutions and health that is uniquely robust to the inclusion of other regressors and interactions.

[36] Institutions are regarded in the literature as very persistent (Acemoglu, Johnson, and Robinson, 2005), while the same is not true for private credit.

Since the policy implications of the results here would clearly indicate a focus on improving institutions and health conditions, more research to find out why health is important and how to improve it on the national scale is warranted. Given that national health systems are usually heavily institutionalized and bureaucratic - witness some debates about the bureaucratic efficiency of hospital administrations, health insurance companies and public administration officials involved - one might be tempted to conclude form the results presented here that institutions are indeed the *"fundamental causes"* not only of long run but also of intermediate run growth and that they represent important reasons why countries are *"catching up, forging ahead and falling behind"*[37].

[37] Abramovitz (1986).

1.7 Appendix Chapter 1

Figure 1.A1
Best Models for Table 1.1
(Green/Red indicate positive/negative coefficient)

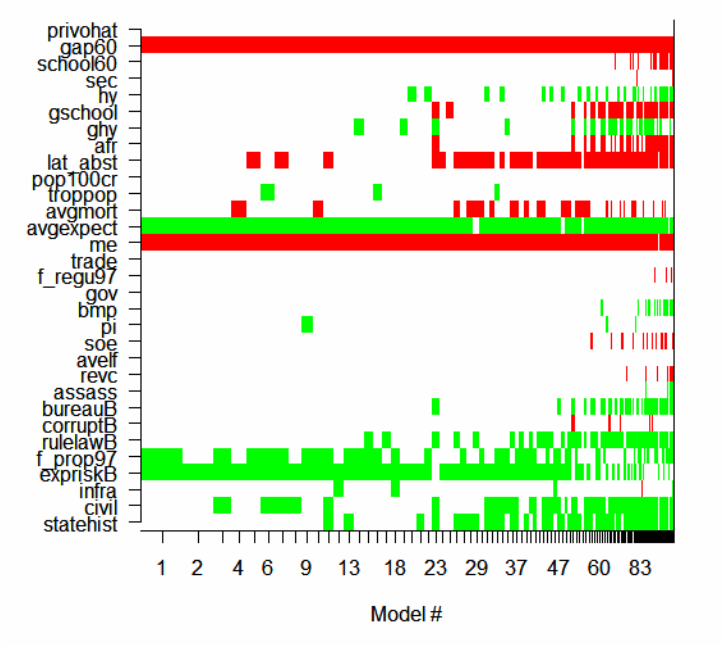


Figure 1.A2
Best Models for Table 1.2
(Green/Red indicate positive/negative coefficient)

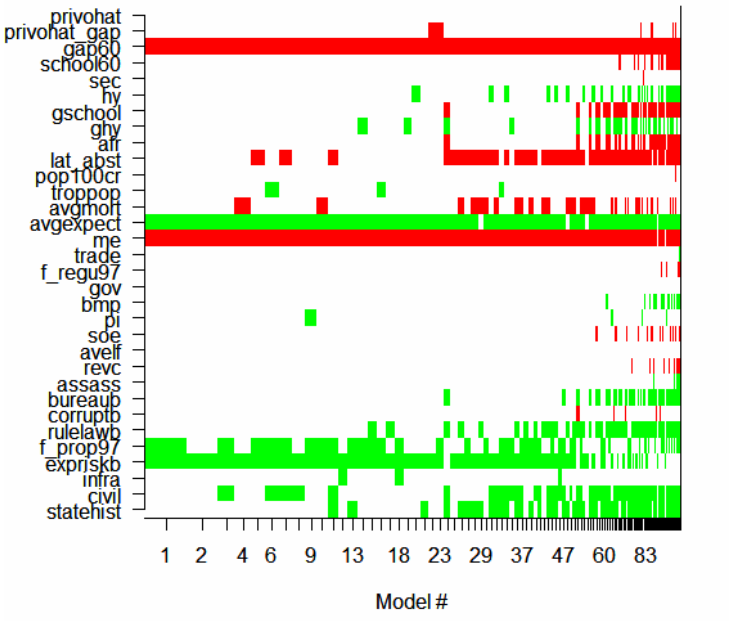


Figure 1.A3
Best Models for Table 1.8
(Green/Red indicate positive/negative coefficient)

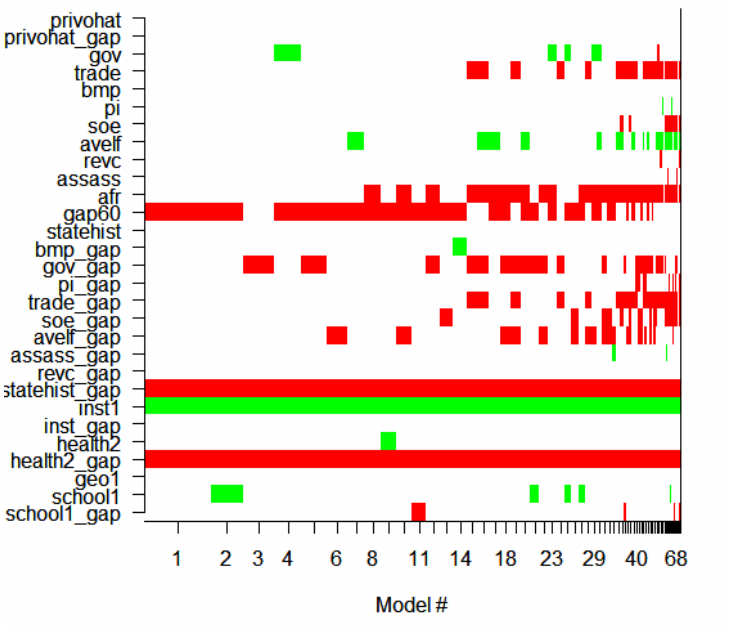


Figure 1.A4
Best Models for Table 1.9
(Green/Red indicate positive/negative coefficient)

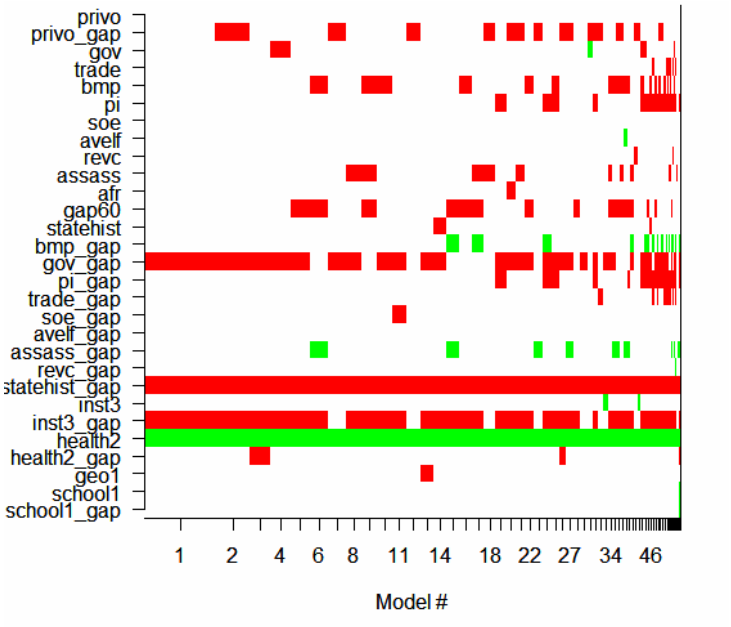


Table 1.A1 Variables Used Grouped By Growth Theories

	Growth: Growth rate of GDP per Capita 1960-1995 **Gap60:** Difference between log per-capita real GDP 1960 in each country and the USA.
Finance	**Privo, private credit (FINANCE):** {(0.5)*[F(t)/Pe(t) + F(t-1)/Pe(t-1)]}/[GDP(t)/ Pa(t)], where F is credit by deposit money bank and other financial institutions to the private sectors (lines 22d +42d), GDP is line 99b, Pe is end- of period CPI (line 64) and Pa is the average CPI for the year, IFS
Institutions	**statehist:** "index of in-depth experience with state-level institutions" and the antiquity of a state (1 to 1950 CE). Bockstette et al (2002) **rulelaw:** Measure of the law and order tradition in a country. Averaged over 1982-1995 **F_reg97**: Business regulation. Rating of regulation policies related to opening and keeping open a business. The scale is from 0 to 5, with higher scores meaning more favorable regulations. **bureau**: An average of three indices published by Business International Corporation (1984): efficiency of the judiciary system, red tape and corruption. The averages are over 1980-1983. **exprisk**: Expropriation risk. Assessment of risk of "outright confiscation" or "forced Nationalization. Lower scores indicating a higher risk. Averaged over 1982-1995 **pr. rights:** Property rights. Rating of property rights on a scale from 0 to 5. **infra**: Measure of social infrastructure (1986-1995) computed as the average of the GADP and an openness measures. GADP is an index of government antidiversion policies including law and order, bureaucratic quality, corruption, risk of expropriation and government repudiation of contracts, Hall and Jones (1999). **civil**: Index of civil liberties, Freedom House 1994. **corruption:** Measure of corruption. Data are averaged over 1982-1995. Higher values indicate less corruption
Health	**avgexpect:** Average life expectancy at birth for the years 1960-1990, Children Data Bank **avgmort**: Average under-5 mortality rate for the years 1970-1990, Children Data Bank for **me:** Malaria Ecology. An ecologically-based variable that is predictive of the extent of malaria transmission (Kiszewski et al., forthcoming).
Geography	**pop100cr:** Percentage of population within 100 km of ice-free coast, CID at Harvard University **tropop:** Percentage of population in geographical tropics, CID at Harvard University. **lat_abst:** Distance from the equator scaled between 0 and 1. (Hall and Jones, 1999) **africa:** Dummy for countries in the African continent.
Human Capital	**sec:** Average years of secondary schooling in the population over 15 from 1960-1995, Barro and Lee (1996). **school:** Average years of schooling in the population over 25 in 1960, Barro and Lee (1996). **gschool:** Average annual growth rate of schooling from 1960 to 1995, LLB (2000). **hy:** 1985 human-capital to output ratio, Klenow and Rodríguez-Clare (1997). **ghy**: 1960-1985 annual growth rate of human capital to output ratio, Klenow and Rodríguez-Clare (1997).
Macro Policies	**bmp:** Black market premium: Ratio of black market exchange rate and official exchange rate minus one, Picks' Currency Yearbook through (1989) and the World Currency Yearbook. **soe:** Index of state owned enterprises (SOE). Higher Scores mean less government ownership **pi**: Inflation rate. Log difference of consumer price index average from 1960-1995, IFS (line 64). **trade:** Openness to trade. Sum of real exports and imports as a share of real GDP average 1960-1995, Levine, Loayza and Beck (2000), henceforth LLB. **gov:** Government expenditure as a share of GDP average 1960-1995, LLB (2000).
Socio. Stability	**assass:** Number of assassinations per 1000 inhabitants, averaged over 1960-1990. **revc**: Revolutions and coups. Data are averaged over 1960-1990, Banks (1994). **avelf** : Ethnic fractionalization. Average value of five indices of ethnolinguistic fractionalization, with values ranging from 0 to 1, where higher values denote higher levels of fractionalization, Easterly and Levine (1998).

Notes: Primary Data Source, if not othewise indicated, Aghion, Howitt and Mayer-Foulkes (2005)

Table 1.A2 - Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
growth	71	1.877485	1.863301	-2.811944	7.156855
privo	71	38.22211	28.70798	4.08484	141.2944
gov	64	14.78803	5.192442	6.681304	31.37076
trade	66	59.12508	35.90345	14.0502	231.6857
bmp	67	26.85629	51.2223	0	277.4202
sec	69	1.032029	1.01067	0	3.76
pi	71	15.28418	17.345	3.628935	90.78316
revc	71	0.1691054	0.2256045	0	0.9703704
assass	71	0.2592723	0.4744023	0	2.466667
civil	70	3.136429	1.877117	1	6.9
afr	71	0.1549296	0.3644129	0	1
school60	71	3.866901	2.54047	0.07	10.07
gschool	71	1.957346	1.583078	-0.4329169	8.897367
lat_abst	70	0.2988444	0.201646	0	0.7222222
f_regu97	66	2.939394	0.8015137	1	4
f_prop97	66	3.712121	1.034262	1	5
soe	66	4.812121	1.939351	0.4	8
avelf	71	0.3039895	0.2841969	0	0.8722529
troppop	67	0.4769708	0.4840587	0	1
pop100cr	67	0.6722388	0.3220946	0	1
infra	69	0.5637904	0.2645136	0.11267	1
statehist	67	0.4443284	0.261952	0.07	0.98
avgmort	64	94.53125	89.64841	11.33333	454.3333
avgexpect	64	62.32813	10.58421	37	75.5
hy	70	0.5401429	0.1492541	0.25	1
ghy	70	0.7481429	0.5084626	-0.64	2.35
gap60	71	-1.537205	0.837083	-3.294423	2.33E-07
me	67	2.767836	5.779551	0	23.325
corruptB	67	3.588396	1.565418	0.11875	6
rulelawB	67	3.685871	1.618471	0.91875	6
bureauB	67	3.713209	1.661099	0.90625	6
expriskB	67	7.578656	1.772431	3.71875	9.985714

Table 1.A3
Including the Square of the Initial Output Gap

Variable	Post. Inclusion	Post. Coeff	Post. S.D.	BMA t-value	Best BMA 1	Best BMA 2	Best BMA 3	Best BMA 4	Best BMA 5
Intercept	100	-9.322	2.501	-3.730	-10.681	-10.526	-5.917	-8.533	-11.488
gap60	100	-4.763	0.727	-6.550	-4.941	-4.747	-4.507	-4.389	-4.547
me	100	-0.105	0.025	-4.270	-0.098	-0.102	-0.110	-0.100	-0.113
GAP_SQRT	**99.3**	**-1.074**	**0.248**	-4.320	-1.083	-1.040	-1.086	-0.969	-0.995
rulelawb	99.2	0.782	0.172	4.550	0.747	0.769	0.867	0.775	0.748
hy	99.1	3.754	1.022	3.670	3.987	3.888	3.869	3.537	3.799
statehist	99.1	1.793	0.494	3.630	1.616	1.818	2.075	1.874	1.917
corruptb	97.9	-0.537	0.187	-2.870	-0.555	-0.501	-0.541	-0.503	-0.489
bureaub	97.4	0.445	0.163	2.720	0.448	0.443	0.406	0.414	0.522
pop100cr	96.5	-0.899	0.383	-2.350	-0.977	-1.002	-0.889	-0.961	-0.829
avgexpect	71.3	0.042	0.035	1.190	0.060	0.062	.	0.044	0.069
lat_abst	63	-1.012	1.020	-0.992	.	-1.167	-1.584	-1.479	-1.521
avgmort	34.4	-0.001	0.002	-0.593	.	.	-0.004	-0.003	.
gov	25.1	0.008	0.018	0.447	.	.	.	.	.
civil	15.4	0.023	0.067	0.336	.	.	.	.	0.140
f_prop97	13.9	0.028	0.091	0.306	.	.	.	.	.
Privohat_GAP	12.4	0.002	0.006	0.273	.	.	.	.	.
ghy	8.4	0.018	0.084	0.218	.	.	.	.	.
troppop	7.9	-0.033	0.152	-0.219	.	.	.	.	.
afr	6.1	-0.047	0.230	-0.206	.	.	.	.	.
sec	3.3	-0.004	0.033	-0.138	.	.	.	.	.
revc	2.7	-0.012	0.102	-0.114	.	.	.	.	.
avelf	1.9	0.008	0.090	0.089	.	.	.	.	.
expriskb	1.7	0.009	0.077	0.122	.	.	.	.	.
f_regu97	0.7	-0.001	0.023	-0.062	.	.	.	.	.
school60	0.5	-0.001	0.012	-0.054	.	.	.	.	.
bmp	0.5	0.000	0.000	0.053	.	.	.	.	.
gschool	0.3	0.000	0.012	-0.039	.	.	.	.	.
pi	0.3	0.000	0.001	0.043	.	.	.	.	.
infra	0.1	0.000	0.027	0.012	.	.	.	.	.
privohat	0	0.000	0.000	0.009	.	.	.	.	.
trade	0	0.000	0.000	0.000	.	.	.	.	.
soe	0	0.000	0.000	0.000	.	.	.	.	.
assass	0	0.000	0.004	0.010	.	.	.	.	.
nVar					10	11	11	12	12
r2					0.883	0.891	0.89	0.897	0.896
BIC					-72.2716	-71.7371	-71.414	-70.9493	-70.31
post. Model prob.					0.084	0.064	0.055	0.043	0.031
Observations					53	53	53	53	53

*Notes: Results obtained with R-BMA BIC.reg software provided by A. Raftery (1995)
Dependent variable is average GDP per capita growth rate 1960-1995

Table 1.A4 - Correlation Matrix for Intsitutions, Health, Geography and HC

Institutions	f_regu97	bureauB	corruptB	rulelawB	f_prop97	expriskB	civil
f_regu97	1						
bureauB	0.5838	1					
corruptB	0.6256	0.9142	1				
rulelawB	0.5509	0.879	0.8863	1			
f_prop97	0.5528	0.7534	0.7404	0.7884	1		
expriskB	0.607	0.9184	0.8913	0.9234	0.8019	1	
civil	0.5006	0.7449	0.7499	0.7404	0.6272	0.8247	1
Health	**avgmort**	**avgexp~t**	**me**				
avgmort	1						
avgexpect	-0.8083	1					
me	0.5889	-0.6686	1				
Geography	**troppop**	**pop100cr**	**lat_abst**				
troppop	1						
pop100cr	-0.2091	1					
lat_abst	-0.8674	0.3177	1				
Schooling/HC	**hy**	**ghy**	**sec**	**school60**	**gschool**		
hy	1						
ghy	0.3829	1					
sec	0.4367	0.1729	1				
school60	0.7418	0.1559	0.6792	1			
gschool	-0.3863	-0.0244	-0.5044	-0.6924	1		

Chapter 2

Institutions and Economic Performance - Endogeneity and Parameter Heterogeneity[1]

[1] This chapter is based on joint work with Theo Eicher, University of Washington.

"What do Thailand, the Dominican Republic, Zimbabwe, Greece, and Bolivia have in common that merits their being put in the same regression?"

Harberger (1987)

2.1 Introduction

The hallmark of the recent development and growth literature is a quest to identify institutions that explain a significant portion of the observed differences in living standards across countries.[2] While the definitions of "institutions" may vary across studies, the results are consistent and strong: institutions explain economically and statistically significant differences in per capita incomes across countries.[3] The set of countries under observation is at times dictated by data availability, but generally the literature examines either the global sample or developing countries. The types of institutions that have been associated with economic performance commonly relate to measures of government risk of expropriation, rule of law, bureaucratic quality, corruption, government repudiation of contracts, civil liberties, and openness to trade.

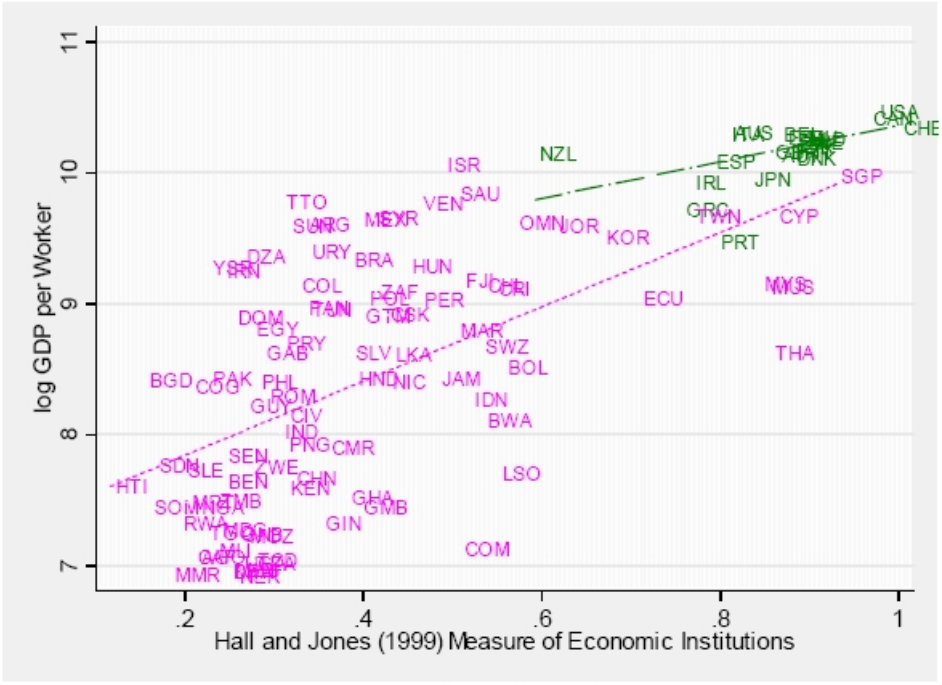
Rather surprising is, however, the absence of a comprehensive literature that analyzes which institutions determine the economic fortunes in developed nations. One might expect, for example, that the above cited institutions hardly vary across OECD countries - too little, perhaps, to provide insights into how these nations achieve and maintain their rank at the front of the income frontier. In this chapter, we examine parameter heterogeneity as it relates to the influence of institutions on output in OECD and Non-OECD subsamples. We seek to examine whether a set of institutions exists which contains explanatory power and economic influence in both subsamples.

While the literature provides ample guidance as to *which* institutions are commonly lacking in developing countries, there exists only a rudimentary understanding to what degree the same institutions actually matter in OECD countries. Research that focuses on advanced economies excludes the rest of the world; as a result, such studies focus on completely different sets of institutions, such as labor market institutions (e.g., Nickell, Nunziata and Ochel, 2005 and Boeri, Nicoletti and Scarpetta, 2000), traditional factor markets such as human and physical capital (e.g., Bassanini, Hemmings and Scarpetta,

[2] Depending on the dataset, income per worker differences are 35- or 94-fold (Hall and Jones, 1999 or Caselli, 2005).

[3] For prominent examples of definitions of "institutions", "economic institutions", "social infrastructure", or "structural policies" see Rodrik, Subramanian, and Trebbi (2004), Acemoglu, Johnson, and Robinson (2001), Hall and Jones (1999) or Persson (2004), respectively.

Figure 2.1
Institutions and Economic Performance
In- and Outside the OECD



Data source: Hall and Jones (1999)

2001), or product regulations (e.g., Nicoletti and Scarpetta, 2003). It is undeniably true that these institutions are crucial determinants of economic performance in advanced countries. Our focus is different; we seek to establish the impact of those institutions that have been shown to hold strong explanatory power in global regressions and to examine whether they also hold explanatory power in the OECD subsample. The goal is to establish a set of institutions that matter not only in advanced or developing countries, but are fundamental determinants of economic performance in both.

Since we seek to investigate whether a set of institutions exists that matters across all countries, our point of departure is the Hall and Jones (1999) methodology which includes instruments to control for the potential endogeneity of institutions in a global, structural model. While their institutional quality measure is clearly correlated with income per worker in the global sample - see Figure 2.1 - the simple OLS regression lines for the two subsamples indicate a differential impact in OECD countries (scattered in the upper right corner of the figure) as compared to the rest of the sample. OECD countries do seem to have a noticeably lower slope than Non-OECD countries. However, conclusive statements to that effect require solid analysis and extensive testing of robustness and endogeneity.

To address issues of parameter heterogeneity we employ two approaches. First, we split the sample and second, we use the interaction methodology of Brock and Durlauf (2001), who applied this approach after calling into question whether institutional indices can reasonably be expected to exhibit parameter homogeneity across "complex heterogeneous objects such as countries." Specifically, they cite the case of the United States and Russia, where Civil Liberties data can hardly be seen to have a similar impact on economic performance.

Our results are not limited to a simple assessment of the impact of established institutions on output in global and OECD samples. As we examine parameter heterogeneity, we find that the established instruments are invalid when we split the sample into OECD and Non-OECD countries. This forces us to consider a new set of appropriate instruments in order to successfully control for endogeneity in all subsamples before we can examine the economic impact of institutions on output.

Our new set of instruments is based on the *hierarchy of institutions hypothesis*. The hypothesis is laid out in detail in Acemoglu, Johnson, and Robinson (2005) and similar approaches have provided empirical validation for such a hierarchy (see Persson, 2004, 2005 and Eicher and Schreiber, 2005). The basic argument is that the constitutional institutions and political rules set the stage for the economic institutions. We thus divide institutions into two dimensions: constitutional/political institutions to serve as instruments, and economic institutions that are thought to exert direct effects on output.

Extensive robustness analysis confirms that the set of established economic institutions is indeed highly significant and holds great explanatory power in both OECD and Non-OECD countries. However, evidence for parameter heterogeneity is strong. We show that these economic institutions matter significantly more in Non-OECD countries than in the global sample, and about two thirds less in OECD than in Non-OECD countries. This highlights that the estimates obtained in the previous literature for the global sample are a weighted average of the impact of institutions on economic performance in advanced and developing countries.

The new set of political instruments that we propose performs strongly across subsamples, and our results are shown to be robust to a number of alternative specifications and tests. The coefficient estimates for the political instruments are highly significant in all subsamples indicating the important impact of such institutions on the fabric of economic institutions in both advanced and developing nations.

The chapter is organized as follows: Section 2.2 first motivates the investigation

into parameter heterogeneity for both instruments and economic institutions. Here we utilize the Hall and Jones (1999) framework and examine two main subsamples: OECD-members and non-members and show how the established instruments fail in section 2.2.1. Section 2.2.2 introduces alternative instruments based on the hierarchy of institutions hypothesis. Section 2.3 consists of a series of robustness checks which examine different estimation techniques, time periods, datasets and samples, before Section 2.4 concludes.

2.2 Parameter Heterogeneity in Instruments and Institutions

2.2.1 Established Instruments and Institutions

We approach parameter heterogeneity sequentially, first examining the possibility of heterogeneity in the instruments, and subsequently focusing on economic institutions. This progression is necessary because we must establish valid instruments across samples (Global, OECD, and Non-OECD). In the absence of valid instruments, the investigation of the impact of economic institutions on output is tarnished by endogeneity bias. Parameter heterogeneity would bias the global regressions even further.

Among the established instruments for economic institutions, immediate candidates for parameter heterogeneity relate to the notion of *Western European historical influence*. Hall and Jones (1999) and Engerman and Sokoloff (1997) provide extensive motivation and historical analysis, respectively, to support the use of those instruments that relate to specific European development influences (e.g., Europeans either settled the countries or the countries speak a European language).[4] The idea is that the colonizers and immigrants brought along with them the basic prerequisites to establish those economic institutions that are conducive to economic development.

For OECD countries the instruments relating to European languages can only be justified if they exhibit sufficient exogenous identifying variation and if they retain similar explanatory power as in the global sample. In addition, the validity of these instruments is directly related to how well they can be motivated. Since most OECD countries were the *source* of the influence that the instruments are supposed to measure,

[4]Hall and Jones (1999) refer to English, French, German, Portuguese, and Spanish languages and Western Europe's discovery of "the ideas of Adam Smith, the importance of property rights, and the system of checks and balances in government".

the motivation is called into question. Specifically, measuring the positive influence of a country's own historical experience upon itself makes for weak instruments.

A similar line of reasoning raises questions about Latitude (distance from the equator) as an appropriate instrument for OECD countries. Certainly, the preference of European settlers to emigrate to similar Latitudes can be seen as a strong motivation for Latitude's influence on economic institutions in developing nations. However, one might argue that, by definition, Latitude holds little power in OECD countries – most of whom were the very source of the settlers.

The last instrument Hall and Jones (1999) employ is the Frankel and Romer (1996, 1999) Implied Trade Share for a country. This measure provides geography-based explanations for trade derived from a gravity approach. Deviations from the implied trade share could thus signal weak, protectionist institutions. While this instrument may appear most suitable for different sub-groups of countries, protectionism has been uniformly low in OECD countries which leads us to suspect that the variable will hold little explanatory power for subsamples of countries.

We commence with simple diagnostics to ascertain the validity of instruments and economic institutions across OECD and Non-OECD subsamples. Subsequently, we address the core issue at hand: are the relevant economic institutions in OECD countries similar to those in the rest of the world? This question has two dimensions. First, we may ask if there exists a common set of economic institutions that determines income in OECD and Non-OECD countries. Certainly, rule of law, bureaucratic quality, corruption, risk of expropriation, government repudiation of contracts, and openness to trade (the components of Hall and Jones' (1999) "social infrastructure" index) are key traits for development. However, in developed nations, by definition, one might be skeptical whether these types of economic institutions are indeed the relevant ones. If a common set of economic institutions exists, the second dimension examines whether their influence on output is uniform across OECD and Non-OECD countries.

To establish a benchmark, we follow the methodology introduced by Hall and Jones (1999), who explore the effects of institutions on output by examining the structural model

$$\log Y/L = \alpha + \beta I + \varepsilon, \tag{2.1}$$

where Y/L denotes income per worker and I is the measure of economic institutional quality. Recognizing that economic institutions are potentially endogenous to income, apart from being determined by a vector of exogenous factors, X, a regression

identifying institutions is specified as

$$I = \gamma + \delta \log Y/L + X\theta + \eta. \tag{2.2}$$

Due to the possible endogeneity of economic institutions, the OLS estimation of equation (2.1) establishes neither causality nor unbiased coefficients. Hall and Jones (1999) therefore provide instruments designed to solve the endogeneity problem. Candidates for instruments are selected from the vector of exogenous covariates, X, in equation (2.2). We adopt their instrumental variable estimation strategy (IV) to achieve identification and unbiased estimates.[5]

Valid instruments fulfill two criteria: they are i) uncorrelated with the error term in equation (2.1), and ii) strongly correlated with the endogenous regressor, I. The two-stage least squares (2SLS) estimation can then be specified as

$$\widehat{I} = \tilde{\gamma} + \overline{X}\tilde{\theta} + \tilde{\eta} \tag{2.3}$$

$$\log Y/L = \tilde{\alpha} + \beta\widehat{I} + \tilde{\varepsilon}, \tag{2.4}$$

where $\overline{X}$ is a subset of X and equations (2.3) and (2.4) represent the first and second stage regressions, respectively.

The 2SLS regression (I) in Table 2.1 replicates the Hall and Jones (1999) results for the global sample, where instruments are successful, in the sense that most regressors in the first stage are highly significant, the adjusted R-squared is satisfactorily high, and in that the overidentifying restrictions cannot be rejected.

Hall and Jones' (1999) compelling motivation of Latitude, Implied Trade Shares, and the fraction of the population which speaks European languages as instruments is reflected in these instruments' strong performance in the global sample. Not only is the first stage strong, but instrumented institutions are highly significant and explain large differences in per capita income across countries.

[5] As pointed out by Hall and Jones (1999), a valid instrumental variable strategy can also address measurement error and omitted variable bias of OLS estimates.

Table 2.1
Explanatory Power of Institutions and Instruments
First Evidence for Parameter Heterogeneity (2SLS)

	(I) Hall and Jones (1999)		(II) Global Sample	
	Institutions	**Y/L**	**Institutions**	**Y/L**
Institutions♦		5.085*** (0.545)		5.580*** (1.268)
OECD Dummy			0.340*** (0.052)	-0.583 (0.522)
English Language Fraction	0.136 (0.092)		0.054 (0.080)	
European Language Fraction	0.170*** (0.056)		0.098** (0.049)	
Implied Trade Share	0.044* (0.025)		0.061*** (0.022)	
Latitude	0.004*** (0.001)		0.001 (0.001)	
N	127	127	127	127
Adjusted R-squared	0.30	0.41	0.48	0.35
Over-ID Test		0.243		0.044**

Notes: Not reported: intercept; standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. The First stage always includes the fraction of the population speaking English or another European Language (English Fraction and European Fraction), the Implied Trade Share from a gravity trade equation (Implied Trade Share) and the geographical Latitude of a country. The second stage regresses the log of income per worker on the instrumented economic institutional variable. The 2SLS regression (II) adds a Dummy for OECD membership in 1999 to both stages. Over-ID Test is the p-value of the Hansen-Sargan Test statistic of overidentifying restrictions of all (but one) Instrument, the joint null being that the instruments are valid. The "♦"superscript indicates instrumented variables.

As a first exploration of parameter heterogeneity to uncover possible differing effects of instruments and institutions in the OECD subsample, we add a region dummy, D, to the 2SLS regression (I). This modifies the structural model to:

$$\widehat{I} = \tilde{\gamma} + \overline{X}\tilde{\theta} + \xi D + \tilde{\eta} \tag{2.5}$$

$$\log Y/L = \tilde{\alpha} + \beta\widehat{I} + \zeta D + \tilde{\varepsilon}. \tag{2.6}$$

The 2SLS regression (II) in Table 2.1 reports that the OECD dummy is indeed highly significant in the first stage. In addition, the introduction of a regional dummy changes the explanatory power of instrumented institutions significantly. Having accounted for OECD specific effects, only two of the original four Hall and Jones instruments remain significant. The Implied Trade Share actually gains significance, moving from 10 to 1 percent levels, while the significance of European Languages and Latitude is

greatly reduced. The explanatory power of Latitude changes dramatically. It looses its 1 percent significance from the 2SLS regression (I) and shows no statistically significant impact on economic institutions in the 2SLS regression (II). Perhaps some of the explanatory power of the instruments in the global sample was derived from the fact that the instruments differed systematically across subsamples.

The fit of the first stage rises strongly as the adjusted R-squared improves, indicating an *increase* in the power of the instruments from the 2SLS regression (I) to the 2SLS regression (II). The introduction of the region dummy thus improves the fit of the first stage significantly, while the established instruments loose power. This provides additional evidence that the region dummy actually drives the results in the 2SLS regression (II). In addition, the Sargan Over-ID Test is now rejected, which raises further doubts about the validity of this particular set of instrumental variables.

The second stage holds two additional surprises. First, the OECD dummy is not significant, which indicates the absence of OECD specific effects in the determination of income levels. Second, the measure of institutions remains highly significant with hardly a change in the point estimate, as compared to Hall and Jones' (1999) original specification. The same is true for the fit of the second stage which is just marginally below the fit of the Hall and Jones (1999) regression.[6] We must consider the second stage preliminary, however, since the estimates in equation (2.6) are potentially contaminated with endogeneity bias, given the weak performance of the first stage of the 2SLS regression (II). With this caveat in mind, we do note that the regression indicates that economic institutions are indeed important in accessing output in the global sample. The rule of law, bureaucratic quality, corruption, risk of expropriation, government repudiation of contracts, and openness to trade do seem to matter just as much for OECD countries as for the world.

Since the OECD dummy lacks explanatory power while economic institutions are highly significant, it is tempting to conclude that there exists little evidence for parameter heterogeneity in economic institutions. However, the estimation of their effect on income levels is only valid to the degree that the instruments can be established as appropriate. The first stage of the 2SLS regression (II) highlights that the instruments lack not only a compelling intuitive motivation for OECD countries, but also explanatory power. Perhaps most importantly, the instruments are neither uncorrelated with the error term in equation (2.1) (the Sargan Test is not accepted), nor are the four

[6] We choose to report the second stage R-squared as an indicator of the fit, although it does not possess statistical meaning in the context of 2SLS/IV, since it measures the proportion of variation in the dependent variable that is accounted for by the fitted explanatory variables.

established instruments strongly correlated with the endogenous regressor, I. The first stage of regression (II) thus casts substantial doubt on the validity of the results obtained in the second stage regression; in addition, the presence of a highly significant OECD dummy in the first stage provides strong evidence of parameter heterogeneity in the instruments.

To explore the issue of instrument heterogeneity head on, we proceed to split the sample and examine OECD and Non-OECD subsamples separately in Table 2.2. The purpose is to isolate the impact of the established instruments and the explanatory power of economic institutions across the respective subsamples.

The 2SLS regression (III) provides further reason to doubt that the established instruments are appropriate for the case of the OECD sample. Of all four instruments, only Latitude remains weakly significant at the 10 percent level in the first stage. This is especially surprising since Latitude had lost explanatory power when we introduced the OECD dummy to the global sample in the 2SLS regression (II). The adjusted R-squared drops sharply in the first stage, and the Over-ID Test is also rejected. All this points to further problems related to either weak or inappropriate instruments for the subsamples.

The coefficient on economic institutions remains highly significant in the 2SLS regression (III), but its magnitude is reduced to about one third of the size obtained in the global sample. The fit for the second stage regression also improves sharply. After considering the caveat that the economic institutions estimate may be contaminated by endogeneity bias, the second stage indicates that institutions do exert a positive effect on output in OECD countries, albeit a substantially smaller one.

Table 2.2
Performance of Institutions and Instruments
Power of Instruments Across Subsamples (2SLS)

	(III) OECD		(IV) Non-OECD		(Va) WB High Income		(VIa) WB Non High Income		(Vb) WB High & Upper Middle Income		(VIb) WB Non High & Non Upper Middle Income	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions♦		1.845*** (0.456)		5.771*** (1.644)		1.184* (0.674)		6.635*** (2.237)		2.226*** (0.454)		3.241 (2.631)
English Lang. Fraction	0.159 (0.125)		0.019 (0.117)		0.067 (0.096)		0.048 (0.104)		0.133 (0.103)		-0.021 (0.134)	
European Lang. Fraction	0.134 (0.089)		0.085 (0.059)		0.028 (0.064)		0.094* (0.053)		0.044 (0.079)		0.079 (0.061)	
Implied Trade Share	0.046 (0.044)		0.066** (0.027)		-0.015 (0.031)		0.026 (0.025)		0.005 (0.036)		0.015 (0.026)	
Latitude	0.003* (0.002)		-0.000 (0.001)		0.003** (0.001)		-0.000 (0.001)		0.004*** (0.001)		-0.001 (0.001)	
N	29	29	98	98	31	31	96	96	50	50	77	77
Adj. R-squared	0.26	0.76	0.09	0.000	0.22	0.20	0.08	-0.31	0.28	0.42	0.04	0.23
Over-ID Test		0.059*		0.059*		0.423		0.005***		0.469		0.000***

Notes: Not reported: intercept; standard errors in parentheses. . Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. First stage always includes the fraction of the population speaking English or another European Language (English Fraction and European Fraction), the Implied Trade Share from a gravity trade equation (Implied Trade Share) and the geographical Latitude of a country; Second stage regresses the log of income per worker only on the instrumented economic institutional variable. Overid Test is the p-value of the Hansen-Sargan Test statistic of overidentifying restrictions of all (but one) Instrument, the joint null being that the instruments are valid. Columns (V) and (VI) split the sample according to the World bank's classifications of High, Medium and Low Income countries. The "♦"superscript indicates instrumented variables.

We expected that the Non-OECD sample in the 2SLS regression (IV) would retain similar explanatory power as in the original Hall and Jones results in the 2SLS regression (I). The instruments were well motivated for the developing world, and the sample now excludes OECD countries for which the instruments have been shown to lack statistical power as well as economic intuition. From this point of view, one could even hope to see that the explanatory power of the institutions for the subset of developing countries should be enhanced. However, the results in the 2SLS regression (IV) are disappointing. Surprisingly, all instruments except the Implied Trade Share loose significance. The fit of the first stage approaches white noise indicating to our surprise that the instruments perform even worse than in the OECD sample. As in the case of OECD countries, the Over-ID Test is rejected in the 2SLS regression (IV). While the coefficient on economic institutions in the second stage remains highly significant, the adjusted R-squared is practically reduced to zero. Note that the coefficient on institutions in the Non-OECD sample rises slightly compared to the coefficient in the global sample (2SLS regression I). Given the weak performance of the first stage, however, we cannot view the second stage results as reliable.

In exploring whether the established instruments are valid for OECD countries, we therefore, quite inadvertently, uncover their weakness in both subsamples. Surprising is that the convincingly motivated instruments for the Non-OECD subsample are also ultimately rejected on the basis of the lack of both, significance and identification. One might suspect that the result is an artifact of having picked an unfortunate division of the global dataset. Therefore, we conducted the same exercise with qualitatively similar sample splits according to the World Bank classification of High/Medium/Low Income Countries. The results in (Va), (Vb), (VIa) and (VIb) are almost identical as in regressions (III) and (IV). The results in regressions (III) and (IV) are robust to different splits of the global data as the instruments lack significance and fail the Over-ID Test in all alternative subsamples reported in Table 2.2.[7]

Perhaps the findings in Table 2.2 provide a deeper understanding of why the Hall and Jones' (1999) instruments do not perform strongly in the Acemoglu, Johnson, and Robinson (2001) sample, which is dominated by former colonies. They show that colonial origins (proxied by settler mortality) as an instrument for economic institutions (in their case government expropriation risk) improves the 2SLS estimation compared to Hall and Jones' (1999) instruments. Since Acemoglu, Johnson, and Robinson (2001) focus only on former colonies, their approach cannot be utilized to solve the endogeneity

[7]Note that the results are confirmed when we control for the small size of the OECD subsample as we bootstrap regressions in section 2.3.2.

problem in OECD sample, which is comprised largely of the nations of origin of the settlers.

The analysis leaves the discussion regarding the impact of economic institutions on growth at a crossroads. Acemoglu, Johnson, and Robinson (2001) have shown that economic institutions do matter for a set of 69 developing countries that are distinguished by their colonial history. On the other hand, we are left without guidance as to which – if any – economic institutions of the type discussed in Hall and Jones (1999) matter to the long-run performance of highly developed countries. In the next section we set out to find alternative instruments that are valid for OECD countries, and to test their explanatory power for the Non-OECD sample.

2.2.2 The Hierarchy of Institutions Hypothesis

In search of alternative instruments that control for endogeneity of economic institutions in both the global and the OECD samples, we turn to political institutions. The recent institutions literature has begun to draw a clear distinction between political and economic institutions. Williamson (2000), Acemoglu, Johnson, and Robinson (2005), Acemoglu and Johnson (2005) and Roland (2004), all posit a *hierarchy of institutions* which we will utilize below. While economic institutions determine economic performance, they are themselves influenced both directly and indirectly by political institutions. The direct effect of political institutions stems, for example, from the concentration of political power in the hands of a malevolent dictator, who dismantles the economic institutions which ensure property rights and equal opportunity. Political institutions may also affect economic institutions indirectly, since they determine the distribution of de jure political power which, in turn, assigns the power to alter economic institutions.

While political institutions may not affect output directly, constitutions are not written in stone. They change slowly but exhibit great persistence over time, for example, as countries evolve from dictatorships to democracy (and vice versa). Acemoglu, Johnson, and Robinson (2005) argue that political institutions are collective choices; hence the distribution of political power in society is the key determinant of their evolution. Persistence is introduced by those holding political power, who find it in their interest to maintain the status quo even at significant economic cost for society as a whole.

Persson (2004, 2005) and Eicher and Schreiber (2005) report empirical evidence for

the hierarchy of constitutions, by employing specific constitutional variables as instruments for economic institutions. We follow the same method below. The instruments perform well because they are slow moving and because their direct impact on output is negligible. As a practical matter, this can be established in our regressions (see footnote 10). Glaeser et al (2004) also argue forcefully against a direct link between output and political institutions. Nonetheless, we are careful to examine our results in a robustness section below to confirm that they do not hinge on the assumption that political institutions are entirely exogenous. We allow for the existence of long-term feedback effects from economic outcomes to constitutions in our robustness section. Specifically we introduce alternative political and constitutional instruments that are even less likely to be contaminated by endogeneity.

To examine whether the hierarchy of institutions hypothesis provides successful instruments, we augment the original Hall and Jones (1999) dataset with a number of political institutions provided by the Polity IV database, the World Bank, and the International Country Risk Guide. From Polity IV we select the Constraints on the Chief Executive ("Executive Constraints" below) and Chief Executive Recruitment Regulation ("Executive Recruitment Regulation") for 1988, the year predating our data on income per worker. For robustness, we also include additional Polity IV variables, Legislative and Executive Indices of Electoral Competitiveness in 1975 from the Database on Political Institutions (World Bank), Voice and Accountability from the "Government Matters" database (World Bank), Type and Age of Democracies (as derived by Persson, 2004 from Polity IV), and variables which reflect legal origins (e.g., the German and Scandinavian legal origins significant in La Porta et al 2004, and Levine Loayza and Beck 2000), judicial independence and Constitutional Review (e.g., rigidity of the constitution, judges' influences over the legislative branch) from La Porta et al (2004).[8] The addition of political institutions reduces the size of our baseline dataset from 127 to 114.[9]

Table 2.A2 in the appendix shows that the economic institutions which comprise Hall and Jones' (1999) social infrastructure variable and our proxies for political institutions are quite distinct. Factor analysis on the entire institutional dataset shows that the variables span different dimensions of the dataspace and separate nicely into one

[8] The additional Polity IV variables included are the Polity2 index, Competitiveness of Executive Recruitment, Good Democracy, Political Competition, Competitiveness of (Political) Participation, Executive Recruitment Regulation, Executive Electoral Competition, Openness of Executive Recruitment, Regime Durability and Regulation of Participation.

[9] The excluded countries are Barbados, Cape Verde Islands, Hong Kong, Iceland, Luxembourg, Malta, Namibia, Puerto Rico, Reunion, Seychelles, Suriname, Yemen, and Zaire.

economic factor (given by the social infrastructure variables) and two political factors.

Table 2.A1 indicates a high correlation among the political variables. To avoid problems of multicollinearity, we choose Executive Constraints and Executive Recruitment Regulation as our baseline instruments, because these two variables have been used extensively in the literature.[10] In our robustness section we examine whether our results depend on a particular selection of political institutions. Table 2.3 reports the results when using our preferred political institutions as instruments in the global sample.

The 2SLS regression (VII) shows that both instruments are highly significant and that their first stage fit is similar to the benchmark in Hall and Jones (1999) as reported in the 2SLS regression (I). The Over-ID Test is accepted and the political instruments perform strongly as previously shown in different contexts by Persson (2004, 2005) and Eicher Schreiber (2005).[11] The coefficient on economic institutions in the second stage is also similar to the one reported in Hall and Jones (1999).[12]

For robustness we also pair our political institutions with Hall and Jones' (1999) instruments in the 2SLS regression (VIII) to show that the former retain their explanatory power once the additional regressors are included in the first stage. In addition, the C-Test (Difference-In-Sargan-Test) allows us to test a subset of the original orthogonality conditions in order to establish the exogeneity of our new instruments (to test our instruments against Hall and Jones') in the 2SLS regression (VIII) and is also accepted. Thus we can claim that in the global sample our new instruments perform at least as well as those of Hall and Jones (1999).

While we have found that political institutions are both strong and exogenous instruments for economic institutions, parameter heterogeneity may still be an issue. The fact that institutions matter in the global sample, as shown above, does not provide a guarantee that they work across subsamples.

[10] These particular variables have been featured prominently in empirical institutional assessments of Persson, Tabellini, and Trebbi (2003), Acemoglu and Johnson (2005) Acemoglu, Johnson, and Robinson (2001, 2002), Acemoglu et al (2003), Gleaser et al (2004) Djankov et al (2002) and Alfaro, Kalelmi-Ozcan, and Volosovych (2005).

[11] Like Acemoglu, Johnson, and Robinson (2001, 2002), we also used the cruder approach of adding the instruments into the second stage regressions to show that they only influence output through their effect on economic institutions. Indeed, we always find them to be insignificant if added to the second stage.

[12] If we reduce the Hall and Jones (1999) 2SLS regression (1) to the same 114 countries, we obtain a coefficient for economic institutions of 5.46.

Table 2.3
Institutions and New Instruments:
The Hierarchy of Institutions (2SLS)

	(VII) Global Sample		(VIII) Global Sample		(IX) Global Sample	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions♦		4.870*** (0.507)		4.871*** (0.459)		5.789*** (1.034)
OECD Dummy					0.300*** (0.043)	-0.628 (0.447)
Executive Constraints	0.040*** (0.012)		0.036*** (0.012)		0.009 (0.011)	
Executive Recruitment Regulation	0.091** (0.042)		0.067 (0.041)		0.109*** (0.036)	
English Language Fraction			0.079 (0.086)			
European Language Fraction			0.047 (0.058)			
Implied Trade Share			0.053)** (0.026			
Latitude			0.002*** (0.001)			
N	114	114	114	114	114	114
Adjusted R-squared	0.37	0.45	0.45	0.45	0.57	0.33
Over-ID Test		0.355		0.104		0.831
Over-ID C-Test for Political Institutions subset				0.37		

Notes: Not reported: intercept; standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. The First stage always includes Constraints on the Executive (Executive Constraints) and Regulation of Chief Executive Recruitment (Executive Recruitment Regulation). The fraction of the population speaking English or another European Language (English Fraction and European Fraction), the Implied Trade Share from a gravity trade equation (Implied Trade Share) and the geographical Latitude of a country and finally a dummy indicating OECD membership as of 1999 are subsequently added; Second stage regresses the log of income per worker only on the instrumented economic institutional variable. The Over-ID Test reports the p-value of the Hansen-Sargan Test statistic of overidentifying restrictions of all (but one) Instrument, the joint null being that the instruments are valid. Over-ID, C-Test is the p-value of the C-statistic when Testing the over-identifying restriction for the two political instruments vis-à-vis the established ones. The "♦"superscript indicates instrumented variables.

The 2SLS regression (IX) highlights that the effect of political institutions does differ across the samples due to the significant OECD dummy. Nevertheless, in contrast to the 2SLS regression (III), the new instruments do not loose their validity; they remain highly significant and pass the Over-ID Test. The fact that the dummy retains its significance in the first stage does raise the question however, of whether there is a systematic difference in the influence of political institutions on economic ones in the OECD vs. Non-OECD samples. We explore such potential parameter heterogeneity more thoroughly in Table 2.4.

Table 2.4
Hierarchy of Institutions and Parameter Heterogeneity (2SLS)

	(X) OECD		(XI) OECD (global sample with interaction terms)		(XII) Non-OECD		(XIII) Non-OECD (global sample with interaction terms)	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions♦		2.317*** (0.267)		2.317*** (.806)		7.529*** (1.869)		7.529*** (1.139)
OECD Dummy			-0.473** (0.219)	2.664*** (0.762)				
Non – OECD Dummy							0.473** (0.219)	-2.664*** (0.762)
Executive Constraints	0.027 (0.027)		0.005 (0.010)		0.005 (0.011)		0.027 (0.045)	
Executive Recruit-ment Regulation	0.323*** (0.086)		0.085** (0.035)		0.085** (0.038)		0.323** (0.144)	
N	27	27	114	114	87	87	114	114
Adjusted R-squared	0.79	0.76	0.60	0.59	0.14	0.52	0.60	0.59
Over-ID Test		0.584		NA		0.974		NA

Notes: Not reported: intercept; standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. The First stage always includes Constraints on the Executive (Executive Constraints) and Regulation of Chief Executive Recruitment (Executive Recruitment). For columns (XI) and (XIII) the specified dummy (OECD or Non-OECD) is included as well as interactions of that dummy with Executive Constraints and Regulation of Chief Executive Recruitment are added in first stage. The Second stage includes the predicted institutions value as well as an interacted predicted institutions value with a (Non-) OECD dummy plus the dummy. The reported coefficients for institutions in the second stage the composite effects of (Institutions♦ + Institutions♦ ?Dummy). Standard errors for that effect are calculated with the delta method. The Over-ID Test is the p-value of the Hansen-Sargan Test statistic of overidentifying restrictions of all (but one) Instrument, the joint null being that the instruments are valid. The "♦"superscript indicates instrumented variables.

We can examine parameter heterogeneity from two perspectives. First, we split the global sample in regressions (X) and (XII). To avoid loosing information as we move to the subsample analysis, we alternatively examine parameter heterogeneity by adding an interaction term to the global sample which interacts instruments and institutions with the region dummy.

$$\widehat{I} = \tilde{\gamma} + \overline{X}\tilde{\theta} + \xi D + \iota \overline{X} D + \tilde{\eta} \tag{2.7}$$

$$\log Y/L = \tilde{\alpha} + \beta \widehat{I} + \zeta D + \varpi \widehat{I} D + \tilde{\varepsilon} \tag{2.8}$$

Following Brock and Durlauf (2001) the coefficients on institutions in regressions (XI) and (XIII) are composite coefficient estimates and standard errors for $\widehat{I} + \widehat{I}D$. The results in regressions (XI) and (XIII) thus take advantage of all information contained in the global dataset, while representing the subsample specific effects of economic institutions on output.

Table 2.4 presents three important results. First, parameter heterogeneity is confirmed to be of statistic and economic significance, no matter whether the sample is split (regressions X, XII) or not (regressions XI, XIII). In either case, the results are significant and stable across methods in the sense that the coefficients in the interacted, global sample are just about identical to the ones obtained in the subsample estimation. The significance of the region dummies provides clear evidence for parameter heterogeneity.

The second important aspect of Table 2.4 is that political institutions perform well as instruments across all samples. While only one of the two instruments is significant, there is strong evidence that the hierarchy of institutions approach does provide sufficiently strong instruments for economic institutions in each subsample. The adjusted R-squared is extremely high across methods and samples (with the exception of first stage in the pure Non-OECD subsample) and the Over-ID Tests are accepted throughout.

The third key implication of Table 2.4 is that the influence of social infrastructure on output is obtained with considerable precision; it is about three times larger for Non-OECD countries than for OECD countries. This result is akin to our preliminary finding in Table 2.2. The smaller coefficient for OECD countries suggests that economic institutions play a smaller, yet equally significant role in determining output in OECD countries as compared to the global or Non-OECD samples. Of course, the income gap between OECD countries (eight-fold in 1970 according to the Penn World tables) is also

much smaller than the 30-fold gap between the richest and the poorest nations in the global sample. For the Non-OECD sample, the importance of the economic institutions, namely, rule of law, bureaucratic quality, corruption, risk of expropriation, government repudiation of contracts, openness to trade, is now significantly greater than in the OECD sample.

The magnitude of the IV-estimate for the impact of economic institutions in the global sample (regression VII) lies between those for the OECD and Non-OECD samples in the 2SLS regressions (XI) and (XIII), which is intuitive. The new instruments thus deliver a similar result across samples as the slopes in our Figure 1 indicated initially: the economic institutions included in the Hall and Jones (1999) social infrastructure index certainly have a larger impact in developing countries. Hence it is no surprise that the coefficient is greatest in the developing country sample, and somewhat lower for OECD countries. The estimate for the combined effect of the two datasets which make up the global sample should then lie in the middle.

While the size of the coefficient is smaller for the OECD, it is interesting to see that institutions explain a larger share of the variation in OECD income as compared to institutions in the Non-OECD sample. The R-squared for the OECD countries ranges from 60 to 76 percent while it is only 52 to 60 percent in the Non-OECD sample. Thus one might be surprised not only how important economic institutions are in the OECD, but also how precisely they forecast income levels in these countries.

Searching for better instruments that are valid for key subsamples of the global dataset, we therefore uncovered important support for the hierarchy of institutions hypothesis in both subsamples and in the global dataset. In the process we come to the surprising conclusion that the type of social infrastructure identified by Hall and Jones (1999) does play a significant role even in advanced OECD economies, which are often seen as representing the gold standard in terms of control of corruption, rule of law and free, well-functioning markets. Interestingly, the impact of such institutions in OECD countries is significant, but about two thirds smaller than in Non-OECD countries.

In the next section, we examine how robust our results are to alternative datasets, alternative measures of economic institution, different groupings of countries, and to specifications that investigate whether current political institutions are truly exogenous.

2.3 Robustness

2.3.1 Alternative Instrument Specifications

An important aspect of our investigation has been the classification of political institutions as exogenous with respect to output levels. However, the income level regressions capture long lasting effects of both political and economic institutional changes that may accumulate over time. While the hierarchy of institutions posits that there is no direct effect of economic outcomes in a particular year on political institutions and constitutions, it is certainly possible to imagine that there are feedback effects between economic outcomes and the distribution of power.

We cannot capture evidence for such feedback effects in our sample when we add the political institutions to the second stage (the coefficients on political institutions are insignificant in this case). An alternative method to establish that our instruments are largely exogenous to output in 1989 is to use political institutions that substantially predate 1989 income. In our case we can trace our political institutions back to 1900, 88 years prior to our political instruments above. If endogeneity did exist in the case of 1989 income levels and 1988 political institutions, it would arguably be a lot smaller for 1989 income levels and institutions in 1900.

Table 2.5
Instrument Robustness
Political Institutions in 1900

	(XIV) Global		(XV) OECD		(XVI) Non-OECD	
	$Institutions_{1989}$	**Y/L**	**$Institutions_{1989}$**	**Y/L**	**$Institutions_{1989}$**	**Y/L**
$Institutions_{1989}^{\blacklozenge}$		2.657*** (0.378)		1.790*** (0.41)		1.284 (2.607)
Executive $Constraints_{1900}$	0.057*** (0.011)		0.050*** (0.015)		0.013 (0.018)	
Executive Recruitment $Regulation_{1900}$	0.110** (0.043)		0.129 (0.108)		0.046 (0.042)	
N	46	46	22	22	24	24
Adjusted R-squared	0.52	0.56	0.43	0.69	0.08	0.02
Over-ID Test		0.528		0.120		0.540

Notes: Not reported: intercept; standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. The First stage always includes Constraints on the Executive (Executive Constraints) and Regulation of Chief Executive Recruitment (Executive Recruitment) in 1900. Economic Institutions are the ones in 1989. Early political institutions data limitations reduce the sample size to 112 for the global sample. The "♦"superscript indicates instrumented variables.

The results for both the OECD and global samples in Table 2.5 are strong, even with

the 89 year lag in political institutions. Both political institutions are highly significant in the global sample, which is reduced to 46 countries due to data constraints, and due to the fact that a number of countries did not exist in 1900. The global estimate for the impact of economic institutions on output is again higher in the global than in the OECD sample. The instruments pass the Over-ID Test for all samples. However, the Non-OECD regression (XVI) is weak overall, with low R-squares, and no significant coefficients. While one might expect that the lack of power is due to small sample size, the result is equally weak if we use the Durlauf et al (2001) method of interacting institutions with region dummies to detect parameter heterogeneity while preserving the variation contained in the whole sample. Therefore, the results are due to the particular set of countries that is included in the 24 Non-OECD countries in 1900. The noticeable difference across all samples as compared to Table 2.4 is the reduction of the impact of economic institutions on output.

An alternative robustness check regarding the choice of political variables that we employ above, is to examine alternative instruments instead of alternative time periods. Above we use Executive Recruitment Regulation and Executive Constraints due to their prevalence in the institutions literature, and because the data can be traced back to 1900. Instead of selecting any number of variables among the universe of possible political institutions, Table 2.6 reports regressions based on the information contained in all 16 political institutions that we identified as potential candidates for instruments. Since the political data is highly correlated (Table 2.A1), we perform factor analysis on the global sample. We identify the two dominant factors (e.g., eigenvalues exceed unity) and report them along with their factor loadings in Table 2.A3. The commonalities among the variables which play important roles in the two factors are such that we label factor 1 *Democratic Rules* and factor 2 *Participation/Stability.*

The use of all possible political variables increases the power of the estimations significantly across all samples. In regressions (XVII) to (IXX) the same pattern emerges as above, where the global sample indicates a significant impact of economic institutions on output which lies between the significant estimates for OECD and the Non-OECD countries. With the exception of Participation/Stability for the Non-OECD Sample, all estimates are highly significant, no matter which subsample or political factor we consider. The political instruments are again strong and uncorrelated with the error term in the global as well as the two subsamples. The factor analysis also improves the first stage in terms of significance and fit. Aside from the fact that we are utilizing information contained in all 16 variables, rather than just two, the improved fit might also be a function of the fact that institutions are probably measured with error, which

Table 2.6
Instrument Robustness
Factor Analysis: All Political Variables

	(XVII) Global		(XVIII) OECD		(IXX) Non OECD	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions♦		4.029*** (0.464)		2.148*** (0.269)		5.690*** (1.958)
Democratic Rules	0.129*** (0.020)		0.117*** (0.033)		0.055 (0.021)***	
Participation / Stability	0.081*** (0.020)		0.108*** (0.028)		0.001 (0.022)	
N	101	101	27	27	74	74
Adjusted R-squared	0.38	0.56	0.76	0.77	0.10	0.03
Over-ID Test		0.862		0.432		0.244

Notes: Not reported: Intercept; robust Standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. Democratic Rules and Participation/Stability are the first two rotated factors from a factor analysis on all political variables (Good Democracy, Polity2, Regime Durability, Executive Recruitment Regulation, Competitiveness of Executive Recruitment, Openness of Executive Recruitment, Executive Constraints, Regulation of Participation, Competitiveness of Participation, Executive Recruitment, Political Competition, Democratic Accountability, Legislative Electoral Competition, Executive Electoral Competition, Voice and Accountability, Political Stability). The "♦"superscript indicates instrumented variables.

is mitigated by the factor analysis.

As an additional robustness experiment we also examine specific sets of political institutions that have featured prominently in the political, constitutional, legal and economic institutions analysis of Persson (2004) and La Porta et al (2004).[13] Persson (2004) uses two main instruments: The Form of Democratic Government (whether an established democracy is a presidential or majoritarian system) and the Age of Democracy. These two political institutions are employed as instruments in Table 2.7.

The Persson instruments for political institutions perform well across all subsamples. The Over-ID Test is accepted, the instruments are strong and the fit is good. Note, however, that the estimates of the influence of economic institutions on output levels are reduced for the global and Non-OECD samples. Nonetheless, their magnitudes are still quite similar to the ones obtained with our preferred instruments in Table 2.4.

A prominent alternative to purely political institutions is provided by La Porta et al. (2004), who emphasize the importance of constitutional variables that regulate the legal and judicial system as determinants of economic and political freedoms. We explore the judicial dimension of constitutions in our robustness by using key variables from

[13] We thank Torsten Persson for making his dataset available to us. La Porta et al (2004) data is available on the their websites.

Table 2.7
Instrument Robustness
Persson's (2004) Political Institutions

	(XX) Global		(XXI) OECD		(XXII) Non OECD	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions♦		3.901*** (0.351)		2.627*** (0.400)		3.291*** (0.844)
Form of Democratic Government	0.224*** (0.034)		0.050 (0.084)		0.209*** (0.042)	
Age of Democracy	0.541*** (0.077)		0.430*** (0.107)		0.280* (0.149)	
N	112	112	27	27	85	85
Adjusted R-squared	0.58	0.59	0.40	0.72	0.29	0.33
Over-ID Test		0.265		0.664		0.029**

Notes: Not reported: intercept; standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. First stage always includes Parliamentary Democracy and Age of Democracy from Persson (2005). The instrumented institutions is Hall and Jones' (1999) social infrastructure and income per worker is from their dataset as well. Adding the Persson (2004) data reduces the sample size to 112 for the global sample. The "♦"superscript indicates instrumented variables.

La Port et al. (2004) which relate to Legal Origin, Duration of Supreme Court Judge Tenure, and Judicial Power (whether judges hold power to review constitutionality of laws).[14]

As in the case of our purely political constitutional variables above, we argue that these legal instruments are valid because they are, at best, slow moving over time. In fact, the legal origins can be argued to be just as predetermined as the colonial experience invoked by both Hall and Jones (1999) and Acemoglu, Johnson and Robinson (2001). Such constitutional variables have usually been in place for long time spans and rarely change. Table 2.8 provides results using the legal constitutional variables as instruments.

The Legal constitutional instruments perform strongly in the global sample in regression (XXIII). However, in the subsample estimation in regressions (XXIV and XXV), the first stages for OECD and Non-OECD countries are weak and do not perform as well as the political instruments introduced above. Again the OECD subsample coefficient estimate for institutions is smaller than for the global and Non-OECD sample. However, the Non-OECD subsample is measured with considerable error. While the instruments are still passing the Sargan Over-ID Test, only German Legal Origins are actually significant and the institution coefficient in the second stage is barely significant at the 10 percent level. Since the Non-OECD sample is reduced to 36 obser-

[14]Note that these instruments do not relate to legal enforcement, which could be argued to be dependent on funds and thus per capita income.

Table 2.8
Instrument Robustness
La Porta et al (2004) Judicial Institutions

	(XXIII) Global		(XXIV) OECD		(XXV) Non OECD	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions$^{\blacklozenge}$		2.790*** (0.540)		1.397** (0.611)		2.730* (1.657)
German legal Origin	0.364*** (0.101)		0.186* (0.096)		0.354* (0.202)	
Scandinavian Legal Origin	0.335*** (0.120)		0.099 (0.085)		NA$^{\clubsuit}$	
Supreme Court Judge Tenure	0.128** (0.056)		0.196* (0.104)		0.061 (0.054)	
Constitutional Review	-0.057 (0.119)		0.003 (0.116)		-0.091 (0.139)	
N	60	60	24	24	36	36
Adj. R-squared	0.30	0.61	0.24	0.59	0.14	0.27
Over-ID Test		0.670		0.722		0.466

Notes: Not reported: intercept; standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. First stages include only the 4 variables from La Porta et al (2004) as specified in the main text. The instrumented institutions is Hall and Jones' (1999) social infrastructure and income per worker is from their dataset as well. The use of the La Porta et al (2004) dataset reduces the sample size to 60 for the global sample. ♣ Dropped due to collinearity. The "♦"superscript indicates instrumented variables.

vations only, it is tempting to attribute the weakness of the results to the small sample size. However, Durlauf et al (2001) interaction of a region dummy with the institutions does not solve the issue (not reported here). One might be led to conclude that judicial institutions may be of significance in developed countries, but that their influence is weaker than political institutions for developing countries (see Tables 2.4 and 2.6).

2.3.2 Outliers and Small Samples

The OECD sample size is small, which raises the question of whether outliers such as Turkey, Mexico, and Korea influence the results. Turkey and Mexico are not in the World Bank's classification of High Income countries (used above), and we are, after all, interested in the contributions of economic institutions to output in highly developed countries. In this section, we provide outlier robust regression estimates for the first and second stage regressions above which use the OECD country sample. Table 2.9 reports estimations that attribute less weight to observations that feature large residuals. These regressions are meant to ensure that our results are not driven by unrepresentative outlying observations.

Table 2.9
Outlier Robust Estimation
OECD Regressions

	(III') Hall and Jones Specification		(X') Hierarchy of Institutions Specification		(XV') Hierarchy of Institutions Specification (1900)		(XVIII') Hierarchy of Institutions (Factor Analysis)	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions♦		0.912		2.381***		1.097***		2.633***
		(1.430)		(.217)		(0.417)		(0.2319)
English Language Fraction	-0.001							
	(0.073)							
European Language. Fraction	0.063							
	(0.052)							
Implied Trade Share	-0.047							
	(0.033)							
Latitude	0.003***							
	(0.001)							
Executive Constraints			-0.024		0.050***			
			(0.051)		(0.017)			
Executive Recruitment Regulation			0.522***		0.131			
			(0.191)		(0.120)			
Democratic Rules							0.0932***	
							(.030)	
Participation / Stability							0.1836***	
							(.0350)	
N	27	27	25	25	22	22	26	26

Notes: Not reported: intercept; standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. The number of observations in the 2SLS regression (X') is reduced to 25 as compared to 27 in (X) because the outlying observation Turkey and South Korea are dropped in the robust regression. R-square and Over-ID Tests are not applicable with these methods. The "♦"superscript indicates instrumented variables.

The outlier robust results in regressions (III'), (X'), (XV') and (XVIII') reinforce our earlier results with coefficients that are in line with the estimates in (III), (X), (XV) and (XVIII). The regressions indicate that our OECD results are not driven by a small subset of unrepresentative countries in the small sample. The Hall and Jones' (1999) specification of instruments in (III') does not perform well as the estimates' significance and magnitudes are greatly reduced. This indicates not only that the instruments fail, but also that the impact of economic institutions on output is estimated with great uncertainty when inadequate instruments are employed in the OECD subsample. The regressions involving political institutions (X', XV' and XVIII') are, however, robust and they exhibit equivalent magnitudes and significance levels as the baseline regressions (X, XV, XVIII). We thus conclude that our results are not negatively impacted by the small sample size or unrepresentative outliers.

The size of the OECD sample also raises doubts about the stability of the estimators. To address this issue we bootstrap standard errors and confidence bands of our OECD estimates.

Table 2.10 reports that bootstrapping reduces the power of the first stage across the board, but not to the degree that our essential insights derived above would have to be altered. All instruments that were significant above remain significant, although usually at lower levels. The impact of institutions on output is not impacted, and only in the case of economic institutions from 1900 is the significance of the estimate reduced to the 5 percent level. Indeed these exercises highlight just how robust the explanatory power and the stability of the coefficient estimates are across different instruments and estimation methods for the OECD subsample. We thus conclude that our results are robust to alternative specifications of the instruments, as well as to alternative estimation techniques.

Table 2.10
Bootstrapped Results
OECD Regressions

	(III'') Hall and Jones Specification		(X'') Hierarchy of Institutions Specification		(XV'') Hierarchy of Institutions Specification (1900)		(XVIII'') Hierarchy of Institutions (Factor Analysis)	
	Institutions	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**	**Institutions**	**Y/L**
Institutions♦		1.847*** (0.558)		2.317*** (0.334)		1.791** (0.734)		2.148*** (.3979)
English Language Fraction	0.143 (0.181)							
European Language Fraction	0.145* (0.082)							
Implied Trade Share	0.027 (0.072)							
Latitude	0.453* (0.236)							
Executive Constraints			.0271 (0.040)		0.050** (0.022)			
Executive Recruit-ment Regulation			0.323** (0.153)		0.129 (0.098)			
Democratic Rules							0.117** (.05386)	
Participation / Stability							0.108** (.04893)	
N	27	27	27	27	22	22	27	27

Notes: Not reported: Intercept; Bootstrapped standard errors in parentheses (from 10000 replications). Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. R-square and Over-ID Tests are not applicable with these methods. The "♦" superscript indicates instrumented variables.

2.3.3 Alternative Economic Institutions

All of our results above have so far been conditional on the use of the Hall and Jones' (1999) social infrastructure data as the proxy for economic institutions. The variable is not uncontroversial, because it consists of only a few institutions chosen from a large set of potential candidates. The literature on economic institutions and the empirical indicators that have been employed is surveyed in Acemoglu, Johnson, and Robinson (2005). In this robustness section, we examine whether our results are perhaps related to a specific choice of economic institutions in the second stage.

Following the publication of Hall and Jones (1999), Acemoglu, Johnson, and Robinson (2001, 2002, and 2005) established property rights and checks against government power as an important measure of economic institutions. As an additional robustness check, we seek to examine whether the Acemoglu, Johnson, and Robinson (2001) *Risk of Expropriation* variable (International Country Risk Guide, averaged over 1985-1995) may also serve as a proxy for economic institutions in our global and OECD samples.[15] We use the McArthur and Sachs (2000) dataset to expand the original Acemoglu, Johnson, and Robinson (2001) dataset from 69 to over 105 countries (including OECD members).

Table 2.11 shows that the hierarchy of institutions hypothesis performs well and that political institutions are strong instruments for Risk of Expropriation across all samples.

[15] Risk of Expropriation measures differences in institutions due to different types of states and state policies.

Table 2.11
Hierarchy of Institutions in Alternative Datasets
Risk of Expropriation across Subsets

	(XXVI) All Countries		(XXVII) Former Colonies		(XXVIII) OECD		(IXXX) Non-OECD	
	Risk of Expropriation	**Y/L**	**Risk of Expropriation**	**Y/L**	**Risk of Expropriation**	**Y/L**	**Risk of Expropriation**	**Y/L**
Risk of Expropriation♦		0.647*** (0.064)		0.742*** (0.120)		0.662*** (0.100)		0.844*** (0.227)
Executive Constraints	0.341*** (0.079)		0.226*** (0.119)		-0.059 (0.210)		.521** (.261)	
Executive Recruit. Reg.	0.485* (0.269)		0.394 (0.383)		1.700*** (0.604)		.075* (.0829)	
N	105	105	60	60	26	26	79	79
Adj. R-sq	0.33	0.60	0.24	0.52	0.59	0.72	0.10	-0.062
Over-ID Test		0.11		0.75		0.24		0.219

Notes: Not reported: Intercept; Robust standard errors in parentheses. Significance at the 10, 5 and 1 percent levels are indicated by *, **, ***, respectively. First stage always includes Constraints on the Executive (Executive Constraints) and Regulation of Chief Executive Recruitment (Executive Recruitment). The (instrumented) economic institutional variable now is Risk of Expropriation from McArthur and Sachs (2001) as is income per worker. Over-ID Test is the p-value of the Hansen-Sargan Test statistic of overidentifying restrictions of all (but one) Instrument, the joint null being that the instruments are valid. The "♦"superscript indicates instrumented variables

Both of our political instruments are significant and the Over-Id Test is accepted in all subsamples. Interestingly, different political institutions matter now for different subsamples. In the global sample, both Executive Constraint and Executive Recruitment matter. However in former colonies, only the Executive Constraints matters, while in OECD countries Executive Recruitment is significant. The fit of the first stage is quite high for all samples other than the Non-OECD first stage. The second stage exhibits statistically significant coefficients for economic institutions in all subsamples. Again, the OECD estimates regarding the impact of economic institutions lies below that of the Non-OECD sample.

We can compare the coefficient estimate in the Acemoglu, Johnson, and Robinson baseline regressions (2001, table 4, p. 1386) with our result for the same sample of countries in the 2SLS regression (XXVII). Our political institution instruments perform well for the subgroup of former colonies, and we find that the instruments lead to a very similar coefficient in the second stage as in Acemoglu, Johnson, and Robinson (2001, which is 0.94 in their baseline specification). Even the fit of the first stage is about as good as the 0.27 reported in Acemoglu, Johnson, and Robinson (2001). We can conclude that the political instruments are strong not only across country samples, but also across different proxies for the economic institutions.

2.4 Conclusion

We examine the impact of economic institutions on economic performance across OECD and Non-OECD subsamples. The goal is to ascertain if the results derived from studies using global datasets readily translate to high income countries. While the relationship between economic institutions and economic outcomes has been established empirically for developing countries and for global datasets, it has not been analyzed for the countries that represent the gold standard of institutions today.

Analysis of institutions among developed countries is inhibited by the absence of established instruments. Popular instruments in the institutions literature are shown to be relevant only for the global sample or for developing countries. We hypothesize that the notion of the *hierarchy of institutions* may provide sufficiently strong instruments and utilize political/constitutional institutions to serve as instruments for economic institutions. To do so, we show that they lead to very similar results when applied to the same groups of countries as the established instruments. The political institutions also pass all relevant statistical tests when they are employed only in the OECD subsample.

We find substantial evidence of parameter heterogeneity in economic institutions: the impact of Hall and Jones' (1999) economic institutions on income in OECD countries is only one third of the effect that the same institutions exert in Non-OECD countries.

Our results are robust to different specifications regarding time periods, different sets of political variables and economic institutions, and to a number of different samples splits and estimation techniques. Most surprising is perhaps, that the established instruments which perform strongly in the global sample, such as Latitude and European Languages, do not perform in either the OECD or the Non-OECD sample.

2.5 Appendix Chapter 2

Table 2.A1
Correlation Matrix of Political Institutions

	Polity 2 index	Executive Recruitment	Competitiveness of Executive Recruit.	Good Democracy	Executive Constraints	Political Competition	Competitiveness of Participation	Executive Recruitment Regulation	Executive Electoral Competition	Democratic Accountability
Polity2 index	1.00									
Executive Recruitment	0.95	1.00								
Competitiveness of Executive Recruit.	0.91	0.86	1.00							
Good Democracy	0.98	0.92	0.92	1.00						
Executive Constraints	0.96	0.87	0.91	0.95	1.00					
Political Competition	0.96	0.85	0.83	0.94	0.88	1.00				
Competitiveness of Participation	0.94	0.83	0.81	0.93	0.87	0.98	1.00			
Executive Recruitment Regulation	0.70	0.62	0.84	0.74	0.70	0.67	0.66	1.00		
Executive Electoral Competition	0.72	0.68	0.66	0.71	0.67	0.70	0.73	0.50	1.00	
Democratic Accountability	0.75	0.65	0.68	0.75	0.75	0.75	0.79	0.53	0.65	1.00
Voice and Accountability	0.68	0.59	0.60	0.70	0.66	0.69	0.74	0.48	0.60	0.88
Openness of Executive Recruitment	0.42	0.31	0.63	0.42	0.54	0.39	0.38	0.41	0.35	0.46
Legislative Electoral Competition	0.54	0.50	0.55	0.54	0.52	0.53	0.57	0.40	0.87	0.54
Political Stability	0.40	0.30	0.38	0.42	0.40	0.45	0.49	0.35	0.38	0.65
Regime Durability	0.24	0.21	0.26	0.31	0.27	0.22	0.28	0.31	0.35	0.40
Regulation of Participation	0.00	-0.05	-0.03	0.11	0.05	0.00	0.15	0.01	0.12	0.30

Table 2.A1 (continued)
Correlation Matrix of Political Institutions

	Voice and Accountability	Openness of Executive Recruitment	Legislative Electoral Competition	Political Stability	Regime Durability	Regulation of Participation
Voice and Accountability	1.00					
Openness of Executive Recruitment	0.33	1.00				
Legislative Electoral Competition	0.47	0.43	1.00			
Political Stability	0.80	0.22	0.28	1.00		
Regime Durability	0.38	0.11	0.35	0.27	1.00	
Regulation of Participation	0.34	-0.05	0.16	0.33	0.45	1.00

Notes: based on the 109 observations for which all data was available.

Table 2.A2
The Hierarchy of Institutions Factor Analysis
(Rotated Factor Loadings)

		Factors		
		1	**2**	**3**
Economic Institutions	Rule of Law	0.35	0.88	0.14
	Government effectiveness	0.35	0.87	0.14
	Corruption	0.32	0.87	0.17
	Government Anti-Diversion Policies	0.32	0.85	0.27
	Social Infrastructure	0.41	0.85	-0.02
	Regulatory Quality	0.37	0.79	0.01
	Years Open	0.42	0.74	-0.18
Political Institutions	Polity2 index	0.93	0.32	0.08
	Executive Recruitment	0.90	0.24	0.02
	Competitiveness of Executive Recruit.	0.90	0.24	0.24
	Good Democracy	0.89	0.37	0.13
	Executive Constraints	0.88	0.29	0.21
	Political Competition	0.88	0.38	0.04
	Competitiveness of Participation	0.81	0.47	0.12
	Executive Recruitment Regulation	0.77	0.25	0.15
	Executive Electoral Competition	0.58	0.33	0.53
	Democratic Accountability	0.52	0.66	0.30
	Voice and Accountability	0.44	0.77	0.17
	Openness of Executive Recruitment	0.43	0.01	0.56
	Legislative Electoral Competition	0.42	0.26	0.67
	Political Stability	0.19	0.81	0.06
	Regime Durability	0.09	0.49	0.36
	Regulation of Participation	-0.26	0.55	0.31

Note: based on 103 observations for which all data was available.

Table 2.A3
Factor Analysis of Political Institutions
(Global Sample, Rotated Factor Loadings)

	Factors	
	"Democratic Rules"	***"Participation and Stability"***
Polity2 index	0.94	-0.04
Good Democracy	0.93	0.11
Executive Recruit. Competitiveness	0.91	-0.07
Political Competition	0.88	-0.08
Executive Constraints	0.87	0.04
Competitiveness of Exec. Recruit.	0.86	0.06
Competitiveness of Participation	0.84	0.05
Executive Recruitment Regulation	0.76	0.27
Democratic Accountability	0.56	0.19
Executive Electoral Competition	0.55	0.08
Voice and Accountability	0.49	0.19
Legislative Electoral Competition	0.35	0.13
Openness of Executive Recruitment	0.25	-0.08
Political Stability	0.24	0.20
Regime Durability	0.18	0.52
Regulation of Participation	-0.09	0.79

Note: based on 109 observations for which all data was available.

Chapter 3

The Dynamics of Institutional Change - Formal and Informal Institutions and Economic Performance

"[..] if institutions are to be adapted to the people for whom they are intended. [..] whose tastes, customs, prejudices and vices are too deeply rooted to be readily crowded out by new plantings."

Jean-Jacques Rousseau[1]

"Lawgivers make the citizen good by inculcating habits in them, and this is the aim of every lawgiver; if he does not succeed in doing that, his legislation is a failure. It is in this that a good constitution differs from a bad one."

Aristotle[2]

3.1 Introduction

The abounding recent empirical literature establishes a clear causal relationship between the level of institutional quality as measured by various indices and economic performance, be that levels of income or growth rates.[3] Hall and Jones (1999) for example find that their index of institutional quality can explain up to 80 percent of the differences in income per capita between industrialized and developing countries. To improve economic performance all one has to do is to raise this quality then, it seems.

Where is the rub? Why have a lot of countries failed or are still failing at these attempts? If this relationship is so clear, "Why Are We So Rich and they So Poor?"[4] Why are the "big bills" that are "left on the sidewalk", as Mancur Olson (1996) puts it, not picked up by the poorest nations who could gain the most from institutional improvement?

One explanation is, that due to conflicting and vested interests no attempts to improve matters are made because the entrenched elites stand to loose from these changes. Even in a democracy ex-ante uncertainty about who might gain and who would loose under a new institutional framework could lead to the rejection of institutional reform, even though a majority would have benefitted ex-post (Fernandez and Rodrik, 1991).

However, if political economy reasons were the only explanation, one could not

[1] "Considerations on the Government of Poland and on its Proposed Reformation" unpublished manuscript, 1772.

[2] Aristotle (1962, p. 1103)

[3] Cf. Acemoglu, Johnson and Robinson (2001, 2002) and Hall and Jones (1999), for the growth accounting literature. By using instrumental variables for the quality of institutions they overcome the inherent problem of reverse causality. For a critical view see Glaeser et al (2004). In the growth regressions literature Sala-i-Martin (1997) and Fernandez, Ley and Steel (2001a) establish a robust relation for some institutional variables.

[4] Landes (1990).

explain another fact about institutions and economic performance that is observed in reality: even countries that did indeed set out on the path of institutional reform do not uniformly perform well. Some succeeded and others failed even though most of them were trying to implement institutional reforms that were generally seen to be efficiency enhancing. In fact, in many cases of the transition economies they had been prescribed by western advisors.[5]

What are the difficulties with changing the formal institutions? Firstly, one would need to know what the relevant institutions are. The measures usually employed in the empirical literature are aggregate indices based on surveys and pundits evaluation and they can broadly be qualified into economic and political institutions[6], but do not offer a very precise strategy as to which part of the complex structure of formal institutions needs to be changed. Then, it might be advisable to copy the perceived best practice institutions of successful countries as they achieve high scores in these variables. However, this *Institutions Transplantation* has failed miserably in many instances as Mukand and Rodrik (2004) among others assess.

The New Institutional Economics (NIE) provides insights as to why formal institutions that work well in one setting lead to dismal results in others. According to Douglass North (1990, 1994) institutions are "humanly devised constraints that structure human interaction". In particular, they can be *formal constraints* such as constitutions, laws and regulations or *informal constraints* namely norms, codes of conduct, established ways of doing business and informal conflict resolution procedures. In fact, the idea that overall institutional quality depends on formal and informal institutions can be traced back to J.S. Mill (1848, pp. 135-6) who wrote that

> "much of the security of person and property in modern nations is the effect of manners and opinion [..and of] the fear of exposure rather [than] the direct operation of the law and the courts of justice"

In accordance with the definitions from the NIE, the view taken in this chapter is, that overall institutional quality is made up of the interplay of the formal institutional framework, the informal institutions prevailing in a society, and the enforcement characteristics for both. Consequently, even a well-intentioned politician cannot directly

[5] For a detailed discussion on the experience of China relative to Latin America or Russia compared to other more successful transition economies see for example Rodrik (2005).

[6] Examples for the former are security of property and constraints on the government for the latter. Hall and Jones (1999) use an aggregate index constructed of diverse entries such as law and order, bureaucratic quality risk of expropriation and government repudiation of contracts. Most other studies use similar measures.

influence the overall institutional quality. She can only change the formal institutional framework and allocate resources to the enforcement of this framework. How the informal institutions evolve over time is beyond her control. This view corresponds to the observation by North (1994), that

> "Developing norms of behavior that will support and legitimize new [formal] rules is a lengthy, incremental process . [...] economies that adopt the formal rules of another economy will have very different performance characteristics than the first economy because of different informal norms [..]. The implication is that transferring the formal political and economic rules of successful Western economies to third-world and Eastern European economies is not a sufficient condition for good economic performance."

The formal institutions can virtually be changed overnight by a determined politician, in theory at no cost -except for the paper and ink that these rules are written down with- while the informal institutions evolve gradually if agents choose to alter them.[7] Many authors consequently argue along these lines that institutions transplantation may well fail, because the imposed formal framework is not supported by the prevailing informal one.[8]

An open question is, why people would not adapt their informal institutions, given that it would yield economic benefits. Simply stating that the new formal institutions do not match well with the prevailing informal ones does not seem an adequate explanation of why institutions transplantation fails for all cases: Why does it fail in some countries but not in others? Why do some countries manage to improve their economic conditions only after a transition period?

At the heart of an explanation to these questions must lie, that in some countries people choose to adjust their informal institutions and in others they do not. In other words, to be fair to the proponents of institutions transplantation and *shock therapy*,[9] one should analyze the incentives of the agents to change their informal institutions.

[7] A similar view is put forward by Roland (2004) who distinguishes slow moving and fast moving institutions.

[8] Cf. North (1990, 1994), Rapaczynski (1996) Roland (2004), Greif (1998) and Landes (1990). Djankov et al. (2003) explicitly state: "A key reason for institutional inefficiency is the transplantation of institutions [..]." Mukand and Rodrik (2004): "[formal] Institutional solutions that perform well in one setting may be inappropriate in other settings without the supporting norms and complementary institutions."

[9] Doing as much institutional reform as fast as possible. For a discussion and an overview of the literature see Rodrik (1993)

Only if one can give compelling reasons why individuals may fail to adapt to the new circumstances, the conclusion that transplanting institutions will fail, even in the long run, is justified.[10]

The present chapter tries to fill that gap and to give reasons, why people might not adapt their informal institutions. This is achieved without recurring to assumptions about heterogenous agents or uncertainty. Instead, a notion that is well established in a different strand of literature is employed: contributions on the evolution of (social) norms stress the importance of social interactions and dependence on others' actions in the process of establishing new informal institutions that are generally accepted.[11]

A further notion about informal institutions, that has already been alluded to, is that they are highly context specific: their value and their quality relate to a specific set of formal institutions, the one they were adapted to. One should not imagine institutions as being a quantitative measure, but a *qualitative* one. The indices observed in the empirical data are assessments of this overall institutional quality by experts or business people.

The government has the power over the legal/constitutional sphere, while economic agents have the possibility to build up new informal institutions to improve overall institutional quality, which should be rewarded by higher economic payoffs. When the government changes the formal institutions, part of the informal institutions loose their value, because they were tailor-made for the old formal setup. Furthermore, people need to learn about how the new institutions work and what organizational adaptions are necessary, in order to make most of the new framework. This is modeled by a loss of value of informal institutional quality proportional to the change in formal institutions as the new 'vintage' of formal institutions is introduced. The economic agents then have to decide whether to adapt their informal institutions, which is a lengthy, costly process.

In order to think about the problem within a clear structure, the following case will be argued upon: The government has a once in a lifetime chance to alter the formal institutional framework (or is forced to do so from the outside by some international entity that conditions lending on large scale reforms) and can only decide on the en-

[10] In fact, Roland (2004) argues that "trying to impose Western fast-moving institutions adequate to the West's own slow-moving institutions in countries with a very different history and culture is not likely to meet the same economic success". Which immediately leads to the question of why the slow-moving institutions should not move (slowly) in the right direction in order to meet this success.

[11] Lindbeck, Nyberg and Weibull (1999) write: "[..] is a social norm. [..] the larger the population share adhering to that norm, the more intensely it is felt by the individual."

forcement measures thereafter. The change leads to an instant (discontinuous) loss of value of the informal institutions. This discrete change in the informal institutional quality should not be seen as a contradiction to the notion that the underlying informal institutions themselves evolve gradually and continuously over time. The idea is to assume some measure of the value of informal institutions *in the context* of a certain vintage of formal institutions. We are not looking at measures of quantity - as in models of accumulation of human and physical capital - but at the quality of institutions. The reason that this quality of the informal institutions drops discontinuously at the instant the formal ones are changed, is not that they literally depreciate, but that they have a lower value in a different formal institutional setting.

Acquiring information about the new system, changing traditional ways of doing business (because established ones may have become illegal or too costly) and building up new useful networks on the other hand is a slow and costly, continuous process. Thus, while the informal institutional quality may and will drop discontinuously, an increase can occur only gradually and continuously. Individuals will start their optimization exercise in the instance after the discrete drop has taken place. They are then faced with a given set of formal institutions and a given starting value for the quality of the informal institutions that will depend on the size and extent of the formal institutional reform. In their optimization they weight the costs and the benefits of adapting. The benefits are increased output through higher institutional quality (and thus production and consumption), while the effort people have to invest to changing the informal institutions constitute the costs.

For an individual, who for some reason is faced with a new institutional environment,[12] it will be just a question of acquiring information about and skills suitable for the new formal framework and adapting to the different norms and ways of doing business. An entire society will face a greater problem, if the legal system and other formal institutions change dramatically. Not only do its individual members have to learn how the new institutions work, but they must develop new corresponding informal institutions as well.

Following the ideas of the literature on the evolution of norms, informal institutions are seen to entail a certain public good character (if all people are law-abiding, being a thief myself will not alter the institutional quality), and exhibit externalities and network effects in their creation. The effort devoted to build up informal institutions

[12] One could imagine an immigrant or a high skilled professional who is transferred to a different country.

is not rewarded by some wage rate, but only by the higher future income generated through higher institutional efficiency. The effectiveness of increasing informal institutional quality depends on the average, social level of informal institutions in the economy, which captures the network and externality problems that are seen to be central to informal institutions.

If this dependence of the effectiveness of building up informal institutions on the average level is strong enough, it leads to multiple equilibria and a critical threshold for the size of institutional reform, beyond which the economy will degenerate to an equilibrium with extremely low overall institutional quality. This explains why large scale institutional reforms may fail, even if the agents could, in principle, adjust their informal institutions to the new formal framework.

This chapter builds on the ideas of the New Institutional Economics (cf. North, 1990, 1994, Williamson, 1985 and Olson, 1996) and tries to formally model them. It goes beyond the ideas discussed in that literature by showing how the changes of formal institutions interact with the incentives of the agents to adapt their informal ones. The explanation given for the failure of institutions transplantation in that literature has simply been the inadequateness of the transplanted formal institutions to locally prevailing informal ones. Why informal ones do not adjust does not seem to be rigorously analyzed. The present chapter fills that gap.

Other formal models have considered the importance of endogenous property rights institutions in general for economic performance. Grossman and Kim (1996) determine the security of property rights as a result of individual defense spending. Zak (2002) allows for a role of the state in protecting property. Eicher and Penalosa (2004) analyze the endogenous strength of intellectual property rights in an endogenous growth model. However, how these parameters of security of property depend on the action of the state in providing the formal rules and the individuals in creating the corresponding norms has not been the focus of these contributions.

Another strand of literature concentrates on the changes of formal institutions. Acemoglu and Robinson (2001, 2000) analyze the transition to the 'institution' of democracy. Aghion, Alesina and Trebbi (2004) determine the type of constitutions (in the narrow sense of voting rules required to block legislation) that result from agents' bargaining in the process of writing the constitution. But this literature does not concern itself with the evolution of the informal institutional arrangements.

On the other hand, the contributions on the evolution of (social) norms have focused exclusively on the informal institutions (taking the formal ones implicitly or explicitly

as given and fixed) and how they evolve in repeated games to solve coordination or cooperation problems.[13] Earlier contributions to this area model norms as imbedded in interdependent preferences: Akerlof (1980) analyzes involuntary unemployment due to norms of fair (rather than market clearing) wages and Lindbeck, Nyberg and Weibull (1999) show how living off welfare may or may not become an accepted norm.

The chapter presented here, formally models both formal and informal institutions and their interaction in a dynamic setting and derives key insights concerning their interdependencies. It demonstrates, what kind of frictions in the formation of informal institutions must exist in order to lead to a situation where agents rationally choose not to adjust their informal institutions. It also shows how the action of the state in changing the formal institutions influences people in their efforts to improve - or not - their informal ones. The government's aim should be, much as in the introductory quote of Aristotle, to optimally try to instill the formation of 'good habits', i.e. the formation of informal institutions that are in line with the formal ones to increase economic efficiency.

Similar to the present chapter in the sense of searching for optimal institutional reforms is the recent contribution by Mukand and Rodrik (2004): optimal policies/ institutions for a country do exist, but what will work best in the local context is uncertain. Institutions transplantation yields better results the more similar the transplanting country is to a leader, who already found his optimal institutions and who is taken as a role model. Informal institutions are, however, not explicitly modeled but taken as a part of the fixed local conditions.

Francios and Zabojnik (2005) model the slow change of social capital, or trustworthiness in an evolutionary context - without explicitly considering formal institutions - and arrive at a similar conclusion of caution against rapid reform and explain why transplanting modes of production from the West may not work for some late-developing countries.

From a technical point of view the model of Azariadis and Drazen (1990) uses a similar type of externality in the context of human capital accumulation and also describes the possibility of a critical threshold level for the state variable. In an overlapping generations model, the effectiveness of a 'training technology' depends on the aggregate level of (the old generation's) human capital. In this chapter we will consider a large

[13] See for example Routledge and von Amsberg (2003) for a repeated Prisoners Dilemma, Sethi and Somanathan (1996), Young (1993) and Bendor and Swistak (2001) for evolutionary game theoretic frameworks. Schotter and Sopher (2003) provide experimental evidence that "word to mouth social learning is a strong force in the creation of social conventions".

number of identical, infinitely lived individuals. The effectiveness of building informal institutions depends on the simultaneous efforts (and thus the average or social level of informal institutional quality) of the other agents to create informal institutions.

The chapter is organized as follows: The model will be treated in reverse order in section 3.2, starting with the agent's problem in section 3.2.1, as their actions will be decisive in generating the multiple equilibria that the government has to be aware of in section 3.2.2. In section 3.3 implications of the model and empirical evidence are discussed before offering some concluding remarks in section 3.4.

3.2 The Model

The model framework presented below analyzes the case where the government has a one time chance to alter the formal institutional framework. After this ´shock´ to the institutional equilibrium, the agents decide whether and how to adjust their informal institutions. As we do not rely on assumptions of asymmetric information but allow for perfect information and foresight, the government is aware of how the agents will react to its actions and takes that into account in its optimal planning. That is why we treat the model in reverse order and start with the agents optimization problem for any given level of formal institutions and starting value of informal institutional quality in section 3.2.1. How the government influences this starting value by altering the formal institutional setting and how it should reform optimally given the agents' reactions is then laid out in section 3.2.2.

3.2.1 The Agent's Decision to Accumulate Informal Institutional Quality

The economy is populated by a large number of identical representative agents, n, who supply labor inelastically to produce output according to a standard production function:

$$Y_t = Q_t f[L]. \tag{3.1}$$

Labor productivity is thus a function of the quality of the institutional framework, Q_t, in a country. Institutions explain a large part of differences in so-called total factor productivity across countries, as pointed out by Hall and Jones (1999). Further evidence is Eicher, Penalosa and Teksoz (2005) who show that the productivity of both

physical and human capital is affected by institutional quality. Institutions are not a factor of production as capital and labor, but determine, how effectively given inputs are used.[14]

The institutional quality itself at time t, Q_t, is modeled in the spirit of the NIE as a composite of the formal and informal institutional quality and the enforcement of formal institutions F_t, I_t and M_t respectively:[15] $Q_t = Q[M_t, F_t, I_t]$ with $\frac{\delta Q}{\delta I} = Q_I > 0$, $\frac{\delta^2 Q}{\delta I^2} = Q_{II} \leq 0$, Q_{IF} and $Q_{FI} > 0$, $Q_M > 0$, $Q_{MM} < 0$ and a lower bound, $Q[\cdot, \cdot, 0] = \underline{q}$.

It is thus stipulated that productivity is non-zero even in the absence of any adherence to formal institutions, which may be thought of as the productivity of a hunter-gatherer. It is argued here that enforcement and formal institutions are the realm of a public entity. Agents thus take M and F as given and optimize over the level of informal institutional quality.

Utility is derived from consuming output, while expanding effort e_t to invest in informal institutions. This effort is modeled as the customary utility loss (see for example Leamer, 1999) such that overall utility is: $V = V[Q_t f[L], e_t]$, with $V_1 > 0$ and $V_2 < 0$. It is assumed that utility is additively separable in the two arguments, $V = U[Q_t f[L]] - C[e_t]$, where $U[\cdot]$, is a standard utility function with $U' > 0$ and $U'' < 0$. The standard effort cost from the efficiency wage literature is used such that: $C' > 0$ and $C'' > 0$. A similar effort cost setup is for example used by Glaeser, Laibson and Sacerdote (2002) in modelling the accumulation of social capital.

The law of motion for the informal institutions will be given by a standard accumulation function with an externality:[16]

$$\dot{I}_t = a[\widehat{I}_t]e_t - \delta I_t. \tag{3.2}$$

This stipulates that informal institutions contain an inherently social aspect. Trust or norms cannot be accumulated and established alone. So we focus on the social (average) level of informal institutions $\widehat{I}_t$, which influences the efficiency of individual

[14] Scully (1988) was among the first to explicitly formulate that efficiency hypothesis of institutional variables and test the predictions of that formulation empirically.

[15] North (1994) for example, writes: "It is the admixture of formal rules, informal norms and enforcement charactersitics that shapes economic performance." Greif (1998): "[..] a society's institutions are a complex in which informal, implicit institutional features inter-relate with formal, explicit features in creating a coherent whole."

[16] Azariadis and Drazen (1990) use a similar type of externality in the context of human capital accumulation.

accumulation of I, $a[\widehat{I}_t]$, with $a' > 0$ and $a'' < 0$, $a(0) = 0$. However, the informal institutions must also have a payoff for the individual, since otherwise no investment in them would occur. Glaeser, Laibson and Sacerdote (2002) also model social capital (which is similar to parts of our notion of informal institutions) as an individually accumulable asset. Empirically this is confirmed for example by Burt (1992) who has found among business firms in the United States that controlling for age, education and experience, employees enjoying strategic positions in networks are more highly compensated than those who are not.

The depreciation parameter δ exemplifies the notion, that without any care on part of the agents, the informal institutions may also deteriorate.[17]

Agents ignore the externality in the accumulation of I_t, but in equilibrium (after everybody chose their respective efforts) as all agents are alike, the consistency condition (Benhabib and Farmer, 1994 and Benhabib and Perli, 1994) thus implies that the individual level I_t equals the average, social level $\widehat{I}_t$ and vice versa. The problem of the individual agent at time $t = 0$ can then be stated as:[18]

$$\max_{e_t} \int_0^\infty \exp(-\rho t)(U[Q_t[F, M, I_t]f[L]] - C[e_t])dt \tag{P1}$$

$$s.t. : \quad \dot{I}_t = a[\widehat{I}]e_t - \delta I_t$$
$$I_{t=0} = I_0.$$

The current value Hamiltonian for this problem is:

$$H = U[Q_t f[L]] - C[e_t] + \lambda(a[\widehat{I}]e_t - \delta I_t),$$

where λ denotes the shadow value of an increase in I. The first-order conditions are:[19]

[17] Norms are for example viewed as the solutions to collectice action problems in repeated games. In order to maintain the Nash equilibrium over time, however, some sanctioning and monitoring of others' behavior has to take place.

[18] It would not be hard to introduce a partial externality in the institutional quality function as well (e.g.: $Q_t = Q[M, F, I_t^\gamma \widehat{I}_t^{1-\gamma}]$). This would qualitatively not change the results of the model and in fact only make the non-adjustment trap (which will be analyzed in what follows) more likely, as people have less incentives to invest in informal institution creation. Similarily, if the depreciation would depend on the aggregate instead of the individual level of I , the steady state solution (3.4) would only be altered by not having the δ in the denominator.

[19] In the following, time subscripts are dropped.

$$C'[e] = \lambda a[\widehat{I}] \quad \text{(F1)}$$
$$\rho\lambda - \dot{\lambda} = U'[Q,\cdot]Q_I - \lambda\delta \quad \text{(F2)}$$
$$\dot{I} = a[\widehat{I}]e - \delta I. \quad \text{(F3)}$$

The usual transversality condition also applies. The first condition is a static optimality condition, which states, that the marginal costs of applying more effort to informal institution formation $C'[e]$, have to just equal the marginal benefits $\lambda a[\widehat{I}]$. This expresses the effectiveness of the effort in informal institution building weighted with the shadow value. The higher that shadow value is, the more effort will be devoted to informal institution building. The individual effort will depend on the average level of I_t, as will the individual success in improving informal institutions. The lower the average level, the less effort an individual will invest.

The second first-order condition governs how the shadow value evolves over time: using the condition (F1) it can be nicely interpreted in terms of the marginal benefit of having an additional unit of I, $U'[Q,\cdot]Q_I$, which increases production and thus consumption. Reformulating the second condition to: $\widehat{\lambda} = \frac{d\lambda}{dt}/\lambda = (\rho+\delta) - \frac{U'[Q,\cdot]Q_I}{C'}a[\widehat{I}]$, it states that λ will increase (and hence lead agents to devote more effort to informal institutions formation) whenever the marginal benefit of an additional unit of I in production (discounted by the depreciation and discount factor) is higher than the marginal cost of providing that additional unit, $\frac{C'}{a[\widehat{I}]}$, and decrease otherwise. It will remain constant whenever these two values are just equal, which will constitute a steady state condition for the problem.

Replacing the control variable e in (F3) with the value that may be obtained from (F1), rearranging (F2) and imposing the equilibrium condition that $I = \widehat{I}$, one can derive the steady state solutions to Problem (P1):

$$\lambda_{|\dot{I}=0} = \frac{\delta I}{a[I]C'^{-1}(\lambda a[I])} \quad (3.3)$$
$$\lambda_{|\dot{\lambda}=0} = \frac{U'[Q,\cdot]Q_I}{(\rho+\delta)}. \quad (3.4)$$

We are interested in examining the dynamic evolution of informal institutions in the phase space for I and λ. Two cases can be distinguished, depending on the relative

magnitudes of the elasticities of the effort cost and informal institution accumulation function in equation (3.3). In equation (3.4), λ is clearly decreasing in I and crosses the vertical axis at $\frac{U'[f[L],\underline{q}]Q_I[\underline{q}]}{(\rho+\delta)}$. The shape of (3.3) will be a decreasing function in I and approach the axis asymptotically, if the elasticity of $a[\cdot]$ with respect to I, $\eta_{a,I}$, is sufficiently large relative to that of $C[\cdot]$ with respect to $e, \eta_{C,e}$, in short if $\eta_{a,I} > 1-\frac{1}{\eta_{C,e}}$. It will be increasing otherwise.

The economy will exhibit a unique stable equilibrium in the case that one curve is upward- and the other one downward-sloping (i.e. the elasticity of the accumulation function is sufficiently low). Any pertubation of I from the steady state will result on a stable adjustment path leading to the (new) steady state. This case occurs for example when the effectiveness of creating informal institutions is independent of I (i.e. it is a constant $\bar{a}$).

The second case where both curves slope downward ($\eta_{C,e} : \eta_{a,I} > 1 - \frac{1}{\eta_{C,e}}$) is more complicated. While an explicit solution cannot be found without giving specific functional forms,[20] it is clear that 3 cases may occur: i) the two curves do not cross, the curves intersect ii) one or iii) two times (the case depicted in the Figure 3.1).[21] Only the last case corresponds to an equilibrium where positive values of informal institutional quality are sustainable, as will become clear below, when the dynamics are analyzed. A phase diagram for this case in Figure 3.1 sheds light on the dynamics and stability of the resulting steady states.

The dynamic behavior of the variables in the respective sectors of the phase diagram is unambiguous (which is shown in the appendix). This leads one to conclude that the higher steady state $\overline{E}$ will be (locally) stable, while the lower one $\underline{E}$ will be unstable. There also exists a third, degenerate steady state E_0, which is stable.[22] Stability thus establishes an informal institutional threshold $\underline{I}$. If informal institutional quality does not exceed $\underline{I}$, the value of an additional unit of informal institutions is too small to warrant personal investment to avoid depreciation and the economy degenerates to a world without informal institutions. This is comparable to the size/development threshold that has been indicated by Eicher and Penalosa (2005).

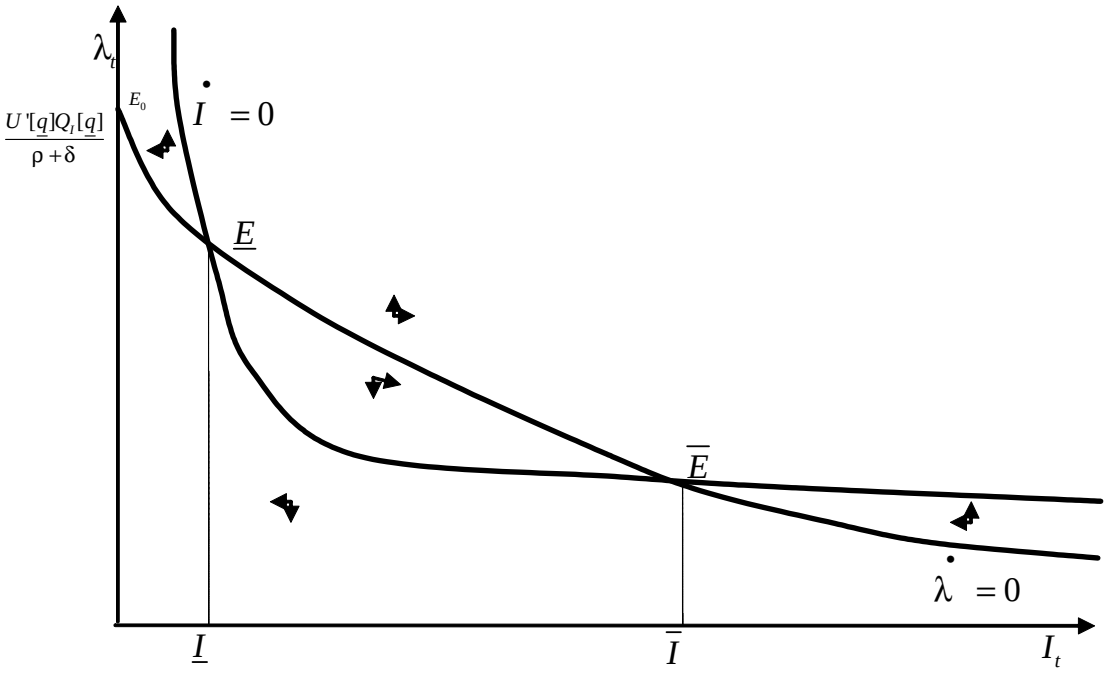
For any starting value $\underline{I} < I < \overline{I}$, the shadow value λ takes on a value on the stable adjustment path, defining a specific effort level e, that will be higher the lower the

[20] This is done in section 3.5.1 in the appendix.

[21] Theoretically, it is of course also possible that the curves are just tangent. As in the first two cases this would induce only a stable equilibrium without any informal institutional quality.

[22] An example is provided and its stability conditions are checked in the appendix section 3.5.1.

Figure 3.1
Multiple Equilibria
Critical Threshold for Informal Institutions



initial value of I, I_o, according to (F1). Then λ and the effort will gradually decrease while I asymptotically grows towards the stable steady $\overline{I}$.

Starting slightly below the critical threshold on the other hand, induces the economy to degenerate towards the equilibrium E_0. The point E_0 with zero informal institutional quality and a positive (irrelevant as $I = 0$) λ is clearly also a solution to the system constituted of equations (3.4) and (3.3). As the overall institutional quality is now at its lower bound, production does not cease but is very inefficient, since there is no trade, cooperation and division of labor possible. In this extreme scenario, agents could literally be imagined as subsistence farmers producing on a low scale by themselves and even spending resources inefficiently on defense as nobody can be trusted and property rights are not respected: a true Hobbesian anarchy. The formal institutions in place may be very sophisticated but are worthless, if nobody behaves in accordance with them. This was for example the case of Liberia until the civil war: the country shared the same formal institutions with the United States (it had the same constitution) but was submerged in total informal institutional anarchy.

Alternatively, with sufficiently large amounts of informal institutional quality, the return to personal investment in it is sufficiently large and agents will incur the effort cost until its disutility equals the return from production/consumption through higher

overall institutional quality.

Below we will continue to explore the implications of the positive valued equilibria, particularly we will analyze the government's ability to alter the formal institutions optimally, given how agents react to changes in the value of informal institutions.

These results are summarized in the following proposition:

Proposition 1 *i) If the effectiveness of building informal institutions is relatively sensitive to the aggregate level of these informal institutions ($\eta_{a,I} > 1 - \frac{1}{\eta_{C,e}}$) and an equilibrium with positive informal institutional quality exists, there will always be a critical threshold level $\underline{I}$ for this quality. Below this critical level the marginal benefit of increasing I will be so low, that it can never outweigh the marginal cost. Initial conditions below this value lead the economy to degenerate to a low institutional quality equilibrium.*

ii) if two interior equilibria for informal institutional quality exist, the higher one will always be stable and the lower one unstable

iii) If $\eta_{a,I} < 1 - \frac{1}{\eta_{C,e}}$ no such critical threshold exists and the agents would build up informal institutions up to the (unique) steady state level under any circumstances.

Proof. see Appendix. ■

Frictions in the creation of informal institutions take the form of threshold externalities in the initial level of informal institutional quality, comparable to those derived by Azariadis and Drazen (1990) in the context of human capital accumulation. Any shock that lowers this level below the critical threshold $\underline{I}$ will result in a deterioration of the conditions in the economy. Regardless of the quality of the formal institutions, the overall institutional quality Q will approach its lower limit $\underline{q}$. A brief example is provided in the appendix 3.5.1 to show that the threshold may exist for reasonable functional specifications and to derive some comparative statics. Next, the role the government may play in influencing the initial level of I and the agents' incentives by setting the formal institutional framework is analyzed.

3.2.2 Optimal Scale of Formal Institutional Reform

Having deduced how the agents behave optimally, faced with any given level of formal institutional quality F and initial informal quality I_0, we now analyze the effect of a one time formal institutional reform at the time t_0.

Changing the formal institutions comes at a cost of a loss in the effectiveness in informal institutions that had been developed to accommodate the previous formal institutional regime. Thus informal institutions are viewed to be linked to a certain vintage of formal institutions. They are highly specific to the context of the formal institutional framework. A number of authors argue along these lines and state that institutions transplantation could fail or at least need not be a sufficient condition for good economic performance, because the formal institutions transplanted would not be in line or at odds with the prevailing informal institutions in a society.[23] Empirical evidence for this is provided by Berkowitz, Pistor and Richard (2003).

We may then conclude that the measure of the quality of the informal institutions is linked to the set of formal institutions in place. Transplanting the institutions of the United States to a third world country does not yield a measure of overall institutional efficiency comparable to that of the United States for this country. The quality of institutions has to be seen as an interaction of the formal and the informal institutions. People need to learn about what the new laws and regulations are, how they function and how to optimally do business within this new framework and develop "norms of behavior that will support and legitimize [the] new [formal] rules" (North, 1990). Djankov et al. (2003) argue that the location of their 'institutional possibility frontier depends on the amount of 'civic capital' of a society: by increasing that capital (which is similar to our notion of informal institutions) higher institutional quality may be achieved for a given set of formal institutions.

How well the informal institutions fit the new formal ones is what we label 'informal institutional quality'. This quality may change because the agents choose to alter (slowly improve) the informal institutions or because the government changes the formal institutional framework and thus drives a wedge between the two types of institutions. This wedge or the loss in informal institutional value is modeled as a function of the difference of the old an the new formal institutions.

To be able to analyze the problem at hand, it is assumed that these different 'vintages' of formal institutions can be ordinally ranked according to their quality in relation to economic performance such that each $F_i \in [0, 1]$. For example, La Porta et al. (1998) argue that different qualities of formal legal rules regarding investor and creditor protection exists, but that their enforcement (what we would label overall institutional quality, as they use empirical measures of overall institutional quality to

[23] Cf. North (1990, 1994), Mukand and Rodrik (2004), Rapaczynski (1996) Roland (2004) and Landes (1990).

proxy for that) differs from country to country.

Without loss of generality the highest possible value of F is normalized to 1. As the empirical data implies some maximum level for Q (even though there might be some measurement problem due to the design of the surveys used to obtain the empirical measures of institutional quality) and since we consider it as a scale factor in production, it seems natural to assume some bound on F. Given that there are steady state solutions to I, this will impose an upper bound on Q.

It is not meant to state that different formal institutional arrangements could not have very similar values (the Anglo-Saxon case-law system and the German civic law are both seen to be relatively effective in enforcing property rights, for example), in fact an extension of the model would implicate to try to find the formal setup that yields the highest quality score, while being most closely in line with the prevailing informal institutions. Section 3.3 discusses this issue further.

As the government decides at $t = 0$ to improve the formal institutional quality by $\Delta F \equiv F_j - F_i > 0$, it is thus implied that the measure of informal institutional quality also changes to $I_j < I_i$ as it is specific to the context of the old formal institutions. It will be lower because the informal institutions that fitted vintage i will be less fitting for vintage j. The resulting new measure of informal institutional quality at time t_0, I_{j,t_0}, will only be a fraction $\alpha < 1$ of the original informal quality. This fraction will be decreasing in the relative change of F, $\frac{F_j}{F_i}$, because the more different the new formal institutions are the less fitting the informal ones would be as pointed out above. Accordingly, $\alpha = \alpha[F_j, F_i]$ with $\alpha(j = i) = 1$ and $\alpha_{F_j} < 0,\ \alpha_{F_i} > 0$. The resulting new informal institutional quality at time t_0 (and thus the decisive initial value of I in the agents' optimization problem P1) would be:[24]

$$I_{j,t_0} = \alpha[F_j, F_i] I_{i,t_0}. \tag{3.5}$$

It is here, that the connection between the government's actions and the incentives for the agents is made. On the one hand, a higher value of F should lead agents to devote more effort to improving informal institutions, because by doing so they can increase future productivity. On the other hand, a greater change in F also leads to a greater disruption of the institutional equilibrium, lowering the efficiency of the

[24] It is assumed that only reforms that increase at least the formal institutional quality are undertaken.

informal institutional accumulation. If this effect is strong enough, agents might not find it optimal to adjust the informal institutions to a new formal framework because the critical threshold level in informal institutional quality is passed.

The new overall institutional quality on impact of the reform is defined as:

$$Q_{j,t_0} = Q_j[M, F_j, \alpha[F_j, F_i]I_{i,t_0}], \tag{3.6}$$

where enforcement M is considered to be fixed for now (implications of M will be discussed below in section 3.2.2). This new value of overall institutional quality may well be lower than the value prior to reform. As it is often argued that some reforms require sacrifices before things improve, we will give the following definition:

Definition 1 *Reforms are* painful*, that is lower the overall institutional quality initially, such that* $\frac{dQ}{dF} < \frac{dQ}{dI}\frac{d\alpha[F_j,F_i]}{dF_J}$*, and thus have an output cost, i.e.* $Q_{j,t_0} - Q_i < 0$ *.*

Generally Q depends positively on F . However, changing F by ΔF also lowers I - which will have a negative influence on Q - initially. The overall change in Q depends on which effect dominates. In what follows we will generally assume that the above definition holds.

If reforms are painful today they should yield benefits in the future, otherwise they would not be worth the sacrifice. To ensure that, the following is defined:

Definition 2 *Reforms are potentially beneficial, that is a new stable steady state of* $I_j > 0$ *is higher than the old value* I_{i,t_0}*.*

Remark 1 *Generally it is assumed that the system has been in a stable steady state with some positive value of I prior to reform. A condition that ensures that the above definition is met for any values of F and I , regardless of whether there is a unique steady state or multiple equilibria, is that* $-\frac{U''}{U'} < \frac{Q_{IF}}{Q_I Q_F}$*. Since only the* $\dot{\lambda} = 0$*-schedule depends on F, this condition requires that this schedule is shifted up for any positive value of I in Figure 1. In the case of multiple equilibria this also has the nice side-effect of guaranteeing that reforms are doubly beneficial in the sense that they increase the new stable steady state, while they decrease the unstable one and thus the critical threshold.*[25]

[25] Consider the general class of CES utilitiy functions with parameter of intertemporal substitutability θ, and a Cobb-Douglass class of institutional quality functions: $Q = \underline{q} + F^{\chi}I^{\omega}$. It can easily be

As we assume that the reform increases the formal institutional quality this ensures that a reform has the potential of increasing welfare by increasing overall institutional efficiency. In fact, if reforms are not painful, any reform that is potentially beneficial will unambiguously increase welfare (provided the new stable steady state is reached). If reforms are painful, a trade-off between output losses for some time versus future output gains has to be considered. As we are concerned with the question of why reforms that ex-ante were seen to be efficiency enhancing fail, we will focus on the case of potentially beneficial reforms in the following.

Now the behavior of a benevolent government /central planer may be analyzed. It would choose the size of reform $\Delta F = F_j - F_i$ (which is equivalent to choosing the new formal institutional set F_j, as F_i is given) so as to maximize the present value of individual utilities:

$$\max_{F_j} V_j^{PV} = \int_0^{\infty} \exp(-\rho t)(U[Q[F_j, F_i, I_{t,j}^*]f[L]] - C[e_t^*])dt \tag{3.7}$$

Under perfect information, the government is aware of how the agents will change I and e, i.e. the times paths $I_{j,t}^*$ and $e_{t,j}^*$ for any given reform j are known to it. Then, the integral V_j^{PV} has a fixed value for any reform, j, that depends on the size of the reform $\Delta F_{(j)}$, since $I_{t,j}^*$ depends on I_{j,t_0}, according to the solutions to problem (P1). It is important to stress that this fixed value not only depends on F_j but also on F_i, or the size of reform $\Delta F_{(j)} = F_j - F_i$, as the old equilibrium value of informal institutions I_{i,t_0} depended on F_i, and the disparagement parameter α depends positively on the old formal institutions and negatively on the new ones.[26]

$$V_j^{PV} = G[\Delta F_{(j)}, \rho] \tag{3.8}$$

By choosing a reform j, the government changes the formal institutional framework and lowers the value of the informal institutional quality, both of which have an effect on the agents' choices about how much effort to invest into creating the informal institutions. The higher F alone would incentivize the agents to invest more effort in institution-building because the return is increased. A potentially beneficial reform would generally rotate the $\dot{\lambda} = 0$ schedule up and to the right in Figure 3.1. This

shown that a sufficient condition for this outward shift is $\theta \leq 1$. The exact condition for a positive reaction is: $\theta \leq 1 + \frac{q}{F^{\chi} I^{\omega}}$. This also shows that for some high values of I and F, a negative reaction would be possible if θ is larger than 1.

[26] Recall that we assumed that the system has been in a stable 'institutional equilibrium' prior to reform.

would result in a stable adjustment path to the new higher steady state equilibrium of I implied by a beneficial reform. On the other hand the change in F also affects the initial value of informal institutional quality, which is lowered by $\alpha[F_j, F_i]$. This means that more adjustment would be necessary to reach the new steady state. Since reforms are painful, an adjustment phase with output losses would need to be incurred. In case that the critical threshold exists it also means a bigger reform increases the chances of lowering the initial value of I by too much.

Formal Institutional Reform with a Unique, Stable Equilibrium

For clarity, first consider the case with only one stable steady state described in the third part of proposition 1: According to definitions 1 and 2 when reforms are painful but potentially beneficial in the long run Q can drop substantially during the initial stages of reform for large changes in formal institutions, as happened, for example, in the transition countries.[27]

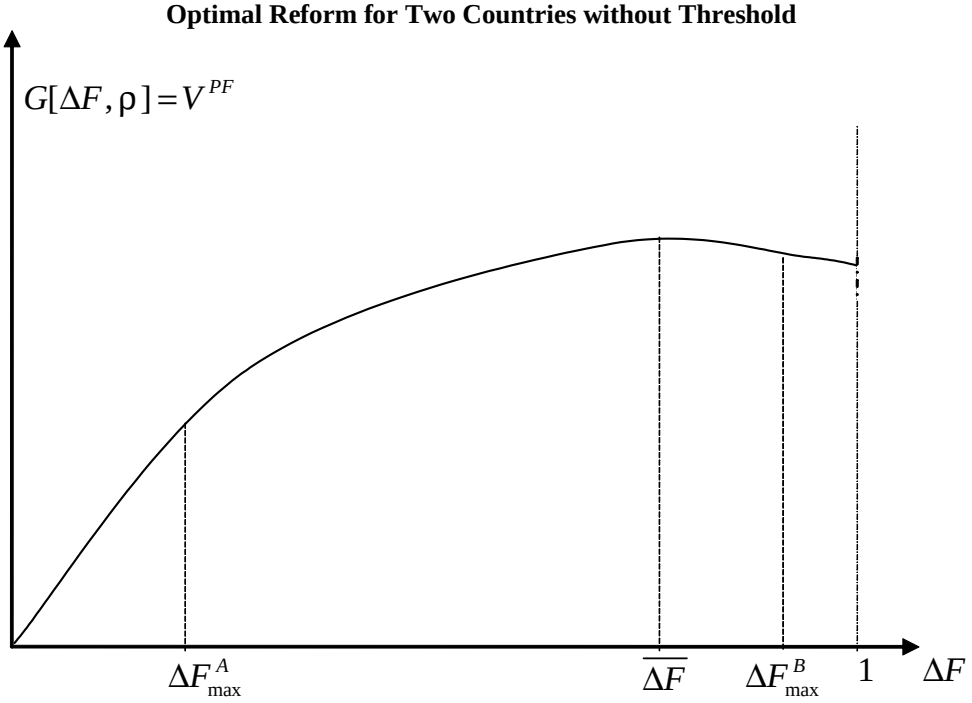
Comparing the present value of different sizes of reforms $\Delta F_{(j)}$, if discounting is high enough, the function G in equation (3.8) will be concave and attain a maximum for some value $\overline{\Delta F}$. For very large changes in formal institutions a reform that does not lower the productivity quite as much might yield a higher present value. This is illustrated graphically in Figure 3.2 where the present value for all possible different sizes of reforms of formal institutions is depicted. The maximum possible change in formal institutions is equal to one for a country that starts with no formal institutional quality.

Two exemplary countries are considered in Figure 3.2: Country A is already endowed with a relatively high quality of formal institutions such that the maximum possible change $\Delta F^A_{\max}$ is small and would optimally be implemented. Country B - with very low initial formal institutional quality - would undergo a very painful initial period if it tried to attain the maximum possible level of formal institutions by choosing $\Delta F^B_{\max}$. Indeed it would be optimal to choose a smaller reform $\overline{\Delta F}$ which maximizes the present value of individual utilities.

In general, for countries whose maximum scale of reform $\Delta F_{\max}$ lies to the left of that value it is optimal to choose the maximum. For countries with relatively low

[27] Obviously, if reforms were not painful and potentially beneficial, then it is optimal to implement a reform that yields the maximum level of formal institutional quality which is 1: $\Delta F_{\max} = (1 - F_i)$.

Figure 3.2
Optimal Reform for Two Countries without Threshold



values of formal institutional quality the interior solution to the problem, $\overline{\Delta F_{(j)}} < F'_{\max}$ is the optimum.

Proposition 2 *For the case of a unique stable equilibrium in informal institutional quality and under definitions 1 and 2 it need not necessarily be socially optimal to transplant the perceived best practice formal institutions to a country, if discounting is sufficiently high and its initial level of formal institutions sufficiently low.*

Proof. *see Appendix.* ■

Even though the largest possible reform in the case of a unique steady state may not be socially optimal this reform will still in the end reach a higher level of overall institutional quality and higher output. The only reason that large scale reforms show bad results in this case could be, that the reforms were large indeed, lowered overall institutional quality substantially and that one has not yet passed the point in time at which informal institutions have build up sufficiently in order to yield higher output. Before turning to the more interesting case with the critical threshold in informal institutions, one might consider a digression that pertains to the political economy of institutional change and why it does not take place on the needed scale so often. With

the results derived so far, in the case of painful reforms, this would be obvious for the case of a politician who has a relatively short time horizon, e.g. until the next election. If output is lower on election day, than it would have been in the absence of reform, that would probably lower her chances of reelection, which in turn would lead her to pursue only small scale reforms that yield immediate benefits.[28]

Optimal Formal Institutional Reform in a World of Multiple Equilibria

Bearing in mind, that the initial value of I_t in the agent's optimization problem depends on the scale of the formal institutional reform ΔF according to (3.5) matters are more delicate in this case. Assuming that the country is in the stable, high steady state $\overline{I_i}$ prior to reform (see Figure 3.1), the task for the government again is to maximize (3.7), however, the function $G(\Delta F)$ now would have a discontinuous downward jump at a critical level of $\widetilde{\Delta F} = (\widetilde{F_j} - F_i)$, that pushes the starting value of the informal institutional quality $I_{0,j}$ in the agent's optimization problem below the critical threshold of $\underline{I_j}$. The discounted present value of the reform would be negative for sizes of reforms greater than that critical threshold, because a painful reform lowers the initial institutional quality and thus consumption and production. That quality would then decrease even further over time as we would move toward the degenerate equilibrium until $Q = \underline{q}$. The government's problem can now be viewed as being subject to the constraint that that threshold level is not passed by the introduction of the new vintage F_j (if one wants to avoid a long run outcome with the lowest possible institutional quality $\underline{q}$)[29]:

$$I_{j,t=0} = \overline{I_i}\alpha[F_j, F_i] > \underline{I_j}[F_j, ...] \tag{3.9}$$

The interpretation of the constraint is simple: starting from a stable institutional quality equilibrium $\overline{I_i}$ prior to reform, we know that a reform will lower the starting value of $I_{t,j}$ in the agent's optimization problem (P1) according to (3.5). This is stated in the LHS of the constraint. The RHS is just the critical threshold level of I in the context of the new formal institutional vintage j. It is the new unstable steady state $\underline{I_j}$, which will depend on the new formal institutional framework F_j and the parameters of the model. This constraint implicitly defines a critical value for F_j.

[28] More sophisticated political economy models like Fernandez and Rodrik (1991) explain the fact that potentially beneficial reforms are not implemented with ex-ante uncertainties about the distribution of losses and gains from the reform which leads them to be blocked ex-ante, even though they would have benefitted a majority of the population ex-post.

[29] Of course this constraint is implicitly contained in the maximization of V_j^{PV} but we want to analyze it explicitly. The function $G(\Delta F)$ would also not be continous in F_j anymore.

If we define the function $\Psi = \overline{I_i}[F_i, ..]\alpha[F_j, F_i] - \underline{I_j}[F_j, ...] = \Psi[F_j, F_i]$, that depends on F_j, F_i and the parameters of the model, we can conclude that the constraint will be binding over some range if Ψ is decreasing in F_j and crosses the horizontal axis at some point to the left of the maximum value of F, which is normalized to one (i.e. turns negative for some feasible value of F).

Proposition 3 *For the case of multiple equilibria in informal institutional quality, if* $\exists\ \widetilde{F}_j$, *such that* $\Psi(\ \widetilde{F}_j, \widetilde{F}_i) = 0$ *for some* $\widetilde{F}_i \in [0,\ \widetilde{F}_j[$ *and* $\frac{d\Psi}{dF_j} < 0$ *for* $F_j < \widetilde{F}_j$ *then the economy will degenerate to the no informal institutional quality equilibrium if a reform* $F_j \geq \widetilde{F}_j$ *is implemented in an economy that has an initial value of* F *below* $\widetilde{F}_i$.

Proof. *see Appendix.* ■

This result describes under which conditions the economy may become trapped in a situation where agents do not find it worthwhile to adapt their informal institutions. It combines the idea on what incentives the agents have to devote effort to changing these norms (evident in the different steady state values of I and the different adjustment dynamics toward them) with the effect the government's actions have on these incentives. By choosing the size of reform the state influences the initial conditions via the parameter of the loss of value of informal institutions α. Given that the quality of informal institutions are context-specific and that there is a friction in their creation, changing the formal framework by too much leads to a too large disparagement of the informal quality.

This in turn has adverse effects on the agents incentives to adapt these informal institutions: the lower their average level the less it pays to devote effort to increase that level. The agents, when optimizing, do not take into account the positive effect that effort would have on the effectiveness of building informal institutions (the externality in the accumulation function) and therefore, a too large disruption of the institutional equilibrium might lead to dismal outcomes, because the necessary adaption of the informal institutions does not take place.

The government does not only set the formal institutions but also controls their level of enforcement M_t , which has been assumed constant so far. Clearly, for the case of a critical threshold, M is a shift parameter of equation (3.4) as Q depends positively on it. Increasing M_t could thus help to overcome the critical threshold as it would shift the $\dot{\lambda} = 0$ schedule downwards. However, if enforcement has to be paid by a balanced budget condition, enforcement spending could not be increased as reforms are painful and output initially drops after a reform. At the same time, since enforcement is a

substitute to informal institutions in the institutional production function Q, incentives for the agents to build up informal institutional quality are decreased. This is obvious from a lower stable steady state that would result in Figure 3.1 if the $\dot{\lambda} = 0$ curve is shifted down. Thus, only if enforcement could be debt financed might it be of help to overcome the critical threshold in informal institutional quality implied by the critical value of the size of formal reform $\widetilde{\Delta F}$ (this issue is discussed further in section 3.5.1 in the appendix).

If the function $G(\Delta F)$ attains a maximum value $\overline{\Delta F}'$ before reaching that critical value $\widetilde{\Delta F} = (\widetilde{F_j} - \widetilde{F_i})$, for which the constraint (3.9) is just violated, $\overline{\Delta F}'$ is the optimal scale of reform (Or the maximum possible level, if that is smaller. The discussion in this case would be analogous to that in section 3.2.2).

More interesting is of course the case where the externalities are very important and pronounced or discounting is relatively low such that the function $G(\Delta F)$ is strictly increasing up to the critical value of formal reform $\widetilde{\Delta F}$, such that $\widetilde{\Delta F}$ is reached before the (unconstrained) function $G(\Delta F)$ attains its maximum $\overline{\Delta F}'$: now the government might be severely limited in the set of choices, optimal being the one that is just below $\widetilde{\Delta F}$, such that the starting value of I is just above the critical threshold.

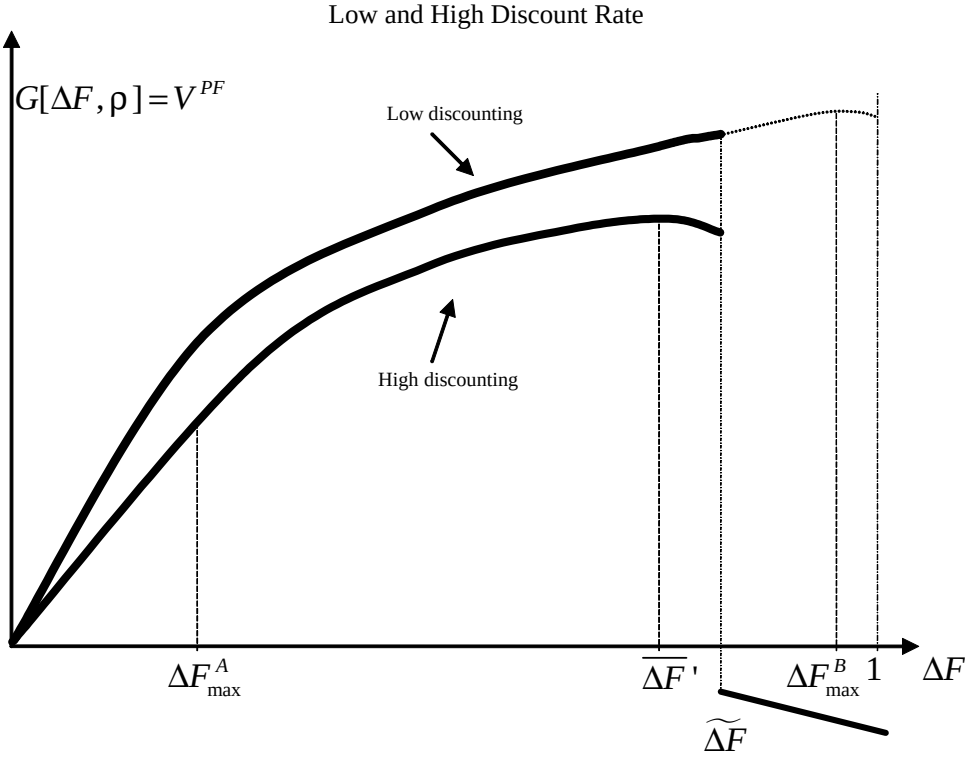
This is shown in a stylized way in Figure 3.3 and summarized in a last proposition. In the Figure, it is assumed that the critical value is the same for two different discount rates, which of course need not be the case. The basic insights are of course correct.

Proposition 4 *If a critical threshold for the size of reform exists, it is optimal to choose a reform that is just infinitely smaller than the threshold itself if the present value of reforms is strictly increasing up to that threshold.*

Proof. This follows immediatly from the previous propositions and can be seen in Figure 3.3. ■

Given that the government has only a one time chance to increase institutional quality, one should try to get as much as possible done without passing the critical threshold. There are reasons for concern, however: A major reform that lowers I_t below the critical threshold $\underline{I}$ will result in a deterioration of the conditions of the economy. While the formal institutions may now be very close to the assumed best practices for economic development, the outcome will be dismal, because the build-up of informal institutions that support this framework does not take place. This may explain why comprehensive Washington Consensus style reforms and institutions

Figure 3.3
Optimal Reform for Two Countries with Threshold –
Low and High Discount Rate



transplantations did not yield the expected benefits (in some cases) even though the formal institutional frameworks put in place were generally seen as efficiency enhancing, while small scale reforms did produce good results, as in China for example.[30] The large reforms opened up a very big gap between the formal and informal institutions that would not be closed due to the threshold externality in the formation of the latter, i.e. the informal institutional quality was pushed below the critical level. Further implications are discussed in the next section.

3.3 Implications and Evidence

Given the uncertainties about the formation of institutions and the length of the process, deciding on the optimal value of reform that lies just above the critical threshold is a delicate choice, where miscalculations may have devastating consequences: Big

[30] A point stressed by Mukand and Rodrik (2004) among others.

failures in large scale institutional reform may be due to the fact that politicians truly trying their best were just slightly off, or simply did not have the problems of externalities and the resulting multiple equilibria in mind. Of course a third reason might be that they were not genuinely trying as is explained by political economy models. As unfortunately in some cases the statement by Jeffrey Frankel (1995, p. 36)) that *"Authoritarians frequently meet neither of the two criteria one wants from a philosopher king: being well informed and being well intentioned"* is also true for politicians, it is left to the reader to decide which of the three is the real cause of failure.

However, his model can explain why the knowledge problem for the politicians may be particularly relevant: in order to calculate the exact critical value for the size of reform we need to assume some specific functional forms as is done in an example in the appendix. Even then, this does not lead to a direct policy recommendation such as take the specific set of formal institutions of country X and transplant them to country Y, as there is no one to one mapping of the values of the formal institutions to actual institutional frameworks in reality. However, the model offers an additional argument (Dewatripont and Roland, 1995 argue for gradualism in the design of large scale reforms for similar reasons: payoffs of reforms are uncertain and reversal is costly) for a cautious approach to large scale reforms, since there is the critical threshold and passing it would be a catastrophe. On the other hand, as the chance for reform occurs only ones one should try to get as much as possible done.

The model shows how frictions in the formation of informal institutions that need to underlie and legitimize the formal institutional framework may lead to failures in attempts at large scale institutions transplantations in some cases, while in others, where the initial level of formal institutions is a little higher (which would mean that they are more similar to the country one is copying from) they might succeed. Empirical support for that result can be found in a recent paper by Berkowitz, Pistor and Richard (2003) who analyze how transplanting the legal systems from 10 stipulated 'origin' countries to 39 'transplant' countries affects the observed overall quality of the legal system, which they view as how effective the legal system is in securing property or investors rights, for example, and which they term 'legality'.[31] This legality variable is a subset of the institutional quality variables used in the empirical literature on institutions and economic development,[32] which depends on both formal and informal

[31] Origin countries are basically 'old' Europe and some other developed countries (the United States, Australia) for more recent transplantations. The Transplant countries is the rest of the world for which the relevantg data was available.

[32] Cf. Acemoglu, Johnson and Robinson (2001, 2002) and Hall and Jones (1999).

institutions. Berkowitz, Pistor and Richard (2003) find that countries whose populations were already familiar with the basic principles of the transplanted law (e.g.: their old laws were more similar to the transplanted law) achieve better overall institutional quality, which is in line with the implications of the model presented here. In fact, given that the threshold exists for some countries with very low initial values of formal institutional quality we found it advisable not to transplant the perceived best practice formal institutions but a set that would have a lower value of formal institutional quality. This would of course imply to copy from a country that is more similar - in our stylized model that means closer in the value of F - to the transplanting one.

Berkowitz, Pistor and Richard (2003) also show that countries that adapt the law to local conditions, in general display higher overall institutional quality. This could be explained by our model if the loss of value of the informal institutions is modeled more carefully. It should not only depend on the difference of the formal institutions, but also on the way the transplanting is done: if carried out in a adaptive way, then the fraction of informal institutional quality that is retained is higher, and the chances of passing the critical threshold are lower.

Similar arguments are put forward by Rodrik (2000) who provides empirical support for his argument that a well-designed strategy for institution building should take into account local knowledge, and should not over-emphasize best practice institutional blueprints used in developed countries at the expense of local participation and experimentation. Similar ideas are behind the ideas of "policy- or reform-ownership", which have recently been discussed in the IMF (cf. Drazen, 2002, Bourgthan and Mourmoras, 2002). Including local information in the process of selecting a formal institutional setup can help to choose one that fits best to local conditions and thus leads to the smallest loss of value in informal institutions.

One crucial problem in the above is, that one exactly needs to know the critical threshold value in choosing the optimal reform. The stylized model shows, that it may indeed exist. However, one has to assume specific functional forms in order to calculate it, such that it would be next to impossible in the actual design of reform packages to try to get as close to that value as possible and indeed very dangerous, as a miscalculation may have dire consequences. If uncertainty about the size of the threshold plays a role, a conservative approach should be in order: better a reform that is a little to small, than one that leads to the degenerate equilibrium.

Due to the setup of the model that allows for only one institutional reform in order to keep it tractable, one cannot apply it directly to the gradualism vs. 'shock therapy'

debate. If one would assume that reforms can be split up into subsets and that the adjustment to the steady state is not influenced by the agents' knowing that accumulated informal 'institutional capital' will lose value again in the future,[33] on could in principle always reach the highest (or socially desired) level of overall institutional quality by a suitable gradualist approach, that circumvents the dangers of the no-adjustment trap. A similar reasoning against rapid reforms is contained in the model of Francios and Zabojnik (2005) due to the slow evolution of social capital. One should be aware of politico-economic constraints that might keep future reforms from being implemented, however.[34]

As the formation of informal institutions was seen to display externalities and in the process of finding and creating new norms and ways of doing business and coordination might be a problem, there could also be a role for the state in trying to coordinate behavior, for example through informational campaigns. In fact, even private enterprises are trying to influence the public to adhere to certain formal rules. For example, record companies are running campaigns reminding people that downloading music files from the internet is illegal. If these campaigns have to be financed by a balanced budget, unfortunately the same caveat applies, that is discussed regarding enforcement in section 3.2.2 and in the example in the appendix: Initially painful reforms in fact lower the funds available for such measures. But financing both enforcement and such informational campaigns through foreign aid or credits could in principle be a way out of a no-adjustment trap.

3.4 Conclusion

In this chapter it was shown, that large scale reforms may fail, because informal institutions are context specific. This holds even if agents can adapt norms, codes of conduct etc. - which were summarized under the notion of informal institutions - after formal rules have been changed and that adaption leads to higher efficiency in production. The reason is not that agents are heterogenous or dislike changes, but that there is an effort cost involved in adapting the informal institutions to the new formal framework, which makes adjustment sluggish and the payoff to that effort depends on the average level of informal institutions. This seems a plausible assumption as network effects and

[33] See Jones and Newman (1995) for a model where this notion plays a role in the accumulation of 'information capital' that is conceptually similar to our informal institutional quality.

[34] Cf. Alesina and Drazen (1991). On the discussion of shock therapy vs gradualism compare also Dewatripont and Roland (1995) and Rodrik (1993).

coordination difficulties are generally seen to play an important role in the formation of norms.

The striking feature of the economy are threshold externalities that make adjustment an inviable alternative if the aggregate level of informal institutional quality is lowered by too much through formal institutional changes. Small and medium size reforms pose no severe problem and in fact countries that are already close to the best practice institutional possibility frontier should face no difficulties in achieving the maximum possible value of institutional quality. However, even if we make the assumption that best practice formal institutions exist,[35] it was shown, that very large scaled reforms may lead to dismal results, even in the long run, if frictions in the formation of informal institutions play an important role. This might explain several transition and institutional transplantation failures. The crux of the matter is that the optimal reform would actually in most cases be one that lowers the measure of informal institutional quality just a notch above the critical threshold level. This is a delicate choice in theory and even more so in practice as uncertainties about the exact value of the critical size of the optimal reform may play an important role. Very ambitious institutional reforms should be viewed with a cautious eye.

[35] As the proponents of institutions transplantation seem to suggest.

3.5 Appendix Chapter 3

3.5.1 An Example

In order to derive some comparative static results, it is necessary to specify functional forms to calculate the exact values of the steady states as they are the decisive factors. Consider the following simple example: Utility is of the logarithmic form: $U = \ln(Q_t f[L])$. $a = \widetilde{a}\overline{I}^{\iota}$ and $C = ce^2$. The simplest institutional function in line with our assumptions on Q is: $Q = (\underline{q} + MFI)$. The resulting non-degenerate steady state solutions then are:

$$\begin{aligned} \lambda_{|\dot{I}=0} &= \frac{2c\delta I}{\widetilde{a}^2 I_t^{2\iota}} \\ \lambda_{|\dot{\lambda}=0} &= \frac{MF}{(\rho+\delta)(\underline{q}+MFI)}, \end{aligned} \tag{3.10}$$

defining $b = \frac{\widetilde{a}^2}{2c\delta(\rho+\delta)}$, and setting $\iota = 0.75$ we have to solve the following equation: $\frac{1}{I^{0.5}} = b\frac{MF}{(\underline{q}+MFI)}$, which has two positive real solutions, if the lower bound of institutional quality is sufficiently small (in particular: $q < \frac{b^2MF}{4}$[36]):

$I_{1,2} = \frac{1/2b(bMF \pm \sqrt{b^2M^2F^2 - 4MFq}) - q}{MF}$. These are our non degenerate steady state values for I :

$$\begin{aligned} \overline{I} &= \frac{1/2b(bMF + \sqrt{b^2M^2F^2 - 4MFq}) - q}{MF} \\ \underline{I} &= \frac{1/2b(bMF - \sqrt{b^2M^2F^2 - 4MFq}) - q}{MF}. \end{aligned} \tag{3.11}$$

This example displays the nice property that the stable steady state is increasing in F, i.e. reforms are doubly beneficial in the sense of Remark 1: the long run institutional quality will certainly be increased, while the unstable one is decreasing in F , as $\frac{d\overline{I}}{dF}\frac{F}{\overline{I}} = \frac{bMF - \sqrt{MF(b^2MF-4q)}}{\sqrt{MF(b^2MF-4q)}} > 0$ and $\frac{d\underline{I}}{dF}\frac{F}{\underline{I}} = \frac{-bMF - \sqrt{MF(b^2MF-4q)}}{\sqrt{MF(b^2MF-4q)}} < 0$.

This should be good news as the critical threshold value is lowered, while the potential for increasing Q substantially is there. In the second last section of this appendix it is shown, that if α depends strongly on the difference between the old and the new formal institutions the constraint $\overline{I}_i\alpha[F_j, F_i] > \underline{I}_j[F_j,...]$ may indeed be binding

[36] This also shows that some minimum level of formal institutions is required to achieve positive values of I.

for some values of F_i and F_j, that lie sufficiently far apart (implementing large scale reforms). This would mean that the no adjustment trap can occur in this example if the initial value of F is low enough.

With these explicit solutions, we can derive comparative statics on the parameters of the model (setting $M = 1$ at the moment):

$$\frac{d(\bar{I}_i)}{db}\frac{b}{\bar{I}_i} = 2\frac{bF_i}{\sqrt{b^2F_i^2-4F_iq}} > 0 \quad \frac{d(\underline{I}_j)}{db}\frac{b}{\underline{I}_j} = -2\frac{bF_j}{\sqrt{b^2F_j^2-4F_Jq}} < 0 \ .$$

This implies that an increase in b unambiguously lowers the chances of passing the threshold. Or equivalently that the critical size of reform is higher the higher is b, as the distance between the two steady states that has to be passed in order to get below the critical value is greater, which increases the scope for reform. As b is defined as $\frac{\widetilde{a}^2}{2c\delta(\rho+\delta)}$, this means in economic terms that higher discounting and depreciation of the informal institutions increase the critical threshold. These results are intuitive as these factors lower the potential benefits of having an additional unit of I in the production as it would depreciate faster and its present discounted value would be lower. Equally intuitive is that a higher cost parameter c increases the threshold as well, while a higher efficiency of creating informal institutions $\widetilde{a}$ lowers it.

It can also easily be shown that the respective derivatives w.r.t. $\underline{q}$ have opposite signs to the ones above, which indicate that a higher 'fall back' position makes falling in the trap more likely and reduces the scope of reform.

We may also analyze the role of enforcement in this example: It is straightforward to show that the effect of enforcement on the unstable steady state is negative: $\frac{d\underline{I}}{dM}\frac{M}{\underline{I}} = \frac{-bMF-\sqrt{MF(b^2MF-4q)}}{\sqrt{MF(b^2MF-4q)}} < 0$. This means that devoting more resources to enforcement of the new formal rules after a reform could help to escape a no-adjustment trap. Unfortunately this is not true if one assumes that these enforcement measures have to be paid for out of current production via a balanced budget condition. Because reforms are painful they would lower overall institutional quality and thus production initially and thus leave less resources available for enforcement. In this simple example this can be shown by imposing a balanced budget condition on M : $M_t = \tau_t Q_t f[L]$, where τ is the tax rate on output. Then it follows that: $M_t = \frac{\tau_t \underline{q} f[L]}{1-\tau_t F I}$. For painful reforms for which the negative effect on I is initially stronger than the positive effect on F (according to the condition in definition 1) the available funding for enforcement will be lower for any level of τ.[37] One possible solution would of course be increased

[37] Compare Zak (2002, p. 63) who shows that even by optimally choosing time path of tax rates

enforcement funded by foreign aid or credits.

3.5.2 Stability in Figure 1 and the Example in Section 3.5.1

Replacing the control e in (F3) with the value that may be obtained from (F1), re-arranging (F2) and imposing the equilibrium condition that $I = \widehat{I}$, we can write the following system of canonical equations for Problem (P1):

$$\begin{aligned} \dot{I} &= a(I)C'^{-1}[\lambda a(I)] - \delta I \\ \dot{\lambda} &= (\rho + \delta)\lambda - U'(Q, \cdot)Q_I \end{aligned} \tag{3.12}$$

These canonical equations unambiguously determine the laws of motion for the problem:

$$\frac{d(\dot{I})}{d\lambda} = a(C'^{-1})' > 0 \tag{3.13}$$

as $C'' > 0$ (recall that C is monotonically increasing and convex in e) and

$$\frac{d(\dot{\lambda})}{dI} = -(U''(\cdot)Q_I) + U'(\cdot)Q_{II} > 0 \tag{3.14}$$

as U'' and $Q_{II} < 0$. This implies the laws of motions as indicated in Figure 3.1.

In the case the curves cross only once, the stable steady state $\overline{E}$, would not exist. In the case of tangency, the equilibrium in the point of tangency would also be unstable according to these laws of motion. Finally in case of an upward sloping $\dot{I}-$schedule the unique equilibrium is clearly stable.

The corresponding Jacobian of (3.12) for the example above is:

$$J = \begin{pmatrix} -\delta + 0.75\widetilde{a}^2 I^{0.5} & \frac{\widetilde{a}^2 I^{1.5}}{2c} \\ \frac{1}{(q+IF)^2} & \rho + \delta \end{pmatrix} \tag{3.15}$$

The determinant is $\det(J) = (\rho + \delta)(0.75\widetilde{a}^2 I^{0.5} - \delta) - (\frac{F}{q+IF})\frac{\widetilde{a}^2 I^2}{2c}$. It is clear that $\det(J^{E_0}) < 0$, i.e. the degenerate steady state is stable. Plugging in the steady state values for I from (3.11) and using the fact that $b = \frac{\widetilde{a}^2}{2c\delta(\rho+\delta)}$, it can also be shown that $\det(J^{\overline{E}}) < 0$ and $\det(J^{\underline{E}}) > 0$ which confirms the results from the phase diagram that the lower steady state is unstable, while the higher one is stable.

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and enforcement measures, under a balanced budget condition it is also not possible to escape the poverty trap in his model.

3.5.3 Negative Ψ for the Example of Section 3.5.1

It is left to verify for the example from above that the new value of I, $I_{i,o}$ may be lowered sufficiently to result in the no adjustment trap: for this we assume that the fraction α that defines the new informal institutional quality is a simple function of the relative change in F : $\alpha = (\frac{F_j}{F_i})^{-3}$, that is reforms are painful and set $M = 1$. For the reform j, the critical value Ψ is then defined as: $\Psi = \frac{1/2b(bF_i+\sqrt{b^2F_i^2-4F_iq})-q}{F_i}(\frac{F_j}{F_i})^{-3} - \frac{1/2b(bF_j-\sqrt{b^2F_j^2-4F_jq})-q}{F_j}$, where the first factor is the new informal institutional quality and the second is the critical threshold level, the new unstable steady state. In order to show that this value can indeed become negative that is that we run the danger of lowering the initial value of I too much, we reformulate Ψ :

$$\Psi = \frac{\left\{F_i^3b^2 - 2F_i^2q + F_i^2b\sqrt{F_i^2b^2 - 4F_iq}\right\} - \left\{F_j^3b^2 - 2F_j^2q - F_j^2b\sqrt{F_j^2b^2 - 4F_jq}\right\}}{F_j^3}.$$

The first part in accolades in the numerator depends only on the old vintage i of formal Institutions, while the second one depends only on the new vintage F_j. Both terms are increasing in the respective vintages F_i, F_j, which can be shown by calculating the elasticities of these terms w.r.t. F_i, F_j respectively and will be the case if $\underline{q}$ is sufficiently small. For the first term we get:

$$\frac{d\left\{F_i^3b^2 - 2F_i^2q + F_i^2b\sqrt{F_i^2b^2 - 4F_iq}\right\}}{dF_i}\frac{F_i}{\left\{F_i^3b^2 - 2F_i^2q + F_i^2b\sqrt{F_i^2b^2 - 4F_iq}\right\}} = \frac{bF_i + 2\sqrt{F_i^2b^2 - 4F_iq}}{\sqrt{F_i^2b^2 - 4F_iq}} > 0$$

and for the second term

$$\frac{d\left\{F_j^3b^2 - 2F_j^2q - F_j^2b\sqrt{F_j^2b^2 - 4F_jq}\right\}}{dF_j}\frac{F_j}{\left\{F_j^3b^2 - 2F_j^2q - F_j^2b\sqrt{F_j^2b^2 - 4F_jq}\right\}} = \frac{-bF_j + 2\sqrt{F_j^2b^2 - 4F_jq}}{\sqrt{F_j^2b^2 - 4F_jq}} \begin{cases} > 0 \; if \;\; b^2F_j > \frac{16}{3}q \\ < 0 \; if \;\; 4q < b^2F_j < \frac{16}{3}q \end{cases}.$$

Note that the condition on q is relatively mild as $b^2F > 4q$ is already required for existence of real solutions to our problem and it will certainly be fulfilled for high $F's$.

Hence there will be some value of the scale of reform $(F_j - F_i)$for which Ψ turns negative.

3.5.4 Proofs

Proof of Proposition1

Proof. [.] For the case of $\eta_{a,I} > 1 - \frac{1}{\eta_{C,e}}$[38] in general the existence of such a positive stable steady state would require that the system (3.3), (3.4) has a positive real solution and that from some point $\widetilde{I}$ onwards, $\left|\frac{d\left[\lambda_{|\dot{I}=0}=\frac{\delta I}{a(I)C'^{-1}[\lambda a(I)]}\right]}{dI}\right| < \left|\frac{d\left[\lambda_{|\dot{\lambda}=0}=\frac{U'(\cdot)Q_I}{(\rho+\delta)}\right]}{dI}\right|$, that is the $\dot{I} = 0-$schedule is flatter then the $\dot{\lambda} = 0-$schedule. If that was not the case, the equilibrium could not be stable, as$\frac{d(\dot{I})}{d\lambda} = a(C'^{-1})' > 0$ since $C'' > 0$ and $\frac{d(\dot{\lambda})}{dI} = -U''(\cdot)Q_I > 0$ since $U'' < 0$. However the $\lim_{I\to 0}\left|\frac{d\left[\lambda_{|\dot{I}=0}=\frac{\delta I}{a(I)C'^{-1}[\lambda a(I)]}\right]}{dI}\right| = \infty$ as $a(0) = 0$ and $a' > 0$, while $\lim_{I\to 0}\left|\frac{d\left[\lambda_{|\dot{\lambda}=0}=\frac{U'(\cdot)Q_I}{(\rho+\delta)}\right]}{dI}\right| = \left|U''(\underline{q})Q_I(\underline{q}) + U'(\underline{q})Q_{II}(\underline{q})\right| < \infty$, which shows that for some point $\widetilde{\widetilde{I}} < \widetilde{I}$ the $\dot{I} = 0-$schedule will be steeper than the $\dot{\lambda} = 0-$line, such that the two lines

will cross again, creating the unstable steady state $\underline{I}$. (the laws of motion $\frac{d(\dot{I})}{d\lambda} = a(C'^{-1})' > 0$ and $\frac{d(\dot{\lambda})}{dI} = -U''(\cdot)Q_I > 0$ imply that it is impossible that this steady state could be stable). ■

Proof of Proposition2

Proof. Given that reforms are painful an initial output loss $\Delta Y_{t=0}$ is incurred for any reform. This loss will proportional to the size of reform ΔF, as overall Productivity Q, depends negatively on it according to equation (3.6). Along the stable adjustment path agents accumulate informal institutional quality and in each instant the output loss ΔY_t is reduced. At some point $\widetilde{t}$, the initial level of Q, will be reached again and passed along the adjustment pass. From that point on the economy is reaping in the benefits ΔB_t of the reform. The total present value of the output loss is then: $\int_o^{\widetilde{t}} \Delta Y_t(\exp(-\rho t))$. The total output gains are similarily $\int_{\widetilde{t}}^{\infty} \Delta B_t(\exp(-\rho t))$.

[38]For the case of $\eta_{a,I} < 1 - \frac{1}{\eta_{C,e}}$, it is obvious that one stable steady state exists, as then we would look at a negativly sloped and a positivly sloped line, which of course will cross once and only once.

Consider 2 reforms $\widehat{j}$ and $\widehat{\widehat{j}}$, with $\Delta F_{\widehat{j}} > \Delta F_{\widehat{\widehat{j}}}$. Consequently the initial output loss for $\widehat{j}$ will be higher as will be the potential benefits, since they are more heavily discounted, however, $\exists\ \widehat{j}$ and $\widehat{\widehat{j}}$ such that $\int_{\widetilde{t}}^{\infty} \widehat{\widehat{\Delta B}}_t(\exp(-\rho t)) - \int_o^{\widetilde{t}} \widehat{\widehat{\Delta Y}}_t(\exp(-\rho t)) > \int_{\widetilde{t}}^{\infty} \widehat{\Delta B}_t(\exp(-\rho t)) - \int_o^{\widetilde{t}} \widehat{\Delta Y}_t(\exp(-\rho t))$ for a sufficiently large ρ.Which proofs that a smaller reform is preferable with discounting and very large possible changes in F. ■

Proof of Proposition 3

Proof. Technically, a potentially beneficial reform lowers the initial value of I via α, but also decreases the unstable steady state (Compare Remark 1) which makes a no-adjustment trap less likely. The condition $\frac{d\Psi}{dF_j} < 0$ in the proposition requires that the reform may lower the starting value in the optimization problem by more than the threshold is lifted. If $\frac{d(\underline{I}_j(F_j,\ldots))}{dF_j} < 0$, which corresponds to the case of potentially beneficial reforms as defined above, it is needed that: $\frac{d(\alpha[F_j,F_i]\overline{I}_i)}{dF_j} > \frac{d(\underline{I}_j(F_j,\ldots))}{dF_j}$. The first condition requires the critical value to lie within the feasible domain of $F : [0,1]$. In order to cross the critical threshold it is not only necessary that Ψ decreases in F, but it has to decrease by an amount that is bigger than the distance between the old stable steady state and the new unstable steady state, $\overline{I}_i - \underline{I}_j$. Given a very low value of F_i this would be more likely, because the size of the reform could be bigger and thus lead to a very low α (since α depends positively on the old level of institutional quality and negatively on the new one, a bigger sized reform $\Delta F = F_j - F_i$, would certainly lead to a lower value of α) and thus a very low initial value of I. A lower initial value of the formal institutional quality also goes hand in hand with a lower value of the stable informal institutional equilibrium level prior to reform, which would heighten the chances of passing the threshold for a reform that is large enough. ■

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