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Institutional Complementarities and different Paths of Economic Development

Doctoral Thesis

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Chapter 1

Outline of the Thesis

1.1 Empirial phenomenon and economic question

Despite increasing international flows of goods, ideas, finance, and persons, we observe huge and persistent cross-country differences in income per capita. Western countries, including Luxembourg, Switzerland, Norway, the United States, Denmark, Australia, Germany, Canada, and the United Kingdom, cluster at the upper end of the income per capita distribution, whereas we find many African and Asian countries, such as Burundi, Malawi, Afghanistan, Burkina Faso, Gambia, Guinea Bissau, Yemen, and Nepal, at the lower end. Within the last 50 years, little has changed in the worldwide ranking of countries in terms of income levels. What did change was the income difference between the richest and the poorest countries in the world. It became larger. In 1988, high income countries were on average 49times as rich as low income countries in terms of real income per capita. By 2018, the difference was already 59fold.

The widening of the income gap between the richest and the poorest countries in the world is contrary to the convergence theory. The convergence theory, which can be derived from the Solow-Swan growth model (Solow, 1956; Swan, 1956), has been hotly discussed among growth economists in the second half of the 20th century. Following the absolute convergence hypothesis, poor countries were expected to show higher growth rates and catch up in income levels for the two reasons that (i) diminishing returns, in particular to capital, are not as strong in poor as in rich countries, and that (ii) poor countries may replicate the production methods, technologies, and institutions of rich countries. Figure 1.1 shows the development of log real GDP per capita for different countries over the period 1968-2018.

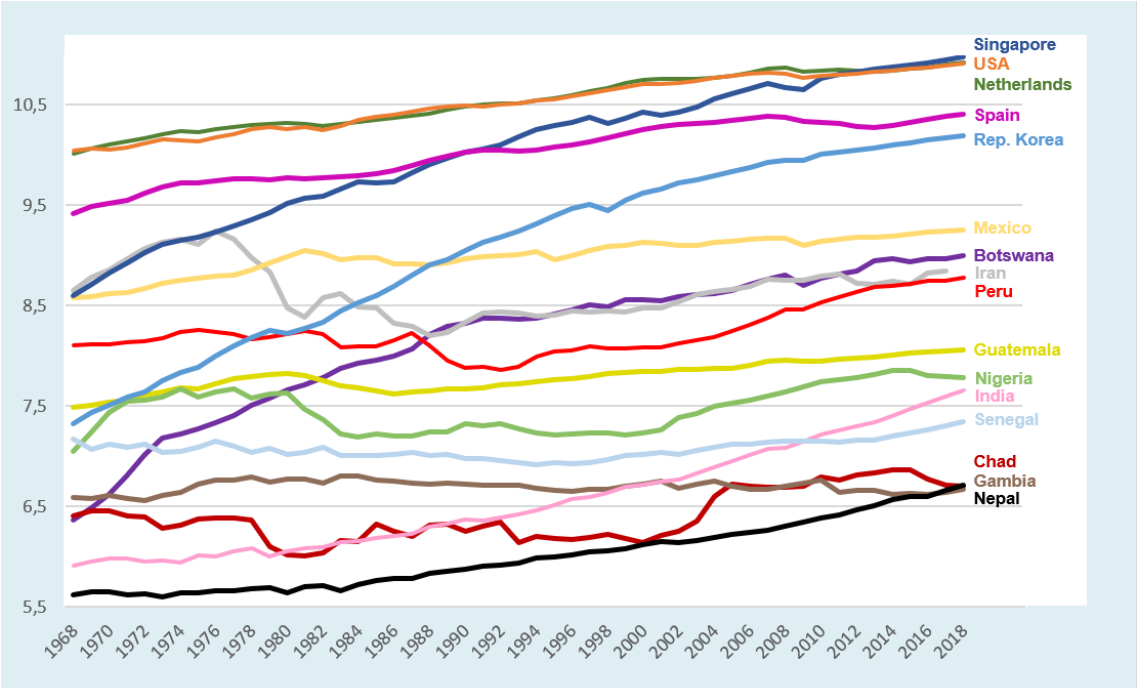

Figure 1.1: Development of log GDP per capita for different countries, 1968-2018

One can easily see that countries' growth paths differed substantially. While India and Nepal have gradually and Botswana, South Korea, and Singapore have rapidly caught up with rich countries' income levels, Sub-Saharan African countries have practically stagnated for decades and experienced relative impoverishment. Although a number of studies provide conclusive evidence against the absolute convergence hypothesis (e.g., Romer, 1986; Lucas, 1989; Barro, 1991), there is evidence in favor of a conditional convergence hypothesis (Barro and Sala-i Martin, 1992; Mankiw et al., 1992) and a club convergence hypothesis (Durlauf and Johnson, 1995; Quah, 1996; Galor, 1996). The latter two suggest that a country's income per capita converges to a long-term equilibrium level that is determined by country-specific *structural characteristics*. The more similar countries are (become) in their structural characteristics, the more similar the are (become) in their growth trajectories.

We still have no satisfactory answer to the question why the absolute convergence or "catch-up" hypothesis fails. Among potential reasons that can contribute to an explanation, two are promising in their combination: The first reason is that capital is expensive, scarce, or unavailable in poor countries. The second reason is that poor countries are less productive because they cannot adopt modern production technologies. The ability to attract capital and participate in global markets can be very

limited for poor countries, just like the ability to absorb new technologies if technologies are not freely tradeable and require capital investment. Abramovitz (1986) emphasizes the need for *social capabilities* to accumulate capital and to adopt the production technolgies used in rich countries. Social capabilities are, like structural characteristics, vague terms that may refer to a set of diverse factors. Abramovitz (1979) evaluates a country's social capabilities with its (i) available technical competences (usually measured by years of education), and its (ii) political, commercial, industrial, and financial institutions that influence the organization of firms and firms' capabilities to mobilize capital and adopt modern production techniques.

Solow (1957) introduced growth accounting to disentangle the contributions of different input factors to total GDP growth. Mankiw et al. (1992) suggested that approximately half of the observed cross-country income differences can be explained by variation in physical capital and human capital investment. The other half—the Solow residual—reflects total factor productivity and increases with the state of technology. Differences in technology concern differences in the techniques and qualities of machines used in the production process, and differences in productive efficiency that depend on how production and markets are organized. Factor inputs and technology are, however, only proximate causes of growth and, as argued by North and Thomas (1973), they are endogenous outcomes and a product of growth themselves. Growth accounting cannot explain why rich countries succeed to invest in physical capital and human capital and adopt new technologies, while poor countries fail to do so. Acemoglu et al. (2001) dig a layer deeper and point to the crucial role of institutions as a fundamental cause of growth and as a key source that drives or hampers investment and the adoption of new technology.

1.2 Fundamental causes of growth

Acemoglu et al. (2005) initiated a debate on the fundamental causes of socioeconomic (under)development and the relative importance of geographic, institutional, and cultural factors for economic growth and related macroeconomic problems. There are still vivid discussions on whether geographic and climate factors (Diamond, 1998; Gallup et al., 1999; Sachs, 2001), institutional factors (Rodrik et al., 2004; Acemoglu et al., 2005), or cultural factors (Guiso et al., 2006; Tabellini, 2010) lie at the heart of development issues. Within the last two decades, a number of studies delivered evidence that differences in national institutions can explain cross-country differences in income levels. This led to the broad agreement among economists that *institutions matter*. North (1991) defines institutions as the "rules of the games"

or the "humanly devised constraints that structure political, economic, and social interactions" that are exogenously given. Aoki (2001) proposes a game-theoretical approach that also sees institutions as the rules that structure interactions but sees the rules themselves as outcomes of these interactions, and hence, as endogenous. Both views of institutions are in line with Ostrom (1990) who proposes the design of durable cooperative institutions as an approach to resolve the problem of the commons and elaborates more thoroughly on the main tasks of institutions that are to exchange information among agents, to monitor behavior of agents, and to sanction agents if they defect the rules.

Since it was acknowledged that institutions matter, poor countries are considered to be plagued with bad institutions that distort factor allocation and the utilization of new technologies. The focus of development economics has shifted towards identifying which institutions are relevant and how they should be designed to be growth-conducive. Acemoglu and Johnson (2005) has been seminal to a stream of empirical literature that aims at isolating the macroeconomic effects of different types of institutions and assessing their relative importance. These studies, however, rely on the assumption that different types of institutions affect economic outcome independently of each other and irrespective of the country-specific environments (i.e., the structural characteristics or the social capabilities) they are embedded in. The policy implications drawn from these studies are straightforward. Rich countries constitute best practice models since they have succeeded in setting up growth-conduvice institutions. Poor countries simply have to undertake reforms until they replicate the institutional set-ups of rich countries. The recipe is easy: "Bad" institutions should be abandoned and "good" institutions should be imitated and transplanted across countries.

The strategy to replicate the economic development as experienced in Western countries in other parts of the world has had, at best, mixed results. Institutional reforms that proved to be succesfully coordinating Western economies delivered very different outcomes in non-Western economies. The structural adjustment programs implemented in many African countries in the 1970s and 1980s are just one example. The International Monetary Fund (IMF) and the World Bank provided loans to African countries under the condition that free-market policies were enforced. The reforms did not translate into any notable enhancements in the economic performance of the African countries. Implemented Western rules and practices have not been effective, at least not in the way it was hoped-for. Enhancements in outcome—if there were any at all—have not been sustainable. Reforms that proved to be a recipe for successful economic development in Western countries did fail in Africa.

1.3 Which institutions matter

By now, it has not only reached mainstream literature *that* institutions matter, there also seems to be some consensus on *which* institutions matter for economic development. The focus lies on specific sets of political and economic institutions, whereby Acemoglu and Robinson (2006, 2008) argue that economic institutions are equilibrium outcomes of political institutions. A number of economists underline the importance of the quality of governance. Kaufmann et al. (1999) measure the quality of governance alongside six different dimensions: Voice and accountability, regulatory quality, political stability and absence of violence, rule of law, government effectiveness, and control of corruption. Other economicsts, including Acemoglu and Johnson (2005) and Djankov et al. (2003), underline the importance of securing property rights institutions and enforcing private contracts for investment, trade, and ultimately, for growth.

While the existing literature provides abundant evidence for the economic relevance of a number of political and economic institutions, there is still a lot of ignorance on the relationships among institutions and the environments and contexts in which institutions work. Neoclassical growth theory and growth accounting provide little help since they miss to discuss the role of institutions completely. More helpful is a stream of literature that sees institutions effective in a system both at the micro-level (Milgrom and Roberts, 1990, 1995) and at the macro-level (Milgrom and Roberts, 1994). The Varieties of Capitalism literature initiated by Soskice and Hall (2001) and Amable (2003) succeeded to draw attention to institutional complementarities and their importance for organizing national economies. Although this literature strongly criticizes the notion that there exists one universally applicable institutional solution, it seems that this critique has not yet reached the IMF, the World Bank, and other influential international organizations that still follow a "one way fits all"-agenda of policy reforms.

1.4 Which institutions matter under which conditions

This thesis takes a necessary next step in investigating *which institutions matter in which combinations, environments, and contexts.* The Varieties of Capitalism literature constitutes a point of departure, whereby the following two insights are of

special importance: First, there exist institutional complementarities, and second, alternative institutional set-ups can likewise organize national economies.

In this thesis, I study institutional complementarities and their relevance for economic development. Recommendations for policy reforms to achieve growth may look very different from those of the IMF, the World Bank, or the European Union (EU) when one gives up the assumption of independent and universal effects of single institutions, e.g., the rule of law, and allows effects to vary with the presence, levels, and characteristics of other institutions and environmental factors. This thesis contributes to get a better understanding of the effects of single institutions in systems. I see institutions, environments, and income as endogenous outcomes of a coevolution process. The investigation of this coevolution process delivers a valuable contribution to understand the huge and persistent cross-country differences in income levels. Besides our lack of knowledge on what ultimately causes growth paths to differ across countries, we also lack in understanding why the same poliy reforms produce diverging results when carried out in different countries. Differences in environmental factors across time and space paired with complementarities and path-dependency in institution-building contribute to an explanation of both phenomena.

1.5 Contributions of the studies

In the following three chapters, I present three studies in which I analyze the relationships among (i) institutions, (ii) institutions and environments, and (iii) institutions and income in a consecutive and complementary manner. I reevaluate the economic effects of institutions that the literature has found to be important for economic development. I put the emphasis on understanding institutions as equilibrium outcomes of strategic interactions and contribute to a micro-foundation of institutional set-ups and macroeconomic outcomes. For the investigation of the different relationships, I draw on both empirical and analytical tools. I present empirical studies in Chapter 2 and Chapter 4, and introduce a theoretical framework in Chapter 3. In all three chapters, I consider the reciprocal influence of institutions, environmental factors, and income. In all three chapters, country-specific factors strongly influence institution-building, institutional change, and the economic effects thereof. In all three chapters, spatial proximity and distance play an important role to explain heterogeneity in institutions, environmental factors, and paths of economic development. I want to give a short overview of the contributions of each of the three studies:

Chapter 2 deals with the relationships among institutions and presents an empirical study on the spatial interdependencies of subnational corruption levels. The study is joint work with Stefan Borsky and motivated by the empirical phenomenon that corruption levels differ and cluster not only between but also within countries. We see the reason for this in the spatial diffusion of corruption levels via the channels of economic, political, and sociocultural exchange. Agents in strongly connected subnational regions reciprocally influence each other's beliefs, expectations, preferences, and social acceptance of corruptive activities. To study the spatial interdependencies of subnational corruption levels, we use data of a large sample of 1,232 subnational regions from 81 countries and formulate a generic spatial autoregressive model that accounts for two spatial processes: (i) spatial correlation in subnational corruption levels, and (ii) spatial correlation in idiosyncratic common features of subnational regions' environments. Our results provide answers to the following research questions: Are there spatial spillovers in subnational corruption levels? Do national borders decrease spatial spillovers? Do spatial spillovers vary with the economic, geographic, climate and natural resource characteristics of a subnational region?

Chapter 3 presents analytical considerations on all three relationships and contributes to unterstand why we are confronted with a variety of institutional set-ups that organize national economies. This study is joint work with Jörn Kleinert, motivated by the European Commission's White Paper on the future of Europe, and able to capture the empirical insights delivered by the Variety of Capitalism literature. The analytical considerations help to understand the challenges of the EU integration process, especially the diverging effects of common regulations in different member states. We provide a basis for a meaningful comparison of the five different scenarios for a future EU integration process that have been put forward by the European Commission. Methodologially, we use a supermodular game approach as proposed by Aoki (2001) that understands institutions as equilibrium outcomes of strategic interactions of agents that play games. The games are played in different domains of the society by different sets of agents in domain-specific and country-specific environments. The games are synchronically and diachronically linked via institutional complementarities.

Chapter 4 brings the analytical considerations on institutional complementarities to empirics. The study starts with a reference to Acemoglu and Johnson (2005) who evaluate the macroeconomic effects of legal property rights versus contracting institutions while relying on the assumption that these two different types of legal institutions are independently effective. In contrast to that, I argue that the

two legal institutions are effective in their combination as they provide interrelated incentives and constraints on investment in phsyical capital, human capital, and technology. After a short review of neoclassical growth theory to get a better understanding on the channels and timespans of effects, I use data of 130 countries over the period 2005–2015 to estimate the individual and interaction effects of legal property rights and contracting institutions on income per capita levels. To do this, I employ a two-step panel estimation procedure that differentiates the determinants of short-term variation in income levels from the determinants of long-term variation in income levels. I further decompose the interaction effect for groups of countries with different quality combinations of the two types of legal institutions. The hypothesis underlying this exercise is that the fit of the two different types of legal institutions matters for the size and the direction of the interaction effect. A varying interaction effect among these groups of countries would be in accordance with the analytical considerations presented in Chapter 3 and provide empirical evidence that institutions work in systems and need to be adjusted.

Chapter 2

Corruption in Space

2.1 Introduction

Corruption has a long history of being investigated in economics. Kaufmann (1997) recognizes corruption in the public sector as the greatest obstacle to development. Corruption lowers investment (Mauro, 1995) and productivity growth (Del Mar Salinas-Jimenez and Del Mar Salinas-Jimenez, 2007). It hampers the effects of industrial policies and fosters the evolution of a private sector that violates tax rules, regulatory rules, and environmental rules (Ackermann, 1999). According to the Corruption Perceptions Index published by Transparency International, corruption is still a worldwide phenomenon in 2017.[1] The majority of countries in South America, Africa, Asia, Southern and Eastern Europe are perceived to have moderate to high corruption levels.

Cross-country differences in corruption levels are explained by a number of factors including a country's level of economic development, trade openness, religious affiliation, level of education, legal origin, degree and tradition of democracy, size of public sector, and wealth in natural resources.[2] However, corruption levels differ not only between but also within countries. Mitton (2016) shows that institutional qualities can vary significantly within a country. Italy is a prominent example. Northern Italian subnational regions, such as Piedmont, Veneto, and Bolzano, are significantly below Italy's average corruption level, whereas Southern subnational regions, such as Campania, Calabria, and Sicily, show a significantly higher degree of corruption. Subnational income and size of bureaucracies (Dininio and Orttung, 2005; Belousova et al., 2011), levels of inequality and education, and wealth of natu-

[1] https://www.transparency.org/research/cpi.

[2] See La Porta et al. (1999), Paldam (2002), Persson et al. (2003), Serra (2006), Seldadyo and de Haan (2006), Treisman (2007) and Jetter and Parmeter (2018).

ral resources (Schulze et al., 2016) are factors that were found to explain differences in corruption levels among Russian regions. The level of corruption is not only heterogeneous between and within countries, it also tends to cluster in space. Becker et al. (2009), Faber and Gerritse (2012) and Jetter and Parmeter (2018) show that countries' corruption levels are characterized by a simultaneous spatial dependence. Recent empirical literature indicates that a similar spatial process works at the subnational level. Dong and Torgler (2012), Bologna (2017) and Lopez-Valcarcel et al. (2017) find spatially interdependent corruption levels of Brazilian municipalities, Spanish municipalities, and Chinese provinces, respectively. Neighboring subnational regions—like countries—tend to have similar corruption levels.

The existing literature has either investigated whether corruption spills among countries or among subnational regions within one country. In this paper, we ask whether interdependencies of corruption levels work between neighboring subnational regions in a broader geographic perspective and irrespective of their national affiliation. The assumption that spatial spillovers do not stop at national borders is plausible and has been inadequately dealt with by the existing literature due to limitations in data availability. We extend the literature by using a novel dataset collected and provided by Mitton (2016) to measure whether corruption spills at a subnational level within and across national borders. Our dataset includes subnational information on economy, geography, climate, natural resources, and institutions from a large set of countries around the world. With this data, we are able to analyze spatial spillovers among subnational regions within and across national borders. This is especially a merit in world regions that are densely nationalized and in intensive cross-border exchange. Europe is such an example where many subnational regions are located at national borders. Restricting the analysis to within-country information ignores spatial interdependencies possibly at work among a large set of subnational regions that are neighbors but belong to different countries.

The subnational regions included in our dataset are heterogeneous in their economic, sociocultural, political, and geographic characteristics. Recent literature suggests that the strength of spatial impacts is not homogenous across countries but depends on countries' absolute and relative characteristics (Kelejian et al., 2013; Borsky and Raschky, 2015). Therefore, as a second research question, we ask whether spatial interdependencies vary across different groups of subnational regions. We extend the existing literature by determining subnational regions' characteristics that drive or hamper their potential to spill in space. We base our analysis on a sample of 81 countries including 1,232 subnational regions for which we have data on the corruption levels, and a generic spatial model that accounts for the

spatial diffusion of corruption on a subnational level. In particular, our model captures two different spatial processes: (i) spatial correlation in subnational corruption levels, and (ii) spatial correlation between idiosyncratic common features of subnational regions' environments. To account for the simultaneity problem in the spatial process, we use the instrumental variable procedure of Kelejian and Prucha (1998, 1999, 2004, 2010b) and deploy spatial lags of independent variables as means of instruments for subnational regions' corruption levels.

Our results show that spatial interdependencies of subnational corruption levels exist. Among the characteristics of subnational regions, population size, land area, degree of market integration, and resource wealth have a significant effect on subnational regions' corruption levels. Further, our results imply that subnational regions are not homogenous in their degree of interdependencies. First, spillovers in corruption levels mainly take place within national borders. Second, rich regions tend to have a stronger impact on the corruption levels of others. We suppose this is due to their higher degree of economic, sociocultural, and political exchange. Third, and in line with Kelejian et al. (2013), we find that subnational regions orientate themselves towards neighbors with lower corruption levels.

The results of this study have important policy implications. Efficient anti-corruption initiatives need to consider spatial interactions and spatial heterogeneity among subnational regions. Since corruption levels are positively correlated, as suggested by literature and our results, estimates of the impacts of anti-corruption initiatives that do not take spatial interdependencies into account are downward biased. Since federal and regional budgets are constrained and widespread institutional policies may be difficult to implement, the design of economically efficient institutional development policies should consider spatial interdependencies among subnational regions. Effective initiatives to control corruption should be tailored to local circumstances and needs. Northern Italian provinces may require different measures to battle corruption than Southern Italian provinces. This is in line with a growing literature on the spatial coordination of policies. Rigg and et al. (2009) underline the importance of vertically and horizontally aligned supranational, national, and subnational policies for a balanced economic development.

In order to achieve a comprehensive strategic policy design, anti-corruption measures should be spatially differentiated. "Spatial targeting" has received much attention in the design of agri-environmental policies (Van der Horst, 2006; Gimona and van der Horst, 2007) and urban development policies (Swyngedouw et al., 2002). Spatial targeting is also promising to help designing more efficient anti-corruption policies. The spatial targeting of anti-corruption measures is of special importance

for subnational regions in which direct interventions or treatments are difficult, such as subnational regions with a low level of the rule of law or regulatory efficiency. Concentrating measures in countries' hubs could yield substantial spillover effects in corruption levels of a number of subnational regions, including those where direct measures are not applicable. Hubs are subnational regions characterized by a high degree of connectivity, such as capitals, subnational regions with highly integrated markets, or subnational regions with a specific geopolitical position.

The remaining study is organized as follows: In Section 2.2, we discuss the economic, sociocultural, and political channels that transmit corruption across space and argue why the strength of spatial interdependencies decreases with geographic distance. In Section 2.3, we present our spatial model, address identification issues, and discuss the structure of our spatial weight matrix. In Section 2.4, we provide information on the underlying dataset including descriptive statistics and a statistical examination of spatial correlation in corruption levels. In Section 2.5, we present the results for the core model, for the extended models that allow for heterogeneous spatial effects, and for a set of robustness exercises. In Section 2.6, we conclude.

2.2 Spatial process of corruption

A variety of mechanisms are at work which diffuse corruption across space (see Kelejian et al., 2013). All of them are grounded in some kind of economic, political, or sociocultural exchange that jointly contribute to subnational regions' connectivity. The strength of the diffusion depends on proximity. The closer two subnational regions are, the stronger they are connected. In the following, we elaborate on the different channels of diffusion and the role of georgaphic distance in more detail.

2.2.1 Channels of diffusion

Economic exchange happens mainly over trade in goods, services, and capital. As argued by Levchenko (2016), when viewing institutions as equilibrium outcomes, there are broadly two reasons why trade can lead to a change in institutions: First, trade may change the balance of political power which can induce a change in institutions. Institutional change does not necessarily have to bring an improvement but can also produce a deterioration in institutional quality as modeled in Do et al. (2009) and empirically shown by Stinchcombe (1995) on the example of Caribbean sugar economies. Second, trade may alter agents' preferences over institutions. Economic exchange entails an exchange of knowledge and ideas which

may change beliefs, expectations, and preferences of agents. Usually, the behavior of others is important for one's own understandings of and decisions on compliance with prevalent rules (Dong and Torgler, 2012). This notion is reflected in Aoki (2001)'s definition of institutions as common beliefs that are sustained and changed in the strategic interactions of agents. Following Aoki (2001)'s concept, economic exchange with non-domestic business partners may affect domestic agents' beliefs, expectations, and preferences on socially acceptable (business) behavior and alter their own action choices. Firms operating in a subnational region with a low corruption level may demand and push for a non-corrupt business environment as a prerequisite to economic exchange with other subnational regions. Ongoing economic exchange with non-domestic business partners operating in a non-corrupt business environment may change beliefs, expectations, and preferences of domestic economic agents and cause a switch in their action choices towards less corruptive activities. The strategic interaction mechanism may, however, also work in the other direction. Starting or intensifying economic exchange with non-domestic business partners that are used to operate in a more corrupt environment may increase the domestic corruption level if adopting a more corrupt business behavior becomes the best response of domestic economic agents in strategic interactions.

The sociocultural exchange channel mainly works over migration. The mechanism on how migration contributes to the diffusion of corruption across space is similar to the one of economic exchange described above. People diffuse their ideas, knowledge, beliefs, expectations, and preferences of socially acceptable behavior in all kind of social interactions, strategic and non-strategic ones. Dong and Torgler (2012) present an interaction-based model that predicts that the level of corruption is positively associated with social interaction. In their model, the corrupt decision of a bureaucrat depends on his or her expectations of others' decisions. Migration can deliver an impetus for a change in action choices towards more or less corruptive activities. Migrants become domestic agents and domestic agents have a variety of roles in which they contribute to upholding and changing beliefs, expectations, and preferences on socially acceptable behavior. They not only hold economic roles as entrepreneurs, workers and consumers, they hold social roles as neighbors and parents, and maybe also political roles as, e.g., council members.

Lastly, consider the channel of political exchange. Subnational institutions may be harmonized by the national political authority. Supranational or foreign authorities may enforce common regulations. Accession to the EU, for instance, requires acceptance of laws and (a quality of) institutions similar to those in the existing member states. Apart from accessions, institutional change may be required for

participation in preferential trade agreements. Grilli (1997) and Winters (1993) argue that this was particularly important for the neighbors of the EU in the 1990s. Today, countries are members of numerous international agreements, such as agreements on specific environmental or labor standards that require the uptaking of a specific common level of institutional and regulatory quality. Also, (subnational) governments may decide on their own to adopt institutions from other (subnational) governments. They may want to seek harmonization of economic rules in order to attract non-domestic business partners and investors. Likewise, in pursuit of market enlargement, non-domestic business partners and investors may demand changes of domestic institutional environments to conform to common principles (David, 1996). Also, when (subnational) governments are in competition, they may seek to adapt their institutions in order to provide a trade and investment friendly environment (Qian and Roland, 1998). In line with that, Ward and Dorussen (2015) argue African national governments improve the quality of institutions in strategic interactions in order to compete for aid donation and foreign direct investment.

Some of the economic, sociocultural, and political channels of exchange that affect today's corruption levels are working at the present time. A good example are the ongoing negotiations between the European Commission and the heads of the Western Balkans on institutional prerequisites for an EU membership which includes a reduction of corruption levels (European Commission, 2018). Other channels have worked a long time ago but their impacts are still reflected in today's corruption levels. Prominent examples for historical political exchange with long-lasting institutional consequences are political annexations in the era of imperialism in the late 19th century. There is a vast number of literature on the colonial legacy of good and bad institutions (see, e.g., Acemoglu et al., 2001; Djankov et al., 2002, 2003). Institutional legacies of imperialism are not always corresponding to or congruent with national affiliation. Because of historical displacements of national borders, there is also subnational variation in the quality of institutions that can be traced back to historical imperialism.[3] Like historical political events, also historical trade centers and historical migration flows have their legacies reflected in the subnational corruption levels we measure at the present time.

[3]See Becker et al. (2016) on the institutional legacy of the Habsburg empire in parts of today's Eastern European countries Poland, Ukraine, Romania, Serbia, and Montenegro.

2.2.2 Diffusion at the cost of distance

Kelejian et al. (2013) argue that institutional diffusion is likely to occur more often and stronger between neighbors. Neighboring subnational regions are more connected because they have a higher degree of economic, sociocultural, and political exchange. In trade literature, geographic distance is the most robust proxy for trade costs. Trade partners closer to each other are in more intense exchange of goods and services (see Limao and Venables, 2001; Anderson and Van Wincoop, 2004; Disdier and Head, 2008). This holds for trade at the national and at the subnational level. Hillberry and Hummels (2008) find that trade within the US is heavily concentrated at the local level. They argue that producers co-locate in supply chains to minimize transportation costs, facilitate just-in-time production, benefit from informational spillovers, and exploit other associated agglomeration effects.

Sociocultural exchange increases with similarity. Since residents of closer subnational regions are more likely to have a common history, culture, language, and ethnical background (Goldscheider, 1973), the intensity of sociocultural exchange is determined by geographic distance. The first of Ravenstein's laws of migration is: Most migrants move over relatively short distances (Ravenstein, 1885). Migration flows at subnational level are significantly larger than flows across national borders. According to the International Organization for Migration and the World Bank, in 2016, more than 1 billion people lived outside their places of origin (without accounting for seasonal and temporary migrants). 740 million of them moved within national borders (Sorichetta et al., 2016). The distribution of migrants within a country seems to be rather uneven. Different migrant groups exhibit different migration patterns (Van der Gaag and Van Wissen, 2001). Economic migrants seek employment, social migrants seek family reunification. While different motives produce different destination choices, literature shows that there is an overall trend of a within-country redistribution of population from rural to urban areas or from somewhat urban to more urban areas (Champion, 2001).

Geographic distance also matters for political exchange. Adopting institutions and learning from each other happens more often among neighbors (Bikhchandani et al., 1992). Since geographically close units face more similar challenges and share a greater deal of environmental factors, neighbors' institutions are more likely to meet domestic requirements (Murrell et al., 1996). Berkowitz et al. (2003) show that institutional transplants among geographically close countries are more likely than transplants among distant lands. Mukand and Rodrik (2005) model the institutional learning decision with countries choosing between experimentation and imitation.

Countries closer to a successful one choose imitation. The same mechanism may carry over to the subnational level. Neighboring subnational regions are more likely to face similar challenges and environmental factors and therefore are more likely to have similar institutional needs. This holds especially for subnational regions under the same national rule.

All of the arguments presented in this section suggest that the degree of economic, political, and sociocultural exchange is highest between immediate neighbors and decreases with geographic distance. Subnational regions that are closer to each other are more likely to share similar market structures, sociocultural backgrounds, and governmental structures and are therefore more connected.

2.3 Empirical implementation

We specify a generic spatial model that accounts for the spatial diffusion of corruption at the subnational level. Our model captures two different spatial processes: (i) a spatial correlation of corruption levels among subnational regions, and (ii) a spatial correlation of idiosyncratic common features of subnational regions' environments. The core model is given by:

$$\begin{aligned} y_{ic} &= \rho \sum_{j=1}^{J} \omega_{ij} y_j + X_i \beta + \theta_c + \mu_{ic}, \\ \mu_{ic} &= \lambda \sum_{j=1}^{J} \omega_{ij} \mu_j + \varepsilon_{ic}, \end{aligned} \tag{2.1}$$

where y_{ic} is the corruption level of subnational region i in country c, ω_{ij} is a spatial weight assigned to subnational region j by subnational region i, y_j is the level of corruption in subnational region j, and ρ is the corresponding parameter of interest. Interdependencies of corruption levels due to economic, political, and sociocultural exchange among subnational regions manifest in a nonzero, statistically significant estimate of ρ. In line with our discussion in Section 2.2, we expect ρ to be positive which means that the corruption levels of subnational regions in a geographically close neighborhood are more similar. The null hypothesis is that there are no spatial interdependencies which means that subnational corruption levels are determined independently from each other. A subnational region's level of corruption is also defined by a set of own subnational factors, X_i that vary within countries. θ_c are country dummies that capture all country-specific influences that do not vary over subnational regions under the same national rule, e.g., a country's legal origin, de-

gree and history of democracy, political stability, membership in the EU or other multilateral agreements that hold for all administrative units of a country. Finally, μ_{ic} is the error term that is allowed to be spatially correlated. λ is a parameter that measures how strong the errors of subnational regions i and j are correlated, and ε_{ic} are the innovations that are assumed to be independent but heteroskedastically distributed where the heteroskedasticity is of unknown form, e.g., due to size differences in the spatial units.

To account for the simultaneity problem in the spatial process as defined in (2.1), we use an instrumental variable procedure following Kelejian and Prucha (1998, 1999, 2004, 2010b) and deploy spatial lags of the independent variables as means of instruments for the corruption level of subnational regions$_{-i}$. In particular, the procedure consists of three steps: First, the regression parameters in equation (2.1) are estimated by a two stage least squares estimator using the subnational region-specific independent variables, X_i, and the spatial lags thereof, WX_i, as instruments for y_j. In this step, the spatial correlation in the errors is ignored as only a consistent and not an efficient estimation of the coefficients is necessary. In the second step, the residuals from the first step are used to estimate the autoregressive parameter λ in the disturbance process. For this, we employ a generalized method of moments procedure as developed in Kelejian and Prucha (2010b). In a third and final step, the estimate of λ is used to transform the model into a spatial version of a Cochrane-Orcutt procedure. This transformed model is then estimated again by a two stage least squares procedure using the same instruments.

An alternative approach to address the inherent endogeneity in spatial models is a maximum likelihood approach as proposed by Anselin (1988). We prefer the instrumental variable approach for four reasons: First, in contrast to the maximum likelihood approach, the instrumental variable estimator does not rely on the normality assumption. Second, the subnational regions in our sample are heterogeneous in important characteristics, e.g., region size, and hence, the homoskedasticity assumption of the maximum likelihood approach may not hold in our application. Third, and as criticized by Gibbons and Overman (2012), the maximum likelihood approach requires prior knowledge on the data-generating process, whereas the instrumental variable estimator allows to estimate (2.1) structurally. Fourth and finally, based on the instruments choice as described above, Das et al. (2003) show that the instrumental variable estimator is almost as efficient as the maximum likelihood approach.

2.3.1 Identification issues

Recent literature points at two ways how the identification of spatial interdependencies could be impeded. First, data on corruption levels and/or independent variables is missing for some subnational regions. Missing data problems in spatial models are particularly problematic because parts of observations relating to one unit are simultaneously used as explanatory variables for other units. We deal with this problem in the following way: In our core and extended models we ignore subnational regions for which we do not have information on corruption levels. In the literature, this procedure is known as listwise deletion. Kelejian and Prucha (2010a) show that as long as the number of missing endogenous variables is small relative to the fully observed sample the two stage least squares instrumental variable estimator stays asymptotically consistent. As in our sample the number of observations with missing data is relative small compared to subnational regions that are fully observed, we are confident that the potential bias of ignoring these observations is negligibly small.[4] Nevertheless, in a robustness exercise in Section 2.5.2, we employ an estimation procedure as laid out in Kelejian and Prucha (2010a) and Kelejian et al. (2013) that explicitly considers the structure of missing data.

Second, spatially correlated unobservable determinants of subnational corruption levels, i.e., factors common to a group of geographically close subnational regions, may affect the estimate of spatial interdependencies. It is likely that subnational regions in the same neighborhood share common environmental conditions or shocks that influence their corruption levels. In a cross-sectional setting, it is difficult to disentangle which part of the spatial autoregressive parameter is due to interaction, i.e., true contagion, and which part actually reflects spatial heterogeneity, i.e., apparent contagion. We address this issue in various ways: First, we use a rich set of subnational control variables and country dummies to control for both observed and unobserved factors that potentially cause spatial heterogeneity. Second, we account for spatial autocorrelation in the errors. Third, we allow the innovations to be heteroscedastic, e.g., due to size differences in the spatial unit. However, there could still be not-included variables that are spatially correlated and influence subnational corruption levels. Kelejian et al. (2013) show that the two stage least squares instrumental variables estimator is in particular suited to deal with the potential bias from omitted common factors. We therefore also estimate a model that includes spatially

[4] In our sample 838 subnational regions are fully observed, whereas for 394 subnational regions data on the corruption level of some directly neighboring subnational regions is missing.

lagged explanatory variables. This controls for potential local spatial factors that could affect the consistency of our core model.

All in all, we are confident that the majority of our spatial lag in subnational corruption levels measures spatial interdependencies. Since the observed cross-sectional values of the subnational corruption levels also carry information on the past, we prefer to see them as outcomes of historical and contemporary spatial interdependencies. The results of the asymmetric effects exercises presented in Section 2.5.3 also support the notion that ρ reflects spatial interdependencies rather than spatial heterogeneity. If spatial heterogeneity was driving the estimates of ρ, then we should not find such strong asymmetric spillover effects as we do.

2.3.2 Spatial weight matrix

Following the discussion in Section 2.2, we base our spatial weight matrix on geographic distance. As laid out above, spatial interdependencies of subnational corruption levels are affected through various channels. Economic exchange and migration is stronger for subnational regions that are closer to each other. The harmonization of institutions through political exchange happens more often among geographically close subnational regions. On top of that, neighboring subnational regions are more likely to have a common history, culture, language, and ethnical background. We are confident that geographic distance is highly correlated with true interactions and therefore is well-fitted to capture the strength of spatial interdependencies stemming from these channels.[5]

In our spatial weight matrix, we use the inverse distance between the center of two subnational regions to define each off-diagonal element of the spatial weight matrix ω_{ij}. Since no subnational region is considered as its own neighbor, $w_{ii} = 0$. This weighting scheme assigns closer subnational regions a stronger degree of spatial interdependencies. We assume that the influence decreases log-linearly in distance. Further, we assume that the influence is limited to subnational regions within a neighborhood of 500 kilometer distance. Every subnational region outside this distance range does not exert influence and enters the weight matrix with zero. This emphasizes the local confined spatial exchange at the subnational level as shown, e.g., by Hillberry and Hummels (2008). The procedure of limiting the spatial

[5]Another advantage of geographic distance is that it can be considered exogenous. Weight matrices based on socioeconomic measures tend to be endogenous which leads to bias and inconsistent estimates (Kelejian and Piras, 2014). Qu and fei Lee (2015) discuss methods to estimate spatial autoregressive models with an endogenous spatial weighting matrix in terms of consistency, asymptotic normality, and finite sample properties.

influence is also known as distance band. To sum up, we define the strength of spatial interdependencies between two subnational regions as:

$$\omega_{ij} = \frac{1}{d_{ij}} \quad if\ d_{ij} \leq 500\,km,$$
$$\omega_{ij} = 0 \quad otherwise.$$

We make one more assumption on the spatial weight matrix, which is that the total spatial dependence is unitary. This means that the degree of spatial interaction cannot be larger than one independent from the number of subnational regions in the neighborhood. In order to achieve this, we row normalize the spatial weight matrix by dividing each weight by its row sum. The element ω_{ij} can then be interpreted as the share of the overall spatial impacts on subnational region i from subnational region j. This type of normalization has recently been criticized in the literature (see Neumayer and Plumper, 2016) as it is not inferentially neutral and therefore needs to be theoretically motivated. In our case, we are analyzing subnational regions in very heterogeneous geographic settings, e.g., densely clustered regions in Central and Southern Europe as compared to sparse subnational regions in Russia and Kazakhstan. Row-normalization allows us to account for this setting so that the average influence of an individual neighboring subnation in a densely clustered region is lower than for an individual neighboring subnational region in a sparse area. Nevertheless, we will relax these assumptions in Section 2.5.2.

Finally, it has to be noted that there is no theoretical guidance on the functional form of the weight matrix that captures the true spatial process of corruption. Many different spatial weight matrices are plausible. To account for this, we employ alternative definitions of the weight matrix in another robustness test to get a better understanding of the spatial process and to see how sensitive our results are with regard to the choice of the spatial weight matrix.

2.4 Data and summary statistics

We utilize cross-sectional data of 1,232 subnational regions from 81 countries around the world for the year 2005.[6] The majority of subnational data is at the first level of administrative divisions (ADM1) of the respective countries, e.g., states in the

[6]We base our analysis on the year 2005 as this is the year on which our main variable of interest, the level of corruption, is based on. We are confident that the main causal mechanisms that determine the spatial interdependencies of corruption levels have not changed significantly over time. Subnational GDP (which is not available for 2005) is adjusted with GDP deflators to be comparable to 2005 data. For some subnational regions and survey questions, information on

U.S., provinces in Panama, regions in Tanzania. For the EU, subnational data is available for NUTS 2 or NUTS 3 regions, e.g., states in Austria and Germany, regions in the Slovak Republic, autonomous communities in Spain. Table B.1 in the appendix reports the decomposition of subnational data by country. In general, our sample provides quite an even split of data from rich and poor countries. Following the World Bank Analytical Country Classification[7] in 2005, our sample includes 554 subnational regions from upper middle to high income countries and 678 subnational regions from low to lower middle income countries. The threshold lies at a gross national income per capita of 3,466 USD in the year 2005.

2.4.1 Corruption data

Our measure for subnational corruption levels is an index based on survey questions collected by Mitton (2016) that fall under the category of local corruption. Mitton (2016) collects the data from six different sources. The sources provide corruption measurements for different world regions either at the respondent level or at the subnational level. Five sources are surveys collecting data on corruption from civil societies: Afrobarometer survey, Latin American Public Opinion Project, Asia Foundation survey, Quality of Government Institute survey, and Latinobarómetro survey. Data from the World Bank Enterprise survey adds additional information from enterprises and experts on the prevalence of corruption in subnational regions of countries around the world. Survey questions that relate specifically to institutions at the country level are excluded to ensure that the responses reflect the local situations in the subnational regions as much as possible.[8] Drawing on survey questions, our measure on the level of corruption is based on perceptions of respondents. This information broadly covers three dimensions: (i) respondents' assessment to what extent local government councillors, officials, police officers, judges, and magistrates are involved in corruption, (ii) to what extent respondents believe that the local government combats corruption, and (iii) respondents' personal experience on how often they had to make informal payments or gifts to get a document or permit in a public office, a child into school, a household service, medical attention, to avoid problems with the police, or to get help from the police.

the corruption level stems from the period 2006-2011. See Tables B.2 - B.7 in the appendix for more information on the data.

[7] http://databank.worldbank.org/data/download/site-content/OGHIST.xls.

[8] Tables B.2 - B.7 in the appendix list the questions from which data is taken, provide information on the data sources and the direction of coding.

Our index on subnational corruption levels is constructed as follows: First, we aggregate the data to the subnational level where necessary, we clean it, put it into the same direction of measurement, and standardize it to a mean of zero and a standard deviation of one such that all questions are weighted equally when aggregated. Second, we average the standardized data for all questions within each survey and then aggregate the data across the different surveys. This produces one measure for each of the 1,232 subnational regions that lies between the range of -5.661 and $+2.990$. A higher value indicates a higher level of subnational corruption. The sample mean is -0.055. Our aggregation method closely follows Mitton (2016) but differs in one respect, the direction of measurement. We chose the direction that assigns more corrupt subnational regions higher variable values. This makes the interpretation of the estimation results on the spatial lag variable easier.

Since it is based on perceptions of survey respondents, our index is primarily a de facto measure of subnational corruption levels. Despite the potential problems of subjectivity, the perception-based indicator is a valuable carrier of information on actual corruption and seems to capture the real phenomenon very closely. Another issue to consider is a potential bias due to measurement error. The data on corruption is collected from experienced organizations and based on information taken from 172,057 respondents all around the world. This ensures that the compiled statistics are not unduly influenced by a small number of uninformative responses. Cultural bias is a common concern in cross-sectional survey data since respondents of different societies may answer differently to questions based on societal norms. We account for this issue by using country dummies in our regressions that capture any cross-country cultural differences. We expect this mitigates the issue of cultural bias and leaves only bias stemming from within-country variation in societal norms, which we believe to be relatively small.

2.4.2 Independent variables

Literature on the determinants of corruption predominately stresses the role of national factors. Empirical studies find significant and robust results that a country's level of economic development, level of international integration, political stability and democratic tradition, legal origin, size and structure of the government, religious affiliation, ethno-linguistic fragmentation, latitude, and fuel exports explain national corruption levels.[9] National factors, however, cannot explain the observed

[9] See La Porta et al. (1999); Paldam (2002); Serra (2006); Seldadyo and de Haan (2006); Treisman (2007).

within-country variation in corruption levels. We include country dummies to control for effects that are invariant for subnational regions under the same national rule. Furthermore, we control for a set of variant subnational characteristics that may potentially influence local corruption levels. Our choice of independent variables includes socioeconomic, cultural, political, geographic and resource endowment factors that are commonly used in the existing literature and show a certain degree of within-country variation.

As socioeconomic factors, we consider GDP per capita, the size of population, and average years of schooling at the subnational level. We further control for the number of seaports, number of airports, and a dummy for the capital city as proxies that should capture the effects of market integration and urbanization. We use ethnic fractionalization as a cultural factor and administrative autonomy as a political factor with subnational variation. We use a set of variables on subnational regions' geography and natural resource endowments which includes geopolitical position, size of land area, accessability, risk of experiencing natural disasters, and endowments in precious metals, diamonds, oil and gas. Table B.8 in the appendix reports details on definitions and data sources for the independent variables. For many of these variables we again draw back on Mitton (2016) who set up a comprehensive dataset including economic, institutions, geographic, climate and natural resource variables at the subnational level.

2.4.3 Descriptive statistics

Table 2.1 reports the summary statistics of the 1,232 subnational regions from 81 countries around the world for which we have information on corruption levels. The dependent and the independent variables show a substantial degree of subnational variation also within countries. To give an example, the Aosta valley in Northern Italy scores -1.029 in the corruption index which ranks it 73 in our sample. Calabria in Southern Italy scores +1.105 in the corruption index which ranks it 1,164 in our sample. Italy's Northern region Aosta valley has a corruption level clearly below and Italy's Southern region Calabria has a corruption level clearly above the average corruption level in our sample. Cross-country studies that are based on country averages fail to capture these within-country differences.

The corruption level is not only heterogeneous within a country. From what literature suggests, it also tends to cluster in space. To investigate this more thoroughly, in a further step, we evaluate the existence of clusters in the spatial arrangement of subnational regions' corruption levels. A statistically significant spatial cluster-

Table 2.1: Summary statistics

	Mean	St.dev	Min	p25	Median	p75	Max
Dependent variable							
Corruption	-0.055	0.739	-5.661	-0.493	-0.117	0.369	2.990
Independent variables							
Log GDP per capita	8.694	1.231	5.347	7.774	8.759	9.742	11.866
Log population	13.653	1.340	9.900	12.675	13.695	14.599	18.336
Education	7.339	3.227	0.219	5.048	7.733	9.675	14.139
Seaports	0.155	0.509	0	0	0	0	4
Airports	2.218	8.793	0	0	0	1	146
Capital city	0.067	0.251	0	0	0	0	1
Border	0.523	0.500	0	0	1	1	1
Ethnic fractionalization	0.194	0.240	0	0	0.060	0.384	0.849
Autonomy	0.045	0.207	0	0	0	0	1
Log land area	9.351	1.651	4.513	8.231	9.207	10.423	14.656
Terrain ruggedness	1.237	1.255	0	0.272	0.743	1.878	7.751
Log stormrisk	0.482	1.161	0	0	0	0	6.303
Log earthquakerisk	0.466	0.859	0	0	0	0.693	4.543
Precious metals (sites)	100.523	1,134.709	0	0	0	2	29,261
Diamonds (sites)	0.272	4.058	0	0	0	0	128
Oil and gas (sites)	188.654	2,334.873	0	0	0	0	67,796

ing process underlines the importance to take spatial autocorrelation into account as formulated in (2.1). Since we assume heterogeneity in subnational regions' corruption levels, we calculate a local version of the Moran's I statistics to determine potential local clustering for each of the subnational regions individually (Anselin, 1995). The local Moran's I is defined as follows:

$$I_i = \frac{(y_i - \bar{y})}{\sigma_y} \sum_{j \neq i}^{J} \omega_{ij}(y_j - \bar{y}), \tag{2.2}$$

where I_i expresses for each subnational region i the degree of similarity in the corruption level y with its neighbors. The spatial weight matrix ω_{ij} defines the degree of spatial interdependencies between subnational regions i and j, and σ stands for the standard deviation. Figure 2.1 shows a graphical representation of the Moran's local index of spatial autocorrelation I_i. In the so called Moran scatter plot, the corruption level of subnational region i is plotted on the x-axis and the sum of the spatially lagged corruption levels of the neighbors is plotted on the y-axis. Since the

plot is centered at the mean which is zero, all circles to the right of zero on the x-axis and above zero on the y-axis have a high level of corruption. All circles to the left of zero on the x-axis and below zero on the y-axis have a low level of corruption. The scatter plot is easily decomposed into four quadrants. The upper right quadrant and the lower left quadrant correspond to positive spatial autocorrelation, meaning neighboring subnational regions are characterized with similar corruption levels. In contrast, the lower right and upper left quadrant correspond to negative spatial autocorrelation, meaning neighboring subnational regions are characterized with dissimilar corruption levels. The clustering of the local Moran's I indices for our sample in the upper right quadrant and the lower left quadrant indicates the presence of a positive spatial autocorrelation.[10] The slope of the linear fit to the scatter plot equals a global Moran's I of $I = 0.432$ at the highest significance level. This further indicates a positive spatial autocorrelation of subnational regions' corruption levels.

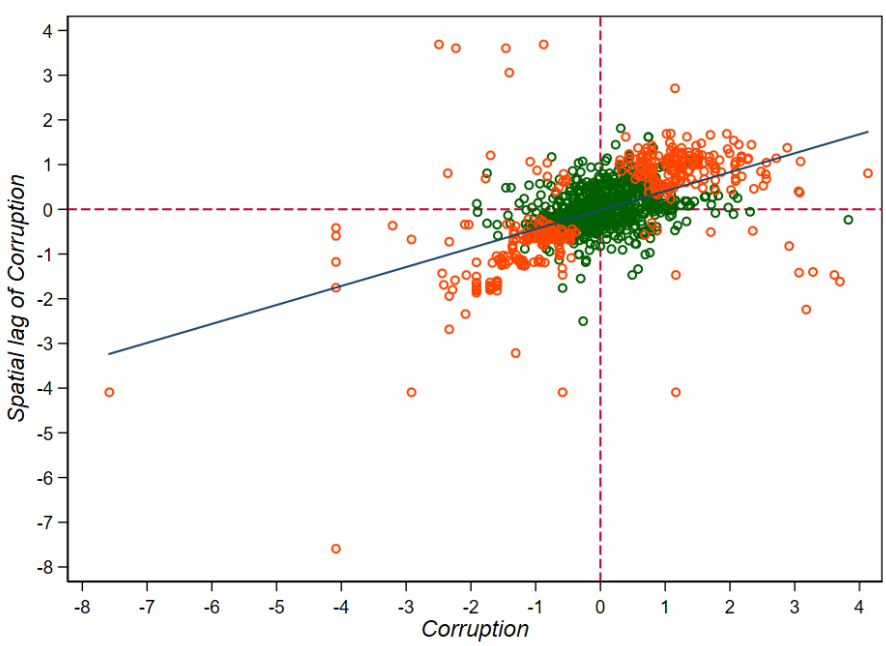

Figure 2.1: Moran scatter plot on subnational corruption levels

2.5 Results

Our estimation results are based on the core model in (2.1) and on the identification strategy using an instrumental variable estimation approach as described in Section 2.3. Columns (1) in Table 2.2 present the results for our core model. The

[10] Local Moran's I indices with a 5% statistically significant clustering process are colored red.

coefficient of our variable of interest, the spatially lagged level of corruption ρ, is statistically significant and positive. This means that the corruption levels of the subnational regions in our sample are positively autocorrelated in space. The corruption level of one subnational region influences (and is influenced by) the corruption levels of its neighbors. Because of their positive relationship, they cluster in space. As elaborated in Section 2.2, we explain this result with contemporary and historical economic, political and sociocultural exchange among subnational regions.

Table 2.2: Results for core model and spatial durbin model

	(1)		(2)			
	Coefficient	SE	Coefficient	SE	WX	SE
Spatial lag (ρ)	0.534***	(0.086)	0.495***	(0.063)		
Log GDP per capita	−0.034	(0.039)	−0.007	(0.045)	−0.007	(0.063)
Log population	0.074***	(0.026)	0.064***	(0.021)	0.080	(0.066)
Education	0.012	(0.021)	0.017	(0.022)	−0.028	(0.025)
Seaports	0.131**	(0.053)	0.163***	(0.053)	−0.181	(0.168)
Airports	0.006	(0.007)	−0.005	(0.008)	0.020**	(0.009)
Capital city	0.034	(0.069)	0.024	(0.061)	−0.243	(0.176)
Border	0.060*	(0.036)	0.038	(0.034)	0.104	(0.114)
Ethnic fractionalization	0.121	(0.078)	0.021	(0.083)	0.371**	(0.211)
Autonomy	−0.150*	(0.094)	−0.205**	(0.099)	0.449*	(0.232)
Log land area	−0.057***	(0.022)	−0.051***	(0.019)	−0.061	(0.044)
Terrain ruggedness	−0.022	(0.018)	−0.029	(0.018)		
Log stormrisk	0.050	(0.033)	0.061**	(0.032)		
Log earthquakerisk	0.016	(0.028)	0.027	(0.028)		
Precious metals	0.054**	(0.023)	0.141***	(0.036)	−0.100	(0.038)
Diamonds	2.891	(2.840)	2.897	(2.111)	−16.773	(12.138)
Oil and gas	−0.015	(0.013)	0.005	(0.013)	−0.048	(0.032)
Spatial error (λ)	−0.625***	(0.146)	−0.605***	(0.153)		
Country fixed effects	Yes		Yes			
Observations	1,232		1,232			
R^2	0.563		0.591			

Notes: Dep. Variable: *Corruption*. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parenthesis. Spatial weight matrix: inverse distance with 500km distance band; row-normalized. Constant included but not reported.

The results for the independent variables are broadly corresponding to previous findings in literature. We find that a subnational region's corruption level significantly increases with the size of its population. This is in accordance with the empirical findings in Dong and Torgler (2012) and Limao and Venables (2001), and with the argument put forward in Kelejian et al. (2013) that a larger population makes it more difficult to reach workable institutional arrangements because of the

logic of collective action. Out of our measures of market integration, we find that the corruption level significantly increases with the number of seaports in a subnational region and if a subnational region is positioned at a national border. Controlling corruption may be more difficult in a complex environment. A highly economically integrated subnational region may serve as a hub where citizens are engaged in a greater variety of economic activities and where citizens have a higher degree of anonymity. Both may increase the opportunity and the propensity of corruptive activities. We do not find a significant effect for the number of airports and if the subnational region comprises a capital city.

The level of corruption in a subnational region decreases significantly with land area. This suggests that larger subnational regions have lower corruption levels which is in line with Seldadyo and de Haan (2006) and Lopez-Valcarcel et al. (2017). Larger subnational regions are more likely to have lower population densities than smaller ones which makes citizens of larger subnational regions less anonymous. Where citizens are less anonymous, the reputation system may serve as a more effective informal mechanism to prevent corruptive activities. We find that the level of corruption increases significantly with the number of mines exploiting precious metals. Subnational regions with a higher wealth in precious metals also show higher corruption levels. This is in accordance with the "resource curse" argument put forward in literature. Increased raw material endowment increases corruption levels as Treisman (2000) shows for the national level. For the other variables capturing natural resource wealth, we do not find statistically significant effects.

We also do not find evidence that subnational corruption levels are affected by subnational income levels. This is in line with Mitton (2016). It seems that the positive relationship between institutions and income, which La Porta et al. (1999) find for the national level, does not carry over to the subnational level. One possible reason for this result may be that subnational variation in income is simply too small to be significantly associated with subnational variation in corruption levels after controlling for country fixed effects, spatial spillovers, and correcting for spatial clustering. The estimate of the cultural factor shows the expected sign. More ethnic fractionalization results in a higher corruption level. However, it barely misses the 10% significance level in the core model. Our estimate of subnational political autonomy shows the expected sign and is just significant. Finally, the economically and statistically significant spatial error implies that not only corruption levels but also unobserved factors are spatially correlated. This suggests that subnational regions do share common factors that affect corruption levels. These common factors are unobserved and therefore captured in the error term.

It is possible that a subnational region's corruption level is also directly affected by the characteristics of neighboring subnational regions (e.g., population size, degree of economic integration, ethnic fractionalization) rather than indirectly via the effect of the characteristics on the neighboring subnational regions' corruption levels. To capture these potential local spillovers, we extend our core model as specified in (2.1) by additionally including spatial lags of explanatory variables that may potentially affect a neighbor's corruption level directly. Formally, this gives:

$$\begin{aligned} y_{ic} &= \rho \sum_{j=1}^{J} \omega_{ij} y_j + X_i \beta + \gamma \sum_{j=1}^{J} \omega_{ij} X_j + \theta_c + \mu_{ic}, \\ \mu_{ic} &= \lambda \sum_{j=1}^{J} \omega_{ij} \mu_j + \varepsilon_{ic}, \end{aligned} \tag{2.3}$$

where γ captures the direct effect of a change in an independent variable of a neighboring subnational region j on subnational region i's corruption level. We assume the spatial weight for each pair of subnational regions to be the same in the dependent as well as in the independent variables. The spatial process of diffusion is therefore the same. We present the results of the so called "spatial durbin model" in columns (2) in Table 2.2. They are in line with and support the estimation result of our core model. Taking the impact of local direct spillovers into account, the estimate of the spatial lag coefficient is slightly smaller but remains statistically significant. The coefficient estimates of the explanatory variables are broadly similar. With regard to the spatially lagged explanatory variables, our results suggest that a neighbors' degree of ethnic fractionalization, market integration, and political autonomy increases the level of corruption. We do not find a statistically significant impact of the other spatially lagged explanatory variables.

2.5.1 Marginal effects

In linear regression models, the marginal effects are simply partial derivatives of the dependent variable with respect to the explanatory variables. This arises from linearity and the assumed independence of observations in the model. In spatial regression models, the calculation of marginal effects becomes more complicated as the parameter estimates include information from the other observations as well. A change in an independent variable in subnational region i will have a direct effect on i's corruption level and an indirect effect on the corruption levels of neighboring subnational regions. The indirect effect is determined by the spatial dependence

structure and incorporates feedback loops. To examplify, an increase in i's population increases i's corruption level in the first place, which increases neighbor j's corruption levels in the second place, which feeds back to further increase subnational region i's corruption level in the third place.

The coefficient estimates of the independent variables presented in Table 2.2 constitute only the direct effects of changes in i's independent variables on i's corruption level. We are, however, interested in the cumulative marginal effects of changes in i's independent variables on i's corruption level which also include the feedback effects from neighboring subnational regions. Following LeSage and Pace (2009) and LeSage and Pace (2014), we calculate the cumulative average direct, indirect, and total effects from the core model for our sample of 1,232 subnational regions.[11] The results are presented in Table 2.3.

Table 2.3: Summary measures on direct, indirect, and total effects

	Cumulative effects on *Corruption*					
	Direct effects		Indirect effects		Total effects	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Log GDP per capita	−0.035	(0.040)	−0.037	(0.043)	−0.072	(0.083)
Log population	0.078***	(0.028)	0.081*	(0.045)	0.160**	(0.072)
Education	0.012	(0.022)	0.013	(0.023)	0.025	(0.045)
Seaports	0.138**	(0.056)	0.143*	(0.079)	0.281**	(0.130)
Airports	0.007	(0.008)	0.007	(0.008)	0.013	(0.016)
Capital city	0.036	(0.072)	0.037	(0.074)	0.073	(0.146)
Border	0.063*	(0.036)	0.065	(0.046)	0.128	(0.079)
Ethnic fractionalization	0.128	(0.083)	0.133	(0.104)	0.261	(0.183)
Autonomy	−0.158*	(0.099)	−0.164	(0.116)	−0.322	(0.209)
Log land area	−0.060***	(0.023)	−0.062*	(0.032)	−0.122**	(0.052)
Terrain ruggedness	−0.023	(0.019)	−0.024	(0.021)	−0.047	(0.040)
Log stormrisk	0.052	(0.034)	0.054	(0.038)	0.107	(0.070)
Log earthquakerisk	0.017	(0.030)	0.017	(0.031)	0.034	(0.061)
Precious metals	0.057**	(0.024)	0.059**	(0.030)	0.116**	(0.051)
Diamonds	3.041	(2.978)	3.160	(3.132)	6.202	(6.029)
Oil and gas	−0.016	(0.014)	−0.017	(0.015)	−0.033	(0.028)

Notes: Inferential statistic based on delta-method. *, **, *** indicate 10, 5, 1 % significance levels. Standard errors in parenthesis. 1232 observations. Spatial weight matrix: inverse distance with 500km distance band, row-normalized.

[11] Appendix A gives a formal derivation of the average direct, indirect, and total effects in a spatial model.

The cumulative average direct effects present the impacts on subnational region i's corruption level caused by changes in i's independent variables. In comparison with the coefficient estimates in Table 2.2, the cumulative direct effects are quantitatively and qualitatively similar. The results confirm that the size of population, the size of land area, a position at the border, the resource endowments in precious metals, and the degree of market integration measured by the number of seaports are the main direct subnational determinants of corruption levels. The differences in the coefficient estimates in Table 2.2 and Table 2.3 stem from feedback loops that arise from neighbors influencing neighbors' corruption levels. This considers that some effects that pass through the neighboring subnational regions will feed back to further affect the corruption level in subnational region i itself.

The cumulative average indirect effects constitute the sum of the impacts that changes in subnational region i's independent variables assert on neighboring subnational regions' corruption levels. The strength of the impacts of a change in i's independent variable on neighboring subnational regions' corruption levels depends on the position of neighboring subnational regions in space and the degree of connectivity among them. Both are defined by the spatial weight matrix and the spatial autoregressive parameter ρ.[12] Our results suggest that the cumulative average indirect effects are quantitatively and qualitatively similar to the cumulative direct effects for almost all independent variables. This clearly indicates the important role of spatial interdependencies in determining subnational corruption levels.

The cumulative average total effects are the sum of the direct and indirect effects. They constitute the average total impacts from changes in the independent variables of subnational region i on the corruption levels of all subnational regions in our sample including itself. The cumulative average total effects therefore account for the interdependencies within the spatial system. To sum up, our results suggest that ignoring spatial interdependencies leads to a serious underestimation of the total impacts of changes in independent variables on subnational corruption levels.

2.5.2 Robustness and sensitivity

We test the sensitivity of our core model estimates by conducting several robustness checks. In Section 2.5.2, we test the sensitivity of our results when we pose different assumptions on the spatial process. We present the estimates when we use four alternative definitions of the spatial weight matrix and when we choose an alternative

[12] The ratio between the indirect and the direct effects of a particular explanatory variable is independent of the coefficient estimate β_k in our models and is therefore constant (Elhorst, 2010).

normalization form of the spatial weight matrix. In Section 2.5.2, we address the endogeneity issue that arises when using income as an independent variable. Lastly, in Section 2.5.2, we tackle the issue of missing observations on some neighboring subnational regions' corruption levels. In all robustness exercises, we find that spatial interdependencies of subnational regions' corruption levels remain considerable in size and statistically significant.

Spatial weight matrix alternatives

In line with our argumentation in Section 2.2 and Section 2.3, we are confident that geographic distance is well-fitted to capture the strength of the spatial interdependencies and (2.1) represents the true data-generating process. However, since there is no theoretical guideline on the structure of the spatial process, we construct alternative weight matrices with different definitions of spatial interdependencies.

First, we calculate a spatial weight matrix using the squared inverse distance between the pairs of subnational regions that lie within a 500km distance band. This considers a non-linear relationship in the strength of spatial interdependencies. Closer subnational regions are given stronger weights which allows closer subnational regions to excert stronger influence on each others' corruption levels and makes the influence decrease faster over distance. As presented in column (1) in Table 2.4, the spatial lag coefficient stays robust with a statistically significant and a slightly smaller coefficient estimate when we use this first spatial weight matrix alternative.

Second, we use a nearest neighbor structure to determine the spatial relationship of subnational corruption levels. For each subnational region i the geographically 8 nearest subnational regions j are defined as neighbors with spatial influence. These 8 nearest subnational regions enter the spatial weight matrix with the value $w_{ij} = 1$. All other subnational regions in the sample are given a value of zero. This weighting alternative gives close subnational regions a strong homogenous weight while ignoring the influence of more remote subnational regions. It has to be noted that this type of defining spatial interdependencies partly ignores the heterogeneous spatial structure in our sample, i.e., densely clustered regions in some parts of the world versus sparse subnational regions in others. Column (2) in Table 2.4 presents the results using this spatial weight matrix. Our parameter of interest, the spatial lag coefficient, stays robust in size and significance.

Third, we extend the distance band to a radius of 1,000km to allow spatial interdependencies across a longer geographic distance. Further, we assume a linear decay in influence as relative distance increases. Column (3) in Table 2.4 shows

Table 2.4: Results for alternative spatial weight matrices

	(1)	(2)	(3)	(4)	(5)
Spatial lag (ρ)	0.498***	0.518***	0.613***	0.470***	1.190***
	(0.086)	(0.090)	(0.121)	(0.076)	(0.266)
Log GDP per capita	−0.040	−0.030	−0.017	−0.024	−0.056
	(0.039)	(0.039)	(0.041)	(0.039)	(0.043)
Log population	0.074***	0.084***	0.074***	0.077**	0.094***
	(0.026)	(0.030)	(0.023)	(0.033)	(0.033)
Education	0.010	0.008	0.010	0.001	0.006
	(0.020)	(0.020)	(0.021)	(0.021)	(0.023)
Seaports	−0.134**	−0.123**	−0.121**	−0.116**	−0.122**
	(0.055)	(0.052)	(0.053)	(0.052)	(0.056)
Airports	0.006	0.012*	0.009	−0.012	−0.012
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Capital city	0.036	0.025	0.015	0.033	0.036
	(0.070)	(0.070)	(0.068)	(0.073)	(0.071)
Border	0.058*	0.060*	0.062*	0.053*	0.045
	(0.033)	(0.033)	(0.034)	(0.032)	(0.034)
Ethnic fractionalization	0.123	0.131*	0.114	0.107	0.158*
	(0.079)	(0.082)	(0.076)	(0.086)	(0.091)
Autonomy	−0.148*	−0.150*	−0.118	−0.144	−0.206**
	(0.092)	(0.086)	(0.089)	(0.091)	(0.096)
Log land area	−0.055***	−0.061***	−0.057***	−0.058**	−0.075***
	(0.021)	(0.022)	(0.022)	(0.023)	(0.024)
Terrain ruggedness	−0.019	−0.023*	−0.024	−0.021	−0.027
	(0.018)	(0.017)	(0.018)	(0.017)	(0.019)
Log stormrisk	0.052	0.061*	0.053	0.055*	0.073**
	(0.032)	(0.031)	(0.033)	(0.030)	(0.037)
Log earthquakerisk	0.0015	0.030	0.015	0.019	0.013
	(0.029)	(0.027)	(0.029)	(0.026)	(0.032)
Precious metals	0.056**	0.066***	0.053**	0.055**	0.066**
	(0.023)	(0.021)	(0.023)	(0.025)	(0.029)
Diamonds	2.934	2.595	2.686	2.421	2.781
	(2.820)	(2.421)	(2.055)	(2.131)	(2.269)
Oil and gas	−0.015	−0.029**	−0.022	−0.025**	−0.023*
	(0.014)	(0.011)	(0.012)	(0.012)	(0.014)
Spatial error (λ)	−0.562***	−1.012***	−0.726***	0.708***	0.200
	(0.129)	(0.257)	(0.223)	(0.158)	(0.749)
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1,232	1,232	1,232	1,232	1,232
R^2	0.562	0.562	0.570	0.558	0.557

Notes: Dep. Variable: *Corruption*. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parenthesis. Alternative spatial weight matrices, all row-normalized except for (5) where the baseline spatial weight matrix is spectral-normalized. Constant included but not reported.

the results when using this type of spatial weight matrix. Again, the spatial lag coefficient stays statistically significant and positive. We observe a small increase in the size of the spatial lag coefficient. This suggests that it is not pure geographic proximity that influences the degree of spatial interdependencies among subnational regions. Spatial spillovers between subnational region i and a geographically more distant subnational region k may be stronger than spatial spillovers between subnational region i and a geographically less distant subnational region j for specific characteristics of the subnational regions. Subnational region k may, e.g., be hosting a capital city and/or show a high degree of market integration.

Fourth, we use a Delaunay triangulation to determine the elements of the spatial weight matrix. The Delaunay triangulation determines neighborhood by creating Voronoi triangles from the centroids of the subnational regions such that each subnational region is a triangle node. Nodes connected by a triangle edge are considered neighbors. This type of neighborhood definition gives the natural spatial structure in our sample a stronger consideration and is especially suited for irregular networks in which distances to nearest neighbors vary significantly. Also, Delanuay triangulation ensures that each subnationational region has at least one neighbor. The results of using a Delaunay triangulation to define the structure of the spatial weight matrix are shown in Table 2.4 column (4). The spatial lag coefficient looses slightly in size but remains statistically significant at the highest level.

Fifth, we test the sensitivity of our core estimation results with respect to the normalization mode of our spatial weight matrix. As discussed earlier in Section 2.3, row normalizing the spatial weight matrix alters the internal weighting structure which makes it inferential not neutral. To give consideration to this issue, we follow Kelejian and Prucha (2010c) and divide the elements w_{ij} by the absolute value of the largest eigenvalue ν of the matrix. This type of normalization (which is also known as spectral normalization) has the advantage that it removes any measure-unit effects but preserves relations between rows. However, spectral normalization makes computation and interpretation of spillover effects more complicated which is the reason why we prefer a row-normalized spatial weight matrix in our core model. Column (5) in Table 2.4 presents the estimation results when using a spectral normalization of the spatial weight matrix. The spatial lag coefficient remains positive and highly significant. It has to be noted that with spectral normalization the magnitude of our spatial lag coefficient estimate lies on the higher range of the admissible parameter space defined as $(-\frac{1}{\nu}, \frac{1}{\nu})$, which makes the interpretation of this estimate problematic.

Possible endogeneity of income

Clague et al. (1996) and La Porta et al. (1999) find a significant negative relationship between national income and corruption levels. They argue that an increase in income enables to channel more resources into controlling corruption and therefore reduces corruption levels. The causal relationship may, however, also run the other direction. A decrease in the corruption level may lead to an increase in income. This potential simultaneity makes a causal interpretation of (2.1) problematic. To account for this issue, we test whether the coefficient estimate of the spatial lag coefficient changes when we either completely omit subnational income per capita from the regression or employ an instrumental variable procedure.

Table 2.5: Results without and with instrumented income

	(1)		(2)	
	Coefficient	SE	Coefficient	SE
Spatial lag (ρ)	0.556***	(0.091)	0.336***	(0.090)
Log GDP per capita			−0.030	(0.066)
Log population	0.073***	(0.025)	0.083***	(0.028)
Education	0.005	(0.020)	0.009	(0.024)
Seaports	0.131**	(0.053)	0.132*	(0.083)
Airports	0.006	(0.007)	0.008	(0.008)
Capital city	0.027	(0.067)	0.020	(0.071)
Border	0.059*	(0.034)	0.053	(0.034)
Ethnic fractionalization	0.119	(0.077)	0.137*	(0.083)
Autonomy	−0.153*	(0.095)	−0.169*	(0.096)
Log land area	−0.055**	(0.022)	−0.063***	(0.022)
Terrain ruggedness	−0.019	(0.018)	−0.023	(0.019)
Log stormrisk	0.050	(0.033)	0.061*	(0.035)
Log earthquakerisk	0.015	(0.028)	0.015	(0.030)
Precious metals	0.053**	(0.023)	0.061**	(0.025)
Diamonds	2.785	(2.858)	2.893	(2.600)
Oil and gas	−0.015	(0.013)	−0.017	(0.014)
Spatial error (λ)	−0.654***	(0.156)	−0.391***	(0.130)
Country fixed effects	Yes		Yes	
Observations	1,232		1,232	
R^2	0.561		0.568	

Notes: Dep. Variable: *Corruption*. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parenthesis. Spatial weight matrices: inverse distance matrix with 500km distance band, row-normalized. Constant included but not reported. In columns (2) GDP per capita is instrumented by the first order spatial lags of the exogenous explanatory variables.

Columns (1) in Table 2.5 present the results when subnational income per capita is omitted as an independent variable. Since the literature lacks agreement on variables that affect income per capita and not institutions and since available data on the subnational level is limited, we instrument subnational income per capita with the first order spatial lags of the exogenous explanatory variables. Columns (2) in Table 2.5 provide the results for that exercise. In both exercises the patterns of estimated coefficients, including the spatial autoregressive parameter and their levels of statistical significance, are broadly comparable to those of the core model apart from a somewhat smaller coefficient estimate of ρ in the instrumental variable application. Although this is not a perfect test, it reassures us that our core estimates and basic conclusions are not particularly sensitive to potential endogeneity issues between income and corruption levels.[13]

Spatial estimation when there is missing data

It is evident from (2.1) that the calculation of the spatial lag for each subnational region requires information on the corruption levels of all neighbors. For some of the 1,232 subnational regions that enter our analysis we do not have information on all of their neighbors' corruption levels. Although Kelejian et al. (2013) show that the consistency of the coefficient estimate of the spatial lag is unaffected by the omission of a wide class of spatially correlated explanatory variables, we address this issue by implementing an estimation procedure suggested by Kelejian and Prucha (2010a) that explicitly takes the structure of missing data into account.

We group the 1,232 subnational regions in our sample into two mutually exclusive and exhaustive sets. In the first set, containing $s_1 = 1, 2, 3, ..., 838$ subnational regions, the corruption levels of all immediate neighbors are observed. We refer to this set of 838 subnational regions as the core set. In the second set, containing $s_2 = 1, 2, 3, ..., 394$ subnational regions, for some immediate neighbors data on corruption levels is missing. We refer to this set of 394 subnational regions as the edge set. Based on this setting, we specify a spatial model that directly accounts for the

[13] In a further robustness exercise we performed a reduced-form regression based on the spatial lag parameter and exogenous geographic variables (i.e., land area, terrain ruggedness, storm risk, earthquake risk, precious metals, diamonds, oil and gas) that should be less prone to endogeneity issues. The coefficient estimate of the spatial autoregressive parameter is smaller in size but remains highly significant. Results provided by the authors upon request.

incomplete dataset:

$$
\begin{aligned}
y_{ic,1} &= \rho \sum_{j=1}^{J} (\omega_{ij} y_{j,1} + \varpi_{ij} y_{j,2}) + X_{i,1}\beta_1 + \theta_{c,1} + \mu_{ic,1}, \\
\mu_{ic,1} &= \lambda \sum_{j=1}^{J} (\omega_{ij} \mu_{j,1} + \varpi_{ij} \mu_{j,2}) + \varepsilon_{ic,1},
\end{aligned}
\tag{2.4}
$$

where the subindex 1 refers to the core set in our sample, i.e., the subnational regions for which corruption levels are fully observed, and subindex 2 refers to the edge set, i.e., the subnational regions for which observations on the corruption level are missing for some immediate neighbors. Further, ω_{ij} are the elements of the spatial weight matrix which relate to the core group. ϖ_{ij} covers the elements of the spatial weight matrix for the edge group.

Table 2.6: Results for restricted sample

	Coefficient	SE
Spatial lag (ρ)	0.582***	(0.083)
Log GDP per capita	−0.007	(0.041)
Log population	0.054**	(0.025)
Education	−0.016	(0.021)
Seaports	0.148***	(0.045)
Airports	0.010*	(0.005)
Capital city	0.050	(0.078)
Border	0.000	(0.046)
Ethnic fractionalization	0.186**	(0.081)
Autonomy	0.100	(0.086)
Log land area	−0.065**	(0.030)
Terrain ruggedness	−0.035**	(0.017)
Log stormrisk	0.075***	(0.028)
Log earthquakerisk	0.021	(0.031)
Precious metals	0.047**	(0.020)
Diamonds	−3.432	(13.486)
Oil and gas	−0.037***	(0.009)
Spatial error (λ)	−0.841*	(0.502)
Country fixed effects	Yes	
Observations	838	
R^2	0.851	

Notes: Dep. Variable: *Corruption*. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parenthesis. Spatial weight matrices: inverse distance matrix with 500km distance band, row-normalized. Constant included but not reported.

Following Kelejian and Prucha (2010a), we first estimate (2.4) by two-stage least squares and use the subnational region-specific independent variables $X_{i,1}$ of the core set and their spatial lags ωX_{i1} as instruments for $y_{j,1}$. This method provides consistent parameter estimates. We estimate $\mu_{ic,1}$ from (2.4) and determine the parameter λ by employing the GMM procedure as proposed in Kelejian and Prucha (1999) with setting $\varpi_{ij}\mu_{j,2} = 0$.[14] Lastly, we use the estimate of λ to transform the model via a spatial variant of the Cochrane-Orcutt procedure and estimate the resulting model by two-stages least squares. The results of this procedure are reported in Table 2.6. The coefficient estimate of the spatial lag coefficient remains robust, slightly higher, and at the highest significance level. The estimates of the independent variables remain largely robust. This indicates that the results of our core model estimations are not strongly biased by potential missing observation issues.

2.5.3 Asymmetric effects

The degree of connectivity between two subnational regions and their position in space determine how changes in one subnational region's corruption level disseminate in space. Recent literature implies that the degree of connectivity is not homogenous between countries but depends on, e.g., the level of economic development (Borsky and Raschky, 2015), or the level of institutional quality (Kelejian et al., 2013). Therefore, in the second part of our empirical analysis, we investigate whether the strength of spatial interdependencies varies for different groups of subnational regions. To do this, we extend the core model and allow for asymmetric spatial effects that depend on the characteristics of subnational regions. In Section 2.5.3, we study whether the strength of spillovers differs when they take place within versus across national borders. In Section 2.5.3, we study whether a subnational region's level of economic development alters its potential to spill corruption in space. In Section 2.5.3, we study whether a subnational region's corruption level relative to the average of its neighbors' corruption levels matters for the strength of the spatial spillover.

[14] We assume for the purposes of large sample results that $s_2/s_1 \longrightarrow 0$ as we move towards infinity. This is reasonable since s_2 is smaller than s_1 which makes the term $\varpi_{ij}\mu_{j,2}$ asymptotically negligible. For a more detailed discussion on this procedure, see Kelejian and Prucha (2010a).

Within versus across border effects

So far we have not allowed for a difference in spillover effects between subnational regions belonging to the same country versus subnational regions belonging to different countries. Prior empirical findings, however, support this intuition. McCallum (1995) suggests that regions within countries trade 10 to 20 times more with each other than regions across countries. This is due to the absence of a "border effect" which according to King and Skeldon (2010) captures tariffs, bureaucratic hurdles, and informational barriers associated with national borders. Remarkably, Nitsch (2000) finds that subnational trade in the EU is about ten times larger among subnational regions under the same national rule despite the absence of formal barriers at national borders. This suggests that the border effect persists even when there is no longer a formal border. The same is true for migration. Most migration flows happen from rural to urban region within a country (Champion, 2001). To capture this asymmetric intensity of exchange, we extend the core model specified in (2.1) as follows:

$$\begin{aligned} y_{ic} &= \rho_w \sum_{j=1}^{J} \omega_{ij}^{w} y_j + \rho_a \sum_{j=1}^{J} \omega_{ij}^{a} y_j + X_i\beta + \theta_c + \mu_{ic}, \\ \mu_{ic} &= \lambda \sum_{j=1}^{J} \omega_{ij}\mu_j + \varepsilon_{ic}, \end{aligned} \tag{2.5}$$

where we split our baseline spatial weight matrix ω into two submatrices such that $\omega = \omega^w + \omega^a$. ω^w is a row-normalized spatial weight submatrix in which each element $\omega_{ij}^w = \frac{1}{d_{ij}}$ only if the subnational regions i and j belong to the same country and are within a geographic neighborhood of 500km, and 0 otherwise. ω^a is a row-normalized spatial weight submatrix in which each element $\omega_{ij}^a = \frac{1}{d_{ij}}$ only if subnational regions i and j belong to different countries and are within a geographic neighborhood of 500km, and 0 otherwise. We estimate the model by the previously described instrumental variable procedure using the subnational region-specific independent variables X_i and their spatial lags $W^w X_i$ and $W^a X_i$ (differentiated for subnational regions belonging to the same vis-a-vis different countries) as instruments for y_j.

Table 2.7 columns (1) contain the results for the border effects exercise. The coefficient estimate ρ_w, which measures the spatial spillovers between subnational regions within a country, is more than the double in size of the coefficient estimate ρ_a, which measures the spatial spillovers between subnational regions across countries. This result suggests that spatial spillovers in corruption levels mainly take place within national borders. Subnational regions under the same national rule are more

strongly connected and therefore have a much greater influence on each others' corruption levels. National borders seem to considerably dampen spillovers.

Table 2.7: Results for border, wealth, and corruption effects

	(1)		(2)		(3)	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Spatial lag within (ρ_w)	0.599***	(0.096)				
Spatial lag across (ρ_a)	0.249**	(0.129)				
Spatial lag middle-high (ρ_r)			0.492***	(0.098)		
Spatial lag low-middle (ρ_p)			0.279**	(0.126)		
Spatial lag more corrupt (ρ_h)					−0.001	(0.173)
Spatial lag less corrupt (ρ_l)					0.170**	(0.073)
Log GDP per capita	−0.042	(0.039)	−0.044	(0.038)	−0.058	(0.041)
Log population	0.069***	(0.024)	0.074***	(0.025)	0.087***	(0.032)
Education	0.013	(0.021)	0.016	(0.021)	0.011	(0.022)
Seaports	0.122**	(0.051)	0.131**	(0.054)	0.134**	(0.056)
Airports	0.006	(0.007)	0.006	(0.008)	0.010	(0.008)
Capital city	0.030	(0.066)	0.032	(0.068)	0.010	(0.071)
Border	0.063*	(0.034)	0.055	(0.034)	0.046	(0.034)
Ethnic fractionalization	0.108	(0.074)	0.124	(0.078)	0.152*	(0.086)
Autonomy	−0.153	(0.095)	−0.159*	(0.096)	−0.175*	(0.099)
Log land area	−0.056***	(0.021)	−0.059***	(0.021)	−0.074***	(0.022)
Terrain ruggedness	−0.025	(0.018)	−0.202	(0.018)	−0.030	(0.019)
Log stormrisk	0.045	(0.033)	0.057*	(0.034)	0.073**	(0.034)
Log earthquakerisk	0.023	(0.025)	0.017	(0.029)	0.019	(0.033)
Precious metals	0.051**	(0.022)	0.057**	(0.023)	0.068***	(0.026)
Diamonds	3.157	(2.990)	2.781	(2.689)	2.811	(2.211)
Oil and gas	−0.015	(0.013)	−0.015	(0.014)	−0.022*	(0.013)
Spatial error (λ)	−0.678***	(0.158)	−0.544***	(0.138)	−0.157	(0.109)
Country fixed effects	Yes		Yes		Yes	
Observations	1,232		1,232		1,232	
R^2	0.560		0.570		0.569	

Notes: Dep. Variable: *Corruption*. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parenthesis. Spatial weight matrix: inverse distance with 500km distance band, row-normalized. Constant included but not reported.

Absolute wealth effects

As discussed in Section 2.2, the strength of subnational regions' spatial interdependencies in corruption levels depends on the extent of economic, political, and sociocultural exchange. A broad literature deals with the relationship between countries' levels of economic development and international market integration. In general, they find that countries with higher economic growth exhibit a higher degree of trade openness (see Edwards, 1998; Harrison, 1996; Frankel and Romer, 1999; Irwin

and Tervio, 2002). As shown in Borsky and Raschky (2015), the level of economic development influences to what extent regulatory standards are exchanged between countries. Economic development also plays a role for migration patterns. A higher level of economic development makes immigration more and emigration less attractive. This may hold for the subnational level the even more. For intensified economic and social exchange, we expect that corruption levels of upper middle to high income subnational regions disseminate more strongly than corruption levels of low to lower middle income subnational regions.[15] We extend the core model as follows:

$$\begin{aligned} y_{ic} &= \rho_r \sum_{j=1}^{J} \omega_{ij}^r y_j + \rho_p \sum_{j=1}^{J} \omega_{ij}^p y_j + X_i\beta + \theta_c + \mu_{ic}, \\ \mu_{ic} &= \lambda \sum_{j=1}^{J} \omega_{ij}\mu_j + \varepsilon_{ic}, \end{aligned} \tag{2.6}$$

where we split our baseline spatial weight matrix ω into two submatrices such that $\omega = \omega^r + \omega^p$. ω^r is a row-normalized spatial weight submatrix where each element $\omega_{ij}^r = \frac{1}{d_{ij}}$ only if subnational region j is characterized by an upper middle to high income and if subnational regions i and j are within a geographic neighborhood of 500km, and 0 otherwise. ω^p is a row-normalized spatial weight submatrix where each element $\omega_{ij}^p = \frac{1}{d_{ij}}$ only if subnational region j is characterized by a low to lower middle income and if subnational regions i and j are within a geographic neighborhood of 500km, and 0 otherwise. We estimate the model by the previously described instrumental variable procedure using the subnational region-specific independent variables X_i and their spatial lags $W^r X_i$ and $W^p X_i$ (which are differentiated for rich and poor subnational regions) as instruments for y_j.

Table 2.7 columns (2) present the results for the absolute wealth effects exercise. The coefficient estimate ρ_r, which measures the spatial impact of subnational regions with an upper middle to high income, is about twice as big as the coefficient estimate ρ_p, which measures the spatial impact of subnational regions with a low to lower middle income. This points at the importance of the level of economic development for the degree of connectivity among subnational regions. Richer subnational regions are more strongly connected and therefore have a greater influence on the corruption levels of other subnational regions.

[15] Following the World Bank Analytical Country Classification in the year 2005, we categorize subnational regions with a income per capita $\geq$ 3,466\$ as upper middle to high income subnational regions and subnational regions $<$ 3,466\$ as low to lower middle income subnational regions.

Relative corruption level effects

Following Kelejian et al. (2013), we investigate whether the strength of the spatial spillovers varies if a subnational region has a higher or a lower corruption level as compared to the average of its neighboring subnational regions. Differences in relative corruption levels may influence the strength of the diffusion. Presumably, it is easier to learn how to control corruption from less rather than more corrupt neighbors. Governments of less corrupt neighboring subnational regions may deliver best practices for setting up effective anti-corruption initiatives. Business partners operating in less corrupt subnational regions may push to decrease corruption levels in other subnational regions to reduce trade costs, uncertainties, and risks. People emigrating from less corrupt subnational regions may spread their beliefs and knowledge on a sound way of organizing interactions elsewhere. To account for this, we extend the core model as follows:

$$\begin{aligned} y_{ic} &= \rho_h \sum_{j=1}^{J} \omega_{ij}^h y_j + \rho_l \sum_{j=1}^{J} \omega_{ij}^l y_j + X_i\beta + \theta_c + \mu_{ic}, \\ \mu_{ic} &= \lambda \sum_{j=1}^{J} \omega_{ij}\mu_j + \varepsilon_{ic}, \end{aligned} \tag{2.7}$$

where we split our baseline spatial weight matrix ω into two submatrices such that $\omega = \omega^h + \omega^l$. ω^h is a row-normalized spatial weight submatrix for which each element $\omega_{ij}^h = \frac{1}{d_{ij}}$ if $y_i \geq y_j$ and subnational regions i and j are within a geographic neighborhood of 500km, and 0 otherwise. ω^l is a row-normalized spatial weight submatrix where each element $\omega_{ij}^l = \frac{1}{d_{ij}}$ if $y_i < y_j$ and subnational regions i and j are within a geographic neighborhood of 500km, and 0 otherwise. Again, we estimate the model by the previously described instrumental variable procedure using the subnational region-specific independent variables X_i and the spatial lags W^hX_i and W^lX_i (which are differentiated for subnational regions with high and low corruption levels) as instruments for y_j.

Table 2.7 columns (3) show the results for this empirical exercise. We find positive and statistically significant spatial spillovers when the neighbors are on average less corrupt and no spatial spillovers when the neighbors are on average more corrupt than the subnational region itself. This implies that relative corruption levels do play a role for the spatial diffusion of corruption as suggest by Kelejian et al. (2013). However, compared to the border and the wealth effects, the relative corruption level effects are smaller in size and lower in significance.

2.6 Conclusion

Corruption levels differ not only between but also within countries. Moreover, they are not randomly distributed, they tend to cluster in space. This paper discusses causes and provides empirical evidence for this spatial phenomenon which helps to get a better understanding of the determinants of corruption. Our main argument is that the corruption level in one subnational region is not only determined by nation-specific factors and its own subnational characteristics but also by the corruption levels of neighboring subnational regions. We extend the existing literature on spatial interdependencies of institutions by analyzing a large dataset of corruption levels of 1,232 subnational regions in 81 countries. To do this, we draw on subnational institutions data collected by Mitton (2016) and use an index variable that measures the perceived corruption level in a subnational region. To determine the strength of spatial interdependencies, we base our analysis on a generic spatial model and employ an instrumental variable procedure that accounts for the spatial autocorrelation in both the dependent variable and in the error term, and allows for heteroskedasticity in the innovations.

Our results indicate that subnational corruption levels are significantly correlated in space. Spatial interdependencies and feedback effects stemming from a marginal change in an independent variable are about the same size as direct effects. This means that the total effects of a marginal change in an independent variable are about twice as large as the coefficient estimate of this independent variable would suggest if a conventional model ignoring spatial effects was estimated. This insight underlines the importance of taking spatial effects into account when analyzing impacts of policy measures.

We provide evidence that the spatial interdependencies of corruption levels, which previous literature found among countries, also work among subnational regions. Investigating spatial spillovers at disaggregated levels has some merits which are of special interest for federal and regional policy design. Following Dong and Torgler (2012), it makes sense to coordinate subnational anti-corruption initiatives. Since federal and regional budgets are constrained and widespread institutional policies may be difficult to implement, the design of economically efficient institutional development policies should take advantage of spatial interdependencies among subnational regions. Coordination of policies is much more feasible at the subnational level for at least two reasons: First, it is much easier to coordinate policies within than across national borders. Second, neighboring subnational regions are much more similar in their characteristics and needs and have a much higher degree of

connectivity as compared to neighboring countries. More similar needs, more exchange, and higher feasibility make the coordination of policies among neighboring subnational regions much more attractive than among neighboring countries.

Moreover, the strength of spatial interdependencies varies with the characteristics of subnational regions. As we extend our core model to allow for heterogeneous spatial effects, we find three things: First, the majority of corruption spillovers takes place within countries. Second, in particular upper middle to high income subnational regions tend to spill in space. Third, neighbors with relatively low corruption levels spill more than neighbors with relatively high corruption levels. From these results we infer that the potential to spill in space lies in subnational regions' degree of connectivity which is larger within national borders and increases with economic development. Moreover, it seems to be more common to adapt to and absorb from neighbors that are less corrupt than oneself. This is in accordance with Kelejian et al. (2013).

We can draw important political implications from our findings. Most importantly, anti-corruption policy design should take both spatial interdependencies and spatial heterogeneity into account. Spatial targeting and spatial differentiation make anti-corruption initiatives more effective and more efficient. Concerning spatial targeting, our analysis can give more detailed policy recommendations. Concentrating measures to decrease corruption in countries' hubs promises substantial spillover effects. In general, hubs are subnational regions with a high degree of connectivity, such as subnational regions comprising the capital, highly market integrated subnational regions, and border subnational regions. As shown in our asymmetric effects exercises, richer subnational regions and subnational regions with relatively low corruption levels are hubs. Where direct local anti-corruption initiatives are either not possible or not effective, e.g., due to weak institutions, investing in connected hubs enables to indirectly battle corruption.

Our study has three limitations we shortly want to discuss: First, the preferred way to measure corruption levels would be by direct observation. Due to corruption's secretive nature, this is obviously difficult. Our measure for subnational corruption levels is based on perceptions which has some drawbacks. Respondents from different regions may respond differently to questions because of variation in societal norms. We address this issue by controlling for cross-country cultural differences in our estimations but cannot account for within-country variation in societal norms. Second, we cannot exclude the possibility that a fraction of the spatial lag coefficient estimate reflects spatial heterogeneity. We are nevertheless confident that our estimation procedure captures much of the spatial heterogeneity elsewhere and

that our spatial autoregressive parameter mainly reflects spatial interdependencies. Lastly, since we base our study on a cross-sectional dataset, we cannot account for the temporal effects of changes in corruption levels. The evolution of corruption, however, is a path-dependent process in which present corruption levels depend on past corruption levels. It is therefore both historical and current spillovers in the corruption levels that our spatial lag coefficient estimate captures. Analyzing spatial interdependencies of observed corruption levels as well as extending the dataset over multiple time periods would be an interesting expansion for future studies on the determinants of corruption as data on observed corruption levels over time gets more available (see Fazekas and Kocsis, 2017).

The next chapter picks up and elaborates more thoroughly on two insights gained from studying spatial interdependencies of subnational corruption levels: The first insight concerns the importance of country-specific factors. As they explain half of the variation in subnational corruption levels, the national affiliation seems to matter a lot for the quality of institutions. This is supported by the results of an extended core model exercise which reveal much stronger spillovers in subnational corruption levels within versus across national borders. The second insight considers the endogenous nature of institutions. Spatial spillovers in subnational corruption levels only work because agents from different subnational regions adopt more or less corruptive activities by learning from or reacting to each other. This makes corruption levels equilibrium outcomes of strategic interactions. Chapter 3 introduces a theoretical framework that helps to get a better understanding of why institutions are equilibrium outcomes of strategic interactions and why we observe a variety of national institutional set-ups. Country-specific factors and complementarity conditions will play a central role to understand cross-country differences institution-building and institutional change as well as the great challenges for the EU integration process.

Chapter 3

The EU and Varieties of Capitalism

3.1 Introduction

The crisis of the EU is a hotly debated topic in politics, academia, and media. Talking about crisis in singular disguises the number of interconnected crises which together threaten the continuity of the EU. One could refer to a financial and euro crisis among the members of the Economic and Monetary Union (EMU), an economic competitiveness crisis of the Southern European countries, a legitimation crisis of EU regulations, EU bodies and EU representatives, and a solidarity crisis among EU citizens. The latter recently became apparent in disagreements on policies regulating migration inflows into Europe. In this analysis, we look at the multidimensional crisis of the EU and the different manifestations in its member states from an institutional perspective.

We argue that the EU integration process has run into trouble because the underlying national institutional set-ups are too different to work smoothly under common regulations. From the European Commission's perspective, the consequence of the single market is a non-discriminatory environment which requires common regulations in all member states. Unfortunately, the same regulations do not produce the same outcomes if introduced in member states with different economic conditions and different institutional set-ups. We understand institutional set-ups as *institutional systems* that are characterized by complementarities among institutions within and between different domains of societies. If there exists a variety of national institutional systems within the EU as suggested by the Varieties of Capitalism literature, then: (i) common regulations cannot be optimal for every member

state, and (ii) structural reforms only succeed if they alter sets of institutions and not just single elements.

We propose a theoretical framework on institution-building and institutional change that allows the evolution of a variety of national institutional systems within the EU and explains the diverging consequences of common regulations for member states with different institutional set-ups. We build on and adapt Aoki (2001)'s game-theoretical approach that sees institutions endogenously created by different sets of agents in strategic interactions. These agents play games that are synchronically and diachronically interlinked. The EU integration process has intendedly and unintendedly altered the environmental conditions in which agents make action choices and thereby (re)produce institutions. In some member states, market integration has reinforced, while in others, it has challenged the functioning of pre-integration national institutional systems. Among those with challenged systems, some have experienced institutional changes, while others have not.

The European Commission (2017) proposes five different scenarios for the future EU integration process. The single market and the common currency form the basis for all scenarios. Strengthening the single market is expected to increase welfare in all member states. This premise is understandable considering that in the past the EU has served as an anchor to stabilize economies on several occasions. However, we are afraid that the hoped-for welfare effects will fail to materialize if the persistent heterogeneity of member states' institutional set-ups is not taken into account.

To make our point as clear as possible, we briefly discuss the literature in Section 3.2 and provide arguments and evidence that institutions are effective in systems. In Section 3.3, we summarize the basics of Aoki (2001)'s game-theoretical approach to understand why institutions are endogenous outcomes of strategic interactions and which mechanisms lead to the evolution of heterogeneous national institutional systems. In Section 3.4, we show what we can learn from the game-theoretical approach to understand the challenges of the EU integration process. In Section 3.5, we briefly present the five scenarios proposed by the European Commission, review their suitability on basis of our theoretical framework, and give recommendations on what should be considered when moving forward. In Section 3.6, we conclude.

3.2 Institutions work in systems

Acemoglu and Johnson (2005) have revitalized a debate on the role of institutions for economic development. They initiated an empirical literature that aims to isolate the effects of different types of institutions and assess their relative importance for economic outcomes. This research has given development economics a push. McCloskey (2016), however, argues that looking at institutions in isolation is insufficient. McCloskey compares Italy and New Zealand to illustrate that differences in ranks in institutional indices do not necessarily mirror GDP per capita differences. While there is an average difference of 70 ranks in various World Bank indices measuring institutional quality (World Bank, 2018), Italy and New Zealand have similar GDP per capita levels (in PPPs). McCloskey concludes that something is missing in the explanation of development that must be added to institutions: ethics in her argument, or the S factor as she calls *speech, stories, shame, and the Sacred* (McCloskey, 2016):4.

We do not deny that ethics play an important role. Indeed, one may argue that ethics are informal institutions. However, we want to put forward a different explanation for the discrepancy between countries' rankings in institutional quality indices and GDP per capita levels. We argue that not single but *sets of institutions* jointly organize economic activities. Political institutions are just one set. The set of political institutions may, however, be effective in combination with other sets of institutions, e.g., a set of economic institutions or a set of cultural traits. Each set can differ across countries in both the composition and the relative importance of single elements. To illustrate, industrial relations in Japan or Italy depend much more on long-term relationships than those in the United States. The rank in rule of law should therefore be less important for Japan and Italy (rank 25 for Japan and rank 82 for Italy in 2016) and more important for the United States (rank 17 in 2016). Italians may have found institutional solutions to coordinate economic activities in which legal conflicts are the exception and in which other means than the legal system create a common basis for investment and transactions.

In different fields of microeconomics it is well elaborated that not a single institution but sets of institutions jointly organize economic activities. Milgrom and Roberts (1990, 1995) discuss the role of complementarities among firm activities for the optimal set-up of production processes. A successful firm organizes its numerous activities using sets of adjusted institutions that jointly shape business strategy, managerial structure, and the production process. In a simple principal-agent model, Heinrich (2000) shows that a set of instruments is required to find the right

balance between giving the manager enough incentives and sharing enough risks with the owner. Blau and Scott (1962), Gibbons (2005) and Baker et al. (2001, 2002) add that complementarities do not only play a role for formal organizational practices but also in their interplay with informal ones. All these studies suggest that institutions do not merely coexist but are effective as a system.

Moreover, there is not only one possible institutional solution for organizing economic activities. Holmström and Roberts (1998) show in very telling case studies that a firm may choose among a variety of sets of corporate institutions to organize firm activities. They illustrate that two firms' institutional set-ups can look very different despite undertaking similar activities, facing similar coordination tasks, and mitigating the same trade-offs. Firms' choices among alternative sets of corporate institutions depend on national institutions for which complementarities also matter. Milgrom and Roberts (1994) explain the economic success of Japan up to the early 1990s and its problems afterwards with the design of a complex system of complementary national institutions. This system is hard to adjust when the environment changes. Japan's institutional set-up was well-designed for rapid economic catch-up with the United States and Western European countries, but it did not work as successfully as other economies at the technological frontier. To make their point formally, Milgrom and Roberts (1994) adapt the "theory of supermodularity and complementarity" developed by Topkis (1978). Here, we draw on this theory and bring it in a game-theoretical setting to study the challenges of the EU integration process.

3.3 Institutions as endogenous outcomes

From North (1991) we have learned that institutions are the rules of the game that provide incentives and constraints to structure political, economic, and social interactions. In North's framework, the rules are exogenous. We want to put emphasis on the endogenous nature of institutions and the need for laws, regulations and guidelines to be institutionalized in order to become effective. To do this, we draw on Aoki (2001) who defines institutions as *common beliefs about the rules of the game* that are "endogenously created through the strategic interactions of agents, held in the minds of agents, and are thus self-sustaining" as equilibrium of a game (Aoki, 2001):10.

3.3.1 Game-theoretical foundations

Let there be a set $N = \{1, 2, ..., n\}$ of a finite number of agents and a set of all technologically feasible actions, one for each agent i such that $\mathcal{A}_i = \{a_i\}$. The combination of actions of all agents is called an action profile. $\mathcal{A} = \times_i \mathcal{A}_i = \{\mathbf{a}\} = \{a_1, a_2, ..., a_n\}$ is the set of technologically feasible action profiles. Time is denoted by t and the realized action profile $\mathbf{a}$ in t is the state of the domain. The set of consequences of action profile $\mathbf{a}$ is denoted by Ω. Let a consequence function ϕ assign for each possible $\mathbf{a}$ in $\mathcal{A}$ a consequence ω in Ω which makes $\omega = \phi(\mathbf{a})$. The shape of the consequence function ϕ depends on a set of parameters $\mathcal{E} = \{e\}$ which determine the state of the environment. Environmental parameters relate to, e.g., the state of technology, initial endowments of resources, laws, regulations, policies.

Agents' action choices are not necessarily observable by others, but their consequences are. In each period agents choose one action according to their action choice rules $s_i : \Omega \to \mathcal{A}_i$ that is based on observable consequence of the action profile realized in the previous period which is $a_i(t+1) = s_i(\omega(t))$. This means agent i bases the action choice in $t+1$ on the observed consequences in t. Action choice rules and the consequence function define the transition of the state of the economy over time as $\mathbf{a}(t+1) = s(\phi(\mathbf{a}(t))) = F(\mathbf{a}(t))$ for all t, where $F : \mathcal{A} \to \mathcal{A}$ is the transition function. A steady-state equilibrium is reached if $\mathbf{a}(t) = \mathbf{a}(t+1) = \mathbf{a}(t+2) = ... = \mathbf{a}^*$, where all agents make the same action choice in every period. The steady state hinges on agents' action choice rules that are guided by the maximization of agents' payoff functions u_i defined in the consequence space.

In repeated games, agents need to be foresighted and take into account the impact of present action choices on future payoffs. Therefore, agents form expectations of other agents' action choice rules and set up strategy plans of present and future action choices contingent on the evolving state. Future payoffs are discounted at a positive discount factor δ. Assume that $\Omega = \mathcal{A}$ and $\omega(t) = \mathbf{a}(t)$, meaning that the consequence of the game in each period is completely described by the action profile in that period. The action choice rules of agents are then given by the functional form $s_i(.) : \mathcal{A} \to \mathcal{A}_i$. The transition function $F(.)$ is simply given by the combination of agents' action choice rules $\mathbf{s(.)} = \{s_1(.), s_2(.), ..., s_n(.)\}$ that we call a strategy profile. The initial internal state of the game is $\mathbf{a}(t)$. The game evolving from that period on is a subgame. The internal state of the subgame at time $\tau > t$ evolving according to the strategy profile is $\mathbf{s}(\tau : \mathbf{a}(t))$.

Denote $\sigma_{-i}(.) : \mathcal{A} \to \mathcal{A}_i$ as i's expectation of other agents' action choice rules. If the expectation of each agent about others' action choice rules is consistent with

others' actual action choices and if the action choice of each agent is the best response to the expectation for all subgames starting from any $t \geq 0$, irrespective of the state $\mathbf{a}(t)$ at that point, then there exists a strategy profile $\mathbf{s}^*(.)$ that maximizes i's payoff such that:

$$\sigma_{-i}(\tau : \mathbf{a}(t)) = \mathbf{s}^*_{-i}(\tau : \mathbf{a}(t)),$$
$$\mathbf{s}^*_i(.) \in \underset{s_i(.)}{\operatorname{argmax}} \sum_{\tau > t} \delta^{\tau - t} u_i(s_i(\tau : \mathbf{a}(t)), \sigma_{-i}(\tau : \mathbf{a}(t))$$

for all $\mathbf{a}(t) \in \Omega, t \geq 0$ and i. The strategy profile $\mathbf{s}^*(.)$ is a *subgame perfect equilibrium*. $\mathbf{s}^*(.)$ is *self-sustaining* because no agent $i \in N$ has an incentive to unilaterally deviate from the specified strategy. The state-constituting action choices are sequentially observed by all agents period after period as the steady-state outcome. Its trajectory is $\mathbf{a}(t) = \mathbf{a}(t+1) = ... = \mathbf{a}(t+n) = \mathbf{a}^* = \mathbf{s}^*(\mathbf{a}^*)$. The trajectory is the path of the play that realizes if every agent follows their own equilibrium strategy plan. Agents also form expectations on off-the-path-of-play states that may be interpreted as rational beliefs about how the other agents act when unexpected states occur, such as by accident, mistake, or experiment.

The expectations constrain the actual observable history to a certain sequence of internal states by eliminating all Nash equilibria that contain an incredible threat. The concept of subgame perfect games can considerably reduce the number of Nash equilibria in repeated games but not necessarily to one. There may exist a set of steady-state equilibria $\mathcal{A}^{\mathbf{P}} = \{\mathbf{a}^*, \mathbf{a}^{**}, \dots\}$ and a set of strategy profiles $\mathcal{S}^{\mathbf{P}} = \{\mathbf{s}^*, \mathbf{s}^{**}, \dots\}$ that all constitute subgame perfect equilibria.

3.3.2 Institutions as summary representations of equilibria

Agents cannot and need not form expectations regarding every detail of all other agents' action choice rules. They are guided as well as constrained in their action choices by institutions that convey compressed information on the equilibrium strategy profile. Suppose that for a stationary environment there exists the equilibrium strategy profile $\mathbf{s}^* = \{s_1^*, s_2^*, ..., s_n^*\} \in \mathcal{S} = \times_i \mathcal{S}_i$, where $\mathcal{S}_i$ denotes the set of action choice rules of i. With equilibrium $\mathbf{s}^*$, there is an associated function $\Sigma_i^*(.)$ for each i that maps $\mathcal{S}$ into a space of the smallest dimensionality such that:

$$\text{whenever} \quad \Sigma_i^*(\mathbf{s}) = \Sigma_i^*(\mathbf{s}^*) \text{ for } \mathbf{s} \in \times_i \mathcal{S}_i,$$
$$\mathbf{s}_i^*(\phi(s)) = \mathbf{s}_i^*(\phi(\mathbf{s}^*)).$$

$\mathcal{S}_{-i}$ is the set that includes the action choice rules of all other agents. In $\mathcal{S}_{-i}$, there exists a subset $\mathcal{S}_{-i}(\mathbf{s}^*)$ which contains $\mathbf{s}^*_{-i}$, the equilibrium strategy plans of all other agents such that if $\mathbf{s}_{-i} \in \mathcal{S}_{-i}(\mathbf{s}^*)$, then $s_i = s_i^*$. Denote $\mathcal{S}_{-i}(\mathbf{s}^*)$ as i's information set on the equilibrium strategy profile and $\Sigma_i^*(\mathbf{s}^*)$ as its corresponding summary representation. $\Sigma_i^*(\mathbf{s}^*)$ provides enough information regarding the equilibrium strategy profile for i to form expectations about others' equilibrium strategy plans and to set up i's own optimal strategy plan s_i^*. All details of the equilibrium that are not included in the summary representation are redundant and irrelevant to i. This entails that if i receives $\Sigma_i^*(\mathbf{s}^*)$ in an off-the-equilibrium-path state, then i continues to follow s_i^* as if the state was on the path.

$\Sigma_i^*(\mathbf{s}^*)$ consists of two parts: A system of common beliefs Σ^* and private residual information about the internal state of the domain $I_i^*(s^*)$. The former is the common feature of private summary representations over all agents implied by $\langle s_i^*, \Sigma_i^*(\mathbf{s}^*)\rangle$. Σ^* captures the *common beliefs about the equilibrium held by all agents*, that is, their shared understandings and cognitions on the rules of the game. Σ^* is characterized by five properties: Endogeneity, information compression, durability, universality and multiplicity. Durability entails that Σ^* has to be persistent within a certain bound of the state of the environment $\hat{\mathcal{E}}$. Let e be the state of the environment for which a strategy profile $\mathbf{s}^*(e)$ and a respective summary representation $\Sigma^*(\mathbf{s}^*(e))$ exist. If the state of the environment is only mildly changing such that $e \in \hat{\mathcal{E}}$ holds, the equilibrium strategy profile remains invariant and Σ^* is reproduced.

3.3.3 Institutional complementarities

In complex societies, millions of agents play a number of games in different social domains. These games are interlinked. We rely on the theory of supermodularity based on Topkis (1978), put into the institutions context by Milgrom and Roberts (1990), and adapted to the endogenous outcome conception of institutions by Aoki (2001), in order to show how institutions build systems that are characterized by manifold complementarities.

Consider two games that are interlinked. The two games can take place in the same or in different domains of the society, which does not make any difference for the mechanism we want to show. Assume the games are played by two different sets of agents in two different domains for which two different institutions are produced to guide agents in making optimal action choices. Denote $\mathcal{M}$ as the set of agents operating in the economic domain. The economic agents produce and are guided by the economic institution Σ. Denote $\mathcal{P}$ as the set of agents operating in the political

domain. The political agents produce and are guided by the political institution Λ. The two sets of agents are not allowed to interact directly, but their action choices are influenced by both institutions. First, and as elaborated in the previous section, the institution prevalent in one domain informs the agents operating in this domain about the equilibrium of the game. Second, the institution prevalent in the other domain becomes an environmental parameter and shapes the consequence function. Assume for now that the institution in the other domain is the only relevant parameter determining the state of the environment. Further, restrict the possible institutions that may be produced to two alternatives: $\{\Sigma^*, \Sigma^{**}\}$ in the economic domain and $\{\Lambda^*, \Lambda^{**}\}$ in the political domain. The payoff functions are given by $u_i = u(i \in \mathcal{M})$ for economic agents and $v_j = v(j \in \mathcal{P})$ for political agents. If in neither domain one alternative institution dominates the other in maximizing agents' payoffs irrespective of which institution prevails in the other domain, then there exist *institutional complementarities* such that:

$$\begin{aligned} u(\Sigma^*, \Lambda^*) - u(\Sigma^{**}, \Lambda^*) &\geq u(\Sigma^*, \Lambda^{**}) - u(\Sigma^{**}, \Lambda^{**}) \\ v(\Lambda^{**}, \Sigma^{**}) - v(\Lambda^*, \Sigma^{**}) &\geq v(\Lambda^{**}, \Sigma^*) - v(\Lambda^*, \Sigma^*). \end{aligned} \tag{3.1}$$

The first line of (3.1) states that the economic agents yield higher payoffs with institution Σ^* (Σ^{**}) if their environment is the political institution Λ^* (Λ^{**}). Likewise, the second line states that having institution Λ^{**} (Λ^*), the political agents achieve a higher payoff if their environment is the economic institution Σ^{**} (Σ^*). The differences between the left-hand and the right-hand sides are extra payoffs accruable to the agents when complementary institutions prevail. These extra payoffs may, e.g., stem from mutually reinforcing incentives or constraints that optimize the organization of economic activities. Under the stated supermodularity conditions, there are two Nash equilibria— (Σ^*, Λ^*) and $(\Sigma^{**}\Lambda^{**})$—among the four possible combinations of institutions. In literature, combinations of institutions are sometimes called institutional arrangements. In this setting, we prefer to call them *institutional systems* as this underlines that the effectiveness of the institutions are interdependent. When a simultaneous game is played, coordination is needed to establish a system of institutions that is a Nash equilibrium. In repeated games, a Nash equilibrium can settle even without coordination. However, since both institutions are produced and sustained by different sets of agents who independently maximize their payoffs, it may take time until the institutional system settles to a Nash equilibrium if the two sets of agents are not allowed to interact or if information is asymmetric.

3.3.4 Institutional environments

Let's relax the assumption that the institution prevalent in the other domain is the only relevant environmental parameter. Consider another, domain-specific parameter that, besides the institution prevalent in the other domain, also influences the shape of the consequence function. We apply the momentum theorem proposed by Milgrom et al. (1991), and adapted in Aoki (2001), to show how (i) differences in the environment make different institutional systems optimal, and (ii) exogenous shocks and internal movements can induce environmental and institutional change. Let θ be a parameter specific to the economic domain, e.g., the state of technology, or physical and human capital endowments. Let η be a parameter specific to the political domain, e.g., the level of corruption, or the degree of constraints on executives. Each payoff function has *increasing differences* in its institution and the domain-specific parameter if:

$$\begin{aligned} &u(\Sigma^* : \Lambda, \theta) - u(\Sigma^{**} : \Lambda, \theta) \text{ is increasing in } \theta \text{ for any fixed value of } \Lambda, \\ &v(\Lambda^* : \Sigma, \eta) - v(\Lambda^{**} : \Sigma, \eta) \text{ is increasing in } \eta \text{ for any fixed value of } \Sigma. \end{aligned} \tag{3.2}$$

The first line in (3.2) implies that the parameters are ordered in such a way that a higher value of θ enhances the fit of the economic institution Σ^* vis-a-vis Σ^{**} for any fixed value of the political institution Λ. Likewise, a higher value of η enhances the fit of Λ^* vis-a-vis Λ^{**} for any fixed value of Σ. Shifts in the values of a domain-specific parameter may change the optimality of not only one institution but the whole system. Assume that Λ^* has evolved in one domain and Σ^{**} in the other in spite of unused complementarities which could occur if the level of θ is sufficiently low and the level of η is sufficiently high. As θ increases, the condition for the evolution of a system with complementary institutions improves. An increase of θ can happen for external or internal reasons. The former includes a θ-specific shock, e.g., an increase in any resource endowment or the invention of a new technology. The latter considers the coevolution of institutions and environmental parameters. To capture this coevolution, denote institution and parameter values at time t by (t) and let parameter values change over time according to the *dynamic system*:

$$\begin{aligned} \theta(t+1) &= F[\theta(t), \eta(t), \Sigma(t), \Lambda(t)], \\ \eta(t+1) &= G[\theta(t), \eta(t), \Sigma(t), \Lambda(t)]. \end{aligned} \tag{3.3}$$

F and G are nondecreasing in all parameters and institutions until unmodeled forces, i.e., shocks, disturb the system. As long as our system moves according

to (3.3), the parameter values do not receive a negative but possibly a positive feedback from the endogenous institutions. This entails that institution-compatible physical capital, human capital, and technologies are continually accumulated and no institution-compatible policy is reversed in either domain. Agents choose actions according to equilibrium strategy plans, their expectations are met and common beliefs about the rules of the games are reinforced. As institutions are reproduced, further institution-compatible physical capital, human capital, and technologies are accumulated. In the absence of shocks, the environmental parameters and institutions coevolve monotonically towards the direction of their best fit.

3.4 Challenges for EU integration

Since the foundation of the European Coal and Steel Community in 1951, European countries have gradually integrated their markets. Over decades, national governments have agreed in numerous consecutive treaties to abolish barriers of international trade, prevent distortion of competition in national markets, and jointly regulate areas of common interests, such as agriculture, energy, and transport markets. In 1993, the Maastricht Treaty formally established the EU, a political and economic union that now includes 27 member states. Common regulations extended, replaced, or required the adaption of national regulations. Together with globalization and technological progress, EU integration has changed institutional environments and affected the national institutional system of every member state. In this section, we apply Aoki (2001)'s game-theoretical approach of institution-building and institutional change to understand the challenges for EU integration.

3.4.1 Varieties of Capitalism in the EU

Soskice and Hall (2001) provide empirical evidence that national institutions indeed form a system that is to a considerable degree characterized by complementarities within and across different domains of a society. Moreover, they show that national institutional systems can look very similar among some countries and very different to others. Amable (2003) finds that often geographic distance can approximate the degree of similarity. Neighboring countries tend to share more institutional characteristics than countries further away from each other. Within Europe, Amable identifies four groups of countries: (i) a Northern group (Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, and in some respects the Netherlands and Ireland), (ii) an Eastern group (Poland, Czech Republic, Slovakia, Hungary), (iii) a Southern

group (Portugal, Spain, Italy, Greece), and (iv) a Central European group (Belgium, France, Germany, Austria, Slovenia, and in some respects the Netherlands). These groups of countries differ significantly in their institutional set-ups as shown in principal component analyses that organize many institutional variables along the five dimensions: product market competition, labor markets, financial markets, social protection, and education.

The supermodular game approach proposed here helps to understand the underlying mechanisms that lead to the evolution of different national institutional systems among (groups of) member states. To exemplify, let agents in member state 1 establish one out of the two alternative political institutions $\{\Lambda^*, \Lambda^{**}\}$ in period t and one out of the two alternative economic institutions $\{\Sigma^*, \Sigma^{**}\}$ in period $t+1$. Moreover, let member state 1 be characterized by a political environment η with a high parameter value. In the presence of increasing differences as stated in (3.2), the set of political agents $\mathcal{P}$ will institutionalize Λ^* in period t as their payoff function is $v(\Lambda^* : \eta) \geq v(\Lambda^{**} : \eta)$. Having Λ^* as an institutional environment, the set of economic agents $\mathcal{M}$ will institutionalize Σ^* in period $t+1$ if their payoff function is $u(\Sigma^* : \Lambda^*, \theta) \geq u(\Sigma^{**} : \Lambda^*, \theta)$, which requires a sufficiently high level of the economic environment θ and/or sufficiently strong institutional complementarities as stated in (3.1). If this requirement is met, the optimal institutional system (Σ^*, Λ^*) will be established in member state 1. Following the same logic for member state 2 but assuming a low parameter value of the political environment η, a sufficiently low parameter value of the economic environment θ and/or strong institutional complementarities, $(\Sigma^{**}, \Lambda^{**})$ will be established in member state 2.

The example shows that the evolution of an institutional system is path-dependent and hinges on (i) past and present environmental conditions, and (ii) the presence and strength of institutional complementarities. Together they can explain why European countries have evolved structurally different national institutional systems. Having different national institutional systems within the EU raises the question of superiority and inferiority. However, institutional systems cannot always easily be ranked with respect to their optimality. One reason is that they may not be mutually Pareto comparable, which is the case if $u(\Sigma^*, \Lambda^*) > u(\Sigma^{**}, \Lambda^{**})$ and $v(\Sigma^*, \Lambda^*) < v(\Sigma^{**}, \Lambda^{**})$, meaning one system may produce superior outcomes for one set of agents and inferior outcomes for the other.

Some institutional systems are clearly inferior to others for the society as a whole. This is the case if $u(\Sigma^*, \Lambda^*) > u(\Sigma^{**}, \Lambda^{**})$ and $v(\Sigma^*, \Lambda^*) > v(\Sigma^{**}, \Lambda^{**})$. Nevertheless, even an inferior system may survive, e.g., when single powerful agents block institutional change because they achieve higher individual payoffs in the inferior

system. Also, an inferior system may survive due to locked-in effects. Suppose that system (Σ^*, Λ^*) is superior to system $(\Sigma^{**}, \Lambda^{**})$ in terms of joint payoffs that reflect global welfare. Once established in member state 2, $(\Sigma^{**}, \Lambda^{**})$ may be robust to a change to (Σ^*, Λ^*) if extra payoffs caused by strong institutional complementarities block the change. If $u(\Sigma^{**}, \Lambda^{**}) > u(\Sigma^*, \Lambda^{**})$, then it is not beneficial for the economic agents to change to institution Σ^*. If $v(\Sigma^{**}, \Lambda^{**}) > v(\Sigma^{**}, \Lambda^*)$, then it is not beneficial for the political agents to change to institution Λ^* either. As long as the two sets of agents do not coordinate, institutional complementarities will prevent institutional change towards the superior system (Σ^*, Λ^*).

3.4.2 Market integration and institutional environments

The integration of national markets within the EU promised to be an engine for institutional change, helping member states to overcome inferior institutional systems and increase welfare. The common economic regulations introduced to facilitate the single market have changed national institutional environments, especially in the EMU area. Market integration led to changes in economic agents' payoffs of action choices in all member states, however, the degree of changes and the implications thereof differed considerably. For some member states, the changes turned out to be not in the way expected or hoped-for. In some respects, EU integration entrenched or even widened the gap between (groups of) member states. This created a great challenge for the EU integration process.

From the supermodular game approach we can learn something about the consequences of integrating national markets for action choices, equilibrium strategy profiles, and institutions. Member states' different reactions to common economic regulations can be captured by country-specific consequence functions. National differences in resource endowments, human capital, states of technology, and industrial policies cause the state of the environment in the economic domain to be idiosyncratic for every member state. A country-specific environmental parameter θ_c entails a country-specific consequence function ϕ_c for $C = 1, 2, \ldots, 27$ member states. If $\omega_c = \phi_c(\mathbf{a})$, as stated in Section 3.3.1, then we have cross-country differences in consequences on action profiles $\mathbf{a}$. As $a_i(t+1) = s_i(\omega_c(t))$ also becomes country-specific, member states may have different optimal action choices, strategy profiles, and institutions.

To show the implications of integrating national markets, we continue with the example from above. Remeber that (Σ^*, Λ^*) has been established in member state 1 and $(\Sigma^{**}, \Lambda^{**})$ in member state 2 by period $t+1$ as a result of differences in the values

of domain-specific environmental parameters. Introducing a set of common economic regulations to facilitate an integrated market at some period $S > t+1$ changes the shape of ϕ_c in both member states in two ways: First, the harmonization of a set of economic regulations makes θ_c more similar across member states. Second, as barriers of trade disappear and competition increases the strategy profile of economic agents operating in one member state becomes an environmental parameter for economic agents operating in the other member state.

Denote a set of possible strategy profiles in a member state $\mathcal{S}_c = \{s_c\}$. Assume for simplicity that economic agents in c have a binary choice set of optimal strategy profiles $\mathcal{S}^{\mathbf{P}} = \{\mathbf{s}^*, \mathbf{s}^{**}\}$ for which the respective institutions $\{\Sigma^*, \Sigma^{**}\}$ are established. In the integrated market, the consequence function ϕ_c becomes $u_c(\mathbf{s}_c : \mathbf{s}_{-c}, \theta_c, \Lambda)$, with $\mathbf{s}_{-c}$ denoting the strategy profiles prevalent in other member states. In the presence of institutional complementarities as in (3.1) and with increasing differences as in (3.2), ϕ_c is supermodular and assimilative in the limited sense. This means for $\mathbf{s}_c$ that if any of $\mathbf{s}_{-c}$, θ_c or Λ shifts from $\mathbf{s}^{**}_{-c}, \theta_L$ or Λ^{**} to $\mathbf{s}^{*}_{-c}, \theta_H$ or Λ^*, then the payoff differential $u_c(\mathbf{s}^*_c : \mathbf{s}_{-c}, \theta_c, \Lambda) - u_c(\mathbf{s}^{**}_c : \mathbf{s}_{-c}, \theta_c, \Lambda)$ becomes greater for all economic agents in member state c. Therefore, the incremental benefit of switching strategy profile from $\mathbf{s}^{**}_c$ to $\mathbf{s}^*_c$ increases if (i) the strategy profile $\mathbf{s}^*_{-c}$ prevails in the other member states, (ii) market integration increases the level of the environmental parameter specific to the economic domain in member state c, and (iii) the political institution Λ^* prevails in member state c.

The direction and degree to which θ_c changes after market integration vary across member states. This will, however, determine whether individual and joint payoffs achieved from pre-integration strategy profiles and national institutional systems will increase or decrease in all periods $t > S$ and whether they will remain optimal or adjustments are needed.

3.4.3 Market integration and institutional change

Recall that robustness is one characteristic of institutions and that changes in the state of the environment within a certain threshold do not alter optimal strategy profiles and institutions. In the example of the previous section, the environment of the economic domain before market integration is a function of two parameters, $e = f(\theta_c, \Lambda)$. Market integration extends the environment with the strategy profiles of economic agents in the other member states. With the additional parameter, the environment becomes a function of three parameters, $e = f(\mathbf{s}_{-c}, \theta_c, \Lambda)$. In member states in which market integration causes changes in the environment within the

threshold $e \in \hat{\mathcal{E}}$, economic agents do not alter action choices in periods $t > S$ and pre-integration strategy profiles and institutions remain robust. In member states in which market integration induces a change in the environment such that $e \notin \hat{\mathcal{E}}$, pre-integration strategy profiles and institutions are no longer optimal. The costs of integration are then a malfunctioning of prevalent national institutional systems which manifests in (temporary) reductions in payoffs and possibly triggers institutional change.

To exemplify this, reconsider member state 2 in which $(\Sigma^{**}, \Lambda^{**})$ has evolved until $t+1$. Market integration at S causes an increase in the level of θ_2, where the subscript identifies member state 2. Following the dynamic system in (3.3), we get $\theta_2(t+1) \geq \theta_2(t)$ and $\eta_2(t+1) \geq \eta_2(t)$ for all $t > S$, which—following increasing differences in (3.2)—gradually enhances the relative fit of Σ^* and Λ^* vis-a-vis Σ^{**} and Λ^{**} irrespective of what strategy profile $\mathbf{s}_1$ the economic agents in member state 1 apply. For a sufficiently large θ_2 achieved by the dynamic process, we obtain the stronger version of increasing differences $u_2(\Sigma^* : \Lambda^{**}, \mathbf{s}_1, \theta_2(T_1)) - u_2(\Sigma^{**} : \Lambda^{**}, \mathbf{s}_1, \theta_2(T_1)) > 0$ at some period $T_1 > S$. In order to maximize their payoffs, economic agents operating in member state 2 review their action choices, change strategy plans, form new common beliefs on the rules of the game, and replace the old institution Σ^{**} with the new institution Σ^*.

Suppose that while new common beliefs institutionalize in the economic domain to form Σ^* at T_1, institution Λ^{**} prevails in the political domain with a payoff function of $v_2(\Lambda^* : \Sigma^*, \eta_2(T_1)) < v_2(\Lambda^{**} : \Sigma^*, \eta_2(T_1))$. This occurs if the environmental parameter value η_2 is still sufficiently low at period T_1. Nevertheless, following the dynamic process, η_2 increases gradually from $t > S$ onwards as a reaction to the increased value of θ_2. The change in the economic institution to Σ^* at period T_1 and the prevalence of or a switch to $\mathbf{s}_1^*$ by economic agents operating in member state 1 will accelerate the increase of η_2 in member state 2. If the dynamic process is not disrupted, there will be a period $T_2 > T_1$ where $v_2(\Lambda^* : \Sigma^*, \eta_2(T_2)) > v_2(\Lambda^{**} : \Sigma^*, \eta_2(T_2))$. At this point, the political agents review their action choices, change their strategy plans, update common beliefs, and replace Λ^{**} by Λ^*. At period T_2 a new institutional system (Σ^*, Λ^*) evolves that is superior to the old one with respect to maximizing national welfare in the new environment. Figure 3.1 places the transition process between equilibria in member state 2 onto a timeline.

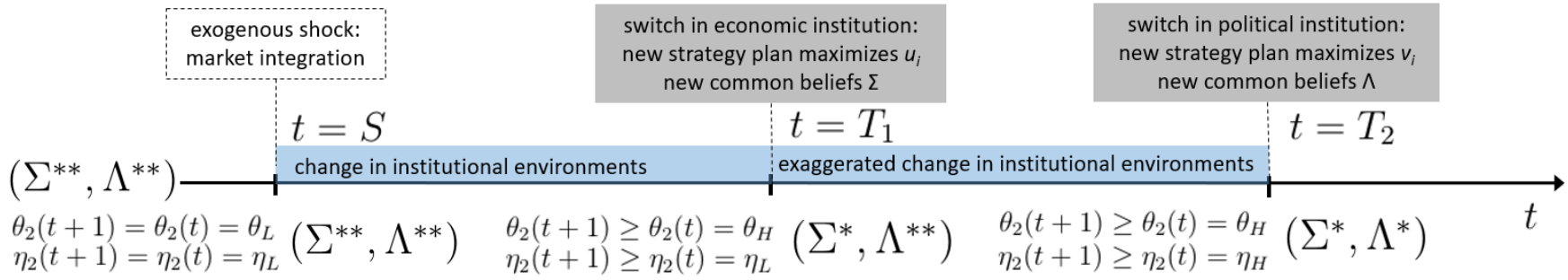

Figure 3.1: Steps of environmental and institutional change in member state 2

3.4.4 EU legislation and institutional uncertainties

EU legislation has harmonized parts of national legislations. This caused drastic changes in the state of environments and the shape of consequence functions in all EU member states. In member states where the changes decreased the suitability of pre-integration strategy profiles and institutions, individual payoffs and national welfare decreased. In the new environment, old institutions were no longer helpful for agents to form expectations and make optimal action choices. When the gap between aspiration and achievement of payoffs was large enough, agents lost their faith in the old institutions, did no longer stick to old strategy plans, and began to experiment with action choices. Institutional uncertainties arised.

Under institutional uncertainties, agents draw on private information to choose actions off the old equilibrium path. Recall from Section 3.3.2 that in addition to the common beliefs about the rules of the game summarized in Σ, each agent i processes and progresses private information $I_i(\mathbf{s})$ about the state of the domain. Together, they constitute individual beliefs about the rules of the game $\Sigma_i(\mathbf{s})$. If Σ becomes uninformative, i forms $\Sigma_i'(\mathbf{s})$ based on $I_i'(\mathbf{s})$ which includes information on the new state of the environment. Based on $I_i'(\mathbf{s})$, i chooses strategy s_i' that i expects to maximize own payoffs. If other agents' realized strategies do not correspond to i's expectations and s_i' consequently fails to be a best response to others' realized strategies s_{-i}', then i's new beliefs about the rules of the game $\Sigma_i'(\mathbf{s})$ are not confirmed and i continues to experiment. This means i updates private information to $I_i''(\mathbf{s})$, forms new beliefs $\Sigma_i''(\mathbf{s})$, and tries new strategies s_i''. Only if a critical mass of agents succeeds to adjust individual beliefs and strategy plans, the domain settles to a new equilibrium with a new self-sustaining strategy profile and new institutions.

The EU and national governments can help agents to adjust private beliefs and strategy plans by sending signals on the new state of the environment. This can substantially reduce time and efforts needed until a new equilibrium settles. Public authorities may, however, also fail in this task. If EU legislation is not enforced in a member state and pre-integration legislation remains de facto in place, agents are left in uncertainty about the state of the environment. Successful institutional change in other member states may be of limited help either. Best practices can even be misleading if environmental parameters remain sufficiently country-specific. If institutional environments do not converge across member states such that they lie within the same range covered by $\hat{\mathcal{E}}$, then for different member states different strategy profiles and institutions remain optimal.

3.4.5 Failed change and foiled national institutional systems

The single market and the common currency introduced in the EMU created substantial changes in the institutional environments of 19 member states. Assume that our example member states are both EMU members. Further assume that with market integration at period S national institutional environments started to converge such that at some period the consequence functions produce the same optimal strategy profile and institution for economic agents in both member states. Let s^* be the optimal strategy profile and Σ^* be the optimal institution after market integration that have prevailed in member state 1 before market integration and that are successfully established in member states 2 at period $t = T_1$.

Strong institutional complementarities can disrupt the process of institutional change and foil the functioning of the national institutional system in member state 2 from $t = T_1$ on. To show this, introduce a cultural domain and allow environments to include multiple institutions as parameters. Denote Δ as the institution that evolves in the cultural domain. Δ captures common beliefs about behavioral norms and customs and evolves under the domain-specific parameter ι. Δ puts constraints on interactions among agents in all domains of a society and affects the shape of consequences functions in all games played in the society. With strong institutional complementarities according to (3.1) but extended with the cultural institution, we get nine possible combinations of institutions among which again two are Nash equilibria: $(\Sigma^*, \Lambda^*, \Delta^*)$ and $(\Sigma^{**}, \Lambda^{**}, \Delta^{**})$. Suppose that until period S member state 2 has evolved $(\Sigma^{**}, \Lambda^{**}, \Delta^{**})$ in the presence of feedback loops between institutions and environmental parameters according to:

$$\begin{aligned}
\theta(t+1) &= F(\theta(t), \eta(t), \iota(t), \Sigma(t), \Lambda(t), \Delta(t)), \\
\eta(t+1) &= G(\theta(t), \eta(t), \iota(t), \Sigma(t), \Lambda(t), \Delta(t)), \\
\iota(t+1) &= H(\theta(t), \eta(t), \iota(t), \Sigma(t), \Lambda(t), \Delta(t)).
\end{aligned} \tag{3.4}$$

The more institutions we allow to become environmental parameters and the stronger institutional complementarities are, the more inert the dynamic system becomes once a Nash equilibrium has settled. Changes in single parameter values may then fail to cause a successful transition to another Nash equilibrium but possibly cause a malfunctioning of the prevalent institutional system. With $\eta_2(t)$ and $\iota_2(t)$ at sufficiently low levels, even a major increase in $\theta_2(t)$ stemming from an exogenous shock, such as market integration, may fail to initiate a motion of the whole system. If, e.g., $v_2(\Lambda^* : \Sigma^*, \Delta^{**}, \eta_t) < v_2(\Lambda^{**} : \Sigma^*, \Delta^{**}, \eta_t)$, then political agents in member state 2 stick to the pre-integration political institution

Λ^{**} and do not adjust to the change in the economic institution. If, additionally, $u_2(\Sigma^* : \Lambda^{**}, \mathbf{s}_1^*, \Delta^{**}, \theta_t) > u_2(\Sigma^{**} : \Lambda^{**}, \mathbf{s}_1^*, \Delta^{**}, \theta_t)$, then economic agents will switch to strategy profile $\mathbf{s}_2^*$, establish institution Σ^*, and member state 2 will find itself in the transition system $(\Sigma^*, \Lambda^{**}, \Delta^{**})$ at $t = T_1$.

In the presence of strong institutional complementarities, the transition system $(\Sigma^*, \Lambda^{**}, \Delta^{**})$ may be inferior to the pre-integration system $(\Sigma^{**}, \Lambda^{**}, \Delta^{**})$ with respect to national welfare. This is due to forgone extra payoffs that could be accrued with complementary institutions and occurs after market integration if $u_2(\Sigma^* : \Lambda^{**}, \mathbf{s}_1^*, \Delta^{**}, \theta_{T_1}) + v_2(\Lambda^{**} : \Sigma^*, \Delta^{**}, \eta_{T_1}) < u_2(\Sigma^{**} : \Lambda^{**}, \Delta^{**}, \theta_{t<S}) + v_2(\Lambda^{**} : \Sigma^{**}, \Delta^{**}, \eta_{t<S})$. National welfare will increase again during transition and exceed the pre-integration level once the transition process is completed in $t = T_2$ and the equilibrium $(\Sigma^*, \Lambda^*, \Delta^*)$ has settled. However, contradicting forces at work in all periods $t > S$ may block the coevolution of environmental parameters and institutions towards a new best fit and prevent the completion of the transition process: While the increase in the value of θ_2 and the presence of Σ^* and $\mathbf{s}_1^*$ work towards institutional change, the presence of Δ^{**} and low values of η_2 and ι_2 work against institutional change. It is possible that member state 2 may never reach T_2 and evolve equilibrium $(\Sigma^*, \Lambda^*, \Delta^*)$, the superior institutional system in the new environment. Instead, member state 2 may get stuck in the transition system $(\Sigma^*, \Lambda^{**}, \Delta^{**})$, which is characterized by misfitted institutions and possibly produces a lower national welfare compared to the system of complementary institutions $(\Sigma^{**}, \Lambda^{**}, \Delta^{**})$, which prevailed before market integration.

3.5 Whither the EU?

The White Paper on the future of Europe (European Commission, 2017) puts five scenarios up to discussion for the future integration of EU member states. Some scenarios consider changes towards more and some towards less integration in different domains. Our theoretical framework can give reasons to go in either direction depending on: (i) the heterogeneity of institutional environments and national institutional systems, and (ii) the existence and strength of institutional complementarities. In this section, we first discuss the conditions required for each of the five scenarios to be appropriate. We then draw on the Varieties of Capitalism literature for insights on actual conditions in order to give more precise recommendations for what should be considered when moving forward in the EU integration process.

3.5.1 Carrying on

The first scenario considers strengthening the single market by investment in digital, transport and energy infrastructures, and strengthening the common currency by enhancing financial supervision, ensuring sustainable public finances and developing capital markets to finance the real economy. The EU focuses on jobs, growth and investment, and targets financial stability and economic convergence of member states. This is achieved by setting up new architectures of common regulations, including a banking and capital market union. Cooperation is strengthened in research, industry, joint procurement, migration, security, foreign policy, and defense, but responsibilities remain primarily with national authorities. Other policy areas, such as employment, education, taxation and the design of welfare systems, product and services markets, public administration, and juridical systems, remain in the hands of member states.

This scenario fits the needs of the member states *if (i) national institutional environments and equilibria in the economic domain are either already similar today or will converge in the near future, and (ii) complementarities among institutions are strong within the economic domain and weak or absent with other domains.* The influence of strategy profiles of other member states $\mathbf{s}_{-c}$, further common economic regulations, and signaling and enforcement of EU legislation cause a considerable convergence of national institutional environments in the economic domain. This yields $e_c \in \hat{\mathcal{E}}_{EU}$ for all games in the economic domain in all $C = 1, 2, \ldots, 27$ member states. Consequently, consequence functions produce the same optimal strategy profiles and economic institutions in all member states. Recent misfits among economic institutions and reductions in national welfare that some member states experience are temporary problems of adjustment and will be overcome by further integration after old institutions have been replaced by new institutions that fit to the new environment. In all other domains, member states' environmental conditions, strategy profiles and institutions remain country-specific.

3.5.2 Nothing but the single market

In the second scenario, the single market becomes the core of the EU. More competencies are transferred from the national to the supranational level to secure the free movement of goods and capital. In other domains, including migration, security, defense, humanitarian and development aid, the EU reduces regulations and withdraws existing pieces of legislation. The EU does not target financial stability and convergence of all member states with respect to consumer, social and environmen-

tal standards, taxation, and the use of public subsidies. Cooperation on new issues of common concern not connected to the single market are managed bilaterally.

This scenario fits the needs of the member states *if (i) apart from the single market, member states are and remain heterogeneous in their institutional environments and equilibria, and (ii) complementarities are strong among the subset of institutions that facilitate the single market and weak or absent to other institutions not facilitating the single market in any domain.* For agents whose action choices are influenced by the subset of institutions facilitating the single market, strategy profiles of other member states become a relevant environmental parameter, further common economic regulations and EU legislation support the convergence of national institutional environments and consequence functions. For these agents, common strategy profiles and institutions become feasible in all member states. For economic and non-economic activities not covered by the single market, country-specific environmental conditions prevent a convergence of national environments. There, optimal strategy plans and institutions remain heterogeneous.

3.5.3 Those who want more do more

"Carrying on" is the baseline for the third scenario. The EU27 proceeds as today, but certain member states coordinate more in the non-economic domains via legal and budgetary arrangements. That includes harmonization of regulations in specific policy areas such as research and industrial base, procurement, defense, internal security, justice, industrial cooperation, corporate law, taxation, and social matters. Member states that decide not to join coordination in other policy areas will be able to preserve their status and retain the possibility to join later on.

This scenario fits the needs of the member states *if (i) institutional environments and equilibria are already similar or expected to converge within groups of member states, and (ii) complementarities are strong among institutions within and across different domains of the societies.* This scenario acknowledges the heterogeneity of national institutional environments and equilibria within the EU to a certain degree. Still, it requires that in the areas regulated by the single market common optimal strategy profiles and institutions are feasible throughout all (groups of) member states. In other areas, member states profit from integration where the characteristics of their national institutional systems allows them to. Member states with more similar characteristics can integrate more. Member states with a need for transition and member states in transition retain the possibility for a step-wise integration that supports institutional change towards a new system.

3.5.4 Doing less more efficiently

The fourth scenario is also based on "Carrying on" but focuses EU actions and resources on a few priorities. In order to deliver more and faster in selected areas, stronger tools are given to the EU to directly implement and enforce collective decisions for policies on innovation, trade, security, migration, the management of borders, and defense. The single market is deepened in the key areas research and development, decarbonization, and digitalization. Where the EU is perceived as having limited added value or as being unable to deliver on promises, it does less or even stops acting. This considers regulations that are not directly related to the functioning of the single market such as regional development, public health, state aid control, parts of employment, and social policy.

This scenario fits the needs of the member states *if (i) institutional environments and equilibria are heterogeneous and not expected to converge across member states in either domain of the societies, and (ii) there are only few complementarities among institutions within and across different domains.* The EU centers its competences on regulating limited sets of activities in which extra payoffs can be achieved from complementarities among institutions organizing these activities, or from providing public goods with international externalities.[1] Stronger EU enforcement tools in the respective policy areas help agents that operate in these limited sets of activities to overcome institutional uncertainties, adapt action choices and establish optimal strategy profiles and institutions in all member states.

3.5.5 Doing much more together

The fifth scenario foresees a comprehensive integration of member states into a federation with joint power, resources, and decision-making across all domains of the societies. The single market is deepened through further harmonization of regulations and a stronger enforcement. A comprehensive economic, financial and fiscal union, a common regulation in defense and security matters, migration, the fight against climate change, humanitarian and development aid provision, and joint investment in innovation and research are introduced.

This scenario fits the needs of the member states *if (i) institutional environments are already similar today or expected to converge across member states in all domains in near future, and (ii) complementarities are strong among institutions within and across different domains.* Globalization, the diffusion of technology, and EU integra-

[1] See Klodt et al. (1992) on potential policy areas in which efficiency gains other than those created by institutional complementarities can be achieved via centralization to the EU level.

tion have caused national institutional environments and consequence functions to become more and more similar across member states. Old institutions that no longer meet the requirements of the new environment foil the smooth operation of new institutions and vice versa. This requires a replacement of old institutions throughout different domains of all societies. The exposure to strategy profiles of agents operating in other member states, further common economic regulations, and signaling and enforcement of EU legislation help to replace old country-specific with new common institutions. This yields $e_c \in \hat{\mathcal{E}}_{EU}$ for all games in all $C = 1, 2, \ldots, 27$ member states and makes common optimal strategy profiles and institutions throughout the domains feasible. As a result, national institutional systems converge towards a common system, an EU variety.

3.5.6 Reflections on the scenarios, status quo, and way ahead

Different scenarios are appropriate under different conditions. Empirical evidence of the Varieties of Capitalism literature suggests that national institutional setups are characterized by strong institutional complementarities within and across different domains of a society. Moreover, in the EU, at least four varieties of national institutional systems exist. None of the scenarios put forward in the White Paper sufficiently considers the challenges of integrating member states with heterogeneous national institutional systems. The starting point for the five scenarios is "that the 27 member states move forward together as a Union" (European Commission, 2017):15. The core of the Union is economic: the single market and the common currency, both are sacrosanct. It is debatable whether this starting point is a good one.[2] Member states have been differently affected by the single market and the common currency. This points to country-specific consequence functions.

We see this most clearly in the different developments of Southern European member states and Central European member states after the introduction of common market regulations. The "leveling the playing field" regulations increased the level of competition in all member states. This worked in favor of large firms with established and untouched advantages. In such an environment small differences in firm productivity or market size can lead to impressive concentration, much more than in a bumpy playing field.[3] The changing regional pattern of production brought

[2] Höpner and Schäfer (2010) argue that the EU is already too much of an economic union, which causes most of its problems.

[3] See Krugman (1993) or the new economic geography literature (Fujita et al., 2001) on the emergence of concentration of economic activities out of an almost symmetric equilibrium. Concentration of economic activities yields migration and/or diverging real wages.

a strong increase in economic activities in Central European member states and a decrease in Southern European member states. Before market integration, the latter were characterized by national institutional systems that were built on, facilitated by, or produced a low degree of competition, which served as means of employment protection. This worked quite well during the second half of the 20th century in a national context.[4] The introduction of the single market in 1993 completely foiled Southern Europe's historically grown product market institutions. Consequently, complementary labor market institutions also no longer worked optimally anymore. The common currency worked into the same direction. It ruled out competitive depreciation, which was a feature of the European exchange rate mechanism. Before 2003, Southern European countries used to devaluate their currencies every three to five years. This was impossible after the introduction of the euro. The common beliefs about the rules of the game changed only slowly and the real appreciation pressure remained. Consequently, within the first ten years of the EMU, a huge competitiveness problem arose for Southern European economies.

So far it seems that adjustments to diverging outcomes in the single market are left to migration. Financial aid for regions and national stabilization policies are restricted and institutions prevalent in the South cannot meet the requirements of the new environment (yet). Free mobility of people is expected to level the differences across member states by people moving to places with higher rewards. To what extent this is more a theoretical than a practical channel to solve the problems of uneven development becomes apparent in discussions about the different perspectives of the *somewheres* and *anywheres* which led to the divide of Brexit, see (Goodhart, 2017). According to Goodhart, people voting "leave", the *somewheres*, are more rooted and therefore miss chances at other locations. People voting "remain", the *anywheres*, are more mobile and can seize opportunities in other locations. Since the remaining 27 member states also do not only host *anywheres*, the potential of migration to solve the adjustment problem is probably very limited.

National institutional systems that have evolved in country-specific environments under complementarity conditions may be the reason why the EU cannot live up to its promise that every member state is better off with an integrated market. Whether the leveled playing field is "good" or "bad" for Southern European countries in the long run depends on whether the new environment delivers an impetus to change the whole institutional system to a new, superior equilibrium. For the next steps of EU integration, however, the presence of a variety of national institutional systems in the EU must be taken into account. Given that national institutional systems

[4] See Amable (2003) for an analysis on Mediterranean countries' features of institutional set-ups.

largely remained robust since the implementation of the single market and common currency, a convergence cannot be expected in the near future.

3.6 Conclusion

The EU experiences a multidimensional crisis which manifests in different domains and intensities among its member states. We see the reason for this in heterogeneous national institutional systems that are subject to manifold complementarities and react differently to market integration. To provide a theoretical framework for our argument, we build up on North (1991)'s notion that *"institutions are effective as a bundle"* and follow Aoki (2001) in setting up a supermodular game in which institutions in different domains of a society evolve endogenously through strategic interactions of different sets of agents. This theoretical framework allows us to capture the empirical insights of the Varieties of Capitalism literature and reflect on the five different scenarios of a possible future EU integration process put forward in the White Paper on the future of Europe (European Commission, 2017).

Our analysis implies that common regulations yield different consequences across member states. Where common regulations cause changes in the environment that are compatible with national institutions, the national institutional systems remain robust and the member state benefits from integration. Where common regulations reduce the fit of national institutions to their environments, the well-functioning of sets of national institutions is foiled and national welfare reduced. This can explain the struggles of Southern European member states after the introduction of common regulations facilitating the single market and the common currency, which disturbed the smooth workings of a set of product and labor market institutions.

Member states that are struggling with environmental changes caused by technological change, globalization, and EU integration are not doomed to remain stuck in suboptimal equilibria or foiled national institutional systems. Over the decades, the EU has served as an initiator and stabilizer of institutional change. The White Paper on the future of Europe is a necessary starting point of a desperately needed discussion on common aims and the future role of the EU. However, a successful integration process will fail if the persistent heterogeneity among national institutional systems remains ignored. Institutional change will be large and hard for some member states and produce uneven development, which needs to be taken care of. Until now, the EU has reacted to challenges with more integration. We doubt this is the solution at this point. Rather, the EU should intervene where institutional complementarities allow member states to integrate more and where integration can trigger

changes of national institutions towards a superior equilibrium. For some member states this could mean a reduction of the already reached level of integration. For this, however, no scenario and coresponding procedure exist so far.

Although heterogeneity in national institutional set-ups and different reactions to common regulations are a great challenge for the EU integration process, from a global perspective, the 27 EU countries are quite alike in their national environments and institutional solutions. One can imagine the heterogeneity in national institutional set-ups among the 193 countries in the world, which show much larger variation in the stocks of physical and human capital, the state of technology, and other environmental parameters. Countries at different levels of economic development vary in the economic challenges they face and therefore in the institutional solutions they need to organize national economies. Consequently, they should also vary in the reforms they need to achieve growth. Chapter 4 investigates this inference and brings the analytical considerations on institutional complementarities and their role for economic development to empirics by studying individual and interaction effects of two types of legal institutions on income levels drawing on panel data of 130 countries around the world.

Chapter 4

Rebundling Institutions

4.1 Introduction

The state plays a crucial role in the building of institutions that North (1991):97 defines as "humanly devised constraints that structure political, economic, and social interaction". The state has the authority to issue and enforce laws and regulations that put incentives and constraints on a wide area of human interaction. Acemoglu and Johnson (2005) open *Unbundling Institutions* with a reference to North (1981), pointing at two spheres of state regulation that ascribe the state a different role for organizing national economies: The first, the "predatory theory" of the state, emphasizes the state's role in distributing political power and allocating resources in the society, underlining the importance of property rights institutions for economic development (see, e.g., Jones, 2003; De Long and Shleifer, 1993; Olson, 2000; Besley and Ghatak, 2010)). The second, the "contract theory" of the state, emphasizes the state's role in providing a legal framework that enables private contracts and facilitates economic transactions (Coase, 1960; Williamson, 1989), underlining the importance of contracting institutions for economic development (see, e.g., Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995).

While Acemoglu and Johnson (2005) acknowledge that the state is responsible for providing a legal framework that regulates *both* the distribution of power and resources and the enforcement of private contracts, they *"(...)attempt to unbundle the broad cluster of institutions and learn more about the relative importance of contracting versus property rights institutions at the macro level."* In a cross-country study on former European colonies, Acemoglu and Johnson find strong and significant effects of legal property rights institutions and much weaker—for non-financial outcomes non-significant—effects of legal contracting institutions. They conclude

that individuals may find informal ways to avoid the adverse effects of a legal system that poorly enforces private contracts but find it harder to mitigate the risk of government expropriation. *Unbundling Institutions* has given development economics a push. It has become a starting point for a number of studies aiming to isolate and compare the economic effects of different types of institutions (see, e.g., Fernandez and Kraay, 2005; Bhattacharyya, 2009; Williamson and Kerekes, 2011; Asongu, 2016). It, however, relies on the assumption that the economic effects of legal property rights and contracting institutions are independent of each other.

This empirical study deviates from the assumption of independent effects and brings the investigation on how legal property rights and contracting institutions influence economic development back to North (1981), Milgrom and Roberts (1994), and towards the Varieties of Capitalism literature (e.g., Soskice and Hall (2001); Amable (2003); Rougier (2015)). This stream of literature suggests that it is not single (sets of) institutions but bundles of (sets of) institutions that together and in their combination organize production, exchange, and income distribution. Voigt and Gutmann (2013) have taken one step towards rebundling the effects of legal property rights institutions. They argue that precisely defined property rights are unlikely to have any economic effects unless accompanied by some credible commitment of the government to enforce these rights. Voigt and Gutmann provide empirical evidence that property rights increase growth rates only if the judicial system is independent enough to guarantee enforcement. The underlying paper goes further and provides arguments and empirical evidence that implementing or improving legal property rights institutions may not suffice to spur economic development and can be ineffective or even countereffective when legal contracting institutions are absent or of bad quality. This is because property rights and contracting institutions provide interrelated incentives and constraints on economic decisions and productive activities, e.g., private investment. A lack in the definition and enforcement of only one of the two different types of institutions as well as a poor fit of the incentives and constraints they provide, may block economic development.

I draw on data of 130 countries from all world regions for the period 2005–2015 and implement a two-step panel estimation procedure to test the hypothesis that the two different types of legal institutions are jointly effective. The two-step estimation strategy allows to consider different channels and timespans of effects. In the first step, I use a fixed effects least squares estimator to identify short-term individual and interaction effects of legal property rights and contracting institutions on real GDP per capita levels whilst controlling for country-specific unobserved heterogeneity, time effects and a set of control variables. In the second step, I use a between effects

least squares estimator to identify individual and interaction effects of the two types of legal institutions on countries' long-term income levels. As second-step dependent variable, I use the estimate of the country-specific unobserved heterogeneity term obtained in the first-step regression since it explains the time-invariant component of GDP per capita levels that varies across countries. Concerning the choice of institutional variables, I closely follow Acemoglu and Johnson (2005) and use the Polity IV Project's variable on executive constraints as baseline measure for legal property rights institutions and the World Bank's indicator on legal enforcement of private contracts as baseline measure for legal contracting institutions.

The baseline estimation results and a number of robustness tests support the hypothesis of joint effects. I find positive individual and interaction effects of legal property rights and contracting institutions on countries' long-term income levels, all at considerable sizes and statistically highly significant. The marginal effects of increases in executive constraints vary to a considerable degree among countries in both direction and size dependent on how efficient the prevalent legal system enforces private contracts. This result relates to and extends Acemoglu and Johnson (2005). Moreover, and building up on Djankov et al. (2003) who find systematic differences in the quality of the legal system dependent on the legal orgin, I find significantly smaller marginal effects for countries that have a French legal origin.

Decomposing the interaction effect reveals that the baseline estimation results are driven by two groups of countries with distinctive quality combinations of legal property rights and contracting institutions. Increasing executive constraints is most income-enhancing in countries with a good quality of both types of legal institutions. This concerns countries at higher levels of economic development. In countries with absent or a bad quality of both types of legal institutions, the positive individual effect of increases in executive constraints are eaten up by a negative interaction effect. In 27 sample countries, the net effects on long-term income levels are even negative. This concerns countries at lower levels of economic development and implies that if non-legal institutional solutions are applied to organize national economies, reforms that consider installing only one type of legal institutions while leaving the other type unchanged can be countereffective. This result relates to literature on lawlessness and second-best institutions which argues that the economic challenges and constraints in countries at low levels of economic development need institutional solutions different from those of more advanced economies. It is in accordance with Dixit (2011) who puts forward that an effort to strengthen judicial enforcement of private property rights can easily backfire in the presence of relational contracting. It is also in line with Rodrik (2008) who argues that conducting

piecemeal reforms towards a best practice system of legal institutions may do more harm than good if the legal institutions are at odds with and disturb the integrity and functioning of prevalent institutionalized rules and practices.

The remainder of this study is structured as follows: In Section 4.2, I elaborate on why the assumption of independent effects is too strong and legal property rights and contracting institutions are jointly effective. In Section 4.3, I put forward some theoretical considerations on the channels and timespans of effects, discuss estimation challenges, and present the identification strategy and the empirical models. In Section 4.4, I address some measurement issues that are considered in the choice of institutional variables and describe the dataset. In Section 4.5, I present the baseline and decomposition estimation results as well as the estimation results for the robustness tests. In Section 4.6, I conclude.

4.2 The argument

The hypothesis is that successful economic development requires an adequate specification and enforcement of both property rights and contracting rules as well as complementarity of these rules. To see more clearly why this should be the case, consider the role of transaction costs in the work of Coase (1937, 1960). The Coase theorem says: *When transaction costs are zero the allocation of resources will be efficient regardless of the initial assignment of property rights.* Everything can be contracted upon efficiently as long as transaction costs are zero and information is complete. In the real world, transaction costs are not zero and information is incomplete. Contracting is costly and property rights are not perfectly defined (Allen, 1999; Barzel, 1997). Consequently, it matters how property rights are specified and resources are allocated and utilized in a society Libecap (1993); Lueck and Miceli (2007), and it matters how the organizational and regulatory framework in which private contracting takes place is set up (Hart, 1995; Goldberg, 1976).

Property rights institutions assign asset ownership to individuals, groups, or the state. Different property rights regimes, e.g., open access, private ownership, common property, state property, produce a specific, predictable allocation and utilization of resources in a society. Regardless of the prevalent regime, property rights must be clearly specified and enforced to be effective (Lueck and Miceli, 2007). There are negative effects on economic development when property rights are not well defined or when they are attenuated by governments or ruling elites that are not constrained in their decision making power and rule by decree. Ho (2016) argues that a poor quality of property rights institutions due to, e.g., lax crime

enforcement, weak court system, excessive regulations, and poor patent protection, creates a wedge between the marginal product of capital and the rate of return that can be appropriated. In the absence of a legal title for property, one is not confident to purchase a house. When corrupt authorities evict people from their lands, one is unwilling to invest.

Contracting institutions help to organize economic exchange. They enable private parties without political power to engage in bargaining and undertake transactions, i.e., transfer or modify property rights on assets. Contracting institutions reduce incentives for contract breach and increase certainty on how others behave, which allows non-simultaneous transactions. Clague et al. (1999) argue that good contracting institutions become more important as economies become more complex. When there is lending and borrowing, capital is lent in expectation of a later return. When a demander and a supplier are some distance apart, one must be at risk for the value of the goods in transit. When there is insurance, some party must make payments now in hope of indemnification if specified contingencies occur.

For both contracting and property rights institutions informal mechanisms can sufficiently organize an economy until a certain degree of complexity. Property rights and private contracts can be defined and enforced by custom, norms, and in repeated interactions (Ellickson, 1991). However, as investment becomes large, long-lived, and highly asset-specific, and as trade in goods and services occurs outside of repeated exchange relationships, informal contract enforcement mechanisms become an increasingly imperfect institutional solution (Trebilcock and Leng, 2006). An increasing number of and heterogeneity among economic agents as well as intensifying competition for assets that can be transfered to high-valued uses require formal governance structures to replace or supplement informal institutions (Lueck and Miceli, 2007; Libecap, 1993). The state has the authority to define and enforce property and contracting law and provide courts as legal mechanisms to enforce these laws. Therefore, legal institutions are important to coordinate the usage, maintenance, and investment in assets in more complex economies (Demsetz, 1967).

Among the various economic decisions and productive activities for which good property rights and contracting institutions matter, their role for investment is crucial for economic development (North, 1981). The impact of institutional quality on growth rates that runs via fostering investment is sizeable (Gwartney et al., 2006; Besley, 1995). Property rights and contracting institutions jointly reduce transaction costs and uncertainties and foster investment in physical capital, human capital, and technology (see, e.g., North and Thomas, 1973; North, 1981; Jones, 2003). While property rights institutions ensure a legal title to property and secure the fruits of

investment from being seized by others, contracting institutions enable the fruits to be traded upon with others. A lack in the definition and enforcement of only one type as well as their poor fit may constitute a bottleneck for economic development and produce an inefficient allocation and utilization of resources. Consider that despite a clear title to property and a low probability of experiencing government expropriation, great inefficiencies in the enforcement of private contracts increases uncertainties and costs for economic transactions. This constrains non-simultaneous transactions and an efficient transfer of assets to high-valued uses. Likewise, despite a set of institutionalized rules that efficiently regulates private transactions, private parties are reluctant to engage in productive activities and undertake investment if the title to property is unclear or the probability of being expropriated by the government or powerful elites is high.

4.3 Implementation

Before disentangling the effects of legal property rights and contracting institutions on income levels, some more general issues on the channels and timespans of effects have to be addressed as this carries important implications for the design of short-, medium-, and long-term policy reforms. A salient feature of time series on GDP per capita levels is that they are rather inert or sluggish. There is a momentum built into GDP per capita levels that makes them continue to grow steadily or stagnate. This empirical phenomenon indicates the influence of constant factors. The huge and persistent differences in GDP per capita levels and growth rates across countries indicates that these constant factors are country-specific. Yet, GDP per capita levels and growth rates do show some short-term variation. A glance into growth theory helps to understand these features of time series on GDP per capita levels and to get a better understanding of where and how institutions play a role for economic development. This will then lead to the appropriate estimation strategy.

4.3.1 Theoretical background and channels of influence

Growth literature differentiates between proximate and fundamental causes of growth. Proximate causes refer to the input factors in the production function. Traditional neoclassical growth theory explains differences in output Y with differences in the accumulation of capital K and labor L, which in turn stem from differences in saving rates that are either exogenously given (Solow, 1956; Swan, 1956) or evolve endogenously (Ramsey, 1928; Cass, 1965; Koopmans, 1965). Yet, differences in input fac-

tors can only explain parts of the variation in output. The remainder is considered due to differences in total factor productivity and exogenous. North and Thomas (1973):2, however, argue that factor accumulation and productivity *"(...) are not causes of growth; they are growth"*. In line with this, Acemoglu et al. (2005) differentiate the proximate causes from fundamental causes of growth. The fundamental causes underlie the proximate causes and drive investment in phsyical capital, human capital, and technology. While also considering geography, culture, and luck as fundamental causes, Acemoglu et al. (2005) put emphasis on institutions.

To analyze the role of institutions in necolassical growth models, reconsider a human capital augmented version of the Solow–Swan model of long-term economic growth with a constant returns to scale Cobb-Douglas production function and a labor-augmented technological progress:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta}. \tag{4.1}$$

$Y(t)$ represents the output, $K(t)$ the stock of physical capital, $H(t)$ the stock of human capital, and $A(t)L(t)$ represents the stock of effective labor. A and L grow from given initial levels $A(0)$ and $L(0)$ at exogenous rates g and n such that $A(t) = A(0)e^{gt}$ and $L(t) = L(0)e^{nt}$. $L(0)$ refers to the initial size of labor force. $A(0)$ stands for the initial state of technology. K and H grow endogenously. The stocks of physical and human capital increase over time via saving a constant fraction of output $s = s_K + s_H$, where s_K is the fraction of s invested in physical capital, e.g., buying and inventing new machines, and s_H is the fraction of s invested in human capital, e.g., educating the labor force. Physical and human capital depreciate at a constant rate δ. In equilibrium, physical capital per effective unit of labor, $k(t) = K(t)/A(t)L(t)$, and human capital per effective unit of labor, $h(t) = H(t)/A(t)L(t)$, are constant. Actual physical and human capital investment equal the break-even investment needed to prevent $k(t)$ and $h(t)$ from falling. The steady state values of k and h are determined by:

$$\begin{aligned} k^* &= \left(s_K^{1-\beta} s_H^{\beta} / (n+g+\delta)\right)^{1/(1-\alpha-\beta)}, \\ h^* &= \left(s_K^{\alpha} s_H^{1-\alpha} / (n+g+\delta)\right)^{1/(1-\alpha-\beta)}. \end{aligned} \tag{4.2}$$

Based on (4.1), output per worker can also be written as:

$$Y(t)/L(t) = A(t)k(t)^{\alpha} h(t)^{\beta}. \tag{4.3}$$

As $k(t)$ converges to k^* and $h(t)$ converges to h^*, $Y(t)/L(t)$ converges to the growth rate of $A(t)$ which is g. The economy moves alongside a steady state growth path with $Y(t)/L(t)$ steadily growing at rate g as long as $k(t)$ and $h(t)$ remain constant over time. The steady state growth path can contemporarily be disturbed. A change in any right-hand side term of (4.2) causes a change in $k(t)$ and $h(t)$ until they reach new steady state values. Consequently, $Y(t)/L(t)$ temporarily also grows at some rate different from g. When the new steady state values are reached, however, the growth rate of $Y(t)/L(t)$ goes back to g.

Neoclassical growth theory misses to address the role of institutions explicitly. Libecap (1993) argues this is because the neoclassical paradigm bases on the assumption that the underlying institutions are well defined, operational, and adapt to marketlike forces so that they cannot stray far from what is considered optimal. From Coase (1937, 1960), North (1981, 1991) and Acemoglu et al. (2005) it has become apparent that institutions may be ill defined, not adapt to market forces, and cause frictions. This makes it necessary to reevaluate growth theory and discuss the role of institutions for economic development.

Consider (4.3). First, institutions can affect $Y(t)/L(t)$ via $A(t)$ as a fundamental cause of growth. Mankiw et al. (1992):411 argue that $A(0)$ not only reflects the initial state of technology but also resource endowments, climate, and institutions. If institutions that determine $A(0)$ are country-specific, then one should expect production functions, steady state income levels, and growth rates to be country-specific as well. If institutions that determine $A(0)$ are moreover persistent, then one should expect the cross-country differences in income levels to be persistent as well. Second, and again considering (4.3), institutions can affect $Y(t)/L(t)$ via $k(t)$ and $h(t)$, the proximate causes of growth. Institutions can determine k^* and h^* via influencing any term at the right-hand side of (4.2). If institutional changes at any time point t alter saving rates s_K and s_H, the population growth rate n, the technology growth rate g, or the depreciation rate δ, then one should expect temporary deviations from the steady state growth path which manifests in short-term variation in the growth rate of $Y(t)/L(t)$.

4.3.2 Identification strategy and empirical models

Rodrik and co-authors strongly suggest to distinguish between short-term and long-term growth effects. Rodrik et al. (2004) formulate a long-term growth model that concentrates on the effects of fundamental causes of growth and suggests to distinguish these effects from the short-term effects of growth collapses (Rodrik, 1999) and

growth accelerations (Hausmann et al., 2005), which can give very different policy implications. To take account of the different channels and timespans of effects, I apply a two-step panel data approach that allows to estimate the time-invariant components of GDP per capita levels caused by country-specifc constant factors, i.e., the fundamental causes of growth, in a first-step regression. I then use these estimates as proxies for countries' long-term income levels in a second-step regression. This identification strategy complies with Islam (1995)'s approach of estimating "country effects" and constructing country-specific measures $A(0)_i$ in order to allow for cross-country differences in aggregate production functions and steady state income levels. Correspondingly, I see my proxy for countries' long-term income levels closely related to growth theory's steady state or target value of output per worker and as a qualified indicator for countries' levels of economic development.[1]

Panel data has the potential advantage of utilizing within and between country variation. However, (i) the strong autocorrelation of GDP per capita levels over time, (ii) the endogenous relationship between institutions and income, and (iii) the persistence of institutions make a proper identification complicated. Because of (i) and (ii), formulating a linear panel data model and using a pooled ordinary least squares estimator is not feasible. The strong serial autocorrelation of GDP per capita levels over time requires to formulate a model that takes unobserved heterogeneity caused by country-specific constant factors into account. The endogenous relationship between income and institutions and the theoretical consideratons on the channels of influence require to allow a correlation between the country-specific constant factors and the explanatory variables, especially the proximate causes of growth. Challenges (i) and (ii) require the application of a fixed effects (FE) estimator. There are, however, two downturns of the FE estimator in this setting: First, the FE estimator uses within-country variation only. Yet, the majority of variation in income levels is between countries. Second, the effects of observable country-specific constant factors cannot be estimated in a FE estimation approach as there is no way to distinguish them from the effects of unobservable country-specific constant factors. This is especially problematic because of (iii), the persistence of institutions.

[1] Alternatively, one could use the 2005–2015 average GDP per capital levels as measures for countries' long-term income levels and estimate a cross-sectional model to identify the effects of institutions as done in Acemoglu and Johnson (2005). This alternative second-step estimation approach, however, does not "clean" the dependent variable from short-term variation in proximate causes of growth. Moreover, the coefficient estimates may suffer from omitted variable bias since the constant country-specific factors (which are very likely correlated with the explanatory variables) are ignored. Islam (1995):1132 states that it is only possible to correct for this bias in panel data frameworks.

The two-step estimation approach allows to deal with these issues. In the first step, I take full account of the panel structure of the underlying dataset and use a FE least squares estimator to identify individual and interaction effects of legal property rights and contracting institutions on GDP per capita levels whilst controlling for the effects of proximate causes of growth, the effects of country-specific constant factors, and time effects. The first-step model is given by:

$$ln(y_{it}) = \beta_1 PR_{it} + \beta_2 C_{it} + \beta_3 PR_{it} \times C_{it} + z'_{it}\zeta + \mu_i + \theta_t + e_{it}, \tag{4.4}$$

where $ln(y_{it})$ is the natural logarithm of the real GDP per capita level of country i at time period t. PR_{it} refers to legal property rights institutions, C_{it} refers to legal contracting institutions, $PR_{it} \times C_{it}$ is the interaction of the two types of legal institutions, and β_1, β_2 and β_3 are the respective coefficients and parameters of interest. z_{it} is a vector of control variables that includes measures for proximate causes of growth and ζ is a vector capturing the effects of them. μ_i is the unobserved heterogeneity term that captures the effects of country-specific constant factors. θ_t is a set of dummies capturing year fixed effects. e_{it} are robust idiosyncratic errors. As μ_i explains long-term cross-country differences in the GDP per capita levels, the remainder is short-term variation in GDP per capita levels that is left to be explained by institutional changes in legal property rights and contracting institutions, physical capital and human capital accumulation, other control variables, time, and unobserved time-variant factors captured in the errors.

In the second step, I use a between effects (BE) least squares estimator that uses variation between countries to identify the long-term income effects of legal property rights and contracting institutions. I proxy countries' long-term income levels with the estimate of the unobserved heterogeneity term $\hat{\mu}_i$ that gives the country-specific, time-invariant component of GDP per capita levels. The corresponding second-step model is:

$$\hat{\mu}_i = \alpha + \gamma_1 \overline{PR}_{i.} + \gamma_2 \overline{C}_{i.} + \gamma_3 \overline{PR}_{i.} \times \overline{C}_{i.} + \overline{z'}_{i.}\eta + (\alpha_i - \alpha + \bar{\epsilon}_{i.}), \tag{4.5}$$

where bars indicate mean values and dots formally define that time has been averaged out. I regress $\hat{\mu}_i$ on the random intercept α, the means of the two types of legal institutions and their interaction, the set of control variables including proximate causes of growth, and an error that consists of country-specific random effects α_i, the random intercept α, and robust mean idiosyncratic errors $\bar{\epsilon}_{i.}$. γ_1, γ_2 and γ_3 are the parameters of interest and η captures the effects of control variables in the

second-step model. An alternative variant of the second-step model would be taking first period values. I prefer using mean values rather than first period values as the former allow to capture the cumulative effects of institutions on income levels over the period 2005–2015, put less weight on and rely less heavily on accurate assessments at single points in time. Using first period values, however, has the advantage of being less prone to endogeneity issues. I therefore present the results when using this alternative variant of the second-step model in the robustness section alongside with and as a reduced form of an IV estimation approach.

4.3.3 Marginal effects

In linear regression models that exclude the interaction term, the marginal effects of improvements in legal property rights institutions are simply partial derivatives of the income measures. This coincides with β_1 for the short-term marginal effects and γ_1 for the long-term marginal effects. Such a model, however, assumes independence of short-term and long-term marginal effects from the quality of legal contracting institutions. The arguments put forward in Section 4.2 give reason to relax this assumption and allow the marginal effects to vary with the quality of legal contracting institutions. For the second-step model given in (4.5), the marginal effects of improvements in legal property rights institutions on countries' long-term income levels are:

$$\frac{\partial \hat{\mu}_i}{\partial \overline{PR}_{i.}} = \gamma_1 + \gamma_3 \times \overline{C}_{i.}. \tag{4.6}$$

The marginal effects consist of two parts: The first part, γ_1, captures the individual effect of an increase in the average quality of legal property rights institutions. The second part, $\gamma_3 \times \overline{C}_{i.}$, captures the interaction effect of an increase in the average quality of legal property rights institutions that depends on the country-specific average quality of legal contracting institutions. One can easily see that including the interaction term produces country-specific marginal effects. In models that exclude the interaction term, γ_3 is zero by assumption and the estimated marginal effects are the same for all countries.

4.4 Data and summary statistics

I utilize panel data of 130 countries for the period 2005–2015. Table B.9 in the appendix reports the countries and the number of observations for each country considered. In general, the sample covers a quite even split of low, middle, and

high income countries from all world regions: 20 Western democracies including Japan, 23 countries from Eastern Europe and the former Soviet Union, 14 Asian countries, 14 countries from Northern Africa and the Middle East, 37 Sub-Saharan African countries, and 22 countries from Latin America and the Caribbean. The dataset includes variables on institutions, macroeconomic outcomes, demographic and cultural factors. Table B.10 in the appendix reports the definitions of variables and sources of data.

4.4.1 Measurement issues

The literature points at the issue of finding a reliable way to measure institutions. Glaeser et al. (2004) name two main characteristics of institutions that should be considered for accurate measurement: (i) institutions constrain behavior, and (ii) institutions are persistent. According to Glaeser et al., many empirical studies purporting to show how institutions affect economic outcomes are based on flawed measures that neither measure constraints nor are persistent. Moreover, many standard measures for political institutions provided by the World Bank, the Polity IV project, and the International Country Risk Guide capture too broad phenomena.[2] The problem with using multidimensional indices is that they capture a number of different constraints which makes it hard to grasp what they actually measure and what policy recommendations can be drawn from their coefficient estimates.

Voigt (2013) raises further theoretical considerations on what should influence how we define and measure institutions. One consideration is that institutions consist of two components: The first component is the substantial content of a rule, e.g., the specification of the degree to which property rights are protected. The second component is the factual implementation of the rule, e.g., the means used to enforce property rights such as impeachment proceedings against those who violate the rules. The factual implementation depends on the behavior of the enforcers which includes legislators, judges, police, prosecutors, and prison staff but also the press, lobby groups, and the public. While non-compliance with economic institutions can be checked by political institutions, the factual implementation of political institutions is often extremely precarious. Checks and balances on governments are an attempt to reduce the expected utility of non-compliance with political institutions.

[2] A number of authors critically evaluate these frequently used indicators, see Woodruff (2006) on the issues of multicollinearity among different institutional indicators, Keefer (2004) on the issue of measurement errors, Cheibub et al. (2010) on the need for a clear theoretical formulation on the phenomenon that should be measured, Munda and Nardo (2005) on the aggregation rules to construct indicators, and Oman and Arndt (2010) on the lack of transparency in the construction of indicators.

4.4.2 Institutional variables data

I choose measures that cover both the content and the legal implementation of institutionalized rules. The measures infer on the quality levels of legal property rights and contracting institutions from a mixture of written laws and regulations, action choices, and outcomes of political and juridical processes which allow to assess to which degree private parties are legally protected from government expropriation and how costly it is to enforce private contracts via a legal process. This entails that two countries may differ in rule content and implementation but yield the same scores in institutional quality if the different mixtures produce the same degree of legal protection of property or the same costs of legally enforcing private contracts.

As baseline measure for legal property rights institutions, I make use of the Polity IV Project's *Executive Constraints* variable that is also the preferred property rights institutions measure in Acemoglu and Johnson (2005) and described in Gurr (1997). Initially referred to as "decision rules" (Eckstein and Gurr, 1975), the variable measures to what extent institutionalized rules constrain the decision-making powers of chief executives, whether individuals or collectives. The constraints may be imposed by any accountability groups. In Western democracies these are usually legislators, others are the ruling party in a one-party state, councils of nobles or powerful advisors in monarchies, military in coup-prone polities, and in many states a strong, independent judiciary. Experts monitor and rate countries on a yearly basis alongside a seven-category scale. Since the variable measures the rules and regulations protecting citizens against the power of the government and ruling elites, it captures to what extent the property of citizens is protected against government expropriation. As laid out in Acemoglu and Johnson (2005), this measure has two advantages: First, it corresponds to the procedural rules constraining government action, and second, it highlights the close relationship between property rights institutions and political institutions. Its disadvantage is that it ignores threats to be expropriated by other powerful bodies and actors.

As baseline measure for legal contracting institutions, I make use of the World Bank's "Enforcing Contracts" indicator, thereafter called *Legal Contract Enforcement*. The indicator is constructed from a number of questions taken from the Doing Business survey. It measures the time and costs of resolving a commercial dispute as well as the quality of the judicial process that is an assessment of whether a country has adopted a series of good practices to promote quality and efficiency in the court system. The data is collected through studies of codes of civil procedure and other court regulations as well as questionnaires completed by local litigation lawyers and

judges. A country's final score in a given year is the simple average of the scores for each of the three indicator components in that year: time, costs, and quality of the judicial process. This methodology builds up on Djankov et al. (2003). The advantage of this measure is that it encompasses and evaluates several aspects that contribute to the functioning of the legal system and rates countries alongside this aggregated score. The downside of this measure is that it is difficult to draw precise policy implications from its coefficient estimates as it is a construct of three different aspects. To deal with this issue, I first reduce the aspects considered in the indicator down to two and then down to one aspect in robustness exercises.

4.4.3 Dependent and control variables data

In the first-step regression, I use the natural logarithm of GDP per capita levels in constant 2010 US Dollars as dependent variable. In the second-step regression, I use $\hat{\mu}_i$ as dependent variable, the estimate of the unobserved heterogeneity term obtained in the first-step regression. As described in Section 4.3, $\hat{\mu}_i$ reflects the country-specific constant part of GDP per capita levels and serves as proxy for countries' long-term income levels. There is a broad literature on which factors influence countries' income levels and growth rates. In a cross-country study, Barro (1996) finds significant effects of physical capital investment, human capital investment, macroeconomic policies, trade openness, fertility, life expectancy, and rule of law on GDP per capita growth. Tabellini (2010) stresses the role of culture and institutions for output per capita. Following the existing literature, I include a set of observable neoclassical growth variables (investment, education, population), a trade variable, and a variable measuring cultural fractionalization as controls.

4.4.4 Descriptive statistics

Table 4.1 reports the summary statistics of the dataset. The two dependent variables are highly, almost perfectly, correlated with a coefficient of 0.9961.[3] This reassures that $\hat{\mu}_i$ carries valuable information on differences in countries' long-term income levels. The variation in both income measures between countries is substantial which hints at large cross-country differences in growth theory's $A(0)$ term. To exemplify: Over the period 2005–2015, the Netherland's average income per capita was $50,423$ US$. This is 50 times the average income per capita of Senegal which was 998 US$. Accordingly, with a $\hat{\mu}_i$ value of $+2.211$, the Netherlands reach place 8

[3] This confirms that GDP per capita levels are strongly autocorrelated over time. This underlines the importance to investigate fundamental causes of growth to understand economic development.

on the list that ranks the 130 sample countries according to their level of economic development. Senegal ranks 103 with a $\hat{\mu}_i$ value of -1.693. In comparison, countries with an average income per capita around $5,000$ US$ (Iraq, Azerbaijan, Jamaica and China) rank around place 60 and are close to the sample's average long-term income level where $\hat{\mu}_i = 0$.

Table 4.1: Summary statistics

	Obs	Mean	St.dev	Min	Max
Dependent variables					
Log real income per capita	1,246	8.576	1.517	5.726	11.425
Long-term income level ($\hat{\mu}_i$)	1,246	0.000	1.495	-2.639	2.969
Institutional variables					
Executive Constraints	1,246	0.000	1.000	-2.196	0.920
Legal Contract Enforcement	1,246	0.000	1.000	-2.868	2.662
Legal Contract Enforcement II	1,253	0.000	1.000	-2.709	2.360
Number of Procedures	1,246	0.000	1.000	-2.651	2.594
Property Rights Protection	1,126	0.000	1.000	-3.194	2.188
Control variables					
Investment (% of GDP)	1,246	23.908	6.784	1.525	61.469
Population (per sqkm)	1,246	180.777	681.271	2.468	7,807
Trade (% of GDP)	1,246	88.497	45.961	19.101	441.604
Cultural fractionalization	1,246	0.312	0.212	0	0.733
Years of schooling	1,246	9.308	2.071	4	15

The institutional variables also show a substantial variation between countries. I adjust the scalings, substract the means, and devide by the standard deviations of the two institutional variables and their interaction term, respectively. I do this for two reasons: First, demeaning the values solves the issue of multicollinearity which occurs when interaction terms are included alongside the interacted variables in regression analysis.[4] Second, demeaning and normalizing the standard deviations of the institutional variables to one makes interpretation of the results easier. The coefficient estimates then correspond to the marginal effects on income levels after an one standard deviation increase in the quality of legal institutions. Investment and trade as percentage of GDP show between and within country variation. Population density has a positive linear trend over the years. Since for cultural fractionalization

[4]Not demeaning the values of the institutional variables increases the variance inflation factors (vif) significantly and clearly above the threshold of 20, especially for the interaction term. This indicates severe multicollinearity. Demeaning the values solves this issue while leaving the coefficient estimates qualitatively unchanged.

no panel data is available, I draw on Fearon (2003)'s cultural fractionalization index constructed for the year 2003. Because the data on cultural fractionalization is time-invariant, it is omitted in the first-step regression. However, it is a valuable carrier of information to explain cross-country differences in long-term income levels in the second-step regression. As proxy for human capital, I use Barro and Lee (2011)'s variable on years of educational attainment. Since there are many missing values over time, I follow Voigt and Gutmann (2013) and use 3-year moving averages.

In order to be able to disentangle the effects of the institution variables and their interaction term, it is crucial that the measures for legal property rights and contracting institutions capture different phenomena that are not too strongly correlated. Theoretically, this could be an issue. A high correlation of legal property rights and contracting institutions would be in accordance with Acemoglu and Robinson (2006, 2008) who see economic institutions as equilibrium outcomes of political institutions. Hence, good (bad) economic institutions could be the consequence of good (bad) political institutions. Figure 4.1 plots countries' scores on the quality of the legal property rights institutions measure in 2015 on the x-axis against countries' scores on the quality of the legal contracting institutions measure in 2015 on the y-axis.

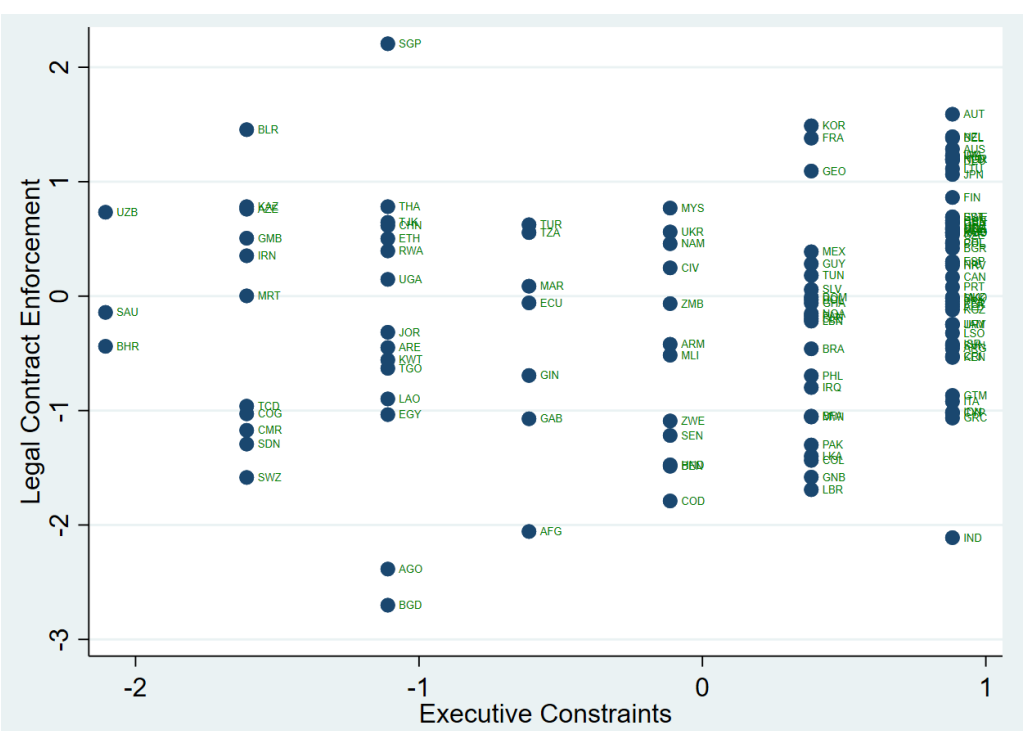

Figure 4.1: *Executive Constraints* and *Legal Contract Enforcement* scores in 2015

Countries score quite differently in the quality levels of the two legal institutions. There are all sorts of combinations of high and low quality levels of *Executive Constraints* and *Legal Contract Enforcement*. While Austria scores high and Bangladesh scores low in the quality levels of both types of legal institutions, India shows the highest quality of *Executive Constraints* and the third lowest quality of *Legal Contract Enforcement* out of all 130 sample countries. Singapore, as another example, shows the highest quality of *Legal Contract Enforcement* but is rated clearly at a below sample average quality of *Executive Constraints*. For the 2015 cross-country sample the correlation coefficient of the two legal institution measures is 0.1828. For the 2005–2015 panel sample it is somewhat higher at 0.2626. This reassures that the two measures of legal institutions capture different phenomena with a minor correlation which should enable a proper identification of individual and interaction effects.

4.5 Results

The results are based on the model given in (4.4) using a FE least squares estimator and the model given in (4.5) using a BE least squares estimator to disentangle the effects of legal property rights and contracting institutions on countries' income levels as described in Section 4.3.2. I find strong and significant individual and interaction effects on countries' long-term income levels which underline the crucial role of institutions as a fundamental cause of growth. Because of the second part of the right-hand side in (4.6), the marginal effects are country-specific and larger for countries that do not have a French legal origin. A further decomposition shows that the size and direction of the interaction effect vary among groups of countries with different quality combinations of the two types of legal institutions. The results remain robust when alternative institution measures are used and when efforts are made to account for the endogenous relationship between income and institutions.

4.5.1 Baseline results

Table 4.2 presents the estimation results of the baseline models. Columns (1) show the coefficient estimates and respective standard errors for the first-step FE estimation. I cannot relate variation in real GDP per capita levels over the period 2005–2015 to institutional changes in the the two types of legal institutions when controlling for proximate causes of growth, other potentially growth-relevant factors, and time effects. However, I do find significant positive effects of the capital invest-

ment ratio and education, the measures for proximate causes of growth. This finding is in accordance with the theoretical considerations presented in Section 4.3.1 which explain short-term variation in income levels with variation in input factor accumulation. Also in accordance with the theoretical considerations, institutional changes may have indirect short-term effects via influencing input factor accumulation.

Table 4.2: Results for the baseline and decomposition models

	1st step: FE		**2nd step: BE**			
	(1)		(2)		(3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Executive Constraints	0.016	(0.015)	0.352***	(0.118)	0.331**	(0.155)
Legal Contract Enforcement	0.037	(0.032)	0.492***	(0.100)	0.575***	(0.130)
EC * LCE	0.023	(0.018)	0.346***	(0.091)		
EC * LCE * $\mathcal{D}_{++}$					0.771**	(0.337)
EC * LCE * $\mathcal{D}_{--}$					0.641***	(0.174)
EC * LCE * $\mathcal{D}_{+-}$					−0.418	(0.293)
Investment (% of GDP)	0.004***	(0.001)	0.008	(0.015)	0.007	(0.014)
Population (per sqkm)	−0.000	(0.000)	0.000**	(0.000)	0.000	(0.000)
Trade (% of GDP)	−0.001***	(0.000)	0.006**	(0.003)	0.007**	(0.003)
Years of schooling	0.018***	(0.005)	0.170***	(0.048)	0.176***	(0.048)
Cultural fractionalization			−1.260***	(0.442)	−1.250***	(0.406)
Observations	1,246		130		130	
Groups	130		.		.	
R^2	0.5195		0.5375		0.5601	

Notes: Dependent variables: *Log real income per capita* in the first-step FE regression in (1) and $\hat{\mu}_i$ in the second-step BE baseline and decomposition regressions in (2) and (3). *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parantheses. Constants are included in both steps but not reported. The first-step FE regression controls for time and country-specific constant factors. The second-step decomposition regression includes group dummies $\mathcal{D}$ that allow the interaction effect to vary among groups of countries with different combinations of above (+) and below (−) sample average quality levels of legal property rights and contracting institutions. The group of countries with a −+ quality combination is omitted and serves as reference.

Columns (2) show the coefficient estimates and respective standard errors for the second-step BE estimation. I find positive and statistically highly significant effects of legal property rights and contracting institutions. This suggests that legal roperty rights and contracting institutions are important fundamental causes of growth that enter growth theory's $A(0)$ term and affect long-term income levels both individually and in their combination. While for the capital investment ratio I find no significant effect, I find a positive and significant effect of education on long-term income levels. This suggests while investment in physical capital seems to be a proximate cause of growth and able to explain short-term variation in GDP per capita levels only,

human capital seems to be both a fundamental and a proximate cause of growth. This ascribes human capital an important role for economic development which is in accordance with, e.g., Wilson and Briscoe (2004). The results on the other control variables are as expected and in line with literature. I find a positive and significant long-term effect of trade openness. This effect is six times the magnitude of the negative short-term effect estimated in the first-step regression which may reflect implementation costs or result from entanglement with the country-specific constant factors captured in the unobserved heterogeneity term. The overall effect of trade on income levels is positive, which is in line with, e.g., Brunner (2003). Lastly, I find a very strong and highly significant negative effect of cultural fractionalization. The more culturally distant different groups within a country are the lower is the country's long-term income level. This is in line with the findings of Alesina et al. (2003) and Fearon (2003).

4.5.2 Cross-country differences in marginal effects

The baseline estimation results entail country-specific marginal effects. Recall (4.6). The first part, γ_1, captures the individual effect that is the same for all countries. The second part, $\gamma_2 \times \overline{C}_{i.}$, refers to the interaction effect that varies across countries. The difference in countries' marginal effects due to the second part can be remarkable as the following country examples show.

Consider the income effects of improving legal property rights institutions for two different African countries: Chad and Gambia both score 2 on the 1-to-7 ranking of Polity IV's *Executive Constraints* variable throughout the period. The baseline estimation results suggest that the same one standard deviation increase in checks and balances on executives yields an increase in the long-term income level of more than 30% in Gambia and roughly zero in Chad.[5] While the individual effect increases both African countries' long-term income levels by 23.55%, the above sample average legal efficiency of enforcing private contracts in Gambia, that scores 0.397 for $\overline{C}_{i.}$, and the below sample average legal efficiency of enforcing private contracts in Chad, that scores -1.021 for $\overline{C}_{i.}$, produces an interaction effect that is positive and supplements the individual effect in Gambia by 9.20% and that is negative and diminishes the individual effect in Chad by 23.63%. Strikingly, for 27 out of the 130 sample countries, the net effects of increasing checks and balances on executives

[5] The marginal effects can easily be calculated by plugging the coefficient estimates of γ_1, γ_3, and countries' mean *Legal Contract Enfocement* scores into (4.6) and devide the outcome by the standard deviation of $\hat{\mu}_i$, which yields the formula: $\frac{0.352+0.346\times\overline{C}_{i.}}{1.495}$.

are negative. This concerns 16 Sub-Saharan African, 7 Asian, 2 Latin American, 1 Western (Italy), and 1 Northern African country (Egypt).

Studying further examples of African countries suggests that the legal origin matters for whether a country benefits more or less from increases in executive constraints. Mali, Cote d'Ivoire, Namibia, and Zambia all score 5 on Polity IV's *Executive Constraints* variable throughout the period. They, however, differ widely in their $\overline{C}_{i.}$ scores: -0.762 for Mali, -0.117 for Cote d'Ivoire, -0.069 for Zambia, and 0.418 for Namibia. An one standard deviation increase in checks and balances on executives leads to an increase in the long-term income levels of 5.93% in Mali, 20.86% in Cote d'Ivoire, 21.95% in Zambia, and 33.23% in Namibia. Chad, Mali, and Cote d'Ivoire are—like Chad—former French colonies, apply civil law, and have a legal efficiency below the sample average. Namibia and Zambia are—like Gambia—former British colonies, apply common law, and have a legal efficiency above the sample average. This finding is in accordance with Acemoglu and Johnson (2005), who show in a sample of former colonies of European powers that French ex-colonies have worse contracting institutions than British ex-colonies.

The examples of African countries indicate that having a French legal origin is disadvantageous when intending to gain in income levels via improvements in legal property rights institutions. To test whether this result is generalizable to the world sample, I perform a two-sample t test on the means of magrinal effects for the group of countries with a French legal origin as compared to the group of countries with other legal origins. Table 4.3 presents the results. The mean marginal effects are significantly smaller for the 59 sample countries with a French legal origin as compared to the 71 sample countries with British, German, Scandinavian, or other legal origin. For the group of countries with a French legal origin the mean marginal effects are 13.67%. For the group of countries with other legal origins the mean marginal effects are 28.27%. The difference is statistically significant at the 1% level and stems from smaller or negative interaction effects in countries with a French legal origin that show a worse quality of legal contracting institutions. This finding relates to and extends Djankov et al. (2003), who report in a global sample that countries' legal origin explains about 40 percent of the variation in the degree of legal formalism.

Table 4.3: Two-sample t test comparing means of marginal effects

Group	Obs	Mean	St. err.	Std. dev.	[95% Conf. Interval]	
Legal origin: Other	71	.2827	.0295	.2483	.2239	.3415
Legal origin: French	59	.1367	.0266	.2040	.0835	.1898
combined	130	.2164	.0210	.2398	.1748	.2580
diff		.1460	.0404		.0661	.2259

diff = mean(0) - mean (1) t = 3.6145
H0: diff = 0 degrees of freedom = 128

Ha: diff < 0	Ha: diff ! = 0	Ha: diff > 0
Pr(T < t) = 0.9998	Pr(|T| > |t|) = 0.0004	Pr(T > t) = 0.0002

4.5.3 Interaction effect for different quality combinations

For the baseline estimates, I pooled information of the 130 sample countries to find that the marginal effects of improvements in legal property rights institutions vary significantly with the prevalent quality level of legal contracting institutions. The marginal effects may, however, also vary with (i) the prevalent quality level of legal property rights institutions themselves, and (ii) the quality combination of the two types of legal institutions. It is possible that the baseline results are driven by a subset of countries with a distinctive quality combination of legal property rights and contracting institutions. To study this, I further decompose the interaction effect by dividing the sample into four groups of countries with different combinations of above and below sample average quality levels of the two types of legal institutions. 43 countries display above sample average and 36 below sample average quality levels of both types of legal institutions. 31 countries have an above sample average quality of legal property rights institutions but a below sample average quality of legal contracting institutions. 20 countries demonstrate the opposite. To measure whether the interaction effect differs among these groups of countries, I include group dummies in the second-step model:

$$\hat{\mu}_i = \alpha + \gamma_1 \overline{PR}_{i.} + \gamma_2 \overline{C}_{i.} + \gamma_3 \overline{PR}_{i.} \times \overline{C}_{i.} \times \mathcal{D}_{qq} + \overline{z'}_{i.}\eta + (\alpha_i - \alpha + \bar{\epsilon}_{i.}). \qquad (4.7)$$

$\mathcal{D}_{qq}$ assigns each country to one of the four groups of quality combinations. The subscript q refers to the quality of each type of legal institutions, where the first q refers to the quality of legal property rights institutions and the second q refers to the quality of legal contracting institutions. If q turns + (−), then the quality

level of the respective type of legal institutions is above (below) the sample average. Columns (3) in Table 4.2 show the estimation results when three group dummies are included in the model and the fourth is omitted to serve as reference. The results suggest that the baseline estimate of the interaction effect is driven by two groups of countries: First, the group with above sample average quality levels of both types of legal institutions, for which the interaction effect is significant, large, and positive, and second, the group with below sample average quality levels of both types of legal institutions, for which the interaction effect is significant, large, and negative.[6]

This finding suggests that the quality combination of the two types of legal institutions matters for the income effects of institutional changes in terms of both the strength and the direction of effects. Increases in checks and balances on executives are most effective when a stock of executive constraints already exists and when it is complemented with a legal system that efficiently enforces private contracts. In 43 sample countries, good quality levels of both types of legal institutions seem to constitute crucial parts of an investment-friendly institutional set-up. A bad quality of legal contracting institutions, instead, seems to render (further) improvements in legal property rights institutions ineffective as it is suggested for the 31 sample countries with a $+-$ quality combination. For these 31 sample countries, a bad quality of legal contracting institutions seems to constitute a bottleneck for economic development. For 36 sample countries with below sample average quality levels of both types of legal institutions, improvements in legal property rights institutions produce a negative interaction effect. For 27 out of these 36 sample countries, the negative interaction effect is stronger than the positive individual effect. This suggests that in 27 sample countries improving legal property rights institutions even reduces long-term income levels if not accompanied with complementary institutional changes in legal contracting institutions.

One explanation for this finding is that the 36 sample countries with below sample average quality levels of both types of legal institutions apply alternative (non-legal) systems of institutions to coordinate their economic activities and transactions. Institutional changes may disrupt the smooth workings of the systems if the incentives and constraints provided by the new, legal institutions are at odds with interrelated incentives and constraints provided by prevalent institutions. This explanation is in accordance with the theoretical framework presented in Chapter 3 as well as Dixit (2011), who argues that an effort to strengthening judicial enforcement of private property rights can easily backfire in the presence of relational contract-

[6]Note that a positive estimate of γ_3 produces a negative interaction effect for countries with a below sample average quality of legal contracting institutions. This can be seen from (4.6).

ing. At low levels of economic development, reforms off the legal path can be more effective institutional solutions than reforms aiming to adopt the legal institutions applied in countries at high levels of economic development. This complies with Rodrik (2008), who argues that it is the function and not the form of institutions that matters and that policy implications should not be derived from a best practice model. Instead, different environmental conditions in different stages of economic development require different institutional solutions.

Table B.11 in the appendix reports the estimation results of the second-step model when the interaction effect is estimated separately for each group. This allows not only the slope but also the intercept to vary among the four different groups. The estimation results of this exercise support the findings presented above. What is more, they provide even stronger support for the quality fit argument. The interaction effect is less strong or insignificant for countries with poorer fitted quality levels of the two types of legal institutions. Increasing the fit is income-enhancing. This provides further evidence that institutions provide interrelated incentives and constraints and have to be adjusted to build a framework conducive for growth. Figure B.1 in the appendix illustrates the findings in two graphs.

4.5.4 Robustness: Alternative institution measures

Following the considerations in Section 4.4.1 and given present limits on panel data availability, I am confident that the baseline measures are good proxies for legal property rights and contracting institutions . However, there exist alternative measures that capture partly the same, partly similar, and partly additional information on the two types of legal institutions. These alternatives have some drawbacks and some advantages over the baseline measures. Table 4.4 presents the second-step regression results when using alternative measures and shows that the main results of the baseline estimation are preserved.[7]

First, I make use of an alternative variant of the legal contracting institutions measure. I draw on the "Legal Enforcement of Contracts" indicator that is part of the Economic Freedom index published by the Fraser Institute. Like the baseline measure, this indicator utilizes World Bank's Doing Business data, but it differs in two ways: First, it utilizes only cost and time information to measure the efficiency of commercial dispute resolution. Second, a different formula is used to calculate the scores, see Table B.10 in the appendix. Second, I proxy legal contracting institutions

[7]The first-step regressions were estimated but results are not reported as they are almost identical with the results of the baseline estimation. There are no significant direct short-term effects of the two institutional variables and their interaction term on log real income per capita.

Table 4.4: Results for alternative institution measures

	2nd step: BE					
	(1)		(2)		(3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Executive Constraints	0.307**	(0.128)	0.516***	(0.122)		
Legal Contract Encorcement					0.258**	(0.110)
Legal Contract Encorcement II	0.633***	(0.010)				
Number of Procedures			0.233*	(0.124)		
Property Rights Protection					0.683***	(0.110)
EC * LCE II	0.227**	(0.096)				
EC * NoP			0.619***	(0.113)		
PRP * LCE					0.166*	(0.090)
Investment (% of GDP)	−0.006	(0.018)	0.019	(0.015)	0.001	(0.013)
Population (per sqkm)	0.000	(0.000)	0.001***	(0.000)	−0.000	(0.000)
Trade (% of GDP)	0.009***	(0.003)	0.006**	(0.003)	0.007**	(0.003)
Years of schooling	0.187***	(0.052)	0.209***	(0.044)	0.196***	(0.051)
Cultural fractionalization	−1.450***	(0.447)	−1.509***	(0.414)	−1.532***	(0.436)
Observations	124		130		125	
R^2	0.5531		0.5497		0.6404	

Notes: Dependent variable: $\hat{\mu}_i$ as measure for countries' long-term income levels obtained in the respective first-step regressions. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parantheses. Constant included but not reported.

with the number of procedures involved in collecting a commercial debt, which allows to assess the quality of the judicial process, the one component that is omitted in the first alternative measure. Columns (1) and (2) in Table 4.4 show that the coefficient estimates of the two types of legal institutions and their interaction term remain positive and statistically significant but vary in sizes when using alternative measures for legal contracting institutions.

Third, I make use of an alternative legal property rights institutions measure. I use Fraser Institute's "Protection of property rights" indicator that is based on information from the World Economic Forum's Executive Opinon survey question: *"In your country, to what extent are property rights, including intellectual property, protected?"* In contrast to the baseline measure, this alternative measure has the advantage of having the explicit focus on measuring how well property rights are protected rather than assessing the quality of a broader set of political institutions. The downside of this measure, however, is that it builds up on subjective evaluations of business executives who were asked on specific aspects of the business environ-

ment in the country they operate in. These evaluations may be prone to changes in business cycles and deliberate contortions of respondents. Nevertheless, and as presented in columns (3) in Table 4.4, the coefficient estimates of the two types of legal institutions and their interaction term remain positive and statistically significant.

4.5.5 Robustness: Restricted and extended models

The results of Acemoglu and Johnson (2005) and the policy recommendations that can be derived thereof rely on the assumption that the marginal effects of legal property rights and contracting institutions are independent. In the following, I estimate first-step and second-step models that exclude the interaction term. The aim of this exercise is to evaluate how much the estimates of the marginal effects differ from the baseline estimates when assuming $\gamma_3 = 0$. Columns (1) in Table 4.5 show the coefficient estimates and respective standard errors of the second-step restricted model. The resticted model estimates of γ_1 and γ_2 are quantitatively and qualitatively similar to the baseline model estimates. The restricted model results suggest that an one standard deviation increase in executive constraints increases long-term income levels by 22.41%. The baseline estimation results, however, reveal that these estimates are only accurate for countries with a quality level of legal contracting institutions close to the sample average, such as Namibia. They are not accurate for countries with legal contracting institutions closer to the lower and upper end of the quality distribution such as Gambia and Chad.

Rich and poor countries are not equally distributed around the world but cluster in world regions. The clustering could be due to spatial heterogeneity caused by growth factors that are region-specific or more similar for countries from the same world region. Besides institutions, these region-specific factors could include geographic and climate conditions, contemporary and historical political events, or cultural traits. The clustering could partly also be due to spatial spillovers caused by economic and political integration of countries as well as trade and migration flows, which are more intensiv among countries located in the same world region. In an extended model, I include region dummies to control for all region-specific effects. This enables to analyze the maginal effects of legal property rights and contracting institutions in a more homogeneous setting. Columns (2) in Table 4.5 show the results when region dummies extend the baseline models. The increase in the R^2 statistic suggests that region-specific effects explain a substantial part of the variation in long-term income levels around the world. All five regions have lower income levels as compared to the sixth, omitted reference region Western democra-

Table 4.5: Results for restricted and extended models

	2nd step: BE			
	(1)		(2)	
	Coeff.	SE	Coeff.	SE
Executive Constraints	0.335***	(0.124)	0.198**	(0.096)
Legal Contract Enforcement	0.449***	(0.106)	0.243***	(0.092)
EC * LCE			0.186**	(0.078)
Investment (% of GDP)	0.000	(0.016)	0.003	(0.011)
Population (per sqkm)	0.000	(0.000)	0.000**	(0.000)
Trade (% of GDP)	0.007**	(0.003)	0.007***	(0.002)
Years of schooling	0.149***	(0.051)	0.117***	(0.045)
Cultural fractionalization	−1.386***	(0.454)	−0.443	(0.420)
Northern Africa/Middle East			−0.585*	(0.337)
Latin America			−1.663***	(0.233)
Eastern Europe			−1.710***	(0.244)
Asia			−1.725***	(0.321)
Sub-Saharan Africa			−2.496***	(0.290)
Observations	130		130	
R^2	0.4872		0.7642	

Notes: Dependent variable: $\hat{\mu}_i$ as proxy for countries' long-term income levels. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parantheses. Constant included but not reported. The Western democracies and Japan region is omitted and serves as reference in the second-step regression.

cies and Japan. The region-specific effects capture all cross-regional differences in institutional quality. This absorbs half of the effects of legal property rights institutions, legal contracting institutions, and their interaction term as compared to the baseline estimation results. Nevertheless, there are still significant individual and interaction effects left to explain within-region variation in long-term income levels.

4.5.6 Robustness: Endogeneity

The argument so far was that institutions affect income and the estimation results have been interpreted in this way. Yet, the channel of influence may also run the other direction, hence, from income to institutions. Increases in income may enable to channel more resources into enhancing institutional quality. Endogeneity among income and institutions is a critical issue that makes a causal interpretation of models (4.4) and (4.5) problematic. The existing literature (e.g., Dollar and Kraay, 2003; Acemoglu et al., 2005; Bluhm and Szirmai, 2012) and the first-step estimation results suggest that income and institutions are not immediately and directly responding to

each other. In the long-term, however, they very likely are. The applied FE and BE estimators do not take care of the issue of reverse causality. The estimation results presented so far merely identify correlations.

Acemoglu et al. (2001) and Acemoglu and Johnson (2005) suggest to exploit exogenous variation in institutions and perform IV estimation procedures in order to be able to give causal interpretations. Since then it has become standard to use historical data as instruments for present institutions. However, this practice is not seen without criticism. Albouy (2012) shows that the settler mortality and legal origin data used in Acemoglu et al. (2001), Acemoglu and Johnson (2005), and many following studies to instrument measures of property rights and contracting institutions is not reliable. Przeworski (2004a,b) rejects the search for principal causality in institutional theory and econometric analysis altogether on the grounds that institutions and income are mutually endogenous. Although countries' income levels and quality levels of legal property rights and contracting institutions are very likely endogenous outcomes of a coevolution process, I want to acknowledge the issue of endogeneity for the consistency of the coefficient estimates. In a final robustness test, I perform an IV estimation procedure to give some hint that the baseline estimation results are not severely biased by reverse causality.

I instrument the 2005–2015 values of legal property rights and contracting institutions with past values that obviously do not respond to 2005–2015 income levels.[8] Table B.12 in the appendix provides the summary statistics on the instruments. Fortunately, for *Executive Constraints* there is information dating back several decades. I use ratings for the period 1985–1995 and their square as instruments for the 2005–2015 ratings. Unfortunately, 2000 is the first year in which questions on time, money, and quality of contract enforcement were included in the World Bank's Doing Business survey. My instrument for *Legal Contract Enforcement* therefore is time-invariant information from the year 2000. To instrument the interaction term, I simply interact the 1985–1995 ratings for executive constraints with countries' scores for the legal enforcement of private contracts in 2000.

Table B.13 in the appendix presents the results of the first-stage IV estimation. The institutional variables show a strong autocorrelation over time, which confirms the persistence of institutions. The reported F-statistics allow to reject the null

[8] Besides for what Albouy (2012) puts forward, I use past values rather than colonial history data for two reasons: First, colonial history data is time-invariant information, while for the past values I (partly) obtain panel data. Panel data allows me to construct $m > k$ instruments for k endogenous institutional variables and perform an overidentification test on whether the instruments are valid. Second, colonial history data fails to reject the null hypothesis that the equation is underidentified, which suggests that colonial history data is a poor instrument for the underlying world sample.

Table 4.6: Results for models tackling endogeneity issues

	2nd step: BE					
	(1)		(2)		(3)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Executive Constraints	1.764***	(0.308)	0.364***	(0.129)	0.370***	(0.07)
Legal Contract Enforcement	0.564***	(0.216)	0.527***	(0.126)	0.498***	(0.099)
EC * LCE	0.800**	(0.386)	0.193*	(0.116)	0.326***	(0.091)
Investment (% of GDP)	0.025	(0.029)	0.002	(0.015)	0.014	(0.012)
Population (per sqkm)	0.000	(0.000)	0.000	(0.000)	0.001***	(0.000)
Trade (% of GDP)	0.005	(0.003)	0.004	(0.003)	0.003	(0.002)
Years of schooling	0.053	(0.076)	0.147**	(0.061)	0.186***	(0.052)
Cultural fractionalization	0.015	(0.700)	−1.071**	(0.521)	−1.158***	(0.434)
Observations	101		101		130	
(Centered) R^2	0.5812		0.4988		0.5378	
Kleibergen-Paap rk LM statistic	9.172					
Chi-sq(2) P-val	0.0102					
Hansen J statistic	1.033					
Chi-sq(1) P-val	0.3094					

Notes: Dependent variable: $\hat{\mu}_i$ as measure for countries' long-term income levels obtained in the respective first step regressions. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parantheses. Constant included but not reported. In (1) the institution variables are instrumented with past values. In (2) values of the year 2005 are used for the right-hand side variables. In (3) values of the first observed year are used for the right-hand side variables.

hypothesis that the instruments are weak.[9] Columns (1) in Table 4.6 present the results of the second-stage IV estimation. The coefficient estimates of the instrumented institutional variables support the baseline estimation results. The individual and interaction effects of the two types of legal institutions remain economically and statistically significant. The increase in the size of the coefficient estimates is in accordance with Acemoglu and Johnson (2005) and Voigt and Gutmann (2013). The Kleibergen-Paap rk LM and Sargan statistics in the lower part of Table 4.6 provides an LM test of whether the equation is identified. The null hypothesis can be rejected, which indicates that the instruments are relevant. The Hansen J statistic is a test of overidentifying restrictions. I cannot reject the joint null hypothesis that the instruments are valid, i.e., uncorrelated with the error term, and that the excluded instruments are correctly excluded from the structural equation.

Columns (2) and (3) in Table 4.6 present the results when estimating (4.5) using first period values rather than mean values. This alternative estimation approach

[9]This follows Staiger and Stock (1997), who suggest that instruments are weak if $F \leq 10$.

for the second-step model represents a reduced form of the IV estimation approach. The results presented in columns (2) refer to a specification that uses values of the year 2005 and considers the same set of sample countries as the second stage of the IV estimation approach. The results presented in columns (3) refer to a specification that uses values of countries' first observed year and considers the same set of sample countries as the baseline second-step BE estimation approach. The results of these estimation exercises confirm previous results. All robustness exercises tackling endogeneity issues suggest that the baseline results are not seriously biased and institutions exhibit significant individual and interaction effects on long-term income levels. This does, however, not exclude the possibility of omitted variable bias. Both income and institutions may be affected by other fundamental causes of growth captured in growth theory's $A(0)$ term, e.g., geographic and climate conditions, cultural traits, or other institutions. To take account of this issue, we need more theoretical and empirical work on the coevolution process of economic outcomes, institutions, and other factors that constitute fundamental causes of growth.

4.6 Conclusion

Motivated by Acemoglu et al. (2005), this study has reevaluated the effects of legal property rights and contracting institutions on economic development. Unlike previous literature that assumes independent effects, this study has considered that the two different types of legal institutions may be effective in their combination. The argument was that legal property rights and contracting institutions provide interrelated incentives and constraints on private investment and thereby jointly determine the accumulation of physical and human capital, as well as the utilization of existing and adoption of new technologies.

This study contributes to the existing literature by revealing that the assumption of independent effects of these two types of institutions is too strong. Ignoring the interaction effect leads to an underestimation (overestimation) of the long-term income effects of improvements in the quality of legal property rights institutions for countries with a strong (weak) legal enforcement of private contracts, occasionally to a substantial degree. Moreover, it reveals that the fit of the two types of legal institutions is crucial for the size and the directon of the marginal effects. For countries with absent or very bad qualities of both types of legal institutions, installing or improving only legal property rights institutions produces negative interaction effects. Presumably, this is caused by interferences with incentives and constraints provided by non-legal contracting institutions. The negative interaction effect can

exceed the positive individual effect, wich applies mostly for countries at lower levels of economic development. This insight adds to literature that addresses the difficulties of institution-building and institutional change in poor countries and may help to get one step closer in understanding in how far and why the slow, incomplete, and controversial privatization efforts contributed to the stagnation of transitioning economies such as Russia or the Ukraine.

The policy implications that can be drawn from this study for institution-building and institutional change in poor and transitioning countries are in favor of deviating from a best practice model that forsees piecemeal reforms towards implementing a specific arrangement of legal institutions and that does not sufficiently take account of institutional complementarities. Instead, institution-building and institutional change should be tailored to local challenges and based on prevalent institutional set-ups. This, however, requires to understand all important prevalent institutionalized rules and practices that put incentives and constraints on economic activities, as well as the nature of the relationships among them. The institutional solution for economic development is country-specific but may be more alike within groups of countries. Future research may investigate more closely similarities and differences in the configuration and interplay of property rights and contracting institutions within and across groups of countries applying different property rights regimes and relate them to differences in economic development.

Chapter 5

Summary and Outlook

This thesis contributed to get a better understanding of the huge and persistent cross-country differences in income levels and growth paths. Growth theory and growth accounting relate this empirical phenomenon to differences in factor inputs and productivity but provide no answer for why rich countries succeed to invest in physical capital and human capital and adopt modern production technologies, while poor countries fail to do so. The existing empirical literature extensively discusses the role of geography, institutions, and culture as fundamental causes of growth that drive investment in factor inputs and the ability to adopt new technologies. While economists are still divided in their opinion about the relative importance of the different fundamental causes, a vast number of studies claims that institutions play a crucial role. In order to learn which institutions are most important, it has become standard to isolate and compare the effects of different types of institutions. This thesis presented studies that give reason to critically review this approach and the policy reforms drawn from studies that assume institutions are independently and universally effective.

In three studies, I looked at the interdependencies of instiutions and the relevance of these interdependencies for institution-building, institutional change, and consequently, for macroeconomic outcomes. I analyzed in how far institutions influence each other's (optimal) values and exhibit joint effects on income. Strategic interactions of agents and complementarity conditions among institutions and environments lie at the heart of my analyses. The three studies add to the existing literature by reevaluating not only *which institutions* matter but also *under which conditions* these institutions matter. This helps not only to understand persistent cross-country differences in income levels and growth paths but also to explain cross-country differences in the evolution of national institutional set-ups and cross-

country differences in the economic effects of regulations and policy reforms. The results from the three studies give good reason to see institutions as intertdependent rather than coexisting and to take account of these interdependencies in policy design. We learned from Chapter 2 that there exist spatial interdependencies in institutional qualities. These spatial interdependencies are created by strategic interactions and are strongest within national borders. In Chapter 3, we elaborated on how complementarities among institutions of different domains of a society and country-specific environments can explain why there exists a variety of national institutional set-ups. These institutional set-ups constitute different systems of institutions that are all equilibria but react differently to common regulations. In Chapter 4, we took the analytical considerations of Chapter 3 to empirics and found that legal property rights and contracting institutions are jointly effective. Their quality fit matters for long-term income levels.

Each of the studies contributed to understand cross-country differences in economic development. The insights are in accordance with the conditional and club convergence hypotheses. Countries that are more similar in their environmental conditions have developed more similar institutional set-ups and follow mor similar growth paths. Since similarity increases with geographic proximity, we see countries with more similar income levels and growth paths clustered on a world map. Since country-specific environments include geographic and cultural factors, it makes limited sense to compare their importance relative to institutions. As argued in this thesis, it makes more sense to see the fundamental causes of growth as building up and depending on each other.

There are two valuable take aways from this thesis I shortly want to elaborate on: First, institutions are endogenous outcomes of strategic interactions. Whether an institution establishes and how effective it is, depends on which other institutions and environmental factors are prevalent or have been prevalent at some point in history. Institutions are manmade, (re)produced in everyday interactions, and can therefore be changed. Yet, since they are part of systems with many other institutions that complement, mitigate, and check each other, they are rather persistent. Second, the analyses reveal a geographic pattern of institutional qualities and macroeconomic outcomes. Both tend to cluster in space, some at subnational levels like corruption levels, some at national levels like institutional set-ups, and some at world regional levels like countries' levels of economic development. Geographically closer units seem to be more alike. The reason for this lies in spatial interdependencies and spatial heterogeneity. The former capture the reciprocal influence between geographically close units via connectivity, the latter captures underlying characteristics

that are common to geographically close units, e.g., geographic conditions, climate conditions, cultural traits, national affiliation, or membership in treaties.

With this thesis, I make an appeal for rethinking current policy reform programs. There is no "one way fits all"-program for successful economic development. Rules and practices that proved to be successful at some place and time were successful in a specific institutional set-up and environment and may or may not yield the desired outcomes in others. Merely replicating the institutions of rich countries is insufficient. An accurate design of policy reform programs requires to thoroughly study the institutional and environmental conditions in which the reforms should be introduced. Spatial interdependencies and spatial heterogeneity should be taken into account for the design of effective and efficient policy programs. Concerning the former, strategic policy design has to consider direct effects and indirect effects. Concerning the latter, one should expect heterogeneous effects from harmonizing regulations across heterogeneous institutional set-ups and environments. This entails that for different groups of subnational regions or countries different degrees of integration may be optimal. Imitation and transplantation of rules and practices are more promising among geopolitical entities with similar environmental and institutional factors. Institutional transplants from countries at high levels of economic development to countries at low levels of economic development will backfire if the transplanted rules are at odds with prevalent rules and practices or do not fit to local challenges and needs.

Avenues for future research may lead to investigating the integrity and coherence of countries' distinctive institutional set-ups as well as their fit to globalized environments. For some countries, the recipe for a desirable economic development may lie in detecting misfitted institutions that constitute bottlenecks and prevent whole systems of institutions from being effective. For other countries, the challenge may be institutional change of a well-fitted institutional system that worked optimally in a context of national production and consumption but can no longer coordinate economic activities in a globalized world. Research in these two directions may deliver valuable contributions to understand growth miracles after long-term stagnation or vice versa as experienced in, e.g., Japan or the four East Asian Tigers, as well as ongowing growth disasters as experienced in Sub-Saharan African countries. Concerning Sub-Saharan African countries, research on the coherence of national institutional set-ups and their fit to globalized environments may be of special importance. African countries' institutional set-ups have not evolved endogenously in country-specific environments, under complementarity conditions, and oriented towards local challenges and needs. They are a conglomerate of many different,

potentially misfitted, elements. There are indigenous rules and practices that are able to meet challenges and local needs in historical but not contemporary environments. There are more or less extractive economic institutions installed by European colonizers that are able to meet challenges and European needs in historical but not contemporary environments. There are political institutions installed in the course of the independence declarations that are based on models of Western countries. There are institutions and environmental conditions created by the IMF's and World Bank's free-market policies. The need for institutional change in Sub-Saharan African countries is urgent. Policy reforms so far have not been successful to solve the problems. This is mainly due to the fact that it is unclear what the problems are. The research presented in this thesis may help getting closer towards understanding the problems, a prerequisite for finding the (institutional) solutions.

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Appendix

A Formal derivation of direct and indirect effects

We follow LeSage and Pace (2009) to derive the direct and indirect effects. The data-generating process is given as:

$$y_{ic} = (I - \rho W)^{-1}(X_{ic}\beta + \theta_c + \mu_{ic}), \tag{1}$$

where

$$(I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \dots \quad .$$

We can rewrite parts of (1) as:

$$\begin{aligned}(I_n - \rho W)^{-1} X\beta &= \sum_{r=1}^{k} (I_n - \rho W)^{-1} x_r, \\ &= S_r(W) x_r,\end{aligned}$$

where r stands for the independent variables. Following LeSage and Pace (2009) and Kim et al. (2003), the data-generating process can then be rewritten as:

$$\begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix} = \sum_{r=1}^{k} \begin{pmatrix} Sr(W)_{11} & Sr(W)_{12} & \dots & Sr(W)_{1n} \\ Sr(W)_{21} & Sr(W)_{22} & \dots & Sr(W)_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ Sr(W)_{n1} & Sr(W)_{n2} & \dots & Sr(W)_{nn} \end{pmatrix} \begin{pmatrix} x_{1r} \\ x_{2r} \\ \vdots \\ x_{nr} \end{pmatrix} + (I_n - \rho W)^{-1}\epsilon. \tag{2}$$

Unlike in the case of the independent data model, the derivative of y_i with respect to x_r is potentially non-zero and takes a value determined by the i, j^{th} element of the matrix $S_r(W)$. We can differentiate between direct effects and indirect effects. The direct effects for subnational region i capture the impacts of a change in an independent variable x_{ir} on i's own level of corruption and are given by:

$$\frac{y_i}{x_{ir}} = S_r(w)_{ii}.$$

The direct effects include the effects of feedback loops where observation i affects observation j and the change in observation j again affects observation i. The loops may also take longer paths and go from i to j to k and back to i. The indirect effects capture the impacts of a change in another subnational regions' independent variable on subnational region i's corruption level. This implies that a change in the independent variable of one subnational region may affect the corruption levels of all other subnational regions which is a logical consequence of introducing Wy as a right-hand side variable in the model. The indirect effects are defined as:

$$\frac{y_i}{x_{jr}} = S_r(w)_{ij}.$$

All diagonal elements of $S_r(W)$ represent direct effects and all off-diagonal elements of $S_r(W)$ represent indirect effects of a change in an independent variable x_r. The size of the effects differs across all subnational regions. It depends on a subnational region's position in space and the degree of connectivity with other subnational regions. Both are determined by the spatial weighting matrix, the parameter ρ that measures the degree of corruption levels' spatial interdependencies, and the parameter β. Following LeSage and Pace (2009) and LeSage and Pace (2014), the effects can be summarized using scalar measures:

$$\begin{aligned} \overline{M}(r)_{direct} &= n^{-1} tr(S_r(W)), \\ \overline{M}(r)_{total} &= n^{-1} \iota_n' S_r(W) \iota_n, \\ \overline{M}(r)_{indirect} &= \overline{M}(r)_{total} - \overline{M}(r)_{direct}, \end{aligned} \tag{3}$$

where tr stands for the trace of the matrix and ι_n is a $n \times 1$ vector of ones. $\overline{M}(r)_{direct}$ refers to the cumulative average direct effects. $\overline{M}(r)_{direct}$ is the average value of the diagonal of $S_r(W)$. $\overline{M}(r)_{total}$ refers to the cumulative average total effects of a change in the r_{th} independent variable of a subnational region on the corruption levels of all subnational regions in the sample including itself. $\overline{M}(r)_{total}$ is the average of all column sums of $S_r(W)$. Finally, $\overline{M}(r)_{indirect}$ refers to the cumulative indirect effects and is by definition the difference between $\overline{M}(r)_{total}$ and $\overline{M}(r)_{direct}$. Formally, $\overline{M}(r)_{indirect}$ is the average column sum of the off-diagonal elements in $S_r(W)$.

B Additional Tables and Figures

Table B.1: Sample composition

Country	Obs.	Type	Level	Country	Obs.	Type	Level
Albania	8	Counties	ADM1	Macedonia	8	Statistical reg.	NUTS3
Argentina	22	Provinces	ADM1	Malaysia	6	States	ADM1
Austria	9	States	NUTS2	Mexico	31	Statistical reg.	ADM1
Bangladesh	7	Divisions	ADM1	Mongolia	20	Aimags	ADM1
Belarus	7	Regions	ADM1	Montenegro	4	Regions	ADM1
Belgium	11	Provinces	NUTS2	Mozambique	11	Provinces	ADM1
Benin	12	Departments	ADM1	Nepal	4	Regions	ADM1
Bolivia	9	Departments	ADM1	Netherlands	12	Provinces	NUTS2
Bosnia Herzegovina	10	Cantons	ADM1	Niger	2	Departments	ADM1
Brazil	24	States	ADM1	Nigeria	31	States	ADM1
Bulgaria	28	Planning reg.	NUTS3	Pakistan	5	Provinces	ADM1
Burkina Faso	45	Provinces	ADM1	Panama	9	Provinces	ADM1
Canada	12	Provinces	ADM1	Paraguay	15	Departments	ADM1
Chile	13	Regions	ADM1	Peru	23	Regions	ADM1
Colombia	27	Departments	ADM1	Philippines	16	Regions	ADM1
Congo, Dem. Rep.	4	Provinces	ADM1	Poland	16	Provinces	NUTS2
Croatia	20	Counties	NUTS3	Portugal	7	Statistical reg.	NUTS2
Czech Republic	14	Regions	NUTS3	Romania	42	Departments	NUTS3
Denmark	5	Regions	NUTS2	Russian Fed.	20	Fed. Subjects	ADM1
Dominican Republic	31	Provinces	ADM1	Senegal	10	Regions	ADM1
Ecuador	21	Provinces	ADM1	Serbia	4	Statistical reg.	ADM1
El Salvador	14	Departments	ADM1	Slovakia	8	Regions	NUTS3
Estonia	5	Statistical reg.	NUTS3	Slovenia	12	Statistical reg.	NUTS3
France	26	Regions	NUTS2	South Africa	9	Provinces	ADM1
Gambia	2	Divisions	ADM1	Spain	17	Auton. com.	NUTS2
Georgia	5	Regions	ADM1	Sri Lanka	9	Provinces	ADM1
Germany	16	States	NUTS2	Swaziland	2	Regions	ADM1
Greece	13	Peripheries	NUTS2	Sweden	21	Provinces	NUTS3
Guatemala	22	Departments	ADM1	Tanzania	21	Regions	ADM1
Honduras	18	Departments	ADM1	Turkey	16	Sub-regions	NUTS2
Hungary	20	Counties	NUTS3	Uganda	4	Admin. regions	ADM1
Indonesia	9	Provinces	ADM1	Ukraine	27	Oblast	ADM1
Italy	21	Regions	NUTS2	United Kingdom	37	Statistical reg.	NUTS2
Kazhakstan	16	Provinces	ADM1	United States	49	States	ADM1
Kenya	8	Provinces	ADM1	Uruguay	19	Departments	ADM1
Kosovo	7	Municipalities	ADM1	Uzbekistan	5	Regions	ADM1
Kyrgyzstan	6	Regions	ADM1	Venezuela	22	States	ADM1
Lao PDR	4	Provinces	ADM1	Vietnam	63	Provinces	ADM1
Latvia	5	Planning reg.	NUTS3	Zambia	9	Provinces	ADM1
Lesotho	10	Districts	ADM1	Zimbabwe	10	Provinces	ADM1
Lithuania	10	Counties	NUTS3				

Table B.2: Questions from the *Afrobarometer survey*

Number	Question	Min	Max	Direction
56C	How many elected local government councilors do you think are involved in corruption?	0	3	+
56E	How many local government officials do you think are involved in corruption?	0	3	+
56F	How many of the police do you think are involved in corruption?	0	3	+
56H	How many judges and magistrates do you think are involved in corruption?	0	3	+
57A	In the past year, how often have you had to pay a bribe to get a document or permit?	0	3	+
57B	In the past year, how often have you had to pay a bribe to get a child into school?	0	3	+
57C	In the past year, how often have you had to pay a bribe to get a household service?	0	3	+
57D	In the past year, how often have you had to pay a bribe to get medical attention?	0	3	+
57E	In the past year, how often have you had to pay a bribe to avoid a problem with police?	0	3	+

Notes: The table reports the questions extracted from the *Afrobarometer survey* to be used in the calculation of *Corruption* as subnational measures on corruption in African countries. Min and Max indicate the range of possible responses. Direction indicates whether a higher response indicates more corruption (+) or less corruption (-). Data is taken from 17,950 individuals surveyed in 2005. Data for Burkina Faso comes from 2008 and includes a subset of the questions listed.

Table B.3: Questions from the *Latin American Public Opinion Project*

Number	Question	Min	Max	Direction
EXC2	Has any police official asked you for a bribe in the last year?	No	Yes	+
EXC6	During the last year has any public official asked you for a bribe?	No	Yes	+
EXC7	Based on your own experience, do you believe corruption among public officials is common?	1	4	-
EXC11	During the last year have you had to pay a bribe to process a document with the municipality?	No	Yes	+
EXC14	Have you had to give a bribe to the courts in the last year?	No	Yes	+
EXC15	Have you had to give a bribe to obtain public health services in the last year?	No	Yes	+
EXC16	Have you had to give a bribe at your child's school in the last year?	No	Yes	+
EXC17	Has anyone asked you for a bribe to avoid having the electricity turned off?	No	Yes	+
N9	To what extent would you say the current government combats government corruption?	1	7	-

Notes: The table reports the questions extracted from the *Latin American Public Opinion Project* to be used in the calculation of *Corruption* as subnational measures on corruption in the Americas. Min and Max indicate the range of possible responses. Direction indicates whether a higher response indicates more corruption (+) or less corruption (-). Data is taken from 27,650 individuals surveyed in 2006. Data for Argentina comes from 2008 and includes a subset of the questions listed. Data from the U.S. and Canada also includes a subset of the questions listed.

Table B.4: Questions from the *Asia Foundation survey*

Country	Question	Min	Max	Direction
Bangladesh	Informal charges	0	10	-
Malaysia	Informal charges	0	10	-
Nepal	Informal charges	3	12	-
Philippines	Corruption prevention	5	20	-
Sri Lanka	Informal charges, favoritism, and discrimination	0	9	-
Vietnam	Informal charges	0	10	-

Notes: The table reports the questions extracted from the *Asia Foundation survey* to be used in the calculation of *Corruption* as subnational measures on corruption in Asian countries. Min and Max indicate the range of possible responses. Sub-indices are created by the survey sponsors except for Nepal, the Philippines, and Thailand, where the sub-indices from available survey questions are aggregated and named by Mitton (2016). Direction indicates whether a higher response indicates more corruption (+) or less corruption (-). Data is taken from 31,903 firms and individuals surveyed between 2006 and 2011.

Table B.5: Questions from the *Quality of Government Institute survey*

Question	Min	Max	Direction
How likely is it the corruption by a public employee or politician would be exposed by the local mass media?	0	10	-
Does the police force give special advantages to certain people in your area?	0	10	-
In the past 12 months has anyone in your household paid a bribe to health or medical services?	Yes	No	-
Do you agree that corruption is prevalent in the police force in your area?	0	10	-
Do you agree that corruption is prevalent in your area's local public school system?	0	10	-
Do you agree that corruption is prevalent in the public health care system in your area?	0	10	-

Notes: The table reports the questions extracted from the *Quality of Government Institute survey* to be used in the calculation of *Corruption* as subnational measures on corruption in European countries. Min and Max indicate the range of possible responses. Direction indicates whether a higher response indicates more corruption (+) or less corruption (-). Data is taken from 33,540 individuals surveyed between 2009 and 2010.

Table B.6: Questions from the *Latinobarómetro survey*

Number	Question	Min	Max	Direction
P82STB	Has anyone in your family known of an act of corruption in the last 12 months?	Yes	No	+
P84ST	If the total number of public employees were 100, how many would you say are corrupted?	0	100	-

Notes: The table reports the questions extracted from the *Latinobarómetro survey* to be used in the calculation of *Corruption* as subnational measures on corruption in Latin American countries. Min and Max indicate the range of possible responses. Direction indicates whether a higher response indicates more corruption (+) or less corruption (-). Data is taken from 20,222 individuals surveyed in 2005.

Table B.7: Questions from the *World Bank Enterprise Survey*

Number	Question	Min	Max	Direction
C5	Was an informal gift or payment expected or requested for an electrical connection?	Yes	No	-
C14	Was an informal gift or payment expected or requested for a water connection?	Yes	No	-
C21	Was an informal gift or payment expected or requested for a telephone connection?	Yes	No	-
G4	Was an informal gift or payment expected or requested for a construction-related permit?	Yes	No	-
J1B	Do you agree that it is common to pay informal payments or gifts to get things done?	1	4	+
J5	In meetings with tax officials was a gift or informal payment expected or requested?	Yes	No	-
J6	In dealing with government, what percent of contract value is paid in informal payments to secure the contract?	0	NA	+
J7A	What percent of annual sales would be paid in informal payments or gifts to public officials to "get things done"?	0	NA	+
J12	Was an informal gift or payment expected or requested for an import license?	Yes	No	-
J15	Was an informal gift or payment expected or requested for an operating license?	Yes	No	-
J30F	How much of an obstacle is corruption to the operations of this establishment?	0	4	+

Notes: The table reports the questions extracted from the *World Bank Enterprise Survey* to be used in the calculation of *Corruption* as subnational measures on corruption around the world. Min and Max indicate the range of possible responses. Direction indicates whether a higher response indicates more corruption (+) or less corruption (-). Data is taken from 40,792 firms surveyed between 2006 and 2011.

Table B.8: Definitions of variables and sources of data

Variable	Description
Corruption	Aggregated score of all survey questions that fall within the category of corruption. Aggregated first within surveys and then across surveys. Before aggregation, responses with no upper bound are logged. All questions are made directionally consistent with higher values indicating higher levels of corruption. All questions are standardized to a mean of zero and standard deviation of one. *Source:* Mitton (2016)
Log GDP per capita	Logarithm of average GDP per capita in the subnational region. *Source:* Various sources see Mitton (2016), additional data from (i) the Pakistan Bureau of Statistics for Pakistan collected in the PSLM survey 2016/2017, and (ii) the Nigeria Data Portal on Nigerian province statistics for the year 2006.
Log population	Logarithm of subnational population. *Source:* Various sources see Mitton (2016).
Education	Average years of schooling from primary school onward for the population aged above 15. *Source:* Gennaioli et al. (2012) and various sources taken from Eurostat for Denmark and Italy; MICS for Albania, Belarus, Kazakhstan, Kosovo, Montenegro, Nigeria, Uzbekistan; DHS program for Dominican Republic and Guatemala; Central Statistical Bureau of Latvia; missing values are constructed from neighbors for Rangpur (Bangladesh), Santa Cruz (Bolivia), Northern and Eastern Sri Lanka, Islamabad (Pakistan), Crimea (Ukraine), Vargas (Venezuela).
Seaports	Number of ports in the subnationational region. *Source:* The World Port Index by the National Geospatial-Intelligence Agency. Authors' own calculation.
Airports	Number of airports in the subnational region. *Source:* Global Airport Database (Release 0.0.2-20170321). Authors' own calculation.
Capital city	Dummy, 1 if the subnational region constitutes or comprises the capital of the nation. *Source:* Google earth. Authors' own calculation.
Ethnic fractionalization	A set of 77 variables representing the percentage (by area) of each subnational region that is home of a given ethnicity. *Source:* Weidmann et al. (2010).
Autonomy	Dummy, 1 if the subnational region is autonomous or partly autonomous. *Source:* List of autonomous areas by country, Wikipedia https://en.wikipedia.org/wiki/List_of_autonomous_areas_by_country.
Border	Dummy, 1 if the subnational region is located at a national border. *Source:* The authors' own calculation.
Log land area	Logarithm of the size of the subnational region in square kilometers. *Source:* Google earth.
Terrain ruggedness	Average terrain ruggedness (in hundreds of meters) across all 30 by 30 arc-second cell contained within the subnational region. *Source:* Nunn and Puga (2012).
Log stormrisk	Logarithm of the number of occurrences of hurricanes and tropical storms in the subnational region between 1842 and 2010. *Source:* National Oceanic and Atmospheric Administration.
Log earthquakerisk	Logarithm on number of fault lines present in the subnational region. *Source:* U.S. Geological Survey's Earthquake Hazards Program Data from Esri Disaster Response.
Precious metals	The number of identifiable mineral sites containing precious metals (gold, silver, or the platinum group) within the subnational region, enters regression analyses scaled by 1,000 sites. *Source:* Mineral Resources Data System of the United States Geological Survey.
Diamonds	The number of identifiable mineral sites containing diamonds within the subnational region, enters regression analyses scaled by 1,000 sites. *Source:* Mineral Resources Data System of the United States Geological Survey.
Oil and gas (sites)	The number of identifiable oil and/or natural gas sites within the subnational region, enters regression analyses scaled by 1,000 sites. *Source:* United States Geological Survey and Petroconsultants International Data corporation (transformed from NAD 1927 to WGS 84 6).
Distance	We measure centroid great circle distance d_{ij} between pairs of subnational regions i and j to construct the weights ω_{ij} of our spatial weights matrix W. *Source:* The authors' own calculation.

Table B.9: Sample composition

Country	Region	Obs.	Country	Region	Obs.
Afghanistan	Asia	2	Kazakhstan	Eastern Europe + form. Sovjet	11
Angola	Sub-Saharan Africa	11	Kenya	Sub-Saharan Africa	11
Albania	Eastern Europe + form. Sovjet	11	Korea, Rep.	Asia	11
Argentina	Latin America + Caribbean	11	Kuweit	Northern Africa + Middle East	11
Armenia	Eastern Europe + form. Sovjet	11	Kyrgyz Rep.	Eastern Europe + form. Sovjet	10
Australia	Western democracies + Japan	11	Lao PDR	Asia	11
Austria	Western democracies + Japan	11	Latvia	Eastern Europe + form. Sovjet	11
Azerbaijan	Eastern Europe + form. Sovjet	11	Lebanon	Northern Africa + Middle East	11
Bahrain	Northern Africa + Middle East	8	Lesotho	Sub-Saharan Africa	7
Bangladesh	Asia	2	Liberia	Sub-Saharan Africa	9
Belarus	Eastern Europe + form. Sovjet	11	Lithuania	Eastern Europe + form. Sovjet	11
Belgium	Western democracies + Japan	11	Macedonia	Eastern Europe + form. Sovjet	11
Benin	Sub-Saharan Africa	11	Malawi	Sub-Saharan Africa	11
Bolivia	Latin America + Caribbean	11	Malaysia	Asia	11
Brazil	Latin America + Caribbean	2	Mali	Sub-Saharan Africa	10
Bulgaria	Eastern Europe + form. Sovjet	11	Mauritania	Sub-Saharan Africa	11
Burkina Faso	Sub-Saharan Africa	11	Mauritius	Sub-Saharan Africa	11
Cameroon	Sub-Saharan Africa	11	Mexico	Latin America + Caribbean	2
Canada	Western democracies + Japan	11	Moldova	Eastern Europe + form. Sovjet	11
Centr. Afr. Rep.	Sub-Saharan Africa	8	Morocco	Northern Africa + Middle East	11
Chad	Sub-Saharan Africa	11	Mozambique	Sub-Saharan Africa	6
Chile	Latin America + Caribbean	11	Myanmar	Asia	2
China	Asia	2	Namibia	Sub-Saharan Africa	11
Colombia	Latin America + Caribbean	11	Netherlands	Western democracies + Japan	11
Congo, Dem. Rep.	Sub-Saharan Africa	10	New Zealand	Western democracies + Japan	11
Congo, Rep.	Sub-Saharan Africa	11	Nicaragua	Latin America + Caribbean	11
Costa Rica	Latin America + Caribbean	11	Nigeria	Sub-Saharan Africa	2
Cote d'Ivoire	Sub-Saharan Africa	5	Norway	Western democracies + Japan	11
Croatia	Eastern Europe + form. Sovjet	11	Pakistan	Asia	2
Cyprus	Northern Africa + Middle East	7	Panama	Latin America + Caribbean	11
Czech Republic	Eastern Europe + form. Sovjet	11	Paraguay	Latin America + Caribbean	11
Denmark	Western democracies + Japan	11	Peru	Latin America + Caribbean	11
Dominican Rep.	Latin America + Caribbean	11	Philippines	Asia	11
Ecuador	Latin America + Caribbean	11	Poland	Eastern Europe + form. Sovjet	11
Egypt, Arab Rep.	Northern Africa + Middle East	10	Portugal	Western democracies + Japan	11
El Salvador	Latin America + Caribbean	11	Romania	Eastern Europe + form. Sovjet	11
Eritrea	Sub-Saharan Africa	3	Rwanda	Sub-Saharan Africa	11
Estonia	Eastern Europe + form. Sovjet	11	Saudi Arabia	Northern Africa + Middle East	11
Eswatini	Sub-Saharan Africa	7	Senegal	Sub-Saharan Africa	11
Ethiopia	Sub-Saharan Africa	5	Sierra Leone	Sub-Saharan Africa	11
Finland	Western democracies + Japan	11	Singapore	Asia	11
France	Western democracies + Japan	11	Slovak Rep.	Eastern Europe + form. Sovjet	11
Gabon	Sub-Saharan Africa	10	Slovenia	Eastern Europe + form. Sovjet	11
Gambia	Sub-Saharan Africa	10	South Africa	Sub-Saharan Africa	11
Georgia	Eastern Europe + form. Sovjet	11	Spain	Western democracies + Japan	11
Germany	Western democracies + Japan	11	Sri Lanka	Asia	11
Ghana	Sub-Saharan Africa	11	Sudan	Sub-Saharan Africa	11
Greece	Western democracies + Japan	11	Sweden	Western democracies + Japan	11
Guatemala	Latin America + Caribbean	11	Switzerland	Western democracies + Japan	11
Guinea	Sub-Saharan Africa	11	Tajikistan	Eastern Europe + form. Sovjet	10
Guinea-Bissau	Sub-Saharan Africa	10	Tanzania	Sub-Saharan Africa	11
Guyana	Latin America + Caribbean	11	Thailand	Asia	11
Haiti	Latin America + Caribbean	4	Togo	Sub-Saharan Africa	11
Honduras	Latin America + Caribbean	11	Tunisa	Northern Africa + Middle East	8
Hungary	Western democracies + Japan	11	Turkey	Northern Africa + Middle East	11
India	Asia	2	Uganda	Sub-Saharan Africa	9
Indonesia	Asia	2	Ukraine	Eastern Europe + form. Sovjet	11
Iran, Isl. Rep.	Northern Africa + Middle East	11	Un. Arab Emir.	Northern Africa + Middle East	11
Iraq	Northern Africa + Middle East	6	United Kingdom	Western democracies + Japan	11
Ireland	Western democracies + Japan	11	United States	Western democracies + Japan	2
Israel	Northern Africa + Middle East	11	Uruguay	Latin America + Caribbean	11
Italy	Western democracies + Japan	11	Uzbekistan	Eastern Europe + form. Sovjet	11
Jamaica	Latin America + Caribbean	11	Venezuela, RB	Latin America + Caribbean	10
Japan	Western democracies + Japan	2	Zambia	Sub-Saharan Africa	6
Jordan	Northern Africa + Middle East	11	Zimbabwe	Sub-Saharan Africa	11

Table B.10: Definitions of variables and sources of data

Variable	Description
Log real income per capita	Logerithm of GDP per capita in constant 2010 US Dollars. *Source:* World Bank national accounts data and OECD national accounts data files.
Executive Constraints	The extent of institutionalized constraints on the decision-making powers of executives imposed by any accountability groups. Originally on a seven-category scale, where (1) Unlimited Authority, (3) Slight to Moderate Limitation on Executive Authority, (5) Substantial Limitations on Executive Authority, (7) Executive Parity or Subordination, and (2), (4), and (6) are intermediary categories. I demean the scores and devide them by the variable's standard deviation to obtain normalized values in the range [-2.196,0.920]. *Source:* Polity IV Project, following Eckstein and Gurr (1975).
Legal Contract Enforcement	Index measuring the efficiency and quality of commercial dispute resolution. It considers cases where the value of the claim is equal to 200% of the economy's income per capita or US$5,000, whichever is greater. The original score ranges from 0 and 100 and is a simple average of the scores for each of the three component variables (time, cost, quality of judicial process). The methodology builds up on Djankov et al. (2003). I multiply the index scores by 0.1 to obtain values between 0 and 10, demean the values, and devide them by the variable's standard deviation to obtain normalized values between [-2.868,2.662]. *Source:* World Bank Doing Business data based on studies of codes of civil procedure, court regulations, and questionnaires completed by local litigation lawyers and judges.
Legal Contract Enforcement II	Index measuring the efficiency of collecting a commercial debt equal 200 percent of the country's income per capita or worth US$5,000, whichever is greater. Time cost and monetary costs are considered. The former is measured in number of calendar days required from the moment the lawsuit is filed until payment, the later as a percentage of the debt. The formula used to calculate the ratings is $(V_{max} - V_i)/(V_{max} - V_{min})$. Vi represents the time or money cost value. The values for V_{max} and V_{min} are set at 725 days and 82.3 percent (1.5 standard deviations above average in 2005) and 62 days (1.5 standard deviations below average in 2005) and 0 percent, respectively. Countries with values outside the V_{max} and V_{max} range receive ratings of either 0 or 10, accordingly. The two scores get averaged into one. I demean the variable's scores and devide them by the variable's standard deviation to obtain normalized values between [-2.709,2.360]. *Source:* Fraser Institute's *Legal Enforcement of Contracts*, an indicator of the Economic Freedom index based on the World Bank's Doing Business estimates.
Number of Procedures	Number of procedures involved in collecting a commercial debt valued at 200 percent of the country's income per capita. The minimum number is 21, the maximum number 55 procedures. Based on the number of procedures, countries are rated on a score between 0 and 100, whereas higher scores indicate a lower number of procedures. I multiply the orignal scores by 0.1, demean them, and devide them by the variable's standard deviation to obtain normalized values in the range [-2.651,2.594]. *Source:* World Bank Doing Business data based on studies of codes of civil procedure, court regulations, questionnaires completed by local litigation lawyers and judges.
Property Rights Protection	Measure on how well property rights are protected based on the World Economic Forum's survey question: *In your country, to what extent are property rights, including intellectual property, protected?* The Fraser Institute converts the original value to a 0-to-10 scale using the formula: $EFW_i = ((GCR_i - 1) \div 6) \times 10$ where 10 refers to the highest protection. I take the variable constructed by the Fraser Institute, demean and devide the values by the variable's standard deviation to obtain normalized values in the range [-3.194,2.188]. *Source:* Fraser Institute's *Protection of property rights*, an indicator of the Economic Freedom index that is a component of the Human Freedom index.
Investment (% of GDP)	Gross capital formation as percentage of GDP (formerly gross domestic investment). *Source:* World Bank, World Development Indicators.
Population (per sqkm)	Population density (people per sq. km of land area), midyear population. *Source:* Food and Agriculture Organization and World Bank population estimates.
Trade (% of GDP)	Sum of exports and imports of goods and services measured as a share of GDP. *Source:* World Bank Open Data, data from World Federation of Exchanges database.
Cultural fractionalization	0-to-1 scale index on how culturally fractionalized the population is in the year 2003. *Source:* Fearon (2003).
Years of schooling	Duration of compulsory education (years) for population 25+, 3-year moving averages. *Source:* Barro and Lee (2011).
Group dummies	4 dummies assigning countries to one of four combinations of above and below sample average quality levels of measures of legal property rights and contracting institutions.
Region dummies	6 dummies assigning countries to one of six world regions, see Table B.9. *Source:* Fearon (2003).

Table B.11: Interaction effect estimated for different groups separately

	2nd step: BE							
	(1)		(2)		(3)		(4)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Executive Constraints	0.227*	(0.124)	0.501***	(0.132)	0.340**	(0.143)	0.165	(0.160)
Legal Contract Enforcement	0.264**	(0.109)	0.637***	(0.100)	0.449***	(0.116)	0.589***	(0.122)
EC * LCE * $\mathcal{D}_{++}$	1.188***	(0.303)						
EC * LCE * $\mathcal{D}_{--}$			0.730***	(0.160)				
EC * LCE * $\mathcal{D}_{+-}$					0.023	(0.332)		
EC * LCE * $\mathcal{D}_{-+}$							0.616**	(0.303)
Investment (% of GDP)	0.006	(0.015)	0.007	(0.014)	0.001	(0.016)	0.003	(0.016)
Population (per sqkm)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Trade (% of GDP)	0.007**	(0.003)	0.007**	(0.003)	0.007**	(0.003)	0.006**	(0.003)
Years of schooling	0.171***	(0.049)	0.170***	(0.048)	0.150***	(0.051)	0.150***	(0.050)
Cultural fractionalization	−1.366***	(0.426)	−1.206***	(0.418)	−1.376***	(0.456)	−1.360***	(0.460)
Observations	130		130		130		130	
R^2	0.5332		0.5402		0.4932		0.5112	

Notes: Dependent variable: $\hat{\mu}_i$ as proxy for countries' long-term income levels obtained in the first-step regression. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parantheses. Constants included but not reported.

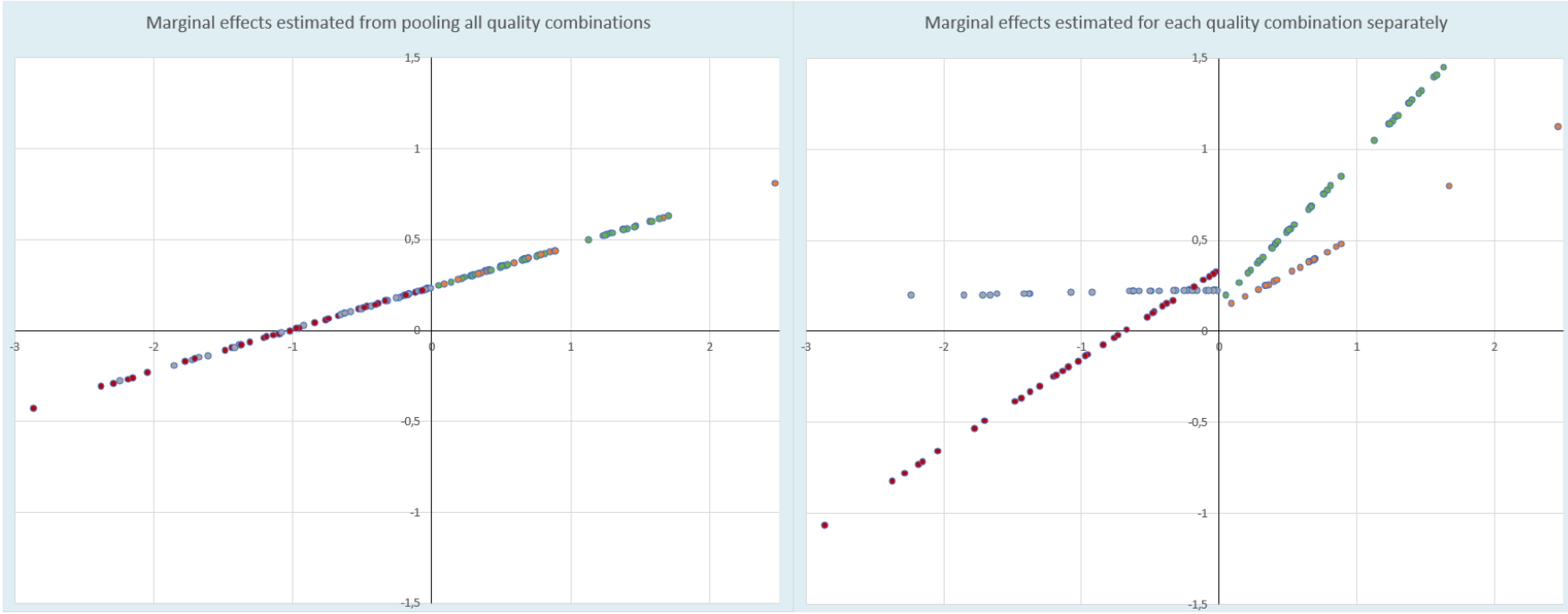

Figure B.1: The x-axis gives countries' 2005–2015 average *Legal Contract Enforcement* scores. The y-axis gives the estimated marginal effects of an one standard deviation increase in *Executive Constraints*. The left diagram plots the average marginal effects estimated for model (4.5) and presented in Table 4.2 columns (2) pooling all 130 sample countries. The right diagram plots the marginal effects when the interaction effect is estimated separately for groups of countries with different quality combinations of legal property rights and contracting institutions as presented in Table B.11. Countries represented by green dots have a ++ quality combination. Countries represented by red dots have a −− quality combination. Countries represented by grey dots have a +− quality combination. Countries with orange dots have a −+ quality combination.

Table B.12: Summary statistics on instruments

	Obs	Mean	St.dev	Min	Max
EC1985-1995	902	0.000	1.000	-1.663	1.013
EC1985-1995sq	902	0.000	1.000	-1.348	1.105
CE2000	902	0.000	1.000	-2.535	2.300
EC1985-1995 * CE2000	902	0.000	1.000	-2.079	3.418

Table B.13: IV estimation results: First stage

Dependent Variable	Executive Constraints		Legal Contract Enforcement		EC * LCE (2005–2015)	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
Investment (% of GDP)	−0.008	(0.017)	0.011	(0.009)	−0.011	(0.012)
Population (per sqkm)	−0.000**	(0.000)	−0.000	(0.000)	−0.000*	(0.000)
Trade (% of GDP)	0.002	(0.002)	0.005***	(0.002)	0.002	(0.003)
Years of schooling	0.037	(0.038)	0.043	(0.030)	−0.039	(0.061)
Cultural fractionalization	−0.508	(0.352)	−0.357	(0.284)	−0.244	(0.340)
EC1985-1995	−0.658	(0.514)	−0.654	(0.473)	0.772	(0.799)
EC1985-1995square	1.121**	(0.487)	0.635	(0.458)	−0.649	(0.702)
CE2000	0.056	0.068	0.747***	(0.064)	0.104	(0.120)
EC1985-1995 * CE2000	−0.032	(0.080)	0.099	(0.067)	0.456***	(0.090)
Observations	101		101		101	
Partial R^2 of excl. instruments	0.3268		0.6818		0.2658	
F (4,91)	13.03		48.01		17.21	

Notes: Dependent variables: baseline measures for institution variables. Excluded instruments: Executive constraints 1985-1995, its square, contract enforcement in 2000, and the interaction of the past executive constraints and contract enforcement scores. *, **, *** indicate 10, 5, 1 % significance levels. Robust standard errors in parantheses. Constants included but not reported.