Essays on Institutions and Institutional Change

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Usman Khalid

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Abstract: This thesis consists of three essays discussing institutional change and its effects. It distinguishes between economic and political institutions, and highlights the need for broader empirical efforts that consider interactions among different types of institutions.

The first essay titled *Effect of Trade and Political Institutions on Economic Institutions* explores the relationship between trade and economic institutions under different political regimes. The findings suggest that the effect of trade on economic institutions reduces significantly in the presence of extractive political institutions. In contrast, there is a positive and significant effect of trade on economic institutions in countries with relatively less extractive and democratic institutions.

The second essay *Catch-up in Institutional Quality: An Empirical Assessment*, studies the process of catch-up in institutional quality by asking whether a catch-up in institutional quality has occurred across countries. The results indicate that a catch-up in economic institutional quality has occurred and that most countries with weak economic institutions have a higher rate of change than that of countries with strong economic institutions. In contrast, for political institutions, the catch-up process lasts only a few years.

The third essay *Firm Ownership and Provincial CO_2 emissions in China*, investigates whether China's move towards a market economy has affected its CO_2 emissions by considering the effect of firm ownership on provincial emissions. The hypothesis is that private firms are economically more efficient than non-private firms resulting in fewer CO_2 emissions by the private firms. The results suggest that capital growth is the main driver of emissions growth and that private firm capital is more energy-efficient than capital employed in non-private firms.

Key words: Institutions, Institutional change, Economic institutions, Political institutions, Firm ownership

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To my parents for their love,
endless support and encouragement.

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Chapter 1
Introduction

The New Institutional Economics (NIE) perspective highlights the importance of institutions in shaping economic outcomes. The basic premise of NIE is that economic outcomes realized by a society are also a function of the institutions put in place, which create incentives and impose constraints that in turn motivate agent's behavior. Numerous empirical studies have established that institutions are critical for economic development (e.g., see Acemoglu, Johnson, & Robinson, 2001; Easterly & Levine, 2003; Hall & Jones, 1999; Knack & Keefer, 1995; Mauro, 1995; Rodrik, Subramanian, & Trebbi, 2004). A large body of literature has explored the relevance of institutions in determining international trade, foreign direct investments, financial development, and efficiency (Adkins, Moomaw, & Savvides, 2002; Busse & Hefeker, 2007; Levchenko, 2007; La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998). Still further, institutions have been identified as substantive predictors of macroeconomic stability, and entrepreneurship (Acemoglu, Johnson, Robinson, & Thaicharoen, 2003; Aidis, Estrin, & Mickiewicz, 2010; Simón-Moya, Revuelto-Taboada, & Guerrero, 2014; Stephen, Urbano, & van Hemmen, 2005).

The quality of these institutions varies significantly across countries. Shirley (2005) highlights four explanations for these differences. The first is a legacy of poor institutions inherited from colonizers (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1999; North, 1990). The second explanation refers to differences in initial resource endowments that led to the development of distinct institutional development pathways (Acemoglu & Johnson, 2002; Acemoglu, Johnson, & Robinson, 2005b; Acemoglu & Robinson, 2012). The third is that a lack of political competition may have encouraged leaders to build institutions to serve their own interests rather than the interests of the people (Nugent & Robinson, 2010). The final explanation is that distinct cultural and ideological beliefs and norms may have discouraged the development of anonymous markets and market-supporting institutions such as property rights, contract laws and investor protection (Knack & Keefer, 1997; North, 1994, 2006). Although these

theoretical explanations help explain the deeper causes of institutional differences, they offer limited guidance to improve local institutions in the short and medium terms.

Another strand in the literature interprets institutional quality as a by-product of economic development and shifting policy demands (Chang, 2011). The modernization hypothesis assumes that the relative benefits of institutions increase with the level of economic development (e.g., see Acemoglu, Johnson, Robinson, & Yared, 2009; Chang, 2011; Lipset, 1959). Along this reasoning, the causal chain predicts that accelerating economic development and increased wealth create corresponding demands for high-quality institutions (e.g., demands for political institutions with greater transparency and accountability), nurture agents who introduce change dynamics, and finally provide resources to introduce and maintain institutional change (Chang, 2011). Similarly, the grand transition perspective interprets "development" as a process of steady economic growth leading to broad institutional transitions (Paldam & Gundlach, 2008). Naturally, other economic factors, such as economic openness and human capital, also contribute and shape these complex processes of institutional change (Al-Marhubi, 2005; Alonso & Garcimartín, 2013; Bergh, Mirkina, & Nilsson, 2014; Bhattacharyya, 2012; Islam & Montenegro, 2002; Nicolini & Paccagnini, 2011).

Most empirical studies aiming to document institutional change do not distinguish between different types of institutions. Rather, they treat different institutions as alternative proxies for overall institutional quality (Acemoglu & Johnson, 2005). However, North's (1990) definition of institutions as "rules of the game" that "structure incentives in human exchange, whether political, social, or economic" distinguishes between different types of institutions that are unlikely to be equally open to change. Economic and social institutions determine the incentives and constraints of economic and social actors, and political institutions determine the incentives and constraints of key actors in the political sphere. In non-democratic systems, these key actors often have ultimate control over the distribution of political rights (Acemoglu, Johnson, & Robinson, 2005a).

This taxonomy provides a useful approach to study the complex dynamics and contingencies of institutional change. For instance, how do modifications of one distinct institution affect other institutions? Does spillover have positive effects or counterbalancing tendencies? Which institutions deserve priority? Finally, how can contingency effects be exploited to advance institutional change? Inspired by these open questions, this thesis distinguishes between political and economic institutions as two types of institutions that likely differ in their malleability and are also likely to mutually affect related change-dynamics. Political institutions form the basis of economic institutions (Acemoglu et al., 2005a; Acemoglu &

Robinson, 2012; North, 1990, 1991, 1994). Thus, Acemoglu et al. (2005a) argue that political institutions define the constraints limiting the use of political power, and they condition the distribution of resources (and rents) within the economy, thereby determining which group holds the de jure political and economic power in a given society. Political institutions play a crucial part in the institutional system. Any change in political institutions can modify the distribution of economic resources and the structure of economic institutions (Acemoglu et al., 2005a). Various historical illustrations demonstrate how the unequal distribution of de facto economic power combined with extractive de jure political institutions can lead to the persistence of socially inefficient economic institutions over time (Acemoglu & Robinson, 2012).

The theoretical and conceptual framework underscores the importance of distinguishing between several types of institutions and the interactions among them. Relying on North's (1990) broader definition of institutions as "rules of the game" provides little insight on the process of institutional change. This basic definition helps identify the importance of institutions in the economic system, but it requires further development to understand their specific functions in relation to different parts of an economy. In particular, institutions should be delineated in terms of their specific effects on economic outcomes to establish how individual institutions (or institutional groupings) cause (either directly or indirectly) or hinder growth. Rodrik (2000, p. 2) summarizes the question as follows: "Which institutions matter and how does one acquire them?" This question highlights the need for broader empirical efforts that consider interactions among different types of institutions. Any discourse on institutions and institutional change should also consider the mutually reinforcing and dynamic relations of well measured, distinct political and economic institutions. As Acemoglu and Johnson (2005) state, it is necessary to "unbundle" institutions to explain how and why they develop.

Overview of the Chapters

Chapter 2: Trade, Political Institutions and Economic Institutions

This chapter contributes to the growing literature on identifying the determinants of economic institutions. Recent empirical studies confirm a positive relation between international trade and the quality of domestic economic institutions (Bergh et al., 2014; Bhattacharyya, 2012; Nicolini & Paccagnini, 2011).

However, the effect of trade on economic institutions is likely to vary with different political regimes. From a short-term perspective, trade regimes and domestic rules of international trade participation reflect the priorities of the ruling class and, in this sense, they are political constructs. In an authoritarian regime, the political elite can effectively restrict broader participation of the public in trade and can use regulations, quotas, and licenses to manipulate the market structure and impede market access (Aidt & Gassebner, 2010). Increased trade is therefore not necessarily associated with better economic institutions. I argue that institutional effects stemming from international trade are unlikely to be independent of the prevailing political regime. Centralized power in the hands of a small group of political elites is likely to have moderating effects on the assumed link between trade and economic institutional quality. Thus, the effect of international trade on economic institutions will be attenuated in countries with more extractive political institutions compared to countries with democratic institutions.

Using panel data from 138 countries from the year 1984 to 2010, this chapter reports a positive link between the level of international trade and the quality of economic institutions. However, in the presence of extractive political institutions, the effect of trade on economic institutions decreases significantly and even becomes negative. The results are in line with the theoretical predictions and reinforce the conditional relationship between trade and economic institutions. These results appear to confirm that authoritarian regimes effectively restrict broader participation of the public in trade and may also resort to use of regulations, quotas, and licenses to manipulate the market structure and impede market access, reducing the effect of trade openness on economic institutions. The findings underscore the role played by political institutions in determining economic institutions and calls for the inclusion of political institutions in the analysis of economic institutions.

Chapter 3: Catch-up in Institutional Quality: An Empirical Assessment

This chapter contributes to the literature studying the dynamics of institutional change and the differences in change patterns among political and economic institutions. This chapter deviates from examining the determinants of institutions and instead focuses on institutional change. The central question is whether there is a process of catch-up in institutional quality across countries and whether there are any differences in how economic and political institutions change. To answer this question, this chapter investigates the evolution of these institutions over time. A key objective of reforms aimed at promoting economic

growth in developing countries has been to improve institutional quality, as dysfunctional and ineffective institutions and weak governance "is increasingly seen to be at the heart of the economic development challenge" and "building effective and accountable institutions is arguably the core challenge for sustainable poverty reduction" (World Bank, 2000, p. 1). However, institutional development is a challenging endeavor, as new institutions must comply with the existing social norms and face opposition from elites (Acemoglu et al., 2005a; Evans, 2004). Moreover, economic institutions are more likely to change, compared to political institutions, as the interests of elites align with changing economic institutions vis-à-vis political institutions (Nye, 2011; Olson, 1993). Therefore, it is fitting to ask whether a catch-up in institutional quality has occurred and whether the catch-up process differs between economic and political institutions.

The chapter uses a novel testing method to test for catch-up in institutional quality across countries. The study uses data on 81 countries from 1985 to 2010 and three different measures of institutional quality that capture both political and economic dimensions of institutions. The results suggest that economic institutions in most countries tend to change in similar directions. Moreover, evidence supports a catch-up in institutional quality, as most countries with weak institutions have a higher rate of change than that in countries with strong institutions. In contrast, for political institutions, the catch-up process was short-lived, lasting only a few years. The results indicate that the pattern of change for economic and political institutions is different and underscores the need to incorporate the differentiation between economic and political institutions in future studies.

Chapter 4: Firm Ownership and Provincial CO_2 emissions in China

(Co-authored with Fredrik N. G. Andersson and Sonja Opper)

Chapter 4 contributes to the literature on the effects of public and private ownership of firms on environmental quality by studying the effects of regional differences in ownership structure on overall provincial carbon dioxide (CO_2) emissions in China. Since the 1980s, China has emerged as one of the world's largest economies and the main emitter of CO_2. Many contend that China's leadership has prioritized economic growth over environmental concerns throughout most of its reform, causing severe air, water, and land pollution (He, Lu, Mol, & Beckers, 2012). However, China has also experienced a gradual capitalist transformation from a fully state-owned economy to a hybrid economy

largely relying on private production and mixed ownership forms (Nee & Opper, 2012). The question remains whether and to what extent the country's openness to capitalist forms of production has reinforced or possibly mitigated accumulating environmental costs.

To model the effect of this capitalist transformation on environmental quality, the chapter uses Chinese provincial data from 1992 to 2012. The approach followed here is to decompose the short-run and long-run cause of emissions into scale, energy, and carbon intensity components. The results show that capital growth is the main driver of emissions growth and that private-firm capital is more energy efficient than capital employed in non-private firms. This translates into emission growth between 3 and 4 percent per year in the long-term, had private firms been as inefficient as non-private firms. This result emphasizes that market-oriented reforms and general firm efficiency can decrease future CO_2 emission growth. The competitive pressure on private firms, as compared to non-private firms, is likely to be the main driver of the negative long-run correlation between private enterprises and emissions. The results also show that continued structural changes from an agricultural economy to a modern industrialized economy, coupled with an active environmental policy (i.e. regulation of carbon price) may reduce overall emissions growth close to zero, despite economic growth in excess of 5 percent per year. These insights offer valuable lessons for many developing countries, which continue to rely on large state-owned sectors. Economic development and environmental concerns can be coupled into a win-win situation through reforms that directly enhance productivity and competition and indirectly decrease environmental degradation.

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Chapter 2
Trade, Political Regimes and Economic Institutions

Introduction

Explaining institutional change is a challenging endeavor that has only recently gained broader academic attention. In economics, changing relative prices and the specific role of trade have long been regarded as crucial drivers of institution building (North, 1990). In their study of Atlantic trade after 1500, Acemoglu, Johnson, and Robinson (2005b) show how the growth of trade has empowered merchant groups to push for institutional changes to constrain monarchies and protect traders' property rights. Others confirm a positive relation between trade openness and the quality of domestic economic institutions (Bergh, Mirkina, & Nilsson, 2014; Bhattacharyya, 2012; Levchenko, 2012; Nicolini & Paccagnini, 2011). A related strand of the literature also identifies a link between trade openness and the quality of governance (Al-Marhubi, 2005; Bonaglia, Braga de Macedo, & Bussolo, 2001; Wei, 2000), the level of corruption, and rent seeking (Ades & Di Tella, 1999; Gatti, 2004; Neeman, Paserman, & Simhon, 2004; Treisman, 2000).

An isolated analysis of trade openness per se, however, may grossly simplify the mechanisms at work. From a short-term perspective, trade regimes and domestic rules of international trade participation clearly reflect the priorities of the ruling class and are, in this sense, political constructs. It is, therefore, an open question whether higher trade flows[1] (henceforth, trade) will – independently of the political system – lead to an improvement in domestic economic institutions. This study shifts attention from trade openness as a construct of institutional quality to the realized trade and corresponding quality of economic institutions under

[1] "Trade flow" is defined as the sum of exports and imports as a share of GDP.

different political institutions. The likely interaction effect between trade and political structures is far from trivial. Not only is this interaction important for understanding and predicting the direction of institutional change, but the assumed interaction effect should also help policymakers devise context-specific policies. Ultimately, such analysis is crucial to understanding whether, in the short-term, bilateral trade with authoritarian regimes is actually helping to improve their institutional quality or merely increasing the survival chances of dictatorial rulers.

To analyze the relation between trade and economic institutional quality under different political regimes, this study uses a longitudinal data set covering 138 countries during the period from 1984 to 2010. The observation period thus includes a time of intense global trade liberalization followed by an average growth in world exports of approximately 6 percent between 1990 and 2008 (World Trade Organization [WTO], 2011). Instrumented estimations yield two robust results: First, the results confirm a positive and significant effect of trade on the quality of economic institutions independent of the domestic political regime. Second, the effect of trade on economic institutional quality is considerably smaller in the presence of authoritarian political institutions. These results are robust to changes in the measurement of political institutions as well as to different identification strategies, and the overall conclusions remain similar.

The remainder of the paper is organized as follows: Section 2 reviews the theoretical arguments detailing central causal mechanisms by which trade may influence a country's economic institutions and highlights the interplay between political institutions and the effects of trade on economic institutions. Section 3 introduces the empirical model; section 4 describes the data, and section 5 presents the results. The final section concludes the paper.

Trade and political institutions

Trade has featured prominently in the recent theoretical literature on the determinants of institutional change. The link between trade and the quality of domestic economic institutions rests on various mutually reinforcing transmission channels.

First, trade introduces a competition effect. Because domestic producers must compete both nationally and internationally with other producers, high transaction costs stemming from weak domestic institutions take a toll on

domestic production. Domestic economic agents, therefore, have incentives to lobby for and invest in better economic institutions to survive in the international marketplace (Islam & Montenegro, 2002). Simultaneously, competition has the potential to decrease corruption and rent-seeking activities and, thereby, improve bureaucratic efficiency (Ades & Di Tella, 1999; Bardhan, 1997; Treisman, 2000).

Trade also brings about a learning effect. Frequent cross-border interactions with international business partners increase knowledge and lead to a more informed citizenry (Al-Marhubi, 2005; Islam & Montenegro, 2002). Global flows of information improve and serve as alternative sources of knowledge and ideas. Such information spillovers help to improve domestic institutions because citizens will treat international practice as a benchmark and increasingly request changes that are consistent with international standards in their home institutions (Al-Marhubi, 2005).

Third, trade brings about a technology effect, which can have second-order effects on the quality of domestic economic institutions. Technological changes or technological shocks are likely to influence the distribution of domestic economic and political power (Coe & Helpman, 1995; Grossman & Helpman, 1991, 1995; Litwin, 1998; Spilimbergo, Londoño, & Székely, 1999). These shifts in relative societal power may subsequently affect the quality of economic institutions (Acemoglu, Johnson, & Robinson, 2005a).

Finally, trade and exposure to international market fluctuations trigger a certain insurance effect. Strong trade dependence can leave the economy more prone to external shocks such as sharp interest rate fluctuations, abrupt changes in the terms of trade, or a sudden capital outflow (Al-Marhubi, 2005). To cope with these fluctuations, countries seek to improve their institutional environments. In parallel, trade with foreign business partners requires a more sophisticated contract law and legal arbitration in case of business conflicts. This may push governments to legal reforms if they wish to reap the benefits of international trade (Islam & Montenegro, 2002). Particularly, membership or aspiration to gain membership in international organizations such as the WTO requires the signatory to bring domestic rules and regulations into compliance with international standards. In sum, the close link between trade and institutional qualities suggests the following hypothesis:

Hypothesis 1: The higher a country's trade is, the better the quality of domestic economic institutions.

The link between trade and the quality of economic institutions, however, is likely to vary with political regimes. If a small elite not subject to an effective system of political checks and balances holds political power, leaders are likely to establish

extractive rules to pursue their own self-interest (North, 1990; North & Weingast, 1989).

The mechanisms impeding positive institutional effects from trade can be twofold: On the one hand, authoritarian regimes applying extractive approaches are likely to have trade regimes in place that do not allow the broader participation of the general populace. Key elements are typically large shares of state-ownership in trading and manufacturing companies, trade monopolies, and monopsonies (Acemoglu et al., 2005a). Many countries, for instance, rely on government-owned agro-food trading companies that buy cash crops from domestic farmers at prices well below the world market prices to generate substantial monopsony rents when trading these products on the world market. In fact, from 1959 to 1960, when cocoa prices dropped by £50 a ton, instead of subsidizing their farmers to maintain a stable price, the governments of Ghana and Nigeria passed the burden of the drop in prices on to them (Acemoglu et al., 2005a).

Similarly, the political elite may use regulations, quotas, and licenses to manipulate the market structure and impede market access (Aidt & Gassebner, 2010). Typically, the goal is to retain control over the bulk of the resources for a few, often politically connected key players. The export boom in the meat and cotton industries in Central America in the 1960s is an example that shows how political institutions were used to retain gains from growing trade for the ruling elite of large landholders (Do & Levchenko, 2006). To capture the economic benefits of a rapidly growing cotton and meat export market in the 1960s and 1970s, large landholders with political power first evicted smallholders from their land by sharply increasing their rents. Politically well-connected landholders then used their power to obtain formal land titles. Domestic rules cemented these landholders' dominant market position by imposing restrictions on the number of firms involved in meat packaging and their production capacity. This regulation effectively instituted market entry barriers that restricted competition and increased economic profits for the elite (Do & Levchenko, 2006).

Evidently, extractive governments can rely on a wide portfolio of policy measures to reduce the expected competition effect associated with trade. Extractive political institutions will dampen the corrective influence of trade on corruption; in fact, the participation of the politically well-connected elite in trading activities may increase corruption levels given the great financial rents at stake (Banlaoi, 2004; Hutchcroft, 1997). Soft budget constraints and frequent state subsidies sponsoring the state's participation in foreign trade reinforce the problem (Broadman & Recanatini, 2001). Similarly, because of the potential restriction of foreign trade to the privileged, politically well-connected elite, information spillovers are limited and direct learning effects may remain modest. The same is

true for technology effects. If the political leadership is in control of those economic sectors that benefit the most from new technologies and innovations, shifts in the societal power balance may be relatively limited. Clearly, political efforts to tightly control new communication technologies and social media tools represent one example of how restrictive political regimes seek to cement their power by controlling access to new technologies (Knutsen, 2015).

In addition, how a country responds to the rules that a trading agreement or an international organization (such as WTO) implements depends largely on the political regime (Mansfield, Milner, & Rosendorff, 2002). A democratic government's willingness to implement the rules of a trade agreement is subject to the voters' preferences, whereas an oligarchic state will first realize the vested interests of the ruling elite (Mansfield et al., 2002). Because institutional reforms generally have a direct redistributive effect from small groups of the political elite towards the general public, external pressure for reforms is rarely successful unless domestic governments are forced to respond for economic and financial reasons (Andrews, 2013).

Thus, institutional effects stemming from trade are unlikely to be independent of the prevailing political regime. Centralized power in the hands of the political elite is likely to have moderating effects on the assumed link between trade and economic institutional quality. This leads to the second hypothesis:

Hypothesis 2: Trade under extractive political regimes will lead to smaller improvements in economic institutional quality than that in democratic systems.

Methodology

The empirical model broadly follows models commonly used in the literature on institutional development (see Bhattacharyya, 2012; La Porta, Lopez-de-Silanes, Shleifer, and Vishny, 1999); however, it differs in two respects. First, to test hypothesis 2, an interaction term is introduced to capture the effect of trade under different political regimes. Second, the dependent variable is bounded from above and below. Therefore, estimation is performed using a two-way Tobit model and the following regression equation is estimated:

$$eci_{it} = \alpha + \beta_1 trade_{it} + \beta_2 (trade_{it} \times poi_{it}) + \beta_3 poi_{it} + \gamma Z_{it} + \varepsilon_{it} \quad (1)$$

in which eci_{it} is a measure of the quality of economic institutions for country i in period t, α is the constant, $trade_{it}$ is the log of trade share, poi_{it} is a measure of country i's quality of political institutions, an Z_{it} is the matrix of other control variables that contains population, legal origin, geography, and GDP per capita. The model is estimated using annual observations. The reason for using annual observations instead of five-year averages is that political institutions experience discontinuous change in large steps, for instance in the form of a sudden political regime change (Roland, 2004).

There may exist a causal link between the quality of economic institutions and trade (e.g., see Jansen & Nordås, 2004; Levchenko, 2007; Linders, de Groot, & Rietveld, 2005), which could introduce bias into the estimates. Two methods are used to identify the causal relationship: an instrumental variable technique and identification through the heteroscedasticity method. The instrumental variable (IV) used for trade is constructed using the approach that Frankel and Romer (1999) suggested. This approach involves estimating a gravity model for bilateral trade shares (relative to GDP) using the geographic and demographic characteristics of a country and the corresponding trading partners as explanatory variables[2]. The predicted values from the gravity equation are then used to estimate a "geographic component of countries' overall trade," sometimes referred to as 'natural openness' (Wei, 2000). This measure of 'natural openness' is then used as an instrument for trade. Because Frankel and Romer (1999) approach is cross-sectional in nature, a year by year estimation of the gravity model is performed in order to capture the time-varying influences of the variables suitable for the panel data estimation. The gravity model used in the construction of the IV is estimated using OLS and is given below:

$$\ln\left(\frac{trade_{ijt}}{GDP_{it}}\right) = \beta_{0t} + \beta_{1t}\ln(pop_{it}) + \beta_{2t}\ln(pop_{jt}) + \beta_{4t}\ln(distance_{ij}) + \beta_{5t}contiguity_{ij} + \varphi_t\left(Geography_j\right) + \delta_t\left(Geography_i\right) + \epsilon_{ijt} \qquad (2)$$

[2] Data on trade with partners comes from the data set by Head, Mayer, and Ries (2010), which is only available up to the year 2006 and restricts the analysis when using instrumental variables. This data set also provides information on the GDP and population for the domestic country and its trading partner, the distance between each pair of countries, and whether they have a common language. Data on the country's other geographical features, such as its area, a dummy indicating whether it is landlocked, and its longitude and latitude, come from Mayer and Zignago (2011).

in which $trade_{iit}$ is bilateral trade from country *i* to country *j* in period *t* and GDP_{it} is the GDP of country *i* in period *t*. Pop_{it} and pop_{jt} represent country *i*'s and country *j*'s populations, respectively; $distance_{ij}$ is the distance between country *i* and country *j ;* and $contiguity_{ij}$ is a dummy variable indicating whether country *i* and country *j* share a border. $Geography_i$ is a matrix containing a set of other geographical features of country *i,* which includes its area, a dummy indicating whether it is landlocked, its longitude and latitude, and a dummy indicating its continent. $Geography_j$ is a matrix containing a set of other geographical features of country *j,* including its area, a dummy indicating whether it is landlocked, and a dummy indicating its continent. Note that the time-varying coefficients indicate that estimation is performed on a single year's data at a time.

The predicted values from equation (2) are then used to determine the predicted value of the bilateral trade share for each pair of countries. The predicted value of bilateral trade shares for each country compared with all other countries are then aggregated to obtain a measure of natural openness of the country denoted by $\widehat{Natopen}_{it}$.

$$\widehat{Natopen}_{it} = \sum_{j} exp(predicted\ value\ of\ ln(\frac{trade_{ijt}}{GDP_{it}})) \qquad (3)$$

The second estimation technique used to resolve the endogeneity problem is the identification through heteroscedasticity (IH) method. The IH method estimates the causal relation between variables by exploiting differences in the variance of the error terms across different sub-samples of the data. Rigobon (2003) shows that the identification problem can be solved if the data can be split into separate groups such that the variance of the structural error term differs while the parameters remain stable across groups. Each additional data split adds more equations to the system than unknowns, which allows the estimation of the structural parameters of interest. In principle, it is sufficient to identify the model if the data can be split into two groups with different variances in the structural error term.

Two different splits of data are used to consistently and robustly estimate the model. The first split – the Euro-colony split – distinguishes between countries that European powers colonized and countries that they did not colonize. The assumption underlying this split is that non-colonized countries may have had more heterogeneous outcomes in institutional arrangements than colonized countries; hence, the variance in structural shocks for non-colonized countries will be higher than that for colonized countries (Rigobon & Rodrik, 2005). The

second split – the development split – differentiates between countries based on their levels of development as measured by their per capita GDP.[3] Compared to that in low-income countries, there is a greater variance in per capita income in high-income countries. This implies that there will be relatively greater variance in investments related to institutional building in the high-income group.[4]

Data

Data is compiled from several sources and covers a total of 138 countries for the period 1984-2010. The data is unbalanced because not all the countries have data from 1984 until 2010. The total number of observations, therefore, differs across the various model specifications.

Dependent variable

Data on the quality of economic institutions comes from the Investment Profile Index (IP Index) and the International Country Risk Guide (ICRG).[5] The score on the IP index is assigned on the basis of subjective analysis of the available information regarding the investment climate in a country. This index is composed of three sub-indices, which present a country's investment profile when combined. These sub-indices are Contract Viability and Expropriation, Profits Repatriation, and Payment Delays. The three sub-indices capture dimensions of economic institutions such as the protection of property rights and contract enforcement. For the purpose of this analysis, a central advantage of these

[3] Countries with a GDP per capita of $5,000 (in current prices) or more in the year 2000 are placed in one group and the rest are placed in the other group.

[4] For the development split variance in IP index for developed countries is 6.08 and for developing countries it is 4.04. Similarly, for the Euro-colony split countries that were colonized have a variance of 5.60 on IP index whereas, countries that were not colonized have a variance of 6.87. The difference in variance between the groups in both of the splits is statistically significant.

[5] Several measures to capture changes in economic institutions are highlighted in the literature. These include the measure of Political Freedom and Civil Liberties from Freedom House (see, for example, La Porta et al., 1999; Nicolini & Paccagnini, 2011; Scully, 1988). Other measures include Expropriation Risk, Rule of Law, and Repudiation of Contracts by Government, which are available from ICRG (see, for example, Acemoglu, Johnson, & Robinson, 2001; Bhattacharyya, 2012; Knack & Keefer, 1995), and the Executive Constraint Index from the Polity IV data set (see, for example, Acemoglu et al., 2001; Bhattacharyya, 2012). These measures either partially reflect the variation in economic institutions and overlap with political institutions or cover a limited time period and are therefore not appropriate for the analysis.

measures is that they do not include any political aspects. This index has been used in similar contexts in a variety of empirical studies (for example, Harms & An de Meulen, 2013; Nsouli, Atoian, & Mourmouras, 2004; Rajan & Subramanian, 2007). The index varies from 0 to 12, and a higher value represents less risk of investment.

Explanatory variables

The explanatory variables include the measure of trade and the measure of political institutions. Trade is measured by the trade to GDP ratio, taken from the Penn World Table 7.0 (PWT 7.0).[6] It is one of the most widely used measures of trade in the literature (see, for example, Dollar & Kraay, 2003, 2004; Frankel & Romer, 1999; Rodrik, Subramanian, & Trebbi, 2004).

To proxy for the quality of political institutions, data is taken from the ICRG's Democratic Accountability Index (DA Index). This measure of political institutions captures political accountability – the extent to which policymakers are restricted from following the interests of the elite in establishing extractive economic institutions. The DA Index measures the responsiveness of government to its citizens and the checks and balances on the executive that are in place. This index varies from 0 to 6 and differentiates between five types of governance: alternating democracy, dominated democracy, de facto one-party state, de jure one-party state, and autarchy. In general, alternating democracies receive the most points and autarchies received the fewest points. For the ease of interpretation of the results, the index is reversed so that democracies receive the fewest points and autarchies receive the most points.

Control variables

Following the literature (e.g., see Bhattacharyya, 2012; La Porta et al., 1999; Levchenko, 2007, 2012), the estimation model includes a set of control variables that can influence economic institutions and that are potentially correlated with the trade. First, it is highly likely that rich countries can afford better institutions as well as they tend to trade more (Acemoglu et al., 2001; Alonso & Garcimartín, 2013; Frankel & Romer, 1999; La Porta et al., 1999; Rigobon & Rodrik, 2005). To control for the level of development, the average of log of PPP-converted GDP per capita (in current prices) is included. In addition to this, yearly growth rate in

[6] The log of trade to GDP ratio is taken.

PPP-converted GDP per capita (in current prices) is included to control for the confounding effect arising from income growth. The log of total population is added to control for the demographic structure of the country because the demographic structure affects the security of property rights (Harms & An de Meulen, 2013). La Porta et al. (1999) observed that a socialist legal system negatively affected institutional development in comparison to common law countries; therefore, legal origins are included as a control in the analysis. The quality of institutions and trade can also be influenced by geographical conditions such as a country's location, natural endowments, and disease environment (Easterly & Levine, 2003; Frankel & Romer, 1999). Hence, geographical conditions are controlled for using the distance from the equator as measured by the absolute value of latitude.

Table A1 in the appendix provides descriptive statistics of the variables used in the analysis. The first two columns report the mean and standard deviations of the full sample. The average IP score is 7.2, and the average trade to GDP ratio in the sample is 78.41. The latter is approximately the same as Switzerland's mean trade to GDP ratio, which is 78.75. Moreover, the average values for the DA index and the PR index are 2.25 and 3.49, respectively. The rest of the table reports the mean and standard deviations when the data is split into sub-samples based on the quartile values of the trade to GDP ratio. A clear pattern is evident in the first two rows of the table; trade and the IP index are positively correlated. The increase in the average trade to GDP ratio across sub-samples is substantial compared to the increase in the IP index, especially when the last two columns are compared. This shows an increase in the average trade to GDP ratio of approximately 1.25 standard deviations. However, the average IP index only increases marginally by only 0.2 standard deviations. This supports the hypothesis that the effect of trade on economic institutions may depend on the quality of political institutions.

Table A2 in the appendix provides correlations between dependent and explanatory variables. The correlation between the IP index and the log of trade to GDP ratio is positive, suggesting that countries with high trade to GDP ratios have better economic institutions. The correlation of the IP index to the DA index is negative, which indicates that countries with better political institutions have better quality economic institutions.

Results

Table 1 presents the OLS and Tobit model estimation results of the effect of trade and political institutions on the quality of economic institutions. Columns 1-3 present the unconditional effect of trade on the quality of economic institutions. Whereas Column 1 shows the results of the OLS model, Columns 2 and 3 show the results of the random effect Tobit model and IV estimation using Tobit. The results suggest that there is a positive and significant effect of trade on economic institutional quality for all the specifications. Moreover, the results hold up when the IV is used. These results are consistent with hypothesis 1, which suggests that larger trade volumes improves economic institutional quality and also confirms the results of previous studies (see Bergh et al., 2014; Bhattacharyya, 2012; Levchenko, 2012). The effect of the DA index is negative and significant for all specifications. This accords with the theory that predicts a positive relation between the quality of political institutions and quality of economic institutions (see, for example, Acemoglu et al., 2005a; North, 1990; North & Weingast, 1989).

Table 1
Effect of Trade and DA Index on IP Index

Variables	OLS	Tobit Random Effect	Tobit IV[§]	OLS	Tobit Random Effect	Tobit IV[§§]
log (trade)	1.08***	1.40***	2.37***	1.36***	2.87***	2.71***
	(0.06)	(0.13)	(0.30)	(0.12)	(0.21)	(0.36)
log (trade) × DA index				-0.09***	-0.43***	-0.38***
				(0.03)	(0.05)	(0.11)
DA index	-0.46***	-0.51***	-0.36***	-0.09	1.29***	1.17***
	(0.02)	(0.03)	(0.03)	(0.14)	(0.20)	(0.44)
log (Avg. GDP per capita)	0.55***	2.69***	0.35***	0.57***	2.58***	0.54***
	(0.04)	(0.46)	(0.05)	(0.04)	(0.44)	(0.06)
GDP per capita growth	3.03***	1.61***	2.81***	3.04***	1.69***	3.38***
	(0.44)	(0.39)	(0.57)	(0.44)	(0.38)	(0.53)
log (Population)	0.18***	3.49***	0.41***	0.21***	3.30***	0.37***
	(0.03)	(0.32)	(0.06)	(0.03)	(0.34)	(0.05)
Constant	-2.63***	-42.92***	-8.70***	-4.22***	-46.9***	-11.1***
	(0.54)	(5.25)	(1.59)	(0.80)	(5.23)	(1.99)
Other Controls	Latitude and Legal origin	Latitude and Legal origin	Latitude and Legal origin	Latitude and Legal origin	Latitude and Legal origin	Latitude and Legal origin
Observations	3,434	3,434	2,798	3,434	3,434	2,798
R-squared	0.37	-	-	0.37	-	-
Number of countries	138	138	134	138	138	134

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; [§] Instrumental variable: $Natopen_{it}$; [§§] Instrumental variable: $Natopen_{it}$ and $Natopen_{it} \times DA\ index_{it}$

However, the relation between trade and the quality of economic institutions may depend on the quality of political institutions as hypothesis 2 indicates. The model that equation (1) gives captures this effect by including an interaction term between trade and political institutions. The results of estimating several specifications of equation (1) while using the DA index as a measure of political institutions are presented in Columns 4-6. The coefficient of the interaction term is negative and significant for all specifications, whereas the coefficient of trade is positive and significant. The results are consistent with the second hypothesis, which suggests that in the presence of extractive political institutions, trade will have an attenuated effect on the quality of economic institutions. These results appear to confirm that authoritarian regimes effectively restrict the broader participation of the public in trade. In addition, they reveal that the regimes may resort to the use of regulations, quotas, and licenses to manipulate the market structure and impede market access, reducing the effect of trade on economic institutions.

For the OLS model in Column 4, the coefficients for trade and the interaction term are 1.36 and -0.09, respectively, and they are statistically significant at a 1 percent level of significance. This indicates that the effect of trade decreases under more extractive political regimes. To visualize the size of the moderating effect, Figure 1 depicts the marginal effect of trade at different values of the DA index for the OLS model in the graph. The graph indicates that the marginal effect of trade decreases as political institutions become more extractive; however, it remains positive and significant, even for the most extractive regime.

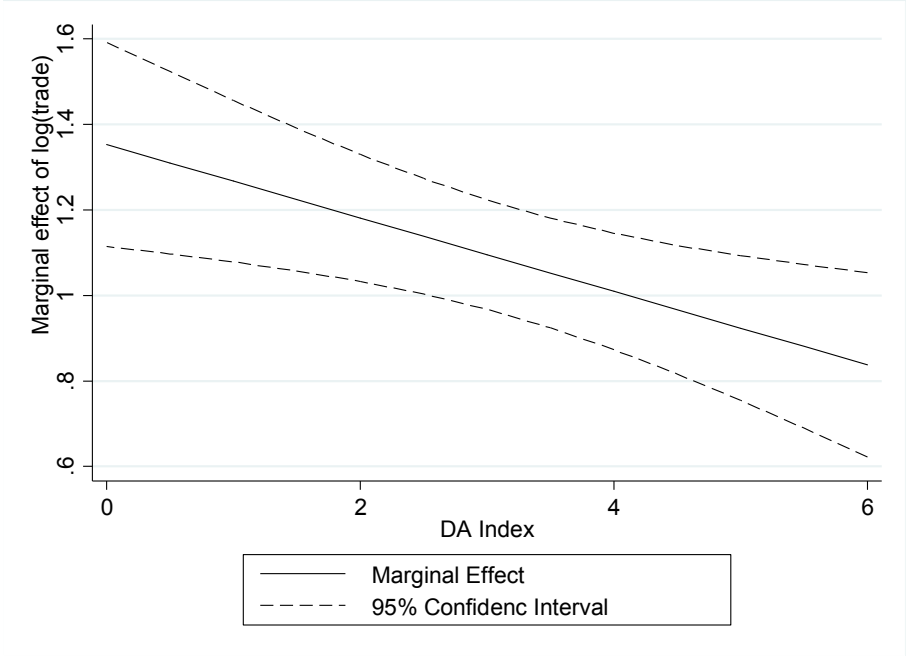

Figure 1
Marginal effect of log of trade on IP index for different values of DA index

The overall conclusions remain unchanged when natural openness as an IV is used in estimation. A comparison of Columns 4 and 6 reveals that the coefficient of trade and the interaction term increased in magnitude in Column 6. Figure 2 provides a graph of the total marginal effect of trade at different values of the DA index when natural openness is used as an IV. The graph suggests that at lower values of the DA index, the marginal effect of trade is higher and that as the DA index increases, the marginal effect tends to decrease.

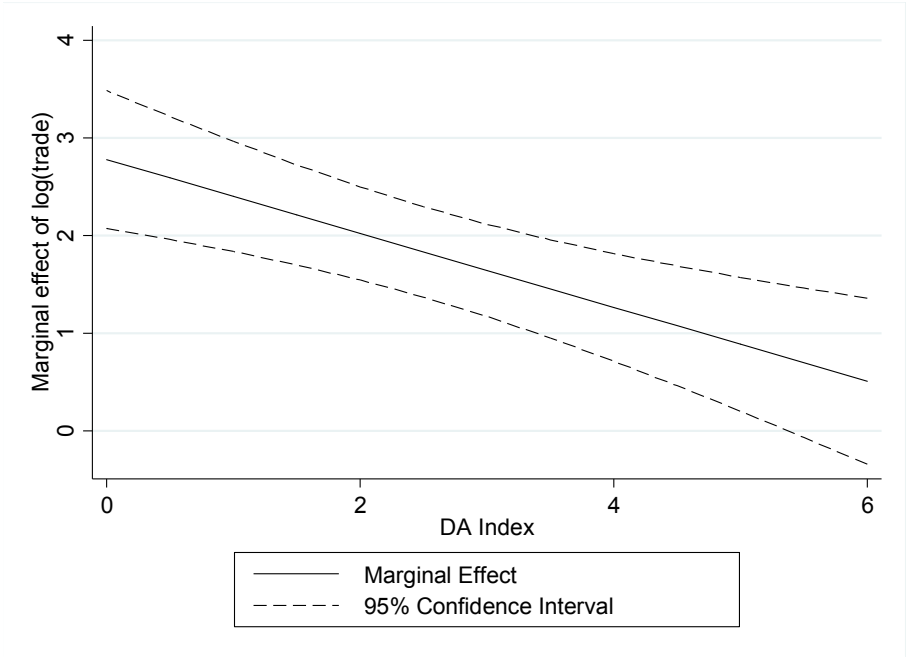

Figure 2
Marginal effect of log of trade on IP index for different values of DA index using natural openness as an IV

Moreover, for extremely high values of the DA index, the marginal effect becomes statistically insignificant. Thus, compared to Vietnam, which has extractive political institutions (average DA score of 4.13), Taiwan, with its inclusive political institutions (average DA score of 1.56), will experience faster improvement in its quality of economic institutions as its cross-border trade increases. Moreover, countries such as Myanmar or Somalia, with an average DA score of 5.4 and 5.02, respectively, may not experience any significant improvements in their quality of economic institutions in response to increases in trade.

The effect of the DA index on the IP index is negative and statistically significant for reasonable values of trade share as Figure 3 shows. For instance, the marginal effect of the DA index at the mean value of the trade is -0.49.[7] This suggests that, for a country with an average trade to GDP ratio, deterioration in political institutions will result in the deterioration of economic institutions.

[7] The mean value of the trade to GDP ratio in the sample is 78.41, and the corresponding value in log is 4.36.

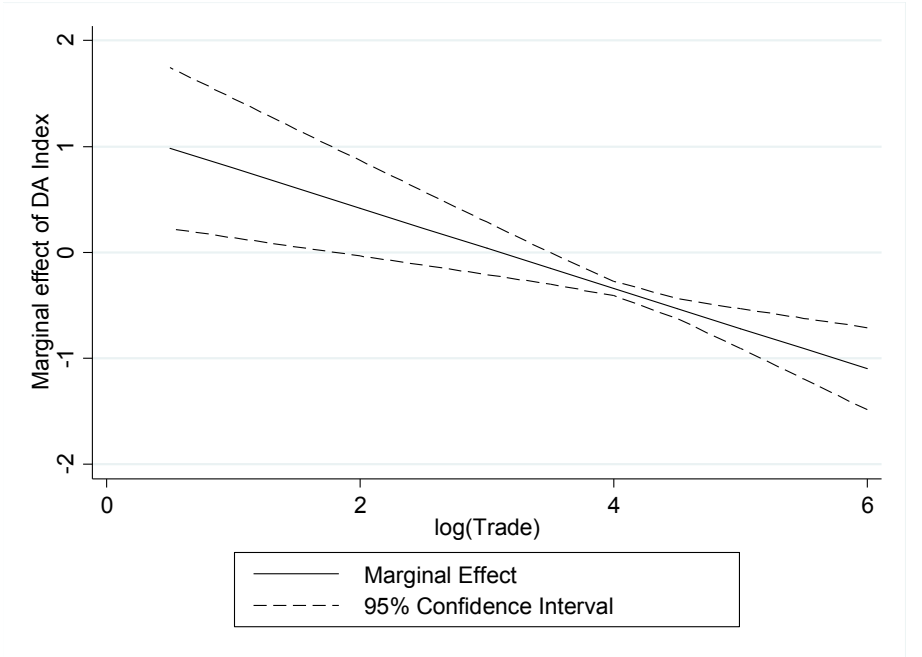

Figure 3
Marginal effect of DA index on IP index for different values of log of trade

The results using the IH method also suggest that there is a positive causal relation between trade and the quality of economic institutions, and this effect becomes attenuated in the presence of extractive political institutions as shown in Table 2.

Table 2
Identification through Heteroscedasticity: Effect of Trade and DA Index on IP Index

Variables	Development Split			Euro Colony Split		
Log(Trade)	1.02	2.66	2.73	1.08	4.81	5.85
	(3.26)	(7.21)	(6.25)	(6.63)	(6.18)	(5.44)
Log(Trade) × DA index		-0.39	-0.36		-0.78	-0.99
		(4.89)	(3.88)		(4.53)	(4.25)
Control Variables						
DA index		Yes	Yes		Yes	Yes
Average GDP per capita		Yes	Yes		Yes	Yes
GDP per capita growth		Yes	Yes		Yes	Yes
Log(Population)		Yes	Yes		Yes	Yes
Latitude		Yes	Yes		Yes	Yes
Legal Origin			Yes			Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3434	3434	3434	3434	3434	3434
Number of Countries	138	138	138	138	138	138

T-statistics in the parentheses. Based on 500 bootstrap samples.

Moreover, the results are similar for both splits of the data. For instance, Column 3 presents the estimates of the full model using the development split, and the result suggests that a 10 percent increase in the trade to GDP ratio is related to an increment of 0.27 units in the IP index for a country with a DA index of 0. For a country with a DA index of 6, this effect decreases to 0.06, which is nearly 4.5 times less than the effect in a country with a DA index of 0. To put this into perspective, consider two countries, A and B, both with similar characteristics and an IP index of 6 in the first year, but with different DA scores. Let country A be an autocracy with a DA score of 6, and let country B be a democracy with a DA score of 0. If both countries experience a 10 percent increase in trade per year for 10 years with all other variables being constant, country B's IP index will increase from 6 in year 1 to 8.7 in year 10, whereas country A will experience a marginal increase of 0.6 units in its IP index as shown in Figure 4.

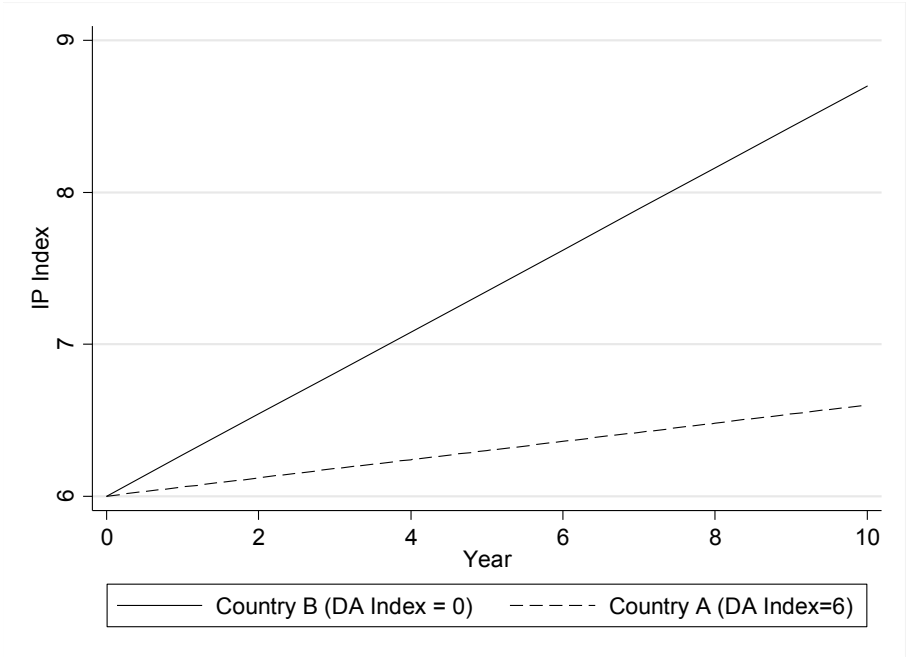

Figure 4
Development of IP index over a 10 year period for a 10% increase in trade to GDP ratio per year

Robustness checks

Several robustness checks are performed to scrutinize the results. First, internal instruments are used to further assess the sensitivity of the results. Second, an alternative measure of political institutions is used to counter any bias resulting from the construction of a particular index. Last, the sample is split by region and estimation is performed on these sub-samples using the IP index and the DA index as measures of economic and political institutions, respectively, to see if the results hold.

In order to robustly establish the link between trade and economic institutions, the model is estimated using internal instruments (see, for example, Dollar & Kraay, 2003, 2004; Yanikkaya, 2003). The tenth, fifteenth, and twentieth lags of trade are used as IVs. The identifying assumption here is that although institutions in period t affect trade openness in period t, they cannot affect trade in previous periods. The reason for choosing a long lag length as an IV is to minimize the correlation that today's institutions may have with past values of trade openness

because of the often slowly changing nature of economic institutional quality. Table 3 shows the estimation results using lag of trade as an IV, which confirms the main result presented in Table 1. The coefficient estimates of trade and the interaction term have the expected signs and are significant at the 5 percent level. However, in comparison to the results of the IV estimation using natural openness, the coefficients are relatively small.

Table 3
Effect of Trade and DA index on IP index using lagged values of trade to GDP ratio as IVs and Tobit model

Variables	IV Estimates‡	IV Estimates§	IV Estimates§§	IV Estimates‡	IV Estimates§	IV Estimates§§
log (trade)	0.95***	1.00***	1.38***	1.26***	1.25***	1.71***
	(0.09)	(0.10)	(0.12)	(0.15)	(0.17)	(0.18)
log (trade) × DA index				-0.10***	-0.09**	-0.13**
				(0.04)	(0.05)	(0.05)
DA index	-0.44***	-0.42***	-0.42***	0.00	-0.04	0.13
	(0.03)	(0.03)	(0.03)	(0.17)	(0.19)	(0.22)
log (Avg. GDP per capita)	0.64***	0.66***	0.55***	0.67***	0.69***	0.61***
	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)
GDP per capita growth	3.01***	2.96***	2.59***	3.02***	2.96***	2.65***
	(0.47)	(0.49)	(0.52)	(0.47)	(0.49)	(0.52)
log (Population)	0.17***	0.19***	0.24***	0.20***	0.21***	0.27***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
latitude	0.52*	0.54*	0.77**	0.36	0.40	0.53
	(0.31)	(0.31)	(0.32)	(0.32)	(0.32)	(0.33)
Constant	-2.83***	-3.36***	-4.60***	-4.61***	-4.85***	-6.58***
	(0.64)	(0.68)	(0.76)	(0.95)	(1.03)	(1.10)
Other Controls	Legal origin	Legal origin	Legal origin	Legal origin	Legal origin	Legal origin
Observations	3,326	3,219	3,043	3,326	3,219	3,043
Number of Countries	138	138	128	138	138	128

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ‡ Instrumental variable: $lnopen_{it-10}$ *and* $lnopen_{it-10} \times DA\ index_{it}$. § Instrumental variable: $lnopen_{it-15}$ and $lnopen_{it-15} \times DA\ index_{it}$ §§ Instrumental variable: $lnopen_{it-20}$ and $lnopen_{it-20} \times DA\ index_{it}$

Table 4 presents the results using Freedom House's Political Rights Index (PR Index) as an alternative measure (of political institutions) to the DA index.[8] The overall conclusion drawn from the results is similar to the conclusions obtained using the DA index. Trade has a positive and significant effect on the quality of

[8] The PR Index "measures the degree of freedom in the electoral process, political pluralism and participation, and functioning of government. Numerically, Freedom House rates political rights on a scale of 1 to 7, with 1 representing the most free and 7 representing the least free" (Freedom in the World, 2010: Survey Methodology). A score of 1 represents a country having free and fair elections, political competition, and autonomy for all citizens, whereas a PR Index value of 7 represents a country in which political rights are essentially missing because of extremely oppressive regimes, civil war, extreme violence, or warlord rule.

economic institutions. Moreover, increased political freedom significantly increases the effect of trade on the quality of economic institutions. These results suggest that the interaction term robustly captures the effect of trade on economic institutions under different political regimes as measured by two different methods. The result of the IV estimation in Column 6 suggests that a 10 percent increase in trade in a country with a PR index of 1 is related to an increment of 0.28 units in the IP index. However, for a country with a PR index of 7, a 10 percent increase in trade merely increases the IP index by 0.014 units, approximately one-half of the effect of a country with a PR index of 1.

Table 4
Effect of Trade and PR Index on IP Index

Variables	OLS	Tobit Random Effects	Tobit IV†	OLS	Tobit Random Effects	Tobit IV††
log(trade)	1.19***	1.88***	2.59***	1.80***	3.62***	2.99***
	(0.07)	(0.11)	(0.30)	(0.14)	(0.25)	(0.39)
log(trade)× PR index				-0.14***	-0.46***	-0.23***
				(0.03)	(0.04)	(0.09)
PR index	-0.28***	-0.32***	-0.24***	0.29**	1.62***	0.71**
	(0.02)	(0.03)	(0.02)	(0.12)	(0.18)	(0.36)
log (Avg. GDP per capita)	0.54***	1.73***	0.34***	0.60***	3.17***	0.50***
	(0.04)	(0.20)	(0.05)	(0.04)	(0.51)	(0.07)
GDP per capita growth	2.94***	1.76***	2.63***	2.93***	1.64***	3.05***
	(0.47)	(0.42)	(0.60)	(0.47)	(0.40)	(0.57)
log (Population)	0.24***	2.26***	0.48***	0.30***	4.20***	0.47***
	(0.03)	(0.09)	(0.06)	(0.03)	(0.31)	(0.06)
Latitude	0.64**	-5.55***	0.76**	0.37	-11.64***	0.30
	(0.31)	(1.80)	(0.36)	(0.31)	(3.94)	(0.38)
Constant	-3.55***	-28.89***	-9.87***	-6.95***	-60.98***	-12.61***
	(0.57)	(1.99)	(1.51)	(0.90)	(5.68)	(2.14)
Other Controls	Legal Origin	Legal Origin	Legal Origin	Legal Origin	Legal Origin	Legal Origin
Observations	3,210	3,210	2,754	3,210	3,210	2,754
R-squared	0.35	-	-	0.36	-	-
Number of Countries	135	135	135	135	135	135

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. † Instrumental variable: $Natopen_{it.}$ †† Instrumental variable: $Natopen_{it}$ and $Natopen_{it} \times PR\ index_{it}$

Lastly, the model is estimated using different sub-samples of the data because the heterogeneity of the countries may bias the results. The sample is divided by regions and the model is re-estimated using linear regression instead of Tobit because there is little or no censoring in the data. The resuits are presented in Table 5. The unconditional effect of trade on economic institutional quality is positive and statistically significant for all the regions. After the addition of the

interaction term in the model, the overall conclusions remain unchanged for all regions except for African countries. For these countries, the coefficient of trade is negative, whereas the coefficient of the interaction term is positive. The counterintuitive results for Africa are driven by the fact that the majority of African countries mainly export natural resources and only 10 percent of the sub-sample is categorized as democratic. These results may also suggest that a certain level of development is a precondition for the improvement of institutional quality.

Table 5
Linear Regression: Effect of Trade and DA Index on IP Index in Various Splits of the Data

Variables	Africa	Asia	Americas	Europe	Africa	Asia	Americas	Europe
log(trade)	0.95***	1.75***	0.94***	3.27***	0.15	2.77***	2.21***	4.02***
	(0.14)	(0.19)	(0.25)	(0.30)	(0.35)	(0.32)	(0.39)	(0.35)
log(trade)× DA index					0.19**	-0.3***	-0.49***	-0.55***
					(0.08)	(0.09)	(0.11)	(0.15)
DA index	-0.42***	-0.35***	-0.91***	-1.13***	-1.19***	1.09***	1.15**	1.26*
	(0.06)	(0.06)	(0.07)	(0.09)	(0.32)	(0.38)	(0.48)	(0.65)
log (Avg. GDP per capita)	0.94***	1.64***	0.06	0.65**	0.95***	1.79***	0.19	0.61**
	(0.21)	(0.19)	(0.40)	(0.31)	(0.21)	(0.20)	(0.41)	(0.31)
GDP per capita growth	2.08***	1.67***	1.23	4.35***	2.12***	1.71***	0.80	4.90***
	(0.60)	(0.63)	(1.14)	(1.18)	(0.60)	(0.62)	(1.13)	(1.18)
log (Population)	1.02***	1.01***	0.50***	0.65***	0.97***	1.11***	0.62***	0.72***
	(0.13)	(0.12)	(0.15)	(0.10)	(0.13)	(0.13)	(0.16)	(0.11)
Latitude	-0.97	-0.02	0.72	-4.57*	-0.97	-0.02	0.89	-5.30*
	(1.82)	(1.46)	(1.88)	(2.66)	(1.78)	(1.47)	(1.89)	(2.73)
Constant	-11.6***	-22.4***		-13.4***		-28.7***		-16.4***
	(2.11)	(2.97)		(2.80)		(3.34)		(2.94)
Other Controls	Legal origin	Legal origin	Legal origin	Legal origin	Legal origin	Legal origin	Legal origin	Legal origin
Observations	977	931	725	784	977	931	725	784
Number of Countries	37	37	27	36	37	37	27	36

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Conclusions

This study explores the relation between trade and economic institutions under different political regimes. There is ample theoretical grounding for the belief that trade has a positive effect on the quality of economic institutions. However, the effect of trade on economic institutions is likely to vary for different political regimes. The political elite are likely to establish extractive economic institutions if political power is not subject to checks and balances. In an authoritarian regime, the political elite can effectively restrict the broader participation of the public in trade and may also resort to the use of regulations, quotas, and licenses to manipulate the market structure and impede market access. Higher trade flow is, therefore, not necessarily associated with better economic institutions. Thus, this study hypothesize that higher trade under extractive political regimes will lead to smaller improvements in institutional quality than that in democratic societies.

The results can be summarized as follows: The study confirms a positive and significant effect of trade on institutional quality. Further, under extractive political regimes, trade has a significantly reduced effect on economic institutional quality. The results hold true for both pooled and panel data specifications and under various model specifications. The findings suggest that in political regimes where there is some democratic accountability, increased trade will result in improvement in economic institutional quality, whereas in the absence of democratic accountability, higher trade volumes will have substantially smaller effects on economic institutions. This shows that increased trade flow alone cannot improve the quality of economic institutions in a country. Rather, political institutions also play a key role in this relationship.

The results also invite several policy implications for donor agencies and international financial institutions (IFIs). Countries that transition from autocracies to more pluralistic regimes will benefit from increased trade in terms of improvements in their economic institutions. Thus, trade liberalization policies to lower trade barriers can be an effective tool for improving institutional quality in newly democratized countries. Moreover, preferential trade agreements that advanced economies initiate with newly democratized countries can lead to institutional change. The results also stress the importance of context-specific policy design, taking into account the domestic social and political context instead of simply adopting a blueprint approach.

The discourse on trade and institutional quality is far from complete and further study is necessary to explore the link between different types of institutions and

different individual channels through which trade affects the quality of institutions. It would also be of interest to see what type of trade (primary goods, industrial goods, services) leads to greater changes in institutional quality.

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Appendix

Table A1
Summary Statistics of the Variables

	Full Sample		1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
IP index	7.26	2.53	6.01	2.30	7.00	2.40	7.75	2.37	8.27	2.49
Trade	78.41	51.85	32.92	10.45	56.67	5.79	79.78	8.66	144.26	60.47
DA index	2.25	1.65	2.70	1.58	2.11	1.57	2.10	1.67	2.09	1.70
PR index	3.49	2.17	4.11	2.15	3.38	2.09	3.31	2.13	3.10	2.16
GDP per capita	10388	12927	5821	8790	7953	8928	12443	14091	15333	16063
Latitude	0.29	0.19	0.23	0.15	0.29	0.19	0.31	0.20	0.31	0.20
British Legal Origin	0.32	0.47	0.35	0.48	0.27	0.44	0.27	0.44	0.37	0.48
French Legal Origin	0.48	0.50	0.53	0.50	0.59	0.49	0.42	0.49	0.38	0.49
Socialist Legal Origin	0.12	0.32	0.08	0.28	0.07	0.25	0.12	0.32	0.21	0.41
German Legal Origin	0.05	0.21	0.04	0.19	0.03	0.17	0.08	0.27	0.03	0.17
Scandinavian Legal Origin	0.04	0.19	0.00	0.03	0.04	0.19	0.11	0.32	0.01	0.09
Population	42352	139959	102351	229185	39634	118492	17716	79404	9705	16297
GDP Growth (%)	4.25	7.85	3.2	8.31	3.95	7.12	4.55	8.57	5.23	9.07

Note: The sub-samples are created based on the quartile values of trade to GDP ratio

Table A2.
Correlation Matrix

	IP Index	Trade	DA Index	PR Index	GDP per capita	Population	Latitude	GDP per capita growth
IP Index	1							
Trade	0.36	1						
DA Index	-0.46	-0.14	1					
PR Index	-0.43	-0.17	0.79	1				
GDP per capita	0.6	0.36	-0.49	-0.52	1			
Population	-0.09	-0.49	-0.03	0.16	-0.15	1		
Latitude	0.32	0.08	-0.46	-0.31	0.51	0.2	1	
GDP per capita growth	0.15	0.09	-0.06	-0.05	0.10	0.05	0.08	1

Chapter 3
Catch-up in Institutional Quality: An Empirical Assessment

Introduction

Since the 1980s, a key objective of reforms aimed at promoting economic growth and development has been to improve institutional quality. According to the World Bank (2000), dysfunctional and ineffective institutions and weak governance are "increasingly seen to be at the heart of the economic development challenge" and "building effective and accountable institutions is arguably the core challenge for sustainable poverty reduction" (p. 1). In response to this challenge, governments and multilateral agencies have shifted focus from getting prices right to getting institutions right in developing countries, often by emulating the institutions of developed countries (Rodrik, 2008). At the same time, rapid globalization has led to increased efforts to harmonize institutions across countries and to bind countries formally to common rules (Dolowitz & Marsh, 2000). This focus on a common set of institutions is exemplified by the creation of the World Trade Organization (WTO) in 1995 and the creation of trade unions such as the EU, NAFTA, and ASEAN.

Despite the resources and efforts devoted to institution building and institutional harmonization, there is little consensus on the effectiveness of these reforms (Andrews, 2013). Proponents argue that developing countries must adopt institutions from industrialized countries in order to bypass the stages that the latter already have been through (Mkandawire, 2009). Others argue that this "blueprint" approach may produce ineffective and poorly enforced rules and laws (Andrews, 2013). Moreover, the blueprint approach assumes that institutions from developed countries are optimal developmental instruments, but in fact they do not consider the unique socioeconomic conditions, local knowledge, and culture of the host country (Evans, 2004). The unsuccessful implementation of

governance-related conditions imposed by international financial institutions corroborates this view (Kapur & Webb, 2000).

Considering the emphasis on institutions in the development process and the widely reported challenges in reforming institutions, it is fitting to ask whether a catch-up in institutional quality has occurred. Scant empirical literature has explored development trends in institutional quality across countries (e.g., see Elert & Halvarsson, 2012; Nieswiadomy & Strazicich, 2004; Savoia & Sen, 2013). Nieswiadomy and Strazicich (2004) report sigma convergence using Freedom House's political rights and civil liberties indices. Savoia and Sen (2013) provide evidence of beta convergence based on analyzing the index for corruption and bureaucratic quality from the International Country Risk Guide and the index of legal system quality from the Fraser Institute's Economic Freedom of the World project. Elert and Halvarsson (2012) also report evidence of cross-country beta convergence in the Economic Freedom of the World index.

These studies use standard testing methods that assume catch-up is a continuous process or has already occurred. Thus, they provide an incomplete account of catch-up in institutional quality. These tests do not account for catch-up as a process that exists in certain time periods and that affects countries differently as countries differ in terms of their economic and social structure, culture, legal system, and capacity to enforce laws. This implies that not all countries follow a similar institutional change trajectory over time, rather it is likely that countries form groups with distinct institutional change trajectories. Moreover, previous research has not distinguished between economic and political institutions, which is important from policy and theoretical standpoints because the dynamics of change can be very different for economic institutions vis-à-vis political institutions.

This study contributes to the institutional change literature from two perspectives. First, in contrast to previous studies, this paper tests for catch-up in institutional quality and allows for heterogeneity in institutional change trajectories by grouping countries into clubs. Compared to previous studies, this approach offers a more nuanced view of institutional change by testing for the number and composition of clubs and then analysing their institutional change trajectories to determine whether catch-up has occurred. Clubs with weaker institutions should follow a faster institutional change trajectory, or catch-up, than that of clubs with good institutions. Building on previous studies, this paper uses a static factor model to test for catch-up in institutional quality by identifying clubs (e.g., see Andersson, Edgerton, & Opper, 2013; Henning, Enflo, & Andersson, 2011). Using this method identifies turning points in the institutional change trajectories of different clubs by providing information on the exact timing of improvements

or deterioration in institutions. Moreover, this method provides a way to investigate whether the catch-up in institutional quality is restricted to certain time periods or if it prevails throughout the entire observation period. This approach identifies the beginning and end of the catch-up process, as well as the speed of institutional catch-up across countries.

Second, this study departs from previous studies by differentiating between economic and political institutions and accounting for the differences in the dynamics of change observed in these institutions. This distinction is important, because theoretical literature on institutional change stresses that economic and political institutions affect political elites differently, which in turn affects how these institutions change. To capture these differences, this study uses three different measures of institutional quality using data from the KOF Index of Globalization, the Economic Freedom of the World index, and the International Country Risk Guide. The three measures focus on: (1) restrictions on trade and capital flows; (2) the quality of legal structure, security of property rights, freedom of exchange with foreigners, and regulation of credit, labor, and business; and (3) the quality of political institutions and rule of law. To enable comparisons across these three institutional indices, the factor model for each index is estimated using a joint sample of 81 countries from 1985 to 2010.

The results suggest different institutional change patterns for economic and political institutions. In the case of economic institutions, most countries experience institutional change in similar directions, and countries with weak institutions have a higher rate of change, indicating a catch-up process across countries. On the contrary, countries form two clubs for political institutions, with most low-income countries in one club and most high- and middle-income countries in the other. The trends for these two clubs indicate a pattern of catch-up at the start of the period, but the converging trend does not persist.

The rest of the paper is organized as follows. Section 2 provides a theoretical discussion on whether institutional quality may catch-up across countries and develops the empirical hypotheses related to institutional catch-up across countries. Section 3 outlines the estimation strategy. Section 4 introduces the data set, followed by results and conclusions in Sections 5 and 6.

Theoretical background

The theoretical and empirical literature provides an ambiguous answer regarding catch-up in institutional quality across countries. It offers three different perspectives about institutional change and the possibility of institutional catch-up: the catch-up perspective, the lagging-behind perspective, and the mixed account.

Catch-up Perspective

The catch-up perspective suggests several potential channels for institutional catch-up across countries. For example, international organizations like the International Monetary Fund (IMF) and World Bank impose policies and reforms that aim to improve the quality of institutions and governance (Dolowitz & Marsh, 2000; Kapur & Webb, 2000). These reforms often transplant previously accepted institutional blueprints for development (Evans, 2004; Rodrik, 2008). For example, the Washington Consensus in the 1990s aimed to improve the quality of economic institutions in the developing world (Rodrik, 2008). These policies include improved credit market policies, reduced taxes (tariffs) on international trade, and relaxed restrictions on the movement of capital (Gwartney, Lawson, & Block, 1996; Rodrik, 1999). Moreover, governments of many developed countries attach conditions to their bilateral aid, trade, and investment agreements (Chang, 2011) that require developing countries to adopt Western market institutions (Kapur & Webb, 2000; Stiglitz, 1999).

Countries tend to emulate the institutions of other countries. Emulation offers readily available blueprints and avoids the uncertainty of experimenting with new institutional arrangements. Developing countries can adopt institutions from developed countries and thereby use "better" institutions without paying the same "prices" (Chang, 2007). In theory, this lowers innovation costs and hastens diffusion, which enables institutional catch-up across countries (Mamadouh, De Jong, & Lalenis, 2002).

International economic integration and globalization can facilitate the exchange of ideas, including ideas about laws and regulations. Therefore, it may encourage the transfer and implementation of legal knowledge (La Porta, Lopez-de-Silanes, & Shleifer, 2008; Sachs, & Warner, 1995). Globalization also fosters competition among countries for foreign direct investment in capital and in business in general, exerting pressure on countries to adopt good legal rules and regulations

and provide trade- and investment-friendly institutions, including privatization, deregulation, balanced budgets, low inflation, and strong property rights (Kelejian, Murrell, & Shepotylo, 2013; Marsh & Sharman, 2009). Importantly, domestic investors have an exit option (and foreign investors have the choice not to enter) and may thereby force governments to improve domestic institutions (Drezner, 2001; Holzinger & Knill, 2005). Thus, globalization may incentivize countries to improve their respective institutional environments in a global competition for capital and skilled labor. In sum, the above arguments suggest the following hypothesis:

Hypothesis 1: Countries with weak institutions will experience a greater change in their institutional quality and catch-up, compared to countries with strong institutions.

Lagging-behind Perspective

Two main strands of literature question the effectiveness of these types of institutional reforms. The structural school criticizes their poor design and implementation. The political-economy school revolves around the willingness of elites to initiate and sustain them.

According to the structural view, emulation of a developed country's institutions may not fit a developing country's context and can conflict with the prevailing social and cultural context (Berkowitz, Pistor, & Richard, 2003a; Rodrik, 2008; Roland, 2004). When governments implement institutional reforms, either based on the blueprints provided by Western economists or through trial and error, the behavior of economic actors often disagrees with the formal rules. Instead, informal norms based on networks and culture shape the behavior of economic agents (Nee, 1998; Page & Bednar, 2006). Thus, reactions to new institutional environments may differ because of differences in cultures and norms. When reactions differ, performance may vary.

Legal institutions imported from the West are likely to be ineffective in developing countries unless they are adapted to the local context or some familiarity with those institutions already exists (Berkowitz et al., 2003a; Berkowitz, Pistor, & Richard, 2003b). Such rules, which were developed in a foreign socioeconomic order, may not apply to local circumstances (Berkowitz et al., 2003a). Thus, interpretation of the rule differs more within the borrowing country than it does within the country of origin, making the transplanted rules largely ineffective (Berkowitz et al., 2003b).

Governments in developing countries may not have the resources and capabilities to enforce these adopted institutions (Khan, 2012). Judges and police may not be trained and may be unfamiliar with the new institutional arrangements, and courts may be politicized and unpredictable, making the legal system expensive and inefficient (Hay, Shleifer, & Vishny, 1996). Thus, Berkowitz et al. (2003a) and Hay et al. (1996) argue that these blueprint reform efforts often fail because the existing institutional environment and laws conflict with the new institutions.

The political-economy stance suggests that institutional reforms in developing countries may be hindered by elites who benefit from existing economic and political institutions (Acemoglu, Johnson, & Robinson, 2005). These elites oppose institutional reforms that threaten their political power. In this situation, low-quality economic and political institutions can persist (Acemoglu & Robinson, 2012). Similarly, Sonin (2003) argues that the elite establish corrupt relationships with state authorities to manipulate redistributive processes. They consequently oppose measures to prevent corruption and protect the public. Resource inequality also enables the rich to subvert the political, regulatory, and legal institutions for their own benefit and leads them to favor established institutions over new efficient ones (Glaeser, Scheinkman, & Shleifer, 2003).

As North, Wallis, Webb, and Weingast (2009) assert, most of today's developing world is characterized by limited access, whereby only the elite enjoy access to and control of valuable resources. These limitations create rents for the elites, and the risk of losing the rents in a violent movement enourages the elite to cooperate rather than fight with the coalition in power (North et al., 2009). Hence, when reforms aim to transplant elements that are associated with the open-access order (e.g., competition, markets, democracy) directly into limited access orders, they fail. These arguments suggest the following hypothesis:

Hypothesis 2: Countries with weak institutions will not experience any significant improvement in their institutional quality and will lag behind.

Mixed Account

A third strand of literature argues that the dynamics of change may differ depending on the nature of the institution being reformed. Multiple arguments suggest that economic institutions are more susceptible to change than are political institutions. First, the elites are more likely to undertake reforms that could change existing economic institutions, because commercialization and market liberalization provides new opportunities for their enrichment, as economic success provides increasing rents (Nye, 2011). The shift towards market

institutions also increases opportunities among agents of the state, as it offers new economic niches (Nee & Lian, 1994). The introduction of market institutions removes political constraints on the accumulation of personal wealth and thus enables the elite to create new market value from access to or trading in public property (Walder, 2003). Moreover, the ruling class, especially an authoritarian ruler, benefits from providing secure property and contract rights, which expand the tax base, increase rents and market income accruing from asset ownership (McGuire & Olson, 1996; Olson, 1993). Concerns about the security of asset ownership in the event of a loss of political power provide an incentive for the elite to maintain secure property rights when institutional restrictions on expropriation are weak or absent (Polishchuk & Syunyaev, 2015). A notable example is China, where political actors allowed economic reforms instituted by economic actors, as the reforms also benefited the Chinese government through tax income, increased employment, and structural change (Nee & Opper, 2012; Taube, 2009).

The political elite can extend their tenure and secure continuing societal support by instituting economic reforms. For instance, political elites support economic reforms to deflect attention from political reforms and preserve their political power (Winiecki, 1996). Additionally, politicians and the political elite view economic reforms (especially those based on "best practices") as tool to garner short-term support (Andrews, 2012). This support typically comes from donors, but it also originates from local contexts. Implementing the "best practice" reform means more money in the national budget, better performance on global indicators of management and governance, and so on, all of which builds political support at home (Andrews, 2012). The political elites who hold power have an incentive to maintain the political institutions that give them political power (Acemoglu & Robinson, 2006, 2008). Therefore, political institutions persist when the political stakes are high or when alternative institutional arrangements are costly for those who currently hold political power and can use force to maintain existing political institutions (Acemoglu, 2006). This leads to the third hypothesis.

Hypothesis 3: Compared to political institutions, economic institutions will exhibit a different pattern of change and will be more likely to catch-up.

Ultimately, whether economies with poor-quality institutions catch-up to economies with high-quality institutions and whether it happens in a political or an economic sphere is a matter of empirical debate. The theoretical literature does not provide a clear answer to this question. Therefore, this paper investigates whether a catch-up process has occurred in the institutional quality for countries with weak institutions.

Methodology

To determine whether catch-up (in economic variables such as institutions, productivity, or income) across countries has occurred, researchers usually apply standard cross-sectional or time series tests. These tests rely on several restrictive assumptions. For instance, the cross-sectional approach assumes that all countries follow a universal model that governs the changes in institutional quality and imposes strict homogeneity restrictions (Bos, Economidou, Koetter, & Kolari, 2010). This approach does not allow countries to follow different trajectories in institutional change, even though some countries lack legal and judiciary systems and proper law enforcement. Given the differences in economic and social structures, it is unlikely that all countries follow an identical institutional change path and catch-up at the same speed. Alternatively, the time series approach tests if convergence has already happened, rather than if catch-up is occurring (Bernard & Durlauf, 1996; Carvalho & Harvey, 2005; Harvey & Bates, 2003).

Another possibility is that countries belong to clubs with different institutional change trajectories. Thus, instead of testing whether convergence has already occurred at the beginning of the period, a test should be performed for the presence of clubs that may only begin to catch-up at later stages of the observation period. Such a test can be constructed by using a factor model (Andersson et al., 2013; Andersson & Ljungberg, 2015; Henning et al., 2011). Factor analysis models covariance relationships among many variables in terms of a few underlying unobservable factors (Johnson & Wichern, 2007). Using a factor model allows grouping of countries based on similarities in institutional change path and helps identify if countries follow a common or idiosyncratic pattern of change.

A factor model alone is insufficient to test for catch-up in institutional quality, however. Distinguishing trends from short-term noise is also essential. Measurement error can occur in the institutional indices, because the institutional quality indices are based on subjective assessments by experts. Thus, the ratings may be influenced by knowledge of recent economic performance (Chang, 2011). Year-to-year changes in the data can mask the long-run catch-up pattern. Moreover, the literature on institutional change has established that changes in institutions are not instantaneous but rather take time. It is therefore highly likely that institutions across countries catch-up in the long term rather than the short term.

To separate the short run from the long run, institutional measures for each country are transformed using the Maximal Overlap Discrete Wavelet Transform

(MODWT).[9] The MODWT is a band pass filter that can be used to analyze the variation of a time series at different frequencies, where each frequency represents a separate time horizon, such as short run and long run (Andersson et al., 2013). Although it is possible to decompose data using several different methods, such as the Hodrick-Prescott filter or Fourier transformation, wavelet transformation offers considerable advantages. Wavelet decomposition combines time and frequency domains. It is localized both in time and in frequency, which preserves the time domain and frequency domain information of the original series (Maslova, Onder, & Sanghi, 2013). Thus, it does not introduce phase shifts that change the location of events in time[10] and allows for the observation of structural breaks, outliers, and nonlinearities in the data series (Percival & Walden, 2006; Ramsey, 1999).[11] Unlike the Hodrick-Prescott filter, in which data are decomposed into short and long runs, the filtered time horizons are known. This data-driven technique for separating short and long runs ensures that short-term fluctuations arising from measurement errors in the data do not affect the results.

The test for institutional catch-up is constructed as follows: let Y_{it} be the quality of institutions or a measure of policy for country i at time t. The change in institutional quality is given by $\Delta y_{it} = \log(Y_{it}) - \log(Y_{it-1})$, where the first difference is taken to avoid spurious results caused by non-stationarity in the data and where the log accounts for incremental institutional change as a country reaches its steady state. Taking the first difference does not affect our ability to analyze the trend in the data (e.g., see Brockwell & Davis, 1998; Percival & Walden, 2006).

The first step is to decompose the change in institutional quality Δy_{it} into a short-run Δy_{it}^{SR} and a long-run Δy_{it}^{LR}, where $\Delta y_{it} = \Delta y_{it}^{SR} + \Delta y_{it}^{LR}$.[12] The short-run period lasts up to eight years. The trend represents relatively persistent changes, with a period lasting for more than eight years. The distinction between the short and long runs is based on the results of the catch-up test, which provides evidence that change dynamics are different for the changes lasting more than eight years, compared to the changes lasting fewer than eight years. Because institutional change is slow, it makes sense to define the long run as a period longer than eight

[9] MODWT transformation is performed in Matlab using WMTSA Wavelet Toolkit.

[10] When using wavelet decomposition, one-off events such as crises do not affect the decomposition at other points in time. In contrast, with traditional smoothing techniques, such as the moving average, the impact of a one-off event spreads over several periods.

[11] For a more detailed technical account of the MODWT, see Crowley (2007) and Andersson (2008).

[12] The cyclical components represent cycles of 2–4 years and 4–8 years. By construction, MODWT decomposes the data such that each *jth* cycle is 2^j long. The trend accounts for fluctuations higher than 2^j.

years, as it reflects permanent change in institutional quality and provides smoother data with reduced noise in the institutional indices. Moreover, given the sample length, it is not possible to decompose the data into longer time horizons. Thus, these persistent movements form the Δy_{it}^{LR} part of Δy_{it}.

In the second step, the long-term change in institutional quality Δy_{it}^{LR} is modelled as a set of common factors and a country-specific idiosyncratic factor,

$$\Delta y_{it}^{LR} = \alpha_i + \sum_{r=1}^{q} \beta_{ir} f_{rt}^{LR} + \varepsilon_{it}^{LR} \qquad (1)$$

where α_i is the country-specific constant, q is the number of common factors or trends, f_{rt}^{LR} denotes the q common factors or trends, β_{ir} represents factor loadings for the common factors, and ε_{it}^{LR} is the idiosyncratic component for each country.[13] The number of common factors indicates the number of clubs, and the factor loadings show which country belongs to which club (a country can belong to more than one club) and provide the contribution of each country to a common factor. To estimate this factor model, principal component analysis is used.

Three possible scenarios can be identified using the model given in equation (1). First, one major common factor could explain most of the variation in the change in institutional quality and the fact that loadings are non-zero and have a similar sign. In this case, institutions in all countries move together in a similar direction over time. However, this scenario does not imply an equal average change in institutional quality across all countries, because the constant for each country is different. Thus, some countries experience greater change than others, but the trajectory of change is the same. A second scenario includes one common factor in which the factor loadings have different signs for different countries. In this scenario, a divergence in institutional quality occurs. A third scenario is that $q >$ 1. For a subset of countries, the factor loadings are non-zero for a particular common factor. In this scenario, countries form independent clubs, with certain clubs experiencing greater institutional change than others. Institutional catch-up occurs if countries with poor-quality institutions experience a higher rate of change in their institutional quality than the countries with high-quality institutions.

To identify significant loadings and thus club composition, the analysis relies on the common convention of using 20% of explained variation as an appropriate

[13] The factor model can be applied to short-run changes; however, short-run changes might contain noise.

cut-off (e.g., see Fidell & Tabachnick, 2006; Stevens, 2012).[14] Countries belong to a particular factor if that factor explains more than 20% of the variation for that country. Because the selection of a cut-off point is ultimately a normative decision, alternative cut-offs of 15% and 25% are also used to scrutinize the findings. However, the choice of these different cut-off points does not have a strong effect on the results, as shown in Tables A5 and A6 in the appendix.

Data

To measure institutional quality and distinguish between the political and economic institutions, this study employs three measures of institutional quality using data from the Economic Freedom of the World index, the KOF Index of Globalization, and the Political Risk Index from International Country Risk Guide. A total of 81 countries are included from 1985 to 2010. Table A1 in the appendix summarizes the composition of the main indices and the indices used in this study.

The Economic Freedom of the World index reflects the quality of a country's economic institutional and policy environment (Gwartney, Holcombe, & Lawson, 2004). Several studies have used it to measure institutional quality (De Haan & Sturm, 2000; Gwartney et al., 2004; Hall, Sobel, & Crowley, 2010). However, De Haan, Lundström, and Sturm (2006) and De Haan and Sturm (2000) question its inclusion of government spending and monetary policy, as these variables do not necessarily restrict citizens' economic freedom and they reflect policy outcomes rather than rules. Following their critique, this study uses an index formulated by taking the average of the following sub-indices: legal structure and security of property rights; freedom to exchange with foreigners; and regulation of credit, labour, and business.[15] These three components more closely capture the restrictions on an individual's economic freedom and economic transactions, thus providing insight about the quality of economic institutions of a country. These three sub-indices are further divided into several sub-components, as explained in Table A2 in the appendix. This index will be referred to as the Economic Freedom index. The index is a continuous variable, ranging between zero and ten, with a higher score corresponding to a higher

[14] According to Stevens (2012), a variable that shares at least 15% of the variation with the factor should be used for interpretation purposes

[15] Following the construction of the Economic Freedom of the World's main index, an average is taken.

quality of institutional and policy environment. Data for this index have been recorded every five years from 1985 to 2000 and annually since 2001. A linear interpolation helps fill in data for missing years. This interpolation does not affect the results, as the interest lies in studying long-run changes (e.g., see Andersson & Ljungberg, 2015; Andersson & Karpestam, 2013).

The second measure is a sub-index of the economic globalization index, which is a part of the KOF globalization index (Dreher, 2006). The sub-index assesses restrictions on long-distance flows of goods, capital, and services and closely represents the "rules of the game." It is used to measure economic institutions, because it reflects the quality of institutions related to market liberalization and competition. Tariffs and import barriers divert resources to the government, and tariffs, quotas, and other trade barriers create lucrative opportunities for private diversion (Hall & Jones, 1999). Trade and capital flow restrictions are measured using data on hidden import barriers, mean tariff rates, taxes on international trade (as a share of current revenue), and an index of capital controls (Dreher, 2006). It takes a value between 0 and 100, where a higher value represents a lower degree of restrictions. This measure will be referred to as the Trade Restrictions index. Table A3 describes its sub-components.

The third index is based on different components of the political risk index from the International Country Risk Guide. The variables in the political risk index are the most commonly used measures of institutional quality in the empirical literature on institutions and growth (e.g., Knack & Keefer, 1995; Hall & Jones, 1999; Acemoglu, Johnson, & Robinson, 2001). They allow assessment of the political stability and government quality in a country (International Country Risk Guide, 2012). However, in addition to capturing institutional quality, the political risk index includes variables that capture economic performance (measured by socioeconomic conditions) and political violence and conflict (measured by external and internal conflict and religious and ethnic tension) that are not suitable for accessing the quality of institutions. Therefore, a sub-index is created by aggregating the scores of each country on the following components: investment profile, corruption, democratic accountability, law and order, and bureaucracy quality.[16] The resultant sub-index ranges from 0 to 34, with higher values indicating better quality of institutions. This sub-index allows assessment of the government's role as a protector against private diversion and as a diverter, as well as assessment of the restrictions on rulers to use power for personal benefit. Therefore, it is classified as measuring the quality of political institutions in a

[16] It is created by following the same methodology as the complete index

country and referred to as the Government Quality index. Table A4 describes its components.

Because the aim of the study is to differentiate between economic and political institutions and to test for catch-up in them separately, it is important to investigate whether the indices actually measure different dimensions of institutions. The correlations indicate that this is the case. The average correlations of the Government Quality index, with the Trade Restrictions and Economic Freedom indices respectively, are 0.32 and 0.40. These are relatively low compared to the correlation of 0.75 between the Trade Restrictions and Economic Freedom indices. The correlations between these three indices indicate that the Trade Restrictions and Economic Freedom indices capture closely related dimensions of institutions, whereas the Government Quality index captures a different dimension of institutional quality.

Descriptive statistics

Table 1 shows a summary statistics of all three indices. Countries are divided into low-, middle-, and high-income to illustrate differences across level of economic development. Table 1 implies two stylized facts. First, the gap in institutional quality between high-income countries and low-income countries is relatively wide. The average score of high-income countries on the Government Quality index is approximately 1.75 times higher than that of low-income countries. Similarly, the average scores of high-income countries are 2.3 times and 1.55 times greater than those of low-income countries for the Trade Restrictions and Economic Freedom indices, respectively. Additionally, all three indices have increased over time since 1985, except for the Trade Restrictions index in advanced countries, which deteriorated marginally. On average, all three indices increased over the period.

Second, the cross-sectional dispersion over the whole sample (as expressed by the standard deviation) decreases from the beginning to the end of the period for every index. This finding indicates some catch-up in institutional quality over time but does not confirm that the difference decreased among all countries. For the Government Quality index, the decrease is monotonic until 1995 and then the dispersion picks up again or stabilizes, suggesting that a catch-up effect in institutional quality has stopped or decelerated. For the Economic Freedom index, the decrease in dispersion is relatively monotonic, whereas for the Trade Restrictions index, dispersion increases until 1995 and then decreases. According to the Government Quality and Economic Freedom indices, high-income

countries remain a more homogeneous group than low- and middle-income countries, which show greater variability in institutional quality over time. However, for the Trade Restrictions index, high-income countries have more variation than low- and middle-income countries. The apparent gap in institutional quality between advanced economies and the rest of the world implies that convergence has not yet occurred. The fact that the standard deviation in different groups does not decrease monotonically supports this finding. Thus, there is a need to test the catch-up hypothesis using a formal testing strategy.

Table 1.
Summary statistics of indices used over 1985-2010

Panel (a): Government Quality index								
		Full Sample	1985	1990	1995	2000	2005	2010
Full Sample (N=2106)	Mean	21.6	19.7	19.4	21.1	22.3	23.3	23.0
	St. Dev	6.36	7.05	6.59	4.85	6.05	6.61	6.40
High-Income Countries (N=676)	Mean	28.4	27.9	26.7	26.4	28.2	30.8	30.2
	St. Dev	3.55	3.92	4.21	2.85	3.19	2.71	2.58
Middle-Income Countries (N=728)	Mean	20.4	17.4	17.5	20.3	22.0	22.3	21.7
	St. Dev	4.24	3.95	4.06	3.04	3.95	3.71	4.05
Low-Income Countries (N=702)	Mean	16.3	14.1	14.2	16.8	16.8	17.2	17.3
	St. Dev	4.04	4.09	3.82	2.71	4.47	4.21	3.88
Panel (b): Trade Restrictions index								
Full Sample (N=2106)	Mean	56.2	45.1	47.0	54.0	61.4	64.0	63.4
	St. Dev	24.6	25.2	25.8	25.9	25.3	20.2	18.2
High-Income Countries (N=676)	Mean	79.7	72.6	75.2	79.2	87.1	82.6	78.4
	St. Dev	17.5	17.6	17.9	18.4	18.2	15.6	15.7
Middle-Income Countries (N=728)	Mean	55.4	42.2	44.2	55.6	61.1	63.5	63.5
	St. Dev	16.6	14.3	14.6	15.6	14.8	15.1	15.3
Low-Income Countries (N=702)	Mean	34.3	21.7	22.8	28.0	36.9	46.6	49.0
	St. Dev	14.8	10.6	10.5	12.1	11.8	11.1	9.84
Panel (c): Economic Freedom index								
Full Sample (N=2106)	Mean	6.28	5.29	5.71	6.44	6.74	6.69	6.71
	St. Dev	1.50	1.70	1.66	1.39	1.36	1.27	1.20
High-Income Countries (N=676)	Mean	7.80	7.17	7.53	7.88	8.25	8.03	7.89
	St. Dev	0.80	0.89	0.89	0.87	0.67	0.59	0.64
Middle-Income Countries (N=728)	Mean	6.09	4.84	5.44	6.40	6.65	6.53	6.47
	St. Dev	1.03	1.19	1.07	0.77	0.62	0.75	0.94
Low-Income Countries (N=702)	Mean	5.01	3.95	4.23	5.11	5.38	5.58	5.82
	St. Dev	1.06	1.00	0.93	0.85	0.82	0.98	0.91

Results and discussion

This section presents results from the catch-up test. It discusses the extent to which each of the factors explains institutional change through variance decomposition and what characteristics explain a country's sensitivity to the factors. It also identifies patterns in the trajectory of institutional change for economic and political institutions.

Economic institutions

The first two factors account for most of the variation in the economic institutional indices, explaining 71% and 81% of all the variations in the trend for the Trade Restrictions and Economic Freedom indices, respectively (see Table 2). The high percentage of explained common variation in the trend shows a strong common world factor that drives institutional change for economic institutions for most countries in the sample. Consequently, in the long run, institutional changes are more likely to be affected by outside or global factors than by country-specific factors. The presence of a world factor is further supported by the fact that, for the Trade Restrictions and Economic Freedom indices, 71% and 76% respectively of the countries in the sample are significantly affected by the first factor with the majority of the loadings having a similar sign (see Table 3).[17]

Table 2
Variation Explained by first three Factors

	Factor 1	Factor 2	Factor 3
Trade Restrictions index	42%	29%	14%
Economic Freedom Index	54%	27%	10%
Government Quality Index	42%	19%	18%

[17] A country is significantly affected if 20% or more of the variation is explained by that particular factor.

Table 3
Percentage of high, middle and low-income countries loading significantly on the first factor for the economic institutions

	Economic Freedom index			
	Factor 1		Factor 2	
	Positive loading	Negative loading	Positive loading	Negative loading
High-Income Countries	80%	0%	20%	8%
Middle-Income Countries	66.6%	8.33%	33.3%	25%
Low-Income Countries	70.4%	6.81%	13.6%	36.3%

	Trade Restrictions index			
	Factor 1		Factor 2	
	Positive loading	Negative loading	Positive loading	Negative loading
High-Income Countries	80%	0%	0%	24%
Middle-Income Countries	58.3%	8.33%	25%	50%
Low-Income Countries	61.3%	6.81%	31.8%	22.7%

Note: Within group percentages are reported; Income classification based on the year 1990

To identify which types of countries are significantly affected by the world factor, the countries are classified into groups based on their income level in 1990. As the result shows, countries in the high-, middle-, and low-income groups are equally affected by the first factor for both economic institution indices. The existence of a world factor is further reinforced by the average variation explained by the first factor, which is similar for all regions of the world, as shown in Table 4.[18] For the Trade Restrictions index, the average variation explained by the world factor ranges between 47% and 68%, whereas for the Economic Freedom index, it ranges between 39% and 56%. The results indicate that a common world factor drives changes in economic institutions in most countries and that most countries experience changes in similar directions.

[18] Regional grouping is based on continents

Table 4
Region-wise explained variance by the first factor for the Trade Restrictions and Economic Freedom index

Region	Full Sample		Significant Countries	
	Trade Restrictions Index	Economic Freedom Index	Trade Restrictions Index	Economic Freedom Index
Africa	0.31	0.38	0.46	0.50
America	0.40	0.58	0.47	0.64
Asia	0.31	0.30	0.53	0.47
Europe	0.49	0.48	0.56	0.56
Pacific	0.29	0.45	0.39	0.68
Total	0.38	0.44	0.50	0.56

The presence of a common world factor underscores the fact that both developing countries with weak institutions and developed countries with strong institutions experience institutional change. Rapid globalization in the last few decades may explain this world factor. Globalization fosters competition among countries and results in a race to the top in institutional quality (Kelejian et al., 2013; Marsh & Sharman, 2009). The harmonization of national policies through international or supranational law, whereby countries must agree and comply with international rules through multilateral negotiations, also could have contributed to this process of co-movement in the institutional change across countries (Knill, 2005).

Most countries are significantly affected by the world factor. Others, such as those in the middle- and low-income groups (e.g., Malaysia, India, and Kenya) have institutional change trajectories that deviate from the very strong first common factor. To analyze what characteristics explain a country's sensitivity to global influences on institutional change, the proportion of variance explained by the world factor is regressed on several potentially important characteristics: (1) real GDP per capita in 2006; (2) average IMF loan participation from 1985 to 1995; (3) initial quality of the institutional index; (4) democratic accountability; (5) dummy for the EU; and (6) dummy for the North American countries. GDP per capita is used to explore whether the differences in variation explained by the world factor differs on the basis of economic development. Average IMF loan participation is added to test whether countries with high IMF loans are more likely to follow the world trend. Initial quality of economic institutions tests whether countries with poor economic institutions initially are more likely to be influenced by the world factor. Democratic accountability is added to check whether democratic countries are likely to be more affected by the world factor because of their high level of economic integration.

Table 5 presents the cross-sectional regression results for both economic institutional indices. For the Economic Freedom index, the initial level of the index is negative and significant, suggesting that countries with poor initial economic institutions are more affected by the world factor. GDP per capita and IMF loan participation are positively associated with the explained variance and are significant at 5% and 10% significance levels, respectively. Democratic accountability and regional dummy variables are insignificant. The result suggests that countries with higher IMF loan participation and higher GDP per capita tend to have higher sensitivity to the world factor. Pressure from the IMF to adopt institutions and policies based on the blueprint approach thus may be an effective way to bring about institutional change in developing countries.

Table 5
Cross-sectional regression results of variance and constant for Economic institutions

Variables	Economic Freedom Index	Trade Restrictions Index
Economic Freedom 1985	-0.11***	
	(0.03)	
IMF Loan Participation	0.23*	-0.12
	(0.12)	(0.11)
Log of GDP per capita	0.10***	-0.01
	(0.03)	(0.03)
Democratic Accountability 1985	0.04	0.06**
	(0.03)	(0.02)
EU	0.05	0.17**
	(0.09)	(0.08)
North America	-0.09	0.18
	(0.17)	(0.15)
Trade Restrictions1985		-0.003
		(0.002)
Constant	0.05	0.32
	(0.21)	(0.20)
Observations	81	81
R-squared	0.21	0.18

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6 also presents a similar picture. The bottom 15% of developing countries with minimal variance, as explained by the first factor for the Economic Freedom index, had relatively low IMF loan participation rates from 1985 to 1995. This includes China, Indonesia, India, Malaysia, and Thailand, which followed more "home-grown" initiatives in reforming their economic institutions (Easterly, 2006). By contrast, the top 15% of developing countries with the highest variance had an average IMF loan participation rate of 49%. Most of these countries belong to Latin America, such as Argentina and Peru, which underwent economic

reforms in the 1980s and 1990s as part of the Washington Consensus (Rodrik, 2006).

Table 6
List of countries with highest and lowest variation explained for Economic Freedom index

Country	Variance Explained by first factor	IMF participation rate	Country	Variance Explained by first factor	IMF participation rate
Top 12 countries with highest explained variation			Bottom 12 countries with lowest explained variation		
Peru	0.96	0.44	Ivory Coast	0.00	0.45
Argentina	0.95	0.81	Thailand	0.00	0.28
Tunisia	0.94	0.37	Nigeria	0.00	0.23
Panama	0.94	0.5	Papua New Guinea	0.00	0.32
El Salvador	0.94	0.49	Malaysia	0.00	0
Philippines	0.93	0.91	Bahrain	0.00	0
Jamaica	0.91	0.73	Oman	0.00	0
Hungary	0.91	0.53	Botswana	0.02	0
Trinidad and Tobago	0.89	0.15	Indonesia	0.05	0.15
Nicaragua	0.84	0.1	Uganda	0.08	0
Poland	0.78	0.37	Kenya	0.10	0.17
Costa Rica	0.77	0.47	India	0.12	0.12

For the Trade Restrictions index, the results show that democratic countries respond more to the world factor influence, compared to other countries. Democratization reduces the ability of governments to use trade barriers as a strategy for building political support. Political leaders in labor rich countries may prefer lower trade barriers as democracy increases and may thus end up following global trends. Moreover, the dummy for EU is also significant, suggesting that EU countries have significantly higher explained variance compared to other countries. This finding again corresponds with the expectation, as EU countries are highly integrated in the world economy and are characterized by a single external tariff applied by all member states to imports from third countries. Apart from these two variables, no other variable is significant for the Trade Restrictions index.

The institutional change patterns of the countries affected by the world factor for the Trade Restrictions and Economic Freedom indices are shown in Figure 1. Low-income countries have a higher rate of change vis-a-vis high- and middle-

income countries for both economic institutional indices. Countries with weak institutions experience a higher rate of change in their economic institutions.

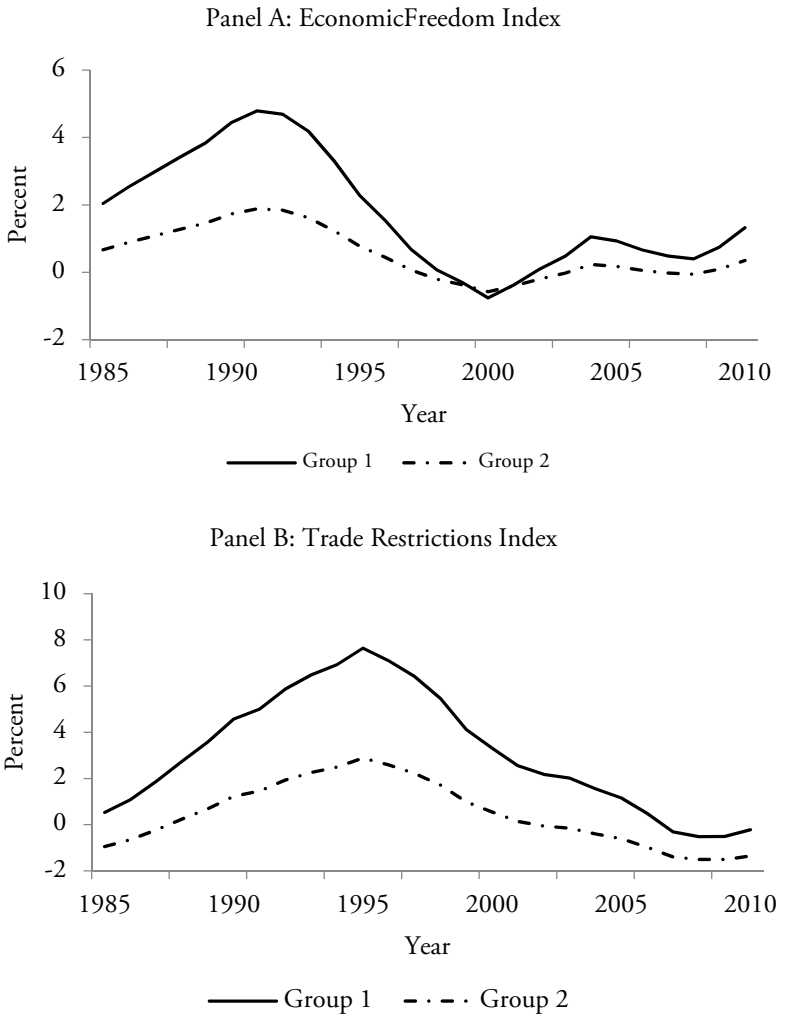

Figure 1
Average change in Trade Restrictions and Economic Freedom index for the significant countries for World factor. (Note: Group 1 consists of low-income countries that load significantly and positively on the first factor and group 2 consists of high and middle-income countries).

If this pattern of change continues, countries with weak institutions will eventually catch-up with the countries with strong institutions. However, the catch-up process will be slow, as countries with strong institutions continue to improve their institutional quality. Moreover, catch-up in the rate of change does not imply a catch-up in levels. Figure 2 compares the scores of an average country from each group on both indices over time. As shown, a considerable gap exists between the scores of the two groups for both indices, showing that the convergence in levels has not yet happened, although the gap between the two groups is diminishing.

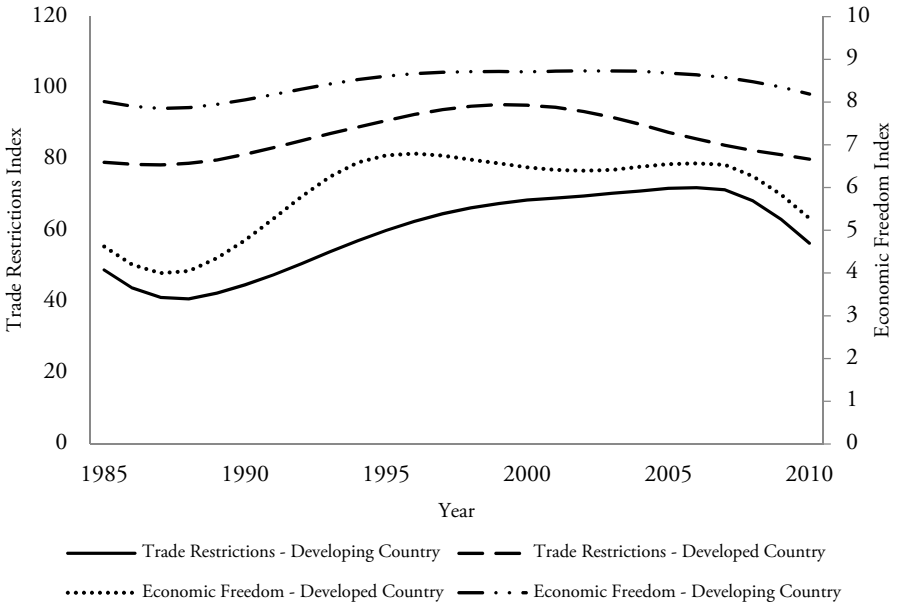

Figure 2
Long run evolution of economic institutions

The temporal evolution of the world factor for economic institutions also reveals some of the main global cyclical episodes of the past few decades that might have had an effect on the economic institutional quality of the countries. The average changes in the Trade Restrictions and Economic Freedom indices can also be used as a guide to study the direction of change for countries loading significantly on the world factor.

For both indices, there are two noticeable periods of change. First, there is an upward trend from 1985 to 1993 for the Economic Freedom index and from 1985 to 1996 for the Trade Restrictions index. The upward trend supports a general move towards market-supporting institutions, low trade barriers, and fewer capital flow restrictions in the late 1980s and early 1990s. This is also reflected in the reduction in the average applied tariff rate in developing countries from 32% in 1984 to 16.6% in 1995[19] (see Figure 3) and by the relatively high rate of change in the Trade Restrictions index for developing countries during the same period. Moreover, the accelerated change in economic institutions in developing countries during the 1980s and 1990s coincides with the adoption of policies under the Washington Consensus. The upward trend also coincides with the introduction of the EU, NAFTA, and WTO, which may explain the changes in institutional quality in developed countries. These findings show that international organizations can influence domestic institutional quality and may help explain the co-movement in institutional change.

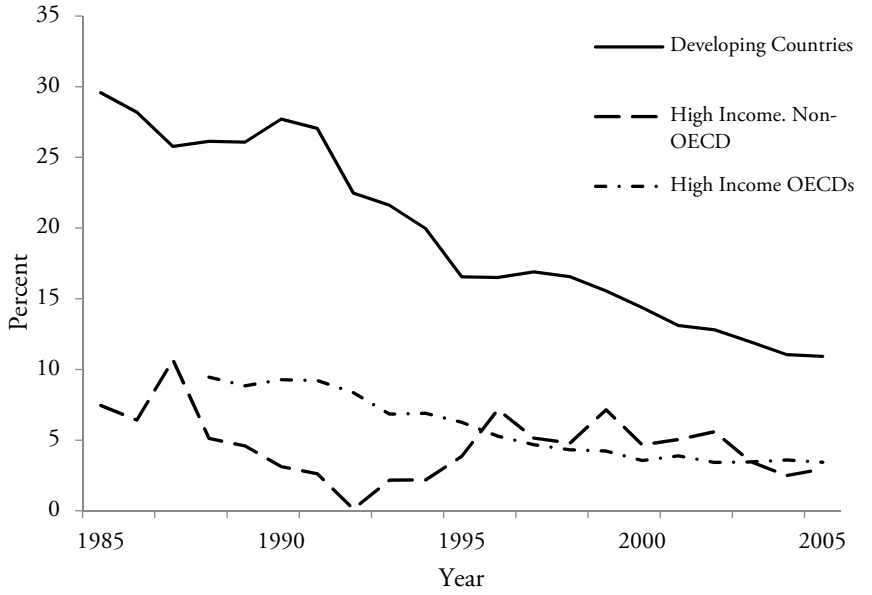

Figure 3
Average tariffs over the years

[19] Source: World Bank trade databases: http://siteresources.worldbank.org/INTRES/Resources/tar2005.xls

The second noticeable change occurs in the late 1990s and early 2000s as changes in both indices started to decline and even became negative. The increased hidden trade barriers in the form of strict quality standards may explain this change (Beghin, 2006). The declining rate of change in these two indices could also be associated with the recurring economic and financial crises in both the developing and developed world. The counter-cyclical relationship between trade protectionism and the business cycle (Bown & Crowley, 2013; Knetter & Prusa, 2003) suggests that the financial crisis during this period might have forced countries to impose capital flow restrictions and resort to protectionist trade policies. Moreover, the decline in the change in the Trade Restrictions index after 1996 indicates that, although the introduction of the WTO had a positive effect in the short run, this effect may have diminished over the years.

Political Institutions

Similar to economic institutions, the first two factors explain 61% of the variation in changes in political institutions (see Table 2). However, the long-term trend for political institutions exhibits different clustering patterns than those observed for economic institutions. The first and second factors have a significant impact on 55% and 40% of the countries, respectively, reflecting a lack of a common world factor. Rather, two main factors drive the changes in political institutions, and different groups of countries respond to different common factors, forming two clusters. The result suggests that political institutions follow a different pattern of change than economic institutions and confirms the third hypothesis. It also suggests that political elites might respond differently to different types of institutional reform because of their vested interests and the fear of redistribution of their political power.

The first cluster comprises 33 countries that load positively and significantly on the first factor and are primarily low- or lower-middle-income countries (see Table 7). Additionally, the first group includes four middle-income countries and two high-income countries (Greece, Hungary, Korea, Portugal, Cyprus, and Israel). These countries were similar to the developing countries in terms of their institutional quality in the 1990s, with high levels of corruption, poor bureaucracy, and low levels of democratic accountability. However, over the years they have experienced significant improvements in these components.

Table 7
Percentage of different types of countries loading significantly on the first factor two factors for the Government Quality index

	Factor 1		Factor 2	
	Positive loading	Negative loading	Positive loading	Negative loading
Income Classification				
High-Income Countries	8%	32%	60%	0%
Middle-Income Countries	33.3%	8.33%	41.6%	0%
Low-Income Countries	61.3%	6.81%	13.6%	15.9%
Democracy Classification				
Free Democracies	27.5%	27.5%	47.5%	2.50%
Partly Free Democracies	69.5%	4.34%	2.17%	4.34%
Not-Free Democracies	33.3%	0%	11.1%	27.8%

Note: Within group percentages are reported; Income classification based on the year 1990; Democracy classification based on Freedom House category of democracy in 1985

Among high-income countries, 60% load positively and significantly on the second factor, together with 41% of middle-income countries and 13% of low-income countries. The fact that countries follow common trends in terms of changes in their political institutions underscores the fact that most countries experience common changes in institutional quality despite the two distinct underlying trends. The division of countries into two clubs highlights a close linkage between the initial quality of political institutions and subsequent club formation. Countries with weak political institutions are significantly affected by the first factor, whereas countries with strong institutions form the second group. This implies the existence of path dependence in political institutions.

The classification of countries into these two groups is further supported by the regression results of the proportion of variance explained by the first and second factors on the income classification, as well as on the initial level of the Government Quality index. As shown in Table 8, low- and middle-income countries have significantly higher explained variance compared to high-income countries. In contrast, for factor 2 high-income countries have significantly higher explained variation. Moreover, adding the initial level of Government Quality renders the coefficient of dummy variables insignificant. However, the coefficient on Government Quality is negative for factor 1 and positive for factor 2, indicating that the first factor belongs to countries with poor initial political

institutions and that the second factor belongs to countries with good initial political institutions.

Table 8
Cross-sectional regression results of variance and constant for Government Quality index

Variables	Variance Factor 1	Variance Factor 2	Variance Factor 1	Variance Factor 2	Constant	Constant
Middle Income Countries	0.14*	0.02	0.001	-0.04	0.70**	-1.47***
	(0.07)	(0.06)	(0.10)	(0.06)	(0.29)	(0.28)
Low Income Countries	0.14*		-0.046		0.77**	-2.09***
	(0.07)		(0.12)		(0.29)	(0.33)
High Income Countries		0.27***		0.02		
		(0.06)		(0.10)		
ICRG 1985			-0.01*	0.01***		-0.21***
			(0.006)	(0.005)		(0.02)
Constant	0.25***	0.17***	0.651***	-0.12	0.280	6.07***
	(0.054)	(0.05)	(0.219)	(0.11)	(0.210)	(0.55)
Observations	81	81	81	81	81	81
R-squared	0.06	0.21	0.10	0.30	0.10	0.64

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Countries with weak institutions form a single cluster, because it is highly likely that they follow a trajectory determined by their past institutions. The ruling elites may not replace them with better quality institutions if they have a vested interest in maintaining the status quo (Acemoglu & Robinson, 2012). This result contrasts with the results for economic institutions, for which a common world factor dominates. It also confirms a difference in the patterns of change for economic and political institutions, as postulated by the third hypothesis.

Figure 4 presents the average long-run change in the quality of political institutions for both the developed and developing country groups. The institutional change path for the developing country group indicates that these countries experienced improvements in their political institutions in the late 1980s and most of the 1990s. This initial change coincides with the third wave of democracy[20], which restricted the arbitrary actions of rulers and bureaucrats (Diamond, 1996; Huntington, 1993). Many developing countries in Latin America and Asia underwent a process of democratization in the 1980s and 1990s that in turn might have helped to reduce corruption and secure property rights (Knutsen, 2011; Rock, 2009). Moreover, the reforms based on aid assistance,

[20] For a detailed discussion on the waves of democracy, see Huntington (1993).

which were targeted at improving the quality of governance in developing countries during the 1980s and 1990s, may have contributed to this initial positive change observed for the developing country group (Naim, 2000; Andrews, 2012).

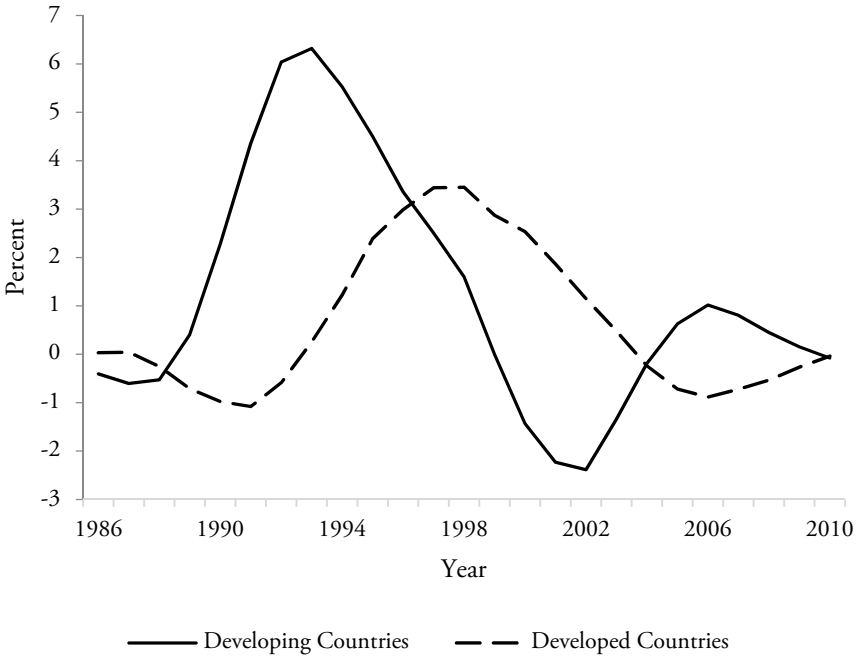

Figure 4
Average change in Government Quality index for developing and developed countries

The developed country group experienced a positive change in the early 1990s, coinciding with the introduction of the EU and NAFTA. Joining a regional economic cooperation arrangement requires member countries to comply with a range of policy requirements, which in turn improves policy credibility (World Bank, 2004). The improved credibility often arises from improved institutional quality and has a direct impact on the investment climate of a country. Accordingly, the average long-run change in the investment profile component of the Government Quality index for the developed country group has a correlation of 0.86 with the second factor, which shows that changes in the investment profile drove changes in the political institutions index.

The developing country group experienced a higher average change in the quality of political institutions than the developed country group, thereby gradually

reducing the gap in institutional quality (in absolute terms) between the two groups. This result is confirmed by regressing the constant on the initial level of the political institution as well as on the income group dummies (see Table 8). Results confirm that countries with a poor initial level of the political institution experienced higher institutional change. The result, however, does not indicate that catch-up occurred between these two groups, as the acceleration in institutional change did not last long and seems to have slowed down or even disappeared in the new millennium. This weakening of the catch-up process in recent periods instead seems compatible with the view that the adoption of Western-style institutions in the global South may not have been as successful as expected, because of developing-economy-specific constraints (Berkowitz et al., 2003a, b; Roland, 2004; Rodrik, 2008; Khan, 2012).

Another plausible explanation for the slowdown of catch-up could be that political elites, influential minorities, or interest groups in the developing countries oppose these changes, especially in the political context (Acemoglu & Robinson, 2006, 2008). Therefore, any external or internal influences to change de jure institutions may leave the sources of de facto power intact, and groups that have lost their de jure power may use their de facto power to re-create a similar system to the previous one (Acemoglu & Robinson 2006, 2008). This process eventually leads to the reversal of policies and any associated reforms.

In sum, the results for all three indices indicate that most countries experience co-movement in institutional change, irrespective of their level of development or other characteristics. This finding confirms that policymakers and governments often look outwards, imitating policy elements from other countries and emulating institutions from elsewhere, instead of designing policies and institutions to meet domestic goals and interests and fit the domestic culture. This finding holds true even for the developed countries in the sample, as they also respond significantly to the common trend. Another important implication of the results is that the changes in economic institutions follow a global trend. However, the changes in economic institutions are higher for developing countries than for developed countries, suggesting that political elites in many developing countries may want to change these institutions so as to increase their rents and maintain their legitimacy. To protect the status quo, these changes happen in the economic sphere only and not in the political arena. This result partially confirms the first hypothesis that a catch-up in institutional quality occurs across countries, at least in the economic sphere. Moreover, the higher rate of change for economic institutions is in line with the third hypothesis that states that economic institutions are more susceptible to change and more likely to converge than are political institutions.

Conclusion

Rapid globalization in recent years and a shift in policy focus towards getting institutions right, have raised the following questions: (1) To what extent does a catch-up in institutional quality occur between countries? (2) Are contemporary differences in institutional quality between countries transitory or permanent? The theoretical and empirical literature does not answer these questions. This study uses a static factor model combined with MODWT and three different institutional measures to test for long-term catch-up in institutional quality.

First, the analysis shows that the pattern of change for economic institutions is different from that for political institutions. Changes in the economic institutions are driven by a common world factor, and most countries with weak institutions experience greater institutional change vis-à-vis countries with strong institutions. Hence, differences in institutional quality between countries may be transitory, but they persist for a long time because countries with strong institutions also experience institutional change. Two main trends occur for political institutions: one trend for countries with weak political institutions and another for countries with strong institutions. The evolution of the trends shows that catch-up occurs at the start of the period. However, the acceleration in catch-up is short-lived and seems to slow quickly and even disappear in the new millennium. Second, the trajectory of institutional change experienced by many countries coincides with some of the major trends and events in the last three decades. These include rapid globalization, the introduction of the EU and NAFTA, the emphasis on policies based on the Washington Consensus, the third wave of democracy, and the financial crisis of 2008.

These findings are consistent with the theoretical assertions that economic institutions are more susceptible to change and more likely to converge than are political institutions. This underscores the theoretical argument that political elites are likely to undertake reforms in economic institutions, as such changes directly benefit the ruling elites by increasing their rents and tax base and elongating their tenure (Nye, 2011; Nee & Lian, 1994; Andrews, 2012; McGuire & Olson, 1996). As for political institutions, enhancing efficiency and improving institutions may not supplant weak institutions in developing countries. These institutions are likely to be path dependent, as it is not in the interest of the political elites to change the existing extractive political institutions (Acemoglu & Robinson, 2012). Based on these findings, future research on institutions and institutional change should categorically differentiate between economic and political institutions and use different measures for them.

The findings also have implications for national and global reform policy in developing countries. Contrary to the general understanding that country-specific factors affect institutional change, evidence indicates that common global factors affect institutional change locally in the long run. Thus, global efforts to harmonize institutions across countries and force countries to adopt certain policies and institutions may lead to institutional catch-up in the long run, at least when such policies aid at improving market-oriented economic institutions. However, the institutional reforms promoted by international financial institutions based on the blueprint approach might not succeed in the long run for political institutions. In this scenario, instead of imposing a single blueprint model based on the experiences of developed countries, policy makers should seek ways to introduce more context-specific reforms that account for the domestic policy environment, the social and economic context, and the prevailing social norms.

A few limitations of the analysis should be noted. First, the study sample contains only 81 countries. Expanding the sample might enable future researchers to better understand the reasons behind common variations and better discern patterns of institutional change. A second data limitation is that the data set spans only 26 years. This range limits decomposition of the long-run institutional change, which lasted for more than 16 years. Future studies should use a more current data set to analyze the catch-up pattern in long-run institutional change. Last, the analysis dates back to 1985 and thus does not identify the impact of prior significant economic and political events, such as the ascendance of communism, Latin America's debt crisis, the 1970s oil crises, and the popularity of import substitution policies on the development and evolution of both political and economic institutions in the global South.

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Appendix

Table A1: Composition of the Indices

Source	Composition
Economic Freedom of the World Index	Economic Globalization
	Index of Acctual Economic Flows
	Index of Economic Restrictions *
	Social Globalization
	Political Glibalization
KOF Index of Globalization	Size of Government: Expenditures, Taxes, and Enterprises
	Legal Structure and Security of Property Rights *
	Access to Sound Money
	Freedom to Trade Internationally *
	Regulation of Credit, Labor, and Business *
Political Risk Index	Government Stability
	Socioeconomic Conditions
	Investment Profile *
	Internal conflict
	External conflict
	Corruption *
	Military in politics
	Religious Tensions
	Law and Order *
	Ethinic Tensions
	Democratic Accountablity *
	Bureaucracy Quality *

Note: Components with * are the ones used in this study

Table A2: Variables comprising the Trade Restrictions index

Variable	Description
Data on Restrictions	
Hidden Import Barriers	The index is based on the Global Competitiveness Report's survey question: "In your country, tariff and non-tariff barriers significantly reduce the ability of imported goods to compete in the domestic market." The question's wording has varied slightly over the years.
Mean Tariff Rate	As the mean tariff rate increases, countries are assigned lower ratings. The rating declines toward zero as the mean tariff rate approaches 50%.
Taxes on International Trade (percent of current revenue)	Taxes on international trade include import duties, export duties, profits of export or import monopolies, exchange profits, and exchange taxes. Current revenue includes all revenue from taxes and non-repayable receipts (other than grants) from the sale of land, intangible assets, government stocks, or fixed capital assets, or from capital transfers from nongovernmental sources. It also includes fines, fees, recoveries, inheritance taxes, and non-recurrent levies on capital. Data are for central government and in percent of all current revenue.
Capital Account Restrictions	Index based on two components: (i) Beginning with the year 2002, this sub-component is based on the question: "Foreign ownership of companies in your country is (1) rare, limited to minority stakes, and often prohibited in key sectors or (2) prevalent and encouraged". For earlier years, this sub-component was based on two questions about "Access of citizens to foreign capital markets and foreign access to domestic capital markets". (ii) Index based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions, including 13 different types of capital controls.

Source: Dreher (2006), Dreher et al. (2008)

Table A3: Variables comprising the Economic Freedom index

Area II: Legal structure and security of property rights
A. Judicial independence: the judiciary is independent and not subject to interference by the government or parties in disputes.
B. Impartial courts: a trusted legal framework exists for private businesses to challenge the legality of government actions.
C. Protection of intellectual property.
D. Military interference in rule of law and the political process.
E. Integrity of the legal system.
F. Legal enforcement of contracts
G. Regulatory restrictions on the sale of real property
H. Reliability of police
I. Business costs of crime
Area IV: Freedom to exchange with foreigners
A. Taxes on international trade.
i. Revenue from taxes on international trade as a percentage of exports plus imports.
ii. Mean tariff rate.
iii. Standard deviation of tariff rates.
B. Regulatory trade barriers.
i. Hidden import barriers: No barriers other than published tariffs and quotas.
ii. Costs of importing: the combined effect of import tariffs, license fees, bank fees, and the time required for administrative red-tape raises costs of importing equipment by (10=10% or less; 0=more than 50%).
C. Difference between official exchange rate and black market rate.
D. Controls of the movement of capital and people
i. Access of citizens to foreign capital markets and foreign access to domestic capital markets.
ii. Restrictions on the freedom of citizens to engage in capital market exchange with foreigners—index of capital controls among 13 IMF categories.
iii. Freedom of foreigners to visit
Area V: Regulation of credit, labor, and business
A. Credit Market Regulations
i. Ownership of banks: percentage of deposits held in privately owned banks.
ii. Extension of credit: percentage of credit extended to the private sector.
iii. Interest rate controls: interest rate controls on bank deposits and/or loans are freely determined by the market.
B. Labor Market Regulations
i. Hiring regulations and minimum wage: the difficulty of hiring index measures (a) whether fixed-term contracts are prohibited for permanent tasks; (b) the maximum cumulative duration of fixed-term contracts; and (c) the ratio of the minimum wage for a trainee or first-time employee to the average value added per worker.
ii. Hiring and firing practices: hiring and firing practices of companies are determined by private contract.
iii. Share of labor force whose wages are set by centralized collective bargaining.
iv. Hours regulations. Countries with less rigid work rules receive better scores in this component.
v. Mandated cost of worker dismissal.
vi. Use of conscripts to obtain military personnel.
C. Business Regulations
i. Administrative requirements: Complying with administrative requirements (permits, regulations, reporting) issued by the government in your country is (1 = burdensome, 7 = not burdensome).
ii. Bureaucracy costs: Standards on product/service quality, energy and other regulations (outside environmental regulations) in your country are: (1 = Lax or non-existent, 7 = world's most stringent).
iii. Starting a new business: starting a new business is generally easy.
iv. Extra payments/bribes/favoritism: irregular, additional payments connected with import and export permits, business licenses, exchange controls, tax assessments, police protection, or loan applications are very rare.
v. Licensing restrictions: the time in days and monetary costs required to obtain a license to construct a standard warehouse.
vi. Cost of tax compliance: the time required per year for a business to prepare, file, and pay taxes on corporate income, value added or sales taxes, and taxes on labor.

Source: Gwartney et al. (2012)

Table A4: Variables comprising the Government Quality index

Variable	Description
Investment Profile	Factors affecting the risk to investment not covered by other political, economic and financial risk components Sub-components: contract viability/expropriation, profits repatriation, payment delays.
Corruption	Corruption within the political system Financial corruption and corruption in the form of excessive patronage, nepotism, job reservation, favors for favors and suspiciously close ties between politics and business.
Law and Order	Law: The strength and impartiality of the legal system. Order: popular observance of the law (people following the law).
Democratic Accountability	How responsive government is to its people on the basis that the less responsive it is, the more likely is it that the government will fall (peacefully or violently). Ranging from Alternating democracies to Autarchy
Bureaucracy Quality	The strength and expertise to govern without drastic changes in policy or interruptions in government services. Ability to absorb shocks to minimize revision of policy when governments change.

Source: ICRG (2012)

Table A5: Percentage of high, middle and low-income countries loading significantly on the first factor for the economic institutions

	Economic Freedom Index		Trade Restrictions Index	
	Factor 1		Factor 1	
	Positive loading	Negative loading	Positive loading	Negative loading
15% cutoff				
High-Income Countries	84%	0%	84%	0%
Middle-Income Countries	66.6%	0%	58.3%	8.33%
Low-Income Countries	70.4%	6.81%	68.1%	6.81%
25% cutoff				
High-Income Countries	72%	0%	76%	0%
Middle-Income Countries	58.3%	0%	58.3%	0%
Low-Income Countries	61.3%	6.81%	54.5%	6.81%

Note: Within group percentages are reported; Income classification based on the year 1990

Table A6: Percentage of high, middle and low-income countries loading significantly on the first two factors for the Government Quality index

	Factor 1		Factor 2	
	Positive loading	Negative loading	Positive loading	Negative loading
15% cutoff				
High-Income Countries	8%	32%	60%	0%
Middle-Income Countries	33.3%	8.33%	41.6%	0%
Low-Income Countries	61.3%	6.81%	13.6%	15.9%
25% cutoff				
High-Income Countries	8%	28%	60%	0%
Middle-Income Countries	33.3%	16.6%	41.6%	8.33%
Low-Income Countries	45.4%	4.54%	11.3%	11.3%

Note: Within group percentages are reported; Income classification based on the year 1990.

Chapter 4
Firm Ownership and Provincial CO_2 emissions in China

With Fredrik N.G. Andersson (Lund University)
and Sonja Opper (Lund University)

Introduction

Within only three decades, China has emerged from one of the world's poorest agricultural economies to a major manufacturing economy taking up the largest share of global carbon dioxide (CO_2) emissions. Projections of future emissions point toward a continuous upward sloping trajectory until 2035–2040 (Andersson & Karpestam, 2013; Yuan, Xu, Zhang, Hu, & Xu, 2014). Clearly, China's capitalist transformation and high-growth strategy poses a threat to any global attempts to slow down global warming. Yet, China's turn toward a market economy and distinct growth strategy are two factors that need to be disentangled. There is a wide consensus that China's leadership prioritized economic growth over environmental concerns throughout most of the reform period, causing severe air, water, and land pollution (He, Lu, Mol, & Beckers, 2012). The 11th five-year plan (2006–2011) was in fact the first to place greater emphasis on environmentally sustainable development (He et al., 2012). Distinct from China's growth strategy, however, the country also underwent a gradual capitalist transformation from a fully state-owned economy to a hybrid economy largely relying on private production and mixed ownership forms (Nee & Opper, 2012). This raises the question of whether, and to what extent, the country's opening up to capitalist forms of production either reinforced or possibly mitigated accumulating environmental costs.

A focus on firm ownership as a potential factor explaining pollution levels is well aligned with the "structural policy approach" to environmental policies, which aims at improving the economy's overall economic efficiency both in terms of total factor productivity (Penn World Tables)[21] and domestic material consumption (Global Material Flow database).[22] Given broad evidence confirming cross-ownership differences in terms of economic efficiency, specifically indicating higher energy consumption of state-owned enterprises (see e.g., Anderson, 1995; Talukdar & Meisner, 2001; Wang & Jin, 2007), ownership (and ownership reforms) should be a natural component of structural policy considerations. Yet, the effect of firm ownership on emissions has attracted relatively little political as well as scholarly attention. Initial firm-level analyses have produced an inconclusive account, with some studies confirming that state-owned enterprises pollute more than private enterprises (Fisher-Vanden, Jefferson, Liu, & Tao, 2004; Jiang, Lin, & Lin, 2014; Wang & Wheeler, 2003), while others diagnose no significant difference between each ownership type (Wang & Jin, 2007; Wang & Wheeler, 2005).

Building on these micro-level accounts studying random samples of firms, this paper shifts attention to the question regarding whether regional differences in ownership structure have a large enough impact to affect regional pollution levels. Our macroeconomic approach focuses on provincial variation to test whether regional differences in ownership structure have a measurable effect on overall provincial CO_2 emissions. Moving to a macroeconomic approach that exploits provincial differences does not only help to separate general growth effects from the role of China's capitalist transformation, but also suits China's decentralized quasi-federalist structure that allocates authority to provincial government in terms of policy implementation and enforcement (Montinola, Qian, & Weingast, 1995), which also includes shared responsibilities between the national government and local authorities in terms of environmental policies (Wang & Wheeler, 2003; Mol & Carter, 2006). The emerging inter-provincial differences in terms of production structure and pollution levels hold great analytical promise. Empirical results not only help to model future trajectories of emissions, but, from a policy perspective, are essential for estimating the overall effect of different policy reforms prioritizing or limiting distinct ownership forms.

We model the effect of firm ownership using provincial data covering the period from 1992 to 2012. Our approach is to decompose the short-run and long-run cause of emissions into scale, energy intensity, and carbon intensity components.

[21] https://pwt.sas.upenn.edu/.

[22] http://www.materialflows.net/home/.

We find that capital growth is the main driver of emissions growth and that private firm capital is more energy-efficient than capital employed in non-private firms. Over the long-term, emissions would have grown by between 3 and 4 percentage points more per year had private firms been as inefficient as non-private firms. This result underscores that continuing market-oriented reforms that increase general firm efficiency will dampen future CO_2 emissions growth. The greater competitive pressure on private firms compared with non-private firms is likely to be a main driver of the negative long-run correlation between private enterprises and emissions. In addition, we find that continued structural changes from an agricultural economy to a modern industrialized economy will stifle future emissions growth. Coupled with an active environmental policy, that is, regulation of carbon price, our results show that overall emissions growth could be reduced to close to zero despite the economy continuing to grow in excess of 5% per year. These insights offer valuable lessons for many developing countries, which continue to rely on large state-owned sectors. Economic development and environmental concerns can be coupled into a win-win situation through reforms that enhance productivity and competition, and indirectly, less environmental degradation.

The remainder of the paper is organized as follows: Section 2 discusses causal channels linking firm ownership and CO_2 emissions, both from a general theoretical perspective and a country-specific perspective, taking context-specific institutional factors into account. Section 3 presents the data and empirical analysis and Section 4 concludes the paper.

Firm Ownership and the Carbon Footprint

Firm Ownership and the Carbon Footprint: A Theoretical Background

Behavioral differences in the management of private and state-owned enterprises have been subject to a long-standing debate on the relative advantages of both ownership forms (Shleifer, 1998; Shleifer & Vishny, 1994). While the comparative study of performance effects has played an important role both in the study of established market economies (Boardman & Vining, 1989; D'souza & Megginson, 1999; Dewenter & Malatesta, 2001; Megginson, & Netter, 2001) and transition economies (Djankov & Murrell, 2002; Estrin, Hanousek, Kočenda, & Svejnar, 2009; Frydman, Gray, Hessel, & Rapaczynski, 1999), second-order effects on environmental outcomes have only gained attention

recently. We highlight two causal channels through which ownership can affect pollution levels. First, private and state-owned firms have different objective functions *(functional perspective)*. Second, owners and managers of private and state-owned firms face a different institutional and resource environment, which invites distinct behavioral responses *(institutional or resource-based perspective)*.

The functional perspective typically interprets private enterprises as following a single objective—profit maximization—whereas state-owned enterprises are assumed to pursue multiple objectives reflecting policy-makers' complex priorities in terms of social, economic, political, or even environmental preferences. The environmental net effect of both objective functions is ambiguous. Pure profit maximization of private firms can rely on waste avoidance or minimization, energy efficient technologies, and highly effective resource use. Profit maximization also provides incentive to the private firms to engage in technology transfer from foreign invested enterprises (Taube, 2003) leading to efficient technology. All of these strategies would also reduce pollution levels as a second-order effect (Schmid & Robin, 1995; Shirley, Kikeri, & Nellis, 1992). However, the opposite effect could occur if profit maximizers pursue their objective function by not internalizing production externalities or by undercutting technology and environmental standards (Eiser, Reicher, & Podpadec, 1996). The overall environmental impact naturally depends on the relative strength of both effects.

For state-owned enterprises, the net environmental effects are equally difficult to predict. On the one hand, the multifaceted objectives of state-owned firms can include the task to advance environmental protection in order to help government bodies comply with aggregate environmental targets (Liu & Wang, 2011; Wang & Jin, 2007; Grout & Stevens, 2003). Yet, weaker profit orientation may also contribute to less efficient resource use and higher pollution levels (Andrews & Dowling, 1998; Boycko, Shleifer, & Vishny, 1996; Djankov & Murrell, 2002).

Differences in institutional and resource environments add to the complexity of the ownership-environment link. Politically well-connected state-owned firms often enjoy 'soft budget constraints' (Kornai, 1980) as a result of the generous provision of tax benefits, subsidies, and government guaranteed low-interest loans (Adhikari, Derashid, & Zhang, 2006; Bunkanwanicha & Wiwattanakantang, 2009; Ding, Jia, Wu, & Zhang, 2014; Faccio, 2006). Whether these softer financial constraints and the resulting lower competitive pressure translate into strengthened ecological responsibility or into inefficient resource use awaits empirical testing. Similarly, managers of state-owned enterprises may either employ their closer political ties to lobby for lighter environmental regulations and to avoid environmental penalties in the case of non-compliance (Wang & Jin, 2007), or they may even experience closer scrutiny by monitoring agencies that

aim at upholding fair standards. The exact outcome will depend on the insulation of government bodies and the importance of political capital in the regulatory economy (Evans, 1995; Nee, Opper, & Wong, 2007).

Firm Ownership and the Carbon Footprint: The Case of China

Institutional incentives and resource constraints are necessarily context specific. In China's reform economy, functional differences between state-owned enterprises and private firms may have been even more pronounced than generally assumed. The constitutional equality of state-owned production and private firms was not granted before 2004, reflecting the government's continuing priority treatment of public ownership throughout most of the reform period. State-owned enterprises continue to dominate key sectors regarded as essential for overall economic development (Fan, Kanbur, Wei, & Zhang, 2014). Broad empirical evidence confirms that state-owned firms are expected to serve multiple goals beyond profit-making. These include a mix of employment, income, structural change, global integration and local growth targets, which are activated depending on the overall economic situation (Bergsager & Korppoo, 2013; Chang & Wong, 2009; Der Heide & Taube, 2013; Hu, Opper, & Sonia, 2006). The influence of multiple objectives pursued by state-owned firms—often exercised through direct political interference (Chang & Wong, 2004; Nee et al., 2007; Taube, 2005)—is reflected by lower investment efficiency and profitability compared with non-public firms (Chen, Sun, Tang, & Wu, 2011; Lardy, 2014; Su & He, 2012). There is, however, no indication that the pursuance of environmental goals played a part in this. Until the beginning of the 11th five-year plan in 2006, the government did not emphasize environmental goals; neither did performance assessments of political leaders incorporate 'soft' goals such as environmental standards. Instead, performance assessments relied on the provision of employment and aggregate economic growth (Landry, 2003; Bo, 2002; Li, 1998).

By contrast, the emergence of a private firm economy was not part of government-sponsored policy reforms, but rather reflected the bottom-up rise of a new entrepreneurial class that sought profit opportunities in industrial niches insufficiently served by state-owned enterprises (Nee & Opper, 2012). From the beginning of China's economic reforms, private entrepreneurs operated outside the state allocation system and relied on rapidly expanding free market exchange, which left entrepreneurs with no alternative but to focus on profit-making to secure the survival of their companies. With the majority of companies focusing on industries with low market entry barriers, competitive pressure tends to be

intense and forces companies to continuously upgrade production processes and minimize resource input. A longitudinal study of private firms in China's Yangzi Delta region reports a stable rate of process innovation between 60% and 64% for the period between 2002 and 2011 (Nee & Opper, 2015). This observation is in line with national firm survey data collected by the World Bank in 2012, which suggests that close to 64% of the interviewed private firms introduced new technology and equipment over the preceding three years. By contrast, only 35% of the companies involving state ownership invested in new technology and equipment.

Functional differences between both ownership forms are further reinforced through institutional differences, which increase competitive pressure on private companies. With factor market liberalization in China generally lagging behind product market liberalization (NERI), private companies are hard-pressed to secure investment capital, land, and skilled labor. The state-dominated banking system channels the majority of capital into state-owned firms and government sponsored projects (Andersson, Burzynska, & Opper, 2014), which leaves private companies with few alternatives but to rely on retained earnings and, to some extent, informal loans from friends and business partners (Nee & Opper, 2012; Tsai, 2002). Productivity maximization thus became a natural response to compensate for the lack of capital and to generate profits from which to further grow the company (Lardy, 2014).

Differences in social and political capital add to the disadvantaged position of private firms. State-owned enterprises typically maintain closer ties with the government and local bureaucracy. In particular, managers of large state-owned enterprises can wield a large influence on local policy makers, possibly helping them to shape local regulation in their interest (Wang and Jin, 2007). Beyond these forms of state-capture commonly found in transition economies (Hellman, Jones, & Kaufmann, 2003), political ties also shield companies from pollution payments and punishments in the case of non-compliance with regulatory standards (Wang & Jin, 2007; Wang, Mamingi, Laplante, & Dasgupta, 2003; Wang & Wheeler, 2003). While private companies also invest strategically in government ties (Ma & Parish, 2006; Nee & Opper, 2010; Taube, 2013; Xin & Pearce, 1996), there is no indication that they enjoy advantages comparable with their publicly owned counterparts. The same World Bank survey conducted in 2012 indicates that private companies are much more likely to be subject to routine inspections than publicly owned companies. While 68% of the interviewed private company managers reported company ınspections over the preceding years, the corresponding share of publicly owned and partially state-owned companies was less than 34% (World Bank, 2012).

To summarize, we assert that functional as well as institutional differences between state-owned companies and private firms in China suggest that private firms are likely to leave a smaller carbon footprint than their publicly owned competitors.

Measuring the Size of the Private Sector

The ownership structure of China's economy is complex and includes, alongside the pure forms of private enterprises and state-owned enterprises, a range of hybrid ownership forms, such as rural and urban collectively owned enterprises, cooperative enterprises, joint-ownership enterprises, limited liability enterprises, and share-holding enterprises with mixed ownership forms (Bruton, Peng, Ahlstrom, Stan, & Xu, 2015). Finally, the portfolio of distinct ownership types also includes wholly foreign-owned enterprises as well as small-scale units of self-employment. For simplicity, we include in the category of private firms only those that are registered as private companies. These companies have at least eight employees and were either established by a natural person or a majority of the company is owned by a natural person (Lardy, 2014). We exclude from our measure companies registered as limited liability enterprises and shareholding enterprises because both registration categories combine purely private firms with organizational hybrids, which combines private and state-owned shares to varying degrees. A large share of these companies are partially privatized, formerly fully state-owned companies still containing some—and in the case of stock listed companies—decisive state-ownership shares (Lee, 2009).

Without detailed information on each individual company, it is impossible to determine the exact ownership of these companies. In our study, we therefore compare the environmental effect of private enterprises against all other ownership types, although we acknowledge that some of these may include a sizable private component. Our estimation results are therefore likely to underestimate the effect of private ownership. Any support for our hypothesis therefore provides strong evidence that private enterprises pollute less that state-owned enterprises.

We use the share of private employment in total employment as a proxy for the relative size of the private sector. Use of total employment numbers rather than number of firms helps to control for regional differences in the firm scale. An alternative would be to rely on output statistics, which are, however, not available at the provincial level before the late 1990s, thus this would reduce our sample to a relatively short observation period. For the available years, however, high

correlation coefficients (0.8) between employment share and output share confirm the employment share as a good indicator of regional private firm activities.

Empirical Analysis

Econometric Model

We model the provincial growth rate in carbon emissions.[23] The econometric model is derived from the emissions decomposition model in which economic activity affects emissions through three separate channels: scale, energy intensity, and carbon intensity (Andersson & Karpestam, 2013; Lise, 2006; Tol, 2007; Tol, Pacala, & Socolow, 2009). *Scale* is the level of energy demand caused by economic activity. *Energy intensity* is defined as the average amount of energy required for each unit of economic activity and thus reflects energy efficiency. *Carbon intensity* is the average amount of CO_2 emitted when producing one unit of energy. Analytically, however, carbon intensity is of minor interest because China's overall energy mix has remained relatively stable since the early 1990s, with only modest increases in non-fossil fuels, such as renewable energies and nuclear power (China Energy Databook, 2013). Our focus is therefore on modeling changes in scale and energy intensity.

To capture changes in scale (i.e., the level of economic activity) we use capital growth and employment growth.[24] We expect capital growth to be the main driver of energy demand. Energy intensity is modeled using our main variable of interest—private firms—and a vector of control variables. To isolate the impact of the private sector on energy intensity, our regression model includes the growth rate in the log of the share of private employment, $\Delta ln\ (private\ employment_{jt}/total\ employment_{jt})$. This specification provides two important properties: First, using the log of the share in private sector

[23] We calculate the growth rate in emissions as the log growth rate, $\Delta ln\big((CO_2)_{jt}\big)$, where j denotes province and t denotes time.

[24] Scale is sometimes modeled using GDP growth, but a reliance on GDP growth would produce ambiguous results because changes in GDP growth are caused by both extensive factors (affecting scale) and intensive factors (affecting the energy intensity). We therefore decompose GDP growth into its three main sources: capital growth, employment growth, and total factor productivity (TFP) and use the first two sources to model scale and the latter source to model energy intensity. A description of how we decompose GDP growth is available in Appendix A.

employment, we take into account that private sector employment growth has outpaced growth in the rest of the economy.[25] Second, using the change in the share rather than the change in the log share, which we use, could cause spurious results (Gerdes, 2010).[26]

Regarding our vector of control variables, first, we include total factor productivity growth to capture productivity improvements in the economy. Higher productivity is expected to reduce energy intensity because the same level of production is achieved as before but with less capital and employment. Growth in the share of manufacturing and service production is included to account for differences in energy intensity across different industries, with the manufacturing industries assumed to be more energy intensive than the service and agricultural industries (Andersson & Karpestam, 2013).

Additionally, growth in private transports (person-km), growth in freight transports (ton-km), log-change in the share of urban population, and real energy prices (coal and oil prices) are included as control variables. We expect a larger share of the population living in urban areas to increase the energy intensity (Jones, 1991). The effect of transport growth is ambiguous. On the one hand, increasing geographical specialization of modern production increases transport volumes of goods and raw material (Rodrigue, 2006), which is expected to increase the energy intensity. On the other hand, greater specialization of production typically co-evolves with efficiency increases of the economy and lower energy intensity of available transport facilities (Rodrigue, Comtois, & Slack, 2013). The expected net effect of freight growth is therefore uncertain. Finally, real coal and oil prices[27] are expected to have a disciplining effect on energy use by creating incentives to reduce energy waste and to invest in energy-saving new technologies.

All explanatory variables refer to the same time period as the carbon emissions. The only exception is energy prices, which enter the estimation model with a five-year time lag. In this case, we assume that actors need a certain adjustment period to respond to price changes because both behavioral changes in the production process as well as the introduction of new energy-efficient technologies (and new skills) require a certain time. We have also experimented with shorter lag lengths

[25] The share of private sector employment in wholly privately owned firms has increased from less than 1% in 1992 to 21% in 2009 (China Statistical Yearbook, 2011).

[26] We have also estimated the models using the change in the absolute share, but our statistical tests clearly indicate that using the log of the share improves the models' statistical properties.

[27] Real energy prices are calculated using the GDP deflator.

of less than five years, with the only effect being that coefficient estimates for real energy prices become insignificant. Estimation results for the other parameters, including those for private ownership, remain unaffected.

Most of the variables included in the model are supply-side variables that affect the economic structure. Such changes take time, and we expect these to explain the long-term movement in emissions but not, to any great extent, the short-term volatility in emissions (Andersson & Karpestam, 2013). In our models, we therefore distinguish between short-term and long-term effects of the explanatory variables. The parameters in the models are estimated using the band spectrum regression estimator (see e.g., Engle, 1974; Andersson, 2011). In simple terms, the band spectrum regression estimator is a two-step estimator: First, all variables are decomposed into short-run and long-run components using a band-pass filter. Second, the regression model is estimated using the decomposed data whereby short-run and long-run parameter estimates are obtained. We use the maximal overall discrete wavelet transform (MODWT) as the band-pass filter. Although other filters can be used, we employ the MODWT because it is suitable for time series that possibly contain structural breaks, outliers, and other non-recurring events that may otherwise negatively affect decomposition of the data (Percival & Walden, 2006).[28] Compared to other estimators that distinguish between short and long-term effects, the band spectrum estimator has good small sample properties (Andersson, 2008, 2011).

Following previous studies (e.g., Ramsey and Lampart, 1998; Assenmacher-Wesche and Gerlach, 2008), we define the short-run as business cycle fluctuations in the economy lasting up to eight years. Accordingly, the long-run is defined as persistent changes in the economy lasting more than eight years. We have also tested other distinctions between the short-run and long-run. Those tests show that fluctuations up to eight years have different dynamics from more persistent changes in the economy. There is, however, no significant difference in the results if we define the long-run as 16 years and beyond compared with our definition of the long-run (eight years and beyond). Specifically, our regression models are given by:

$$\Delta ln\left((CO_2)_{jt}\right) = \beta_{j1} + \beta_2 \Delta X_{SRjt} + \beta_3 \Delta X_{LRjt} + \beta_4 \Delta Z_{SRjt} + \beta_5 \Delta Z_{LRjt} + \varepsilon_{jt} \quad (1)$$

where X is a vector containing the variables explaining changes in scale and Z are the variables explaining changes in the energy intensity. By construction, the

[28] For more information about the MODWT, see Percival and Walden (2006), Crowley (2007) and Anderson (2008).

decomposition of the data into short-run and long-run variations is linear whereby, $\Delta X_{jt} = \Delta X_{SRjt} + \Delta X_{LRjt}$ and $\Delta Z_{jt} = \Delta Z_{SRjt} + \Delta Z_{LRjt}$. We model the first difference to make the data stationary and avoid spurious regressions without affecting the ability to identify respective time horizons. In fact, in small samples, the use of first differenced data and band spectrum regression may yield more reliable parameter estimates than cointegration techniques (Andersson, 2011).

We estimate two main model specifications: In Model 1, all variables are included independently. In Model 2 we also consider interaction effects between capital growth and growth in the share of private employment, capital growth with growth in the share of manufacturing capital, and capital growth with growth in the share of service sector production. Given that we expect capital growth to be the main driver of scale, we include these interaction variables to test if any change in ownership or industrial composition has an effect on the energy intensity or if emission is only affected by these variables if they are linked to changes in the capital composition.

Provincial level data for energy prices is not available for the entire observation period, which forces us to rely on national level energy prices. This implies that we cannot include fixed time effects and price levels in the same model specification. We therefore estimate two specifications of Models 1 and 2. In the first set of models (Models 1a and 2a), we include all explanatory variables but only introduce fixed provincial effects. In the second set of models (Models 1b and 2b), we exclude energy prices, which allows us to include both fixed provincial effects and fixed time effects. In these models the effect of changes in national energy prices are captured by the fixed time effects.

Data Sources and Descriptive Statistics

Data is collected from five sources: China Data Online[29], China Energy Databook (2013)[30], China Statistical Yearbook, Zhao and Burnett (2014), and Wu (2009). A detailed description of the data and the respective data sources is available in Appendix B.

Emissions of CO_2 have grown on average, by 6.1%, but yearly growth is relatively volatile, with fluctuations of +/-18% p.a. Most of these fluctuations are due to short-term causes (see Table 1). The short-term standard deviation in emissions

[29] http://chinadataonline.org/.

[30] https://china.lbl.gov/.

is 12.1 compared with the long-run standard deviation of 4.4.[31] Growth in the share of private employment is 18.4% per year on average, with almost equal short-term and long-term volatility of 11.6 and 11.8, respectively. Capital stock and freight transport have, on average, grown in excess of 10% per year, while employment growth, growth in the share of manufacturing, and growth in the share of service production has been less than 1.5% per year. Both real coal prices and real oil prices increased during the sample period.

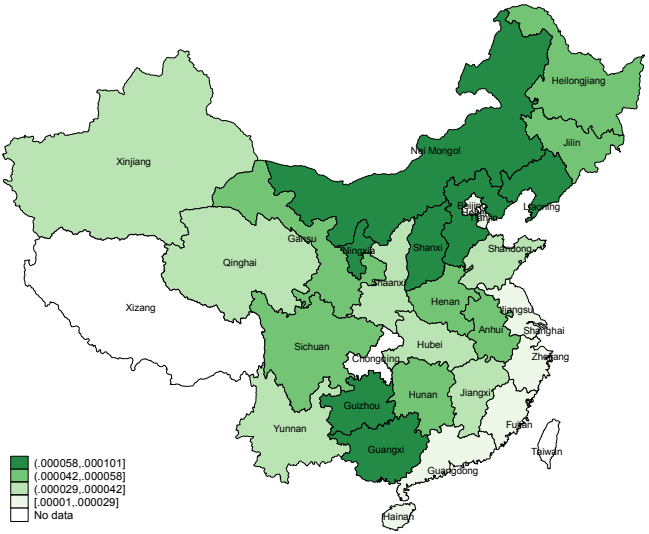
Table 1: Descriptive statistics: Average percentage change 1992–2010

	Average	Short-run Std.Dev.	Long-run Std.Dev.
CO_2	6.1	12.1	4.4
Labor	1.4	3.5	1.4
Capital	11.2	0.4	7.9
TFP	4.6	1.1	1.5
Manufacturing	0.8	1.9	1.8
Service	0.8	1.9	1.8
Private Employment	18.4	11.6	11.8
Urbanization	0.4	4.3	2.3
PKM	7.4	5.6	2.7
TKM	10.8	15.6	7.9
Coal	4.2	2.8	1.7
Oil	8.3	6.8	2.2

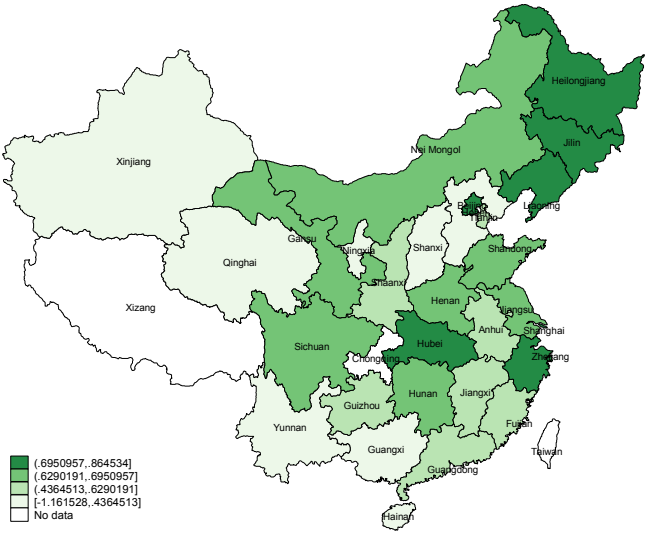
Note. The percentage changes are calculated as $x_t = ln(X_t) - ln(X_{t-1})$.

At the provincial level, CO_2 emissions per unit of capital (CO_2/capital intensity) are lowest along the east coast and higher in the northern and western provinces (see Panel A in Figure 1). The five provinces with the highest emissions emit 3.75 times as much CO_2 per unit of capital as the five least polluting provinces. The intensity has, on average, been reduced by 52% during the sample period and the reduction is generally higher in the Eastern provinces compared with the Western and Northern provinces (see Panel B). The private employment share follows a similar, but inverse pattern, as the CO_2/capital intensity. The private employment share is higher along the east coast, and this part of the country has also had among the largest increases in the share of private employment (see Figure 2).

[31] The total volatility is obtained by summing the short-run and the long-run volatility.

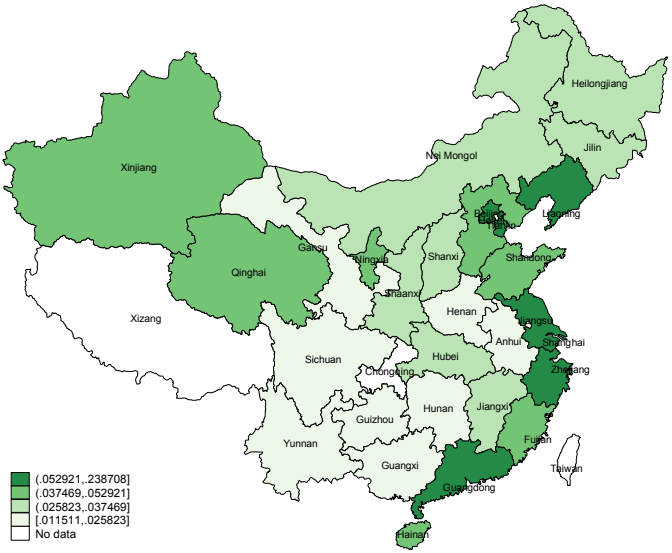


Panel A: Average CO_2/capital intensity

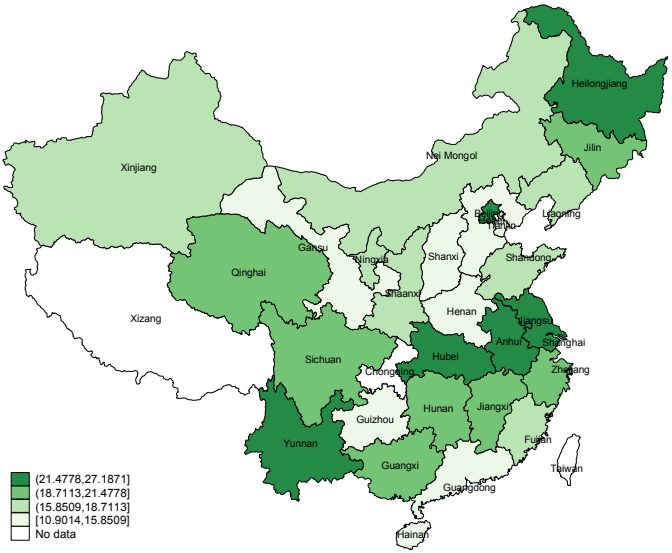


Panel B: Percentage change in CO_2/capital intensity

Figure 1.CO_2/capital intensity 1992–2012
Note: A darker (lighter) shade illustrates higher (lower) CO_2 emissions per GDP unit in panel A and a greater (smaller) reduction in CO_2 emissions per GDP unit in panel B.



Panel A: Average private employment share



Panel B: Average percentage change in the employment share.

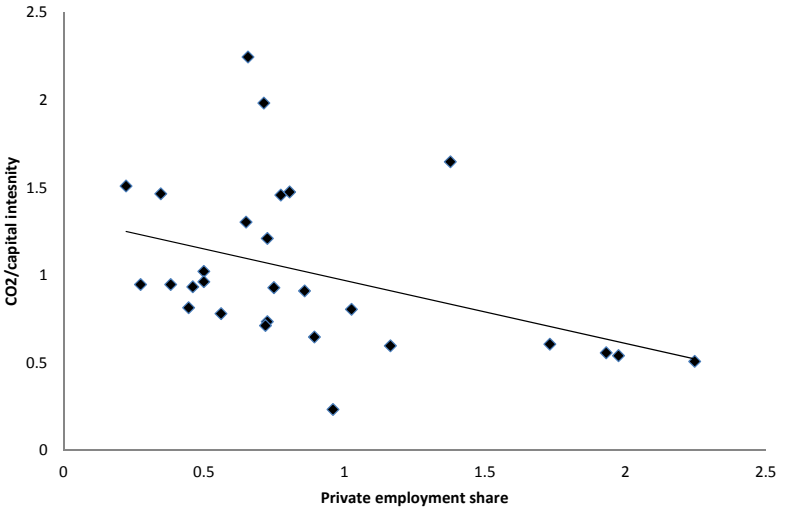
Figure 2. Private employment share 1992–2012

The link between the CO_2/capital intensity and the share of private employment is illustrated in Figure 3, which compares the relationship between the levels of intensity and employment (Panel A), as well as the change in the two variables (Panel B). Evidently, a higher share of private sector employment is associated with a lower CO_2/capital intensity. This linear relationship is even more pronounced when changes in the share of private enterprise employment are plotted against the change in the CO_2/capital intensity. Rapid growth of private sector employment is clearly correlated with a rapid decline in the CO_2/capital intensity.

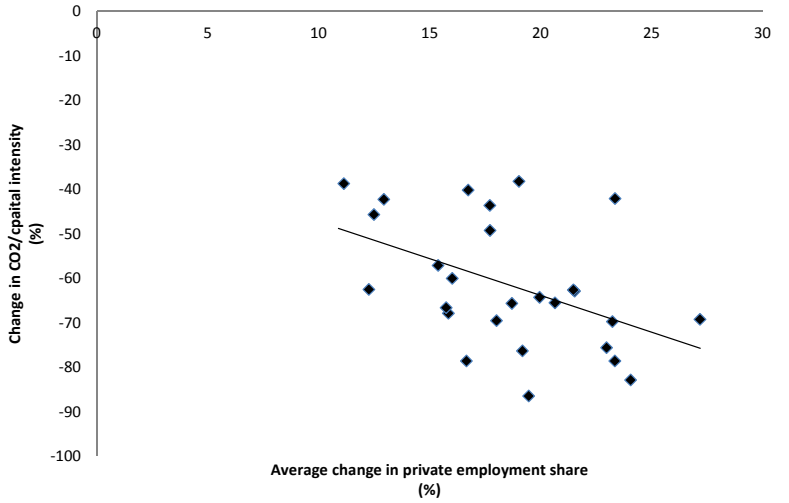
One potential explanation for the negative correlation between private firms and CO_2 emissions is that the private sector is more involved in light industries with lower emissions compared with the state-owned sector. This is not the case, however, as Table 2 reveals. This Table illustrates emissions from the manufacturing industries as well as the relative distribution of private and state-owned net fixed investments in each sector.[32] The two most polluting industries are the chemical (row 7) and metal industries (row 9), both in terms of total emissions (column 1) and emissions per unit of net fixed assets (column 3). Both private and state-owned firms have invested a relatively large capital share in these two sectors. Of the total private mining and manufacturing capital, 24% is invested in metal industries and 10% is invested in chemical industries. The corresponding investment shares for state-owned firms are 27% and 11%, respectively. There are some differences in the investment shares for the remaining industries, but none of these industries are major polluting industries and therefore not consequential for our results.

To summarize, Figure 3 and Table 2 offer some initial support for our claim that private firms are less polluting than state-owned firms and that these differences are not due to structural differences in firm activities.

[32] Similar data is not available for the service sector. Despite this, the manufacturing sectors emit 4.5 times more than the service sector, thus any differences between private and state-owned investments in the service sector are unlikely to have any major impacts on the results.



Panel A: CO_2 emissions per capital unit and private employment share



Panel B: Percentage change in CO_2/capital intensity and private employment share

Figure 3. CO_2/capital intensity and private employment share.
Note: The average *CO_2/capital* intensity and the average private employment share in Panel A have been normalized to 1.

Table 2:
CO_2 emissions and net fixed private and state-owned assets in the mining and manufacturing sector in 2009

	CO_2 emissions (kilotones)	Net fixed assets (100 million yuan)	CO_2 / net fixed assets	Distribution of private net fixed assets	Distribution of SOE net fixed assets
	(1)	(2)	(3)	(4)	(5)
(1) Mining and quarrying	195 472	19 513	10.0	6.2%	30.6%
(2) Food, beverages, and tobacco	70 816	5 907	12.0	10.5%	3.6%
(3)Textile, textile products, leather, and footwear	53 266	4 310	12.4	10.8%	0.6%
(4) Wood and products of wood and cork	12 007	886	13.6	2.2%	0.1%
(5) Pulp, paper, printing, and publishing	52 004	2 350	22.1	3.9%	1.6%
(6) Coke, refined petroleum, and nuclear fuel	100 868	5 181	19.5	2.3%	7.7%
(7) Chemicals and chemical products	269 228	9 761	27.6	10.4%	10.6%
(8) Rubber and plastics	23 432	1 883	12.4	4.2%	0.6%
(9) Other non-metallic mineral, basic metals, and fabricated metal	1 340 739	24 451	54.6	24.1%	27.9%
(10) Machinery, electrical, and optical equipment	58 147	11 947	4.9	20.4%	7.9%
(11) Transport equipment	25 382	6 747	3.8	4.8%	8.8%
Total	2 201 360	93 025	23.7	100%	100%

Regression Results and Policy Conclusions

Estimation results are presented in Table 3.[33] As expected, there is no significant difference between the results including real energy prices but no time fixed effects (Models 1a and 2a) and those results excluding real energy prices and including fixed time effects (Models 1b and 2b). According to the information criterion, Model b has slightly better statistical properties compared with Model a, but the differences in the information criterion are small.

Overall, each respective model's explanatory power, as estimated by the adjusted R^2, is relatively high for the long-run, between 0.8 and 0.9, but more modest for the short-run, approximately 0.1. The lower explanatory power for the short-run model indicates that fluctuations in short-run emissions are due to other non-economic factors, for example, an unusually cold winter, whereas economic factors play a key role in determining emission levels over the long term. These results indicate that emissions growth can fluctuate for periods of up to a five-year, and periodically depart from expectations purely based on economic growth. However, such short-term variations in emissions are to be expected (see Table 1) and can even lead to relatively large temporary deviations from the trajectory expected by economic trends.

[33] Short-run TFP has been excluded from the model due to multicollinearity.

Table 3
Regression results

	Model 1a		Model 1b		Model 2a		Model 2b	
	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
$Labor_{jt}$	0.03	0.34	0.13	0.18	0.04	0.96	0.14	0.78
	(0.20)	(0.34)	(0.16)	(0.36)	(0.20)	(0.61)	(0.16)	(0.65)
$Capital_{jt}$	1.40*	0.65***	0.83	0.62***	0.39	1.09***	0.13	1.00***
	(0.75)	(0.21)	(1.23)	(0.21)	(0.93)	(0.35)	(1.26)	(0.37)
TFP_{jt}		0.48		0.46		0.96*		0.84*
		(0.48)		(0.45)		(0.46)		(0.43)
$Manuf_{jt}$	-1.4**	-0.66	-1.36*	-0.67	-0.34**	-0.95	-1.36*	-1.12
	(0.64)	(0.43)	(0.75)	(0.45)	(0.67)	(1.28)	(0.77)	(1.28)
$Service_{jt}$	-1.4**	-1.18***	-1.63***	-1.12***	-1.45***	-0.97***	-1.69***	-0.67***
	(0.056)	(0.41)	(0.56)	(0.42)	(0.51)	(0.21)	(0.50)	(0.20)
PKM_{jt}	-0.19*	-0.40**	-0.07	-0.39*	-0.17	-0.31*	-0.06	-0.33*
	(0.12)	(0.20)	(0.13)	(0.20)	(0.11)	(0.16)	(0.11)	(0.17)
TKM_{jt}	-0.03	0.07	-0.03	0.06	-0.03	0.04	-0.03	0.04
	(0.04)	(0.07)	(0.05)	(0.07)	(0.04)	(0.05)	(0.05)	(0.05)
$Urbanization_{jt}$	0.41*	-0.01	0.23	-0.11	0.42*	0.16	0.22	0.09
	(0.22)	(0.25)	(0.20)	(0.26)	(0.21)	(0.28)	(0.19)	(0.31)
$Private_{jt}$	0.04	-0.22***	-0.02	-0.17**	-0.04	0.15	-0.01	0.17
	(0.06)	(0.04)	(0.05)	(0.08)	(0.06)	(0.28)	(0.05)	(0.25)
$Private_{jt} \times Capital_{jt}$					0.18***	-0.03***	0.18**	-0.03***
					(0.07)	(0.01)	(0.06)	(0.01)
$Manuf_{jt} \times Capital_{jt}$					0.19	0.09	0.54	0.10
					(0.78)	(0.13)	(0.89)	(0.13)
$Service_{jt} \times Capital_{jt}$					0.28	0.50	0.37	0.48
					(0.58)	(0.63)	(0.84)	(0.35)
$Coal_{jt-5}$	0.17	-1.35***			0.31	-1.60***		
	(0.26)	(0.33)			(0.26)	(0.31)		
Oil_{jt-5}	0.04	-0.58*			-0.02	-0.30		
	(0.12)	(0.32)			(0.12)	(0.32)		
Fixed province	Yes		Yes		Yes		Yes	
Fixed time	No		Yes		No		Yes	
Adjusted R^2	0.04	0.827	0.090	0.789	0.05	0.812	0.089	0.903
BIC	5.767		5.663		5.721		5.806	

Note: (a) Standard errors are estimated using Arrelano's (1987) robust standard errors. (b) ***, **, * denote statistically significant at the 1%, 5%, and 10% level, respectively. (c) TFP is excluded from the short-run model due to multicolinearity.

Considering Model 1, we find no significant short-run effect of ownership on emissions. But, we do find a significant and negative effect for the long-run: the estimated long-run elasticity is -0.17 for Model 1a and -0.22 for Model 1b. On average, the share of private sector employment has grown by 18.4% per year, which indicates that private sector growth has reduced the annual growth rate in emissions in the range of 3 and 4 percentage points.

The main driver of emissions growth (scale effect) in the long-run is capital accumulation, whereas employment growth remains insignificant. The long-run CO_2/capital elasticity is 0.6, which translates into an average 7% increase of emissions annually due to capital growth. Total Factor Productivity (TFP) growth has no significant effect on the energy intensity, a result that is in line with China's growth strategy emphasizing capital accumulation (Andersson, Edgerton, & Opper, 2013): capital growth is close to 11%. Notwithstanding, with the size of the capital stock/GDP ratio reaching high levels even in comparison with international standards (Penn World Tables, 2015) capital growth is likely to slow down in the future. A lower capital growth rate would also imply a lower rate of emissions growth.

For the remaining control variables, we confirm that a larger service sector and more private transport are associated with lower emissions in the long-run. The combined effect, however, is insufficient to stop further emissions growth. Real energy prices also contribute to slower emissions growth. Especially the coal price, with an estimated elasticity of -1.35, incentivizes producers to reduce energy consumption. However, producers do not respond to short-term fluctuations but accommodate them only as a response to stable price increases over longer periods of time.

Model 2 traces the causal channel through which ownership affects emission outcomes. For the short-run, we find a positive relationship between emissions and the interaction variable between capital growth and growth in private sector employment. For the long-run we find a significant negative effect. From these results we can draw two main conclusions. First, the general ownership effect identified in Model 1 disappears. Instead, private ownership affects emissions growth through ownership-specific differences in capital stock investments. Second, these results also show that the private sector is more receptive to changes in the market than non-private firms. In the short-run, private firm production responds to temporary changes in demand in line with changing market conditions, which in turn causes a positive correlation with emissions. In the long-run, competitive pressure forces private firms to make efficient use of their capital and invest more in energy-efficient technologies than non-private firms, which in

turn causes a negative long-run correlation with emissions. To summarize, competitive pressure forces private firms to limit their carbon footprint.

In Model 2, the estimated CO_2/capital elasticity increases from approximately 0.65 to 1.09 compared with Model 1. Given that we control for private sector capital using the interaction variable, the estimated elasticity applies to non-private enterprises. A one-unit increase in non-private owned capital increases emissions by 1% *ceteris paribus*. To illustrate the importance of the private sector we calculate the average CO_2/capital elasticity for each province based on the regional share of private and non-private firms. Figure 4 illustrates our results, with an average elasticity of 0.71 and provincial averages ranging from a minimum of 0.48 (Jiangsu and Zhejiang) to a maximum of 0.94 (Hainan). Along the east coast, the center of private firm production, the estimates are usually below 0.65, while corresponding elasticities of inland provinces typically exceed 0.75. While these differences in the elasticity may appear small, the cumulative effects over time become substantial due to the country's rapidly expanding capital stock. As a thought experiment, we compare actual CO_2 emissions growth with a hypothetical growth rate that would have been accomplished based on state-owned production only. For the average province, this suggests annual savings in CO_2 emissions growth of 3.4 percentage points. Over a period of 20 years, realized emissions are approximately 35% to 40% lower than they would have been in an economy absent private firm production.

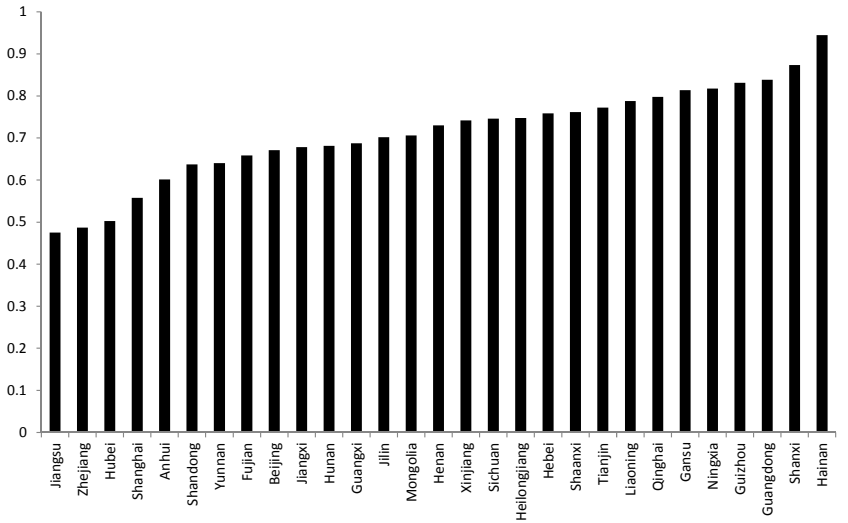


Figure 4. Estimated CO_2/capital elasticity for the respective provinces.

Our results offer the basis for some policy implications. Most importantly, our findings suggest that China's continuing economic growth does not necessarily imply an ever-growing carbon footprint. On the contrary, reforms that emphasize increasing marketization and privatization are likely to also limit emissions growth. This may involve further hardening of budget constraints of state-owned enterprises to increase market orientation and efficient resource use, but may also imply a continuing reduction of state-owned shares in public firms. In parallel, bureaucratic reforms need to ensure equal treatment of firms independent of ownership. Indication of greater leeway of law enforcement and scarce inspection efforts of state-owned firms compared with private firms are likely to have a decisive impact on the management's approach to energy efficiency. Our results show that emissions growth would be substantially smaller if the efficiency gap was closed between private and non-private firms. For example, if the CO_2/capital elasticity throughout China was as low as in Zhejiang province, the country's leader in terms of private firm production, the average annual growth rate in emissions due to capital accumulation would be 2.5 percentage points lower every year.

Although continued economic reforms facilitating closure of the efficiency gap between private and non-private enterprises would have a substantial effect on the future trajectory of emissions, it is not enough to stop emissions from growing. Our results, however, also point toward additional policies that will reduce emissions. For example, producers respond fairly sensitively to energy prices. Higher carbon prices, for instance, would lead to greater energy efficiency throughout the Chinese economy. A long-term increase in the real coal price of 1% would decrease energy intensity by 1.35%. Given the currently low level of—partly subsidized—energy prices (Lin & Jiang, 2011), market liberalization of the energy market would substantially reduce the country's environmental costs associated with CO_2 emissions.

In addition, China's continuing structural change is likely to contain future emissions growth. Two transmission channels are important: First, given the relatively lower energy intensity, the expansion of a modern service economy will also bring about a slowdown in emissions growth. Second, continued restructuring of the economy and technological updating of production clusters, in our models captured by private transport, will also reduce the future growth rate in CO_2 emissions by reducing the energy intensity.

A back-of-the envelope calculation highlights our point. Assume capital continues to grow by 7.5% per year (i.e., by the same rate as the official GDP growth target), and assume further that the efficiency gap between private and non-private production is reduced such that all provinces reach the same CO_2/capital intensity

as Zhejiang province, then annual emissions growth will reach 3.6% due to the scale effect. Further assume that policymakers introduce a real long-term increase of the coal price by 2% above inflation, then emissions growth would be reduced to 0.9% per year. Finally, with continued structural transformation, the growth rate could be further reduced and potentially even turn negative.

It is important to note that these results are based on our long-run estimations because short-term variations in emissions are only, to a small degree, caused by economic activity. Policies attempting to reduce emissions should therefore consistently focus on the long-run and abstract from short-term volatility in emissions. Moreover, to avoid disrupting the economic process, any system aimed at reducing emission, such as an Emissions Trading System (ETS) currently planned to be introduced in China (Lo, 2012), must be designed to accommodate for these short-term fluctuations (with a standard deviation of 12.1) to avoid both negative economic consequences (see e.g., Andersson & Karpestam, 2011, 2013) and a disturbance of the price signal.

Conclusion

China has emerged as the world's top polluter of greenhouse gases. While China's political leadership is well aware of the costs associated with accumulating environmental damage and already facing societal discontent (Knight, 2014), there is still great skepticism regarding how the commitment and enforcement of tighter environmental laws would affect the country's growth trajectory. Our study shows that China's ongoing reforms and continuing capitalist transformation need not be at odds with environmental goals. To the contrary, there is substantial unexploited opportunity to limit CO_2 emissions without sacrificing ambitious growth targets, but it will require a change of policies.

Our focus was on the impact of ongoing structural ownership changes of the economy and associated regional pollution levels. Our results show that private firms are more efficient than non-private firms, which translates into measurable effects at the provincial level. The inherently greater market and profit orientation of private firms forces managers to look for efficient production technologies and to operate the available capital stock with minimal resource waste. This is clear evidence of the beneficial second-order effects of free markets, which limit wasteful production through competitive pressure. By contrast, deviation from the market mechanism—either through subsidized state-ownership or through controlled energy prices—reduces competitive pressure and leads to suboptimal production in terms of energy efficiency.

These findings have broader implications because they suggest that only the continuing modernization and transformation of China's economy into a full-fledged market economy will be able to decrease pollution levels to the international standards of industrialized economies. Modernization, not a slowdown in ongoing reforms, needs to be the future path for development of the Chinese economy. Clearly, it is a myth to assume that the environment cannot digest a growing China. Quite to the contrary, the environment cannot digest a stagnating China because this would imply freezing current inefficiencies that stem from unfinished ownership and market reforms.

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Appendix

Appendix A: Total Factor Productivity Estimation

Total factor productivity is estimated using a Cobb-Douglas production function assuming constant returns to scale:

$$Y_{it} = A_{it} L_{it}^{1-\beta} K_{it}^{\beta}, \qquad \text{(A1)}$$

where Y_{it} is real GDP for province *i* at time point *t*, A_{it} is technology, L is employment, and K is real capital. Dividing by A1 by K, taking the log and first difference, and distinguishing between short and long-run effects provides the following regression model:

$$\Delta y_{it} = \alpha_{it} + \beta_{SR} l_{it}^{SR} + \beta_{LR} l_{it}^{LR} + f_t + e_{it}, \quad \text{(A2)}$$

where $y = log\left(\frac{Y}{K}\right)$ $l = log\left(\frac{L}{K}\right)$, and β_{SR} and β_{LR} are the short-run and long-run labor elasticities, respectively. By estimating A2, we obtain estimates of the labor elasticities from which we can estimate TFP as the Solow residual:

$$\Delta\widehat{TFP}_{it} = \Delta y_{it} - \hat{\alpha}_{it} + \hat{\beta}_{LR} l_{it}^{LR} + \hat{\beta}_{SR} l_{it}^{SR}. \quad \text{(A3)}$$

Estimates of the parameters are given in Table A2.1. In the short-run, all variations in output linked to capital and labor are due to variations in labor. This result is expected because it takes time for firms to adjust the capital stock, and a temporary variation in demand is more likely to be met by a change in employment rather than a change in the capital stock. Over the long term, however, labor elasticity is 0.55 and capital elasticity is 0.45.

Table A2.1
Regression results from growth regression

Variable	Parameter estimate
ι_{it}^{SR}	1.17***
	(0.03)
ι_{it}^{LR}	0.48***
	(0.05)
Short –run Adjusted R^2	0.12
Long run Adjusted R^2	0.80

Appendix B: Variable Description and Data Sources

Variable name	Description	Data source
CO_2	Provincial CO_2 emissions constructed using the IPCC guidelines	Zhao and Burnett (2014)
Real GDP	Real GDP in 2009 prices	China Data Online
GDP deflator	GDP deflator	China Data Online
Employment	Number of persons employed	China Data Online
Private employment	Number of persons employed by private enterprises	China Statistical Yearbook, various years, Blue book of China's private enterprises
Capital	Real capital stock in 1978 prices	Wu (2009), and own estimations using investment data from China Data Online
Manufacturing	Manufacturing sector (secondary sector) share of GDP	China Data Online
Service	Service sector (tertiary sector) share of GDP	China Data Online
PKM	Total number of personal km	China Energy Databook, version 8.0, 2013
TKM	Total number of ton-km	China Energy Databook, version 8.0, 2013
Coal	Real coil price deflated using the provincial GDP deflator	China Energy Databook, version 8.0, 2013
Oil	Real oil prices deflated using the provincial GDP deflator	China Energy Databook, version 8.0, 2013

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