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REBELLIONS, TECHNICAL CHANGE, AND THE EARLY DEVELOPMENT OF POLITICAL INSTITUTIONS IN LATIN AMERICA*

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Abstract

This paper documents that differences in the early development of institutions in Latin America that led to the consolidation of oligarchic republics in the first decades of the twentieth century, explain the subsequent economic performance in the region. It develops a model with the aim of identifying the factors behind this institutional development. The model predicts that, due to asymmetric and uncertain costs, the risk of conflict leads to political institutions that poorly restrict the powers of chief executives. Since elite members cannot commit to a strong response to this type of conflicts, which in the model arise due to labor coercion, they empower the executive so he may react forcefully to conflicts. Then, in countries with a larger fraction of labor to be coerced, lower executive constraints are imposed. On the other hand, technical advance leads to higher constraints as expropriation becomes more costly. But this does not happen in countries with a large fraction of coerced labor because higher returns raise labor demand and hence larger production comes with more risk of conflict. Finally, the paper conducts an econometric exercise focusing in two factors, namely the risk of uprisings by natives and slaves, which historians have identified as an important risk for the Latin American elites at that time, and the first era of globalization that led to better economic conditions throughout the region. The results show that the dynamics of the institutional gap can be explained to a large extent by the risk of rebellion, globalization, and their interaction.

Resumen

Este trabajo muestra que las diferencias en el desarrollo temprano de las instituciones de América Latina que llevaron a la consolidación de las repúblicas oligárquicas a comienzos del siglo XX, explican el desempeño económico posterior de la región. Desarrollamos un modelo que busca identificar los factores que hay tras este desarrollo institucional. El modelo predice que, debido a costos asimétricos e inciertos, el riesgo de conflicto genera instituciones políticas incapaces de restringir las facultades del poder ejecutivo. Como la élite no puede comprometerse a responder con fuerza a este tipo de conflictos, que en el modelo surgen de la coerción laboral, faculta al ejecutivo para que sea éste quien reaccione enérgicamente frente a los conflictos. Así, en los países con mayor proporción de trabajadores dominados, se imponen menores restricciones a los ejecutivos. Por otro lado, los avances técnicos resultan en mayores restricciones ya que se hace más costoso expropiar. Pero esto no ocurre en los países con una gran proporción de mano de obra forzada, ya que los mayores retornos aumentan la demanda laboral y por lo tanto, la mayor producción se asocia a un mayor riesgo de conflicto. Para terminar, realizamos un ejercicio econométrico centrado en dos factores: el riesgo de levantamiento de indígenas y esclavos—que los historiadores han identificado como un riesgo importante para las élites latinoamericanas de la época— y la primera era de la globalización, que mejoró las condiciones económicas a través de la región. Los resultados muestran que la dinámica de la brecha institucional se puede explicar en gran medida por el riesgo de rebelión, la globalización y la interacción entre ambas.

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1 Introduction

After almost 200 years since achieving its independence, the economic performance of Latin America has been disappointing. This resource-rich region has been unable to catch-up with the developed world, and has even fallen behind other initially poorer former colonies. More strikingly, despite a common colonial experience, Latin America has the highest dispersion in GDP per capita among world developing regions.[1]

This weak economic performance has been the focus of a large body of research, mostly narrative, where common features, particularly the colonial heritage manifested in inefficient institutions and geographic features, which have contributed to disparities in wealth and significant racial diversity, have been identified as crucial factors behind Latin America's relative underdevelopment (Engerman and Sokoloff, 1997, 2002; North et al., 2000; Lange et al., 2006). The literature on the colonial determinants of development, which empirically studies the causes and long-run consequences for the introduction of certain legal and political institutions by colonial powers around the world, can also shed some light on the causes of economic backwardness in Latin America (La Porta et al., 1997, 1998; Acemoglu et al., 2001, 2002). However, strong similarities across Latin American countries in terms of fundamental economic growth determinants and post-independence institutional and economic development, hinder comparative studies within the region about the long-run causes of underdevelopment. Additionally, the lack of theoretical models that can guide quantitative analysis make it difficult to apply the findings in the literature to the particular case of Latin America.

Others have focused on more recent features to explain the current economic problems in Latin America (see e.g. Calderón et al., 2005; Solimano and Soto, 2006). Among these it has been widely suggested that inward-looking policies and macroeconomic instability were fundamental in obstructing the development process in the region. Although they give valuable policy recommendations, these studies identify *proximate*, instead of *deep* causes of economic growth, and hence they can not be used to explain why some countries followed certain policies that were not conductive to long-run development.

This paper pursues a dynamic comparative analysis among Latin American economies of *deep* determinants of long-run development to explain current differences in economic outcomes within the region. In order to do this it develops a theoretical model, which guides an econometric exercise, with the aim of identifying the factors leading to differences in institutional development from independence to the eve of the first World War.

Political institutions in Latin America have transited through distinct stages since independence (Drake, 2009; Hartlyn and Valenzuela, 1998). During the first decades instability, conflict,

[1] The definition of world developing regions and the source of GDP per capita is the World Development Indicators. Regions, as defined by the World Bank, are South Asia, Europe & Central Asia, Middle East & North Africa, East Asia & Pacific, Sub-Saharan Africa, and Latin America & Caribbean. We adjust the last group to include only Latin American countries (see footnote 10), although in both cases the standard deviation of GDP per capita is the highest.

and despotism abounded throughout the region, until the 1870s, when many countries restored some order through the establishment of more stable political institutions. This was the period of oligarchic republicanism, or protected democracy, featuring robust civilian and constitutional regimes, and open, although not fully fair, electoral competition, but with most of the population excluded from electoral participation. The Great Depression of the 1930s marked the end of that era and the starting point for the development of popular democracy, a process interrupted in the 1970s but recommenced again around 1980.

This paper focuses on the first period of institutional development, which started some decades after independence and ended with the consolidation of oligarchic republics in the first decades of the twentieth century. These regimes were "largely comparable to the restrictive representative regimes in Europe of the same period", and even though they were replaced by authoritarian regimes, these disruptions did not represent serious breaks with the past in most of the countries (Hartlyn and Valenzuela, 1998, p.3 and 42). Within oligarchic regimes there were important differences; while rule was exercised by reasonably republican regimes in some countries, it was done by fundamentally authoritarian ones in others, and they either led to gradual incorporation of excluded groups, or to intensified oppression (Drake, 2009, p.129). It is a period identified by some political scientists as a crucial period of transition, with a profound impact on subsequent patterns of change in Latin America (Collier and Collier, 1991; Mahoney, 2001). Coatsworth (2005) considers this period as key for understanding the link between colonial development and modern economic performance in the region.

This paper presents evidence to support the claim that fundamental differences within these political regimes did exist, primarily in the extent of influence different members of the elite had in the decision making process, i.e. in the constraints imposed on executives, or checks and balances. It further shows that these differences are crucial in understanding the subsequent economic development within the region, not only due to their persistence and subsequent effect on more recent institutional features, but also because of their influence on additional factors not accounted for by them. In particular we show that the institutional gap strongly explains differences in educational enrollment during subsequent decades.

The theoretical analysis focuses on the determinants of political institutions to explain the divergence that started in the second half of the nineteenth century in Latin America. In the model there is an elite that faces a risk of uprisings by external groups. The benefit of fighting an insurgency is not internalized equally by the elite's members, and hence there is disagreement in terms of the size of an eventual response. But disagreement is lower ex-ante because who will be affected by future uprisings is uncertain. Therefore the expected benefits of fighting are shared more evenly among members of the elite. Thus, elite members would like to commit in advance to a larger military response to conflicts than the one they are willing to sustain once a conflict has erupted. One way of solving this is by empowering the executive so he may react forcefully

to conflicts, despite the opposition of some fraction of the elite. However doing this raises the likelihood of expropriation, as the executive is able to tax more freely. Elite members then face a trade-off: imposing fewer constraints on the executive reduces the expected costs from uprisings, but on the other hand it distorts investment incentives.[2] The main implication of the model follows; a higher likelihood of a civil conflict in the future incites the elite to impose fewer constraints on the executive.

The trade-off between military reactions to conflicts and the risk of expropriation is affected by technical change. Expropriation is particularly costly when returns to investment are high, and hence technological advance may lead to the imposition of more constraints on executive power. But on the other hand it raises the demand for coerced labor, which, in the model, drives rebellions. This last effect is stronger in countries where the availability of involuntary labor is larger. Therefore the second prediction of the model is that the response of institutions to technical change depends on the potential to exploit non elites. In countries where it is possible to coerce a larger fraction of the labor force the change in executive constraints due to an increase in productivity is smaller, and it can even be negative. This implies that, in this particular context, institutional variation rises with technology.

The early development of political institutions in Latin America constitutes a unique case to apply the model. This is not only because of its relevance for the subsequent economic development of the region, but also because it is possible to clearly identify two factors that can be associated with the determinants of political institutions according to the model. First, the risk of uprisings, which were closely related to the exploitation of natives and slaves, identified by historians as an important risk for the elites throughout the region (Katz, 1988; Coatsworth, 1988, 2008; Chevalier, 2005; Eakin, 2007; Williamson, 2009a; Rouquié, 2010).[3] Second, the first era of globalization, led by a worldwide transport revolution (North, 1958; Harley, 1988), that served to integrate the region with the global economy (Williamson, 2006). This development generated new economic opportunities for the economy as a whole, introducing dynamic incentives to develop less autocratic political institutions according to the model. But, also as argued by historians (Bauer, 1986; Coatsworth, 1988, 2005; Chevalier, 2005; Eakin, 2007; Sánchez et al., 2010), this process may have increased the risk of uprisings in countries with large indigenous and slave populations, generating the opposite incentives.

[2]This trade-off is clearly illustrated by Heise (2007) when referring to the position of Chilean elites on the Constitution of 1833, which strengthened executive power: *"Our aristocracy knew that in the context of an authoritarian regime it would have to confront the Executive, but at the same time it was convinced that a strong government was fundamental for achieving order, a basic condition to sustain its economic activities."* (Heise, 2007, p.47, author's translation).

[3]As we argue in Section 3, referring to historical studies, we focus on racial conflicts because they were relevant for the region and period analyzed, they fulfil the requirements imposed by the model, and it is relatively easy to measure their incidence. Additionally they were probably the main source of class conflicts, as socioeconomic differences in the region were defined mainly in terms of race.

The paper empirically tests these predictions and finds that the institutional gap in terms of executive constraints observed in the first decades of the twentieth century can be explained to a large extent by the availability of labor to be coerced, technical change in transportation, and their interaction. Countries prone to racial conflict due to a high fraction of the population comprised of natives and slaves, were the ones that showed fewer constraints on the executive on average between 1870 and 1910. Moreover it is shown that this was particularly the case in countries with geographic conditions preventing an efficient reaction to uprisings by the government. These results are robust to the inclusion of additional controls associated with alternative theories linking colonial experiences and long-run political and economic development, e.g. Engerman and Sokoloff (1997, 2002); Acemoglu et al. (2001, 2002).

In terms of institutional dynamics the evidence supports the hypothesis that integration was behind the reform of political institutions during the same period, as the largest changes occurred in countries that were relatively more favored by the transport revolution. More importantly, the estimated effect is conditional on our proxy for labor coercion. In line with the prediction of the model, this implies that the rise in the risk of riots provoked by the process of modernization, which only started long after independence, helped to widen the institutional gap across the region.

This paper is organized as follows. After reviewing the related literature the next section studies the long-run effects of the development of political institutions in Latin America during the nineteenth century, supporting the claim that explaining the causes for this process can illuminate the current debate on the development trap in the region. Section 3 presents the theoretical model and its implications for the post-independence period in Latin America are discussed and tested in section 4. The last section concludes.

Related Literature

This paper belongs to the literature on the determinants of institutional reform, particularly when conflict is considered as a fundamental cause (Tilly, 1992; Acemoglu and Robinson, 2000, 2006; Boix, 2003; North et al., 2009), and when Latin America is taken as the focus of the study (North et al., 2000; Munck, 2011). This literature has focused on the democratization process, and not on institutional developments within nondemocratic environments, as this paper does. Indeed one of the main theses in this literature is that conflicts, or the fear of conflicts, led to democratization or faster development of the state. This differs from the hypothesis explored in this paper as this literature considers large social uprisings or external conflicts, which threaten the survival of the elite as a whole, and not those that impose asymmetric and uncertain costs on the elites as this paper does.

Although the type of conflicts studied in this paper have been identified as a relevant danger for nineteenth century Latin American elites, they have not been identified explicitly as a determinant of political institutions in the region. Probably the most important exception is the emphasis

on rebellions by Coatsworth (1998) in his critical analysis of political economy theories linking Latin American underdevelopment to its colonial past, and in his own historical assessment of the causes of Latin American economic backwardness. Coatsworth argues that economies stagnated after independence because they inherited the manifold weaknesses of the colonial state, but now lacked the imperial deterrent to rebellion. This influenced the nature of post independence civil conflicts, whose duration and depth depended on how the power of elites was challenged from below. Civil conflicts and their constraints on growth were shorter where the contended issues centered on the spatial distribution of political power between provincial and central power, and longer where settler elites dominated large slave or indigenous populations. In the second case it was necessary a struggle to restore colonial stability, but also to avert a recurrence of destructive rebellion from below (Coatsworth, 1998, pp. 562-565).

After claiming that modern civil wars impose asymmetric and uncertain costs for the elites, Aguirre (2011) tests the implications of a simpler version of the model presented here in a sample of more than 80 countries.[4] Using geographic variables to identify causality, the results show that a higher likelihood of a civil war in the future reduces the constraints imposed on the executive during the first years after independence, particularly when only minor conflicts and irregular wars are considered. These results are in line with the model's theoretical prediction, since the costs of internal conflicts are more likely to be asymmetric and uncertain when the conflicts are small and wars are irregular. Aguirre (2011) also presents anecdotal evidence regarding the US constitution, characterized by a strong executive, which was importantly influenced by rebellions and the different experience of the states with executive power.

Regarding the effect of technical change in political institutions the main prediction of the model, that it increases institutional variation, depends on a specific feature of the environment. Technical progress needs to raise the risk of rebellions, otherwise it would have an unambiguously positive effect on institutions. The contingent nature of this relationship is similar to the one proposed by Brenner (1976) between demographic change and development in pre-industrial Europe. The same downward trend in population, interacting with different balances of class forces, led by 1500 to an almost totally free peasant population in the west, and its debasement to serfdom in the east. Acemoglu and Robinson (2012) also highlight the contingent nature of institutional development. In this paper we revisit previous historical studies to show that in the region and period under consideration technical change very likely raised the risk of rebellions, primarily due to the increasing demand for coerced labor and the intensification of land expropriation by elites.[5] Indeed this fact is common in other regions as well, particularly the least developed, as modernization has long been identified as a determinant of ethnic conflict (Horowitz, 1985).

[4] In Aguirre (2011) the model does not include technical change, endogenous investment, or endogenous rebellions.

[5] Consistent with the mechanisms of the model, Acemoglu and Wolitzky (2011) show theoretically that a rise in the price of output, equivalent to technical change in our environment, intensifies labor coercion, while Naidu and Yuchtman (2009) find evidence consistent with this in nineteenth century Britain.

A final related literature is the one that highlights property rights institutions to link colonial regimes with current economic development (Engerman and Sokoloff, 1997, 2002; Acemoglu et al., 2001, 2002). The common theme is that natural resource endowments and the exploitation of natives by Europeans generated deep inequalities and extractive institutions that were not designed to enforce property rights for a broad spectrum of the population. However, this paper deals with institutions regulating the relationship among members of the elite, and not between the elite and the rest of the population. In this context this paper stresses that colonial features not only generated a concentration of political power within societies, but also within the group holding the political power. This may have had dynamic consequences, such as reducing the political power of new members of the elite, or hindering the evolution of democratic institutions.[6]

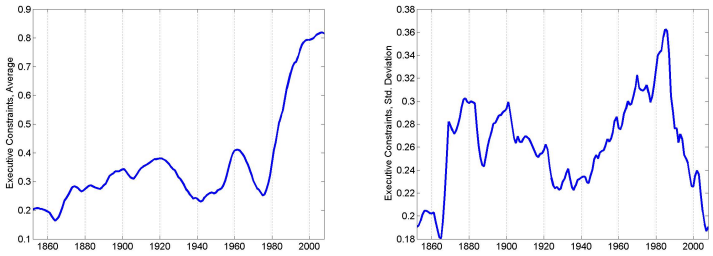
We see our paper as a complement to this literature on the colonial origins of development. Indeed its main empirical fact, i.e. that current development depends on colonial endowments and institutions, is consistent with the model.[7] But the mechanism we propose is new. And the theoretical model guides the empirical exercise in trying to conclude that the general results are indeed given by this proposed mechanism. In the empirical part we control for variables potentially capturing alternative mechanisms and explore interactions with variables associated with conflict in previous studies. Moreover, in line with the model's predictions, we study interactions with a proxy of technical change, which allows us to characterize the dynamics of institutional development. The results from this last exercise show that the effect of the risk of rebellions started long after independence, during what Coatsworth (2005) identifies as the period when colonial heritage started to influence development in the region.

2 The Long-Run Effects of Early Institutional Development

In this section we show that understanding the development of political institutions during the second half of the nineteen century is key in explaining the current development problems facing Latin America. After independence it took decades of civil discord before most countries could bring about enough order to construct functioning governments. Why some countries actually improved their institutions at that time, and why others kept the autocratic institutions built in the aftermath of post-independence conflicts, is the question we try to answer in the following sections of the paper. Here we show that these different paths existed, and that they have been crucial for understanding the differences in economic development leading to the large disparities

[6] Boix (2003) (p.210) discusses the different outcomes, particularly related to the risk of expropriation and internal political dynamics, of authoritarian regimes that differ in the extent of power concentration at the elite level. Olson (1993) argues that the spread of the franchise is an expected consequence of a movement to less autocratic polities.

[7] There is a growing empirical literature testing this hypothesis at a subnational level (Nunn, 2008; Dell, 2010; Summerhill, 2010; Acemoglu et al., 2012; Bruhn and Gallego, 2012). However it is not straightforward to link the findings to the model since it would rely on the existence of subnational institutions. Nunn (2008) also finds a relationship between slavery and development across countries, generated by institutions and not inequality.



Notes: 5 years moving average of average executive constraints (right panel) and its standard deviation (left panel) in Latin America (see footnote 10).

Figure 1: Executive Constraints, Latin America 1850-2010

in income per capita inside the region we observe today. Moreover, the evidence shows that these different paths were not related to contemporaneous differences in income per capita, lowering the incidence of endogeneity in the results.

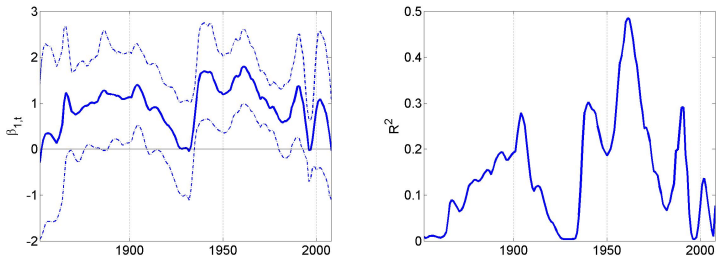
To characterize political institutions we use the index Constraints on the Executive, from the Polity IV database.[8] This variable explicitly measures how constrained the executive is in making arbitrary decisions, which is the institutional dimension we focus on in this paper. Good scores in this index are possible with large groups excluded from the political process (and vice versa).[9] In the case of Latin America we think this is the most relevant measure of political institutions for the period under consideration, where widespread voting restrictions led to no more than 15% of the population having voting rights, in elections that were far from being regular, free, and fair (Colomer, 2004; Hartlyn and Valenzuela, 1998).

Figure 1 shows average executive constraints (left panel) and its standard deviation (right panel) for the group of 20 Latin American countries since 1850.[10] We can distinguish three periods where an upward trend in the indicator was apparent, 1865-1920, 1950-1960, and 1975-2010. The first two episodes were almost completely reversed afterwards. Out of these three periods the first one, which is the focus of this paper, is the most persistent and very uneven within the region, as shown by the relatively high value of the standard deviation. The second period of increasing constraints is very short, while the last one is the most pronounced. In terms of standard deviation it seems that further disparities were related mainly to the reversal of the second upward trend around 1980.

[8]The source for all the variables used in the paper, and notes on their construction, are presented in Appendix A.

[9]For instance, South Africa under apartheid, and the US before the National Voting Rights Act of 1965, had the top-coded score, while France today does not.

[10]In this paper we define Latin America as composed by countries where languages derived from Latin are officially spoken (except Canada), i.e. all the nations in the Americas colonized by countries from continental Europe: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Rep., Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela. Cuba and Panama achieved their independence later and so they are included only from 1905 onwards. We do not include Canada and the US in order to illustrate that the results are not influenced by (very) different colonial pasts.



Notes: Regression results from estimating equation (1). In the left panel the dotted lines are 90% confidence intervals based on robust standard errors.

Figure 2: Historical Constraints on the Executive and Current GDP per capita, Regression Results

How important were the long-run development effects of the divergence in institutional development experienced in the nineteen century? To answer this question we estimate the following set of regressions,

$$y_{j,2008} = \beta_{0,t} + \beta_{1,t} XC_{j,t} + \beta_{2,t} XC_{j,indep} + \epsilon_{j,t} \tag{1}$$

where $y_{j,2008}$ is GDP per capita in 2008 in country j, $XC_{j,t}$ is the five years moving average of executive constraints in country j centered in period $t = 1850 : 2008$, $XC_{j,indep}$ is the same index but in the period after independence (to control for any colonial feature that may affect both institutional development and current income per capita), $\beta_{0,t}$, $\beta_{1,t}$ and $\beta_{2,t}$ are time-varying parameters to be estimated, and $\epsilon_{j,t}$ is an error term. In the left panel of Figure 2 we plot $\beta_{1,t}$, which captures the effect of additional executive constraints in period $t = 1850 : 2008$ on the level of GDP per capita in 2008 and its 10% confidence interval. We can see that this effect increased with the rise in average executive constraints during the first period identified in Figure 1 (1850-1920). Around 1890 it becomes significant and remains so until 1910, when it becomes close to zero for the next 20 years. In 1930 the coefficient increases again, coinciding with the first reversion depicted in Figure 1 around the same year. The effect remains very significant until 1960, when it starts to fall until becoming non-significant in the years after 1980. In the right panel of Figure 2 the R^2 of the regression is plotted. The first wave of institutional reform explains, at its peak around 1905, close to one fifth of the variance in GDP per capita today.[11]

It is likely that endogeneity issues are affecting the results. Since we consider institutional features in place almost a century before the realization of the dependent variable reverse causality is not a concern. But endogeneity may be relevant for the effect of early institutions if the estimated relationship is driven by a third factor explaining both GDP per capita and institutional quality. To see if this is the case we can check the correlation between early institutional development and

[11] From around 1930 to 1970 the regression explains a large fraction of the variance as well. It is worth noticing though that due to the high persistence in institutional quality, part of this may be explained by institutional differences originated in previous decades, making the comparison of the R^2 not very informative regarding the relative importance of different periods to explain current GDP per capita.

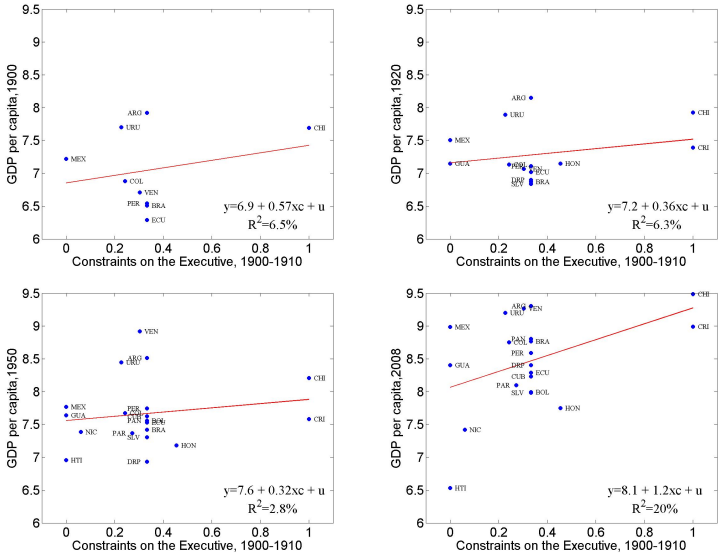


Figure 3: Constraints on the Executive 1900-1910, and GDP per capita 1900, 1920, 1950, and 2008

early income per capita. If there is no correlation, then it is more likely that causality is running from early political development to current GDP per capita, and hence studying the determinants of the former is of greater interest.

In Figure 3 we present the partial correlation between the 10 year average of executive constraints from 1900 to 1910 and GDP per capita in 1900, 1920, 1950 and 2008. We choose the period 1900-1910 because is the one showing the highest effect on current GDP per capita in Figure 2. This period roughly coincides with the consolidation of the longer period of institutional development we consider in the rest of the paper.[12] In the upper panels we can see that there is no contemporaneous correlation between these constraints and GDP per capita. An OLS regression shows that executive constraints explain only about 6% of the variance of income per capita at the beginning of the twentieth century, and the slope coefficient is not significant. In the lower left panel we can see that even in 1950, the first year for which we have data for all the countries, the relationship is unchanged. The significant relationship between early institutional development and current GDP per capita in Latin America, shown again in the lower right panel of Figure 3, but without controlling for initial constraints, materialized only during the last 60 years, favoring the claim that causality runs from institutional development to income.

[12]The first sustained rise in executive constraints ends in 1918 (Figure 1). We set 1910 as the final year because of data availability for the dynamic analysis in Section 3. In any case from 1910 to 1918 only Mexico and Haiti show changes in the indicator, due to foreign interruption and an anarchy period respectively, as defined in Marshall and Jaggers (2007). With this choice any effects from World War I are left aside. Although constraints in 1900-1910 may show low variability across countries, this does not affect the empirical results in Section 4 as the evolution of constraints for a longer period are considered.

Figure 3 raises the concern that the relationship between early political institutions and current GDP per capita, documented in Figure 2, may be driven by the small sample size and the consequent effect of outliers and influential observations on the results. Since we pursue a comparative analysis of Latin American countries we face this problem many times in the paper, although at the end the dynamic analysis allows us to exploit temporal variation and hence to effectively increase the number of observations. To address this issue we implement a bootstrap technique (Efron, 1979, 1982) to construct confidence intervals (CI) and thus assess the significance of the estimated parameters. This method achieves accurate estimates of the parameters' distributions in small samples, where the classical assumptions may not hold and when the influence of outliers is very likely, especially if these are located at high leverage points (Chernick, 2008).[13] In Appendix B we show that the slope of the regression line presented in the right panel of Figure 3 is still significant at the 95% confidence level using bootstrap CI.[14] Additionally it is shown that the evolution of constraints during the period we analyze is significant in explaining current GDP per capita, and GDP per capita in 1950 as well. This is important because understanding this evolution is the focus of the remaining sections.

It is not the aim of this paper to identify the exact mechanism connecting early institutions and current GDP per capita. However exploring this connection may make this relationship more evident, and hence the study of early institutions in Latin America of greater interest. The first possibility we explore is institutional persistence, a well known theoretical and empirical feature (see e.g. Acemoglu et al., 2005; Acemoglu and Robinson, 2008). The idea is that the institutional divergence occurred during the second half of the nineteenth century generated persistent differences even after the root causes disappeared, and these differences affected agents' incentives to innovate and accumulate factors of production, thereby affecting GDP per capita. In the left panel of Table 1 we present regression results to explore this hypothesis. Significance levels are based on bootstrap CI. In the first column we can see that more than half of the difference in executive constraints observed during 1900-1910 persisted to the next century. To see if this persistence is with respect to the differences generated during the period we analyze in the paper, in column (2) we control for average executive constraints from independence to 1870, roughly the year when the divergence started (see the left panel of Figure 1). The coefficient of interest is almost unchanged, implying

[13] An alternative method is to drop the outliers or to use dummy variables. This has several disadvantages in this context. First it is not straightforward to identify outliers. Second, the small sample problem becomes even worse. Nonetheless the relationship between GDP per capita in 2008 and executive constraints in 1900-1910 is still significant at the 90% confidence level when dropping Haiti from the sample (which shows the highest distance with respect to the regression line), at the 95% level when dropping both Haiti and Mexico (the first and second highest distance), and at the 90% level when dropping Haiti, Dominican Republic, and Cuba altogether (the three countries not considered in the empirical analysis in Section 3 for reasons to be explained there).

[14] When bootstrap CI are used in this paper they are based on the most general method in Efron and Tibshirani (1994), the bias-corrected and accelerated (BCa) CI. We bootstrap the vector of observations and draw 10,000 samples.

	Executive Constraints (1911 − 2010)			Δ *Enrollment (1900, 1950)*		
				Primary	*Secondary*	*All*
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Executive Constraints 1900-1910	0.47***	0.42**	0.35**	4.73**	0.51*	5.14**
	0.17	*0.16*	*0.15*	*1.37*	*0.14*	*1.44*
Executive Constraints Indep-1870		0.20				
		0.18				
Executive Constraints Indep-1900			0.26			
			0.21			
School Enrollment, 1900				−0.61**	−0.58	−0.57
				0.18	*0.25*	*0.26*
Constant	0.28***	0.28***	0.27***	6.32***	0.32	6.54*
	0.05	*0.05*	*0.05*	*1.14*	*0.10*	*1.27*
R^2	0.48	0.60	0.62	0.39	0.17	0.31
Countries	20	18	18	19	18	18

Notes: Robust standard errors in italics. Significance levels are based on bootstrap bias-corrected and accelerated CI: * means significant at 10%, ** significant at 5%, and *** significant at 1%.

Table 1: Executive Constraints in 1900-1910, Persistence and Education, Regression Results.

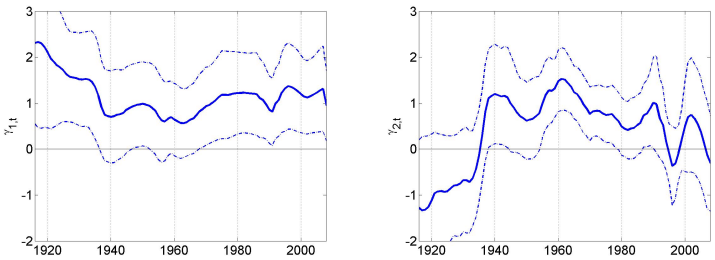
that what persisted were differences that originated after 1870. In column (3) we control for average constraints until 1900 with similar results. Although previous average constraints become more relevant, as expected, it is what happened at the end of the divergence process that persisted afterwards.

Is the effect on current GDP per capita through the institutions in place during the second half of the nineteen century only due to the effect on the subsequent path of institutional development? To answer this question we run the following rolling regression,

$$y_{j,2008} = \gamma_{0,t} + \gamma_{1,t} XC_{j,1905} + \gamma_{2,t} XC_{j,t} + \epsilon_{j,t} \tag{2}$$

where now $XC_{j,1905}$ is the moving average of executive constraints in country j centered in period 1905, and t goes from 1915 to 2008. Figure 4 shows the results. In the left panel $\gamma_{1,t}$ is plotted. We can see that the coefficient on executive constraints in 1905 remains significant even when controlling for future values of this variable, suggesting that the former influenced current GDP per capita through channels not fully captured by recent institutional developments. In the right panel of Figure 4 we plot $\gamma_{2,t}$. Executive constraints during the twentieth century are now significant only for the fifteen years from 1955 to 1970.[15]

[15]This contrasts with the period 1935-1980 when not controlling for $XC_{j,1905}$. This suggests that a fraction of the explanatory power of more contemporaneous institutions revealed in Figure 2 is due to the early development started in the second half of the nineteenth century.



Notes: Regression results from estimating equation (2). Dotted lines are 90% CI based on robust standard errors.

Figure 4: Constraints on the Executive in 1905 and Current GDP per capita, Regression Results

A potential mechanism different from persistence we explore quantitatively is human capital.[16] We hypothesize that the way power was shared within the elite shaped the provision of public goods, particularly public education. For instance the increase in executive constraints may have raised the political power of industrialists relative to landowners. This, in line with Galor et al. (2009), could have changed the political equilibrium towards more public education. It is possible as well that once power was shared among more diverse groups within the elite new groups were enfranchised thereafter (see e.g. Olson, 1993), and education was a public good highly desired by them (Acemoglu and Robinson, 2000). Additionally after World War I social inequalities together with industrialization generated larger social movements that started to push for more political inclusion (Hall, 1986; Collier and Collier, 1991).[17] The outcome of this process, either inclusion or repression, may have been influenced by the political institutions existent at the beginning of the process, and one of the most important ways of incorporation of new classes was public education.[18]

It follows that the institutional divergence should have been reflected in different patterns of school enrollment and human capital accumulation. Since human capital is an important proximate determinant of economic growth, different levels of human capital may explain in part the relationship between early institutional development and current GDP per capita.[19]

[16] Alternative, although complementary, mechanisms could be the increase in inequality (Williamson, 2009b), with the subsequent effect on social conflicts and economic outcomes, the form taken by frontier colonization, influenced by executive constraints as argued by García-Jimeno and Robinson (2011), and the different assimilations of the labor movement during those decades (Collier and Collier, 1991).

[17] This type of conflict may have led to the process of democratization proposed among others by Acemoglu and Robinson (2000, 2006), Bourguignon and Verdier (2000), and Benhabib and Przeworski (2006).

[18] As stated by Drake (2009) regarding Uruguay's President José Battle y Ordóñez (1903-07 and 1911-15), "*who provided a prime example of democratization combined with social reform*", "[he] *did not lead a middle and working class coalition... Rather, he engaged in preemptive or anticipatory reform and incorporation of those subordinate classes from an elite vantage point.*" Reform emanated from above, not from below, providing the counterpart to Mexico, where after a revolution, the country retained a protected authoritarian system (Drake, 2009, p.135).

[19] It is worth noticing that before the twentieth century, despite the prosperity of many of the countries, few of them had made educational investments sufficient to serve the general population (Engerman and Sokoloff, 2011).

To explore this hypothesis we use data on primary and secondary school enrollment (in per capita terms) in 1900 and 1950. In the right panel of Table 1 we show the results for primary, secondary, and total school enrollment in columns (4) to (6), with significance levels based on bootstrap CI. In each regression we include as a regressor initial enrollment to account for any pre-existing differences before 1900-1910, or any other fixed explanatory variable. The estimated coefficient is significant in every case, particularly when primary education is considered. This suggests, as expected, that countries that improved their institutions at the end of the nineteenth century improved school enrollment as well, and consequently their levels of income per capita thereafter.

We may conclude from the evidence presented in this section that the early development of institutions during the nineteen century is informative about current differences in income per capita inside the region. The rest of the paper focuses on explaining this early political development. The following section presents a theoretical model, which is used in section 4 to empirically assess its determinants.

3 The Model

The Environment

The economy is divided into N districts indexed by j. A district j may be in conflict or in peace. We denote district specific states by s_j, where $s_j = 1$ if there is conflict in the district and $s_j = 0$ otherwise. It is assumed for simplicity that there are only $N + 1$ aggregate states, one state where every district is in peace, and N states where only one district is in conflict. Define by $S = 1$ an aggregate state where there is conflict in one district and $S = 0$ otherwise. As will be clear later there are only three possible combination of states for district j, $(s_j, S) \in \{(0,0),(1,1),(0,1)\}$.

The economy is populated by a continuum of agents, who are of three types, each equally distributed across and inside districts. A measure 1 of agents are elites, who are the only ones with access to a technology to produce output, and do not work. The reminder of the agents can only work. A measure λ do so voluntarily at the market wage, w. A measure $1 - \lambda$ are forced to work and do not receive a payment for their services.

Elite members, indexed by $h \in [0,1]$, have access to the following technologies to produce two different goods, denoted i and a respectively,

$$\begin{aligned} i &= z k^{\alpha} \nu^{1-\alpha} \\ a &= z l^{\alpha} (1+f)^{1-\alpha} \end{aligned}$$

where $z > 0$ is productivity, k capital, l land, ν and f voluntary and forced labor respectively, and $\alpha \in (0, \frac{1}{2})$ is a constant.[20] Total output in this economy is $y = i + a$. Elites have one unit of land

[20]The assumption $\alpha < \frac{1}{2}$ is a sufficient condition for the main results. This is because, given the assumed functional

so there is always positive production of a, even if forced labor is unavailable. Elites also receive an endowment $\bar{k}$ each period, which can be consumed or used as capital. We assume $z < \bar{z}$ and $\alpha \bar{z} \bar{k}^{\alpha-1} < 1$. This ensures $k < \bar{k}$ in equilibrium under the assumptions for the utility function and the supply of labor made below.[21] To save notation we further assume $\bar{k} = 1$, and hence $\bar{z} < 1/\alpha$. We can think of z as total factor productivity or the international price of local goods, including transport costs. We could also include sector-specific technology parameters, but the focus is on economy wide changes. We assume there is a market for coerced labor, which has a price p per period, and where the supply is decreasing in its net availability, $1 - \lambda - f$. Specifically we assume $p = f/(1 - \lambda - f)$ as the supply schedule. Notice that under this functional form no equilibrium will use all coerced labor available in the economy.

There is a government that collects revenues by imposing a tax to rents, τ_j, in each district. Total revenues, T, are split into those financing a public good, denoted by g, and those financing military responses to conflicts, d.

Elites are risk neutral. They consume any endowment not used as investment as well as rents net of taxes. Flow utility for a producer h in district j is,

$$u(s_j, S) = (1 - \tau_j)\ \pi_{hj} - k'_{hj} + \gamma\Big((1 - S)g - (S + s_j\bar{\gamma})\ (q - d)\Big),$$

where k'_{hj} is next period's investment, $\pi_{hj} = y_{hj} - w\nu_{hj} - pf_{hj}$ are rents, and γ, $\bar{\gamma}$ and q are positive constants[22]. The parameter q captures the cost of conflicts.[23] These costs are mitigated with government's military responses so in the event of a conflict ($S = 1$) the total cost is $q - d > 0$. To make this term positive in any equilibrium outcome we assume $q > \bar{z}$. The parameter γ reflects tastes about public expenditures.[24] Notice that $\gamma > 0$ implies that conflict is costly for all regions, but since $\bar{\gamma} > 0$, the costs of these events are asymmetric. This is key for the main prediction of the model.[25]

The probability of conflict onset is defined by $\phi(F) = \kappa/(1 - F)$, where $F = \sum_{hj} f_{hj}$ and $\kappa \in (0, \lambda)$, so $\phi'(\cdot) > 0$, $\phi''(\cdot) > 0$, $\phi(0) > 0$ and $\phi(1 - \lambda) < 1$. Therefore, unlike the price p, the aggregate cost of forced labor is not a function of total availability, but only of the fraction actually

forms, a marginal increase in constraints would have an effect on i, through k, that is too large to make it non-optimal.

[21] Therefore it is assumed, to reduce the number of states, that capital does not need to be financed out of current output. Then future output is not affected by current output and taxes, and hence neither by current conflicts.

[22] We omit from the utility the constant $\bar{k} = 1$.

[23] It is natural to think that a conflict should affect production. Aguirre (2011) considers this case. Here we assume production is not affected, so aggregate output does not depend on S. However, in equilibrium, output in the district with conflict is fully taxed, reducing the return of investment in a similar way than assuming that output is destroyed.

[24] And also production technology. The function assumes linear utility as well as linear technology.

[25] For simplicity it is assumed that g and d have the same marginal utility γ. Results do not change if this assumption is relaxed. In that case taxes will vary depending on the state. Since this is not the case under the present assumptions taxes are the same and hence the return to investment is not affected by the risk of conflicts (for the same level of executive constraints).

employed.[26] Under these conditions in a country with more of this type of labor available we would observe more demand for it, and hence a higher probability of conflict, than in a country with a lower supply. For simplicity it is assumed the conflict lasts for only one period and that there is an equal probability of conflict onset in each district, so the probability of observing a conflict in district j is ϕ/N. This implies a degree of uncertainty in terms of the incidence of future conflicts and their costs, which is the second key feature behind the main prediction of the model.

Taxes need to be set every period. Each district has a member in a legislature, who is an elite chosen stochastically. As these agents are identical inside each district we do not model elections. There is one agent, the executive, with agenda power. Every period he proposes the set $\{\tau_j\}_{j=1}^N$, which defines a tax rate for every district, and he can not commit to future proposals. Proposals need to be approved by a fraction $m > 0$ of the legislature to be implemented, otherwise $\tau_j = 0$ in all districts is the outcome. We assume members from districts with conflicts do not vote. It is also assumed that the district of the executive is not represented in the legislature and that the probability of conflict is zero there.[27] Flow utility of the executive is $u_e = c_e + \gamma((1-S)g - S(q-d))$.

The ratio m captures the constraints on the executive, and it is set before production takes place and taxes are decided. Since members of the legislature are ex-ante identical there is no disagreement, and so we may assume that m is chosen by unanimity.[28] As usual the subset of members whose votes are decisive for approving the proposal is called the minimum winning coalition (WC).[29]

Given (z, λ), the timing of the events is as follows:

1. Given k_{hj} members of the legislature choose m.
2. States $\{s_j\}_{j=1}^N$ and S are realized, production takes place, and ϕ takes its corresponding value.
3. Given k_{hj}, m, $(\{s_j\}_{j=1}^N, S)$, and ϕ, the executive proposes $(\{\tau_j\}_{j=1}^N, g, d)$, which is either accepted or rejected by the legislature.
4. Given k_{hj}, m, (s_j, S), ϕ, and (τ_j, g, d), agents choose k'_{hj}.

Let us define $n = 1/N$ to simplify notation. We can write the problem for elite hj at step 4 as,

$$\begin{aligned} V(s_j, S) \;=\; & \max_{\{k'_{hj}\}} \Big\{(1-\tau_j)\ \pi^*(k_{hj}) - k'_{hj} + \gamma\Big((1-S)g - (S + s_j\bar{\gamma})\ (q-d)\Big) + \\ & \delta\Big((1-\phi)EV(0,0) + n\phi EV(1,1) + (1-n)\phi EV(0,1)\Big)\Big\}, \end{aligned} \tag{3}$$

where $\delta < 1$ is the discount factor, E is the expectation operator, which is taken with respect to future government policies, and $\pi^*(k_{hj})$ solves the static problem of elites. The problem of the

[26] More realistically the probability of conflict would depend on the amount of forced labor in each district. But since districts are homogenous we make ϕ a function of F only.

[27] These assumptions are not needed to get the main implication of the model but they simplify its solution since otherwise the policy function is different when the conflict arises in the district of the executive.

[28] The ratio m is assumed to be continuous, which may be the case if the number of legislators per district varies.

[29] The institutional framework is greatly simplified since constraints are only imposed by the legislature. In the empirical part executive constrains considers constraints from different political agents like parties or the judiciary.

executive at step 3 is the following,

$$\begin{aligned} V_e(S) &= \max_{\{\{\tau_j\}_{j=1}^N, g, d\}} \Big\{ c_e + \gamma\Big((1-S)g - S(q-d)\Big) + \delta EV_e \Big\} \\ \text{s.t. } V(0,S;\tau_j,g,d) &\geq V(0,S;0,0,0) \qquad \forall j \in \text{WC} \\ T = g+d &= \textstyle\sum_{hj} \tau_j \ \pi^*(k_{hj}). \end{aligned} \tag{4}$$

The optimization problem at step 2 is static,

$$\pi^*(k_{hj}) = \max_{\{f_{hj}, \nu_{hj}\}} \Big\{ y - w\nu_{hj} - pf_{hj} \Big\}, \tag{5}$$

Finally the problem faced by each member of the elite when deciding institutions is to choose m that maximizes $EV(s_j, S)$, where the expectation now is taken with respect to policies and states.

An equilibrium is levels of capital, k^*_{hj}, and labor, ν^*_{hj}, f^*_{hj}, which are optimal for the elites in the current period, given the initial conditions, prices, and taking into account subsequent equilibrium outcomes; a policy vector $(\{\tau^*_j\}_{j=1}^N, g^*, d^*)$ that is optimal for the executive in the current period, given initial conditions, prices, the voting strategy by members of the legislature, and subsequent equilibrium outcomes; a level of constraints, m^*, which is optimal for every member of the legislature given the initial conditions and taking into account subsequent equilibrium outcomes; and prices, p^* and w^*, that clear the markets for labor. Since decisions need to be optimal in the current period we rule out pre-commitment to decision rules and hence we restrict attention to symmetric Markov-perfect equilibria (SMPE).

Before deriving the equilibrium allocations notice that elites' problems differ inside districts only if k_{hj} does as well. Therefore in a SMPE we have $k_{hj} = k_j$ for all hj, so we drop the index h for the rest of this section.

Equilibrium

To characterize the equilibrium the model is first solved for a given value of m. This implies finding the optimal level of capital as a function of future taxes and also finding a proposal, which means finding the maximum tax rate that makes a member of the legislature as well off as with $\tau = 0$ and $g = d = 0$, as a function of capital. Since this is a repeated game we get the equilibrium level of capital and revenues, as a function of m, as those that are consistent with both relationships, and explore how they depend on m and the exogenous parameters (z, λ). Finally, given these implicit functions, the institutional design problem can be solved, which consists of finding m^* that maximizes the utility of the members of the legislature through its effect on k^* and T^*, and explore how this depends on the parameters (z, λ).

First it is convenient to analyze step 3, how policies are set for a given $m > 0$ and a k_j distribution. When $S = 0$ nobody values defense spending so it is clear that $d = 0$ in equilibrium. The same happens with public goods when $S = 1$, so $g = 0$ in that case. Since the executive enjoys

public expenditures and he does not bear any costs of financing them, his problem is equivalent to maximizing T subject to the approval constraint. It is clear then that the equilibrium proposal includes a tax rate of 1 for members outside the WC. For members inside the WC he needs to propose the maximum tax rate consistent with the first constraint in (4). Since the provision of public goods or defense spending does not affect expected utility, flow utility under the proposed tax needs to be at least equal to flow utility when no district pays taxes. Hence the first constraint in problem (4) becomes $u(0, S; \tau_j, g, d) \geq u(0, S; 0, 0, 0)$. Using the fact that current investment is not a function of current policies (the FOC in problem 3 is not a function of current taxes), the tax rate proposed and accepted in any state is the maximum consistent with the following expression,

$$\tau_j \pi^*(k_j) \leq \gamma T = \frac{\gamma}{N}\Big(\sum_{x \in \text{WC}} \tau_x \pi^*(k_x) + \sum_{x \notin \text{WC}} \pi^*(k_x) \Big). \tag{6}$$

The LHS of this expression is the amount the legislator pays under the proposal. The RHS is what he gets in public goods or defense spending when this is approved. Notice first that (6) is independent of the current state and hence so is the tax rate. Furthermore only τ and k are district specific in equation (6), implying that tax rates will differ across districts only if capital does also. But, since districts are homogeneous ex-ante, investment would differ only if expected taxes depend on j. Therefore in a symmetric equilibrium capital is the same in every district, $k_j = I$, $\forall j$, and every member of the WC, independently of the state, faces the same tax, τ_{wc}. Hence we drop the index j and (6) becomes,

$$\tau_{\text{wc}} \pi^*(k) \leq \gamma T = \gamma \pi^*(k) \Big(m\tau_{\text{wc}} + (1-m) \Big). \tag{7}$$

If $\gamma > 1$ there is no $\tau_{\text{wc}} \in [0, 1]$ that makes this expression hold with equality, hence $\tau_{\text{wc}} = 1$.[30] But in this case there is no investment in equilibrium, so $i = 0$. If there is, if for instance it is not feasible to set the tax rate above a certain level, there would not be a commitment problem because everyone agrees ex-post to pay the maximum tax rate that is feasible to fight insurgencies. We focus on the case where $\gamma < 1$, and so there exists positive investment and a commitment problem, and (7) always holds with equality for a unique $\tau_{\text{wc}} \in [0, 1)$. Then we can solve for the level of taxes,

$$\tau_{\text{wc}} = \frac{\gamma(1-m)}{(1-\gamma m)}. \tag{8}$$

The tax rate proposed and approved by the legislature is strictly decreasing in executive constraints, m. This is because this tax rate is increasing in the amount every other district pays, as opposing the proposal means renouncing more spending when there are more revenues from other districts. Because there are fewer members outside the WC when m increases, and because they pay the maximum amount, this tax rate is decreasing in m and likewise in T, given the investment distribution. Notice also that the tax rate does not depend on ϕ or profits (and hence z, k, or λ).

[30] In this case $\gamma(m\tau_{\text{wc}} + (1-m)) > m\tau_{\text{wc}} + (1-m) \geq \tau_{\text{wc}}$, hence $\gamma \pi^*(k)(m\tau_{\text{wc}} + (1-m)) > \pi^*(k)\tau_{\text{wc}}$.

Now, keeping $m > 0$ fixed, we solve step 4. The FOC for capital in (3) is independent of current and future states. Previous results and the fact that agents cannot influence investment at the district level implies that selection into the WC is stochastic, and so $E(\tau) = m\tau_{\text{wc}} + (1 - m) = 1 - m(1 - \tau_{\text{wc}})$. Hence the FOC is

$$m\delta y_k(1 - \tau_{\text{wc}}) = 1 \tag{9}$$

where $y_k = i_k$ is the marginal product of capital. Expression (9) implies that capital is increasing in z and λ, as these increase its marginal product. It is also increasing in executive constraints: only with probability m the agent can get a positive return. Otherwise he needs to pay everything in taxes. This can be interpreted as a probability of expropriation that is decreasing in the size of the WC. Since τ_{wc} does not differ across states, the expected return, and so k in equilibrium, is not a function of ϕ.

We finally solve the static problem of elites. Marginal productivities are equal to prices in equilibrium. Since the supply of voluntary labor is inelastic, $\nu = \lambda$. In the case of forced labor the FOC in problem (5) and the market clearing condition imply

$$\frac{(1 - \alpha)z}{F^{\alpha}} = p = \Big(\frac{F}{1 - \lambda - F}\Big). \tag{10}$$

An increase in the relative endowment of free labor, λ, reduces F, and hence the probability of conflict as well. Both F and ϕ are increasing in total productivity, although the size of the effect depends on the supply, i.e. in λ. In particular an increase in the demand for forced labor due to a positive productivity shock will be lower in countries with low availability of this type of labor.

We have now found the response of taxes to capital through the political process, and the response of investment to future taxes through the decisions of individual elites. Since this is a repeated game, we can now characterize the optimal level of capital and taxes, which determines the amount of public goods provided and the size of the responses to conflicts, for a given level of executive constraints.

Proposition 1

Suppose $\gamma < 1$. For a given $m \in (0, 1]$ there exists a unique equilibrium with positive capital, k^*, and revenues, T^*. Moreover in this case,

$$\frac{\partial k^*}{\partial z} > 0, \quad \frac{\partial T^*}{\partial z} > 0, \quad \frac{\partial k^*}{\partial m} > 0,$$

and, $\exists\ \underline{m} < 1$ such that if $m > \underline{m}$,

$$\frac{\partial T^*}{\partial m} < 0,$$

and if $m < \underline{m}$ the opposite is true. Also,

$$\frac{\partial i^*}{\partial \lambda} > 0 \text{ and } \frac{\partial a^*}{\partial \lambda} < 0.$$

Proof. See Appendix C. ■

Thus, in the unique equilibrium with positive capital, technology raises the return to investment and then raises the tax base, increasing revenues. The positive effect of a higher stock of capital on labor demand generates a positive relationship between technological change and the risk of rebellions.

More constraints on the executive raises capital as well, as the risk of being expropriated and paying all output in taxes is reduced. The effect on revenues is ambiguous because this positive effect on the tax base is offset by the fact that fewer districts are being expropriated and the reduction in the tax rate for members of the WC. But the first effect is weaker when the WC is large, because in that case most of the districts pay just a fraction of the increase in investment to the government. The proposition shows that there exists some level of constraints such that increasing them above that level always leads to less revenues. This fall in revenues is costly for the district facing a rebellion, and generates an ex-ante trade-off between higher risk of expropriation and smaller responses to conflicts when rising constraints. Since this trade-off does not exist when constraints are lower than the cut-off defined by the proposition, this cannot be an equilibrium, as increasing them will lower expropriation and the strength of conflict responses. Since land is fixed constraints do not affect the demand for coerced labor and hence neither the probability of future rebellions.

Finally the composition of the labor force has an effect on the composition of output. A relative increase in the supply of free labor will translate to an increase in this type of employment and capital. But on the other hand it makes coerced labor more costly for elites, reducing that type of employment and consequently the risk of conflicts. Although this externality will affect the choice of constraints, it does not influence the equilibrium when constraints are kept constant.

Corollary 1 *In the unique equilibrium with positive investment, for a given* $m \in (0, 1]$,

$$\frac{\partial \phi^*}{\partial z} > 0, \quad \frac{\partial \phi^*}{\partial m} = 0, \quad \textit{and} \quad \frac{\partial \phi^*}{\partial \lambda} < 0.$$

Now we solve the stage of the game when legislators choose the level of constraints anticipating their effects on the equilibrium level of investment and the future response to conflicts. First we can express $V(s_j, S)$ as current utility plus discounted expected utility as a function of k^*, τ^*_{WC}, T^*, ϕ^*, m, and the exogenous parameters. Using (7) we get,

$$V(s_j, S) = \tilde{u}(s_j, S) + \frac{\delta}{(1-\delta)}\Big[\frac{\delta \pi^*(k^*)(m + (1-m)\tau^*_{\text{WC}}) - k^*}{\delta} + n\phi^* \gamma \bar{\gamma}\ T^* - \phi^* \tilde{q}\Big]. \tag{11}$$

This expression shows the trade-off involved in choosing m. The first term is flow utility plus capital ($\tilde{u}(s_j, S) = u(s_j, S) + k^*$). This flow is realized before m is chosen and it is the only term in (11) which is a function of the current state. Hence m^* is not a function of S. The first

term inside the brackets are the net gains from investment. With probability m the legislator will be part of the WC in the future and hence will pay a fraction τ_{wc} of profits. But the utility cost of doing this is exactly the same as the gain from provision of the public good or defence expenditure. Therefore with probability m total profits are simply the return. Of course still taxes distort individual investment decisions, and hence output will be lower than its optimal level. With probability $(1-m)$ the legislator will be out of the WC and will have to pay more taxes than those that finance the desired level of public goods. Then the net cost, or actual expropriation, is the difference between its valuation of public expenditures, i.e. $\tau_{\text{wc}}\pi^*$, and profits, which is what he pays in taxes. This is why as τ^*_{wc} approaches 1 the return on investment approaches profits.

The following term in (11) captures the benefits of lowering the constraints on the executive, i.e. reducing m. With probability $n\phi$ there is a rebellion in the district, which is $\bar{\gamma}$ more costly than for others members of the legislature, who are the ones that need to approve the proposal. In that event then there is an additional benefit from revenues, which are used to mitigate the cost of conflicts. If constraints are low, specifically if $m \leq \underline{m}$ as shown in Proposition 1, a higher m increases revenues, T^*, because of the positive effect on the tax base, and hence there is no cost of raising m. On the other hand, if $m > \underline{m}$, the negative effect on tax rates is stronger than the effect on the tax base, and an increase in m leads to lower defense expenditures. At this point there is a trade off when raising m between a lower expropriation risk and a lower response to conflicts. The higher the cost of conflicts in districts affected by them, captured by $\bar{\gamma}$, and the higher is the probability of conflicts, ϕ, the more costly it is to constrain the executive. This generates the main prediction of the model, a positive causal relationship between the amount of labor that can be coerced, $1-\lambda$, which raises the risk of conflicts, ϕ, and executive constraints, m, conditional on asymmetric costs of conflicts (a high $\bar{\gamma}$).

Proposition 2 *There exists a constant $\gamma^* > 0$ such that if $\bar{\gamma} > \gamma^*$ and $\gamma < 1$, there exists a unique $m^* \in (0,1)$ consistent with an equilibrium with positive investment, and,*

$$\frac{\partial m^*}{\partial \lambda} > 0.$$

Also $\exists\ \underline{\lambda} \in (0,1)$ such that if $\lambda < \underline{\lambda}$,

$$\frac{\partial m^*}{\partial z} > 0 \quad \textit{and} \quad \frac{\partial^2 m^*}{\partial \lambda\ \partial z} > 0.$$

Otherwise $\partial m^*/\partial z < 0$.

Proof. See Appendix C. ■

Proposition 2 formalizes the main prediction of the model. Given uncertain and asymmetric costs of conflicts, the last condition being captured by a high $\bar{\gamma}$, we should observe more constraints in the executive in countries where a larger fraction of labor is free, as conflicts are less likely in the

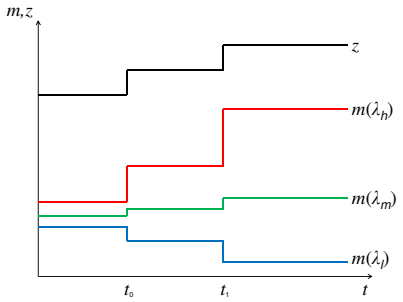


Figure 5: Executive Constraints, Technical Change, and Coerced Labor

future. In countries where a large fraction of the population can be forced to work the equilibrium level of coerced labor is larger because individual producers do not internalize the aggregate increase in the risk of conflicts. Legislators faced with this risk and knowing the commitment problem they face, empower the executive ex-ante so he can react more forcefully to conflicts.

The effect of technology depends on the distribution of labor. When technology improves, the share of profits that are expropriated becomes more important than the expected cost of conflicts, leading legislators to choose more constraints on the executive. However in countries where unfree labor is abundant the elasticity of this factor with respect to technology is larger. This generates a larger increase in conflicts as the economy grows, offsetting the first effect and making the expected cost of conflicts even larger than what is lost due to expropriation. Hence technical change raises the dispersion of constraints due to differences in labor endowments, and, if λ is low enough, it can even lead to fewer constraints in the executive. We illustrate these dynamics in Figure 5, where we assume that the technological parameter, z, jumps twice, and we show three cases for the trajectory of constraints, one with low unfree labor availability (λ_l), one with a medium level (λ_m), and one with a high level (λ_h). It is always the case, for any z, that m is higher the higher is λ. However the differences are increasing in the level of z, as the responses to the jumps in z are also positively related to the value of λ.[31]

In the next section we argue that the early institutional development in Latin America in the second half of the nineteenth century is remarkably suitable to test the model's main prediction.

[31] As shown in Section 2 the institutional gap was not accompanied by an income gap, which argues against double causality. However the model does predict a causal effect from the institutional gap to an income gap. Countries with a lower risk of conflicts are favored not only by technological change but also by less expropriation. But if conflict risk affects output, those with higher risk may end up with more output as they lower executive constraints. As argued by Coatsworth (2008), growth required consolidation of the dominance of precarious elites, and provided security for them. This would explain why the concentration of elite power had the opposite effects to what Engerman and Sokoloff (1997) postulated, as it actually led to economic growth during those years (Coatsworth, 2005, p.140).

4 Evidence

In this section we study the determinants of the early development of institutions in Latin America characterized in Section 2, in light of the theoretical model developed in the last section. Before pursuing a regression analysis, we briefly describe the experience of Latin America after independence. We identify two exogenous features that deeply affected the region during the second half of the nineteenth century, which closely relate to the main drivers of institutional development according to the model. These are the availability of labor to be coerced, or the variable $(1 - \lambda)$ in the model, and the development of transport technologies, associated with the variable z. The historical account shows that, in accordance with the theoretical structure of the model, the exploitation of a large fraction of the population produced a relevant risk of rebellions for elites, and moreover that this risk was intensified by the improvement in economic conditions brought by the change in transport technology.

Latin America after Independence

In the aftermath of independence the new countries in Latin America suffered a vacuum of political power, which led to a lack of governance and numerous armed conflicts. The first decades were chaotic and disorganized; there was little institutionalization and almost no agreement on national goals or ideology (Wiarda, 2005). The wars of independence unleashed a crisis with power struggles between regional elites or *caudillos* for control of the new independent countries, predatory militarism, and clashes between civilians and the military, or between the church and anticlerical forces.

After a short period where power was generally held by radical groups who favored wide popular participation following the spirit of the wars of independence, conservatives dominated politics. This group supported the rebuild of the colonial order so as to secure authority over the lower classes. In constitutional terms, see e.g. Loevman (1993), Gargarella (2004) and Wiarda (2005), they supported a strong executive, with extraordinary powers during internal or external crises. Consequently, authoritarian governments were common throughout the region in the aftermath of independence.

The rise of conservatives in almost every country after 1820 in the context of intra-elite conflicts can be potentially explained by the model. According to its main prediction, fragmented societies like the ones in Latin America after independence needed to concentrate political power to impose order. But authoritarism raised the expected pay-off from controlling the government, increasing the incentives to fight with different factions inside the ruling class.[32] Nevertheless we do not test

[32]Coatsworth (1998) argues that conflicts were shorter when the issues centered on the distribution of power between provinces and the center, and longer where elites dominated large slave or indigenous populations. In this last case governments struggled to restore stability, but also struggled to avert destructive rebellions from below (Coatsworth, 1998, pp. 562-565). See also footnote 2.

the model empirically by trying to explain the events that occurred during these decades. There is little variance during that period in terms of executive power, beyond the differences between North America and Latin America. Neither is there data to capture the incidence nor the main features of these conflicts, which would need to comply with the main requirements described in the previous section in order to reasonably apply the model. Furthermore there is no identifiable factor pushing for more inclusive institutions, as independence was not accompanied by identifiable productivity shocks. Finally, if there was a serious effort in building institutions during these decades, the process was probably influenced by the ongoing conflicts in most of the countries, further obscuring the mapping of the model into the data. The focus of our empirical exercise is on the likelihood of rebellions from non elites, and on technological advances originated in the developed regions of the world, which impacted the region after the "lost decades" following independence.

The Risk of Rebellions: Historians have identified the fear of a race war as one of the main causes for the lack of revolutionary support by the elites in the Americas at the end of the nineteenth century, mainly because the colonial pact also relied on the effective maintenance of internal colonialism of white over non-white which the Catholic monarchy had been able to provide (Williamson, 2009a, p.203). In short, the elite had little choice but to seek protection in exchange for loyalty (Coatsworth, 2008), and only when the king faltered did they understand they could no longer rely on Spain to protect them (Bates et al., 2007).[33] During the colonial period rebellions were common, costly for the elites –including in some cases the indiscriminate slaughtering of whites–, and far from seizing political power, save the Haitian Revolution –a colony where roughly 95% of the population were slaves.[34]

Rebellion by non whites continued to be endemic after independence, and there are good reasons to think that these risks persisted for most of the nineteenth century. This is because achieving independence was a political and not a social or economic revolution. The ethnic nature of social structures was not modified by it (Rouquié, 2010, p.38). White elites still employed coerced non-white labor in agrarian or mining economies. The labor market changed only slightly, slavery was abolished only where it was of little consequence, and coercive practices were restored when it became clear that the Indian laborer had no incentive to seek paid work (Bulmer-Thomas, 1995, p.30). In some areas landowners succeeded in extracting a surplus from workers through the control of land and water, and with the help of state armed forces (Bauer, 1986, p.171).

Katz (1988), analyzing rural rebellions in Mexico, argues that rural revolts between 1810 and

[33] In Mexico for instance the elites initially opposed independence, influenced by the 1810 Hidalgo revolt (Acemoglu and Robinson, 2012, ch.1).

[34] The most spectacular, notorious, and disturbing indigenous uprising in the Colonial period exploded across Peru in 1780, led by Túpac Amaru (Eakin, 2007; Drake, 2009). Other notable episodes were the revolt by the Aymara speakers in Upper Peru, the *comunero* revolt in Colombia, the local revolts linked to the Hidalgo movement in Mexico, and a mulatto revolt in the northeastern province of Bahia in Brazil.

1920 affected that country much more than such revolts had ever influenced the territory during the colonial period. Between 1840 and 1870 there was an unprecedented resurgence of village revolts, race wars, and regional rebellions (Coatsworth, 1988). According to Katz (1988) and in line with the model, one of the reasons for this was the greater strength of the Spanish crown relative to the new Mexican state. Moreover he argues that post-independence rebellions became less common around 1884 due, among other factors, to the beginning of the strongest state that independent Mexico had ever known, led by Porfirio Díaz, despite the massive expropriation of villagers' lands by wealthier classes that began in the late nineteenth century.[35]

Coatsworth (1988) surveys the literature on rural rebellions since the end of the seventeenth century in Latin America. This literature consists mainly of case studies and therefore is not exhaustive. Most of the events studied took place in Mexico, Guatemala, Peru, Bolivia, and Brazil. Revolts involving Mesoamerican and Andean villages consisted of land invasions, village riots, and caste wars. They involved high degrees of violence, including theft and assassinations, and they were mostly directed against the rural elites: land owners, public officials, or whites. Caste wars, regional uprisings directed towards the expulsion or elimination of non-Indian authority, were the largest revolts, while the most common and prolonged revolts involved formal and informal alliances between Indian villagers and non-Indian lower classes. Finally, slave-based revolts consisted of plantation riots and uprisings, slave insurrections, and maroon warfare. Slave insurrections, although uncommon, usually sought the expulsion or extermination of the European elite and, together with caste wars, could arise from small riots via contagion, a danger recognized by ruling classes throughout Latin America (Coatsworth, 1988, p.30). Because the analysis is based on case studies for certain countries only, statistics are not representative. However the numbers reported by Coatsworth (1988) imply a large lower bound on the number of conflicts, and show that, although they had a local nature, they were not localized only in some specific regions.[36]

The model in this paper predicts that fear of race conflicts generated by the coercion of labor affected the institutions built after independence. The main features of this type of conflict resemble those needed by the main mechanism of the model. These rebellions were costly, localized in certain regions but widespread, and, with very few exceptions, far from seizing power.[37] The elite was geographically dispersed, since these were mainly agrarian and mining economies.

[35]For the case of Mexico see also Chevalier (2005) (p.479-482), who highlights the Caste War in Yucatán in 1847, an indigenous rebellion, brutally repressed, aimed for the extermination of all whites.

[36]Coatsworth (1988) reports 521 village riots and uprisings and 286 slave-based revolts from 1700 to 1899. In the case of regional, "peasant", and caste wars, he reports 6 events before 1810 and 42 thereafter; 23 in Mexico, 8 in Brazil, 7 in Peru, and 10 in other countries, including Argentina, Bolivia, Ecuador, El Salvador, and Guatemala. In the case of Mexico these rebellions took place in 15 different regions. A similar pattern is observed in Brazil and Peru. Of 31 maroon wars and slave insurrections between 1700 and 1832, 13 occurred in the Guianas, Suriname, and Venezuela, while the rest were spread throughout the Caribbean islands and the mainland.

[37]The small influence of these conflicts at a national level comes from the local character of their grievances, and the difficulty their leaders had in thinking about policy at a national level (Chevalier, 2005, p.481).

Indeed it has been documented by historians that the risk of uprisings by non whites, together perhaps with the risk of intra-elite conflicts, was among the main reasons for the establishment of autocratic regimes throughout the continent after independence. The trade-off facing the elite was similar to the one highlighted in the model: "*...a contradiction appeared: the only coherent political ideology available to [the elites] was liberalism, but democratic values ... tended to undermine state authority in regionally dispersed societies which were still seigniorial, hierarchical, racially divided and often based on slavery.*" (Williamson, 2009a, p.233). Given severe racial and class inequalities, elite fears of mass upheaval compelled many of them to prefer authoritarism over republicanism, and where colonial rule relied on exploitation of large indigenous or slave populations, that cleavage carried on past independence and hindered democratic prospects (Drake, 2009, p.54).

It is worth noticing that other types of social conflicts are also valid for the main prediction of the model. The feature that is really important is that they impose asymmetric and uncertain costs for members of the elite. Since in the period studied social groups were not as powerful or well organized yet to threaten the elite political control, we may consider all types of socioeconomic conflicts.[38] But as the previous discussion shows, with the exception of intra-elite conflicts during the decades after independence, racial conflicts were probably the main source of conflicts as social differences in the region were defined mainly in terms of race. Indeed social conflicts were even more pronounced as they were based on ethnic differences (Rouquié, 2010, p.77). Consequently, as argued by Chevalier (2005) (p.477), and in line with what we could infer from the previous discussion, during the period analyzed peasant uprisings were particularly numerous in regions of large indigenous populations.

Technical Change in Maritime Transportation: Historians suggest that only after the negative economic and political effects of the wars of independence started to be overcome were countries able to move to less autocratic political institutions. It took decades of civil discord before most could bring about enough order to construct functioning governments (Drake, 2009, p.15). It is interesting in this context to see that the origin of the institutional gap throughout the region coincides with the period of economic recovery and political domination by liberals, who dominated politics in almost every country by 1870. This group, who particularly benefited from overseas trade and new economic opportunities, supported the creation of a modern liberal state following the US constitution, trying to constrain the potential abuses of the executive (Gargarella, 2004; Drake, 2009).[39]

[38] Rural workers organized in unions later (Bauer, 1986), while urban workers, then a relatively small population, started their increasingly intense demonstrations late in the century generating reactions from political regimes after World War I (Hall, 1986; Collier and Collier, 1991).

[39] The institutional divergence is reflected in the fact that this group was not always able, or willing, to establish institutions consistent with these principles. As documented by Eakin (2007) (p.220), they sided with the option of authoritarian governments once they obtained power in Mexico and Brazil, but extended political participation in

Better economic conditions and the diversification of the economy, leading to order and a period of institutional building, was driven by external factors. As stated by Williamson (2009a) (p.234), only after about 1850 did overseas demand begin to pull a few Latin American economies out of stagnation, leading to a degree of political consolidation and, in some republics, to a period of constitutional politics and rule of law. These external factors were mainly related to technological developments in industrialized countries, specifically a transportation revolution that started in the early nineteenth century, generating spectacular maritime transport cost declines (North, 1958; Harley, 1988; Estevadeordal et al., 2003). O'Rourke and Williamson (2002) estimate that transport improvements over sea lanes between 1870 and 1913 induced a 45 percentage-point fall in trade barriers. Trade expansion was driven by the integration of markets, inducing commodity price convergence and a reshuffling of resources within national economies, instead of booming import demand or export supply (O'Rourke and Williamson, 2002). This distinction is relevant since it implies that this phenomenon benefited most of the sectors in the economy and not only those with political power. Bulmer-Thomas (1995) shows that the period from the middle of the nineteen century to the First World War witnessed the rise of new export products throughout Latin America, finally eclipsing the colonial pattern of exports (Bulmer-Thomas, 1995, p.57).

This technological advance in transportation is particularly suitable to test the model. It was clearly exogenous for the region, large, relatively easily identifiable, and every country in the region felt its consequences. Moreover it affected most economic sectors, and not only those that may have had political power before the reforms. Therefore these developments in the transportation sector may have increased the marginal benefits for the elite when constraining the executive according to the model.[40]

But, as captured by the model, the risk of uprisings by Indians and slaves rose with the improved long-run economic prospects brought by this technological development. This was mainly because the demand for forced labor increased and because landowners tried to enlarge their land possessions at the expense of the lower classes, mostly indigenous communities (Bauer, 1986; Coatsworth, 1988).[41] Regarding the modernization process in the last decades of the nineteenth century, Eakin (2007) argues that its main cost was an enormous dislocation and hardships for rural peoples, as they lost their lands and saw their villages disrupted or destroyed (Eakin, 2007, p.221). A massive new concentration of landholdings provoked violence in densely populated indigenous regions

Chile, Argentina, Uruguay, and Costa Rica.

[40]Railroad expansion was also important in the region. We do not consider this in the empirical exercise because it responded to economic conditions, and hence it is difficult to capture its exogenous component. Nonetheless we think this expansion was associated with the development of navigation technologies as well. Migration is another important development, which may have been facilitated by these technical improvements. But it is not clear if it had an effect on the risk of rebellions.

[41]Although in the model conflicts are driven by coerced labor, the expropriation of land by elites, common during that period, would generate the same mechanism, as the incentives to expropriate land also rises with demand pressures derived from better economic conditions.

(Coatsworth, 2005). As the expansion of agrarian properties intensified in countries like Mexico, Peru, and Bolivia, aggression increased and the risk of uprisings rose (Chevalier, 2005, p.478-9). Sánchez et al. (2010) show empirically that opportunities for higher revenues from exports in Colombia during the period 1850-1925, together with the lack of formal property rights, led to the emergence of land conflicts between peasants and landowners due to the desire of large landowners to expand their estates. Acemoglu and Robinson (2012) (ch.12) revise the post independence experience of Guatemala. They show how the increased demand for coffee in the second part of the nineteenth century led the elite to expropriate large sections of land, mostly indigenous, and to intensify labor coercion.

Regression Results

Now we pursue a quantitative analysis of the sources of institutional development highlighted above. First the focus is on differences across countries, where the effect of labor coercion and the risk of rebellions is emphasized. We verify whether this effect was more relevant during the period of economic recovery. Later we focus on the effect of technological progress in transportation to explore the dynamic process.

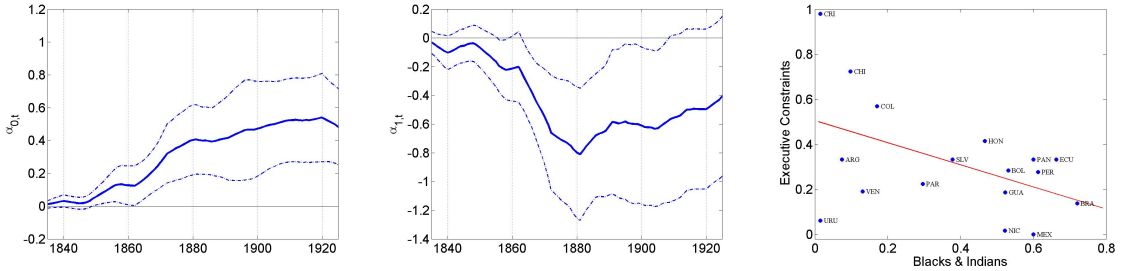
The discussion in the last subsection shows that, in accordance with the structure of the theoretical model, the existence of oppressed indigenous and black populations generated a risk of conflict for the elites. We use an estimate of Indians and blacks as a fraction of total population for the years around 1800, which we denote by BI.[42] This variable, together with all the data used in the regressions, is presented in Appendix A. It ranges from roughly 1% in Uruguay and Costa Rica, to more than 70% in Brazil.

First, to capture the dynamic nature of the relationship between labor available to be coerced and institutions we estimate the following regression from 1835 to 1925,

$$XC_{j,t} = \alpha_{0,t} + \alpha_{1,t} BI_j + \alpha_{2t} XC_{j,indep} + \epsilon_{j,t} \tag{12}$$

Estimation results are shown in Figure 6. In the left panel the sequence of $\alpha_{0,t}$ is plotted. We observe a sustained increase in this coefficient from 1850 to 1920, consistent with the evidence in Section 2. In the central panel the sequence for $\alpha_{1,t}$ is plotted, and we can see that the rapid institutional development took place only in countries with small Indian and black populations, as expected. Moreover the temporal change in the value and significance of the coefficient validates the fact that the risk of rebellions rose along with the economic recovery throughout the region. It only becomes negative and significant around 1865. This coincides with the period of fastest

[42] Since we use data around 1800 reverse causality is not an issue in our estimations. However the availability of coerced labor may be endogenous (Dell, 2010; Summerhill, 2010; Acemoglu et al., 2012). Geography or colonial features may have influenced both the availability of coerced labor and institutional reform. We control for other potential determinants in our regressions and also show that the effect depends specifically on how difficult is to fight insurgencies. Additionally we pursue a panel estimation, which may control for any fixed effect.



Left and center: Regression results from estimating equation (12). Dotted lines are 90% CI based on robust standard errors. Right: Executive Constraints 1870-1910, and Blacks and Indians as % of total pop, circa 1800.

Figure 6: Natives, Blacks, and Political Institutions: Regression Results

development, and rising dispersion across countries, of the quality of political institutions (see Figure 1). In addition this suggests that the gap generated by our explanatory variable arose long after independence, lowering the likelihood that it directly captures colonial differences rather than the risks of conflicts.[43]

The right panel of Figure 6 shows the negative correlation between BI and average executive constraints from 1870 to 1910, without controlling for initial constraints. Uruguay, and to a lesser degree Venezuela and Argentina, situated in the lower left region, hinder a stronger negative relationship. It is worth noticing that these countries started their independent life with the lowest executive constraints, and so the average level may underestimate true institutional development.

In order to incorporate additional factors we pursue a regression analysis. In Table 2 we show the results, using the average executive constraints between 1870 and 1910 as the dependent variable. Significance levels are computed using bootstrap CI. Column (1) shows that the negative relationship depicted in the right panel of Figure 6 is significant at a 90% level of confidence, with the regression explaining about one fourth of the variance in average executive constraints during these forty years.[44] In column (2) we add executive constraints at the time of independence to control for other idiosyncratic features that may have affected institutions, such as the colonial system of government or the process of independence. After doing this the estimated coefficient on BI increases and becomes significant now at the 95% level of confidence, showing that the explanatory power of BI is even larger when analyzing institutional development, i.e. the change in executive constraints since independence.

To confirm that the results really correspond to the mechanism predicted by the model an

[43]The coefficient becomes not significant around 1910, consistent with the idea that race uprisings like the ones highlighted by the model were replaced by wider class conflicts for which neither the model nor the explanatory variable have much to say.

[44]It is worth emphasizing that the estimated relationship is not a direct outcome of the exclusion of certain groups from political participation. As explained above, constraints on the executive is only indirectly related to the fraction of population voting in elections, and this fraction was much lower than the fraction of whites in the population (Colomer, 2004; Hartlyn and Valenzuela, 1998).

	Dep. Var.: Executive Constraints 1870-1910					
			RT: Mountains		*RT: Small-Scale*	
	(1)	(2)	(3)	(4)	(5)	(6)
Blacks & Indians (BI)	-0.49^{*}	-0.58^{**}	-0.56^{***}	-0.59^{**}	-0.49^{**}	-0.53^{***}
	0.30	*0.26*	*0.26*	*0.25*	*0.22*	*0.16*
Initial Constraints (XC_{ind})		0.67^{***}				
		0.29				
Rough Terrain (RT)			0.10^{***}	0.16^{*}	0.20^{***}	0.39^{**}
			0.03	*0.04*	*0.07*	*0.09*
Rough Terrain (RT) × *Blacks & Indians (BI)*				-0.22 †		-0.65^{**}‡
				0.09		*0.20*
Constant	0.50^{***}	0.43^{***}	0.53^{***}	0.55^{***}	0.50^{***}	0.52^{***}
	0.16	*0.14*	*0.13*	*0.13*	*0.10*	*0.07*
R^2	0.23	0.43	0.46	0.53	0.52	0.71
Countries	17	17	17	17	17	17

Notes: The variable RT is normalized by its mean. Robust standard errors in italics. Significance levels are based on bootstrap bias-corrected and accelerated (BCa) CI: * means significant at 10%, ** significant at 5%, and *** significant at 1%. † Based on BCa CI the effect of BI is not significant only for values of RT lower than 78% the sample mean (18% of the countries). ‡ The corresponding threshold is 72% of the sample mean (24% of the countries).

Table 2: Executive Constraints and the Risk of Rebellions, Regression Results.

interaction term with a variable capturing the roughness of the territory, denoted by RT, is included in the regressions. This variable captures how difficult is to fight an uprising. As argued by Hegre and Sambanis (2006), rough terrain is ideal for guerrilla warfare and difficult for a government army to control. This is consistent with theories that focus on feasibility to explain the causes of civil conflicts (Collier and Hoeffler, 2007), and it has also been used as an instrument to capture the exogenous likelihood of civil wars (Aguirre, 2011). Hence the model would predict that a relatively larger oppressed population should have a larger effect on the constraints imposed on the executive in countries with a relatively high value of RT. Therefore we introduce an interaction term between BI and RT and expect a negative sign.

There are at least two alternatives for measuring RT. Fearon and Laitin (2003), Hegre and Sambanis (2006), and Aguirre (2011) use the proportion of the country that is mountainous, identifying it as an important determinant of civil conflicts. Another variable is the one constructed by Nunn and Puga (2012), which captures small-scale instead of large-scale terrain irregularities as the first measure does. Each of these variables may be relevant for different conflicts. The first one is likely more relevant in capturing obstacles to military reactions by governments in present times, but the second one may be more relevant for older fighting technologies. It captures the existence of caves for hiding and the ability to watch the lowlands and incoming paths (Nunn and Puga, 2012). The correlation of these variables for our sample of 17 countries is 0.65.

	Dep. Var.: Executive Constraints 1870-1910								
	Wheat-sugar ratio (1)	*Land Inequality* (2)	*Pop Density 1500* (3)	*Urbanization 1500* (4)	*Settler Mortality* (5)	*State Antiquity 1500-1800* (6)	*Fertile Soil* (7)	*Latitude* (8)	*Principal Component* (9)
Blacks & Indians (BI)	-0.71^{**} *0.31*	-0.49^{*} *0.30*	-0.68 *0.31*	-0.69^{*} *0.33*	-0.47^{*} *0.31*	-0.82^{***} *0.29*	-0.49^{*} *0.29*	-0.70^{**} *0.31*	-0.88^{***} *0.29*
Control	-0.50 *0.36*	4.19 *7.80*	0.11 *0.07*	1.81 *1.48*	-0.14 *0.41*	0.03^{*} *0.01*	-0.05 *0.40*	-1.07 *0.68*	0.17^{**} *0.06*
R^2	0.36	0.25	0.41	0.32	0.23	0.47	0.23	0.39	0.54
Blacks & Indians (BI)	-0.75^{***} *0.26*	-0.58^{***} *0.27*	-0.67^{*} *0.30*	-0.57 *0.30*	-0.56^{**} *0.28*	-0.83^{***} *0.28*	-0.64^{***} *0.25*	-0.70^{***} *0.27*	-0.84^{***} *0.31*
Control	-0.40 *0.30*	-0.04 *7.65*	0.07 *0.08*	-0.10 *1.57*	-0.16 *0.25*	0.03^{**} *0.01*	-0.36 *0.37*	-0.72 *0.69*	0.14 *0.08*
Initial Constraints (XC_{ind})	0.59^{*} *0.27*	0.67^{*} *0.30*	0.45 *0.30*	0.68^{*} *0.31*	0.67^{*} *0.30*	0.51^{*} *0.29*	0.79^{*} *0.34*	0.51^{*} *0.29*	0.29 *0.32*
R^2	0.50	0.43	0.47	0.43	0.43	0.58	0.47	0.49	0.56
Countries	17	17	17	17	17	17	17	17	17

Notes: Constant included but not shown. Robust standard errors in italics. Significance levels are based on bootstrap bias-corrected and accelerated CI: * means significant at 10%, ** significant at 5%, and *** significant at 1%. For each column the row labeled *Control* shows the coefficient of the variable defined in the second row of the table.

Table 3: Executive Constraints and the Risk of Rebellions, Robustness Analysis.

In columns (3) and (5) of Table 2 we include our measures of RT, normalized by their means, as controls in the baseline regression. The coefficient on BI does not change much. Results with the interaction term are shown in columns (4) and (6) of Table 2. As expected, the coefficients are negative, implying that the effect of BI rises with the roughness of the territory. This is true for both RT measures. In particular the coefficient on BI is negative and significant at a 90% confidence level only in countries with values of RT larger than around 75% the sample mean, corresponding to about 80% of the countries in the sample. These results suggest that the channel is the one predicted by the model: a larger population of oppressed Indians and blacks meant a higher probability of civil conflicts, and when these conflicts were difficult to fight, the elite needed to organize itself in a certain way to ensure a proper response.

To further ensure that the relationship between BI and political institutions is really capturing the mechanism explained by the model, we now control for a series of variables associated with different theories that have been proposed in the literature to link colonial and pre-colonial experiences with current economic and political development.[45] The results from this robustness

[45] As noted in the introduction we see most of these theories as complementary to our model. Accordingly the aim of this exercise is not to test the validity of these theories, especially since we use only proxies of the relevant variables, and the mechanisms identified by them could have realized before or after the period we consider. Moreover they may have explanatory power for a larger cross-section of countries and not solely Latin America countries, which are

analysis are presented in Table 3. In the upper panel we show results without controlling for initial constraints and in the lower panel we show the results when we control for them. In each column we include a new explanatory variable, and show the corresponding coefficient in the row labeled *Control*. Significance levels are based on bootstrap CI to address the issues raised by the small sample.

Engerman and Sokoloff (1997, 2002) argue that factor endowments affected inequality, and inequality in turn led to bad institutions and underdevelopment in the Americas. To control for this mechanism we use a measure of land suitability for wheat versus sugarcane. Easterly (2007) argues that this variable captures the exogenous component of the type of inequality considered by Engerman and Sokoloff (1997, 2002). In column (1) of Table 3 we can see that the size as well as the significance of the coefficient of interest increases when this variable is included in the regressions. Meanwhile the wheat-sugar ratio does not have a significant effect on executive constraints. An alternative measure of inequality is the degree of concentration in the ownership of land. We include in column (2) the share of agricultural land occupied by family farms in 1858, constructed by Vanhanen (2003), and used by Easterly (2007) as a proxy for historical inequality. Again the coefficient of interest is negative and significant.

Acemoglu et al. (2002) showed that relatively rich areas in 1500 are now relatively poor countries. Their explanation is that in poorer areas Europeans established institutions of private property that favored long-run growth, while in richer areas they established extractive institutions, which discourage investment and economic development. We control for each of the three variables that these authors have used to capture this mechanism: population density in 1500 (column 3), urbanization in 1500 (column 4), and settler mortality (column 5). In all cases the size of the coefficient on BI is at least as large as in the baseline estimations (columns 1 and 2 of Table 2). Although in all cases the coefficient is significant when using robust standard errors, it becomes not significant when using bootstrap CI when controlling for population density in the upper panel, and for urbanization in 1500 in the lower panel. In both cases the control is not significant as well. Since the size of the coefficient is as large as in the baseline model it seems that the inclusion of these variables diminish the precision of the estimation rather than capturing the effect of the variable of interest.

In column (5) of Table 3 we include a measure of state development during colonial times. This is the State Antiquity Index developed by Bockstette et al. (2002). This index captures the presence of a supra-tribal polity in present-day countries. Higher scores are associated with countries where intensive agriculture, urbanization, use of money, taxation, and government administration developed earlier.[46] We use the average of the index from 1500 to 1800 to roughly capture the colonial period. The coefficient of interest is now more significant and larger than the baseline estimation,

very similar in many of the relevant dimensions.

[46]Bockstette et al. (2002) show that earlier state development is a good predictor of recent economic growth, while Hariri (2012) shows it impeded democracy outside Europe because it constrained institutional transplantation.

while the State Antiquity Index has a positive and significant effect on executive constraints. In columns (6) and (7) we introduce geographic variables to control for agricultural productivity and the disease environment. These features influenced the incentives for settlement by colonialists and the distribution and level of income per capita during colonial times (Engerman and Sokoloff, 1997, 2002; Acemoglu et al., 2001, 2002; Easterly and Levine, 2003). In both cases the coefficient of interest is negative and significant, while the new explanatory variables are not.

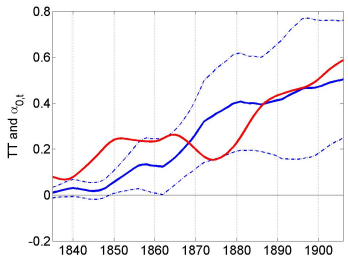
Since including all the controls together is not possible due to the lost degrees of freedom we compute the principal component and use it as an additional control.[47] Results are presented in column (9), where it can be seen that the coefficient of interest is large and significant at the 99% confidence level.

In sum this exercise demonstrates that the channel behind the negative and significant relationship found in Table 2 is likely the one highlighted by the model. Keeping alternative determinants of early state and economic development constant, the fraction of blacks and Indians to total population around 1800 is negatively associated with executive constraints around 1900. To know more about the causes of early institutional development in Latin America we now study the dynamic process of reform. This will allow us to study the institutional effects from the gains in productivity derived from the transport revolution.

Historians have quantified the technological advances in maritime transportation, allowing us to pursue a dynamic econometric exercise. North (1958) constructs an index of ocean freight rates from 1750 to 1913. During most of the years from 1750 to 1815 freight rates were at very high levels, experiencing thereafter two periods of decline, 1815 to 1851, when cargos from Europe were particularly affected, and 1870-73 to 1908-09, when freight rates on the long hauls showed the greatest decline (North, 1958, p.542). Harley (1988) presents an alternative index and shows that the long decline in freight costs started only around 1850, falling by the early 1900s to only about a third of what they were before 1850. Mohammed and Williamson (2004) construct another index that starts in 1870, and show that the pre-World War I sharp decline in real transport costs slowed down during the interwar decades, and fell only modestly after 1950. It is clear then that this transport revolution, which deeply influenced the region's integration with the rest of the world, coincides very closely with the period of reform intensification in Latin America. Figure 7 plots the HP trend of the negative of the ocean freight index reported by North (1958), which we define as an index of transportation technology (TT), against the sequence of coefficients estimated in equation (12). We can see a positive long-run relationship, especially for the period after 1870.[48]

[47] The factor accounts for 55% of the variance of the seven controls. Its correlation with each of these are -0.80 with the wheat-sugar ratio, 0.23 with land inequality, 0.91 with population density in 1500, 0.81 with urbanization in 1500, 0.36 with settler mortality, 0.81 with state antiquity, -0.08 with fertile soil, and -0.73 with latitude.

[48] Harley (1988) argues that the difference between his and North's index is that the latter is dominated by cotton freights, which actually decline before 1850. Using Harley's revised index the rise in TT would start later (around 1850-1860), and we would not observe the subsequent and temporary fall (1865-1875), strengthening the correlation with the sequence of $\alpha_{0,t}$. However we have been unable to access the index, only Figure 1 in Harley's paper.



Notes: Blue lines are the estimated coefficient $\alpha_{0,t}$ from equation 12 and its 90% CI based on robust standard errors. Red line is the Transport Technology index (see Appendix A for details).

Figure 7: Institutional Development and Transportation Technology

First we test if TT had a positive effect on average executive constraints starting in 1850.[49] But it is not easy to rigorously explore this relationship. Although it is clear it was an exogenous shock that affected the whole region, which is good because it can explain the gap jointly with BI, it hinders the search for a significant relationship as there is no exploitable cross-country variation. Therefore we follow an indirect way of testing the hypothesis. We explore the interaction of technological advances with certain characteristics of the countries that, in light of the model's predictions, may have affected the influence of integration on political reform. We select features that are exogenous to the political process, but due to data restrictions, they need to be easily available. The first factor we consider is the distance to the UK. The reason is that the reduction in transport costs affected mostly long-distance sea routes. In particular North (1958) finds that "in the case of any internationally traded bulk commodity the narrowing of the difference between the freight cost on short hauls versus long hauls is the most striking feature" (North, 1958, p.542). Moreover these countries were more isolated before the technological shock. Therefore we expect that as integration improves, countries further away from the UK reform their institutions faster. The second variable is the size of the country. This is the simplest proxy for the potential of diversification of an economy facing a structural change of this sort. In small countries it is very likely that those that have the political power control the few economic sectors. Hence we expect a positive interaction of this variable with our proxy for technological advance.

We estimate a panel regression with data averaged for 5 years from 1850 to 1910 and incorporate time and fixed effects. Notice then that the relationships we measure here are different from those presented in Table 2, as the cross-country variance of the dependent variable is eliminated. We now investigate the slope of the institutional process, not the average.[50] Results are presented in the

[49]The model does not have an unambiguous prediction about the effect of technical change on institutions since this is contingent on the possibility of coercing labor. However, since we observe an increase in average constraints during the period (see Figure 1), we hypothesize the effect on the average was positive. This is useful to validate our variable TT as a significant determinant of political institutions.

[50]The lagged value of the dependent variable is not included in the specification because we are interested in long-run relationships since we do not have predictions for interactions at a higher frequency. Moreover, when the lagged

	Dep. Var.: Executive Constraints					
	(1)	(2)	(3)	(4)	(5)	(6)
Distance to the UK × *TT*	0.14**			0.21***		0.21***
	0.06			*0.06*		*0.06*
Size × *TT*		0.04**		0.08***		0.08***
		0.02		*0.03*		*0.02*
Blacks & Indians (BI) × *TT*			−0.50*	−0.98***		−0.98***
			0.28	*0.31*		*0.31*
TT					0.20***	0.15**
					0.06	*0.06*
R^2	0.15	0.14	0.16	0.23	0.06	0.15
Countries	20	20	17	17	20	17
Periods	12	12	12	12	12	12
Observations	220	220	194	194	220	194

Notes: Time and fixed effects included in all specifications except for (5) and (6) where only fixed effects are included. Robust standard errors are in italics, * means significant at 10%, ** significant at 5%, and *** significant at 1%.

Table 4: Executive Constraints and Transportation Technology, Regression Results.

first two columns of Table 4. As expected, in both cases the interaction with transport technology is positive and significant, suggesting that institutions in more isolated and larger countries were more influenced by the integration process in developing more inclusive political institutions.

Now that we have shown that TT has explanatory power, we test the main prediction of the model, i.e. that technical change has a larger effect on executive constraints as less labor is available to be coerced. In order to do this the third variable we consider in Table 4 is BI. The interaction term is included in column (3) and, as expected, it is negative and significant. In column (4) we add the three explanatory variables together and all the effects become larger and more significant. Hence only countries with a relatively low slave and indigenous populations constrained their executives when the gains of doing so rose due to technological change. If this were the only exogenous shock then the dispersion of constraints rose with it. This is in line with the prediction of the model illustrated in Figure 5.

To get some sense of the size of the effects we include TT as an additional regressor in the equation. This allows us to identify for which level of BI the effect of the technology shock is positive and significant. Of course this is feasible only if time effects are not included in the regressions. These results need to be taken with extreme caution as a spurious relationship is very possible. We include TT as the only regressor in column (5) and, as expected from Figure 7, it is highly significant. In column (6) we add the interaction terms. Taking into account now the independent effect of TT, results imply that only countries with indigenous and black populations

dependent variable is included as a regressor an endogeneity issue is introduced in the regression. Although there are methods to fix this problem we try to keep the exercise as simple as possible given the small number of countries.

below or close to the sample mean saw their institutions improve due to economic integration. The conditional effect becomes negative when TT is high, i.e. institutions get worse due to economic integration. This effect is significant for countries with black and Indian populations close to twice the sample mean.

In sum the results of the econometric exercises performed in this section are consistent with the hypothesis that economic integration and the risk of rebellions due to labor coercion were significant causes for the divergence observed within the region in terms of political institutions.

5 Conclusions

This paper develops a theoretical model where the risk of conflicts due to labor coercion interacts with technical change in shaping endogenous political institutions. Economy-wide technical change increases the costs of empowering the chief executive, since in this case expropriation is easier to perform. However, if the economy faces the risk of rebellions and if these generate uncertain and asymmetric costs to the elites it may be beneficial not to constrain the executive in order to have an ex-ante efficient response to these conflicts.

An ideal environment to which the model is applied is the post independence period in the Americas. Historians have argued that due to their exploitation the risk of uprisings from non-whites was important, and some evidence reviewed in the paper suggests that these risks meet the conditions required by the theoretical model. On the other hand the region experienced a deep structural change in the second half of the last century, when a transport revolution allowed integration with the developed world. The empirical part of the paper focuses on this era, which was characterized by divergent institutional development among Latin American economies. The econometric evidence shows that countries with a low availability of labor to be coerced were able to raise the constraints imposed on the executive after the lost decades following independence, when a process of institutional design could take place at the same time that the technological advance in the transport sector started. But even though these countries were similarly influenced by this technical change, and they were similar to reformer countries before 1870, countries facing a high risk of rebellion kept their executives empowered. This may explain the institutional gap observed in the region during the process of consolidation of oligarchic republics in the first decades of the twentieth century.

Evidence presented in the paper shows that this institutional gap has significant explanatory power for income per capita today, in part due to its subsequent effect on contemporaneous institutions and the subsequent rates of school enrollment. Therefore this paper contributes to a better understanding of the origins of political institutions and their relevance for explaining the large differences in GDP per capita in Latin America.

Appendix A

Sources of Data

Variable	Source	Notes
Executive Constraints	Polity Project, Marshall and Jaggers (2007)	Instances of "standardized authority codes" (i.e., -66, -77, and -88) are converted to conventional scores with a linear interpolation.
Distance to UK	Prados (2009) and sea-distance.com	Prados (2009) presents data on average maritime freight costs from England, c. 1842, by Celia W. Branding, "Un análisis Comparativo del Costo de la Vida en Diversas Capitales de Hispanoamérica (1842)," Boletín Histórico de la Fundación John Boulton, 20(1969):229-66. This data is for 9 countries. For Brazil we use the average for Argentina and Colombia, for Paraguay we use the value for Uruguay. The variable is closely related to the distance to UK, as reported by sea-distance.com. We use this source for the rest of the countries.
Fertile Soil	Nunn and Puga (2012)	
GDP per capita, 1900, 1920, 1950, and 2008.	Maddison (2008)	Maddison (2008) only presents estimates of GDP per capita for 8 Latin American countries for 1900, and 12 in 1920. We add data for Ecuador (1900 and 1920) and the Dominican Republic (1920) from the Montevideo Oxford Latin American Economic History (MOxLAD) Database, after fitting an OLS regression using the countries that are included in both databases. Similar results are obtained using data from Maddison (2008) only, from Astorga et al. (2005), or from MOxLAD only.
Indians and blacks as a fraction of total population, circa 1800.	Mahoney (2003) and McEvedy and Jones (1978)	Data for Brazil and Panama only from McEvedy and Jones (1978).
Land Inequality	Vanhanen (2003)	
Latitude	La Porta et al. (1999)	
Population Denisty in 1500	Acemoglu et al. (2002)	
Primary and secondary school enrollment, per capita, 1900 and 1950.	Banks (1994)	MOxLAD also has data on enrollment rates but for a smaller sample. We use data for Cuban primary enrollment in 1900 from MOxLAD (the predicted value from a linear regression between the two series).
Rough Terrain, Mountains.	Fearon and Laitin (2003)	
Rough Terrain, Small scale	Nunn and Puga (2012)	
Settler Mortality	Acemoglu et al. (2001)	
Size	Parker (1997)	
State Antiquity Index	Bockstette et al. (2002)	
Transport Technology	North (1958)	Negative value of the American Export Freight Rate Index
Urbanization in 1500	Acemoglu et al. (2002)	
Wheat-sugar ratio	Easterly (2007)	

Variables used in Section 4

	Country	XC, 1870-1910	BI	XC_{ind}	RT: Mountains	RT: Small-scale	Dist. to the UK	Size
1	Chile	0.72	0.10	0	4.07	2.48	3.80	0.76
2	Argentina	0.33	0.07	0	3.38	0.78	2.00	2.77
3	Brazil	0.14	0.72	0	1.41	0.24	2.25	8.51
4	Uruguay	0.06	0.02	0	0	0.44	2.00	0.18
5	Peru	0.28	0.61	0	3.88	1.35	4.00	1.29
6	Colombia	0.57	0.17	0.33	3.64	0.89	2.50	1.14
7	Venezuela	0.19	0.13	0	3.10	0.63	3.00	0.91
8	Mexico	0	0.60	0.33	3.47	1.73	2.50	1.97
9	Costa Rica	0.98	0.02	0.33	3.14	2.11	1.97	0.05
10	El Salvador	0.33	0.38	0.33	2.42	1.75	1.96	0.02
11	Guatemala	0.19	0.52	0	3.76	1.81	1.98	0.11
12	Honduras	0.41	0.47	0.33	3.99	2.15	1.96	0.11
13	Paraguay	0.22	0.30	0	0.74	0.25	2.00	0.41
14	Bolivia	0.28	0.53	0.33	3.61	0.85	4.50	1.10
15	Dominican Rep.	0.33	n.a.	0.33	2.86	1.64	1.63	0.05
16	Ecuador	0.33	0.66	0.33	3.66	1.28	4.50	0.28
17	Nicaragua	0.02	0.52	0	2.33	0.99	1.97	0.13
18	Panama	0.33	0.60	0.33	2.56	1.54	1.94	0.08
19	Haiti	0	-	0	2.80	2.36	1.69	0.03
20	Cuba	0.33	n.a.	0.33	1.69	0.53	1.74	0.11

Appendix B

Here we further analyze the relationship between current GDP per capita and executive constraints in 1900-1910, shown in figures 2 and 3. First we show results with bootstrap CI to assess significance levels minimizing the effects of outliers and influential observations. In Table A.1 we show the results for the four years reported in Figure 3, with and without controlling for initial executive constraints, as in Figure 3 (see expression 1).

	GDP pc 2008			*GDP pc 1950*			*GDP pc 1920*			*GDP pc 1900*		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Executive Constraints, 1900-1910	1.21**	1.27*		0.32	0.45		0.36	0.38		0.57	0.32	
($XC_{1900-1910}$)	*0.54*	*0.55*		*0.30*	*0.27*		*0.30*	*0.27*		*0.46*	*0.72*	
Initial Constraints		−0.58			−1.28**			−0.98			−0.93	
(XC_{indep})		*0.87*			*0.63*			*0.65*			*1.47*	
Change in Constraints			1.09*			0.67**			0.53			0.53
($\Delta XC_{1900-1910,indep}$)			*0.43*			*0.27*			*0.27*			*0.38*
Constant	8.07***	8.14***	8.29**	7.56***	7.73***	7.56**	7.16***	7.31***	7.18**	6.85	7.04*	6.93
	0.29	*0.36*	*0.20*	*0.16*	*0.23*	*0.11*	*0.17*	*0.23*	*0.12*	*0.29*	*0.49*	*0.23*
R^2	0.20	0.22	0.20	0.03	0.21	0.15	0.06	0.22	0.18	0.06	0.12	0.11
Countries	20	20	20	20	20	20	14	14	3.74	3.00	3.00	3.00

Notes: Robust standard errors in italics. Significance levels are based on bootstrap bias-corrected and accelerated CI: * means significant at 10%, ** significant at 5%, and *** significant at 1%.

Table A.1: Executive Constraints in 1900-1910 and GDP per capita, Regression Results.

The effect of executive constraints in 1900-1910 on GDP per capita in 2008 is significant at a 95% confidence level based on bootstrap CI (column 1), the same level achieved when using robust standard errors (reported in italics in Table A.1). The significance falls slightly when controlling for initial constraints (column 2). In this case we also see an improvement for GDP per capita in 1950, where the effect would be significant if robust standard errors were used. Then we include the change in constraints since independence, which is significant even for 1950 using bootstrap CI.

Appendix C

Proof of Proposition 1

We can apply the Implicit Function Theorem (IFT) to expression (10) to get,

$$\frac{\partial F}{\partial z} = \Big(\frac{F}{z}\Big)\frac{(1-\lambda-F)}{(1+\alpha)(1-\lambda-F)+F} > 0 \tag{B.1}$$

$$\frac{\partial F}{\partial \lambda} = \frac{-F}{(1+\alpha)(1-\lambda-F)+F} < 0 \tag{B.2}$$

Also $\partial F/\partial m = 0$, $\partial F/\partial k = 0$, and $\partial F/\partial \tau = 0$. Now fix $0 < \gamma < 1$ and express k using (9) and (7) as

$$k = \lambda\Big(m\delta\alpha z\frac{(1-\gamma)}{(1-\gamma m)}\Big)^{\frac{1}{1-\alpha}} \tag{B.3}$$

Hence $k^* > 0$ is unique (of course $k^* = 0$ and $\tau_{\text{WC}} = 1$ is always an equilibrium). Moreover

$$\frac{\partial k}{\partial m} = \frac{k}{m(1-\alpha)(1-\gamma m)} > 0 \tag{B.4}$$

$$\frac{\partial k}{\partial z} = \frac{k}{z(1-\alpha)} > 0 \tag{B.5}$$

and $\partial k/\partial \lambda = k/\lambda > 0$. Since labor is paid its marginal productivity $\pi = \alpha(a+i)$ and $T = \alpha(a+i)(1-m(1-\tau_{\text{WC}})) = \alpha(a+i)(1-m)/(1-\gamma m)$. Because k and F are strictly increasing in z, both a and i, and hence T, are strictly

increasing as well. To see the effect of m on T we differentiate T and use (B.4) to get,

$$\frac{\partial T}{\partial m} = \frac{\alpha(1-\gamma)}{(1-\gamma m)^2}\Big[\frac{(1-m)(1-\gamma m)}{1-\gamma}\alpha i_k \frac{\partial k}{\partial m} - (a+i)\Big] = \frac{\alpha(1-\gamma)}{(1-\gamma m)^2}\Big[\frac{\alpha}{(1-\gamma)(1-\alpha)}\frac{(1-m)i}{m} - (a+i)\Big] \tag{B.6}$$

Using (B.3),

$$\frac{(1-m)i}{m} = z^{\frac{1}{1-\alpha}}\lambda(\delta\alpha(1-\gamma))^{\frac{\alpha}{1-\alpha}}\frac{1-m}{(1-\gamma m)^{\frac{\alpha}{1-\alpha}}}m^{\frac{\alpha}{1-\alpha}-1}$$

Since $\alpha < 1/2$, $\partial(i(1-m)/m)/\partial m < 0$ and $lim_{m\to 0}((1-m)i/m) = \infty$. Hence $lim_{m\to 0}\partial T/\partial m = \infty$, because $lim_{m\to 0}(a+i) = a > 0$, and $\partial T/\partial m = -\alpha(a+i)/(1-\gamma) < 0$ when $m = 1$. The existence of $\underline{m}$ as defined in the proposition comes from the fact that the term inside the square brackets is strictly decreasing in m as $\partial(a+i)/\partial m > 0$.

Finally $\partial i/\partial\lambda > 0$ comes directly from (B.3), and $\partial a/\partial\lambda < 0$ comes directly from (B.2). ***QED.***

Proof of Proposition 2

The FOC of (11) with respect to m is,

$$\delta\Big[\Big(\frac{i}{i+a}\Big)\frac{\alpha(1-m)}{(1-\alpha)m} + \frac{(1-\gamma)^2}{\gamma}\Big] = \phi n\bar{\gamma}\Big[(1-\gamma) - \Big(\frac{i}{i+a}\Big)\frac{\alpha(1-m)}{(1-\alpha)m}\Big] \tag{B.7}$$

Since $\partial(i(1-m)/m)/\partial m < 0$, $\partial(a+i)/\partial m > 0$, $lim_{m\to 0}((1-m)i/m) = \infty$, and $lim_{m\to 0}(a+i) = a > 0$ (see proof of Proposition 1), the LHS in (B.7) is strictly decreasing in m and goes from ∞ when $m \to 0$ to $\delta(1-\gamma)^2/\gamma$ when $m = 1$, and the RHS is strictly increasing in m, and goes from $-\infty$ when $m \to 0$ to $\phi n\bar{\gamma}(1-\gamma)$ when $m = 1$. We then have a unique solution, m^*, which is lower than 1 if $\kappa n\bar{\gamma} > \delta(1-\gamma)/\gamma$, or $\bar{\gamma} > \gamma^* = \delta(1-\gamma)/(\kappa n\gamma) > 0$.

To show $\partial m/\partial\lambda > 0$ when $\bar{\gamma} > \gamma^*$ notice that since $\partial i/\partial\lambda > 0$, $\partial a/\partial\lambda < 0$, and $\partial\phi/\partial\lambda < 0$, an increase in λ raises the LHS and lowers the RHS, which implies that the m that solves (B.7) needs to be strictly higher (strictly because the limits of the two expressions are unchanged so still $m^* \in (0,1)$).

Now we show the relationship with z. Defining H as $LHS - RHS$ of (B.7), we can use the IFT to obtain,

$$\frac{\partial m}{\partial z} = \frac{-1}{\partial H/\partial m}\Big[\frac{\partial(i/(i+a))}{\partial z}c(m)(\delta+\phi n\bar{\gamma}) - \frac{\partial\phi}{\partial z}n\bar{\gamma}\Big((1-\gamma) - \Big(\frac{i}{i+a}\Big)c(m)\Big)\Big] \tag{B.8}$$

where $c(m) = \alpha(1-m)/(1-\alpha)m$. Using

$$\frac{\partial(i/(i+a))}{\partial z} = \frac{ai}{z(a+i)^2}\Big(\frac{\alpha}{1-\alpha} - (1-\alpha)s(F,\lambda)\Big),$$

where

$$s(F,\lambda) = \frac{(1-\lambda-F)}{(1+\alpha)(1-\lambda-F)+F} = \frac{1}{(1+\alpha)+zF^{-\alpha}},$$

and

$$\frac{\partial\phi}{\partial z} = \phi s(F,\lambda)\frac{F}{(1-F)z}$$

in (B.8) we get,

$$\frac{\partial m}{\partial z} = \frac{-\phi F/z}{\partial H/\partial m}\Big[\frac{zi(F^{-\alpha}+F^{-1})}{(a+i)^2}\Big(\frac{\alpha}{1-\alpha} - (1-\alpha)s(F,\lambda)\Big)c(m)(\frac{\delta}{\phi}+n\bar{\gamma}) - \frac{1}{1-F}s(F,\lambda)n\bar{\gamma}\Big((1-\gamma) - \Big(\frac{i}{i+a}\Big)c(m)\Big)\Big] \tag{B.9}$$

Because $\partial H/\partial m < 0$, the sign of this expression is given by the sign of the term inside the square brackets. If $\lambda \to 0$, the first term converges to 0 (because $i \to 0$ and all the other terms converge to finite constants), while the second term converges to $1/(1-F)s(F,\lambda)n\bar{\gamma}(1-\gamma) > 0$. Hence $lim_{\lambda\to 0}\partial m/\partial z < 0$. If $\lambda \to 1$, the first term converges to ∞ (because $F \to 0$, $s(F,\lambda) \to 0$, and all the other terms converge to finite constants), while the second term converges to 0. Hence $lim_{\lambda\to 1}\partial m/\partial z > 0$. And since the term inside the square brackets is strictly increasing in λ (because $\partial F/\partial\lambda < 0$, $\partial(i/(i+a)^2)/\partial\lambda > 0$ (see B.10 below), $\partial s(F,\lambda)/\partial\lambda < 0$, $\partial\phi/\partial\lambda < 0$), we conclude there exists $\bar{\lambda}$ as defined in the proposition. Finally, since the term outside the parenthesis is decreasing in λ, and when $\lambda > \bar{\lambda}$ the term inside the square brackets is increasing in λ, we conclude that $\partial m/\partial z$ is increasing in λ in this case.

It is left to show $\partial(i/(i+a)^2)/\partial\lambda > 0$. Taking the derivative,

$$\frac{\partial(i/(i+a)^2)}{\partial\lambda} = \frac{i}{\lambda(i+a)^3}\Big[a\Big(1 + \frac{2\lambda(1-\alpha)}{(1+\alpha)(1-\lambda-F)+F}\Big) - i\Big] \tag{B.10}$$

since the term multiplying a is greater than 1, the fact that $a = z(1+F)^{1-\alpha} > z > max(i) = z\lambda^{1-\alpha}$, implies that the derivative is positive. ***QED.***

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