Explorations in Latin American economic history

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Warsaw, Poland
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Javier L. Arnaut

Chapter 1

Explorations in Latin American Economic History

1.1 Preface

This dissertation takes a quest for an empirical exploration of key macro-historical questions in Latin America's economic development. It addresses previous historiographical inquiries of early modern and modern Latin American history. The assortment of these questions is motivated by the economic literature of historical legacies.[1] Various generations of scholars have questioned whether major historical junctures such as the financial decay of *colonialism* in the late eighteenth and early nineteenth century; the emergence of dictatorships and *revolutions* in the mid- nineteenth and early twentieth century; and the rise of *protectionism* in the mid-twentieth century have determined the fate of relative underperformance of the region.[2]

The underlying notion of associating legacies to current underperformance often involves the hypothesis of "path-dependence". Acemoglu and Robinson (2012: 101) argue that a path-dependent process stems from *critical junctures*. These are "major events or a confluence of factors disrupting the existing political and economic balance in one or many societies". Accordingly, these junctures appear typically in periods of crisis that are followed by radical institutional/policy changes influencing permanently the long-term development path (e.g. Mahoney, 2000; David, 2007).[3]

[1] See a broad review of this literature in Nunn (2014) and Spolaore and Wacziarg (2013).

[2] See for e.g. Centeno (2002) on the legacies of civil wars in the nineteenth century. See also, Coatsworth (1993) for a general view on Latin America's relative underperformance since colonial times.

[3] See also, Mahoney and Schensul (2006) for an overview of the historical-institutionalist literature on path-dependence.

Although the periodization of Latin American history is still much debated, various historians have used major economic and political junctures as temporal borderlines to demarcate a broad long-term periodization. Notwithstanding other distinctive periods, this thesis builds on the periodization that is related to the common understanding among economic historians tracing key historical junctures in Latin America in the following periods: *Colonialism* (c.1520-c.1820); *Belle Époque* (c.1870-c.1910); *State-led industrialization* (c.1930-c.1975); *Restructuring and market reforms* (c.1975-2010).[4] Aside from the temporal discontinuities across themes, this periodization may not perfectly match in every single country because of the regional diversity of Latin America. However, although some authors have defined additional sub-periods, this broad periodization captures a global trend in Latin American historiography encompassing key turning points.[5]

This dissertation's empirical exploration draws on a cliometric approach combining the advances of statistical methods and long-term historical data with the aim to provide new empirical evidence on four major topics in Latin American economic history: *fiscal sustainability, real wages, structural change, and productivity catch up.* Yet, it does not intend to analyze these phenomena as continuous historical processes impacting on current outcomes as often is implicit in empirical studies. The analysis follows the inductive methodological tradition of quantitative economic history looking to examine directly the historical junctures by revisiting and testing statistically how well do historical 'facts' travel across time employing theory and a combination of historical datasets.[6]

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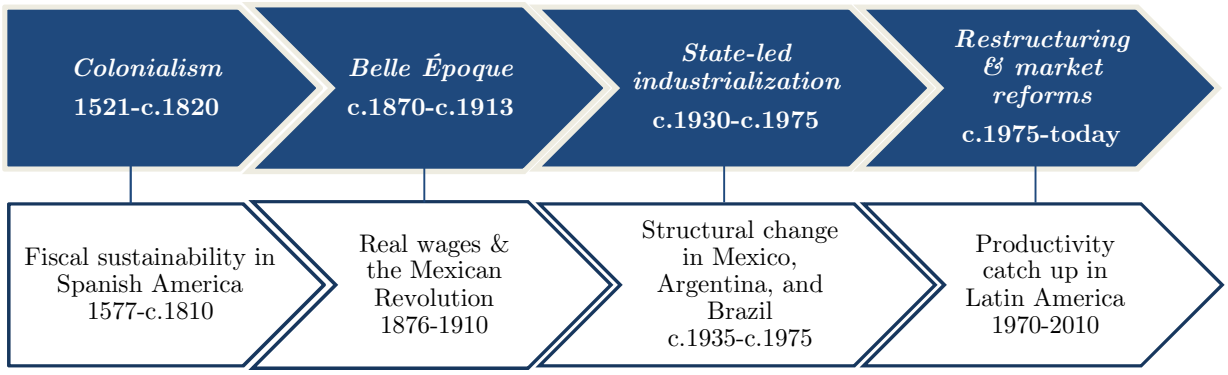
[4] This categorization can be regarded as a conventional periodization linked to the long-term fluctuations of the global economy. There are other approaches that use other historical notions of a 'long-term' process (see for e.g. Adelman, *Latin American longues durées*). The present analysis focuses on the periodization typically mentioned (e.g. Bulmer-Thomas, 2003) in the quantitative historical research that associates major institutional changes and the issue of relative economic backwardness. For instance, in the work of Coatsworth (1993, 2008) and Haber (1997) the 'falling behind' of the region as a whole (in per capita GDP terms) is traced specifically to long periods between the colonial era and the nineteenth century. For a general discussion see, Coatsworth (2005) and Prados de la Escosura (2007). For a survey of arguments locating the origins of the relative backwardness in the mid-twentieth century see, Edwards (2009) and Taylor (1998). On the persistent growth effects from the institutional and market reforms in the last quarter of the twentieth century, see Grilli (2005) and Zettelmeyer (2006).

[5] In the literature of critical junctures, a change (institutional) as such is not the only reason to consider it as an historical juncture because this change may eventually lead to the restoration of the pre-juncture status quo (see, Capoccia and Kelemen 2007). Thus, this periodization holds under the assumption that the depiction in the historiography related to these junctures are permanent (or 'irreversible') processes.

[6] See a recent review on this inductive cliometric approach in Haupert (2016).

Figure 1.1 Historical periods and topics analyzed in the dissertation



Note: Based on the general thesis outline.

Much of the ongoing econometric literature on legacies in Latin America relies on transversal (cross-sectional) evidence, connecting present outcomes (e.g. today's output measures) to a set of historical variables. The economics of colonialism in the Americas has been studied extensively using this empirical methodology.[7] However, although the idea of tracing colonial contexts to explain current outcomes may be well represented with this approach, the nuances of the historical evolution of the economic subjects during colonialism is often unobservable. As the celebrated economist Richard Easterlin (2013) argues, those methods (cross-sections) tend to "register the results of history not insights into likely [historical] experience".[8]

This thesis explores Latin America's historical junctures by examining the fiscal sustainability of the colonial system in the Americas with a longitudinal empirical view. Yet, the topic of colonialism in Latin America offers many macro-historical questions that are not limited to fiscal matters. My choice for the fiscal issue is motivated by the following reasons. It has been generally presumed that the colonial fiscal regime was at one point 'unsustainable' for the local economies of Spanish America. Various historical studies have documented that this phenomenon occurred during periods of economic crises in which the Spanish crown forced its American treasuries to finance the imperial needs (e.g. Stein and Stein, 2003; Marichal, 2007). However, despite the relevance of this feature in colonial economic history and its interrelations with other key topics, the historical literature has not substantiated this conventional wisdom in a systematic and empirical way.

[7] The most influential empirical work is the *Reversal of Fortune* hypothesis (Acemoglu et al. 2002). See a similar approach in Bruhn and Gallego (2012) on the diversity of colonial institutions on current GDP measures.

[8] Easterlin, 'Cross-sections are history', p. 5. See an analogous methodological reflection in Austin (2008).

Whether the colonial system in the Americas was fiscally unsustainable or not is a big, important empirical question in the historiography of colonialism; not only judged by the need to 'validate' distant cross-sections with a more nuanced longitudinal view, but also for a quantitative understanding of the persistence or discontinuity of the colonial 'fiscality' during the colonial period (e.g. Sokoloff and Zolt, 2007). Furthermore, there is an increasing interest in looking at the empires' fiscal capacity to sustain economic growth by tracing eventual turning points through sharper long-run macroeconomic aggregates (e.g. Dincecco, 2015). Thus, through a re-construction of time-series data, the next chapter provides an empirical reassessment of the Spanish American treasuries trying to unveil statistically whether these Spanish American finances followed sustainable long-term paths across time and space.

However, the colonial period has not been the only focal point in the literature of path-dependence. Seminal studies have also attempted to analyze turning points in other periods. The pre-World War I period known as the *Belle Époque* (1870-1913) has received special attention for the unprecedented economic prosperity (e.g. O'Rourke and Williamson, 1999; Daudin et al., 2010). For the case of Latin America this can be exemplified by the contentious decades in Mexico's *Porfiriato* (1877-1910). The Porfiriato has been a controversial issue in the historiography not because the exceptional growth performance was a juncture in itself, but because of the widespread belief that the economic exceptionalism coincided with a decline in the country's living standards paving the way for the revolution (see for e.g. Knight, 1990)

Undoubtedly, the Mexican Revolution in 1910 was a critical juncture because it was a radical change that has shaped permanently the institutions of present Mexico. However, the *regional* economic factors that led to that juncture have been underexplored empirically. While there are some empirical studies using sub-national data looking to uncover the path-dependence outcomes of the Porfiriato (e.g. Dell, 2012), little emphasis has been given to the 'direct' evolution of regional living standards of Mexican worker's during that period. Naturally, focusing on the sub-national trends of living standards during this juncture does not imply that this was the key driver of the revolution, but certainly it is not a trivial one. A quantitative revision of the regional patterns of real wages under the Porfiriato may shed new insights on how relevant regional economic factors were in this critical juncture in Mexican history.

In a similar fashion, for many scholars the post-revolutionary period and in particular the middle decades of the twentieth century are regarded as another turning point in Latin America.[9] The disruption of world trade caused by the Great Depression and Second World War meant the beginning of an era of 'inward-looking' development

[9] For e.g., in the seminal analysis of Collier and Collier (1991) the decades after the Mexican revolution are regarded as a critical juncture for Latin America because of the unprecedented incorporation of the labor movement in the industrialization agenda. See a similar view in Soifer (2012).

in countries like Mexico, Brazil, and Argentina; a period also epitomized as *State-led industrialization* (e.g. Bulmer-Thomas, 2003; Bértola and Ocampo, 2012). The outcomes from autarkic policies based on trade protectionism implemented in this period have been highly controversial in the historiography. Whereas some authors have praised the economic achievements under these policies others have regarded them as the culprit of the subsequent economic underperformance. The present work adds new evidence to this discussion to further understand whether the positive effects of these policies were materialized in key industrial sectors in major Latin American countries.

Moreover, the commitment of Latin American governments to the protectionist paradigm as a vehicle to transform their economies can be regarded as analogous to the 'promise' from the *restructuring and market reforms* framed in the late-1970s and implemented extensively across the region by the 1980s. While catching up to the world's economic frontier was the underlying goal under the protectionist autarky (1930s-1970s), a similar parallel outcome was expected under the restructuring phase and market-oriented reforms (post-1975). Although the reform process is still underway, the initial market reforms in 1980s have been widely regarded as a major turning point influencing today's development policy. The last theme analyzed in this thesis attempts to examine a long-standing question on whether upgrading economic, legal, and political institutions has had an effect on productivity growth and 'catch up' to the frontier.

The selection of these macro-historical questions, evidently, is not the whole story of the turning points related to Latin America's long-run economic backwardness. The questions associated to the deep or 'ultimate' causes like the role of institutions on economic growth have been leading topics.[10] However, the 'proximate' causes assessed here such as the issues of colonial fiscality, real wages, structural change, and productivity catch up are themselves central to understand how ultimate causes can operate and can be readably assessed (Maddison, 1991: 11).

Focusing on such a broad range of economic history questions across different thematic subfields carry a methodological shortcoming: the implausibility of relying on a single and generalized model. Thus, this work draws on a wide toolbox of theoretical and empirical concepts applied to the corresponding sets of historical data; a well-known methodological approach built in the tradition of cliometrics.[11]

[10] See in particular the monograph collection related to these issues in Fukuyama (2008); Ocampo and Ros (2011); and Edwards et al. (2007).

[11] For an historiographical overview and evolution of cliometrics as a discipline see, Greif (1997). See the recent empirical developments in Greasley and Oxley (2011) and Diebolt and Haupert (2016).

1.2. Analytical framework

As will be shown in the ensuing chapters, the four themes' theoretical background frequently touches upon the interactions between economics and institutions. This intersection in quantitative economic history analysis has a vast tradition rooted in the so-called 'New Economic History'. This practice has been also referred to as the 'Cliometric Revolution' because of the unparalleled proliferation in the use of statistical methods among economic historians during the 1960s. The framework evolved within the American scholarship from compiling statistical data and applying neoclassical concepts into a more integral analytical framework placing the link between institutions and long-run economic performance in the center stage.[12] Influenced by the Coase theorem, the work of Douglass North and Robert Fogel allowed cliometrics to go beyond the neoclassical paradigm recognizing the different interactions between institutions and economic performance (Goldin, 1995; Wallis, 2016).

The succeeding scholarship of cliometricians incorporated the neoclassical framework viewing it "as a theory of choice subject to constraints; employing price theory as an essential part of the analysis of institutions; and the change in relative prices as a major force inducing change in institutions" (North, 1995: 2). The 'neo-institutional' approach to history however, expanded and modified the neoclassical paradigm aiming to resolve the problems to explain the market failures of resource allocation. Essentially, this perspective maintains that economic progress (or lack of it) has been the result of productivity increases generated by the efficient (or inefficient) allocation of factors of production through functioning market institutions.[13] The incorporation of institutional mechanisms such as property rights, credible commitments, and various notions of *imperfect competition* into the historical discipline opened new directions for social analysis (Oxley and Greasley, 2010).[14]

According to Oliver Williamson's (2000) seminal classification of social analysis, it is possible to categorize *four* levels: 1) embeddedness and informal rules; 2) institutional

[12] Although decades later and relatively less common, studies following this methodology also emerged within the Latin American's scholarship. For instance, the work of John H. Coatsworth on Mexican railroads and Jeffrey Williamson's research on Latin America's long-run trade and inequality pioneered the agenda in this regard. See Haber (1997) and Love (2005) for a review of the evolution of the historiography in Latin America. Also, see Yáñez (2015) for a recent collection of contributions containing new cliometric data for different Latin American countries.

[13] Institutions understood as laws, rules (formal and informal), and agreements within a society (North 1990).

[14] See for e.g. Alston et al (1996).

environment and social rules; 3) governance and transaction costs; and 4) allocation of resources.

The underlying framework in this thesis focuses mainly on the *fourth level* of analysis (allocation of resources) or what Williamson calls 'getting the marginal conditions right'.[15] The logic followed in each chapter draws on a basic macroeconomic approach, attempting to test empirically some of the core principles of the resource allocation approach against the historical records of Latin American economies. This 'standard' theory encompasses the subfields of public finance and income distribution to find the conditions that lead to 'socially efficient' outcomes. Accordingly, in a regime of market failure, economic resources under weak institutions (i.e. poorly specified property rights, credible commitments, etc.) may generate allocative inefficiency, and hence the need for corrective policies and the promotion of 'good' institutions.[16]

Through this standard background, the chapters aim to describe and interpret different historical junctures using the following principles separately and respectively:[17] a) *Government budget constraint;* b) *Factor-price equalization;* c) *Factor reallocation;* and d) *Productivity catch up.*

a) *Government budget constraint.* - Various studies using the framework of the efficiency of resource allocation in public finance have pointed out the relevance in understanding the relationship between the sustainability of government finance and concrete historical turning points (e.g. Sargent and Velde, 1995; Dempster, 2006). This standard macroeconomic approach suggests that there is an intertemporal budget constraint that limits the ability of governments to finance deficits. The government spending is financed through a combination of tax revenues, money supply, and debt financing. Thus, if there are restrictions (across time) on these aggregates then the government's budget can be binding. The relevance of binding to this constraint is key for the institutional principle of a 'credible commitment' to a long-term fiscal sustainability.[18] The depiction of the financial weakening of Spanish American economies in different time intervals has been common in the historical literature. Those descriptions pose questions on whether the

[15] Williamson (2000; 597)

[16] In the sense that institutions and policies would promote a movement towards a *Pareto frontier*. Evidently the idealization of the (constrained) Pareto optimality is merely a normative theoretical tool to understand the counterfactuals and derive testable hypotheses. See for e.g. Bates (1995) for a critical assessment of these assumptions within the 'New Institutional Economics' and its applicability to history.

[17] These principles are applied 'separately and respectively' because they are not employed altogether on each historical juncture analyzed. Instead, these are assorted accordingly; one theoretical principle on one particular juncture.

[18] The most common example of the vital role of credible commitments to fiscal sustainability is the seminal work of North and Weingast (1989). In broad terms, they argued that the English Parliament after the Glorious Revolution provided a solid credible commitment not to default on its debt in the future which allegedly became a precondition for the Industrial Revolution.

local treasuries where near or over these theoretical budget restrictions in the long-run and whether these potential fiscal imbalances are linked to the political tensions between the Crown and the local authorities in the onset of the eighteenth and start of the nineteenth century.

b) *Factor-price equalization.* – Another standard macroeconomic principle dealing with resource allocation efficiency is the factor-price equalization model in international trade. This model suggests that an uninterrupted trade across nations will lead to the equalization of goods prices and factor prices. In the case of labor, the specialization in factor-abundant production combined with free interregional trade results in equal wages across regions for workers with similar skills. However, the equalization process is not immediate but a long run process of convergence. This framework has helped economic historians to explain the price adjustments of goods and services in the global market over long periods of time. O'Rourke and Williamson (2001) found that during the *Belle Époque* a process of convergence occurred with prices of commodities and wages among the most open economies. This was driven in particular by the early process of globalization characterized by mass migration and a decline in transportation costs. The theoretical notion of wage convergence has been applied at the regional level across countries in recent time-periods (e.g. Rodriguez-Pose 2012) but to a much lesser degree on historical case-studies in the developing world.

c) *Factor reallocation.* - According to Kuznets (1973) one of the main features in the process of economic growth is structural transformation, defined as the reallocation of economic activity across the broad sectors agriculture, manufacturing and services. This general notion emanates typically from the standard neoclassical growth model (Solow 1956), where production factors (capital and labor) move to more efficient uses within the economic space. Accordingly, the differences in marginal productivity and differentials in productivity growth generate movements of input factors from sectors with lower productivity to those with higher productivity (Jorgenson 1998). While this neoclassical view focuses on the growth process of industries within sectors, other approaches like the dual-economy model of Lewis (1954) focuses on inter-sectoral interrelationships. Empirical studies have considered these notions (neoclassical and dual-economy) as complementary, quantifying both channels of growth 'within' and 'across sectors' (Herrendorf et al 2013; Rodrik 2013).

d) *Productivity catch up.* – A well-known notion in the neoclassical growth model is that catch up (or *convergence*) is driven by diminishing returns to aggregate capital, and in the long-run the growth of output per capita is determined only by the rate of exogenously determined technological progress (after accounting for the effect of capital accumulation). Conditional catch up occurs when output per capita levels of countries far removed from the leader's output per capita levels converge towards the 'steady-state' of the leader if they have similar savings rates for both physical capital and human capital as a share of output (if these parameters are not similar then these will reach to different steady-states). In this, catch up is conditional on savings, depreciation, population growth, and human capital (Mankiw et al., 1992). Similarly, the so-called Schumpeterian growth models

predict a process of conditional catch up as in neoclassical models, where the driving factors are 'imitation' and technology 'transfer' that can be shaped by policies and institutions (Aghion and Howitt, 2006). Empirically, although there is an emerging growth literature on the underlying forces driving the catch up patterns, evidence is still not definitive, varying according to the dimension of analysis (aggregate, sectoral, or industry level), countries, and periodization considered.

1.3. Outline of the dissertation

Chapter 2: The fiscal sustainability of colonialism: a new exploration to the Spanish American treasuries, c.1577-c.1810

The opening topic addressed in this thesis concerns the following question: Is the argument of the historiography regarding colonial fiscal sustainability consistent with standard public finance theory and can it also be empirically verified employing long-span data over the entire colonial period (c.1570-c.1810)? A typical argument used to answer the issue of fiscal sustainability in this period is to determine if there were more economic costs than benefits during and after colonialism. Various studies (e.g. Prados de la Escosura & Amaral, 1993) have already shown that the economic benefits from independence were low and proportional to the ones under the colonial regime.[19] However, the underlying empirical question that precedes the issue on the burden of colonialism is whether the colonial fiscal system was in itself economically self-sufficient before independence.

For various economic historians the management of the economies of Spanish America shaped the evolution of institutions, tax structures, and the growth performance during and after colonialism (e.g. Engerman and Zolt, 2007; Marichal and Carmagnani, 2001). Empirical studies have been chiefly attentive to the long-term fiscal dynamics of the Spanish American treasuries (cajas reales) because in the absence of other reliable statistics of economic activity, the records on public finance have helped to reveal indirectly the growth performance of the region (see for e.g. TePaske and Klein 1986; Garner 1988).[20]

Scholars have reconstructed the colonial treasuries with relative success unveiling the complexity of the imperial mechanisms to manage the fiscal resources of the colonial Spanish America. However, they have not yet provided a clear picture of the 'real' long-

[19] For a discussion on the economic effects of independence see, Prados de la Escosura and Amaral (1993), and Prados De La Escosura (2009).

[20] Also, Ponzio (2005), TePaske (1988), Klein (1994), and Marichal (2008).

run fiscal dynamics of the colonies. For instance, the colonial historian Kenneth Andrien (1995: 190) argues: "...colonial officials were successful in raising [imperial] revenue... but in the 'long run' predatory policies, disrupted business, trade, and capital accumulation". The Mexican historian Carlos Marichal (2007, 249) argues: "In summary, the Crown's fiscal policy weighed unequally on New Spain's population [...]. At the end of the century the finances of Spanish American viceroyalties were crumbling, slowly but surely".

On the other hand, according to Grafe and Irigoin (2006), the imperial fiscal system "...aimed at making the colonies [fiscally] self-sufficient, with intra-colonial transfers covering the needs of regions that either could not or would not raise sufficient revenue".[21] Under the latter logic, it would be difficult to portray the colonial regime in the Americas as a purely 'extractive' fiscal system since the intra-regional income transfers may have promoted growth across the regions, making the finances of the Spanish American colonies sustainable. In general, most of existing quantitative analysis have employed sound data for the mid-eighteen centuries and the primary concern has been to look solely at the mechanisms of the fiscal apparatus during that period; yet, a systematic examination over different colonial periods on whether those mechanisms made the imperial system fiscally sustainable has been overlooked so far. Furthermore, most of these studies analyzing the long-term performance of colonial public finance have neglected a fundamental financial problem: the changing value of money across time.

Chapter 2 of this thesis aims to fill these historiographical gaps examining empirically the long-run fiscal sustainability of the colonial treasuries of Spanish America. It introduces the basic macroeconomic framework of the government budget constraint into the historical case of the Spanish American finances to show statistical evidence on how these macroeconomic conditions changed over time in different colonies. Furthermore, it provides new estimates by adjusting the fiscal series of major colonial treasuries for inflation.

Findings suggest the long-run fiscal performance of the treasuries can be misleading when inflation is not taken into account; the colonial finances of the largest caja for the Spanish empire, Mexico City, can be misrepresented for the period of 1760-1813. Also, for Peru when inflation is not considered, total revenues and expenditures in Lima's caja are undervalued for most of the seventeenth century.

Moreover, there was a shifting process of fiscal sustainability between the colonial treasuries across centuries. While the treasuries of New Spain were unsustainable during the 'Habsburg reign', Peru's treasuries experienced a sustainable fiscal pattern. During the period of 'succession and transition', New Spain's treasuries restored their sustainability in contrast to Peru and Buenos Aires. And finally, in the period of the 'reformism and Napoleonic wars', the treasuries of New Spain deteriorated vastly reaching to an unsustainable position, contrary to their counterparts in Peru and Rio de la Plata.

[21] Grafe and Irigoin (2006: 263).

Chapter 3: Real wages and the Mexican Revolution: a quantitative reappraisal, 1876-1910

The second historical turning point addressed in this work is a rather different historical context; the period following the post-independence decades, that is, the *Belle Époque* (c.1870-1913). The global buoyancy of those years has sparked the attention of numerous economists mostly for the integration of the world economy as a result of the globalization of trade. However, global economic prosperity carried an unprecedented rise in income inequality, an issue that has motived the emergence of new quantitative studies particularly on peripheral regions like Latin America.[22]

This period of high economic growth and income inequality coincide with a contentious period in the economic history of Mexico, the so-called *Porfiriato* (1876-1910). Despite the great economic achievements, this era is considered infamous owing to the political authoritarianism and social segregation which culminated in the world's first armed uprising of the twentieth century: The Mexican Revolution. Various scholars have claimed that the economic and social inequality and in particular a deterioration of the Mexican worker's living standards in those years inspired the popular support for the revolutionary forces that overthrew the dictatorial regime in 1910.[23]

Did worker's living standards really decline during this period in Mexico? **Chapter 3** examines this question by addressing in depth the assumption of a relationship of a declining trend of real wages and the Mexican Revolution. The findings based on regional data show that estimated lower-bound regionally-adjusted wages remained relatively stable in most of the Mexican regions throughout the period. Although these wages followed divergent within-country patterns and there was a slight declining trend in wages of the industrial sector of the Pacific South region, from a broader quantitative perspective there was no dramatic decline as the conventional literature argues. The present estimates indicate that the interpretation of a secular decline in workers' living standards in Mexico from 1877-1910 does not have strong quantitative foundations.

However, a pattern of real wage divergence across regions was a salient feature. The regions in the Center and Pacific South of the country experienced slower real wage growth relative to the North, Pacific-North, and Gulf generating wide sectoral wage gaps. A tension between the forces of regional convergence and divergence emerged in which prevalent labor market institutions in Mexico tended to promote regional divergence,

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[22] Williamson (2015); Frankema (2009); and Bértola and Williamson (2003).

[23] See for instance, Knight (1990). Also in Nickel, H. J. (1988). Agricultural Labourers in the Mexican Revolution (1910–40): Some Hypotheses and Facts about Participation and Restraint in the Highlands of Puebla-Tlaxcala. In *Riot, Rebellion and Revolution. Rural Social Conflict in Mexico,* Princeton.

keeping structural labor market barriers that prevented inter-regional labor mobility and income convergence within the country.

Chapter 4: Did import substitution promote structural change? A comparative study of manufacturing productivity in Mexico, Argentina, and Brazil, 1935-1975

The decades after the Mexican Revolution are regarded as the years of state-led industrialization not only for Mexico but also for other major countries like Brazil and Argentina. In general, the period spanning the decades of the 1930s to the 1970s has been seen as an era of remarkable economic success for the majority of Latin American countries. According to prevalent literature there was an overall improvement in the population's living standards, particularly after the Second World War.[24] As a result this period is considered as the 'Golden Age' of Latin America.[25] Allegedly, the economic achievements took place under a regime of strong state intervention characterized by an economic strategy of industrial protection also known as 'import substitution'. Paradoxically, in the international comparisons of per capita GDP (Gross Domestic Product) by Prados de la Escosura (2007) it is suggested that it was precisely during these years when Latin America fell behind to a set of high-income countries.

In light of this paradox, the subject matter examined in **chapter 4** is centered on one of the ultimate objectives of industrial policy, "reallocation" labor and capital from traditional to modern economic activities in order to increase overall productivity, a feature known as *structural change.* Many authors have also implied that the fast pace of productivity growth may have stemmed from this process. Rodrik (2008), and McMillan *et al.* (2014) using aggregated data have found that in relative terms, structural change in Latin America was higher during the years of protectionism (import substitution) than during the post-liberalization period. Did the policies of import substitution really generate structural change?

Using a higher degree of data disaggregation, this chapter tackles empirically the competing views on productivity and structural change during the period of 1935-1975 in three Latin American countries: Mexico, Argentina, and Brazil. It tests the existence of a *structural bonus/burden* within manufacturing industries by analyzing whether there were significant labor input shifts from less to more productive manufacturing branches induced by tariff policies. The analysis employs disaggregated data from official industrial censuses and produces new estimates of labor productivity for 1935/39, 1950, and 1975.

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[24] e.g. Thorp (1998). See also in Astorga et al. (2005).

[25] For instance, Ocampo and Ros (2011: 10) paraphrased the prominent economist Albert Hirschman for his expression on the period of 1950-1980 as 'les trente glorieuses'.

Next, it decomposes the components of productivity growth in manufacturing industries by applying a shift-share analysis to this newly compiled data.

Estimates from the analysis are unable to find significant evidence of structural change within manufacturing in these countries over the period. The reallocation of labor within the sector did not provide an extra bonus to aggregate productivity growth in addition to growth within individual branches. Most of these branches (food and beverages; textiles and wearing apparel) were by nature labor-intensive and contributed the most to overall productivity growth. Needless to say, one of the broad accomplishments of import substitution was the development of a productive 'light' industry; however, despite the government incentives in protecting other more relatively sophisticated sectors (machinery, transport equipment, and chemicals) with capital-intensive technologies, manufacturing remained 'stuck' into traditional industrial activities.

Chapter 5: Catching up, falling behind, and the role of institutions: Explaining productivity growth in Latin America and Asia from a sectoral perspective

Lastly, earlier and new generations of economic historians have examined the nature of institutions and their impact on long-term performance taking Latin America as a 'natural experiment'. From the celebrated economic historian Alexander Gerschenkron (1962) whose 'catch-up' theory is based on developing regions like Latin America and Eastern Europe's economic characteristics, to seminal works of political economy such as North *et al.* (2000), institutions have been a central part to explain the region's underdevelopment.[26]

However, the existing empirical literature has been unclear in answering which institutions matter the most for long-term growth. **Chapter 5** investigates the role of a set of different institutions in the process of catching up at the sectoral level. Employing various indicators of institutional quality, it examines through a panel dataset the partial effects of a set of institutions on sectoral productivity growth. Drawing on the range of sectoral data from 1970 to 2010, the empirical analysis is based on nineteen 'catch up' economies and taking the United States as the technology leader.

The empirical approach relies on a re-arranged version of the Nelson-Phelps catch up model of technology diffusion. The analysis points out different channels in which institutional quality impacts sectoral productivity growth. Controlling for other growth factors, institutions which interacted with the distance to the frontier affected positively and significantly the growth of labor productivity at the sectoral level. This indicates

[26] See also in P. Gootenberg, 'Hijos of Dr. Gerschenkron'.

that backward sectors in countries endowed with higher institutional quality grow faster than in sectors of countries with lower institutional quality.

Following the empirical specification, I analyzed the different effects that the same institutions have on sectors far-removed from the frontier. The results point to different channels through which institutional quality impacts on sectoral productivity growth. Greater freedom in the legal structure and property rights, freedom from tight market regulations, greater access to sound money, and a small and more efficient government, all in a different magnitude affected positively the growth of sectoral productivity.

In hindsight the results are in line with the body of literature of the so-called 'New Institutional Economics' regarding the prominence of 'market-friendly' institutions in enhancing productivity growth in the long-run. However, in spite of controlling for country and time-invariant factors, estimates are sensitive to the sample selection. The model predictions apply to the majority of the sectors in the Asian sample. On the other hand, sectoral productivity growth in Latin America is not statistically associated with the quality of property rights and market regulations; only in the mining and construction sectors, productivity is statistically associated with the reduction in the size of government and with a better access to sound money. The lessons that this last chapter provides are fundamental for understanding the long-standing debate on the quality of institutions and the appropriateness of transplanting 'good' institutions into underdeveloped regions.

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Chapter 2

The Fiscal Sustainability of Colonialism: A New Exploration of the Spanish American Treasuries, 1576-1810*

"The Indies and Spain represent two powers under the same sovereign;
but the Indies is the main one and Spain is merely an accessory"

— Montesquieu, 1725

2.1 Introduction

In addition to explanations related to the political and social disputes between Spaniards and 'creoles' as chief precursors of the Spanish American independence, various historians have argued that the emancipation of the colonies from Spain originated from the critical situation of the finances of the imperial regime.[27] Several studies have indicated that the financial weakness at the end of the eighteenth century was a key catalyst for the independence movements in Spanish America.[28] For instance, the Mexican historian Carlos Marichal argues:

* A version of this chapter appears also as Arnaut (2017) 'Was colonialism fiscally sustainable?'.

[27] See an overview in V. Uribe, 'The enigma of Latin American independence'; and in G. Paquette, 'The dissolution'.

[28] For example, in C. Archer, 'Bourbon Finances and Military Policy in New Spain'; Stein, S. J., and Stein, B. H. *Apogee of empire*; and in Johnson, L. *The Political Economy of Spanish America.*

> "It was clearly the war that finally undermined the royal administration, but the weakening of the fiscal and financial system was also a key factor (for the declaration of independence)".[29]

Quantitative research has shown that the military conflicts with Britain and France in the last years of the eighteenth century and at the onset of the nineteenth century weakened the public finance of Spain and its American colonies enormously. However, could the financial weakening have been part of a much broader fiscal process originating from previous periods which gradually accrued and culminated in the financial collapse that led to independence? Determining an ultimate combination of the causes of the Spanish American independence would be an empirical task beyond the scope of this chapter. Instead of examining the fiscal performance during the last years of the Spanish 'Bourbon' regime (c.1780-1808), this chapter attempts to re-evaluate quantitatively the long-run fiscal dynamics of the finances of the Spanish American colonies from c.1580 to c.1810.[30]

Naturally, this is not the first attempt to conduct this task. Over the years economic historians have reconstructed and analyzed the colonial treasury accounts of the Americas with relative success; however, they have not yet provided a clear picture of the 'real' long-run fiscal dynamics of the colonies. A systematic account of the inflationary episodes that affected the value of local finance together with the effects of the fiscal policies imposed by the Spanish administration have been downplayed in the cliometric literature.

The aim of this chapter is twofold: First, it provides new estimates of fiscal data adjusted for inflation for the major treasuries of colonial Spanish America. And second, using this newly adjusted data, it examines the long-run fiscal sustainability of the colonial finances building upon the theory of the intertemporal budget constraint of the government.

The analysis is motivated by previous views depicting Spain as one of the major debt 'defaulters' in history by going 'bankrupt' numerous times particularly during its colonial rule.[31] The financial struggles have been associated with a continuous rise of military costs from the wars engaged with its Atlantic rivals. Yet, by the mid-eighteenth century the Spanish royal administration was able to reorganize its finances implementing a series of wide-ranging economic reforms.[32]

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[29] C. Marichal, *Bankruptcy of empire*, p. 254

[30] Samples vary according to the treasury employed; see details in the data section (2.3).

[31] C. Reinhart *et al.*, (2003) estimate thirteen defaulting episodes in Spain before the twentieth century, seven of these occurring between 1557 and 1820.

[32] The set of reforms are known as 'Bourbon reforms'. Implemented after the ascension of Charles III in 1759, these reforms intended to modernize the administration of the Spanish public sector and to restructure the finances of Spanish American colonies by centralizing their fiscal administration,

A fiscal system is considered sustainable in the long-run if the 'intertemporal budget constraint' is expected to hold in present terms, meaning that debt holders expect the current debt to be offset by the sum of the expected future discounted public budget surpluses. In this historical case, the royal administration in Madrid backed their debt instruments with fiscal revenues as collateral which were dependent on the remittances from the Americas. [33] The Spanish American finances provided the certainty for the multiple loans contracted with the Crown's creditors, and were also an immediate source of revenue to finance the empire's military costs.[34]

This study is related to other works on the Spanish empire's financial sustainability. Mauricio Drelichman and Joachim Voth reconstructed Spain's financial position under the Habsburg reign of Philip II (1566–1596) relying exclusively on the Spanish colonial accounts of Castile.[35] In Carlos Marichal's *Bankruptcy of empire*, various secondary sources for Spanish America from 1760 to 1810 are combined to analyze the financial situation of Spain's main colony: New Spain.

This chapter contributes to previous literature by examining with an econometric perspective the fiscal dynamics in the major treasuries of Spanish America, placing historical data into a framework to test fiscal sustainability. To assess this, I employ colonial treasury data from the local fiscal records also known as c*ajas reales* reconstructed in the seminal volumes by John Jay TePaske and Herbert S. Klein (1998).

Unlike previous works, this study takes into account local price developments by adjusting the referred treasury data for inflation. Using the adjusted fiscal series, I exploit its statistical properties by applying a battery of time series techniques to revenue, expenditure and deficit data of nine local treasuries for the colonial period of 1577-1813. The long span of annual data allows the application of this empirical methodology in order to determine structural breakpoints, and indicate the proximate causes and effects of the imperial fiscal policies during different time intervals.

The overall result varies depending on the local royal treasury and the period analyzed. The findings suggest that there were long-run equilibrium relationships between revenue and expenditure data adjusted for inflation, supporting the intertemporal budget constraint of long-run sustainability of the public finances.

However, there are shifts of fiscal sustainability across regimes and regions. When the treasuries of New Spain were unsustainable during the 'Habsburg reign', Peru's treasuries experienced a sustainable fiscal pattern. During the period of 'succession and transition', New Spain's treasuries restored their sustainability unlike in Peru and Buenos

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introducing new taxes, reorganizing the military, and curbing the political power of the church, among many others changes. See an analysis in Lynch (1992).

[33] The terms 'Spanish America' and 'the Americas' are used interchangeably.

[34] A similar financial mechanism was used to back Imperial debt since the mid-sixteenth century. See Alvarez-Nogal and Chamley, 'Debt policy under constraints'; and in E. Hamilton, 'American treasure';

[35] Drelichman and Voth, 'The sustainable debts of Philip II'.

Aires. And finally, in the period of the 'reformism and Napoleonic wars', the treasuries of New Spain deteriorated reaching an unsustainable position, contrary to their counterparts in Peru and Rio de la Plata.

The chapter is organized as follows. The next section provides a brief overview of the historical context of the Spanish American colonial fiscal system and it reviews the recent related literature. Section 2.3 describes the nature, adjustments and trends of the data employed. Section 2.4 describes the theoretical approach and empirical strategy to assess fiscal sustainability, followed by section 2.5 which discusses the empirical results. Section 2.6 concludes.

2.2 Historical context

Since the 'age of discoveries' until the mid-nineteenth century the Spanish Crown ruled vast territories in Europe, Asia, and the Americas. Its economic ascension as global power was particularly fueled in the sixteenth century with the control of the world's supply of precious metals located in the mines of the Americas. The creation of the Spanish *Council of the Indies* in 1524 besides of establishing a new economic structure for the 'New World' implied the transferring of the fiscal bureaucracy from the Spanish *metropole* to the colonies. In order to increase the 'royal' wealth expanding its domains, the Kingdom of Castile in Spain ordered the creation of a system of *royal local treasuries* in the most important ports and regions of the conquered territories in the Americas.

The imposed colonial administrative system was initially divided in two main *viceroyalties*:[36] New Spain (covering the current territory of Mexico, Central America, and part of the United States) established in 1524, and Peru (covering most of South America except for the east of current-day Brazil) in 1542. The viceroyalty of New Granada would be established by 1714, and Rio de la Plata in 1776. This administrative structure was part of a decentralized fiscal system shaped in part by a share of revenue that had to be shipped to the Iberian Peninsula, and a share of revenue and expenditure for the local colonial economy.

The aim of establishing this new institutional framework into the colonies was to administer the extraction of surplus for the Spanish *metropole*.[37] For this, and to fund the cost of the local colonial bureaucracy, a royal fifth (20% tax) or *quinto real* was levied on the production from mining precious metals, and on agriculture.[38] Given the large

[36] 'Viceroyalty' is the English term for the Spanish 'Virreinato' meaning literally 'vice-kingdom'.

[37] It was considered 'new' because pre-colonial indigenous societies had a different economic structure and organization. See the argument in M. León-Portilla, 'Mesoamerica before 1519'.

[38] By 1723 this tax became the *diezmo minero* or 'mining tenth'.

deposits of silver in the mines of various territories in the region, silver extraction became one of the most lucrative activities for the local economy and for the Spanish Crown.

Figure 2.1: Spanish America circa 1650

Source: Mahoney (2003), p. 65.

According to the historian Herbert Klein, the viceroyalty of Peru was unquestionably Spain's prime colony from the sixteenth to the seventeenth century due to the mercury deposits located in the Andean region that were used for large-scale production of silver. These extraordinary amounts of silver from the Peruvian mines were the main source of silver in the world often used to manufacture currency coins.

However, at the end of the seventeenth century silver production declined in Peru and thereafter New Spain's silver production tripled the Peruvian production in the beginnings of the eighteenth century.[39] Consequently, after 1700 the viceroyalty of New Spain became the dominant economic zone and financial center, and Mexico City was a 'sub-metropole' for the empire which accounted for the largest silver outflows to Spain.

An important element that provided great wealth for the Crown was the fiscal burden imposed via *indirect taxation.* Upon the great dynamism of silver exports from the Americas, the Crown enjoyed the monopoly of the transatlantic commerce. The Spanish American ports were not allowed to trade with each other nor with other

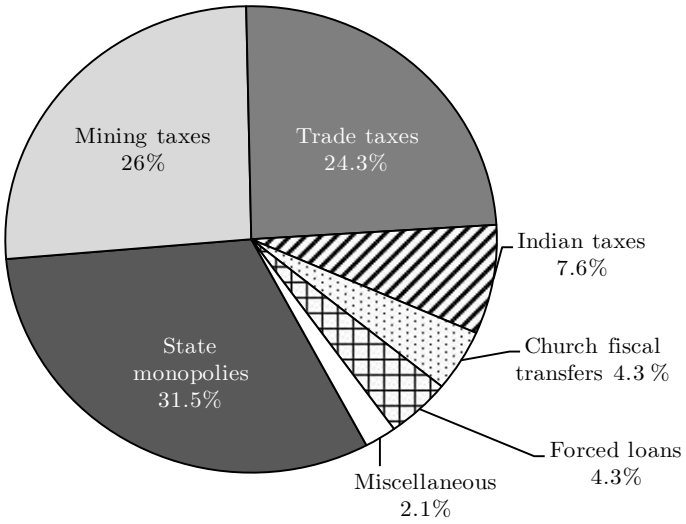
[39] H. Klein, 'The great shift'.

countries except with the Spanish ports of Andalucía. Trade tariffs, known as *almojarifazgos* were a central source of income recorded in the largest treasuries of Spanish America. By 1778, a decree of 'free trade' (only to other Spanish American ports) was enacted. This generated an increase in the shipping traffic in the customs of the ports such as Veracruz in New Spain and Cadiz and Seville in Spain, and hence increasing the overall collection of tax revenues.[40]

Another fundamental source of indirect tax collection was the existence of state monopolies of high-value commodities such as gunpowder, salt, and tobacco, among many other goods. Sale taxes, called *alcabalas* targeted many of these increasingly demanded goods.

As figure 2.2 shows, these types of revenues coming from state monopolies in New Spain had the largest share in total tax collection at the end of eighteenth century accounting for more than thirty percent (31.5) of the total fiscal revenue recorded.

Figure 2.2: Share of fiscal revenue by entry in the cajas reales of New Spain from 1795-1799



Source: Based on Marichal and Carmagnani (2001), p.288.
Note: Miscellaneous refers to administrative and/or other of types of income.

The share of the revenue branches as a percent of the total changed throughout the colonial period. This was mainly due to the lack of uniformity in the *direct* and indirect tax rates, but also because different economic activities in diverse regions generally tended to grow faster than others, and therefore, their tax incidence. But as a broad generalization, although other direct taxes such as the 'tithe' or *diezmo* (10% of personal income) and the 'indian head tax' were important fiscal components, revenues

[40] See in J. Fisher, 'Commerce and imperial decline'.

originating from mining, trade, and state monopolies were the central source of the colonial fiscal administration.[41]

Moreover, although the clergy was in charge of collecting the 'tithe' and transfer it to the local treasury, they also accepted payments in kind. However, tax collection was made most generally in cash. Spanish royal officials began gradually to demand deposits in coins forcing the church and the general population to exchange their goods and labor for cash.[42]

On the other hand, the structure of treasury expenditure in the most important cajas was shaped by a more stable number of entries dominated by fixed costs (*gastos generales*). These expenses comprehended mainly the branches of; salaries of administrative personal; war expenses; and *situados* (intra-regional transfers). Evidently, 'war expenses' tended to rise during the European conflicts, especially during and after the *Seven Years' War* (1754-1763).

However, the branch of the situados gained significant importance for the creation of additional treasuries. These intra-regional transfers had the aim to be allocated to other 'deficitary' cajas (mostly in the Caribbean) in order to further develop the local economy and defend the territory from foreign invasions.

The fiscal administrative personnel in each treasury was formed by local royal treasurers, accountants (*contadores*), and supervisors (*veedores*) who were commissioned to keep the records of all financial transactions in books of their respective treasury. These local treasurers were subject of regular visits from external royal officials (*visitadores*) from Spain to check that local books were following the official guidelines and prevent any type of fraud.

Overall, there are many other entries in the categories of revenues and expenditures; however, they represented only a small share of the totals at the end of each year. Nevertheless, these entries are included in the totals computed (nominal revenues and expenditures) of the dataset employed for this analysis.

Recent studies on the finances of the Spanish empire

New studies on the finances of the Spanish empire have emerged in the last years. Although some of them are a continuation of a rich historiographical tradition that aims to quantify the economic rise and decline of Spain from the sixteenth to the nineteenth century, many of these studies have focused on reinterpreting from a political economy perspective the way the Spanish monarchy has been portrayed by prevalent literature.

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[41] The 'indian head tax' was a tribute collected from the indigenous population as a symbol of their subject status. Other important branches from the income side were the sale of papal bulls (indulgencies) by the church, overlays from other treasuries, amortizations, and various private donations.

[42] M. McCloud, 'Aspects of the internal economy'.

For instance, in some of these new studies the view of an imperial state continuously at war and dealing with an unsustainable fiscal position during the sixteenth century has been challenged by empirical evidence. Drelichman and Voth (2010) analyzed the debt statements of Spain with its international lenders during the Habsburg's reign (1506-1600). They showed that although Spain defaulted on its debt four times during the era of Philip II, evidence suggests that these episodes were 'short-term liquidity' crises and its long-run fiscal position by the end the sixteenth century was not unsustainable.[43]

Most of the prevalent historical studies on the finance of Spanish colonialism in the Americas have relied on a 'one-sided' perspective of the transatlantic colonial exchange; a view from the *metropole* towards its colonies. However, the study of Marichal (2007) ended this historiographical drought.[44] His work focuses in detail on the finances of the transatlantic colonial exchange. He argues that the success of the Spanish Crown under the Bourbon regime by the mid-1700s was due to a limited government control together with the government's great capacity to extract tax revenue. Marichal claims that the fiscal machinery in Spanish America prospered thanks to the efficient allocation of inter-regional transfers (situados) from the rich treasuries to poor ones.[45]

Furthermore, he shows that since the Madrid central treasury depended largely on tax income from the Americas by the last quarter of the eighteenth century, the Crown 'transferred' part of its public deficits to its colonies. Due to this conflictive situation at the start of the nineteenth century, and in order to finance warfare against France and Britain, Spain over-burdened its fiscal base. A spiral of increasing military costs eventually bankrupted the central treasury house in Madrid and in the colonies.[46] He concludes:

> "In the end, all financial expedients were vain. The silver obtained from New Spain through taxes, *donativos* (donations), numerous loans [...] was absorbed by military expenditures and the service on domestic and foreign debts taken by the Spanish government to pay for the international wars in which the Crown engaged almost incessantly. By 1810, the governments of both viceroyalty and monarchy were bankrupt".[47]

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[43] Drelichman and Voth, 'The sustainable debts of Philip II'. The term 'short-term liquidity' crisis has been disputed recently by Alvarez-Nogal and Chamley (2014) arguing that short-term crises were related to a tax renegotiation with lenders and not to a problem of short-term solvency.

[44] Although related works from prominent economic historians such as Lyman L. Johnson, Stanley Stein, Josep Fontana, among others, have previously analysed the colonial finances of the Spanish empire, they have not explored systematically the fiscal accounts and regional transactions of the colonies.

[45] See also in Marichal and Souto, 'Silver and the situados'.

[46] Marichal, *Bankruptcy of empire.* p. 255.

[47] *Idem,* p. 255.

Conversely, Grafe and Irigoin (2012) argue that the taxation system of the Spanish Crown towards the Americas has been portrayed inaccurately by previous studies. Their discussion focused on the claim that Spanish imperial fiscal coercion has been exaggerated by the 'conventional' historical literature.[48] Their claim is that several colonial treasury districts in Spanish America had their own 'informal' control and decisions over their local budgets in terms of tax collection and expenditure allocation. Grafe and Irigoin (2006) documented that revenue tax collection was decentralized and fragmented into a large number of tax collecting interdependent districts that managed their own local tax rates and financial instruments.[49]

Additionally, these authors claim that this fiscal 'semi-autonomy' of the colonies was granted by negotiation and not by command from the treasury of Madrid with the local elites in the Americas. This enabled the Spanish monarchy to keep official control of the territories with an 'informal rule'. [50] As a result, the colonies raised their military expenses (via *situados*) to defend themselves against potential invasions by Spain's military enemies in the Atlantic. This type of fiscal mechanism increased the wealth and power of the local colonial elites and stimulated regional economic growth. The success of this fiscal apparatus allowed its expansion by creating two additional viceroyalties (New Granada and Rio de la Plata) in order to increase the colonial fiscal base.

This semi-autonomy of the treasuries generated fiscal de-centralization, which limited the Crown's ability to impose fiscal reforms before 1700. This (de-centralized) fiscal regime came to an end with the imposition of the Bourbon reforms (after 1759). As has been argued by Arias (2013), the reforms succeeded because they proposed to negotiate fiscal centralization with local powerful elites, aligning their interests with the Crown.[51] With this, the treasury in Madrid (General Treasury) gained more control over the Spanish America fiscal administration, generating a marked increase in fiscal revenue and remittances to Spain.

However, it is not clear how damaging this was for the local treasuries in the Americas in financial terms. It is still not evident that an increase in remittances from Spanish America to Spain implied an increase in 'fiscal exaction', especially if they represented only a small share of the total revenue in nominal or real terms.[52]

Despite emerging quantitative studies on the economics of Spanish empire in the colonies of the Americas, there is still no agreement on their fiscal position; neither during

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[48] See a discussion between, Grafe and Irigoin, 'Bargaining for absolutism'; Marichal, 'Rethinking negotiation'; and Summerhill, 'Fiscal bargains'.

[49] Grafe and Irigoin, 'The Spanish empire and its legacy';

[50] Coatsworth 'Political economy'; Grafe & Irigoin, 'Stakeholder empire'.

[51] L. Arias, 'Building fiscal capacity'.

[52] For instance, Marichal (1997) argues that increases in remittances after 1790 meant a large economic 'cost' for the treasuries.

the crucial years of the Spanish American insurgency or from a long-run view. To illustrate the contending interpretations, Irigoin and Grafe (2006) conclude:

> "The system of fiscal redistribution between treasury districts served its purpose [...]. It funded military defence, kept the empire self-sufficient, aligned local elites' interests with those of the Crown by fostering economic growth [...].[53]

On the other hand, Marichal argues:

> "In summary, the Crown's fiscal policy weighed unequally on New Spain's population [...]. At the end of the century the finances of Spanish American viceroyalties were crumbling, slowly but surely".[54]

2.3 Data

Data employed in this analysis is derived from the compilation and reconstruction by John J. TePaske and Herbert S. Klein (1998) of the colonial treasury accounts (in Spanish known as *cajas reales*) of Spanish America. Their original data was collected from a 'single-entry' bookkeeping system (*cartas cuentas*) located in the *Archive of the Indies* in Seville, Spain.[55] The dataset covers the entire colonial period for four viceroyalties: New Spain, Peru (and upper Peru), New Granada, and Rio de la Plata, what today are North America (Mexico and part of the south of the United States), Central and South America (except for Brazil). In total, the coverage from the original source includes 72 cajas reales over a period of more than 250 years (1576-1823).

The present study focuses on the largest cajas of the main viceroyalties covering a period spanning from 1577 to 1813. The selection of the sample and treasuries was based on the fact that most of the analyzed cajas were considered as 'intendency capitals' that centralized tax collection from other small treasury districts. Also, other small *cajas* suffer from missing values and lack of data continuity.[56]

Therefore, as table 2.1 indicates I included in total annual treasury data from the following major nine treasuries; For the Viceroyalty of New Spain: Mexico City, Guadalajara, Veracruz, Acapulco, and Zacatecas; for the Viceroyalty of Peru: Lima, Potosí, Santiago; and for Rio de la Plata I include the treasury of Buenos Aires (see table 2.1).

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[53] Grafe and Irigoin (2006), p. 260.

[54] Marichal (2007), p. 249-255.

[55] A 'double-entry' bookkeeping system was ordered to be established in 1784, but it was abandoned in 1787, restoring the original 'single-entry' system.

[56] The omitted data is New Granada (today's Colombia and Venezuela). However, the present sample presented covers roughly three quarters of the entire treasury revenue of Spanish America.

The aim of establishing this new institutional framework into the colonies was to administer the extraction of surplus for the Spanish *metropole*.[57] For this, and to fund the cost of the local colonial bureaucracy, a royal fifth (20% tax) or *quinto real* was levied on the production from mining precious metals, and on agriculture.[58] Given the large deposits of silver in the mines of various territories in the region, silver extraction became one of the most lucrative activities for the local economy and for the Spanish Crown.

Table 2.1: Data sample of colonial treasuries employed in this study

Viceroyalty	Treasury	Coverage
New Spain	Mexico City	1577-1813
	Guadalajara	1584-1804
	Veracruz	1590-1801
	Acapulco	1591-1809
	Zacatecas	1584-1813
Peru	Lima	1580-1813
	Potosí *	1679-1805
	Santiago	1690-1805
Rio de la Plata	Buenos Aires	1700-1809

* The 'intendancy' of Potosí became part of the Viceroyalty of Rio de la Plata in 1776.

Fiscal series are reported in a single currency, the *Spanish silver peso* (also called "peso de a ocho").[59] This was *de facto* legal tender in the Americas and in Europe, and therefore the standard currency used in the colonial tax accounts of the General Treasury of Madrid (Tesorería General de Madrid).

Previous quantitative research like Klein (1995), Marichal and Souto (1994), and Grafe and Irigoin (2012), among others, have analyzed partially the records of these treasuries presenting graphical evidence of nominal figures for different historical periods. Yet, no empirical attempt has been made to adjust these treasuries for price movements for the entire colonial era to provide a full systematic accounting of the long-run 'real' fiscal dynamics.

[57] It was considered 'new' because pre-colonial indigenous societies had a different economic structure and organization. See the argument in M. León-Portilla, 'Mesoamerica before 1519'.

[58] By 1723 this tax became the *diezmo minero* or 'mining tenth'.

[59] This was also equal to the Spanish standard of *20 reales de vellón* introduced by 1808.

Inflation-adjusted treasuries

Nominal values of assets in currencies expended at different points of time do not reflect their real value if inflation is not taken into account. Although there is a vast literature documenting the long inflationary episodes in the Spanish American region during colonial times, these have not been included in the historical description of the fiscal dynamics of Spanish America.

Studies on the 'price revolution' in Europe, that is, the inflationary effects from the massive influx of bullion from Spanish America into Europe in the sixteenth century, have been well-documented by seminal literature.[60] In contrast, quantitative analyses on the effects of inflation on the colonial economy on the other side of the Atlantic (in Spanish America) are relatively scarce.[61] A possible reason impeding the proliferation of more studies on this issue is data scarcity on systematic records of regional output and prices for the Americas. Indeed, as in many regions in the world, there is practically no information on an annual basis of gross domestic output disaggregated by region before 1800.[62]

TePaske and Klein's colonial treasury data has been employed as an approximation to analyze the economic performance of the Spanish American regions.[63] Thereafter different interpretations have emerged in light of various observed 'break points' and changing trends emanated from this statistical source.

A discussion on this issue was brought up by the British historian David A. Brading who wrote a controversial essay criticizing the American scholar John H. Coatsworth on his interpretation of the treasury data for Mexico City in the eighteenth century.[64] Coatsworth argued that from 1700 to 1810, TePaske and Klein's nominal treasury revenue estimates must have been affected by the inflationary tendencies experienced during the period. He argued that in 'real' terms the total value of receipts should have fallen sharply. To demonstrate this, Coatsworth adjusted nominal figures with a maize price index which showed that original nominal figures shrank considerably when adjusting for inflation. This effect was prominent during an 'extraordinary' rise in

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[60] For instance, E. Hamilton, American *treasure*, P. Vilar, *Oro y moneda*, J. Elliott, 'The decline of Spain', D. Fischer, *The great wave*, among several others.

[61] The few are found among the empirical works of Garner (1985) and Ouweneel and Bijleveld (1989) for the case of eighteenth-century Mexico. See an overview of this historiographical lacuna in Klein and Engerman (1992).

[62] Angus Maddison's historical statistics only reported 'centennial' GDP estimates for Latin American countries before 1800, that is, one single estimate every hundred years.

[63] See for instance the works of Garner (1993), and Ponzio (2005).

[64] D. Brading, 'Facts and figments in Bourbon Mexico'; and J. Coatsworth, 'The limits of colonial absolutism'.

revenue and expenditure registered at the end of the eighteenth and the first decade of the nineteenth century.

Conversely, Brading claimed that the rise in revenue and expenditure was in fact a 'real' phenomenon in terms of observed production (growth of total output), and that it was not a price effect as Coatsworth suggested. Brading argued that the silver-export boom at the end of the eighteenth century benefited the colonial Mexican economy creating additional demand for capital and labor, and thus expanding the colonial fiscal base which can explain the large peaks in the Spanish American public finances during the same period.

As mentioned, since there are no reliable records of total regional output to accurately confirm a causal multiplying effect from silver production expansion, the present estimates examine the price effect through the *purchasing power of money* of the treasuries.[65] Hence, our data takes into account Coatsworth's claim of the inflationary effects on the treasuries. However, unlike the latter, instead of analyzing one single treasury (Mexico City) and adjusting it with the cost of one single item (maize), the ensuing analysis adjusted all major treasuries available using different indices of the cost of living in the related treasuries.

For this purpose, this analysis makes use of the price information from Arroyo-Abad *et al.* (2012) of the total average costs of a consumption basket in the main colonial cities of Spanish America. A bare-bones basket is a representation of the minimum expenditure on basic consumer goods. It uses the prices of the cheapest goods of a basket that delivers a number of calories necessary for subsistence including food and non-food resources for an individual to survive.[66] Although these baskets are only a proportion of a typical 'respectable' consumer basket, in the absence of more detailed data, they provide a consistent equivalent metric of the average cost of living over time.

Alternatively, it could have been feasible the use of the cost of labor (i.e. wage index) as a deflator for government expenditures since these encompassed a significant share of salaries and public servant's wages. However, since the empirical analysis aims at evaluating the intertemporal primary fiscal balance which is compounded by government revenues and expenditures, the measurement of the revenue component (tax revenues and other transfer payments) would not be effectively measured with that deflator. This is because from the revenue side (in the public balance identity), branches referring to personal income taxes and other private transfers (e.g. donations) represented a minor share in the treasuries.[67] On the other hand, tax revenues stemming from state

[65] Dobado and Marrero (2011) argue the existence of a 'mining-led growth' trend for Mexico in this period attributed to a strong correlation between the silver production and treasury receipts.

[66] See Arroyo Abad *et al.*, (2012) and also in Allen *et al.*, (2012) for a full detailed description on the method, quantities, and nutritional values employed in the construction of the baskets.

[67] Except during wartime periods. Forced loans (donations) and church transfers increased their share exponentially in total government revenue during wartime.

monopolies of basic consumption commodities (staples from the consumption basket), and trade and sales taxes ('alcabalas') were significantly more important (as shown in figure 2.2). Therefore, a systematic indexation of the colonial fiscal aggregates based on the inclusion of the relevant movements of the average consumer price changes (from a subsistence basket) could offer a more comprehensive inflation-indexation measure of the local treasuries.[68]

Based on this, this study uses the changes in the average costs of the baskets in order to measure the inflationary effects on each colonial city related to the location of the treasury. For example, the measurement employs the average cost of a bare-bones basket of Mexico City to adjust all the treasuries in the viceroyalty of New Spain. The same was used with the average cost of a basket in Buenos Aires for the viceroyalty of Rio de la Plata; and in the treasuries of the viceroyalty of Peru (using data from the cities of Lima, Potosí, and Santiago respectively).[69]

To illustrate the effect of adjustment for inflation, and considering that the average price of a basket of goods is potentially a better metric than the price of a single item, the analysis shows that by adjusting the data with the former will yield more accurate estimates than previous exercises.

Table 2.2 displays the ten-year average revenue by decade of the Mexico City treasury, considered the richest of the Spanish Crown after 1700. It highlights the argument raised by Coatsworth depicting the differences of the original nominal series when applying a deflation procedure. In particular, it shows that in the first decade of the nineteenth century (1800-1809), on average the revenues collected were worth approximately the same in real terms of what they once had been worth collected in nominal terms in the preceding decade.

As mentioned, it was expected that discrepancies would arise when employing a more comprehensive price index to adjust the referred data. For instance, looking at the revenue series adjusted with the new index, during that decade (1800-1809) the average

[68] If consumer prices rise faster than wages (as in the post-1700 period), an inflation-indexation based on a measure of wage movements would entail a mismeasurement of the real value of the intertemporal public fiscal balance. This is because if that indexation (through wage indices) is applied exclusively on government expenditure and not on revenues, the fiscal identity would be deliberately biased, i.e. resulting in a larger government deficit induced by 'overvalued' expenditures (deflated with lower wage indices relative to the consumer price indices). Conversely, if the same wage indices are applied to deflate the corresponding government revenues, it would 'undervalue' their long-term evolution, affecting the 'real' public fiscal balance. See a similar accounting concern in Goldsmith (1985: 97). In general, the inflation-indexation follows the standard balance sheet approach (e.g. Blejer and Cheasty 1991) by employing the consumer price deflators accordingly (in this case, total average costs of a consumption basket) on both key variables: government nominal revenues and expenditures.

[69] It can be argued that within New Spain there were significant price differentials across its regions and therefore in its different treasuries. However, the scope of available price data allows only the adjustment of New Spain's treasuries with Mexico City prices.

revenues collected were worth slightly less than the estimate of Coatsworth, which was less than half of their nominal value.

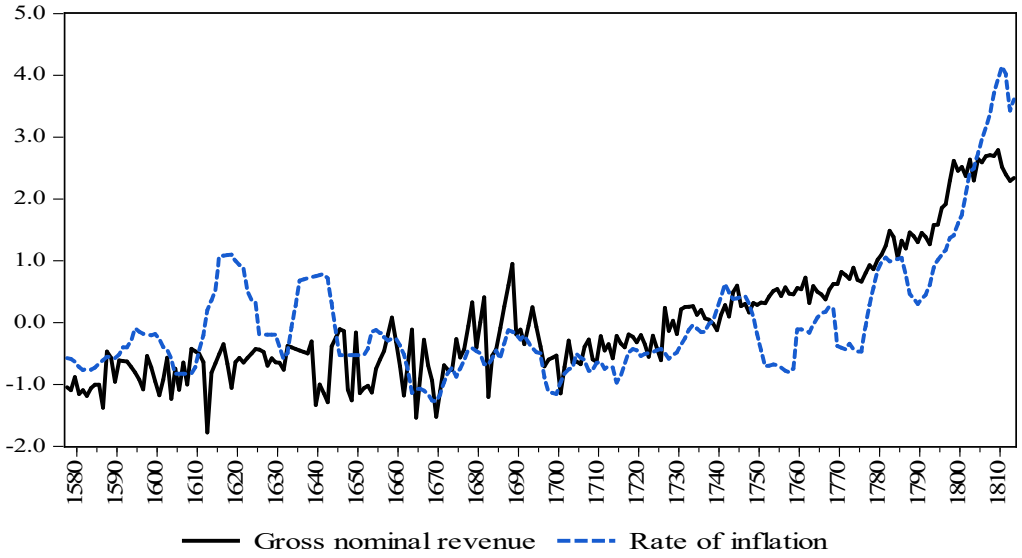
Table 2.2: Ten-year average of treasury revenue in Mexico City, 1700-1809
(Millions of Spanish silver pesos)

Period	TePaske and Klein's gross nominal revenue series (in thousands)	Coatsworth's revenue series adjusted with the average price of maize (in thousands)[a]	New series of revenue adjusted with the average cost of a bare-bones basket (in thousands)[b]
1700-1709	2,077	1,730	2,131
1710-1719	2,646	3,086	2,881
1720-1729	3,040	2,992	2,367
1730-1739	4,244	3,669	3,230
1740-1749	5,040	4,062	3,294
1750-1759	5,937	7,006	5,313
1760-1769	6,388	8,114	5,143
1770-1779	8,565	8,457	6,809
1780-1789	14,557	8,207	7,449
1790-1799	27,287	18,950	13,968
1800-1809	51,736	27,652	21,978

[a] Coatsworth reported its maize index for Mexico City with 1700 as reference year. His source of maize prices is a combination of data by Rabell (1986), and Florescano (1969). However, he does not report the price series employed for deflation.
[b] Adjusted with the ten-year average of the index of the average cost of a bare-bones basket in Mexico City (1700=100).
Source: Coatsworth's revenue series is from *Los orígenes del atraso* (1990). p. 39. Table II.1.

However, although there are marked differences in terms of levels before 1800, real figures adjusted with the new index yielded a similar trend to the ones that Coatsworth estimated (for Mexico City). This is due to the fact that maize price data employed by Coatsworth (maize was the major commodity in the consumption basket of the Spanish American population) is captured in the weights of the consumer baskets of the present indices (of the average cost of bare-bones baskets). Nevertheless, these findings show a clear indication that the purchasing power of 'treasury money' went down in eighteenth-century Mexico.

Figure 2.3: Evolution of inflation and gross nominal revenue in Mexico City, 1577-1813



Note: Graph plotted as normalized data.
Equation estimated in OLS is: $\Delta[\text{price}]_t = \alpha + \beta\,[(\log)\text{revenue}]_t + \textit{years} + \varepsilon_t$
OLS refers to an ordinary least squares regression. The rate of inflation (Δ[price]) was calculated as the change of a five-year moving average of the index of the average cost of bare-bones baskets. Gross nominal expenditure is in logarithmic terms.
Source: Appendix I.

Moreover, figure 2.3 shows the significance of including these price developments into the analysis of colonial finances. Since inflation can be viewed as an indirect type of taxation for money holders, tax revenues and the rate of inflation moved together indicating the effect of printing additional currency (via seigniorage).[70] This income stemming from coinage (known as *amonedación*) was recorded on the revenue side; therefore, inflation fluctuated depending on the changes of money in circulation. Although for statistical robustness purposes it is necessary to control for other trend determinants, figure 2.3 shows a rough depiction of this long-term relationship across the colonial period for the case of Mexico City.

According to the pioneering work of Richard Garner (1985) who provided records of maize prices for Mexico City, there was a steep rise in overall prices from the mid-sixteenth century onwards. This inflationary period ended around the 1650s. Thereafter

[70] This macroeconomic assumption holds under a closed economy scenario, otherwise an unmatched growth of money supply would be reflected on a balance of payments deficit. However, the former depiction is consistent with the Spanish American economy since trade was limited for most of the colonial period (Trade monopoly was lifted after the free trade decree in 1778).

and until the first decades of the 1700s there was a period of modest deflation.[71] However, after 1750, prices rose again. These price trends are confirmed by Arroyo-Abad *et al.* (2012) who assembled price data not only on maize prices for Mexico City but on the average prices of other goods and for other major colonial cities (see appendix I).

Figure 2.4 reports five indices (1700=100) drawn from the data on the average cost of the 'bare-bones' basket for each city. Although price volatility was a common denominator in the majority of the Spanish American cities, Lima and Santiago experienced relative stability compared to the price trends of Mexico City, Potosí and Buenos Aires that were characterized by higher price volatility during the entire colonial period.

Another salient feature from these price records is the exorbitant price increase in Mexico and Buenos Aires at the end of the eighteenth century. These price hikes were well-established facts in the historical literature.[72] Price levels at the end of the century tripled 1700 levels and even more in the case of Buenos Aires.

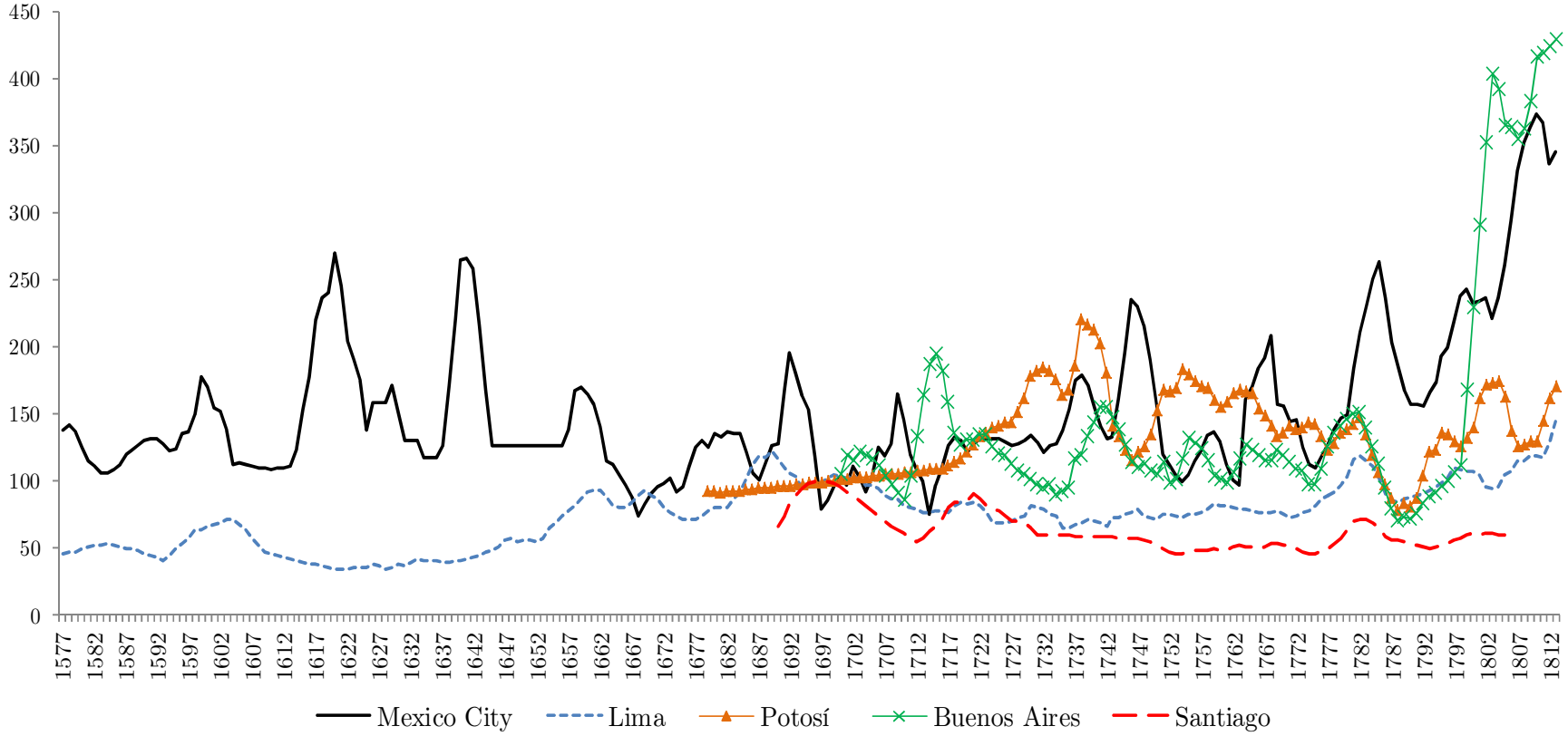
However, the origins of these increases are still under-explored in existent studies. For instance, Coatsworth (1982) claimed that an increase in silver available in Mexico City implied an expansion of New Spain's monetary base and therefore generated higher inflation.[73]

[71] R. Garner, 'Price trends in eighteenth-century Mexico'

[72] See in S. Amaral, 'El descubrimiento de la financiación inflacionaria' for the case of Buenos Aires, and E. van Young, 'La crisis del orden colonial', for Mexico City.

[73] Similarly, for the case of Buenos Aires, Amaral (1988) argues the spike in the rate of inflation was associated to the large amounts of silver circulating at the end of the eighteenth century.

Figure 2.4: Price indices by colonial city, 1577-1813
(Index of the average costs of a bare-bones basket, 1700=100)



Note: Author's elaboration based on Arroyo-Abad *et al.* (2012). Data are five-year moving averages. The average cost was re-converted from silver grams to Spanish silver pesos. Data for Mexico City for the period 1655 to 1798 refers to data of the Mexican central region of 'El Bajío'. Price data for Potosí from 1682 to 1719 was interpolated.
Source: See *Appendix* I

Conversely, the historian Eric Van Young (1992) has argued that the Bourbon reforms, despite their usual depiction in the literature as positive changes that accelerated productivity growth in New Spain after 1750, never reached the agricultural sector. According to this view the sector stagnated, generating a meager supply of agricultural goods creating inflationary pressures as a result of demand in a growing population.

Notwithstanding the structural origins of these price changes (supply or demand shock), to properly measure the real levels of fiscal revenues, expenditures, and deficit, it is necessary to incorporate the movements of prices in each local treasury in order to adjust them as conventionally utilized in public finance accounting (see e.g. Tanzi *et al.*, 1993).[74] This is because inflation affects revenue and expenditure via multiple channels. One of the most important is the *Olivera-Tanzi effect* which occurs in periods of high inflation. Under this scenario, there is a reduction in the purchasing power of the consumer, a decline in firms' profits, and as a result, a reduction in government revenue collection.[75]

The long-run dynamics of the 'cajas reales' in constant terms

The ensuing analysis adjusts the nominal treasury figures with the new price indices in order to provide better measures of 'real' revenue and expenditure for each treasury. Figure 2.5 displays the major trend that Klein (1995) labeled as the 'Great Shift'. Up until the end of the seventeenth century the viceroyalty of Peru (Lima) was the most important colony in Spanish America; thereafter it was overtaken by New Spain (Mexico City). In real revenue terms, Mexico and Lima were the major treasuries in the continent, followed by the treasuries of Potosí, Buenos Aires, and Santiago.

The figure shows increasing real revenue in Lima in this period surpassing the revenues of Mexico City. This depiction differs from the widespread interpretation regarding the seventeenth century as a period of economic crisis in the Americas.[76] Although figure 2.6 shows that Lima ran modest budget deficits in the middle of the seventeenth century, it would rather be difficult to consider this as a 'fiscal crisis'.

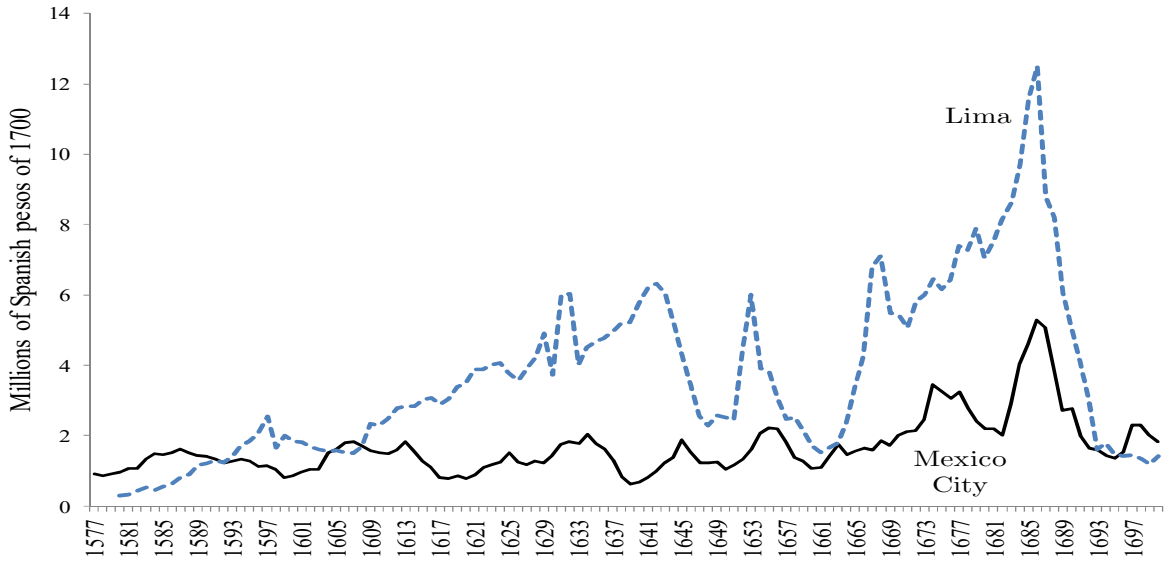
[74] See 'operational measures' in V. Tanzi *et al.*, 'Effects of inflation on measurement of fiscal deficits'.

[75] J. Escolano, 'A practical guide to public debt dynamics', p. 18.

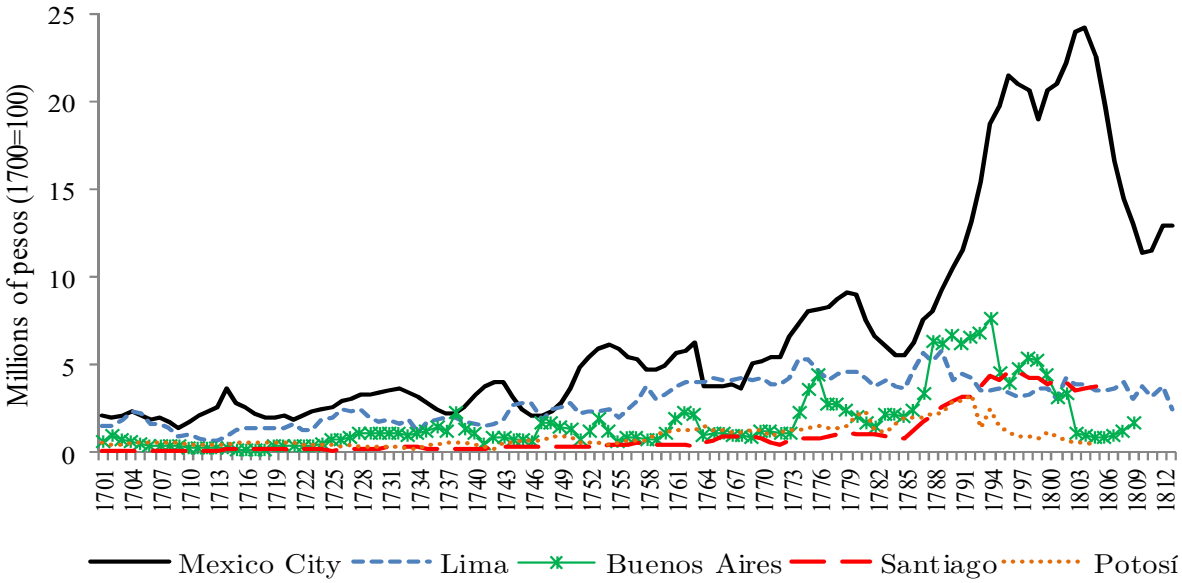
[76] For instance, see K. Andrien, 'Crisis and decline'; and TePaske and Klein 'Seventeenth-century crisis'.

Figure 2.5: Treasury revenue adjusted for inflation in selected treasuries, 1577-1700 and 1701-1813.
(Millions of Spanish silver pesos of 1700)

a. 1577-1700



b. 1701-1813



Note: Data adjusted for inflation using the index of the average costs of a bare-bones basket. Figures are computed in five-year moving averages.
Source: See appendix I

In fact, as figure 2.6 shows, in the last quarter of the century Lima recorded succeeding primary surpluses. It was up until the start of the eighteenth century when the treasury in Lima (and also Mexico City) followed a 'conservative' policy characterized by fiscal discipline that resulted in overall balanced budgets. The Spanish Wars of Succession (1701-1715), represented a financial challenge for the Spanish Crown, and thus resorted in the use of remittances from the *Indies* to finance military costs, which was reflected in the budgets of the major Spanish American treasuries. Moreover, large relative differences arise when comparing nominal to real revenue (in terms of levels). If there were no inflation adjustments, the magnitudes of revenue records in Lima would be undervalued for almost the whole seventeenth century. These trends are shown in the figures 1A and 1B of appendix II from this chapter.

On the other hand, comparing the nominal and real revenues series of Mexico City (see figure 1B in appendix II) yields a similar trend until the last quarter of the eighteenth century, precisely during and after the Bourbon reforms (1760s). As mentioned, the large nominal revenues recorded during this period (until 1760-1813) shrank gradually reaching less than half of their nominal value when inflation is taken into account (table 2). Therefore, if these adjustments are not considered for Mexico City, revenue records during the Bourbon reforms are largely overvalued.

From a long-term view, however, Mexico City ran relatively minor deficits during the whole colonial period. As figure 2.6 depicts, there were only a few episodes of deficit recorded under the Habsburg regime at the end the sixteenth century. For this major treasury having primary surpluses was a rule rather than the exception.

Still, the large primary surpluses at the end of the eighteenth century eroded during the 'Napoleonic wars' (1803-1814). A rise of military expenses coupled with a decline in local revenue stemming from the prevailing political uncertainty brought Mexico City's treasury to a difficult financial position in those years.[77] The fiscal bonanza accomplished throughout the Bourbon reforms was washed-out by the year 1813 when Mexico City's treasury recorded a near to 'zero-balance budget' (figure 2.6.b).

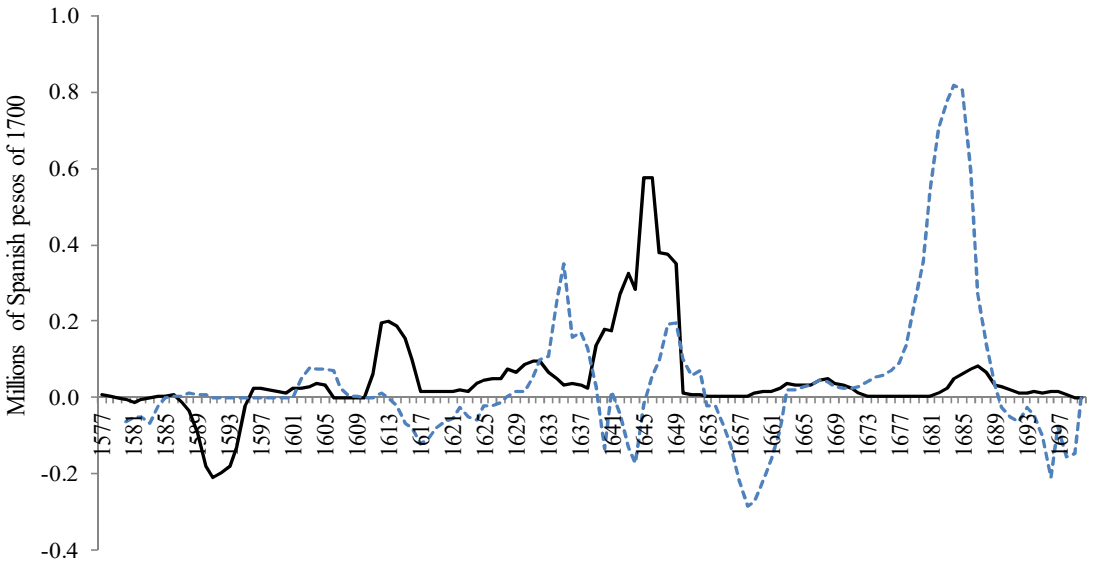
As some studies have indicated, the creation of new treasuries was possible because of the intra-regional fiscal transfers.[78] Parts of the surpluses from the treasury of Lima (and Upper Peru) were allocated as subsidies to the treasuries of Santiago and Buenos Aires. The importance of the creation of more treasuries was fundamental in order to expand the empire's fiscal base in South America.

[77] See a detailed explanation of the revenue collapse in Mexico City in the work of J. TePaske, 'La crisis financiera', and in L. Jaúregui, 'La caída de los ingresos'.

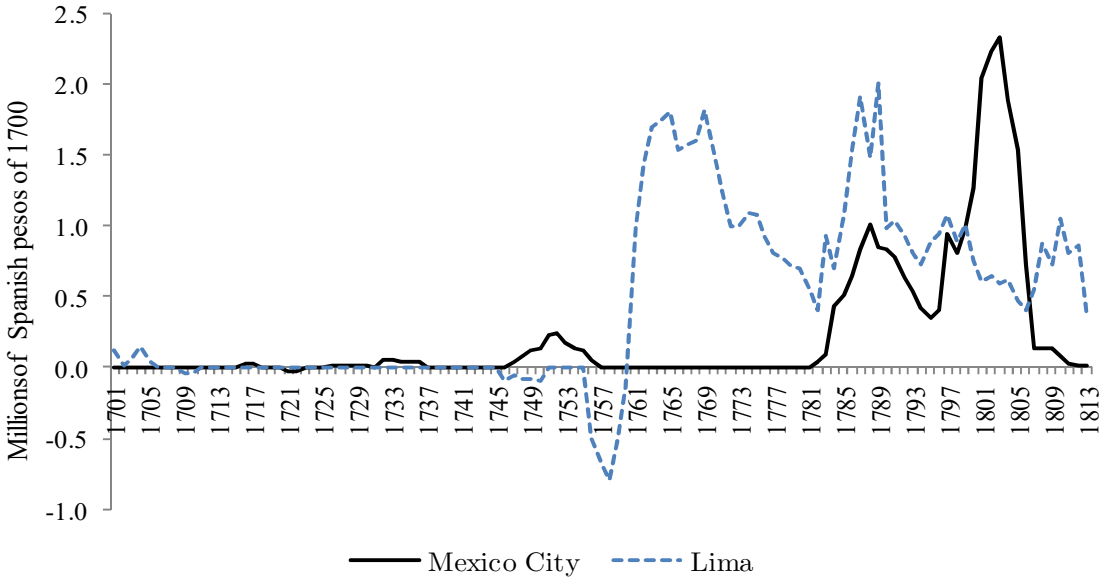
[78] Marichal and Souto, 'Silver and the situados'.

Figure 2.6: Primary budget balance adjusted for inflation in Mexico City and Lima, 1577-1700 and 1701-1813.
(Millions of Spanish silver pesos of 1700)

a. 1577-1700



b. 1701-1813



Note: The primary budget balance by definition is the total annual revenue minus the total annual expenditure before interest payments. Data adjusted for inflation using the index of the average costs of a bare-bones basket. Figures are computed in five-year moving averages.
Source: See appendix I.

Although their real revenue amounts never reached to the levels of Mexico City or Peru (as figure 2.5b shows), their fiscal budgets (revenues and expenditures) were necessary for the development of the local economy. However, the downside of the inter-regional network for treasury financing was that when the revenue of a large treasury declined, it tended to affect the main treasury of the viceroyalty. For example, when silver mining declined in Potosí at the end of the seventeenth century, revenue collapsed in this treasury generating a secular decline in the tax collection of Lima's treasury.

In addition, the prominence of other major treasuries within New Spain (other than Mexico City) such as Guadalajara, Acapulco, Zacatecas, and Veracruz cannot be overlooked. These treasuries were of fundamental significance for the Spanish American fiscal administration and the Crown (figure 2.3.B in appendix III). Most of the collection of the port duties came from Acapulco and Veracruz, the main entry ports of New Spain. Whereas the port of Acapulco had the trade route of the Pacific Ocean that carried goods from the Philippines and Peru, Veracruz had an indispensable role in tariff collection (*almojarifazgos*) from the transatlantic commerce.[79] This made the treasury of Veracruz, the most important in revenue collection in the continent after Mexico City.

2.4 Testing fiscal sustainability: theory and empirics

The empirical issue of fiscal sustainability from a long historical perspective has received increased attention. The persistence of fiscal deficits in the United States and in various European countries has raised concerns on their government's ability to cope with these deficits in the long-run, and as a consequence several fiscal studies employing a combination of historical indicators and modern financial theory have emerged in recent years.[80]

Yet, the historical case of the Spanish American economies is to some extent different from the modern fiscal mechanisms that rule in present-day economies. The colonial treasuries in Spanish America were subordinated economic units of the royal government in Spain. Thus, an interpretation based solely on their fiscal performance is warranted considering that the modifications (increases or reductions) of tax rates and expenditure decisions were semi-autonomous. Although the local treasuries where fiscal subjects of the central authority in Madrid, they were allowed to control revenues and allocate expenses according to the local requirements.[81] Still, officially they could not issue

[79] See in K. Bjork, 'The link that kept the Philippines Spanish'.

[80] See for e.g. Sargent and Velde (1995), Dempster (2006) and Lusinyan and Thornton (2009) for empirical exercises on historical case-studies; see also a similar approach on the public debt in the work Drelichman and Voth, 'Debt sustainability in historical perspective'.

[81] See the argument in depth in R. Grafe and A. Irigoin, 'A stakeholder empire'.

debt.[82] Most of the financial liabilities were subject to the Spanish Crown and not to the local treasury.

However, fiscal centralization was persistently challenged by the local authorities in Spanish America throughout the colonial period. Accordingly, the fiscal authority in Madrid possessed a constrained capacity to directly enforce taxes and withhold Spanish American revenues as remittances for the crown's treasury. Instead, there were sequential rounds of negotiation with the local treasuries regarding the fiscal mechanisms and financial commitments. In these negotiations, the exchange of fiscal exemptions and other economic privileges were commonly at stake.[83]

In general, the fiscal policy of Spanish America was semi-autonomous because running a deficit or a surplus was a bilateral 'negotiated' decision. Although the local treasuries operated on cash-based transfers they had their own budget constraints depending on the amount of expected revenues and expenditures to execute on the local economy but also subjected to prior arrangements with the central fiscal authority in Madrid.

The inability to issue official debt and other financial instruments at the local treasury-level is an important limitation to properly portray the colonial treasuries as representative modern fiscal entities. However, given the semi-autonomy fiscal status to allocate their own gross revenues and expenditures, the local colonial authorities faced in practice an intertemporal budget constraint, a framework that dictated fundamentally the local fiscal dynamics.

The intertemporal budget constraint

A well-developed body of literature on the issue of fiscal sustainability has adopted the framework of the intertemporal budget constraint of the government.[84] In theory, any value for the budget deficit would be possible if the government could raise its liabilities without limit. However, in practice this situation is impossible since the government is restricted by the present value of its budget constraint, and because of this, it faces the problem of balancing its budget across time, meaning that the discounted value of the public debt must go to zero in the long-run (Blanchard *et al.*, 1990). That is, a sustainable fiscal policy is a position in which the public debt does not exceed the present value of all future primary surpluses.

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[82] The extraordinary funds so-called *donativos* acted as debt instruments during wars, however, within the cajas' bookkeeping system they usually did not enter as such. See Marichal (1990) for details.

[83] L. Arias, 'Building fiscal capacity in colonial Mexico'.

[84] See a complete theoretical and empirical overview in Chalk and Hemming, 'Assessing fiscal sustainability'.

The standard derivation of the intertemporal budget constraint (hereafter IBC) starts with a version of public sector income statement, that is, a one-period budget constraint which describes the evolution of public debt as follows:

$$B_{t+1} = (1+r)B_t - PB_{t+1} \quad (1)$$

where B_t is the stock of the government net debt, r is the interest rate, PB_t is the primary balance of the public sector which equals revenues minus expenditures excluding interest expenditure.

Solving the budget constraint recursively forward by n:

$$B_{t+1} = (1+r)^{-n} B_{t+n} + \sum_{i=1}^{n} (1+r)^{-i} PB_{t+i} \quad (2)$$

Taking the limit as n tends to infinity:

$$B_{t+1} = \lim_{n\to\infty} (1+r)^{-n} B_{t+n} + \sum_{i=1}^{\infty} (1+r)^{-i} PB_{t+i} \quad (3)$$

Therefore, the IBC holds if and only if the present value of the government debt in infinity is assumed to be zero:

$$\lim_{n\to\infty} (1+r)^{-n} B_{t+n} = 0 \quad (4)$$

By substituting the above into equation (3) we obtain:

$$B_t = \sum_{i=1}^{\infty} (1+r)^{-i} PB_{t+i} \quad (5)$$

According to this restriction (also called *no-ponzi* game condition), the IBC implies that the current value of the public debt is equal to the present value of the expected future budget surpluses. In other words, a fiscal policy in place is sustainable if the sum of all discounted future primary surpluses is enough to offset the market value of public debt.[85]

Empirical methodology

In order to disentangle the long-term statistical trends of the cajas reales across time, this analysis establishes a periodization based on the political regimes and the wars

[85] Wilcox, 'The sustainability of government deficits'.

engaged by Spain during the colonial period. Thus, the full sample was split into three sub-periods: starting from a period of the 'Habsburg reign' that in the dataset covers 1577-1698; it is then followed by a period of 'succession and transition' from 1699-1759; and lastly a third sub-period that spans from 1760 to 1813 characterized by 'reformism and the Napoleonic wars'. As mentioned the sample coverage of different cajas varies, therefore, the starting sub-period was set according to the range of the statistical series.

As mentioned above, in practice the concept of fiscal sustainability implies that a fiscal policy can be maintained in the long-run without resort to a sudden adjustment. To evaluate this, many studies have analyzed whether the financial data are consistent with the 'transversality' condition by examining the stationarity properties of the budget deficit excluding interest payments of the public debt.[86] Seminal empirical research has suggested the exploration of the statistical properties of long-span data to determine if the government debt follows a stationary process. An approximation for this is to analyze fiscal data to establish if there are 'cointegration relationships' between government revenues and expenditures.[87]

According to this assumption, if a fiscal deficit is stationary, the IBC holds and no adjustment to the debt process would be necessary. This condition is also seen in empirical studies as a case of 'strong sustainability'. On the other hand, if a budget deficit is non-stationary, still there are cases where the IBC could hold as in the case where government revenues and expenditures are *cointegrated*, however in that case, the ability to pay the debt is compromised.

Accordingly, a sudden change in the budgetary process is expected in order for the government to keep the public debt viable. This situation is referred to as "weak sustainability" (Hakkio and Rush, 1991; Quintos, 1995). To test the IBC it is necessary to determine whether the series of real revenues R and real expenditures E are non-stationary I(1) variables (and integrated in the same order, usually first order) and that the first differences are stationary variables I(0).[88]

In order to assess the long-run sustainability of the IBC, I estimate the following cointegration regression:

$$R_t = \alpha_t + \beta_t E_t + u_t \qquad (6)$$

Where R_t is the logarithm of real revenues, and E_t is the logarithm of real expenditures. If the null hypothesis of no cointegration is rejected, then it would imply

[86] 'Transversality' means that the present value of a variable converges to zero as the planning horizon recedes towards infinity.

[87] See for instance, J. Hamilton, 'On the limitations of government borrowing' and H. Bohn, 'The behavior of US public debt and deficits'.

[88] Notation I(1) refers to a variable integrated in its first order. And I(0) refers to a stationary variable.

that the variables are cointegrated (alternative hypothesis). For that to hold, the residuals series of u_t must be stationary and should not display a 'unit root'. α_t is an intercept to capture the initial level of the deviation. Binary variables (dummies) were included to capture the effects of time-trends in the data. As Hakkio and Rush (1991) established, $\beta \geq 1$ would imply that all government expenditure will be financed by primary revenue, and thus, the public debt will not be growing without bound. On the contrary, if these variables are not cointegrated the gap between them will grow indefinitely, and fiscal policy would not be sustainable. I can summarize these features with the following assumptions:

a. When there is no cointegration, the fiscal deficit is not sustainable.
b. When there is cointegration with $\beta \geq 1$, the deficit is sustainable.
c. When there is cointegration with $\beta < 1$, the deficit may not be sustainable.

Estimations

The standard method to test for cointegration consists of two steps: first, the stationarity properties of the time series are studied by using stationarity or 'unit root' tests. Second, if it is established that the series are non-stationary $I(1)$, the tests of cointegration (Johansen' test and, single equation tests) are applied to the time series variables.

Stationarity

Conventional regression models for non-stationary variables yield spurious results. For this reason, exploring the stationarity of time series variables is crucial to determine the existence of a 'true' (non-spurious) long-run relationship. The stationarity properties of the series (full sample) of real revenues, real and expenditures (E) are examined using the tests Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS). Table 2.3 report unit root tests results for the series in levels and in first differences.

Results are fairly consistent using different tests. They show that revenue and expenditure in levels of all selected treasuries followed 'unit root' processes [or I(1)], then become stationary [$I(0)$] in first differences. For the case of New Spain, these results are clear for the treasuries of Mexico City, Veracruz, Zacatecas and Guadalajara. However, the fiscal series of the treasury of Acapulco are already stationary in level terms. This implies that this treasury (Acapulco) originally (thus, in levels) did not have a clear trend-like behavior; its standard parameters such as the mean and variance did not change significantly over time.

Table 2.3: Stationarity tests to revenue and expenditure: New Spain (full sample; series adjusted for inflation)

Caja / test		ADF		PP		KPSS	
		Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Intercept & trend
Mexico City	*Revenue*	-1.44	-2.63	-1.22	-2.30	1.16***	0.30***
	Δ *Revenue*	-5.23***	-5.25**	-8.33***	-8.33***	0.07	0.03
	Expenditure	-1.19	-2.95	-1.45	-2.29	1.19***	0.30***
	Δ *Expenditure*	-3.80***	-3.80***	-8.69***	-8.70***	0.08	0.02
Guadalajara	*Revenue*	-2.81	-4.96***	-2.27	-4.98**	1.42***	0.24***
	Δ *Revenue*	-11.25***	-11.24***	-8.08***	-8.02***	0.11	0.04
	Expenditure	-2.61	-3.23*	-2.61*	-3.23*	0.64*	0.06*
	Δ *Expenditure*	-7.97***	-7.98***	-7.97***	-7.98***	0.06***	0.04***
Veracruz	*Revenue*	-2.93*	-5.10**	-2.52	-5.01**	1.42***	0.23***
	Δ *Revenue*	-11.77***	-11.75***	-21.46***	-21.40***	0.07	0.11
	Expenditure	2.87*	-5.13*	-2.39	-4.97**	1.42***	0.24***
	Δ *Expenditure*	11.99***	-11.96***	22.78***	-22.93***	0.08	0.07
Acapulco	*Revenue*	-5.05***	-5.15***	-5.16***	-5.28***	0.39*	0.11*
	Δ *Revenue*	-15.32***	-15.30***	-16.13***	-16.11***	0.04	0.03
	Expenditure	-5.16***	-5.24***	-5.45***	-5.57***	0.38*	0.07
	Δ *Expenditure*	-12.51***	-12.67***	-16.05***	-16.04***	0.06	0.03
Zacatecas	*Revenue*	-1.84	-1.91	-1.39	-1.41	0.22*	0.21**
	Δ *Revenue*	-9.85***	-10.40***	-14.95***	-15.23***	0.03	0.04
	Expenditure	0.01	-1.01	-2.44	-4.62	0.23*	0.32*
	Δ *Expenditure*	-13.63***	-13.66***	-18.45***	-18.86***	0.08	0.06

Note: For ADF and PP tests the symbols ***, ** and * indicate respectively statistical significance at 1%, 5%, and 10% of the rejection that the series has a 'unit root'. The KPSS test has the opposite null, meaning the rejection of the null hypothesis that the series is stationary. Maximum lag-lengths were chosen using the Schwarz information criterion for ADF tests. For PP and KPSS tests the Newey-West bandwidth was used.

Table 2.4: Stationarity tests on revenue and expenditure: Peru and Rio de la Plata (full sample; series adjusted for inflation)

Caja / test		ADF		PP		KPSS	
		Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Intercept & trend
Lima	*Revenue*	-2.74*	-2.67	-3.04*	-2.98	0.14	0.14
	Δ *Revenue*	-13.98***	-13.98***	14.01***	-14.00***	0.06	0.03
	Expenditure	-2.76*	-2.77	-3.07	-3.07	0.16	0.16
	Δ *Expenditure*	-13.62***	-13.62***	-13.62***	-13.61***	0.07	0.03
Potosí	*Revenue*	-5.20**	-5.37**	-3.43**	-3.79**	0.19	0.19
	Δ *Revenue*	-8.52***	-8.69***	-8.39***	-8.54***	0.26	0.11
	Expenditure	-5.63***	-5.64***	-3.58**	-4.03***	0.19	0.20
	Δ *Expenditure*	-7.95***	-8.13***	7.77***	-7.93***	0.27	0.12
Santiago	*Revenue*	0.35	-2.24	0.14	-1.34	0.82***	0.23***
	Δ *Revenue*	-4.08***	-4.38***	-7.38***	-7.94***	0.24	0.05
	Expenditure	0.50	-1.41	0.80	-0.92	0.99***	0.23***
	Δ *Expenditure*	-8.26***	-8.43***	-8.27***	-8.36***	0.32	0.04
Buenos Aires (Rio de la Plata)	*Revenue*	-2.03	-2.50	-2.15	-2.70	0.72*	0.07
	Δ *Revenue*	-9.72***	-9.68***	-9.72***	-9.68***	0.05	0.05
	Expenditure	2.35	-2.85	-2.40	-2.93	0.66*	0.07
	Δ *Expenditure*	-10.23***	-10.19***	-10.26***	-10.22***	0.05	0.05

Note: For ADF and PP tests the symbols ***, ** and * indicate respectively statistical significance at 1%, 5%, and 10% of the rejection that the series has a 'unit root'. The KPSS test has the opposite null, meaning the rejection of the null hypothesis that the series is stationary. Maximum lag-lengths were chosen using the Schwarz information criterion for ADF tests. For the PP and KPSS tests the Newey-West bandwidth was used.

For the viceroyalty of Peru and Rio de la Plata, Table 2.4 equally displays the feature of New Spain's treasuries. The exception is the real revenues and real expenditures in the treasury of Potosí which test shows evidence that these are stationary in their original form (levels).

The significance of finding stationary variables in levels presents an even stronger case of supporting evidence that the series (real revenues and real expenditures) are cointegrated without further empirical examination. However, most of the other treasuries are $I(1)$ (first-order integration), which means that they followed a common trend.

Cointegration

Exploring the statistical properties of times series variables have been a widely used tool to make inferences about their short and long-run performance. The IBC theory (as various theoretical propositions) implies the existence of equilibrium relationships in the levels of times-series variables. The concept of *cointegration* has been often used in applications to long-term financial data with the aim to establish if they follow a common *stochastic* drift.[89]

The economic interpretation of cointegration is that times-series variables $I(1)$ with a long-run equilibrium relationship cannot drift 'too far' apart from the equilibrium because economic forces will act to restore it. In this case, if fiscal policy and all budgetary local decisions on revenues and expenditures were sustainable (consistent with the IBC) then the fiscal series of the colonial treasuries should be cointegrated. Conversely, if there is no evidence of cointegration that may imply that the financial sustainability of the treasuries was at risk of default and/or highly exposed to a sudden fiscal adjustment. As mentioned in previous sections, seminal studies are still contending quantitatively whether this was a feature in the economies of colonial Spanish America.

Since most of the unit root (stationarity) tests of table 2.3 and 2.4 confirm the stationarity property of the variables and follow the same order of integration $I(1)$, the ensuing analysis employs two cointegration tests conventionally used within the time-series econometric literature: the 'Johansen's test', and a 'single equation test'.[90]

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[89] A formal definition of the term 'cointegration' refers to the case when a linear combination of two or more series in their first order of integration $I(1)$ results in a stationary $I(0)$ relationship. See a cliometric perspective in Greasley and Oxley (2011).

[90] Johansen's procedure employs two test likelihood ratio (LR) test statistics: the maximal 'eigenvalue' and 'trace' value to test the presence or absence of long-run equilibria between the variables as stated in equation 6. This implies finding whether there is a 'cointegration vector' (excluding the constant term) close to [1 -1] (See Johansen, *et al.*, 2000). Once having normalized the cointegration vector on (1,-1), the condition ensuring sustainability is read as: $\beta \leq 1$. The 'single equation' test, also called 'Engle & Granger', consists in using the residual-based equation of an ordinary least square's regression from equation 6. The

Interpreting cointegration tests

The cointegration tests in tables 2.5 and 2.6 show mixed results that are conditional to the specifics of the caja and the sample analysed. For instance, for the case of the caja of Mexico City, the full sample (1577-1813) analysis shows the existence of a cointegration relationship (significance of 'trace' value and 'maximum eigenvalue'). Its β coefficients (in both tests Johansen's and single equation) are near to 1 (0.99 and 0.98 respectively).

The relationship changes by analysing the sub-period 1577-1698. In this, there is no evidence of cointegration in either test and the β coefficient drops significantly (to 0.78 and 0.90 respectively). In the following period (1699-1759), cointegration is restored and β equals unity (1.03 and 1.01). However, in the last sub-period (1760-1813), despite of reaching unity, there is no evidence of the existence of cointegration.

Similarly, other treasuries within New Spain experienced a comparable trend (except of the caja of Acapulco); evidence of a cointegration relationship is found in the full sample, and the sub-period 1699-1759, but also 'no-cointegration' for the last sub-period (after 1760), the period of reforms and the Napoleonic wars.

On the other hand, following this statistical analysis, the trends of the treasuries in Peru (and Rio de la Plata) are relatively different from New Spain. For example, looking at the full sample of the caja of Lima, there is no evidence of cointegration.

Yet, there is evidence of this during the first and last sub-period. In other major treasuries such as Potosí, the evidence is quite mixed; although there is evidence of it in the full sample, in the first sub-period it is not statistically significant. Whereas there is evidence of cointegration and β near unity, the 'single equation' test fails to confirm it.

Furthermore, regarding the treasury of Santiago the analysis shows unclear evidence of cointegration when looking at the full sample. However, when looking at the period of 1690-1759 it is possible to detect evidence of it with β on unity (1.01 and 1.05). Lastly, the treasury of Buenos Aires shows also that in the full sample cointegration is weak, still, there is a strong case for it during the last sub-period (1760-1809) with a β on unity (1.19 and 1.02).

β coefficient from it will be statistically valid by rejecting the non-stationarity of the residuals obtained from that regression, implying the existence of a cointegration relationship.

Table 2.5: Cointegration tests: New Spain (revenue and expenditure series in logarithms adjusted for inflation)

Caja	Period	*Johansen maximum likelihood test*				*Single equation test*	
		Trace (Ho: r=0 ; Hi: r>0)		λ max (Ho: r=0 ; Hi: r=1)	β	Stationarity (residuals)	β
		Eigenvalue	trace value	λ max eigenvalue			
Mexico City	Full sample	0.066	17.50***	15.86***	0.99 (0.02)	-4.02***	0.98 (0.05)
	1577-1698	0.080	16.99*	13.26	0.78 (0.07)	-2.89	0.90 (0.01)
	1699-1759	0.146	14.79***	9.65***	1.03 (0.01)	-4.29***	1.01 (0.00)
	1760-1813	0.136	10.30	7.90	1.04 (0.02)	-3.18*	1.02 (0.00)
Guadalajara	Full sample	0.019	13.16**	8.88**	0.96 (0.03)	-3.53*	0.93 (0.00)
	1584-1698	0.042	7.24	4.75	0.91 (0.08)	-2.65	0.89 (0.01)
	1699-1759	0.257	35.32**	18.14**	1.06 (0.01)	-3.02*	1.00 (0.00)
	1760-1804	0.148	10.28	7.25	1.32 (0.12)	-1.57	1.00 (0.00)
Veracruz	Full sample	0.075	19.22**	16.26*	0.95 (0.00)	-3.05*	0.96 (0.00)
	1590-1698	0.086	11.35	9.39	0.94 (0.01)	-2.38	0.95 (0.00)
	1699-1759	0.205	25.24*	14.03*	1.03 (0.00)	-1.89	1.01 (0.00)
	1760-1801	0.065	2.92	2.86	0.82 (0.11)	-1.28	0.99 (0.00)
Acapulco	Full sample	1.118	39.87*	27.11*	1.23 (0.05)	-2.24	0.97 (0.00)
	1591-1698	0.089	17.85**	9.67*	0.36 (0.19)	-4.36***	0.96 (0.00)
	1699-1759	0.241	21.96*	16.89*	1.49 (0.13)	-2.95*	0.94 (0.02)
	1760-1809	0.089	6.33	4.68	0.78 (0.10)	0.11	0.97 (0.01)
Zacatecas	Full sample	0.092	28.93**	21.89**	1.02 (0.01)	-2.31*	1.00 (0.00)
	1584-1698	0.237	33.04*	29.83***	0.97 (0.00)	-3.29**	0.98 (0.00)
	1699-1759	0.161	16.91*	10.77*	0.86 (0.05)	-3.52**	0.96 (0.01)
	1760-1813	0.149	10.01	8.76	1.10 (0.03)	-0.48	1.01 (0.01)

Note: Parenthesis on β for Johansen's and 'single equation' tests indicates their standard errors. Symbols ***, ** and * indicate respectively statistical significance at 1%, 5%, and 10% of the rejection of the existence of at least one cointegration equation. The Johansen test results are based on a lag length of three (p=3) for the VAR in levels (p=3), i.e. Using lags 1 and 4. The length was chosen using the Akaike information criteria. Estimations were obtained assuming a linear deterministic trend, and an intercept in the cointegration equations. The critical values (tau-statistic) for the residuals of single equation test are from MacKinnon (1996). Symbols ***, ** and * indicate respectively statistical significance at 1%, 5%, and 10% of the rejection the null hypothesis of no cointegration.

Table 2.6: Cointegration tests: Peru and Rio de la Plata (revenue and expenditure series in logarithms adjusted for inflation)

Caja	Period	*Johansen maximum likelihood test*				*Single equation test*	
		Trace (Ho: r=0 ; Hi: r>0)		λ max (Ho: r=0 ; Hi: r=1)	β	Stationarity (residuals)	β
		Eigenvalue	trace value	λ max eigenvalue			
Lima	Full sample	0.058	26.43	13.91	0.59 (0.44)	-2.55	1.04(0.01)
	1580-1698	0.131	21.02**	16.03**	1.04 (0.01)	-4.26***	1.03 (0.00)
	1699-1759	0.169	14.73	11.30	0.81 (0.05)	-3.51*	0.93 (0.01)
	1760-1813	0.234	18.59**	14.41*	0.86 (0.19)	-3.11*	0.62 (0.08)
Potosí	Full sample	0.105	20.07***	13.59**	1.01 (0.05)	-2.97*	0.90 (0.01)
	1679-1759	0.283	31.25**	25.32**	1.95 (0.21)	-1.55	0.87 (0.02)
	1760-1805	0.223	13.28*	11.61*	0.98 (0.04)	-3.88**	0.92 (0.02)
Santiago	Full sample	0.055	7.04	6.39	1.28 (0.07)	-1.89	1.24 (0.01)
	1690-1759	0.294	26.18***	22.69***	1.01 (0.01)	-4.59***	1.05 (0.00)
	1760-1805	0.219	13.48	11.39	1.65 (0.09)	-1.70	1.49 (0.05)
Buenos Aires (Rio de la Plata)	Full sample	0.121	16.41*	13.54*	1.21 (0.06)	-2.74	1.09 (0.02)
	1700-1759	0.156	10.17	9.38	0.88 (0.06)	-0.01	1.96 (0.03)
	1760-1809	0.243	19.89***	13.95***	1.19 (0.08)	-3.21**	1.02 (0.03)

Note: Parenthesis on β for Johansen's and 'single equation' tests indicates their standard errors. Symbols ***, ** and * indicate respectively statistical significance at 1%, 5%, and 10% of the rejection of the existence of at least one cointegration equation. The Johansen test results are based on a lag length of three (p=3) for the VAR in levels (p=3), i.e. using lags 1 and 4. The length was chosen using the Akaike information criteria. Estimations were obtained assuming a linear deterministic trend, and an intercept in the cointegration equations. The critical values (tau-statistic) for the residuals of single equation test are from MacKinnon (1996). Symbols ***, ** and * indicate respectively statistical significance at 1%, 5%, and 10% of the rejection the null hypothesis of no cointegration.

Structural break

Although splitting the full sample into sub-samples is an approach to examine a structural change in the series, there are more accurate ways to detect a structural break that may have generated that change. Indeed, a criticism on the robustness of cointegration tests is the existence of structural breaks in the equilibrium relationships. A structural break appears when an unexpected shift is detected in time series variables.

However, the problem is often that the 'break date' is unknown and also there are (unknown) breaks in the variance.[91] Thus, the use of the 'Gregory-Hansen test' has become more useful in time-series analysis because it tests for one 'unknown' structural break. Since many high-frequency series have usually multiple structural breaks, Bai and Perron (2003) developed a test to determine multiple breaks in the data indicating the precise year.

Table 2.7: Tests for multiple structural breaks in long-run equations (full samples)

Caja	Total of structural breaks	Year(s) of structural break	F-statistic (scaled) [a]	Critical value [b]
Mexico City	1	1779	33.55	14.03
Guadalajara	2	1617, 1653	27.79	12.95
Veracruz	2	1621, 1652	18.97	12.95
Acapulco	0	-	-	-
Zacatecas	0	-	-	-
Lima	1	1761	48.55	11.47
Potosí	1	1707	153.77	11.47
Santiago	2	1708, 1781	128.9	14.85
Buenos Aires	3	1716, 1737, 1754	41.07	15.29

Note: Test refers to the Bai-Perron test of L+1 vs. L sequentially determined breaks. Estimation was made with trimming at 0.15, with five breaks as maximum, and with a significance level of 0.05. Test statistics employed HAC covariances (Quadratic-Spectral kernel, and Andrews bandwidth).
[a] reports the scaled F-stat of the last breakpoint year found.
[b] indicates the critical value of Bai-Perron (2003).

Table 2.7 shows an application of this to the treasury data. Although it displays the existence of structural breaks for most of the treasuries, the treasury of Mexico City, one of the most important ones, only reports one structural breakpoint (none for the case of Acapulco and Zacatecas). To some extent this empirical finding is surprising given the collapse of real revenues 'graphically' detected (fig. 2.5b) at the start of the nineteenth century (circa 1804) in Mexico City, which would have led us to assume *a priori* the

[91] Various empirical studies set a predetermined 'break date' for structural change through a simple 'Chow test', however, that test is unable to detect endogenously the exact breakpoint.

existence of a sudden change in the mean and/or variance in that year. However, the structural change started by 1779, precisely in the midst of the Bourbon reforms.

One the other hand, various structural breaks are reported in Santiago and Buenos Aires during the eighteenth century. It has been documented for the case of Buenos Aires that its treasury experienced a notable unstable fiscal performance before its adherence to the Viceroyalty of Rio de la Plata in 1776. After that, its fiscal revenues stabilized relying mostly on the inter-regional transfers from surpluses of other treasuries.[92] Certainly, this pre-1776 fiscal instability in Buenos Aires is revealed statistically in table 2.7 with three structural breakpoints.

2.5 Empirical findings and discussion

After estimating long-run equilibrium relationships of the colonial fiscal series through various time-series techniques, a vital question emerges when recapitulating the usefulness of this econometric approach: what can these statistical tests reveal that previous quantitative historical works have not?

First, the present data adjustments are one of the first attempts to adjust the colonial treasuries of Spanish America for price movements in a systematic way. Since inflation distorts taxpayers' income and thus, revenue collection, this adjustment is necessary as taxation and finance in colonial times were not pegged to inflation rates (tax indexation).[93] The analysis has shown that in the absence of this adjustment the fiscal trends of the local treasuries over different periods can be misrepresented.

This is not to say that the inflation-adjustment procedure impacted the condition of long-term fiscal sustainability. The price adjustment was applied equally to nominal revenues and expenditures, thus, deflating by the same factor (prices) evidently does not alter the differences between the series. The price adjustment merely reveals (on each separated series of revenue and expenditure) in relative terms with other treasuries, the effects of local inflation and deflation on the fiscal budgets. These adjustments were aimed to quantify the real fiscal stance of the treasuries from a long-term view and measure the magnitude in which high inflation caused the erosion (*Olivera-Tanzi effect*) of the value of money.

Second, a long-term historical analysis involving relationships of time-series variables should always verify that these relationships are not spurious. Thus, exploring their statistical properties (such as non-stationarity, cointegration, and structural breaks) can be a useful tool to have a better understanding of their long term-dynamics. Statistically speaking, the econometric analysis established the existence of long term

[92] For e.g. Cuesta (2009), Halperín Dongui (1982)

[93] Except in colonial North America. See for e.g. the case of the Commonwealth of Massachusetts in R. Shiller, 'The invention of inflation-indexed bonds'.

equilibrium relationships of the fiscal data of the treasury budgets of Spanish America. Although there were marked changes across time and space (change in trend and structural breaks) that yielded mixed results on the overall coefficients, the robustness of this was statistically significant.

Moreover, the issue of uncovering cointegration relationships in the full sample but failing to find them in different sub-periods is very much relevant to understand fiscal sustainability. In general, these findings reveal different signs of deterioration or improvement of fiscal position in the colonial treasuries across time.

In particular, it indicates that when 'no cointegration' was found in a certain sub-period, expenditures and revenues were not following an equilibrium path, so the resulting difference between them (primary balance) was not stationary. This suggests that the budget deficit grew without bound reaching an unsustainable fiscal position. On the other hand, when cointegration was found in a sub-period, the colonial treasury operated under its own intertemporal budget constraints.

The following table summarizes the overall findings according to the periodization and the cointegration tests employed:

Table 2.8: Results of intertemporal budget constraints across regimes

Caja	Habsburg reign (c.1577 to 1699)	Succession and transition (c.1700 to 1760)	Bourbon reforms and Napoleonic wars (after 1760)
Mexico City	Unsustainable	Sustainable	Unsustainable
Guadalajara	Unsustainable	Sustainable	Unsustainable
Veracruz	Unsustainable	Sustainable	Unsustainable
Acapulco	Sustainable	Sustainable	Unsustainable
Zacatecas	Sustainable	Sustainable	Unsustainable
Lima	Sustainable	Unsustainable	Sustainable
Potosí	-	Sustainable	Sustainable
Santiago	-	Sustainable	Unsustainable
Buenos Aires	-	Unsustainable	Sustainable

Note: Results based on tables 2.5 and 2.6

Most of the existing quantitative studies have focused on the last sub-period because it has been presumed that the Bourbon reforms greatly improved the efficiency of the Spanish American fiscal administration by increasing the fiscal revenues and raising the remittances to Spain. Indeed, the present estimates in real terms showed that total revenues in the main treasuries increased greatly during this period. However, real

expenditures also rose immensely in different treasuries during that period, making the overall evaluation of fiscal sustainability highly differentiated across the treasuries.

Whereas most of the treasuries of New Spain during the Bourbon reforms (after 1760) experienced an unsustainable fiscal behavior, other treasuries like in Peru and Rio de la Plata were sustainable. Surprisingly, in spite of the inflationary trends in Buenos Aires, real primary balances in its treasury experienced a sustainable pattern.

On the other hand, during the period of 'succession and transition' (circa 1700 to 1760), this fiscal pattern was different. Whereas New Spain's treasuries were fiscally sustainable, unsustainable behavior was observed in the treasuries of Lima and Buenos Aires. Although revenue growth and fiscal balances in New Spain's treasuries were not extraordinary, their finances were viable during this period. The period of the Habsburg reign (circa 1577-1699) is also a phase of shifting fiscal performance across the treasuries. Whereas the treasury of Lima, Spain's prime treasury in this period was sustainable, the major treasuries of New Spain (except Acapulco and Zacatecas) were not.

The findings of different shifts in fiscal sustainability between treasuries and across centuries in Spanish America suggest the following: The 'Great Shift' that according to Herbert Klein started in the eighteenth century was actually reversed after 1760 with the start of the Bourbon reforms. Marichal and Souto (1994) have suggested that after 1760 intra-regional transfers within Spanish America were the channel with which small treasuries were sustained by large treasuries, distorting the fiscal budgets (mainly Mexico City).

Indeed, although newly founded treasuries (such as Buenos Aires) were aided and sustained with this, the present empirical findings suggest that the shifting fiscal performance is part of a more complex fiscal development that predates the period of the Bourbon reforms.

This analysis indicates that the so-called 'decadence' of the Spanish empire in the Americas at the onset of the nineteenth century cannot be linked solely to the fiscal performance of New Spain's treasuries as commonly portrayed in the literature. Although Mexico City's treasury plunged into an unsustainable position in the last years of the colonial period, other key high-revenue treasuries were not.

The empire's fiscal sustainability cannot be evaluated separately from the developments of other viceroyalties and from other periods in time because as was shown in this study, there was a clear shifting of fiscal performance across the Spanish American treasuries. Whether this was a fiscal policy choice from Madrid aimed purposely to manage in this manner the Spanish American budgets, or merely a circumstantial fiscal dynamic developed at the local level in Spanish America remains a political economy question.

The quantitative puzzle analyzed here, on whether the colonial fiscal system in Spanish America was sustainable, unfolds statistically in the various tests presented how their magnitude varied according to a particular treasury and the period analyzed. Furthermore, it can be said that the *price revolution* experienced in Europe in the

sixteenth century was also an historical feature in Spanish America in subsequent periods, which had a significant effect on the value of the purchasing power of money in the local treasuries.

2.6 Final remarks

After his famous journeys to colonial Latin America, the illustrious Prussian explorer Alexander von Humboldt published in 1809 the *Political Essay on the Kingdom of New Spain*. His work provided the first conjectural estimates of the treasury revenue in New Spain which revealed the vast wealth and fiscal capacity of the colonies in Spanish America. In this he indicated the following:

> "The territorial tax levied, [...] indicates with precision, the progress of industry only if we compare the periods in the intervals of which the price of commodities has undergone no sensible variation".[94]

Various historical studies on the treasury accounts in Spanish America have usually overlooked this feature, thereby neglecting a fundamental financial problem: the changing value of money across time. Seminal historical literature has constantly emphasized the great efficiency of the colonial fiscal administration to collect taxes which yielded large surpluses in various treasuries throughout the colonial period. Yet, all units registered in existent studies are amounts reported in nominal terms. And although the Spanish Crown deliberately ordered the debasement of silver, this chapter shows evidence that what really pushed down the value of 'treasury money' was the high rate of inflation in the local colonial economies of the Americas.

The analysis produced quantitative evidence that when this is not taken into account, the colonial finances of the largest caja for the Spanish empire, Mexico City, can be misrepresented for the period of 1760-1813. Also, for Peru when inflation is not considered, total revenues and expenditures in Lima's caja are undervalued for most of the seventeenth century.

These findings are relevant not only to understand the long-run fiscal position of the colonial treasuries, but also for re-examining singular historical events at the end of the colonial rule. For instance, when the Spanish Crown resorted in issuing treasury bills (*vales reales*) in the Americas in order to cover Spain's deficits, it generated an increase in the money supply that may have affected the overall price level in the colonies and thus, the real value of all financial instruments and the value of the public finance in the colonies.

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[94] Originally published in French as *Essai politique sur le royaume de la Nouvelle Espagne*. Sentence taken from the 1822 Spanish version, *Ensayo Político del reino de la Nueva España*. Book IV, chapter X. p. 459.

Moreover, this chapter introduced the framework of fiscal sustainability into the historical literature of the Spanish American finances. It applied a series of statistical tests to establish the existence of long-term relationships between the fiscal series of the colonial treasuries according to the IBC theory. The results are statistically significant but mixed.

There was a shifting process of fiscal sustainability across regimes. While the treasuries of New Spain were unsustainable during the 'Habsburg reign', Peru's treasuries experienced a sustainable fiscal pattern. During the period of 'succession and transition', New Spain's treasuries restored their sustainability in contrast to Peru and Buenos Aires. And finally, in the period of the 'reformism and Napoleonic wars', the treasuries of New Spain deteriorated vastly reaching to an unsustainable position, contrary to their counterparts in Peru and Rio de la Plata.

The analysis has an important limitation that is worth emphasizing because it may lead to the improvement of this empirical perspective and also to stimulate future research avenues. Aside from the inevitable oversimplification of various political economy aspects that this econometric approach entails, from an empirical-finance perspective it is necessary to construct better long-term measures of fiscal sustainability. Computing systematic measures across regimes of the ratio of the present value of primary surpluses (in the local colonial treasuries and in Madrid) to the value of all debt payments would yield a more accurate measure on whether the Spanish Crown (as a broad fiscal unit) was on the path to reach its financial obligations.

Furthermore, a complementary element to the latter would be the inclusion of continuous data on real output by region. In spite of the overall fiscal extraction portrayed by the literature, the analysis in this chapter has shown that various colonial treasuries recorded large fiscal revenues, and particularly expenditures. This may have impacted the local economic activity which also might have expanded the fiscal budgetary constraints. New regional data on gross output would allow the proper estimation of the standard fiscal ratios (all variables could then be defined in terms of ratios to Gross Domestic Product).

An extension of this would allow us to unveil how the intertemporal budget constraints in the local treasuries were related (or not) to the growth of their colonial economies, but more importantly whether the financial liabilities of the empire were warranted on the grounds of the economic growth of Spanish America.

Appendix I to chapter 2

As mentioned along the document, the fiscal series of the colonial treasury accounts are from TePaske and Klein (1998). Since that all original information is reported in gross nominal terms, I adjusted the original series with price indices (deflators) of the colonial cities using information from Arroyo-Abad *et al.* (2012) in order to obtain fiscal measures in 'real terms'. From the latter source, I took the average cost of a bare-bones basket for each colonial city, and I set an index with 1700 as reference year (1700=100).

According to the source, the average cost of these baskets include items such as foodstuff that covered around 70 percent of which 40 percent are maize and wheat, and the rest where other utility goods (30 percent) such as textiles, soap, candles and fuel [See detailed weighting description in the appendix of Arroyo-Abad *et al.* (2012)].

Exchange rate conversion

All treasury data from TePaske and Klein is reported in 'Spanish silver pesos' (pesos de a ocho de 272 maravedís; or *real de ocho*) also called 'Spanish dollar'. However, the price data from Arroyo-Abad *et al.* (2012) particularly the average cost of the bare-bones baskets was originally reported in 'grams of silver'.

Table 2.1.A. Conversion Spanish peso-silver grams

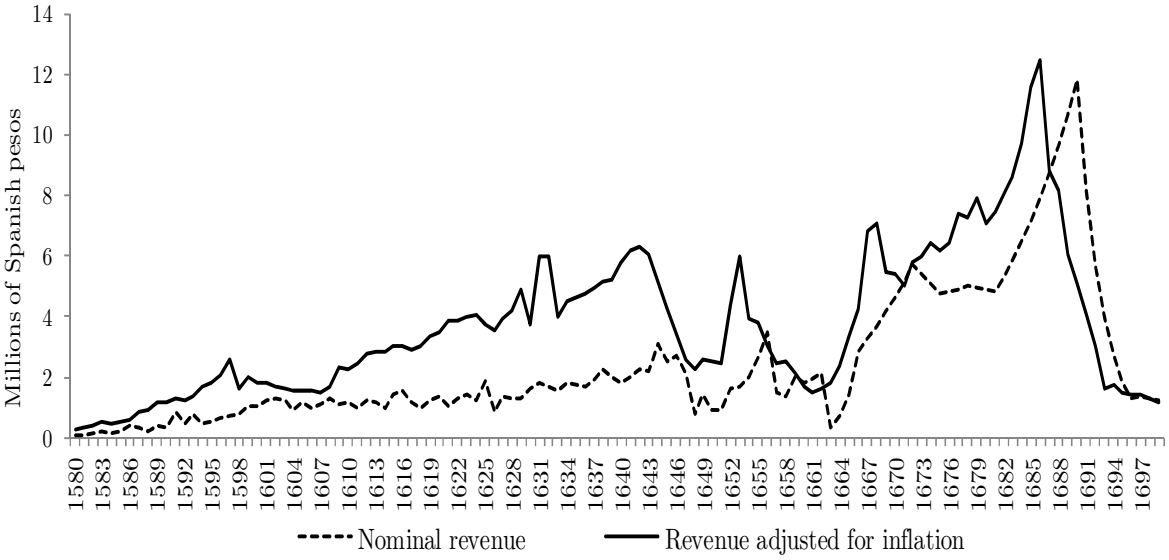
Period	Spanish peso per grams of silver
1577-1626	21.561
1627	22.561
1628	23.561
1629	24.561
1630-1728	25.561
1729-1771	24.908
1772-1786	24.433
1787-1813	24.245

Thus, I converted their data into Spanish pesos in order to set all data in the same unit of account. Although the silver value of the peso was held fairly constant across the colonial period in Spanish America, there were a few episodes of debasement affecting the exchange rate. I introduced these changes based on the data from Burzio (1958) following the conversion of table 2.1A.

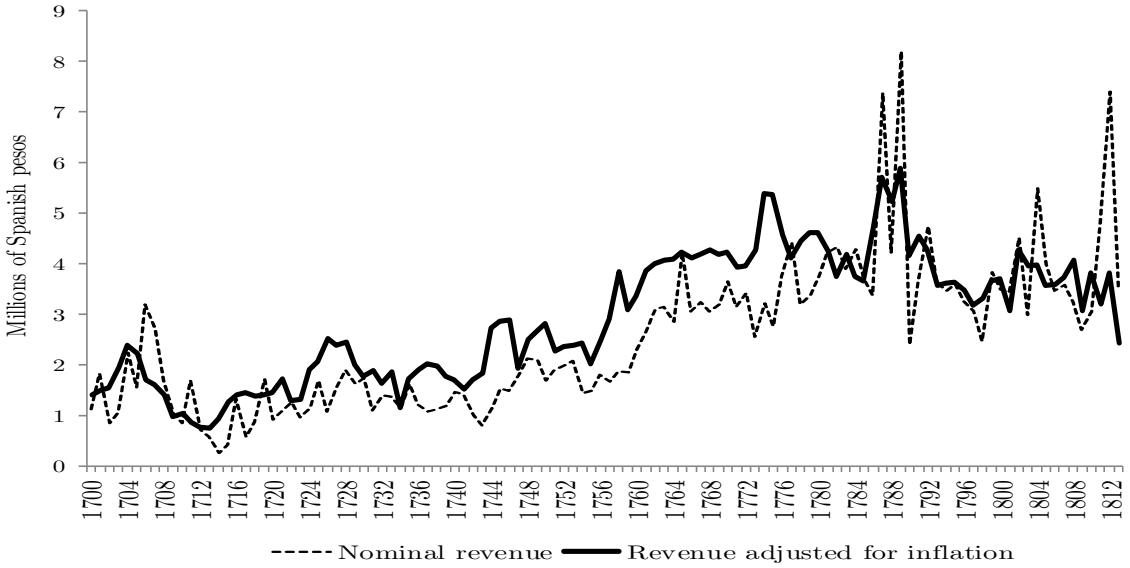
Appendix II to chapter 2

Figure 2.2.A. Nominal vs real revenue and primary balance: Lima

a) 1580-1699



b) 1700-1813



c) Spread nominal to real on primary balance (full sample)

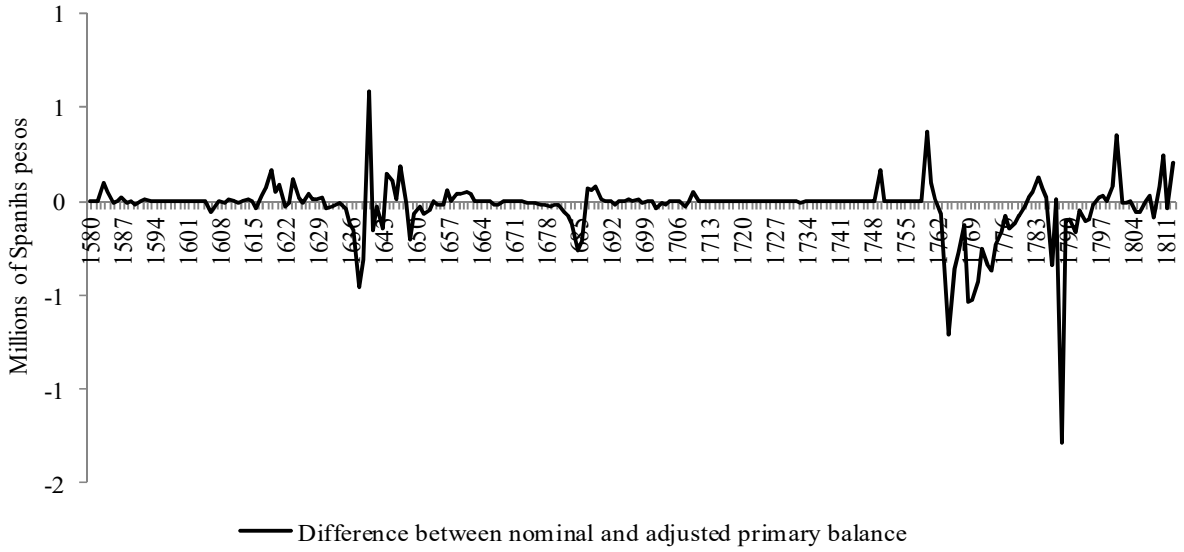
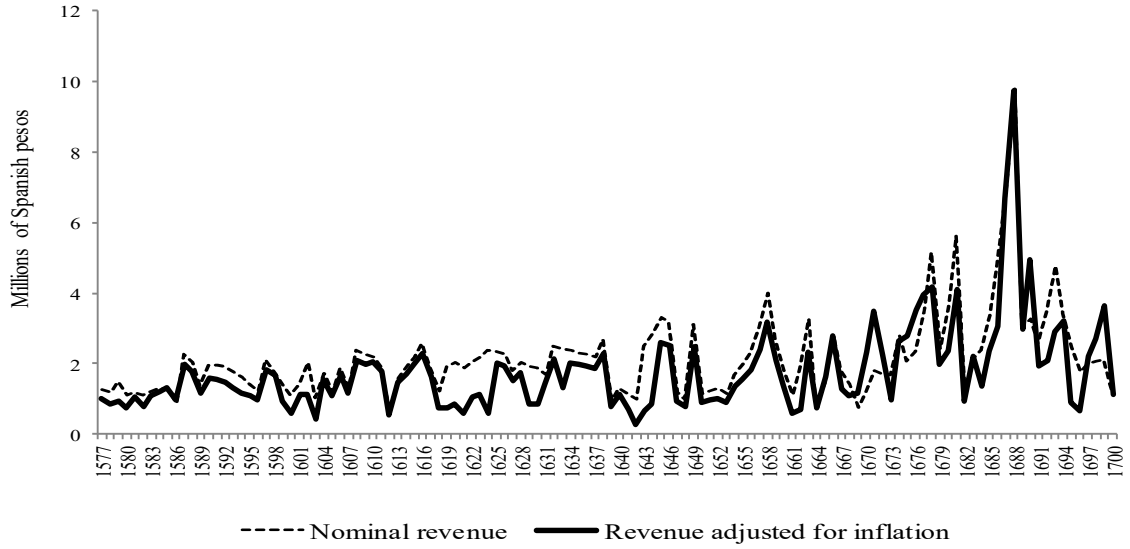
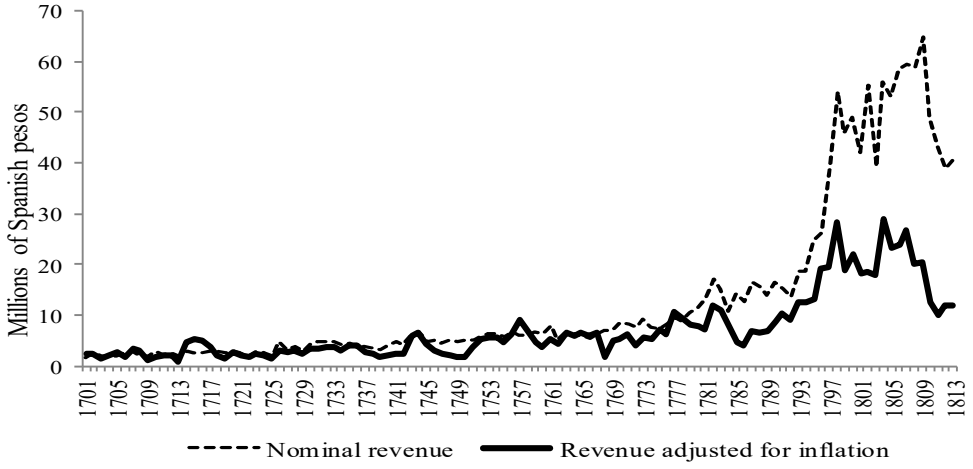


Figure 2.2.B. Nominal vs real revenue and primary balance: Mexico City

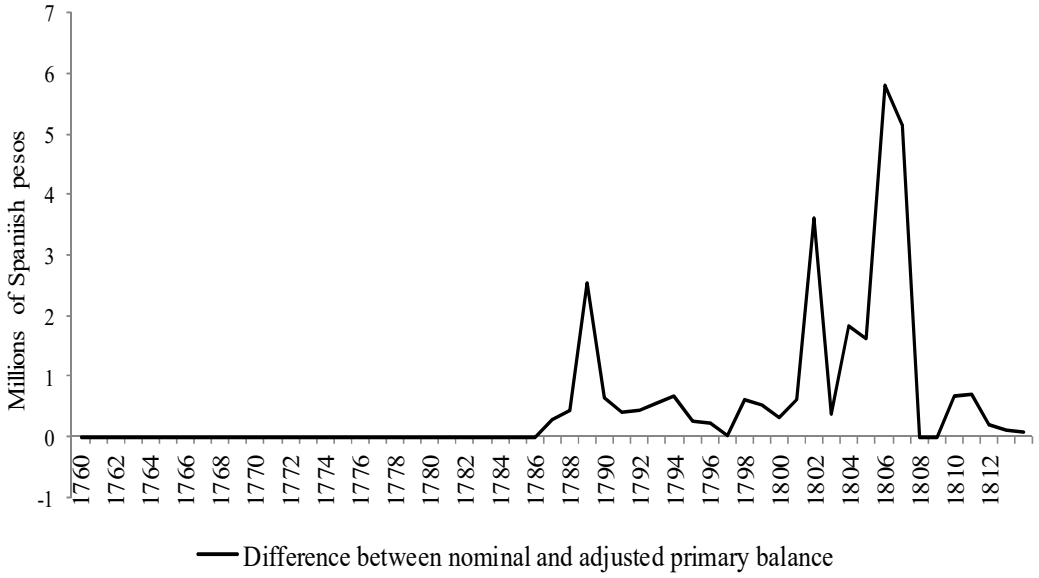
a) 1580-1700



b) 1701-1813



c) Spread nominal to real on primary balance after 1760 (during Bourbon reforms)



Appendix III to chapter 2

Figure 2.3.A. Real revenue and primary balance of the treasury of Veracruz, 1590-1801

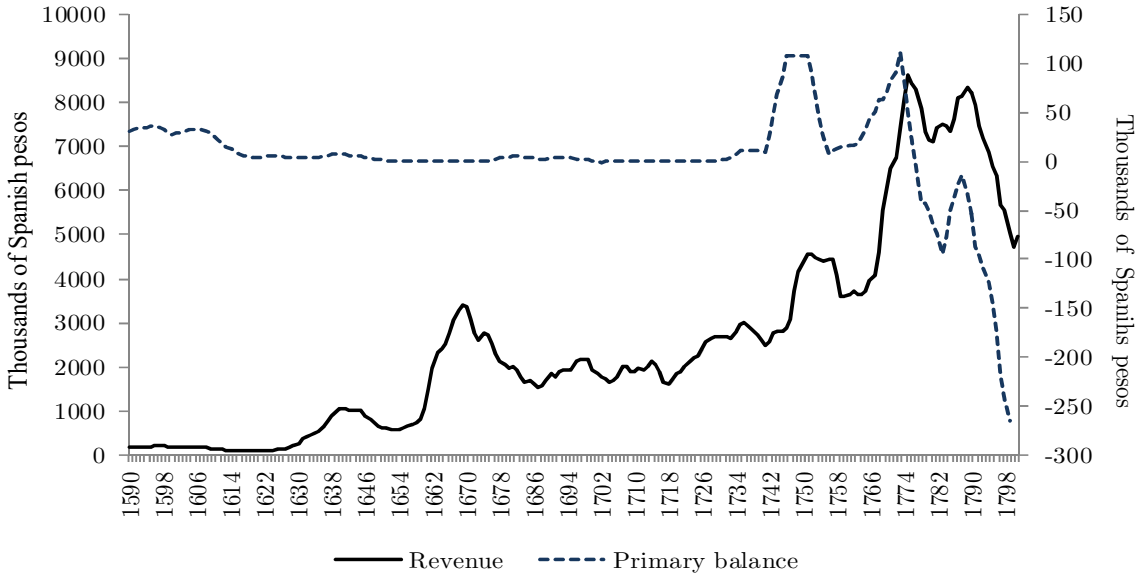
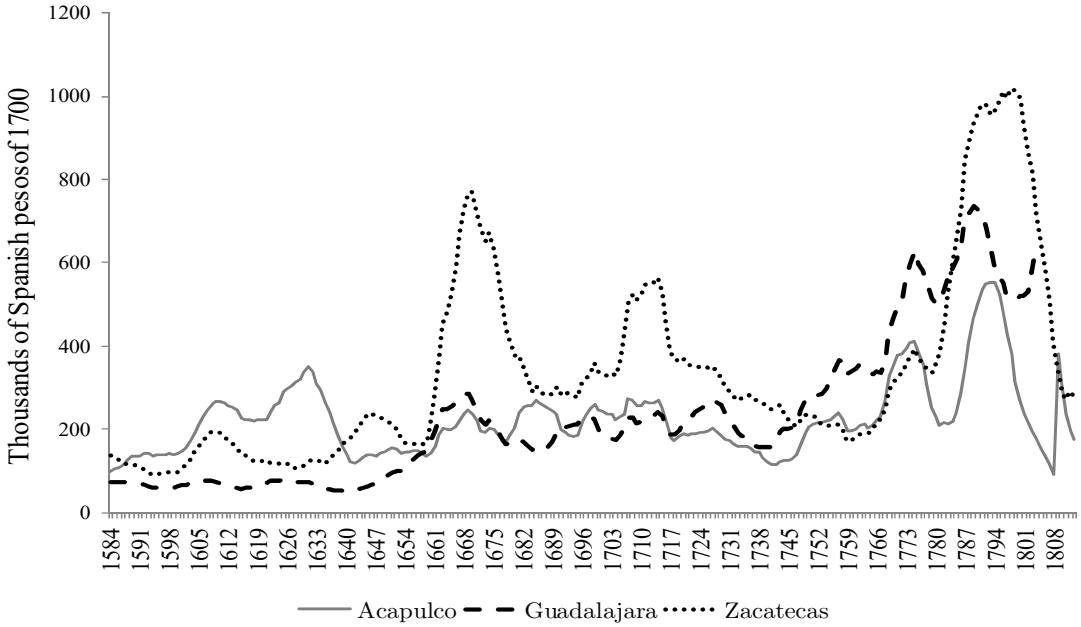


Figure 2.3.B. Real revenues in the treasuries of Acapulco, Guadalajara, and Zacatecas



Note: Data adjusted by inflation using the index of the average cost of bare-bones baskets. Figures are computed in five-year moving averages.

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Chapter 3

Real Wages and the Mexican Revolution, 1877-1910: A Reappraisal

"Neither increases in wages nor decreases in working hours depend upon the government, and. . . . we are not going to offer these to you because that is not what you want. You want freedom. You want your rights to be respected so that you will be able to form powerful associations in order that united, you will be able to defend your own rights".

Francisco I. Madero [95]
(Revolutionary and President of Mexico from 1911 to 1913)

3.1 Introduction

One of the most important features of the international economy from the mid-nineteenth century until the start of the First World War was the rapid process of globalization. International trade boomed as transport costs declined, driving an unprecedented pattern of global integration of commodities, capital, and labor markets, generating a process of convergence in the living standards of a group of industrial countries.[96]

The periphery, particularly Latin American countries were not absent from this. It has been documented how countries like Mexico benefited from the integration of markets associated with the introduction of railroads that caused a sharp fall in transport costs increasing the integration of commodity prices in the country. As a result, Mexican real GDP per capita nearly tripled from 1870 to 1913. However, at the inter-regional level we know very little about the integration of labor markets. Existing studies on the developing

[95] El Constitucional (Mexico, weekly newspaper), June 2 1910, p.2. Translated to English by R. Anderson (1974).
[96] Williamson, 'Globalization, convergence, and history'.

world have merely focused on the integration of agricultural commodities without particular reference to the integration of the cost of labor across regions.[97]

In the case of Mexico, the evolution of income disparities during the late-nineteenth century industrialization has been a controversial feature in the historical literature suggesting anecdotally that a continuous decline in the population's living standards generated social unrest in different regions of the country. Compelling narratives about peasant's rebellions in the *haciendas*, worker's protests in the northern and central parts of the country, and in the plantations of the southern state of *Yucatán* have been part of a rich strand of literature that has depicted a deterioration in the living standards of the Mexican population during those years. These and particularly a decline in real wages have been considered as one of the main motives that inspired the public support for the revolution of 1910 that deposed the presidency of Porfirio Díaz that had ruled the country for more than thirty years.[98]

This chapter explores these aspects in order to answer the following questions: Did Mexican regional real wages really decline during this period? And, did real wages converge across regions in the late-nineteenth century? The aim is to contribute to the existing literature in two ways. First, by combining records of regional wage rates with basic commodity price information disaggregated by region, this chapter provides broader evidence on Mexican real wage trends, and inter-regional and inter-sectoral gaps during the period. Second, it offers an analysis and economic explanation of the phenomenon of regional wage divergence.

The findings based on regional data show that estimated *lower-bound* regionally-adjusted wages remained relatively stable in most of the Mexican regions throughout the period. Although these wages followed divergent within country patterns and although there was a slight declining trend in wages of the industrial sector of the Pacific South region, from a broader quantitative perspective there was no dramatic decline as the conventional literature argues. The present estimates indicate that the interpretation of a secular decline in workers' living standards in Mexico from 1877-1910 does not have strong quantitative foundations.

However, a pattern of real wage divergence across regions was a salient feature. The regions in the Center and Pacific South of the country experienced slower real wage growth relative to the North, Pacific-North, and Gulf generating wide sectoral wage gaps. A tension between the forces of regional convergence and divergence emerged in which prevalent labor market institutions in Mexico tended to promote regional divergence,

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[97] See O'Rourke, et al. (1996) for an international comparative perspective on commodity market integration. For the cases of Argentina, Spain, and Mexico see Taylor (1997), Rosés (2003), and Dobado and Marrero (2005) respectively.

[98] Seminal historical studies associating the decline of real wages to the Mexican Revolution are found among the works of Tannenbaum (1968), Gilly (1971), Knight (1986), and Nickel (1988).

keeping structural labor market barriers that prevented inter-regional labor mobility and income convergence within the country.

The chapter is organized as follows: The next section describes briefly the overall performance of the Mexican economy during this period together with some related historical studies in the field. Section 3, describes data, sources, and methods used. Section 4 analyses the regional and sectoral wage trends, followed by section 5 which provides an explanation of regional divergence. Section 6 concludes.

3.2 The Mexican economy during the "Porfiriato" and related historical studies

The Mexican economy, 1876-1910

In 1876, Porfirio Díaz as new president of Mexico promoted a series of reforms that set the country on the longest period of political and economic stability since its independence. During his thirty-four years in office (1876-1910),[99] a period known in the historiography as the *Porfiriato* the country was radically transformed; liberal reforms promoted an expansion in industry, trade, and foreign investment, leading to unprecedented rates of economic growth.[100]

Table 3.1: Levels of GDP per capita in selected countries, 1870 and 1910 (1990 Geary–Khamis dollars)

Year	United Kingdom	France	United States	Mexico	Latin American average *
1870	3190	1876	2445	674	778
1910	4611	2965	4964	1694	1038
Increase in GDP (%)	45	58	103	150	33

Source: Based on data from Maddison (2007) updated by Bolt and van Zanden (2014).
* Average of GDP per capita levels of eight Latin American countries: Argentina, Brazil, Colombia, Chile, Mexico, Peru, Uruguay, and Venezuela.

[99] Diaz stepped down as president in 1880 and handpicked one of his trusted political operatives Manuel González as his successor whereas he continued as government minister. However, by 1884 Diaz was re-elected as President and continued uninterruptedly in office until 1910. Historians have broadly considered the period 1876-1910 as the Porfiriato.

[100] See an overview of the economic and institutional reforms during this period in Bortz and Haber, *The Mexican economy, 1870-1910*.

As illustrated in table 3.1, by 1910 Mexico's GDP (Gross Domestic Product) per capita nearly tripled its level of 1870, and although these levels were still behind other advanced countries this represented an outstanding growth achievement for the country in relative terms. While attaining this, Mexico underwent a process of structural transformation. By 1877, nearly forty percent of output per capita was generated in agriculture; but this percentage declined by 1910 to almost thirty percent, whereas other sectors such as commerce increased their share in the economy (see table 3.2).

During the first years of the regime and claiming to be adherents of the *laissez-faire* philosophy, the officials of the Díaz administration regarded many of the existing colonial policies (such as trade tariffs and inter-regional sales taxes) as obstacles for economic growth, therefore, the main objective of the government reformers was to remove these barriers by promoting a modernization process based on an outward-looking development strategy.[101]

Table 3.2: Sectoral shares of real GDP per capita, 1877-1910
(Percentages)

Sectors	1877	1895	1910
Agriculture and livestock	42.2	38.2	33.7
Mining	10.4	6.3	8.4
Manufacturing	16.2	12.8	14.9
Construction	0.6	0.6	0.9
Transportation	2.5	3.3	2.7
Commerce	16.9	16.8	19.3
Government	11.2	8.9	7.2
Other	-	13.1	12.9
Total	100	100	100

Source: J. Coatsworth, *Los orígenes del atraso*. Shares based on GDP per capita in prices of 1900.

The country had a comparative advantage in the production of highly-demanded commodities such as silver, copper, coal, iron, and oil (Mexico was a world leading producer of silver and second in copper) in international markets. Furthermore, there was a growing demand for intermediate inputs in industrialized countries, thus, the expansion of transport infrastructure for commodity exports was considered a necessity in order to increase trade and integrate the country into the global economy.[102]

Initially, the government of Díaz did not have enough resources to fully undertake the investments that the railway system needed. Hence, subsidies and concessions were

[101] R. Weiner, 'Battle for survival: Porfirian views of the international marketplace'.

[102] S. Kuntz-Ficker, 'Mercado interno y vinculación con el exterior'.

provided to foreign companies which covered around one third of the total construction costs.[103] From only 893 kilometers of railway track at the end of 1879, the network expanded close to 20,000 kilometers by 1910.[104] The expansion of the network linked the trade routes of the main exporting centers of the country which reduced freight rates sharply. For instance, estimates indicate that the freight of one ton of cotton textiles on the route Mexico-Querétaro (about 130 miles) dropped from $61 dollars in 1877 to only $3 dollars by 1910. This decline in transportation costs had a massive impact on production and prices, boosting the mining exporting sector, and the domestic commercialization of agriculture and manufacturing.

Figure 3.1: Mexican railway network and main towns in 1910

Source: Knight, *The Mexican Revolution*: *Counter-revolution and Reconstruction.* Map 2.

The domestic impact from the expansion of foreign trade varied from region to region. Some rose and flourished but others declined according to the trade intensity of the region. The majority of the population was located in the center of the country where the home of large-scale farms for wheat, maize, and textile manufacturers where. The northern region with less population density was typically specialized in mining and ranching. The renowned historian Friedrich Katz pointed out that economic growth was concentrated mainly in the northern states:

[103] It is estimated that 80 % of the capital for railroad construction was covered by North American investors. See Meyer and Sherman (1987), pg. 444.

[104] Coatsworth, 'Indispensable railroads in a backward economy'.

"Another deep-seated discrepancy that Porfirian development produced was an increasing regional disparity between the center, the south and the north of the country" (Katz, 1991, p. 79).[105]

Table 3.3. Population in Mexico by region, 1895-1910

	1895		1900		1910	
	Total	%	Total	%	Total	%
Total	12,632,428	100	13,607,560	100	15,160,368	100
Center	6,586,813	52	6,920,822	51	7,469,739	49
North	2,335,648	18	2,579,523	19	2,971,120	20
Pacific-South	1,680,599	13	1,853,752	14	2,151,223	14
Gulf	1,388,165	11	1,537,059	11	1,755,816	12
Pacific-North	641,167	5	716,104	5	812,470	5

Source: González-Navarro, *Estadísticas sociales del Porfiriato.*
Note: See appendix for details on regional classification.

Regional differences in natural resource endowments and population densities shaped the structure of the country's labor market; inhabitants in the northern region were located in towns near to the copper, coal, and silver mines; in the Gulf, people were employed in the emergent textile industries, and inhabitants in the central and southern regions were engaged in agricultural activities in large *haciendas* and plantations.

Land concentration would become a factor that allegedly increased regional income disparities. The Díaz administration promoted a land reform in the beginning of the 1880s to accelerate land redistribution with the aim of promoting investment by privatizing communal land which allowed the legal acquisition of property by development companies and high-income individuals (foreign and nationals). As a result, by the year of 1910, only 835 families owned 95% of the arable land in the country. This unbalanced regional development which broadly characterized the course of the Porfirian economy led journalists and contemporary historians to claim that the exacerbation of regional disparities had serious implications that prevented the country's transition from a traditional to a modern economy.[106]

Indeed, one of the recurrent elements in the literature of the Mexican Revolution is that the critical labor conditions of the expropriated peasants of whom many had become *peones* (pawns) working for the *hacendados* (landlords), coupled to a deterioration in the standards of living throughout these years, generated widespread discontent and unrest among workers sparking organized political associations in different parts of the

[105] F. Katz, 'The Liberal Republic and the Porfiriato'.
[106] For example, see the writings of Andrés Molina Enríquez in *Los grandes problemas nacionales.*

country leading ultimately to support an armed revolution that would overthrow the regime.[107]

Related historical studies

The period of the *Porfiriato* has fascinated economic historians in Mexico and observers around the world. For many years the prevailing image of this period portrayed in Mexican school textbooks was a sort of a black legend. These often paid attention to popular stories that depicted atrocious social conditions and the unequal environment allegedly promoted by the Díaz government.[108] By the 1970s a strand of 'Hacienda studies' popular among historians specialized on Mexico tended to confirm some of these dreadful conditions. However, recent historiography has provided a more balanced picture incorporating the quantitative methods that characterize the approach of the so-called *New Economic History*. Aspects such as the effects on growth of transport innovation, financial development, foreign trade, and the reorganization of public finances, among others areas, have been explored by several economic historians in recent decades.[109]

The work during the 1980s conducted by John H. Coatsworth particularly in *Growth against development* (1981) provided a new perspective on the economic performance of Porfirian Mexico, principally on the importance that the railways had in enhancing economic growth. Coatsworth found that the railway expansion during the *Porfiriato* generated in social savings near to 50 percent of the increase in Mexican GDP per capita.[110] The decline of transport costs reduced price differentials in basic commodities and minerals for exportation, generating a highly dynamic export sector. But, Coatsworth also highlighted a paradox in the economy; the expansion of railroads had brought growth to the country and at the same time carried popular discontent since this new way of transportation had changed agrarian landholding, leaving a vast portion of the population without their property giving rise to agrarian protests.

In general terms, this issue re-opened a long standing discussion on whether the developments of the Mexican economy improved the overall standards of living of Mexicans in the late-nineteenth century.

Different quantitative analyses and economic interpretations of the Porfiriato's performance have emerged since Coatsworth's work. Although much of the discussion on

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[107] See for instance the arguments of Jean Meyer, 'Haciendas y ranchos, peones y campesinos en el Porfiriato' or in Alan Knight, *The Mexican Revolution*.

[108] One of the most popular narratives is John Kenneth Turner's *Barbarous Mexico*.

[109] See a review of the most recent literature in P. Riguzzi, 'From globalisation to revolution?'; and in A. Gómez Galvarriato, 'Industrialización, empresas y trabajadores durante la revolución: la nueva historiografía'

[110] J. Coatsworth, 'Growth against development'.

economic history has focused on the buoyancy of mining exports, public finance, and the concentration of the banking sector, studies on living standards are scarce. Some of the most recent quantitative analyses on living standards are found in the works of Aurora Gómez-Galvarriato.[111]

These studies have analyzed the evolution of industrial real wages before and after the revolution in Mexico from 1900 to 1930. Based on wage records from a textile mill located in Veracruz (Gulf region), one of her studies found that real wages in this company followed a stable upward trend from 1900 until 1907. However, after this period there was a deterioration (a decline of 18% from 1907-1910). Needless to say, in spite of the uniqueness of the information in Gómez-Galvarriato's study, the trends described in that study cannot be regarded as a broad representation of the country's overall real wage rates since other manufacturing and commercial activities were emerging in those years in the north and center of the country, and also a substantial share of rural labor of the country does not take part in these analyses.

Following a different approach, López-Alonso (2007) analyzed Mexican living standards for the period 1850-1950 employing anthropometric information. Exploring the evolution of average heights of the working population she found that for the period of 1877-1910 there was no change in the average heights unlike the growth in other periods of time, suggesting that the biological standards of living did not improve during the Porfiriato.[112] However, regardless the typical issues and criticism on the use and reliability of anthropometric data, this study does not elaborate an analysis at the regional level.

Recently, Campos-Vázquez and Vélez-Grajales (2012) constructed an index similar to a human development index which was disaggregated by main cities and regions using data from official population censuses from 1895 to 1910.[113] Their index accounts for literacy, urbanization rates, and health. Contrasting to previous studies, they found that the well-being of the population improved during these years, particularly in the northern states and to some extent in the southern ones, unlike the central region where there was no improvement.

In general, existing studies for this period have used consistently different measures of living standards (single-industry real wage, height records, and human development indices) and apparently there is still no clear consensus about the wage trends at the national or regional level.

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[111] A. Gómez-Galvarriato, *Industry and Revolution,* and in 'The evolution of prices and real wages from the Porfiriato to the Revolution'.

[112] M. López-Alonso, 'Growth with inequality'.

[113] Campos-Vázquez and Vélez-Grajales, 'Did population well-being improve during Porfirian Mexico'.

Studies on the economic causes of the Mexican Revolution

Seminal historical studies have argued that the armed insurgency had deep economic causes stemming from developments occurring in the decades prior to 1910 (see e.g. in Riguzzi 2009). The predominant notion behind those studies is the existence of a secular deterioration of worker's real wages. In particular, this literature has emphasized temporary and structural factors. A sequence of external shocks, namely the deterioration of the Mexico's terms of trade due to the international financial crisis, and a series of bad harvests of major staples in the last decade the regime (1900-1910) have been referred as temporary factors generating high inflation impacting negatively the purchasing power of workers (e.g. Hart 1989; Cerda 1991).

As for structural factors, the literature has vastly documented the dreadful labor conditions in the haciendas. Most of these studies have depicted the feudal-type relations and the unequal bargaining power of workers (e.g. Tutino 1988; Katz 1988). Hacienda owners manipulated nominal wages at will, often maintaining them at very low levels over long periods. Consequently, the impoverished rural workers with stagnant wages and poor working conditions sparked the massive unrest and led to the spread of several rebellions. These, compounded with a discontent of the urban population with the undemocratic political system motivated the support for the armed insurgency. Other studies have argued that the revolution had a less agrarian background. The process of industrialization produced the appearance of a new generation of workers coming from the countryside that relocated into mining towns and urban areas. Driven by the unbearable working conditions and low wages in the industrial and mining sector, workers formed an organized labor movement that started major strikes across the country (Hart, 1978).

Evidently, these perspectives are not mutually excluding because both factors (temporary and structural) might have played a simultaneous role in the deterioration of real wages: a generalized rise in basic consumer prices, and/or a relative stagnation (or decline) of nominal wage rates. Perhaps one of the most influential anecdotal works describing the secular decline in workers' earnings during the Porfiriato is Frank Tannenbaum's *Mexican Agrarian Revolution*. In this study, largely focused on the rural areas and relatively small *pueblos*, it is depicted how the combination of the adverse effects of the rise in the cost of living and the dreadful working conditions in the hacienda contributed to the peasant's impoverishment that inspired the revolution.[114] For the industrial sector, González Navarro (1970: 202) argued that roughly half of the factory

[114] Tannebaum (1968:120-155).

strikes across the country obeyed to the unsuccessful petitions of demanding a salary raise.[115]

Famously stated in a Mexican newspaper in 1906, the spokesman of a major workers' association asked:

> "With all the progress in the country, why has not the worker also progressed? If because of this the price of everything rises, housing, food, clothing ... and if the same progress benefits the factories and increases their profits, why are not the salaries of those who contribute the most also increased...?"[116]

Studies employing statistical data on national prices and overall wage rates have tended to confirm this general characterization; Solis (1974), Meyer (1986), and Knight (1990) have suggested that it was indeed a combination of the aforementioned factors that contributed to the deterioration of nationwide real wages. As mentioned, however, this feature (downward trend of real wage rates) has been repeatedly regarded as a nationwide development and quantitative studies have not properly assessed this notion with a regional and sectoral dimension in a systematic way.[117] These particular patterns are of fundamental importance because the regional economic changes have been part of the historical narrative of the workers' resistance that legitimized the emergence of the *caudillos* (regional leaders) of the revolution (Coatsworth 1988; Miller 1991).

3.3 Data, adjustments, and limitations

Empirical research on the determination of wages has devoted special attention to the effects of regional price differentials on the calculation of real wages across time and space. These studies have suggested that the analysis of wage differentials should take into account regional differences within countries in the cost of living in order to provide more accurate real wage estimates.[118] Historical research for the case of United States and

[115] González Navarro, 'Las huelgas textiles durante el Porfiriato'. The other half of the demands were linked to a delay in the salaries' payment, the rejection of payment of wages in credit, unfair dismissals, opposition to new regulations on work schedules, among others.

[116] Newspaper *El Imparcial*, Dec. 27, 1 (quote translated by David Walker [1981:28]). The association's name was *Gran Círculo de Obreros Libres*.

[117] In light of this statistical lacuna on Mexican historical regional incomes, recently, Aguilar (2016) provided new estimates of regional GDPs covering this period.

[118] See for instance J. Roback, 'Wage, rents, and the quality of life'.

Britain has reexamined previous real wage estimates yielding considerable discrepancies when regional prices and other factors such as the cost of urbanization are included.[119]

For the case of Mexico, few studies have attempted to undertake a systematic assessment on the regional patterns of the standards of living during the *Porfiriato*. Existent historiography has generally focused either on a single town/city, or on a sector/company, but there are no systematic analyses available at the national level for these years.[120] Also, international historical comparisons have made use only of a single real wage series neglecting intra-regional differences within the country.[121] One of the possible reasons behind this research lacuna is that data availability is very limited for this period. Although there is a vast tradition in the historical literature describing the conditions of peasants on the Mexican haciendas, records on prices and wages are scattered and discontinuous.[122]

A distinctive effort of compiling information at the regional level is found in *Estadísticas Económicas del Porfiriato: Fuerza de trabajo y actividad económica por sectores* (hereafter *Estadísticas*) published originally in 1964 by El Colegio de Mexico.[123] These statistics were collected by a group of Mexican researchers as part of a large project aimed to give quantitative support to a series of monographs for a seminal multi-volume book collection on the history of Mexico.[124] The complete dataset had the objective of providing a general overview of the Mexican economy covering five main areas: population, sectoral production, prices and wages, money and banking, and public finance. However, only the sections of 'sectoral production' and 'prices and wages' were disaggregated at the regional level.

Far from being perfect, this dataset represents an important approximation of the developments in the Mexican economy and has been used by previous authors for different purposes, however, regional categories on prices and wages have remained underexploited in existent studies. At the same time this data has received strong criticism by some

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[119] See the historical case of the United States in Easterlin, 'Regional income', and in Feinstein, 'Pessimism perpetuated' for Britain.

[120] For instance, see the most recent study on the textile mill in the valley of Veracruz described in Gómez-Galvarriato, *Industry and Revolution*. Also, in Cross, 'Living standards in rural nineteenth century Mexico: Zacatecas', and in Katz, 'Labor conditions on haciendas in Porfirian Mexico: some trends and tendencies'.

[121] See an international comparison in Bértola and Williamson, 'Globalization in Latin America before 1940'.

[122] As it has been reviewed by Bortz and Águila, 'Earning a living', pp. 4-6.

[123] Seminario de Historia Moderna de México, *Estadísticas Económicas del Porfiriato. Fuerza de Trabajo y Actividad Económica por Sectores*.

[124] The collection series was published in Spanish as *Historia moderna de México* edited by Daniel Cosío Villegas consisting in a total of ten volumes on political, social and economic history of Mexico. Volume VII published in 1965 as 'Porfiriato: Vida Económica' was particularly devoted to the history of this period.

scholars for its poor quality and unspecified methods of classification.[125] The alternative to circumvent these issues has been either to adjust this data with additional information, or to discard it entirely and switch into other types of information directly from primary sources such as micro-data from single case studies.

In order to account for the regional dynamics with a broader view we opted for the former alternative by adjusting the data from *Estadísticas* with additional price information disaggregated by region.

Price information used in the present study is derived from the price series from 1886 to 1910 by Gómez-Galvarriato and Musacchio (2000).[126] For previous years (1877-1885) we constructed a price index linked to the annual commodity price information from the referred volume of *Estadísticas*. As for regional nominal wages, we have also taken these from the same source which we proceeded to adjust with price deflators for their corresponding region.

Adjustments on wage and price data

As mentioned, given that there are differences in the cost of living across regions, our estimates of real wages are adjusted to take account of this. Surprisingly, compilers of the mentioned source neglected these differences and opted to construct a single deflator drawn on Mexico City's wholesale price index.[127]

Authors of that index considered that since the number of goods included in it was greater than in other estimations, it was therefore a more reliable indicator for the country's inflation. However, they neglected the potential variations of regional prices that could have impacted differently the living standards of Mexican workers residing in the location/region where the actual price change occurs.

To regionally adjust wages, we have constructed consumer price indices for each region of the country. Following data from *Estadísticas*, we took the weighted average of the wholesale price of six basic consumption goods for a group of Mexican states classified regionally according to each geographical location (see classification details in *appendix*).[128]

These price averages were adjusted by weighting them with given household consumption weights of Mexico City (consumption household survey of 1914) taken from

[125] See the criticism in the essay of Coatsworth, 'Anotaciones sobre la producción de alimentos', and in Gómez-Galvarriato, 'Porfiriato: vida económica'.

[126] Gómez-Galvarriato and Musacchio, 'Un nuevo índice de precios para México, 1886-1929'

[127] Their index (Mexico City wholesale price index) was based on thirteen goods with production weights of 1939.

[128] Annual price data for each commodity collected in *Estadísticas* comes originally from the weekly publications of a Mexican financial magazine *La Semana Mercantil*.

Gómez-Galvarriato and Musacchio (2000). Nominal wage rates are taken also from *Estadísticas*, which are available by sectors and regions, originally compiled as 'daily minimum wages' (*salario mínimo diario*) in agriculture, industry, mining, the public sector, and the army.[129]

Limitations

Since expenditure weights used for the construction of regional price indexes were taken from a single household consumption survey from Mexico City, we are assuming that there is no substitution of goods due to changes in relative prices. Although this is a standard assumption for *Laspeyres* type indices, it means for this case that there is a homogenous expenditure pattern across the country. The latter represents a strong conjecture, but considering the evidence of existing records of a stable agricultural production and homogenous household consumption, this should not affect significantly our regional estimates.[130]

The main limitation for these estimates is the representativeness of the consumer goods basket at the regional level. Our calculations of regional price indices relied on the availability of price information for these regions. These indices draw on the fixed-weighted price changes of maize, wheat, rice, meat, sugar, and beans (see *appendix* for further details). Prices of goods other than food products (clothing, electricity, and housing) are not available at the regional level, therefore, our indices can be also regarded as *consumer staple indices.*

Another limitation is that wage information from *Estadísticas* does not report the type of activity that the worker undertook within the sector; therefore, it is not possible to disaggregate by the specific type of occupation and/or draw the skill intensity of the salaried worker.

As mentioned, wage information originally refers to *minimum daily wages*; however, back then the legal concept of 'minimum wage' did not exist in the Mexican labor legislation. Data compilers of this information were referring to the lowest daily wage level they could find in the sector in a particular year. Therefore, our sectoral and regional estimates may be interpreted as *lower-bound* sectoral and regional indicators of the worker's living standards.

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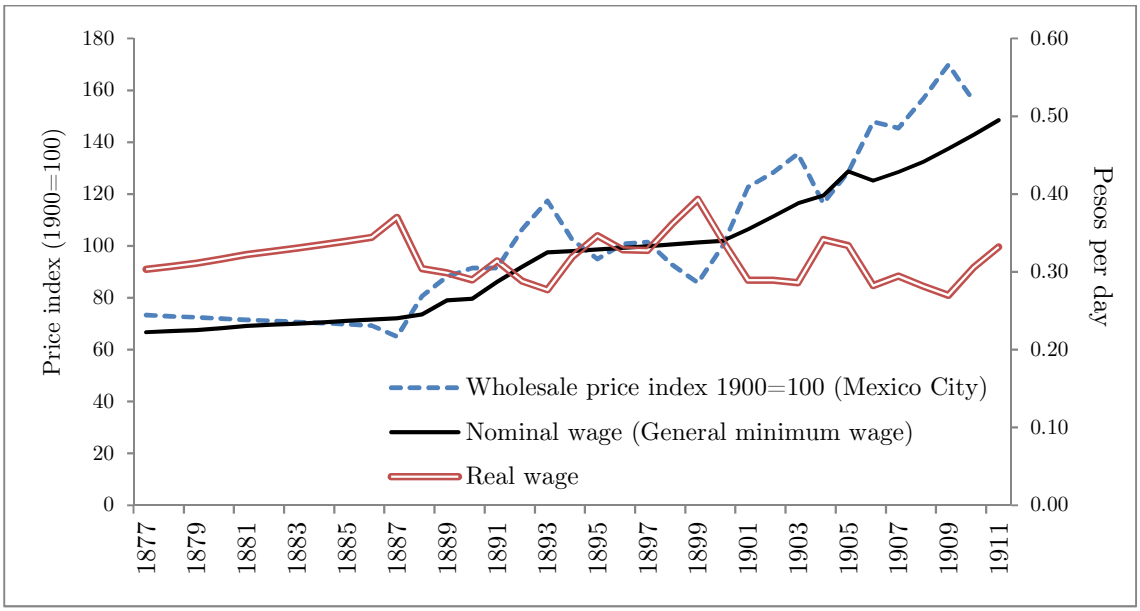
[129] Nominal wage rates for the army and public sector were left out in the present analysis since there is no regional disaggregation on these categories.

[130] Previous studies argued that there was a shortage of agricultural basic goods during the decade 1890-1900 that caused inflation in the subsequent decade. However, Coatsworth (1976) re-calculated several agricultural production statistics and showed evidence of the contrary; there was no shortage of agricultural production for domestic consumption during these years.

Figure 3.2 shows an overall picture of the trends in wages and prices using the country's national estimates. As previous studies have shown, a rising trend in general prices in the last decade of the period caused a slight decline in real wages.

Figure 3.2: Evolution of prices, nominal wages, and real wages in Mexico, 1877-1911



Source: See details in *appendix*.

Despite the increases in the average national nominal wages, inflation (the annual change in the wholesale price index) grew faster than wages as depicted in table 3.4. After a period of relative price stability before 1900, inflation reached an annual average of 6% which inhibited real wage growth from 1900 to 1910. However, this trend may have had a different impact in other regions of the country considering the intra-regional differentials in prices and wages.

Table 3.4: National wage growth and inflation, 1877-1910

	Average growth of national nominal wages (%)	Average growth of national real wages (%)	Inflation (% change in logarithm of wholesale price index)
1877-1899	1.89	0.77	0.72
1900-1910	3.51	-0.85	7.02
1877-1910	2.52	0.58	2.91

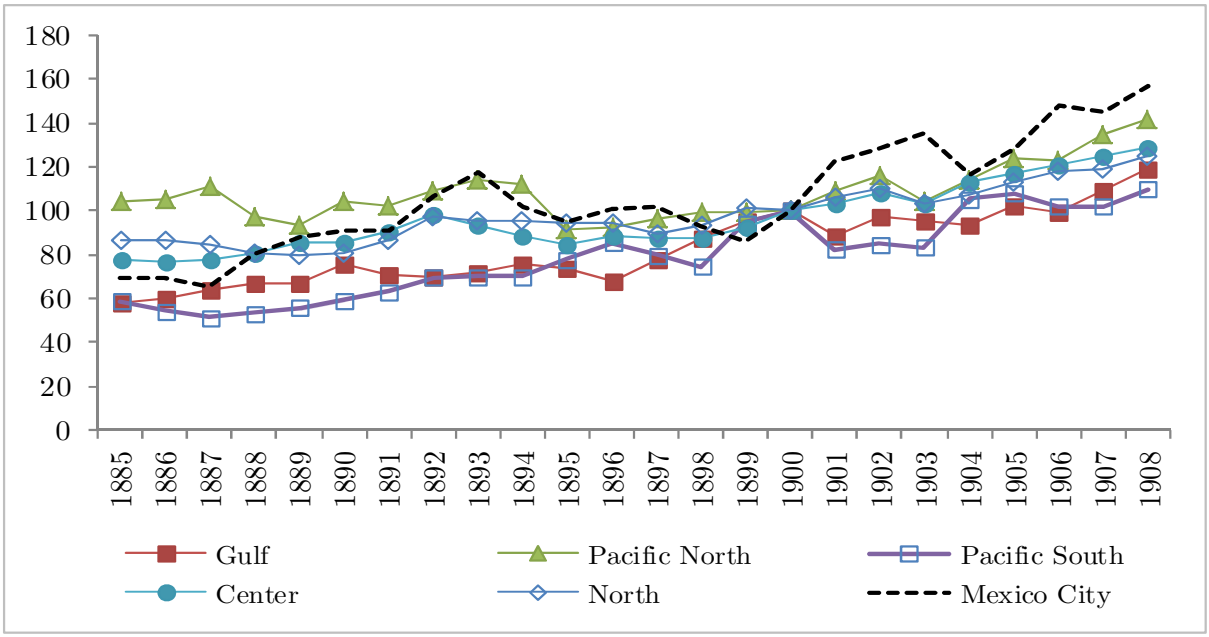
Source: See text and *appendix*.

Regional prices

Regional price information drawn from *Estadísticas* is based on six main commodities (maize, wheat, meat, beans, rice, and sugar) for five regions, which are included to construct fixed-weighted regional price indices. Figure 3.3 shows that price levels across regions differed across time.

The cost of living in the Pacific-South region of the country was much less than in the Pacific-North around 1885. Regional price indices show that these trends continued until the turn of the century, and although thereafter regional prices started to converge, an upward trend in all prices occurred after 1900.

Figure 3.3: Price index by region (1900=100)



Source: Based on prices from *Estadísticas* and household expenditure weights from Gómez-Galvarriato and Musacchio (2000). See methods in *appendix*.
Note: Mexico City refers to the wholesale price index of Mexico City.

The inflationary trend observed in the price data for the last eight years of the period has been highly contested in the literature. One the one hand, it has been regarded as an outcome of the impact of currency depreciation in those years that affected the terms of trade of the country increasing the price of non-tradable goods.

On the other hand, price increases are also attributed to climate shocks that generated consecutive seasons of bad harvests of staple crops from 1901 to 1907. However, whichever factor that may have generated inflation in this sub-period, our main aim in this chapter is to emphasize its differentiated effect on the cost of living according to the regional developments of wages and prices.

3.4 Regional and sectoral wage disparities

The accelerated rise in the demand of Mexican primary commodities by the United States (and by major European countries) and a rise in the Mexican demand for American manufacturing goods was a feature that characterized Mexico's foreign trade throughout the Porfiriato. According to the logic of the Heckscher-Stolper-Samuelson model (under strict assumptions two countries and two factors: same technologies among trading countries, perfect labor mobility, and constant returns to scale) the removal of trade barriers affects relative factor prices differently between trading countries by raising the relative return of the abundant factor. That is, for e.g. when a country is relatively abundant in land (and labor scarce), its exports will tend to be land-intensive, thus, land rents increase with freer trade. A parallel effect is predicted in a labor-abundant country, a reciprocal feature that ultimately equalizes factor prices among trading countries.

In relative terms, Mexico was (is) land abundant and land reform in those years favored this comparative advantage.[131] According to the predictions of trade theory, because of its relative abundance (i.e. relative price of land in Mexico was lower than its trading counterpart) the relative demand and land rents increased in Porfirian Mexico (and the relative price of labor decreased). In other words, landowners received greater benefits under the removal of trade barriers than wage earners; a feature revealed in the declining wage-rental ratio.[132]

Mexican trade specialization in those years can also be seen in the composition of its exports. Figure 3.3.A (in the appendix) shows that the initial orientation of the country's trade was dominated by land-intensive commodities such as agricultural products; a land-intensive orientation that later extended towards extractive industries (requiring more skilled labor) located in the north of the country.

Discerning between skilled and unskilled labor, the country had a comparative advantage in the latter with their trading partners. Theoretically, under free trade the relative return of the unskilled labor would increase. Endowed with relatively more unskilled labor, a reduction of trade barriers in Mexico should *raise* the wages of unskilled workers and *lower* the wages of the skilled (relative to the unskilled).[133] In line with basic trade theory, this effect should have aided in *reducing* the wage differentials in the

[131] A law issued in 1856 ('Ley Lerdo') expanded extraordinarily the availability of land by empowering the government of Diaz to auction communal and ecclesiastical land.

[132] Williamson's (1998) historical wage-rental ratios estimates confirmed this pattern for Mexico.

[133] Other models suggest that not only trade may cause wage divergence but also 'skill-biased technological change'. See, Goldberg and Pavcnik (2007).

Mexican regional labor market.[134] However, as mentioned (depicted in figure 3.3.A of the appendix), Mexico had very strong endowments of mineral resources that required (semi) skilled-labor, and so liberalization could have stimulated these sectors more than unskilled labor-intensive ones.

Empirical and theoretical literature has argued that liberalization may also alter the optimal location choice of firms, promoting the movement of economic activity towards the regions that are closer to their trading markets (e.g. Baldwin and Venables 1995; Krugman 1995; Hanson 1998). Recent evidence on the 'modern' wave of globalization (post-1980s) has indicated indeed that Mexican regions more exposed to international trade appeared to exhibit an increase in wage rates relative to other regions in the country (see for e.g. Chiquiar, 2008).

How were the trends of Mexican wages across regions and sectors during the Porfiriato? It is expected that some regions had an advantage due to their geographical position and offered initially higher nominal wages, but as theory suggests when adjusting them by their purchasing power these disparities would dissipate over time.

As mentioned, one of the most important premises in trade theory is that factor price equalization forces promote regional real wage convergence. The factor equalization theorem predicts that as a result of international commodity trade and in the absence of market distortions, the price of imperfectly mobile factors of production will equalize within countries and regions. The market mechanism through international trade would work sufficiently well to equalize the returns to unskilled labor and capital across regions.[135]

According to this, one expects that improvement in transportation and communication enhances mobility of capital and labor, and this would lead regions, and their incomes (of unskilled labor), to look more equal.[136] Thus, the booming Mexican economy of the late-nineteenth century provides an opportunity to identify the strength of these assumptions at the regional level related to the reduction of price differentials of the real cost of labor. First, let us explore the real wage trends.

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[134] Accordingly, as labor markets take time to adjust (towards wage equalization) the initial trade shock could generate unemployment and worsen labor market conditions temporarily (increasing wage inequality and raising poverty rates). However, since unskilled workers (the intensively used factor) are likely to be the poorest, hence, theoretically liberalization would be poverty-alleviating over time. An exception to this are mineral exporting countries. See, Winters *et al.,* (2004) for an extensive discussion on the distributional effects of trade liberalization on poverty and wage inequality.

[135] See in R. Margo, 'Regional wage gaps' for the historical case of regional integration of labor in the United States; and also in J. Rosés and B. Sánchez-Alonso, 'Regional wage convergence' for the case of Spain.

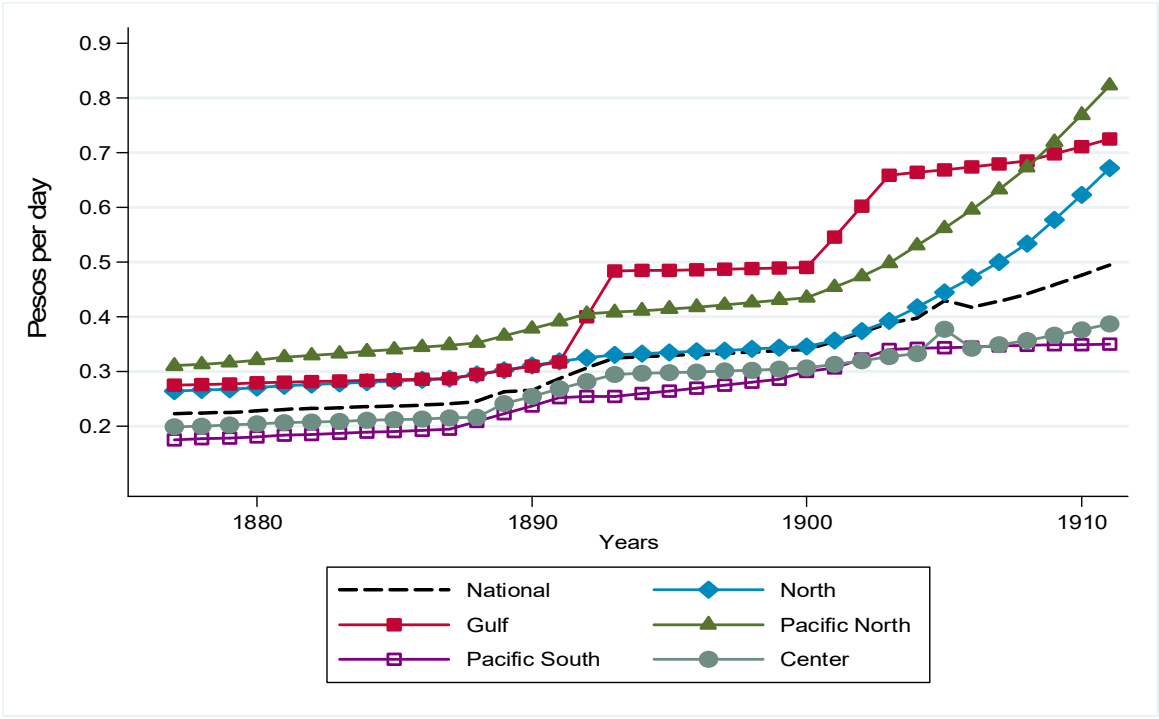
[136] The standard theorem assumes that demand functions for all goods are identical between trading areas and must have identical constant returns to scale production functions. Samuelson (1949) predicted that under certain strict assumptions, international trade will actually lead to complete factor price equalization.

Regional and sectoral wage trends

Following the records of Mexican nominal wage rates originally computed in *Estadísticas,* the first fifteen years are characterized by a nearly flat trend followed thereafter by an upward trend in most of the regions (see figure 3.4).

At the sectoral level (table 3.5), when adjusting with a single price deflator (Mexico City's wholesale prices), wages were compressed in all three sectors until the turn of the century.

Figure 3.4: Mexican nominal wages, 1877-1911



Source: Estadísticas Económicas del Porfiriato*, El Colegio de México,* 1965.

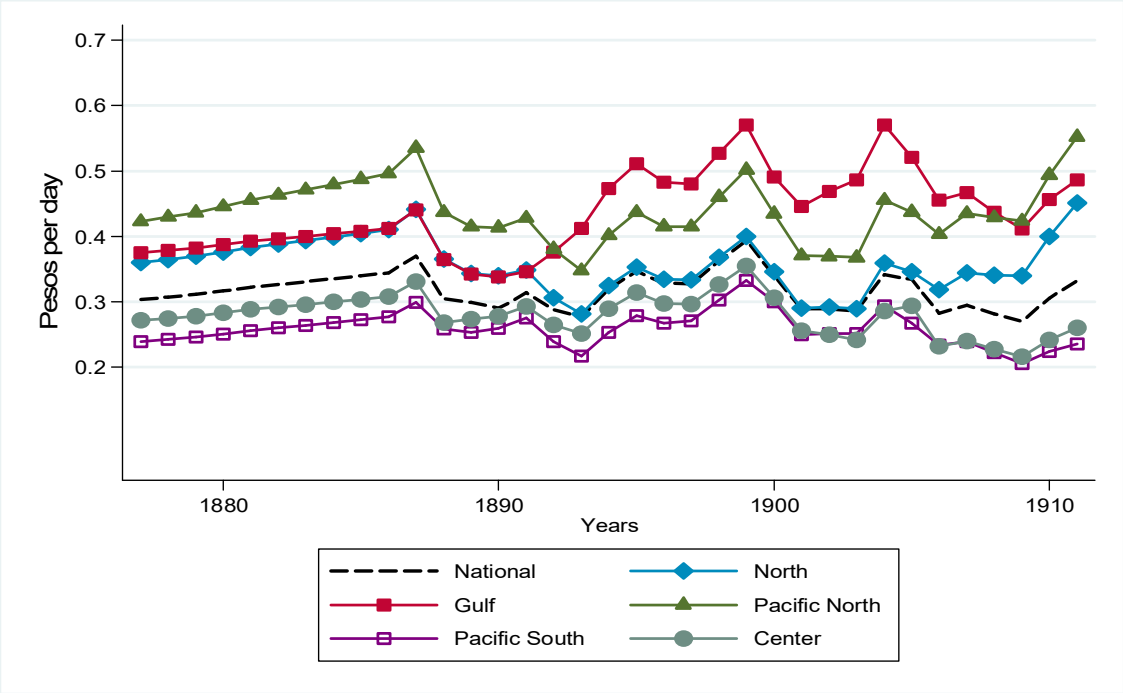
Table 3.5: Growth of nominal wages by sector
(Average annual growth rates)

	1877-1889	1889-1900	1900-1910	Full period
Agriculture	0.92	2.11	2.68	1.97
Industry	3.03	1.69	3.54	2.99
Mining	2.40	2.91	8.16	4.72

Source: See text and *appendix.*

However, regional inflation may have eroded these trends. Indeed, the picture changes when nominal wages are adjusted with Mexico City's wholesale prices index as the following figure 3.5 depicts. It is possible to observe three main features: i) an increase in the variability of all real wage rates; ii) increasing wage disparities between regions that persisted throughout the period; iii) regions in the Pacific-North and Gulf captured higher real wages than others.

Figure 3.5: Wages by region adjusted with prices of Mexico City, 1877-1910



Note: Adjusted with wholesale price index of Mexico City
Source: See text and *appendix*.

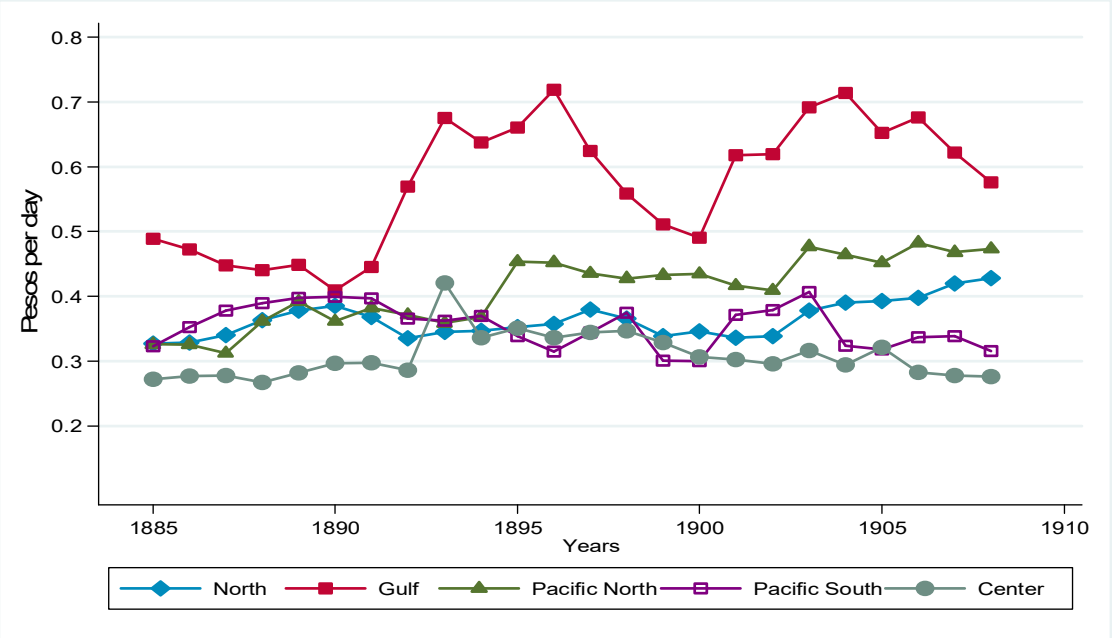
Table 3.6: Growth of wages by sector adjusted with prices of Mexico City
(Average annual growth rates)

	1877-1889	1889-1900	1900-1910
Agriculture	-0.26	0.30	-0.23
Industry	2.01	0.57	-1.12
Mining	1.29	1.84	3.88

Note: Adjusted with wholesale price index of Mexico City
Source: See text and *appendix*.

Figure 3.6 shows that after adjusting for regional prices (that is *regionally-adjusted* real wages), the Gulf region yielded higher wages relative to other regions (although with a larger variation), whereas others remained stable and compressed over the years as a result of a nearly simultaneous growth of regional prices with their respective nominal wages.

Figure 3.6: Regional wages adjusted with regional deflators, 1885-1908



Note: Adjusted with consumer price indices from their corresponding region.
Source: See text and *appendix*.

But why did the Gulf have this real wage advantage over other regions? Firstly, the Gulf region comprised the states of Veracruz, Campeche, Quintana Roo, and Yucatán, states characterized by the cultivation of *henequén,* a plant whose fibers were used for the textile industry. This commodity experienced a price boom during these years making textile companies and plantations highly profitable especially in the fields of Veracruz and Yucatán.[137] Thus, regional specialization had a clear positive effect on the growth of nominal wages in this region. And secondly, as it has been previously shown (figure 3.3), prices in the Gulf were relatively lower than in other regions, thus creating an advantage in the purchasing power of wages.

The Pacific-North region had also a wage advantage over the Pacific South and Center of the country. Although the advantage was less pronounced like in the Gulf, it is worth highlighting a feature that may have impacted on wage levels; the proliferation and

[137] See for instance the 'export engine' that the production of *henequén* meant for the state of Yucatán in the work of Allen Wells in 'All in the family: Railroads and henequen monoculture in Porfirian Yucatán'.

settlement of North American and French copper companies in the Pacific-North, particularly in the states of Sonora and in the peninsula of Baja California transformed this region through increasingly specializing in export mining.

As a result, higher wages rates were required to attract mining workers within the predominantly ranching northern states. Also, there was an external aggregate shock, a decline in the price of silver during the last decade of the regime. Zabludowsky (1992) has documented how this phenomenon pushed upwards the price of imported goods promoting the export sector which favored the northern regions, and at the same time impacting positively nominal wages.[138]

Real wage rates in other regions remained relatively stable, although in the Gulf there was a slight wage decline after 1905. Unfortunately, and due to the nature of this data, there is no information available of subsequent wage rates regionally disaggregated for the last two years of the regime (1909-1910).

Table 3.7 displays a view at a sectoral and regional level. It shows that the northern mining regions (North and Pacific-North) were the ones that yielded on average a higher real wage growth (around 6% per year) principally during the period of 1900-1908, similarly to the expanding agricultural sectors (above 2%) of the Gulf and the Pacific South. The growth of industry wages was rather moderate compared to the wages in the booming mining sector. However, in broad terms the Pacific South and Center regions were the ones that benefited relatively less than others.

Table 3.7: Growth of regionally-adjusted wages by sector and region
(Average annual growth rates)

	North	Gulf	Pacific-North	Pacific-South	Center
			1885-1900		
Agriculture	1.52	0.25	1.26	-0.12	1.04
Industry	1.49	-1.13	3.34	-1.94	0.35
Mining	2.06	-0.93	3.17	-0.34	1.53
			1900-1908		
Agriculture	0.20	2.21	0.77	2.36	-1.47
Industry	2.01	0.10	1.23	-0.24	-1.52
Mining	6.08	-1.32	5.57	4.79	3.53

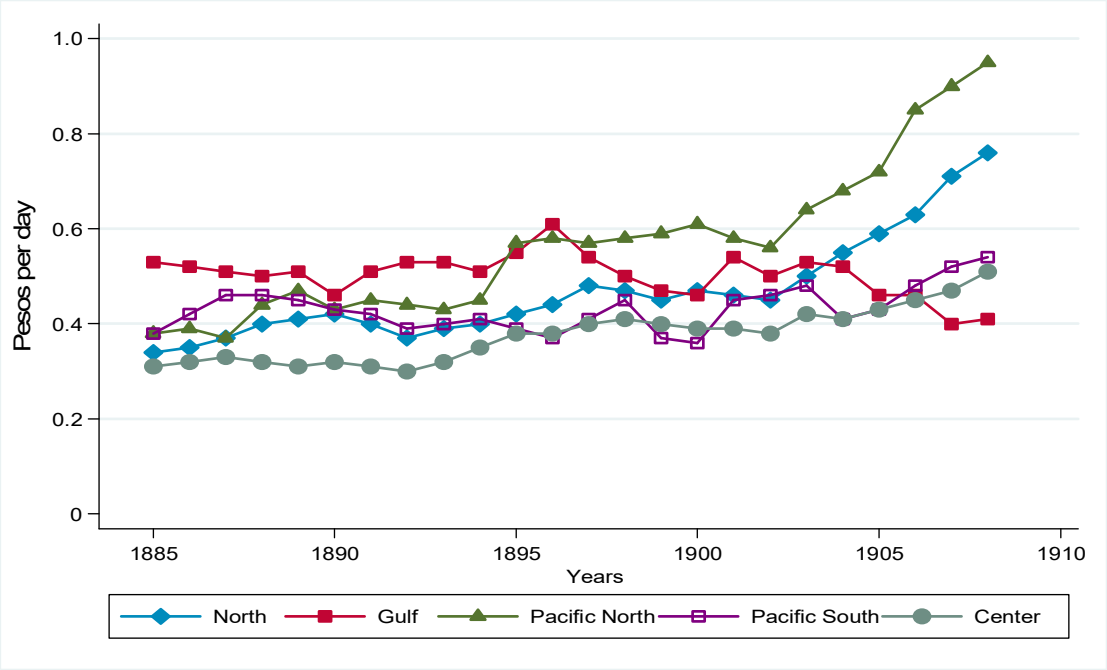
Note: Adjusted with regional deflators (1900=100)

Many historians have placed special emphasis on the Mexican mining industry during the Porfiriato due to its paradoxical effects on the economy throughout the regime.

[138] The Mexican monetary commission back then reported this feature regarding the observed wage increase in the North. See in Comisión Monetaria, *datos para el estudio de la cuestión monetaria*, Secretaria de Hacienda y Crédito Público, 1904.

One the one hand, its expansion through mineral exports brought an unprecedented development for the center and northern region of the country, but on the other, the predominance of foreign exploitation of natural resources and the deplorable working conditions brought a series of unrest and clashes between mining company owners, workers, and government.[139] Still, as figure 3.7 depicts, the high risk activity in the mines, made mining workers among the highest paid, especially the ones located in the northern regions where mining towns constantly suffered from shortages of labor.

Figure 3.7. Regionally-adjusted wages in the mining sector, 1885-1908



Note: Adjusted with consumer price indices (1900=100) from their corresponding region.

By 1908 a typical mining worker living in the Pacific-North earned per day in real terms more than double than its counterpart working in a mine located in the Gulf. Of course, wage rates may have varied among mining companies and depended on the type of mineral extracted, but in a regional average, there was a large wage disparity observed within this sector. However, despite the relatively high wage economy in the North and Pacific-North, mining strikes proliferated in these areas.

Studies on the formation of worker's unions in Mexico have described that although unrest of miners in the north of the country was growing in the first decade of the 1900s, the propagation of strikes in other sectors and regions had different worker's demands. For instance, whereas several groups of miners demanded better safety

[139] The 'Cananea riot' that took place in the town in the northern state of Sonora where several protesting miners were killed in June of 1906 is one of the most famous narratives of this struggle. See for instance, M. Bernstein, 'The Mexican mining industry, 1890-1950'.

conditions and health benefits, industrial workers in the textile industries of the Gulf and Pacific-South mainly demanded salary raises and an equalization of wages between nationals and foreign employees.[140] Indeed, table 3.8 shows that regionally-adjusted wage growth in Pacific South, Gulf, and Center declined relatively to the regions in the North and Pacific-North, whereas the latter experienced positive growth rates throughout the years.

Table 3.8: Growth of real wages in industry by region adjusted with regional deflators, 1885-1908
(Average annual growth rates)

	1885-1900	1900-1908
North	1.49	2.01
Pacific-North	3.34	1.24
Gulf	-1.13	0.10
Pacific-South	-1.94	-0.24
Center	0.35	-1.52

Source: See text.

Another important feature that the estimates of regionally-adjusted wages show is that there are considerable differences compared to single deflator estimates (adjusted with Mexico City prices). Figure 3.8 illustrates this. In the predominantly agricultural regions of the country (Pacific-South and Gulf), levels and growth trends of real wages are substantially different when they are adjusted with different deflators.

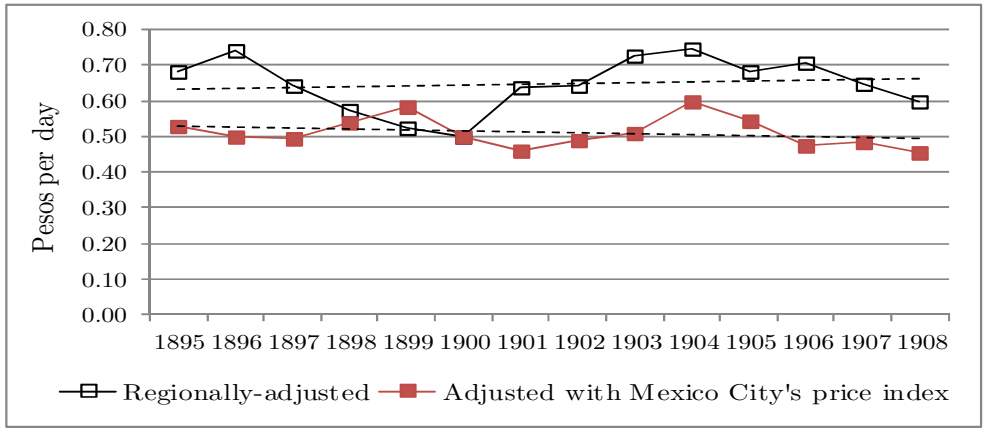
Overall, looking at the wage development of all Mexican regions and sectors, and with the exception of the workers in the Pacific-South which benefited the least of all, the stable trends in the growth of regionally-adjusted wages may provide an impression that the working conditions during the Porfiriato were very favorable for the majority of the workers (especially in the northern regions).

However, this feature should be judged carefully since wage rates are not a straightforward indication of the nature of the labor regime, i.e. length of labor shifts, working days, etc. It is difficult to generalize since these depended on the particular type of occupation, company, and location. During these years there was no standard labor code that allowed workers associations to be consented by the Mexican legislation.[141]

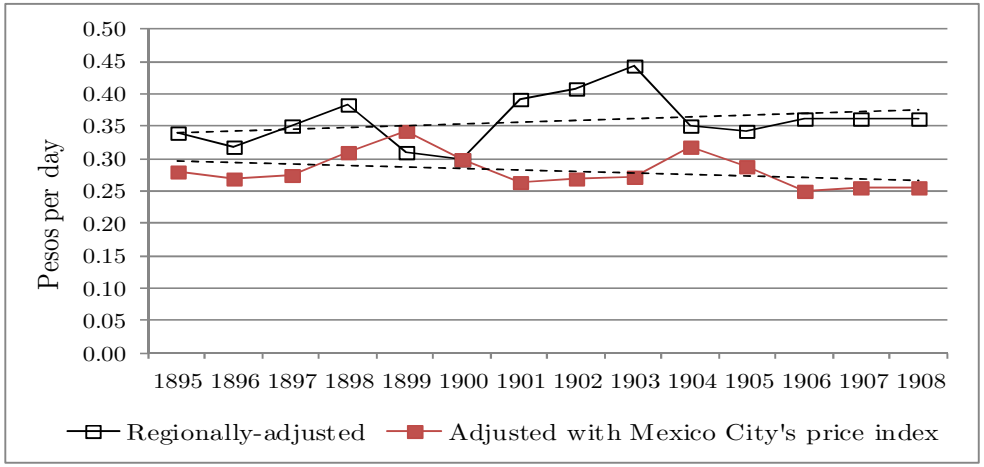
[140] See for e.g. in J. Leal and J. Woldenberg, 'Del estado liberal a los inicios de la dictadura porfirista'.
[141] Although worker's associations emerged stealthily before 1910, the creation of the Mexican Liberal Party in 1900 gave a platform for workers' advocacy. However, it was after the official recognition of the labor code in the Constitution of 1917 where the minimum wage and an eight-hour working day were legally enforced.

Figure 3.8: Real wages of the agricultural sector in the Gulf and Pacific-South, 1895-1908

a. Gulf's agricultural wages (with trend lines)



b. Pacific-South's agricultural wages (with trend lines)



Source: See appendix.

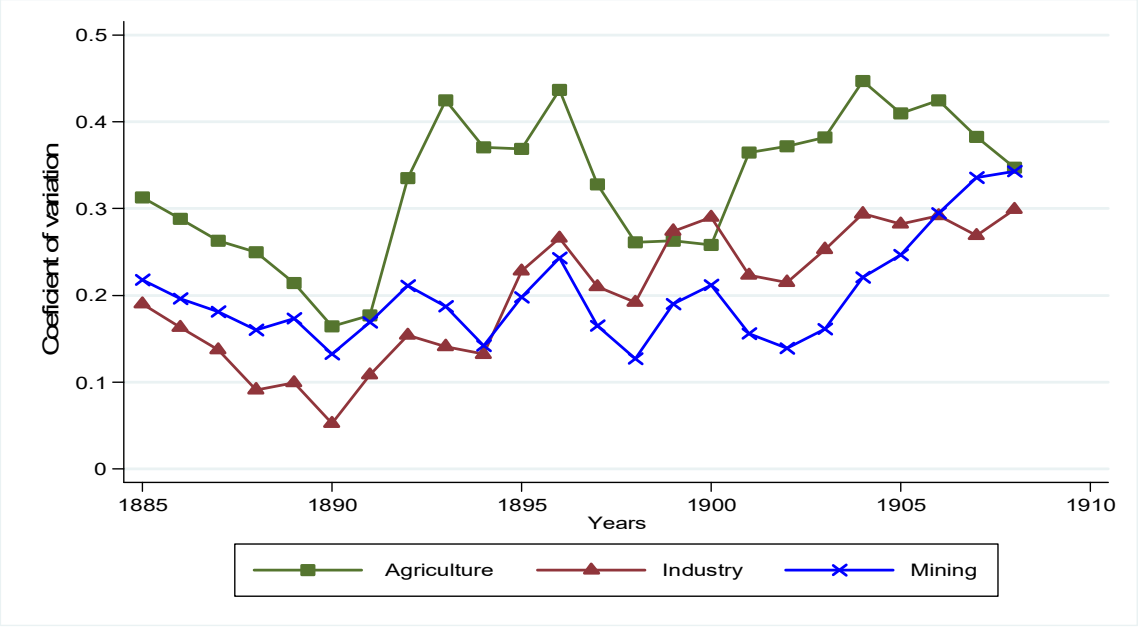
In fact, except for foreign railroad employees, Mexican workers were not unionized; trade unions were prohibited, and some studies have reported that labor shifts were up from 12 to 14 hours in textile companies, whereas salaried peasants in the *haciendas* of the south were up to work 16 hours per day.[142]

Wage convergence or divergence?

If some sectors and regions experienced higher wage growth than others, it is possible that across time the lagging ones were catching up to the levels of others, giving as a result a process of wage convergence. The idea of convergence and divergence across countries and regions is mainly derived from the predictions of the standard neoclassical growth model.

The 'convergence literature' (e.g. Barro and Sala-i-Martin, 2004) refers to σ-convergence if the dispersion of income (in this case real wages) between a group of economies or regions falls over time. And/or, there is β-convergence, when the partial correlation between income growth and its initial level is negative over time.[143]

Figure 3.9: σ-convergence/divergence of real regional wages, 1885-1908



Note: σ-convergence/divergence is measured as the coefficient of variation of wages adjusted with regional prices among the five regions within a sector for each year.
Source: See text and *appendix*

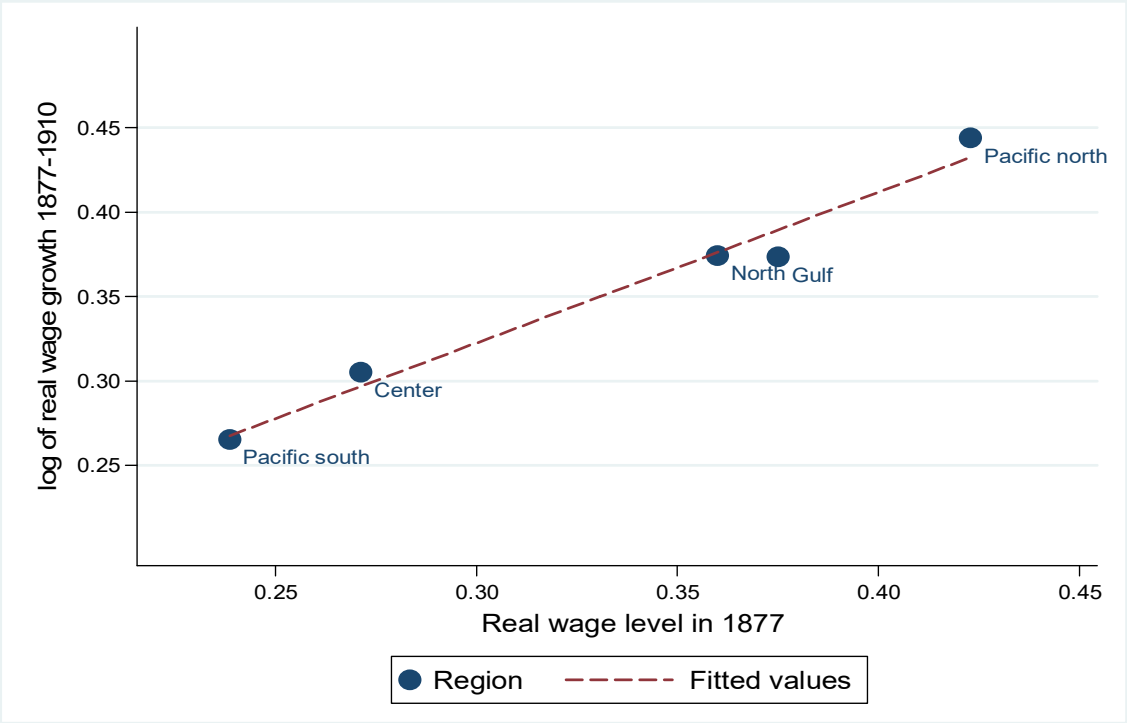
[142] See Alston et al. 'Coercion, Culture, and Contracts: Labor and Debt on Henequen Haciendas in Yucatán, Mexico, 1870–1915'.

[143] Barro and Sala-i-Martin, chapter 11, 'Empirical analysis on regional data sets'.

Figure 3.9 depicts the evolution of the coefficient of variation of regionally-adjusted real wages across regions in three sectors. The figure indicates that wage dispersion did not decline over time, but instead, increased throughout the period. Although it declined shortly from 1885-1890, thereafter a continuous dispersion rose in the three sectors (especially in agriculture), suggesting that there was no σ-convergence across Mexican regions, but a marked trend of σ-divergence.

On the other hand, figure 3.10 presents a test for evidence of β-convergence which refers to a tendency for initially low-wage regions to experience faster wage growth than high-wage regions. However, the figure reports the opposite (β-divergence), confirming the previous result.

Figure 3.10: β-divergence of real wages across Mexican regions



Source: See in text.

There is a positive correlation of initial wage levels with their growth, that is: regions that had initially low-wage levels grew at a slower pace than regions that had higher wage levels.

Even though the exercise to test β-convergence requires more data observations for statistical significance and robustness, the relationship with the present adjusted data shows clear signals that the Pacific South and Center regions lagged behind in the growth of real wages of the North, Pacific-North, and Gulf.

3.5 What can explain the regional wage gaps in Porfirian Mexico?

According to evidence presented in the previous section, the price of labor did not converge across Mexican regions during this period. Even after adjusting nominal wages with regional prices, real wage gaps persisted across regions and sectors. Why did Mexican workers accept less income in one region if they could have obtained much more in another region? Explanations on this issue are part of a long tradition in the field of development economics. One of the standard arguments is the existence of labor market imperfections such as lack of information on wage differences, and institutional barriers to labor mobility: firms and individuals are unaware of different income opportunities.

The existence of wage gaps within countries are considered a temporary phenomenon related to the geographical distances between urban centers and rural areas; since the rural-urban migration process is not instantaneous due to the costs related to relocation, potential rural migrants would gradually respond to differences in wages, and gaps disappear, equalizing regional wages. The economic historian Jeffrey Williamson has argued that wage gaps are a manifestation of labor market disequilibria that most industrializing countries experience during episodes of drastic economic transformation.[144] Thus, the changes that Mexico underwent during the Porfiriato may be an illustration of the unequal impact that industrialization had on regional labor markets since factories, mines, and plantations were highly dispersed geographically.

According to the present calculations, the temporary labor market disequilibrium was certainly not corrected. The underlying causes of this may have been determined by external, and domestic structural factors; a differentiated regional impact by an external shock; and the prevalence of extractive labor market institutions. For instance, silver depreciation at the turn of the century was transmitted through a rise of trade exports in a different proportion by raising nominal wages in the less populated mining regions in the North and the Pacific-North, and not much to the densely-populated agricultural states in the South which widened the wage gap between these regions.[145] However, this external shock (currency depreciation) was a transitory factor, which may have contributed to the existence of wage gaps but should have dissipated thereafter. But as we have shown, these gaps widened over time which may have obeyed to prevalent structural factors in the Mexican labor market.

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[144] Williamson, 'Inequality, poverty and history', p. 42.

[145] *Idem*, Zabludowsky, 1992.

Regarding this, a strand of empirical studies appeared in the 1970s for the case of developing countries, further formalizing into theoretical models that showed that wage gaps can persist in the course of development. The emergence of a 'dual economy' framework implied that there were different patterns of development within a country because the demand of labor and technology were different between the rural and urban sector. This type of analysis inspired by the pioneering work of Sir Arthur Lewis became the conventional wisdom for development economists to study the structural transformation during industrialization.

It is argued that in early stages of industrialization, capital formation in urban industry is far more rapid than in agriculture. Consequently, urban wage rates rise relative to rural wage rates, releasing labor into the city which was absorbed (holding down urban wages) until the rural labor surplus is exhausted. Thus, wage differentials are a result of an unbalanced growth in the demand for labor. Migration is seen as a favorable factor for growth since it was an indication that labor is moving out of low productivity areas. The *Harris-Todaro* model has become the workhorse framework that links wages and migration. The model is a formalization of the process mentioned which basically states that because domestic urban and rural labor markets are linked, any rise in *expected* urban wages will be exhausted by migration from the rural-agricultural sector.[146]

However, high rates of migration in Porfirian Mexico were not precisely a common feature, foreign nor inter-regional. Although foreign immigration flows predominantly from Spain increased, comparatively speaking, during the so-called era of 'mass migration' the country never experienced high immigration flows of Europeans as in the United States or even near to the ones in other Latin American countries like Argentina and Brazil.[147] But interestingly, given the existence of coerced labor in the southern rural areas, unrestricted inter-regional migration within Mexico was also not very common, an aspect that had crucial implications in the determination of national wages.

Coerced labor and regional wage gaps

The existence of *debt peonage* (bonded labor) has been a well-known feature in rural areas of Latin American countries since colonial times.[148] For the case of Mexico it has been documented in a series of regional studies. Debt peonage was basically a coercive mechanism used by owners of the haciendas and large plantations to attract workers within a market framework to voluntarily work in commercial and agricultural activities in which

[146] Under the assumption that workers will migrate only if the real wage differential exceeds these combined costs of reallocation. See a thorough explanation for the case of the United States in the work of Hatton and Williamson, 'What explains wage gaps between farm and city?'

[147] Sánchez-Alonso, 'The other Europeans'

[148] See Bauer, 'Rural workers in Spanish America'.

employers would give payments in advance to workers for their temporary subsistence and/or transportation costs. The worker's labor services were the means of repayment for their debts.

Frequently, more productive workers tended to incur into more debt, accumulating it over time which legally locked them to remain under a fixed contract in a particular plantation until the debt was fully paid. Although this framework was outlawed by the Mexican Federal Constitution of 1857, studies indicate that during the Porfiriato this mechanism was used to upfront the labor shortages in regional markets in booming economic activities, especially the ones in the south such as the large plantations in the state of Yucatán.[149]

Knight (1986) and Katz (1991) have characterized how different labor market regimes were in place according to the geographical distribution of the country: in the North, a 'free' labor force was in place; in the Center prevailed a more 'traditional' debt peonage; and in the South, a coercive and extractive debt peonage was common.

Figure 3.11: Agricultural real wage gap to industry and mining

Source: See text.

Note: Regionally-adjusted wages from the corresponding sector.

[149] There are studies documenting a process of forced relocation of groups of indigenous population in the north (for e.g. indigenous group of the *Yaquis*) to work in the plantations of the south. Also, there is evidence on the existence of a penalization to landowners if their *peones* moved to work to other plantations out of the region without official notice. See also in Alston, *et al.* 'Coercion'; and Wells, 'All in the family'.

The prevalence of this type of institution in the South and Center encouraged coerced labor contracts which prevented worker's unrestricted mobility across regions and sectors. Thus, inter-regional migration was insufficient to balance labor markets via wages. As a consequence, this induced labor market segmentation affected profoundly the evolution and size of regional and sectoral wage gaps.

Figure 3.11 reports an increasing inter-sectoral wage gap of agriculture to industry and to mining. Instead of an equalizing trend, it shows that by the end of the decade of the 1900s wage levels in agriculture experienced a fast decline reaching to a point of being less than half of the level than in mining.

Because of the competition from the mines of the northern Mexican regions and in the cotton fields in the south of the United States, employers of the agricultural sector in the Mexican south tightened labor coercion measures, and also raised nominal wages to retain workers.[150] However, as shown in figure 3.11, in real terms these increases in agriculture were not enough to match the steeped progress in wages of the industrial and mining sector, accentuating the wage gap *vis-à-vis* agriculture after 1900. The standard Heckscher–Ohlin trade model (and the *factor equalization theorem*) predicts that real wages converge between and within trading countries.

3.6 Concluding remarks

The Mexican Revolution has been a topic of recurrent dispute among historians interpreting the origins behind the uprising in Mexico in 1910. Most of the explanations have pointed at causes associated to the frustration of the peasantry bereft from its rights of their land; to the undemocratic attitude of the president in its reluctance to step down after governing for more than three decades and committing atrocious acts of violence against rural indigenous populations; and to a rise of income inequality coupled with a continuous deterioration of the workers' living standards, among other numerous explanations. Evidently, social phenomena can be multi-causal and multi-dimensional, and for many observers it has been customary to accept that it was the combination of all of these factors that inspired the emergence of revolutionary movements across the country.

This chapter has shown that the interpretation on a secular decline in the workers' living standards in Mexico from 1877-1910 does not have strong quantitative foundations. The analysis provided evidence based on regional data showing that estimated *lower-bound* regionally-adjusted wages remained relatively stable in most of the Mexican regions throughout the period. Although wages followed divergent patterns within country and there was a slight declining trend in wages of the industrial sector of the Pacific South

[150] Katz, 'Labor conditions', p. 34.

region, from a broader quantitative perspective there was no dramatic decline as conventional literature argues. Of course, this does not mean the working conditions were improving considering the length of working days and the meager labor contract benefits, but certainly there was no extreme deterioration in the purchasing power of lower-bound wages.

However, real wages were not equalized across regions. In fact, they tended to diverge over time, which is a paradoxical feature considering the well-documented process of commodity price integration as an outcome from the improvements of the transportation system during this period. The regions and sectors in the Center and Pacific South of the country experienced a slower real wage growth relative to the North, Pacific-North, and Gulf. A tension between the forces of regional convergence and divergence emerged in which prevalent labor market institutions in Mexico tilted the scale for divergence by not allowing the removal of structural barriers for labor market mobility. Coerced labor was institutionalized in the rural labor markets of the southern regions affecting inter-regional migration which in turn generated rigidities in nominal wages and thus, regional real wage divergence.

Unlike the experience of factor price convergence in the United States and other open economies over the same period, the Porfirian regime in Mexico claiming to embrace inter-regional free trade and the abolishment of extractive labor market institutions inherited from the colonial period, tended to tolerate labor coercion schemes with the purpose of up-fronting labor scarcity in large-scale plantations and mining companies. Seemingly, instead of promoting efficient labor reallocation, this institution (labor coercion) was unable to clear out the differences in the regional demand for labor being reflected in the widening real wage gaps across sectors and regions.

Although case-country experiences of regional convergence are more common in the economic growth literature, the phenomenon of regional real wage divergence is not an exceptional case. In fact, it is consistent with the theoretical developments of the so-called 'New Economic Geography'. In that view, regional divergence is driven by the increasing returns in industry, decreasing returns in other sectors, a high share of non-agricultural activities in GDP that yields high labor productivity and income heterogeneity across regions.[151]

But in a 'cliometric' sense, there are more inquiries than answers for the Porfiriato. Perhaps one of the most difficult and unresolved questions is that if the country experienced an unprecedented expansion in real output per capita, why did the worker's real earnings in the most productive sectors and regions not parallel this? Indeed, although real wages diverged, they did not collapse and remained stable (if not 'stagnant'). One

[151] Krugman and Venables, 'Globalization'.

question remains however on the *bonanza* during those years; where did all the fruits of economic growth go if Mexican laborers did not capture it in its entirety?

This feature could be an historical analogy of the 'growth puzzle' visible in other industrializing countries that experienced a 'Kuznets curve' type of development which presumes increasing income inequality during early industrialization and declining inequality in a modern industrial society. The data limitations of range and coverage in the present study prevent us to confirm this long-term empirical observation. To provide more precise answers on the underlying causes of convergence and divergence in the periphery during the *belle époque* it is necessary to have a greater detail in historical data disaggregation and coverage. [152] This calls for additional efforts in re-constructing historical data not only on regional wages and prices, but on systematic regional estimates of capital (physical and human) for Mexico and other developing regions.

Nevertheless, the quantitative findings of a 'divergent real wage growth' in Porfirian Mexico illustrate that mainstream wage equalization theories may not travel well through the breakdown of historical data. It also unveils that aggregate comparative income measures may not be very informative about the effects of globalization on the standards of living of the developing world in the late-nineteenth century.

[152] As mentioned in the data section, an important limitation for the calculation of more accurate rates of real regional wages was the absence of regional price data (other than the typical consumer food items) such as the price of housing, electricity, and clothing. If new quantitative research is able to construct reliable estimates on those items at the regional level, it may reveal different price trends across the country.

Appendix to chapter 3

Notes on data and methods of regional price indices

A fixed-weight (Laspeyres) index was taken to be the most suitable procedure for measuring regional real wages for this period in Mexico. The reason for adopting this is that the alternative (Paasche index) requires information on expenditure weights for each year. These weights refer to the structure of expenditure of a consumption basket from a typical household in the country in a given period. However, for these years there was no systematic national consumer survey collection in Mexico that would have comprised expenditure data for different regions. In the absence of this, we took the expenditure shares for the nearest year available at the national level and we assumed a homogenous expenditure pattern for low-income households across selected regions.

Thus, the index for region i is computed as:

$$P_i = \sum_k w_k \left(\frac{P_{jk}}{P_k}\right)$$

where W_k is the weight given to good k , P_{jk} is the price of good k in region j, and P_k is the price of region k. By definition the *Laspeyres* index takes the ratio of the costs of the reference-period bundle of goods under two different sets of prices, maintaining the base period (for this case 1900) level of consumption of each good:

$$L_t = \frac{\sum_{j=1}^{n} p_{jt} q_{j0}}{\sum_{j=1}^{n} p_{j0} q_{j0}}$$

where the subscript j_0 refers to the base year value for the basket good j, and t, refers to the current year.

The actual weights selected for the construction of our indices are based from a household survey of low-income families in Mexico City for the year of 1914. These were taken from Gómez-Galvarriato and Mussachio (2000) and given the availability of regional price data we adjusted these for missing items as table 3.1.A shows. Originally, these authors published expenditure weights for *high* and *low-income* families. We decided to use their weights for *low-income* since these are more likely to match our usage of the data of minimum wage rates from *Estadísticas*.

Table 3.1.A. Expenditure weights for regional price indices

Expenditure component	Household expenditure weights in Mexico City in 1914 (%) *	Household expenditure weights adjusted for missing items (%)
Rice	2.4	3.5
Sugar	5.1	7.5
Meat	17.5	25.7
Beans	6.7	9.8
Maize	14.2	20.8
Wheat	22.3	32.7
Total	*68.2*	100

* Weights derived from Gómez-Galvarriato and Musacchio, 'Un nuevo índice para México'.

As indicated in table 3.1.A, the prices of six basic food goods were included in all regional indices representing near to 70% (68.2) the consumer basket. Although other price information such as housing, clothing, and electricity were not available at the regional level, most of studies on consumer price indices indicate that changes in the average price of *staple food* capture the largest proportion of the changes in the cost of living.

Nominal wages

Nominal wage rates compiled by *Estadísticas* correspond to the average minimum daily wage of unskilled workers in each sector (agriculture, industry, mining, and public sector) of the country. Compilers of the source indicated that since they faced different wage information for various working occupations within the sector, they proceeded to select only the lowest wage rates in the type of occupation that was commonly paid on a daily basis, such as a *peon* in a plantation (agriculture), textile worker or weaver (industry), and mining workers (see in *Estadísticas*, p. 16).

These records were originally taken from a report of 1877 in the *Memoria de Hacienda* (annual report of the Mexican ministry of finance), and thereafter linked to the wage rate series published in *Anuario Estadistíco de la República Mexicana* (1908) by Antonio Peñafiel for the years of 1892-1908. Subsequent regional wage breakdown was made by calculating the annual change of the sectoral share of employment for each region as a percentage of the country's total labor force.

Regional classification

The classification for prices and wages followed the data structure according to the original disaggregation from *Estadísticas* based on five main regions (comprised by thirty states and a federal district):

North: Coahuila, Chihuahua, Durango, Nuevo León, San Luis Potosí, Tamaulipas, and Zacatecas.
Gulf: Campeche, Quintana Roo, Tabasco, Veracruz, and Yucatán.
Pacific-North: Baja California, Sinaloa, Sonora, and Nayarit.
Pacific-South: Colima, Chiapas, Guerrero, and Oaxaca.
Center: Aguascalientes, Distrito Federal, Guanajuato, Hidalgo, Jalisco, México, Michoacán, Morelos, Puebla, Querétaro, and Tlaxcala.

3.2.A: Regional price indices in Mexico, 1885-1908 (1900=100)

Year	Mexico Total	North	Gulf	Pacific-North	Pacific-South	Center
1885	75.48	86.38	58.16	104.38	58.92	77.81
1886	74.03	86.64	60.40	105.61	54.53	76.97
1887	74.18	84.34	63.92	111.53	51.43	77.36
1888	75.36	81.16	66.81	97.50	53.57	81.18
1889	77.57	80.10	67.23	93.21	56.06	85.54
1890	79.87	80.74	75.57	104.61	59.40	85.69
1891	83.12	86.55	71.18	102.43	63.48	90.15
1892	89.93	97.10	70.29	109.05	69.50	98.49
1893	88.18	95.93	71.62	113.78	70.16	93.90
1894	86.01	95.93	75.95	111.79	70.11	88.12
1895	84.11	94.87	73.43	91.39	78.09	84.81
1896	86.37	94.06	67.65	92.42	85.62	89.01
1897	85.62	89.12	78.01	96.74	79.79	87.32
1898	87.00	93.19	87.45	99.67	74.63	87.34
1899	95.51	101.37	95.80	99.59	94.99	92.77
1900	100.00	100.00	100.00	100.00	100.00	100.00
1901	98.67	106.12	88.40	108.98	82.42	103.61
1902	103.63	110.57	97.17	115.77	85.08	108.13
1903	99.11	103.75	95.23	104.49	83.65	103.27
1904	108.02	106.97	93.08	114.20	105.67	112.95
1905	113.56	113.01	102.58	124.32	108.00	117.63
1906	114.65	118.49	99.62	123.42	102.37	121.07
1907	118.87	119.06	109.21	135.19	102.39	125.50
1908	124.62	124.69	118.98	142.22	110.12	129.13

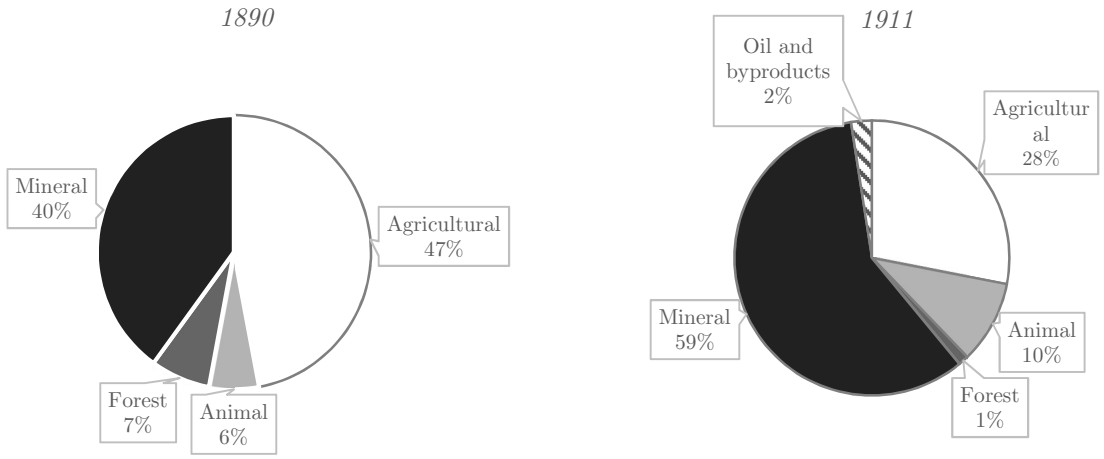
Source: Based on prices series from Seminario de Historia Moderna de México, *Estadísticas Económicas del Porfiriato. Precios*, Mexico D.F.: El Colegio de México, 1965; and from Gómez-Galvarriato and Musacchio (2000), 'Un nuevo índice para México'.

3.2.B: Mexican regional wages adjusted with regional deflators, 1885-1908 (pesos per day)

Year	North	Gulf	Pacific-North	Pacific-South	Center
1885	0.327	0.489	0.326	0.323	0.272
1886	0.328	0.473	0.326	0.353	0.277
1887	0.340	0.448	0.312	0.378	0.278
1888	0.363	0.440	0.361	0.389	0.267
1889	0.378	0.449	0.392	0.397	0.282
1890	0.385	0.409	0.362	0.399	0.297
1891	0.368	0.445	0.382	0.396	0.297
1892	0.335	0.569	0.372	0.366	0.286
1893	0.345	0.675	0.359	0.362	0.420
1894	0.347	0.638	0.368	0.370	0.336
1895	0.353	0.661	0.454	0.338	0.351
1896	0.358	0.719	0.452	0.315	0.336
1897	0.380	0.625	0.435	0.344	0.344
1898	0.366	0.558	0.427	0.375	0.346
1899	0.339	0.511	0.433	0.300	0.328
1900	0.346	0.490	0.435	0.300	0.306
1901	0.336	0.618	0.417	0.372	0.302
1902	0.339	0.619	0.409	0.379	0.296
1903	0.378	0.692	0.477	0.407	0.317
1904	0.391	0.714	0.464	0.324	0.294
1905	0.393	0.652	0.452	0.318	0.321
1906	0.398	0.676	0.483	0.337	0.283
1907	0.420	0.622	0.468	0.339	0.278
1908	0.428	0.576	0.473	0.316	0.276

Source: Based on price data from table 3.2.A and nominal wages series from *Anuario Estadistíco de la República Mexicana* (1908), and from Seminario de Historia Moderna de México, *Estadísticas Económicas del Porfiriato. Fuerza de Trabajo y Actividad Económica por Sectores*, Mexico D.F.: El Colegio de México, 1965.

Figure 3.3.A. Composition of Mexican exports to its main trading partners (export value as % of total) in 1890 and 1911



Note: Shares adjusted to the total sample available based on data from Kuntz-Ficker (2004: 279).
Agricultural products: coffee, sugar, ixtle, henequen, dyes, vanilla, tobacco, peas, beans raw cotton, bananas. Animal products: Cattle, hides, and skins. Forest products: mahogany, and dye woods. Mineral products: copper, lead, silver ores and ingots, gold ore, antimony, and zinc ore. Oil products: crude, semi-refined and refined, lubricating and topped oils. Main trading partners included are the United States, United Kingdom, France, and Germany.
Source: Kuntz-Ficker (2004).

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Chapter 4

Did 'Import Substitution' Promote Structural Change?
A Comparative Study of Manufacturing Productivity in Mexico, Argentina, and Brazil, 1935-1975

"For all its faults, IS (import substitution) promoted rapid structural change.
Labor moved from agriculture to industry, and within industry from
lower-productivity activities to higher-productivity ones.
So much for the inherent inefficiency of IS policies!"

Dani Rodrik, *weblog* (June, 2010)

4.1 Introduction

Import substitution was perhaps one of the most debated topics on economic policy in Latin America during the middle of the twentieth century. Promoting a country's industrialization by reducing imports and substituting them with locally produced industrial products was a policy consensus until the late 1970s. The debt crises and the subsequent economic collapse suffered in the 1980s produced a radical change in the views of the development strategy based on trade protectionism. Thereafter, a vast strand of policy studies sponsored by international organizations analyzing the growth performance of Latin America emerged suggesting new policy directions.[153] The culprit was clear: excessive protectionism granted by industrial policies generated large distortions, resource misallocation and low productivity. In other words, import substitution policies failed to deliver sustained growth in the region. However, there were other views.

[153] Seminal cross-country policy studies suggesting structural reforms to liberalize trade during the 1980s are associated to the works of Balassa (1983), Bell, *et al.* (1984), Bhagwati (1985), and Krueger (1981).

Various economists from the United Nations - Economic Commission for Latin America and the Caribbean (UN-ECLAC) suggested that import substitution should not bear the weight of failure for the collapse of the 1980s; instead, external shocks, debt mismanagement, and political instability were the underlying causes of an unfavorable environment that 'interrupted' the rapid pace of industrial productivity in the region.[154] According to that view, the manufacturing sector served as an 'engine of growth' and tariff policies targeting this sector generated a process of structural transformation in domestic industries; fostering the reallocation of employment from low to high-productivity activities. Hence, import substitution policies favored the expansion of industry, employment, and technological learning, yielding as a result high aggregate productivity growth, and ultimately an increase in the standards of living of Latin Americans during those years (1930s-1970s).[155]

Despite the vast literature on this topic, existing quantitative evidence on the industrial sector has been largely focused on the last years of protectionism (late-1970s) and the liberalization period (1980s-1990s) overlooking the dynamics and productivity performance in previous decades (1930-1960s): lack of consistent data disaggregated by industrial activity has obscured empirical research preventing a systematic assessment of the effects of protectionism on productivity prior to 1970.

This chapter proposes to add breadth to the existing historical literature on Latin American industrialization by exploring the dynamics of productivity growth within manufacturing industries during the period of import substitution from a comparative perspective. Relying on official industrial censuses, it covers the period right after the Great Depression (1935/39) until the mid-1970s (1974/75).

The relevance of this study is related to the current industrial policy debate in the region; despite marked productivity improvements, major Latin American countries are still underperforming, falling short of the reform expectations from trade liberalizations, and thus, lagging behind high-income OECD countries.[156] As a consequence, in recent years several economists have claimed that Latin American policymakers should 'experiment' with new growth strategies including pro-active industrial policies to induce a 'growth-enhancing' structural change and boost productivity growth as accomplished allegedly during the years of import substitution.[157]

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[154] For e.g. Fajnzylber (1983), and Macario (1964). See a review in Baer (1994) and Ocampo and Ros (2011).

[155] See for instance, Astorga *et al.* (2005), Astorga *et al.* (2003), Cardoso and Fishlow (1992), Di Maio (2009), Katz and Kosacoff (2003), Moreno-Brid and Ros (2009), and Thorp (1998).

[156] See Pagés (2010) for a survey of the recent productivity performance of Latin American countries in comparison with other OECD (Organisation for Economic Cooperation and Development) countries.

[157] For example, Cimoli, *et al.* (2009), Greenwald and Stiglitz (2006), Lin (2012), Rodrik (2008), among others.

These growth strategies based on upgrading the quality of economic institutions, also include a typology of industrial policies that resemble the 'old' development strategies from the years of protectionism (e.g. Rodrik, 2005). These policies are mainly characterized by a series of macroeconomic stimulus, industry subsidies, and trade (and non-trade) barriers.

However, in the midst of this renewed debate it is necessary to revisit the claim that protectionist policies were indeed effective in the past as several authors argue. The argument advanced in this study is that one of the most important channels through which tariff policies may have impacted growth is by changing the sectoral distribution of employment towards the most productive activities that increase aggregate productivity (total manufacturing output per worker).

Therefore, if tariffs were important in driving labor productivity growth through this channel (structural change), then protected manufacturing sectors should have experienced faster output growth than non-protected sectors or have higher levels of labor productivity.

Brazil, Mexico, and Argentina have been exemplified as the powerhouses of import substitution policies in Latin America after the Great Depression; therefore, this study takes their manufacturing industries as a benchmark to provide a comparative analysis seeking a relationship between labor productivity growth and industry protection during the middle decades of the twentieth century.

This chapter examines the existence of a *structural bonus/burden* within manufacturing industries on whether there were significant labor input shifts from less to more productive manufacturing branches induced by tariff policies. With this purpose, the analysis employs disaggregated data from official industrial censuses and produce new estimates of labor productivity for 1935/39, 1950, and 1975. Then, it decomposes the components of productivity growth in manufacturing industries by applying a shift-share analysis to this newly compiled data.

4.2 Literature review and recent debate

Structural change is broadly defined as a process of reallocation of labor, capital, and intermediate inputs from traditional to modern economic activities.[158] This is typically characterized by a change in the economic structure that involves the movement of the labor force from low-productivity to high-productivity activities generating a rise in overall productivity and an expansion of aggregate incomes.[159] With rising overall incomes, a decline occurs in the share of food consumption (Engel's law) and a rise in the share of

[158] See a synthesis and broad quantitative evaluation in Herrendorf *et al.*, (2014).

[159] See in Chenery *et al.,* (1986) and Harberger (1998).

resources allocated to investment. In a closed economy framework, this shift in demand away from agricultural goods aided by a faster rise of productivity in manufacturing produces a natural reallocation of production inputs (Syrquin, 1988).

Large shifts in factors inputs are considered as part of a secular process across the stages of economic development; from agriculture to industry, and subsequently from industry to services. As argued by Chenery (1986), structural transformation within the industrial sector may entail shifting the pattern of specialization from traditional to more sophisticated goods, a process which would generate higher productivity growth at the aggregate level.

Within a sector, this structural transformation can be 'partially' visible on the reallocation of labor. Because of the well-known existence of large inter-sectoral differences in labor productivity (i.e. temporal disequilibrium in factor markets), labor tends to shift towards more productive sectors.[160] Determined by changes in domestic demand, and by the patterns of international trade (comparative advantage), this process of structural change can be accelerated by industrial policies, such as import substitution.

The primary goal of substituting imported goods is to change the country's pattern of trade with the purpose of upgrading and/or developing a new competitive industrial base.[161] Erecting a variety of barriers to the importation of foreign goods and substituting them for domestically produced goods, these policies promote new economic activities that require the reallocation of the labor force (and other inputs such as capital and intermediates) across and within sectors of the economy. The replacement of imports (of consumer, intermediate, and capital goods) with domestic production comes from the premise that by creating 'infant' industries and targeting existing 'priority' ones with a variety of industry incentives, the economy would be more diversified, self-sufficient, and resilient to the fluctuations of the international business cycle. This ultimately would enhance domestic welfare over time.

Protection reduces the competitiveness of newly import-competing products by raising the price of their output in domestic markets to favor local producers. In addition to the 'traditional' import barriers such as tariffs, and quotas, the protectionist 'toolbox' can be extensive and accompanied by a series of measures including: subsidies, tax breaks, low interest loans directed to selected industries, and also the manipulation of exchange rates (Bruton, 1998).

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[160] As formally exposed by Syrquin (1984: 78): "because of the shift of labor from low to high (average) productivity sectors, the growth of the aggregate labor productivity exceeds the weighted average of the corresponding sectoral growth rates".

[161] The technical definition of import substitution generally refers to the position when the import share of the supply of a specific good declines in relation to that of domestic production either because a new tariff is levied on imports of that product, or because devaluation raises import prices (Chenery, 1970).

Although the original argument ('infant industry') for protectionism as a comprehensive set of industrial policies dates back to the classical work of Alexander Hamilton (1790) and later of Friedrich List (1841), a modern theory of protection has emerged in the last decades setting a case for industry policy. Currently, it is possible to identify three strands of approaches on the welfare gains of protectionism: models with a *Schumpeterian* approach, a *Marshallian* approach, and a *strategic trade* argument.

The first strand (Schumpeterian) argues that targeting of high-technology sectors via a combination of trade protection, subsidies, and tax breaks may provide large incentives to invest in new technologies and processes. This, in turn, would lead to a stage of 'accumulation' characterized by rapid growth in productivity, and then to a phase of 'assimilation' where innovation processes enhance welfare and competitiveness (Fagerberg, 1994; Nelson and Pack, 1999).

On the other hand, authors who are inclined to support the Marshallian approach and/or the strategic trade argument claim that the temporary protection (targeting) of a sector/industry that displays *Marshallian externalities* enhances productivity growth by raising total output in those sectors. It is argued that sectors with these externalities can arise through localized industry-level knowledge spillovers, input-output linkages together with transportation costs which give rise to geographic agglomeration of industries (Krugman, 1991).[162]

At the empirical level, there are several cross-country studies that have analyzed the effect of tariffs on welfare and structural change, giving rise to the so-called 'tariff–growth paradox'. These studies have addressed with large country samples the shifting effects of tariff protection on economic growth over time; protection promoted growth before the Second World War, but inhibit it thereafter (e.g. Clemens and Williamson, 2004; and Jacks, 2006). In a related cross-country study, Irwin (2002) explored if trade tariffs had an impact on growth by shifting resources out of agriculture to industry during the nineteenth century. His findings suggest that although there was a correlation between tariffs and growth, the evidence is conditional on the country's comparative advantage and the institutions in place. He concludes: "tariff policies are complex and vary greatly across countries in ways depending strongly on resources, institutions, and government strategies".[163]

Although there are empirical cross-country studies on structural change focused on the 'total-economy' and at a sectoral level (agriculture, manufacturing, and services) such as Timmer and de Vries (2009), Duarte and Restuccia (2010), Debowicz and Segal (2014) there are also several studies at the industry level. These studies have sought at a more disaggregated level a relationship between productivity growth and tariff protection;

[162] See a full theoretical explanation in Harrison and Rodriguez-Clare (2009).

[163] D. Irwin, 'Did import substitution promote growth', p. 22.

however, with the exception of Baldwin and Krugman (1988), most of them have found little support for this relationship. Seminal studies are found in Krueger and Tuncer (1982) for the manufacturing industries in Turkey, Lee (1996) for South Korea, and Beason and Weinstein (1996) for Japan.

Moreover, at the micro-level (plant level) studies using more recent data for a sample of manufacturing plants such as Muendler (2004) for Brazil, Pavcnik (2000) for Mexico, Eslava *et al.* (2010) for Colombia, have tended to confirm this weak relationship. One of the most peculiar cases is shown in Luzio and Greenstein (1995) for the unsuccessful attempt of the Brazilian government to promote productivity growth within the microprocessor industry through tariff protection in the mid-1980s.

In a study on the dynamics of manufacturing industries, Timmer and Szirmai (2000) presented evidence testing the *structural-bonus hypothesis* for a group of Asian countries. Using a shift-share method, they explored if labor and capital shifted from less productive manufacturing branches towards more productive branches. The results failed to confirm this effect, however, after this study, further analyses using this method have been carried out for other regions (except for Latin American manufacturing).[164] Katz (2000) analyzed through a sample of Latin American manufacturing industries from 1970 to 1992 the process of productivity catch-up relative to the levels of United States. However, in that study there was a limited year-coverage for the period of protectionism and the phenomenon of shifting resources within and between industrial branches (structural change) was not explored.

Recent debate

During the years of import substitution in Latin America, specifically for the period of 'explicit' industrial protection between 1930 and 1975 the evidence on the link of productivity growth and manufacturing protection is still not clear.[165] In fact, although the structural problems of the import substitution model in Latin America and its political and economic consequences were notably emphasized long ago in the seminal works from Albert Hirschman (1968), on the empirical side the issue on the dynamics of productivity growth for these years has remained speculative and controversial due to serious data problems (see e.g. Edwards, 1993).

Whereas some authors have argued that overall productivity grew faster in Latin America thanks to protectionist policies than in any other period in the history of the

[164] See also a comparison of Taiwan and South Korean manufacturing in Dollar and Sokoloff (1994).

[165] It is labelled 'explicit protection' because prior to this period trade tariffs levels were also high as they were inherited from post-independence tax regimes. It was after the Great Depression when governments embraced tariff policies in the official discourse as elements of their industrial promotion programs (Sokoloff and Zolt, 2007).

region (e.g. Astorga *et al.* 2003; Thorp, 1998), others consider Latin America's current productivity gap (post-1980) and stagnant growth performance as a legacy of the policies of the import substitution period (1930-c.1975).[166] The latter studies argue that erecting barriers to international trade and prolonging them for more than three decades meant missing the opportunity to build technological capabilities and upgrading domestic industrial structures based on competition and openness that would have raised labor productivity and spurring domestic innovation.[167]

Moreover, although during this period of protectionism Latin American industries increased their shares in the world economy presumably aided by trade protection, it is claimed that the benefits of this 'inward-looking development' strategy were 'offset' by the consequential costs of distortions and rent-seeking activities that impacted negatively on productivity growth (Taylor, 1998).

On the other hand, more recently McMillan and Rodrik (2011) have documented that after the import substitution period (after the liberalization in the 1980s) as trade barriers declined, Latin American industries became more productive and efficient, but this occurred at a major cost for the region: a productivity 'growth-reducing' structural change. These authors showed with sectoral-based evidence that liberalization instead of promoting the reallocation of employment towards the most productive sectors, shifted employment to the less productive such as agriculture and the informal sector.

These findings have re-opened the debate not only on whether protectionism or openness are good for growth by inducing or reducing structural change, but on how the structure of regulation (i.e. protection) can be complementary to market competition within a sector.[168] For instance, Nunn and Trefler (2010) showed with cross-country evidence that the *skill-bias* of the structure of tariffs is positively correlated with productivity growth. That is, there are productivity gains when tariffs targeted *skill-intensive* industries. Yet, theirs and the other existing studies are cross-country correlations between productivity growth and tariff protection, and are based on GDP (Gross Domestic Product) per capita, a variable that neglects the shifting dynamics within industries. The present study aims to contribute in filling this lacuna by showing historical evidence with disaggregated data in manufacturing for Brazil, Mexico and Argentina.

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[166] See e.g. Cole *et al.* (2005), Edwards (2009), and Taylor (1998).

[167] There is growing body of empirical studies suggesting that export-oriented regimes lead to rapid technological development in labour-intensive industries. This is because exposure to international trade induce firms to acquire new technical expertise, facilitating the acquisition of new skills by workers and thus, increasing overall productivity. See a review in Syverson (2011) and Tybout (2000).

[168] See for e.g. a debate in Lin and Chang (2009), and further empirical evidence in Aghion *et al.* (2012).

4.3. Industry and protectionism in Latin America after 1930: a brief historical overview

As mentioned previously, Latin American countries grew rapidly during protectionism. The years after 1930 and especially in the aftermath of the Second World War have been considered as the twentieth century's 'golden age' of economic growth around the world and Latin America was not an exception.

Countries like Mexico and Brazil grew even faster than some advanced industrial countries. By 1980 their real incomes (per capita) where nearly four and five-times the 1930 levels respectively (see table 4.1). Although these GDP levels were still behind countries like the United States and the United Kingdom, the growth performance of Latin America during this period was unprecedented.[169]

Table 4.1: Levels of GDP per capita in selected countries, 1930 and 1980 (1990 Geary–Khamis dollars)

Year	United Kingdom	United States	Mexico	Brazil	Argentina
1930	5 441	6 213	1 618	1 048	4 080
1980	12 931	18 577	6 320	5 195	8 206
Increase in GDP per capita (%)	237	300	390	495	205

Source: Based on Maddison (2007) updated by Bolt and van Zanden (2014).

Countries in the region experienced the 'stylized' sectoral transition from agriculture to industry, and to services. As figure 4.1 shows, in Mexico, Brazil and Argentina, the share of agricultural employment fell sharply followed by an increase in the industry and services employment shares. As in other major industrial economies such as the United Kingdom, the United States, and Italy, industrial policies attempted to speed up this process of structural change, which in some cases failed or had little effect.[170]

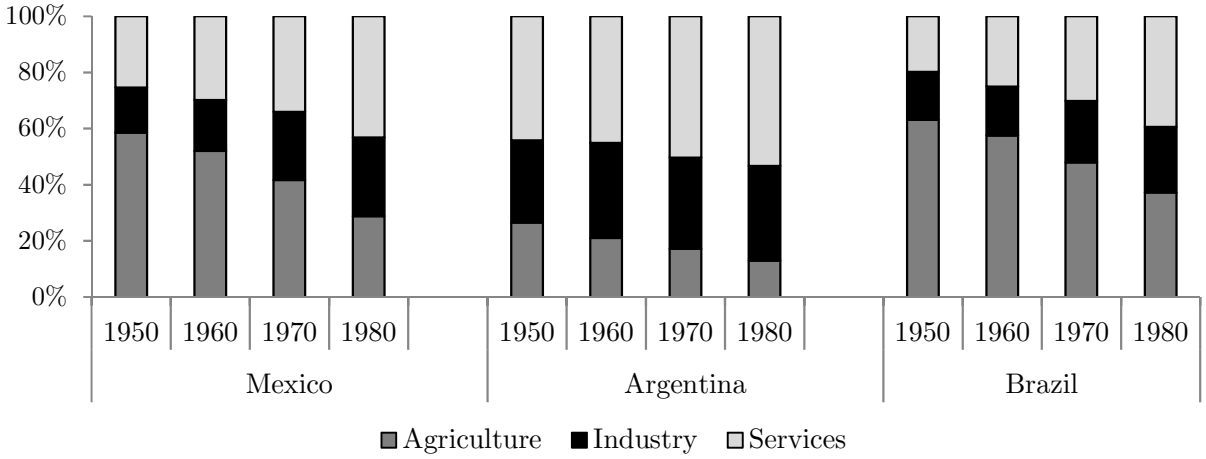
After the outbreak of the Great Depression, protectionist policies enacted by the United States and the United Kingdom such as the Smoot-Hawley tariff in 1930 and the British General Tariff in 1931 affected negatively the commercial flows around the world. Latin American countries that were highly dependent on commodity-trade were severely

[169] An exception is Argentina which had a relatively higher real GDP growth rates in the late nineteenth century. See Taylor (1994).

[170] See for example, Broadberry and Crafts (1996) for the case of the United Kingdom, Cole and Ohianian (2004) for the United States, and Giordano and Giugliano (2014) for Italy.

hit. Exports, tax revenues, and total employment collapsed by the early-1930s in major Latin American economies. Thereafter, a period of 'explicit' government interventions began aiming to foster domestic manufacturing industries.

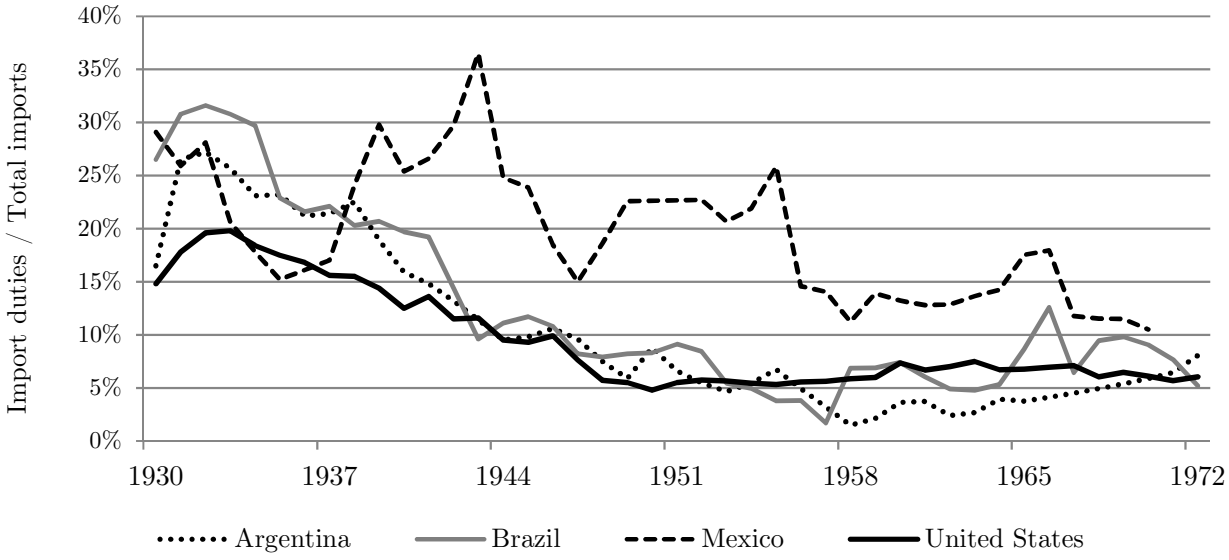
Figure 4.1: Sectoral employment shares of Mexico, Argentina, and Brazil, 1950-1980 (%)



Source: Data from GGDC 10-sector database (Timmer and de Vries, 2009).

However, protectionist policies did not appear as a coordinated regional policy effort. Although many Latin American governments reacted with protectionist measures after 1930, high tariffs were already a common feature before the Great Depression (see for e.g. Coatsworth and Williamson, 2004).

Figure 4.2: Average tariffs in Argentina, Brazil, Mexico, and United States, 1930-1972



Note: Unweighted average of country's own tariffs (total economy).
Source: Data from Clemens and Williamson (2004).

Most of the conventional literature has portrayed protectionism in Latin America as part of nationalist projects influenced by 'dependencia' economists like Raúl Prebisch (1949). Yet, it was the administration of the United States back then who advised governments in Mexico and Argentina with plans and procedures to implement tariffs, tax reforms, and other industry incentives aiming to channel American private investments into the targeted industries (Maxfield and Nolt, 1990).

Moreover, most of these protectionist measures were enacted gradually over the years at the behest of manufacturers and in response to the existing conditions of international markets (Haber, 2006). As figure 4.2 shows, although the average level of tariffs was higher than in the United States there was a clear downward trend in the protection of major Latin American countries from 1930 to the early-1970s.

It is difficult to make a generalization of a single regional Latin American set of industrial policies since there was no uniform 'development strategy' based on import substitution. Instead, the 'typology' of protectionism erected in these countries was diverse. According to Baer (1994) and Teitel and Thoumi (1986) in Chile and Venezuela protection followed different stages based on gradual horizontal integration. In larger economies like Brazil, Mexico, and Argentina there was an 'urge' to foster industrialization based on vertical integration, i.e., promote both final consumer goods industries, and intermediate and the capital goods sector.

Table 4.2: Average rate of effective protection in Argentina, Brazil, and Mexico's manufacturing in the mid-twentieth century
(Percentages of industrial value added)

	Consumption goods	Intermediate goods	Capital goods	All manufacturing
Argentina	164	167	133	162
Brazil	230	68	31	118
Mexico	22	34	55	27

Note: The effective rate of total protection is the percentage by which the value added at a particular stage of processing in a domestic industry can exceed what it would be without protection. Data for Argentina is for 1958 and Brazil for 1966 and Mexico for 1959.
Source: Little, Scitovsky and Scott (1970), p. 174.

As is shown in figure 4.2, average total tariffs levels were higher in Mexico, but effective protection within manufacturing was much higher in Argentina and Brazil during this period. Table 4.2 shows this feature; whereas Argentina and Brazil's effective protection was heavily directed to the production of consumption and intermediate goods,

in Mexico effective protection was relatively lower and more directed to the protection of capital goods.

Latin American industrial corporatism after 1935

Cliometric studies have tended to neglect a common factor that assisted industrial targeting programs: *corporatism*. This scheme was fundamental in mediating disputes between labor and capital. But more importantly, this allowed governments to expand their influence on manufacturing industries by creating special programs directed to facilitate high investment rates together with the coordination of domestic labor markets. Government officials along with company managers would set wage restraints to factory workers, and subsequently industrialists (owners) would reinvest their profits. Since most of employers' associations and trade unions were attached to the state, corporatism aimed to control labor relations at the firm level, setting wage demands to the growth of labor productivity.

Similarly to the European type of labor market coordination after the Second World War, manufacturing wages were set to move in tandem with productivity levels (see e.g. Eichengreen, 2008). Governments headed by Getúlio Vargas (1930-45, 1951-54) in Brazil; Lázaro Cárdenas (1934-40) and Manuel Ávila-Camacho (1940-46) in Mexico; and Agustin Justo (1932-38) and Juan Perón (1946-55) in Argentina, engaged effusively in corporatist schemes to facilitate the implementation of their industrial policies.

In the following decades (1940s to 1960s), trade unions gained political ground in the industrial sector throughout the region. Labor rights and benefits were implemented such as a social security program and a minimum wage for urban workers. In Brazil, the coalition of political forces led by Getúlio Vargas brought an era of government interventions in the midst of conflicting interests between landowners, industrialists, and workers. Vargas advocated a program of economic modernization by imposing tariffs to favor agro-businesses and textile manufacturers. The so-called *Estado Novo* (new state) established a new Constitution which gave absolute power to the executive branch, a feature that facilitated discretionary policy measures. Although at the beginnings of Vargas' administration the agenda tended to favor trade unions, it rather repressed them aiming to compact industry wages and prices (Colistete, 2001).

Brazilian industrialists and unions were in a continuous conflict of interests and often trade unions controlled the economic agenda towards an economic reform that industrialists rejected. It has been argued that this lack of 'social compact for growth' prevented industrial real wages to grow in tandem with labor productivity (Colistete, 2007).

In the same period, the Mexican economy was experiencing a secular decline in mining and oil activities which where the leading sectors at the end of the nineteenth century. In turn, these were being replaced by agricultural and manufacturing production. The severe shortages of imported manufactured goods caused by the Great Depression in the United States raised their relative prices and thus, the profitability of producing them domestically. Thereafter a corporatist industrial model emerged in Mexico propelled by the rise of the Partido Nacional Revolucionario (National Revolutionary Party).[171] This new political movement 'unified' the interests of the government and industrial workers to promote national development.

The administration of Lázaro Cárdenas in the mid-1930s, was heavily involved in worker's organizations resulting in the creation of the Mexican Workers' Confederation (Confederación de Trabajadores de México). In this, the majority of trade unions were organized and attached to the political party. The consolidation of this scheme provided the basis of both popular support for the industrial policies to protect Mexican manufacturers offering preferential tariffs, together with a tight control of industry wages through trade union arrangements. In the following decades (1950s and 1960s) high output growth and low ('stable') inflation rates would characterize the Mexican economy, a period also known as the *desarrollo estabilizador* (stabilizing development).[172]

For the case of Argentina, unquestionably the most prosperous Latin American country at the start of the twentieth century, the period after the Great Depression until the 1970s has been generally considered as a 'growth reversal'.[173] The country experienced a decline in GDP growth rates in relation to the United States and other advanced countries. However, manufacturing remained a fundamental sector in terms of employment and it witnessed substantial changes, including the emergence of important sectors such as transportation and machinery equipment. The new industries produced for the domestic market and a large share of these firms had foreign, especially British ownership (Taylor, 1998). During these years, governments such as the administration of Juan Perón began to intervene directly in 'national' industries. Perón's regime aimed at diversifying an economy that was dominated by food processing, leather, textiles, and other less-capital intensive industries.

The five-year economic plans instructed by Perón raised industrial workers' pay, but also included fostering high (and medium)-capital intensive industries like the machinery and transportation industries via subsidies and trade tariffs. Previously, during the so-called *infamous decade* (1930-1943) Argentinian trade unions had begun to occupy a space in public life which strengthened labor-industrialists negotiations which at the

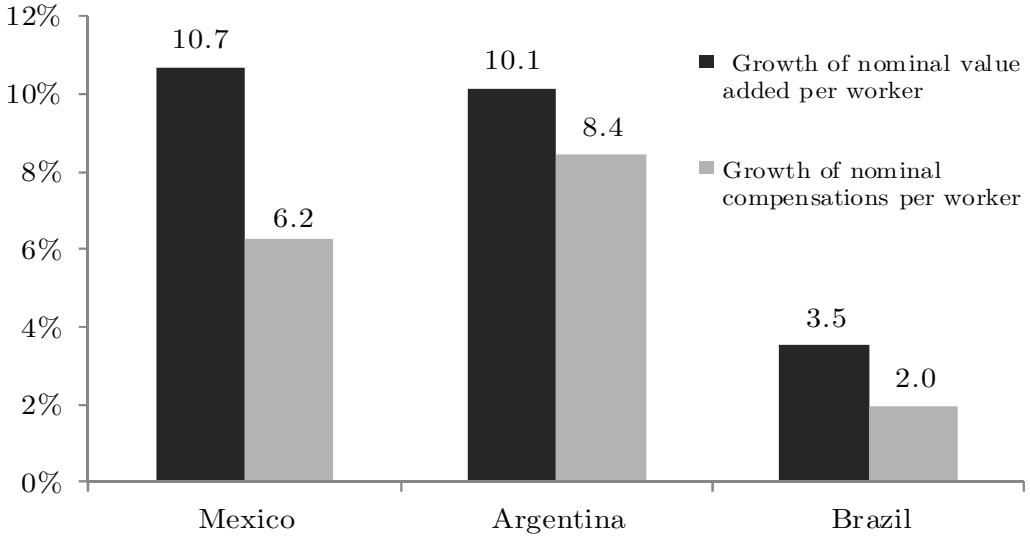
[171] The party was renamed later as Partido Revolucionario Institucional (PRI) in 1946.

[172] The term 'desarrollo estabilizador' appeared for the first time in Mexico's official annual economic report for the World Bank in 1970.

[173] della Paolera and Taylor (2003).

time was formalized in the General Confederation of Labor (Confederación General del Trabajo*)*. In the same way to their trade union's counterparts in Mexico and Brazil, collective bargaining demands in Argentina were subject to labor productivity increases, a corporatist arrangement that supported import substitution policies of the Perón regime and subsequent governments.[174]

Figure 4.3. Growth of total manufacturing nominal value added per worker and nominal compensations per worker in Mexico, Argentina, and Brazil, c.1950-1975
(% compound growth rates)



Note: Growth rates are annual average compound growth rates of nominal values in local currencies for the period 1947/1950 to 1974/75. Nominal compensations refer to the sum of total wages, salaries and other paid benefits.
Source: See next section and appendix B.

However, as figure 4.3 depicts, in spite of these arrangements, workers' compensations lagged behind productivity (total value added per worker) during this period.[175] The message of this overview of the institutional arrangements in the industrial sector is that overall labor productivity within each of these countries interacted not only with the level of tariff policies in specific branches. The prevailing corporatist schemes

[174] During Peron's regime (by 1955) the so-called *Congreso de la productividad* (Congress for productivity) was instituted aiming to align the interests of unions, industrialists, and government.

[175] Figure 4.3. is displayed purposely in nominal terms. Collective wage bargaining was usually set in nominal terms and were adjusted for inflation only after prolonged periods of time and/or the expiration of the collective contract. There is vast evidence indicating the existence of the 'money illusion' phenomena in these countries (e.g. Dornbusch and Edwards, 1991); workers preferred to see their nominal wages rise, giving them the illusion that their living standards were improving, even though in real (inflation-adjusted) terms they may not be better off.

imposed to compress industry wages were a key element for implementing the industrial policies during the years of import substitution.

4.4 Data description, adjustments, and limitations

Detailed statistical data of the industrial sector for most of the Latin American countries in the years previous to 1960 suffer from large discontinuities and inconsistencies. There have been various efforts to collect and reconstruct statistical information with a consistent time-span based on the SNA (System of National Accounts).

For instance, ECLAC (Economic Commission for Latin America and the Caribbean) assembled country-based statistics on economic and social variables since 1930. Unfortunately, in their industry-specific studies most of the information related to the manufacturing sector is not disaggregated by the type of industrial activity or branch. Their aggregate results on 'sector totals' are derived from interpolations linking growth rates between missing years. On the other hand, the datasets of United Nations Industrial Development Organization (UNIDO) contain highly disaggregated data (3-digit level); however, their data only include the years after 1970.[176]

For longer periods previous to 1970, the widely used historical datasets such as Mitchell (2007), Penn World Tables, Maddison (2007) and Bolt and van Zanden (2014) have provided a series of sound long-term GDP information which have been used to make international comparisons of output and productivity including Latin American countries.[177] However, the issue of employing GDP at an aggregate level (or the share of manufacturing in total GDP) as proxy for industrial productivity is that these measures by themselves do not capture the intra-industry dynamics of a changing economy over time. The sectoral disaggregation by Timmer and de Vries (2009) (GGDC 10-sector database) comprises industrial sectors including manufacturing since the year 1950; yet, it does not further disaggregate by manufacturing branches.

Therefore, the statistical data employed in this study draws on primary sources obtained from *industrial censuses*, or 'censos industriales' in Spanish/Portuguese (currently renamed as 'censos económicos' or 'censo nacional económico'). These censuses are official country surveys of economic units elaborated by national statistical offices every three to five years depending on the country of analysis and cover the manufacturing branches of 3-digit level industries.

In Argentina, national censuses have been conducted since 1869. In 1914, the census included a subsection devoted to the manufacturing sector labeled as 'censo de las

[176] The same applies for the ECLAC-PADI dataset (Program of Analysis of Industrial Dynamics).

[177] Another similar source is the Montevideo-Oxford Latin America database (MoxLAD) which covers 20 Latin American countries for this period; however, the manufacturing sector is largely incomplete.

industrias'. However, the disaggregation of manufacturing branches was conducted for the first time in 1934 and published the following year (1935). Similarly, in Mexico, the first *censo industrial* was conducted by 1930. In Brazil, this statistical collection of manufacturing industries was conducted in 1939 and published in 1940.

Consistency and adjustment

For comparison purposes the present analysis establishes three reference benchmark-years according to the date that matched a similar census-year between these countries: 1935/39, 1947/49/50, and 1974/75.[178]

Table 4.3: Industry census country/year sample

Country	Reference year of census data
Mexico	1935, 1950 1975
Brazil	1939, 1949, 1975
Argentina	1935, 1947, 1974

Source: Data for Mexico is from *Segundo Censo Industrial* (1935), *Quinto Censo Industrial* (1957), *Décimo Censo Industrial* (1976); For Brazil, data is from *Recenseamento geral do Brasil* 1940, and 1950: Censo Industrial; and 1975 from *IBGE*, Censo Industrial: Brasil, Serie Nacional, Vol. 2, Part I, Rio de Janeiro, (1981). For Argentina data is from *Censo Industrial de 1935 (Comisión Nacional del Censo Industrial 1938), Censo Industrial de 1947* (IV *Censo General de la Nación 1946*) and *Censo Económico Nacional de la República de Argentina de 1973 y 1974* (1974).

However, the information in these censuses cannot be compared directly in their original form for two main reasons; firstly, their classification methodology is different. Thus, I re-classified the industrial activities originally compiled by the national statistical offices to get a harmonized classification. I followed the one corresponding to the manufacturing codes of the ISIC (International Standard Industrial Classification, revision 3) two-digit divisions or groups of three-digit major industries (see appendix A).[179]

From these censuses, I use disaggregated data on value added, and employment for 11 manufacturing branches.[180] To achieve consistency in our estimates, I have

[178] Other censuses for this period where available however only the mentioned 'census dates' matched across this country sample. For Argentina, the following industry census after 1947 was officially conducted for the year 1954; therefore, I opted to include the former (IV Censo Industrial 1947).

[179] In this study 'aggregated' various 3-digit level industries into 2-digit level in order to make cross-country comparisons following a standard ISIC classification (see appendix A).

[180] Data of investments by industry were not included in this analysis. Besides the additional data and assumptions needed to estimate the real stock of physical investments, the data quality of investments

constructed/adjusted the value added figures into the modern definition of gross value added introduced in 1993 in the SNA.

The branches analyzed are: Food, Beverages, and Tobacco (ISIC 31), Textile, Textile Products, and Wearing Apparel (321), Leather, Leather Products and Footwear (323+324), Wood, Wood Products, and Cork (33), Paper, Printing and Publishing (34), Chemical Products, Rubber and Plastic Products (355+356), Non-metallic Mineral Products (36), Basic and Fabricated Metals (37+381), Machinery and Transport equipment (382+384), Electrical Machinery, Electrical Apparatus, and Precision Instruments (383) and Other Manufacturing (Miscellaneous) (385+39).

The second reason why these figures should be properly adjusted for comparison purposes is the changing value of currency units over time. All data of gross value added by industry/branch are originally expressed in their own local currencies. However, to compare industrial productivity across countries and sectors, an important issue arises in converting real value added into common currency units.

The proper rate of exchange in common currencies is to use a PPP (Purchasing Power Parity).[181] Recent research has shown that relative prices vary largely across tradable and non-tradable sectors and using aggregate PPPs raises doubts in converting production-side figures (see e.g. Bernard and Jones 1996).

Ideally, the proper way to adjust and deflate our data would have been to take manufacturing unit value ratios based on the production surveys and to construct industry-specific PPPs (see, Inklaar and Timmer, 2013). The 'industry of origin' methodology has been a common technique to derive price indices by industry taking unit values for each specific product, and matching them with its counterpart (or with the United States).

However, a major drawback to construct deflators based on unit-value ratios for these countries is that the official industry censuses published in those years do not report data on quantities and values of the goods produced in each industry which are necessary for that adjustment technique. This adjustment issue could raise concerns on the data employed in this study especially considering the government price-setting schemes that kept the prices of most import-substituted goods artificially low, and the hyperinflation

recorded over time is much less consistent than value added or employment series for cross-country comparisons. Information on hours-worked were not available in these surveys.

[181] Maddison and van Ark (1989) conducted a comparative study of Brazil, Mexico and the United States for the year 1975 to derive PPPs based on an 'industry of origin' approach. However, their study (in order to match the prices of industrial items/products) selected only 38 and 47 percent of the manufacturing censuses for Brazil and Mexico respectively. The present study included the 'total' of the manufacturing census of 1975.

episodes in Argentina during the Perón era (1950s) and the years around the mid-1970s (a similar case in Brazil).[182]

In order to solve this data issue, I follow an alternative approach to adjust gross value added: I employ information of the price changes of the commodities traded between industries before retail; that is from a producer price index. Thus, this study uses 'wholesale price indices' of each country to adjust the disaggregated nominal figures into constant terms (base 1975=100).[183] After adjusting for inflation, I converted the data into 1975 dollars using US exchange rates for the respective years of analysis. I follow this adjustment drawing on the quantitative findings by Maddison and van Ark (1989) that established that the PPP exchange rates of Mexico and Brazil did not vary substantially from those countries' market exchange rates with the US dollar in 1975.[184]

In order to verify the robustness of this assumption and check whether the price dynamics within manufacturing industries evolved in the same direction as the aggregate (total economy) wholesale price deflator, I derived a disaggregated wholesale price index for Brazil based on a combination of secondary data (see appendix B 'prices'). With this, I proceeded to make adjustments on the industry census data comparing estimates (on gross value added) with disaggregated and aggregated wholesale price deflators. The deflation procedure was applied to the data for the benchmark years of the country in accordance to the censuses mentioned above (table 4.3); however, it is important to determine if price changes within branches differed across time.

As shown in figure 4.4, wholesale price trends of other sectors did differ from the 'total' wholesale price index for Brazil. These differences are taken into account in this study in order to test whether this may impact the results of our productivity estimates.

Another limitation is the range and coverage of the censuses. I am employing in total three industrial censuses across eleven aggregated branches for each of the three countries to ultimately establish three benchmark estimates. Industrial censuses for these countries do not cover seasonal workers and therefore, it can be argued that employment figures can be underestimated because they and part-time workers are not included. A possible solution would have been to compare industry employment with figures from population censuses; however, for this period such data were not available by type of industry in most of Latin American countries.

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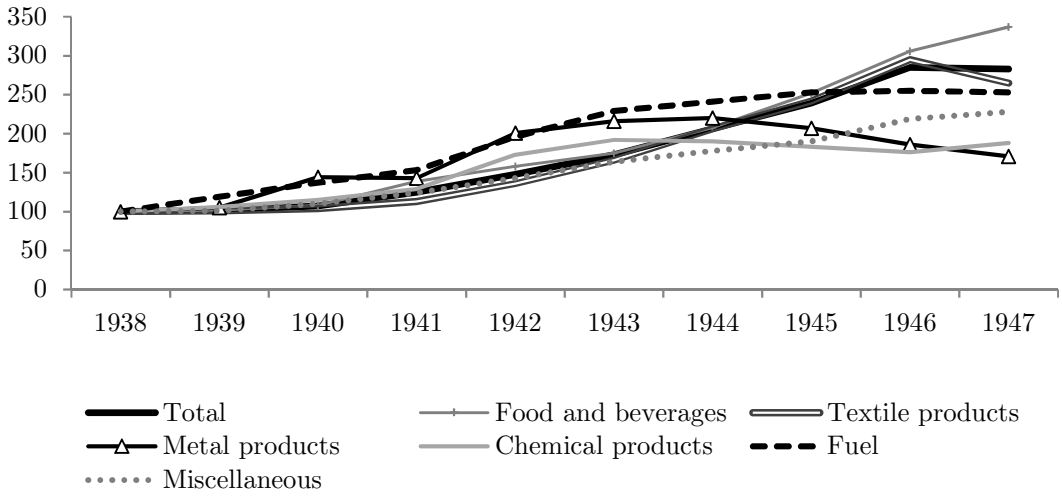
[182] See this data adjustment issue in Frankema and Visker (2011) for the case of Argentina.

[183] I use average index numbers of one year prior, during, and one after the census reference year to derive the deflators because these censuses include data for the year prior to its publication (e.g. the average wholesale price index for Mexico in 1950 was derived from the unweighted average growth of the index for 1949-1950).

[184] Figures in US dollars are only displayed in tables 4.1.A. to 4.1.C of the appendix.

Figure 4.4: Wholesale price index, Brazil 1938-1947
(1938=100)



Source: Derived from Bulhões (1948). See detailed table in appendix B.

The analysis follows a definition of labor productivity as the branch's gross value added over total workers-engaged in the respective branch. It would have been preferred to employ hours worked for a more accurate productivity measure, however, due to the limitations of the original source already mentioned, I proceeded in using data on the number of persons engaged within each industrial branch.

Labor shares are shown in table 4.4. They indicate that a large proportion of the labor force in all three countries in 1935/39 and 1947/50 were concentrated in 'traditional' or low-technology intensity branches such as food, and textile manufacturing (near to a quarter or a third of total employment) and to a lesser extent on medium-low or medium-high-technology branches.[185]

The picture changes by the mid-1970s where the shares in traditional branches declined relatively and employment began to spread out into other more sophisticated branches. For instance, the most dramatic change in Mexico and Brazil is that the share of the branch of textiles declined from 37% and 34.7% to 13.7% and 16.4% respectively.[186] This contrasts with a smaller share in textiles in Argentina. Its economic structure was more diversified relative to Mexico and Brazil already in 1935. In a technology-

[185] Categories of low, medium, and high-technology intensity are based on the OECD classification of R&D intensities. See in T. Hatzichronoglou, 'ISIC Rev. 3 Technology intensity definition'. See detailed categories in the appendix of this chapter, table 4.2.D.

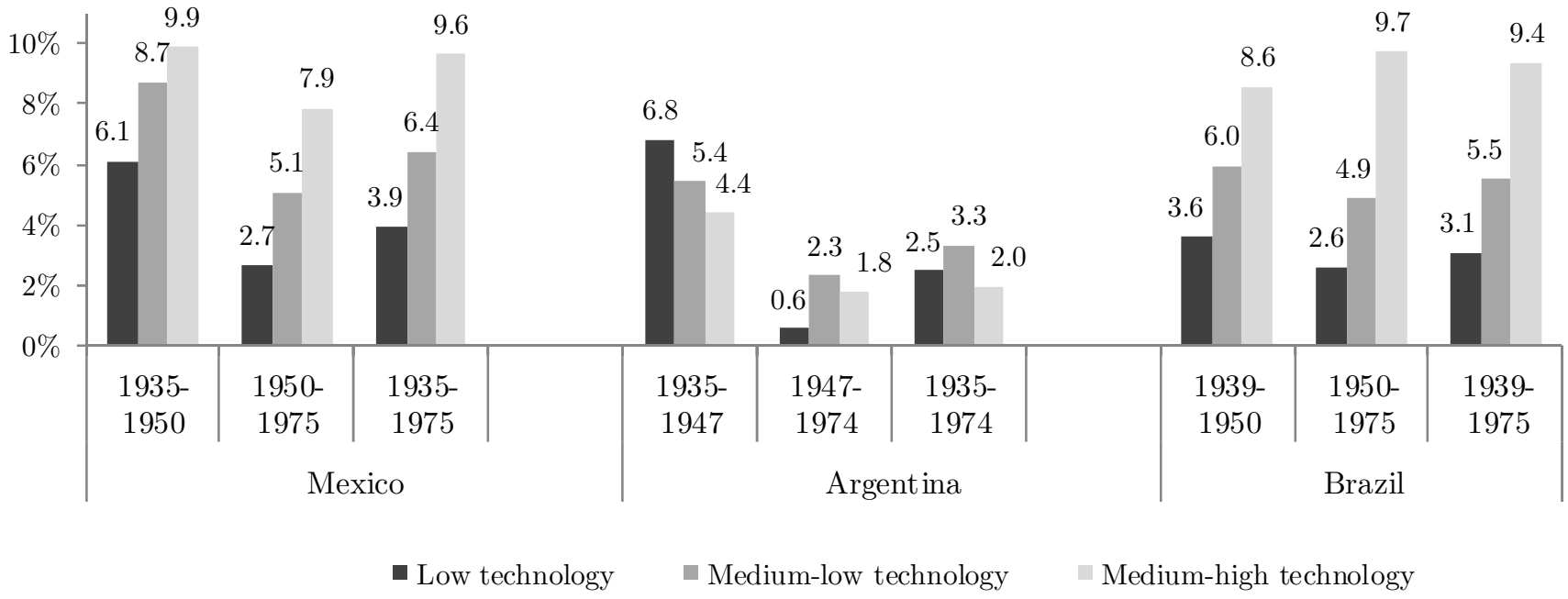
[186] However, as table 4.5 shows, the relative value added per worker in the leather and footwear branch remained extraordinarily high for the case of Brazil. Industry-case studies have indicated how the Brazilian government favored the generation of leather shoe exporting clusters. By the late-1970s, Brazil became the third largest (after Italy and Korea) leather shoe exporter in the world. See for e.g. Schmitz (1995).

classification view from 1950 to 1975 the branches that expanded the most in terms of employment were the ones based on medium-high technology intensity.

Figure 4.5 shows the change in industrial employment over this period. It depicts according to a classification based on the OECD (Organization for Economic Cooperation and Development) extraordinary high growth rates of employment across industries, for Mexico and Brazil. Medium-high technology intensity branches reached around nine percent annually (compound growth rate).[187]

[187] Changes in employment shares could have been also driven by the growth of the population or by increasing the rates of labor force participation. However, the discussion of this analysis focuses on the factors of labor absorption and the movements within industries that raised overall labor productivity.

Figure 4.5. Growth of industrial employment by period according to classification of 'technological intensity'
(% compound growth rates)



Note: Based on OECD classification (Hatzichronoglou, 1997). Since the aircraft and pharmaceutical industry represented a very small share in total manufacturing employment during this period, the high-technology classification was not shown for graphical purposes.
Source: See text.

Table 4.4: Employment shares by manufacturing branch in Mexico, Argentina, and Brazil c.1935-1975 (%)

Industry	Mexico			Argentina			Brazil		
	1935	1950	1975	1935	1947	1974	1939	1949	1975
Food, Beverages, and Tobacco	24.5	26.5	23.2	22.5	24.3	21.0	25.0	21.9	15.2
Textile, Textile Products, and Wearing Apparel	37.0	30.0	13.7	16.0	19.2	13.0	34.7	31.7	16.4
Leather, Leather and Footwear	5.2	1.3	2.9	3.2	5.1	3.1	1.8	1.6	0.9
Wood, Products of Wood, and Cork	6.1	6.3	4.5	6.3	10.5	5.7	8.1	8.2	8.7
Pulp, Paper, Printing and Publishing	4.8	4.2	5.3	6.2	1.9	4.7	5.4	5.7	5.6
Chemicals, Chemical Products, and Rubber	3.6	6.3	12.6	3.4	6.0	9.7	5.9	6.4	8.1
Non-metallic Mineral Products	5.0	5.5	6.0	12.5	6.9	6.8	7.0	9.8	8.5
Basic and Fabricated Metals	10.2	12.1	12.3	8.1	10.2	13.4	7.5	7.9	11.7
Electrical Machinery, Electrical Apparatus, and Prec. Instrum.	1.0	1.7	6.8	5.1	2.1	4.4	0.6	1.2	4.6
Machinery and Transport Equipment	0.9	4.7	10.7	9.1	10.2	17.1	2.5	3.6	16.2
Other Manufacturing	1.8	1.5	2.0	7.5	3.5	1.0	1.3	2.1	4.0
Total*	100	100	100	100	100	100	100	100	100

Note: Data refers to total employment (workers + employees by branch). Shares are the ratio of total employment branch to total manufacturing.
* Total sum may not sum up to 100 due to rounded decimals.
Source: Table 4.3.

Table 4.5. Relative labor productivity levels by manufacturing branch in Mexico, Argentina, and Brazil c.1935-1975

Industry	Mexico			Argentina			Brazil		
	1935	1950	1975	1935	1947	1974	1939	1950	1975
Food, Beverages, and Tobacco	1.23	1.14	0.83	1.22	1.17	0.98	1.29	1.17	0.90
Textile, Textile Products, and Wearing Apparel	0.89	0.63	0.63	0.85	1.14	0.81	0.83	0.76	0.58
Leather, Leather and Footwear	0.70	0.74	1.77	1.00	0.92	0.52	1.00	2.68	2.50
Wood, Products of Wood, and Cork	0.55	0.61	0.47	0.71	0.60	0.44	0.70	0.65	0.55
Pulp, Paper, Printing and Publishing	1.15	0.95	1.07	1.45	1.01	0.98	1.00	1.08	1.08
Chemicals, Chemical Products, and Rubber	1.49	1.83	1.69	1.25	1.47	2.06	2.05	1.68	2.35
Non-metallic Mineral Products	1.13	0.72	0.87	1.09	1.05	0.68	0.80	0.72	0.71
Basic and Fabricated Metals	0.86	1.64	1.11	0.83	0.85	1.09	0.19	1.20	1.05
Electrical Machinery, Electrical Apparatus, and Prec. instrum.	1.61	1.08	0.86	0.38	0.85	0.99	3.30	1.34	1.20
Machinery and Transport Equipment	0.69	0.88	1.10	0.97	0.75	0.94	1.50	1.10	1.03
Other Manufacturing	1.37	0.65	0.70	0.64	0.73	0.53	0.89	0.88	0.79
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Note: Data refers to the level of value added per worker employed of branch relative to the total manufacturing value added per worker level
Source: Table 4.3.

In Argentina these branches (medium-high technology) did not exceed the growth of the medium-low and low ones. This feature is attributable to a catch-up effect. It has been documented how Argentina developed earlier (before the Great Depression, c.1910-1920s) its manufacturing base, whereas the era of state 'developmentalism' in Mexico and Brazil started much later. Brazil and Mexico experienced an unprecedented 'exponential' growth in manufacturing per capita output between 1950 and 1975.[188] Chenery *et al.*, (1975) foresaw however, that those extraordinary high output growth rates would carry large structural imbalances in industrial employment and productivity in these countries.[189] Nevertheless, the outstanding employment rates (for Brazil and Mexico) were only matched by the ones achieved in Korea and Japan over the same period (e.g. Dollar and Sokoloff, 1994).

A paradox may appear at first sight when comparing table 4.5 with the global technology intensity classification (appendix 4.2.E). Several branches classified as 'low-tech' (e.g. food, beverages, & tobacco) displayed high labor productivities relative to 'medium high-tech' (e.g. electrical machinery). This feature may appear counterintuitive since it usually presumes that higher-technology intensive industries should be more productive then less-technology intensive.

This presumption has been the focus of analysis in several industry-case studies in countries with a restricted access to the international knowledge stock or technology transfer (see a review in Tybout, 2000). According to Diaz-Alejandro (1965) in developing countries, inter-industry labor productivity differentials can be explained by the type of activity conducted within the industry.[190] There are types of industrial branches that are 'process-centered' (or machine paced), and 'product-centered' (or labor paced activities). On the latter type, productivity is more dependent on the quality of *local* labor and other resources, and vice versa for process-centred activities. Industry-case studies have revealed that although the labor productivity differentials between advanced and less-advanced industrial countries tends to be larger in process-centered industries (e.g. chemicals, non-metallic minerals), labor productivity growth in product-centered activities (e.g. leather, textiles) in developing countries experience relatively high labor productivity growth (inter-sectoral labor productivity growth rates), and therefore, a smaller differential between countries (advanced and less-advanced).

This paradox occurs because the margin for improvement through 'learning by doing' in those activities is much wider than in machine paced activities. Particularly, a

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[188] See benchmark tables 4.1.B and 4.1.C in appendix A of this chapter.

[189] Similarly, Chenery *et al.*, (1975) arrived at very high estimates of compound growth rates of industrial per capita output (near to 7% per year) during this period.

[190] Diaz-Alejandro (1965) and Teitel (1981) analyzed a modified version of the Hirschman hypothesis for a sample of Latin American countries. The original notion in broad terms refers to the conjecture that manufacturing productivity differentials between highly-industrialized countries and developing countries is larger in labor-intensive industries.

large scope for high labor productivity growth (spillovers) is likely to appear in branches where the skills requirements of the workers is low (see for e.g. Pack 1988). For Latin America it has been documented that during this period 'light' industries displayed relatively high labor productivities particularly in those based on abundant local resources (see, Teitel 1981).[191]

Nonetheless, this general observation on high labor productivity rates in low-tech branches relative to medium-high technology branches has relevant implications for the ensuing empirical examination.[192] Firstly, because the apparent indistinct relation of technology intensity and labor productivity growth across the period may reveal the invariant effects of policy related to the 'initial conditions' of the existent comparative advantage that labor-intensive industries possessed at the start of the protectionist strategy. Secondly, for policy design reasons. Despite the relatively low labor productivity in branches regarded as more technology (medium-high) and capital intensive in early periods, the degree of support via import substitution was based on the widely held view (by Latin American policy makers) that the expansion of these (medium-high technology intensive) branches was the route to break with the existing labor specialization patterns and to become technologically independent.[193]

However, since various low-technology manufacturing branches were highly productive at the start of import substitution (c.1935/1939), it does not necessarily imply that the notion of the reallocation of labor toward technology-intensive sectors to raise labor aggregate productivity is untenable. As mentioned, the reallocation away from low-tech to medium high-tech industries was a deliberate policy effort to gain autonomy reducing the dependency from technology intensive imported goods. Although there is an intrinsic interaction between import substitution and the labor productivity dynamics (associated to pre-existent factor endowments), disentangling them statistically would have been only plausible with a sample selection control such as an *ad-hoc* counterfactual (e.g. productivity comparisons in a period of non-protected industries, i.e. autarky vs free trade). Thus, looking to maintain the measurement strategy of this chapter, the analysis

[191] Due to the nature of the present census data it is not plausible to account for the level of 'mechanization'. In order to accurately confirm the aforementioned feature, it would have required the inclusion of records of capital stock and the type of skills embodied within the industry/branch.

[192] Sandven et al., (2005) found that in OECD countries, taking both types of industries together (low and medium-low technology industries) they outweigh the corresponding value added per worker contribution of high-tech industries on aggregate labor productivity growth.

[193] As Prebisch (1964) contended, despite their high growth (labor-intensive), not all sectors possessed the same ability to inject dynamism to "propagate technical progress" in the long run. This was considered one of the most important preoccupations of the theorists of ECLAC. The creation of a capital goods industry was a priority because of the increasing dependency on these type of imports would imply that the balance of payments would impose a constraint to economic growth in the long run.

focuses exclusively on the statistical claim of the historiography that aggregate labor productivity growth during this period was indeed enhanced through labor reallocation.

The phenomenon of structural change entails that shift in the pattern of specialization of traditional into modern activities. Evidently, the labels 'traditional' and 'modern' coined in the dual-economy framework are not the most accurate to describe the complexity of the evolution of structure of the Latin American manufacturing. The ensuing examination puts forth a decomposition of labor productivity into its main components looking to provide a more accurate description of the process of labor reallocation.

4.5 Productivity decomposition methodology

The industrial productivity decomposition employed in the present study relies on a standard 'shift-share' analysis framework. This has been used in several studies to measure the contribution of structural change to aggregate productivity growth (e.g. McMillan, *et al.,* 2014).[194] The decomposition technique has been also applied for cases within manufacturing industries to disentangle their sources of productivity growth (e.g. Timmer and Szirmai, 2000; and Wang and Szirmai, 2008). Most of these studies have analyzed the impact of the shifts in capital and labor inputs on productivity growth (total factor productivity).[195] Due to the lack of comparable data on capital series for these countries during this period the analysis focuses exclusively on the effects of shifts of labor inputs on aggregate labor productivity growth.[196]

Decomposition of labor productivity

$$LP^T = \frac{Y^T}{L^T} = \sum_{T=1}^{N} \frac{Y_i^T L_i^T}{L_i^T L^T} = \sum_{i=1}^{n} LP_i^T S_i^T \qquad (1)$$

$$LP^T - LP^0 = \sum_{i=1}^{n} (LP_i^T - LP_i^0)\, S_i^0 + \sum_{i=1}^{n} (S_i^T - S_i^0) LP_i^0 + \sum_{i=1}^{n} (LP_i^T - LP_i^0)(S_i^T - S_i^0) \qquad (2)$$

LP^{T} is the aggregate labor productivity at year t;
LP^0 is the aggregate labor productivity at year 0;

[194] The method was first introduced by Fabricant (1942).

[195] This disaggregation has become a standard in structural change studies; however, one of the main drawbacks is that it cannot provide evidence of the effects of changes from the demand side.

[196] According to Syrquin (1984: 78), the 'complete' measurement should include the impact of shifts in both capital and labor on total factor productivity. Thus, the present shift-share measurement can be regarded as 'partial'.

LP^{T}_{i} is the labor productivity of branch i at year t;
LP^{0}_{i} is the labor productivity of branch i at year 0;
S^{T}_{i} is the employment share of branch i at year t;
S^{0}_{i} is the employment share of branch i at year 0.

The first term (from left to right) in the right side of equation (2) denotes the effect of productivity growth within industries (industrial branches). This term can be interpreted as the contribution to productivity growth resulting from learning by doing, capital intensity, hours worked in the sector (branch). The second term measures the effect of reallocation of labor between branches with differing levels of labor productivity (also known as 'static shift' effect). A positive sign in the total sum of this term is also seen as a 'structural bonus':[197]

$$\sum_{i=1}^{n}(S_i^T - S_i^0)LP_i^0 > 0 \qquad (3)$$

The third (last term), is an interaction effect of productivity growth and labor shifts (known as 'dynamic shift' effect). This reflects the effect of shifts towards branches with higher than average or to lower than average productivity growth. This last term will have a positive effect on productivity growth if labor shifts to branches where productivity is improving more rapidly than the average. Conversely, it will have a negative contribution if labor moves to branches where productivity is increasing less rapidly than average productivity, when this is the case (when its total sum is negative), the term can be seen as a 'structural burden' effect:

$$\sum_{i=1}^{n}(LP_i^T - LP_i^0)(S_i^T - S_i^0) < 0 \qquad (4)$$

This last term also captures Baumol's hypothesis derived from the 'unbalanced growth' model; since there are inherent differences between industries in their capabilities to raise labor productivity through technological progress, innovation, or capital deepening, labor may tend to move towards industries where productivity is growing slower (technologically stagnant industries). As a result, in the long-run, if this 'structural burden' persists it will generate a fall in the aggregate productivity growth rate.[198]

In general, a positive total sum of both shifts effects ('static effect' plus 'dynamic effect') would reflect a process of structural change that boosts aggregate (labor) productivity growth.

[197] See also in Peneder (2003).
[198] See in Baumol *et al.* (1989)

4.6 Results and discussion

The analysis applied the shift-share model (equation 2) discussed in the previous section to the eleven manufacturing branches in each of the three countries. Tables 4.6 to 4.8 report the results for each country on the contribution to productivity growth disaggregated by industrial branch. The column 'total' indicates the total contribution from intra-branch productivity growth (within effect) and the shifts between branches (static and dynamic).

Mexico

During the first period (1935-1950) of import substitution, industrial productivity growth in Mexico was driven predominantly by traditional branches (food, beverages; and textiles and wearing apparel). On the other hand, branches with relatively high-capital intensity (e.g. machinery or electrical apparatus) were unable to expand as 'national' industrial policies intended to promote. This salient feature appears when we look at the composition of the structural components of overall productivity growth (see table 4.6) which was dominated by a 'within' industry effect (91.2%). The contribution of labor reallocations related to a 'structural bonus' (static-shift effect), although positive had a very weak impact (0.4%).

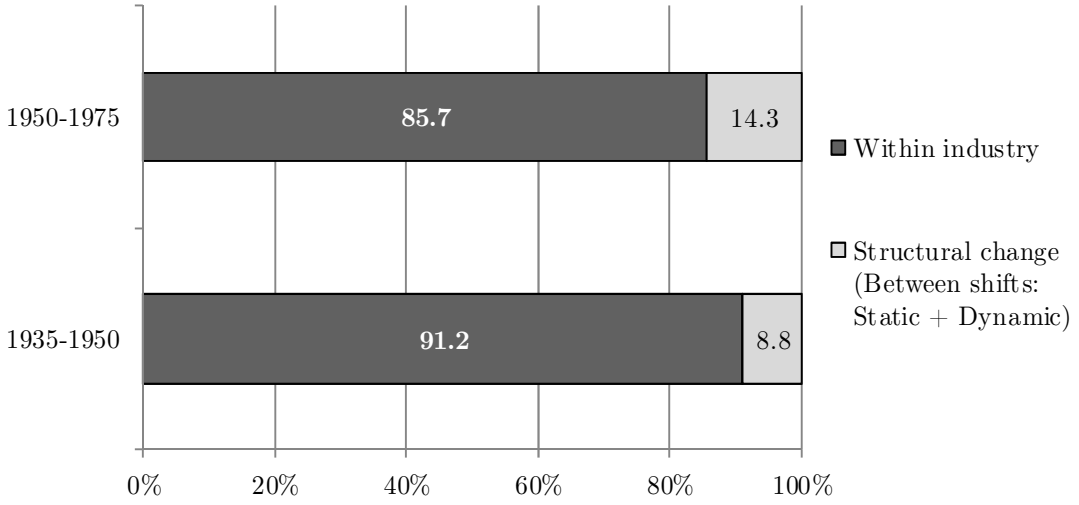
On the other hand, productivity growth due to reallocation to industries with high productivity growth reveals that 8.4% was derived from a dynamic shift effect. In the second period (1950-1975), Mexico's aggregate labor productivity growth continued to accelerate (8.3%). During this period, other industrial branches such as chemicals and fabricated metals contributed to productivity growth (1.8 and 1.0% respectively). Moreover, the contribution from labor reallocation from static shifts was higher than in the previous period but still small. Although, the 'structural bonus' effect on productivity growth increased to 1.3%, and the interaction effect (dynamic effect) added up to around 13%, overall productivity growth was explained by growth 'within' industries (85.7%).

Table 4.6: Shift-share decomposition of manufacturing labor productivity growth in Mexico, 1935-1975

	1935-1950				1950-1975			
Industry	Within	Static	Dynamic	Total	Within	Static	Dynamic	Total
Food, Beverages, and Tobacco	1.745	0.025	0.145	1.915	1.756	-0.037	-0.221	1.498
Textile, Textile Products, and Wearing Apparel	1.295	-0.062	-0.244	0.988	1.587	-0.096	-0.864	0.627
Leather, Leather and Footwear	0.228	-0.028	-0.170	0.030	0.209	0.010	0.245	0.465
Wood, Products of Wood, and Cork	0.242	0.001	0.008	0.251	0.236	-0.011	-0.067	0.159
Pulp, Paper, Printing and Publishing	0.277	-0.007	-0.033	0.237	0.381	0.010	0.100	0.491
Chemicals, Chemical Products, and Rubber	0.416	0.041	0.316	0.772	0.881	0.110	0.876	1.867
Non-metallic Mineral Products	0.233	0.005	0.021	0.259	0.401	0.004	0.039	0.445
Basic and Fabricated Metals	1.296	0.016	0.235	1.547	1.029	0.005	0.024	1.058
Electrical Machinery, Electrical Apparatus, and Prec. instrum.	0.057	0.012	0.041	0.109	0.122	0.050	0.360	0.532
Machinery and Transport Equipment	0.053	0.026	0.234	0.313	0.434	0.055	0.560	1.049
Other Manufacturing	0.054	-0.004	-0.009	0.041	0.086	0.003	0.034	0.124
Sum of industry productivity growth	5.894	0.025	0.543	6.461	7.123	0.104	1.087	8.314
Total contribution to growth of aggregate productivity	91.2%	0.4%	8.4%	100%	85.7%	1.3%	13.1%	100%

Note: Data adjusted with Mexico's branch-specific wholesale price indices. See appendix A.

Figure 4.6: Shift-share decomposition of aggregate labor productivity growth in Mexico's manufacturing, 1935-1975
(% contribution to aggregate labor productivity growth)



Note: Sum of last row in table 4.6, 'total contribution to growth of aggregate productivity'.

Figure 4.6 displays a summary of the decomposition of the structural components of aggregate productivity growth in these periods in Mexico. It indicates that although it played a relatively minor a role in boosting overall labor productivity, structural change (the sum of between-industry shifts) contributed in 8.8% from the 1935-1950 period and 14.3% from 1950 to 1975. These results suggest that there was a small but positive increase in the tendency of industrial labor moving into higher-productivity activities which promoted to some extent the rapid pace in aggregate labor productivity, particularly during the second period of analysis or the so-called *desarrollo estabilizador* (1950s-1960s).

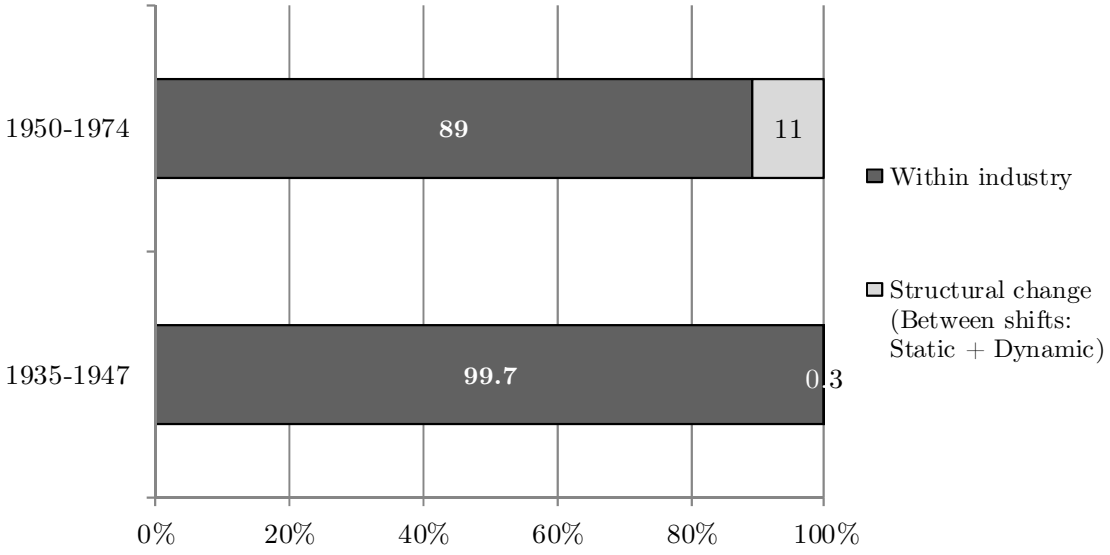
Argentina

Most of the discussion in the literature on Argentina's post-1930 relative economic decline has focused on the deterioration of the agricultural sector and the decline of the land-labor ratio with little emphasis on the dynamics of the industrial sector (manufacturing).[199]

Our new quantitative evidence based on industry shift-share estimates reports that although Argentine manufacturing was more diversified (in terms of employment shares) than Mexico (and Brazil), aggregate labor productivity growth was similarly driven by traditional branches (food and beverages, and textiles and wearing apparel).

[199] Recently, Debowicz and Segal (2014) explored this lacuna through data simulations (on broad sectors: agriculture, industry and services) using a computable general equilibrium model.

Figure 4.7: Shift-share decomposition of aggregate labor productivity growth in Argentina's manufacturing, 1935-1974
(% contribution to aggregate labor productivity growth)



Note: Sum of last row in table 4.7, 'total contribution to growth of aggregate productivity'.

For the period 1947-1974 other branches were involved in the acceleration of labor productivity; machinery, transport equipment, basic metals, and chemicals (see table 4.7). However, productivity gains from labor shifts were meager. For the first period (1935-1947), although the dynamic effect was positive (1.5%), this was nearly offset by a negative 'structural bonus' (-1.3%). The overriding interpretation of this is that aggregate productivity growth was driven by growth 'within' industries in Argentina (99.7%). During the second period (1947-1974), there was a slight change of labor moving out to more productive branches (gains from dynamic shifts accounted 10.9%).

Yet, as figure 4.7 summarizes, structural change did not play an important role in explaining aggregate productivity. Its contribution after 1947 in Argentina was higher than before but small (11%) in comparison with the impact of 'intra' industry contribution (89%).

Table 4.7: Shift-share decomposition of manufacturing labor productivity growth in Argentina, 1935-1974

	1935-1947				1950-1974			
Industry	Within	Static	Dynamic	Total	Within	Static	Dynamic	Total
Food, Beverages, and Tobacco	0.475	0.012	0.021	0.508	1.333	-0.042	-0.195	1.097
Textile, Textile Products, and Wearing Apparel	0.386	0.022	0.062	0.470	0.839	-0.073	-0.278	0.489
Leather, Leather and Footwear	0.052	0.018	0.027	0.097	0.135	-0.019	-0.054	0.063
Wood, Products of Wood, and Cork	0.061	0.029	0.038	0.129	0.256	-0.029	-0.118	0.109
Pulp, Paper, Printing and Publishing	0.087	-0.065	-0.061	-0.040	0.107	0.028	0.159	0.294
Chemicals, Chemical Products, and Rubber	0.100	0.031	0.070	0.200	0.753	0.053	0.456	1.262
Non-metallic Mineral Products	0.238	-0.065	-0.110	0.062	0.249	-0.002	-0.008	0.238
Basic and Fabricated Metals	0.128	0.015	0.028	0.171	0.678	0.025	0.197	0.900
Electrical Machinery, Electrical Apparatus, and Prec. instrum.	0.040	0.000	0.002	0.042	0.126	0.019	0.135	0.280
Machinery and Transport Equipment	0.105	0.008	0.009	0.121	0.575	0.050	0.377	1.002
Other Manufacturing	0.108	-0.027	-0.058	0.023	0.103	-0.009	-0.038	0.056
Sum of industry productivity growth	1.778	-0.022	0.027	1.783	5.155	0.002	0.733	5.890
Total contribution to growth of aggregate productivity	99.7%	-1.3%	1.5%	100%	88.4%	0.0%	10.9%	100%

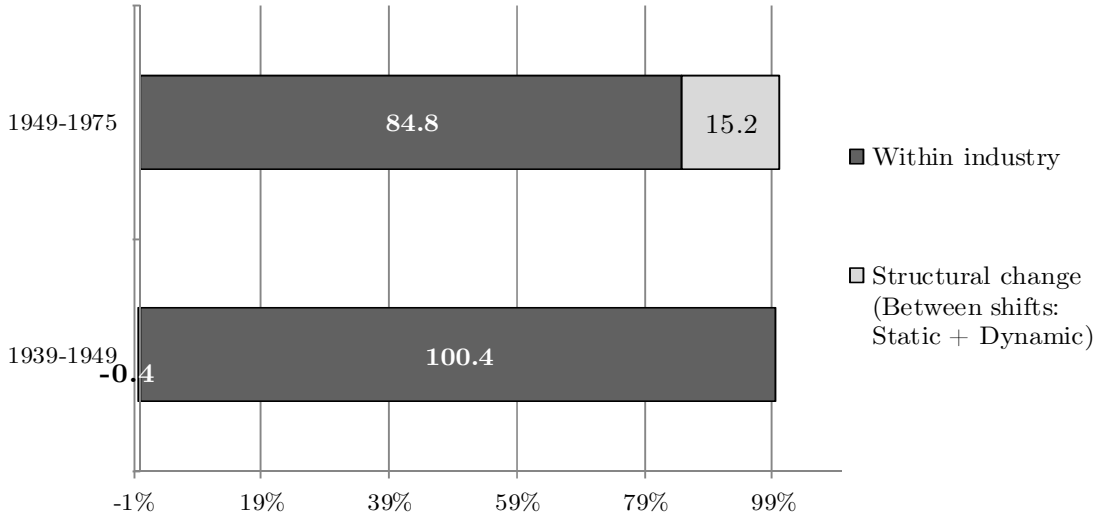
Note: Data was adjusted with Argentina's total wholesale price indices. See appendix A.

Brazil

Brazil's rapid growth after the Great Depression has been a well-documented feature in previous research. Studies have found that despite the fast pace of industrialization, the Brazilian economy continued relying on primary products, and its manufactured exports were mostly natural resource-based (Baer, 1994).

Our shift-share results on Brazilian manufacturing report that this feature may only be accurate for the 1939-1949 period in terms of labor productivity (see table 4.8). Thereafter, from 1949 to 1975, although productivity growth decelerated (sum of industry productivity growth), it slightly shifted to other more sophisticated branches such as machinery and chemicals. A noticeable feature for the first period (1939-1949) is that there was a 'structural burden' (negative dynamic effect) on aggregate productivity led by shrinking traditional sectors (-0.4%). This suggests that the Brazilian manufacturing sector may have suffered from a problem of labor misallocation, possibly arising from 'X-inefficiency' across firms, mainly those in traditional branches which could have accounted for the negative static and dynamic shift effects.[200]

Figure 4.8: Shift-share decomposition of aggregate labor productivity growth in Brazil's manufacturing, 1935-1975
(% contribution to aggregate labor productivity growth)



Note: Sum of last row in table 4.8, 'total contribution to growth of aggregate productivity'.

[200] On the other hand, Baer *et al.,* (1987) have documented that the large foreign investment inflows into Brazilian private manufacturing particularly into companies producing machinery, electric equipment, and pharmaceutical goods generated a more vertically-integrated manufacturing sector during the post-war years.

Table 4.8: Shift-share decomposition of manufacturing labor productivity growth in Brazil, 1939-1975

	1939-1949				1949-1975			
Industry	Within	Static	Dynamic	Total	Within	Static	Dynamic	Total
Food, Beverages, and Tobacco	1.055	-0.037	-0.131	0.887	0.146	-0.078	-0.045	0.023
Textile, Textile Products, and Wearing Apparel	0.994	-0.019	-0.088	0.887	0.140	-0.115	-0.067	-0.043
Leather, Leather and Footwear	0.162	-0.008	-0.019	0.135	0.088	-0.019	-0.038	0.032
Wood, Products of Wood, and Cork	0.189	0.001	0.002	0.192	0.038	0.003	0.002	0.044
Pulp, Paper, Printing and Publishing	0.219	0.003	0.011	0.233	0.064	-0.001	-0.001	0.062
Chemicals, Chemical Products, and Rubber	0.347	0.009	0.029	0.385	0.202	0.028	0.053	0.283
Non-metallic Mineral Products	0.181	0.021	0.072	0.274	0.073	-0.010	-0.010	0.053
Basic and Fabricated Metals	0.343	0.003	0.015	0.361	0.074	0.046	0.036	0.156
Electrical Machinery, Electrical Apparatus, and Prec. instrum.	0.020	0.018	0.018	0.055	0.013	0.046	0.039	0.098
Machinery and Transport Equipment	0.092	0.015	0.039	0.146	0.034	0.139	0.119	0.291
Other Manufacturing	0.042	0.006	0.025	0.073	0.015	0.017	0.014	0.046
Sum of industry productivity growth	3.644	0.012	-0.027	3.629	0.887	0.057	0.102	1.046
Total contribution to growth of aggregate productivity	100.4%	0.3%	-0.7%	100%	84.8%	5.4%	9.8%	100%

Note: Data was adjusted with Brazil's branch-specific wholesale price indices. See appendix A.

Figure 4.8 depicts yet again that aggregate productivity was dominated by growth within industries in both periods. From 1949 to 1975, a slight proportion of it was induced by structural change, contributing 15.2% to overall labor productivity growth in Brazil.

Is Rodrik wrong?

The evidence presented has indicated a very limited effect of structural change on aggregate productivity growth. Contrary to this, recent analyses by the economist Dani Rodrik have brought up a discussion on whether protectionist regimes can boost economic growth. In his book, *One Economics, Many Recipes* (2008) he states:

> "...Import-substituting industrialization (ISI) worked in Brazil, but not in Argentina" (p. 42) ...the model (ISI) was quite effective in stimulating growth in a large number of developing countries, for example in Brazil, Mexico, and Turkey" (p. 50).

The fragment cites as evidence estimates of aggregate TFP (Total Factor Productivity) growth rates from Bosworth and Collins (2003) where Brazil outperformed Argentina during the 1960-1973 period.[201] The overall message that Rodrik tries to put forward is that similar economic policies and institutions have worked for some countries but not for several others. Moreover, he claims that an 'unconventional' set of policies (such as industry protection) can ignite and accelerate growth initially with 'minimal' institutional change. However, Rodrik argues that over time it becomes more difficult to sustain growth without the reforms that promote a long-term 'sound' institutional underpinning to maintain a productive dynamism.[202]

Certainly, although Brazil and Argentina (and Mexico) had different initial institutional arrangements, their rapid growth from the 1930s until the 1970s was closely linked to their political economy model based on corporatism and industry protection. Following Rodrik's argument, it is likely that the lack of economic and institutional reform by the end of the mid-1960s or early-1970s may have contributed to the subsequent breakdown of the model during the Latin American crisis of the 1980s. Also, the combination of other factors (high debt-to-GDP ratios, overvalued exchange rates, 1973 oil shock, etc.) may have also contributed to the subsequent crisis.

However, could have been the lack of structural change the underlying cause of the 1980s crisis? McMillan *et al.* (2014) drawing on the findings of sectoral estimates by Timmer and de Vries (2009) argued that in fact, there was structural change during the period of protectionism in Latin America:

[201] TFP growth rates reported for that period in Brazil and Argentina are 2.3 and 0.6 respectively.
[202] *Idem*, p. 6.

> "...during the quarter century between 1950 and 1975, the contribution of structural change to overall productivity growth was positive and large, of roughly the same magnitude as the within component" (p. 31).

This notion is not incorrect but rather incomplete. As they show, during this period labor moved from agriculture to manufacturing and services contributing significantly to aggregate productivity growth. However, a view at a *higher* level of sectoral aggregation may mask the 'specific' effects of import substitution policies where manufacturing was the main targeted sector. The shift-share estimates from Timmer and de Vries (2009) referenced by McMillan and Rodrik (2011) employed a different dimension of structural change based on data from broad sectors across the economy (agriculture, manufacturing, and services).[203]

The estimates presented in this chapter are quite different to previous broad examinations since these are based exclusively on manufacturing censuses disaggregated at the 3-digit level. Yet, these estimates could be seen as complementary evidence of the latter. Our estimates accounted for the effect of structural change on 'total manufacturing' productivity growth but not on the 'total economy' aggregate productivity as the latter study is referred to.

It may not be implausible in attributing to various industrial policies in Latin America the 'success' of generating roughly 50% of 'bonus' on aggregate productivity growth from shifting the agricultural *labor surplus* into manufacturing (and services) as argued by previous authors. However, if the assessment of the effect of import substitution on structural change is viewed on the basis of how much of this bonus was gained from changing the structure of production inside the 'targeted' sector, then the shift-share examination broken down at the manufacturing level is more appropriate.

Our evidence presented shows a less optimistic picture compared to Rodrik and other research using a different data aggregation. As mentioned, the bonus (structural change effect on productivity growth) accounted at most roughly 15% for Brazil (period 1949-1975) and to a less extent in Mexico (14%) and Argentina (11%). Nonetheless, this meager contribution of structural change within manufacturing is not unusual. In comparative terms with other industrial sectors outside of Latin America, structural change in manufacturing also played a very limited role in the so-called East Asian growth miracle (post-1960s) which is usually portrayed as an example of successful industry 'interventions'.[204]

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[203] See 'GGDC 10-sector database' in www.ggdc.net

[204] 'Industry interventions' understood as selective industrial policies aiming to alter the structure of production towards sectors that offer greater prospects to accelerate overall economic growth (see Nolan and Pack, 2006).

For instance, Timmer and Szirmai (2000) estimated that the structural change component in India contributed only about 10% to 15% on manufacturing (labor) productivity growth, whereas in other Asian economies like South Korea, Indonesia, and Taiwan this component was nearly zero or negative.[205] Thus, what explanation can we draw in light on these similar findings?

As in Harberger's (1998) famous analogy on the shape of growth distributions, instead of expanding uniformly as yeast when baking bread in an oven, productivity growth in Latin America followed patterns in the shape of mushrooms. Resembling mushrooms in the forest bed, manufacturing labor productivity in this period 'popped out' sporadically only in specific branches. As argued by the growth literature a 'yeast-type' of productivity growth requires broad externalities which are related to the total stock of knowledge in the economy such as human capital. This ultimately could have been more important to boost growth uniformly rather than relying only on the structural change stemming from the dynamic effects of specific branches.

However, this does not mean that the present findings are a case against industrial policy in Latin America. On the contrary, although major aggregate labor productivity improvements were driven 'within' growth of individual industries, the magnitude of at least this type of growth has not been replicated in the region since. As McMillan *et al.,* (2014) indicate, patterns of structural change in Latin America not only have been absent after the 1980s, but since the 1990s (post-liberalization) have been even 'growth-reducing' for aggregate productivity growth.

Besides, as previous studies have shown the success of industrial policies in raising overall welfare in East Asian countries did not generate extraordinary TFP growth rates or caused major technological breakthroughs. Instead, their selected industry interventions raised also labor productivity 'within' industries together with high rates of capital accumulation which in the end accounted the most for overall output growth (per capita).[206]

As for Latin America, although it has been widely documented that import substitution had an anti-export bias that persisted until its later stages (1970s), Taylor (1998) has pointed out that the productivity divergence with their East Asian counterparts may have been not only related to the failure of creating a comparative advantage in the export sector; instead, the failure could be traced to the low capital-investment path that these economies experienced throughout this period relative to East Asia. Although more research is needed on whether Latin American manufacturing industries were operating at a sub-optimal level or with low capital intensity levels relative to other catch up economies

[205] Most of the increases of aggregate productivity growth in these countries were found driven by growth 'within' branches. See also an analysis on TFP growth comparison in Dollar and Sokoloff (1994).

[206] See for example Young (1995).

during this period, the nature of the data in the present estimations prevents us to go further on that issue.[207]

Nevertheless, it is necessary to highlight that most recent macroeconomic analyses on Latin America have usually blamed liberalization and the effects of globalization of the 1980s decade as the main drivers of the industrial productivity divergence relative the rest of the world. Our analysis has shown that the roots of industrial retardation predates the 1980s. The drivers of productivity divergence were engendered during the years of protectionism (between 1930 and 1975) characterized by the inability to diversify and shift the structure of production out of traditional activities towards the ones with higher value added which ultimately may have led to an industrial base that was highly vulnerable to the international competition under liberalization.

Yet, our estimates require caution in deriving policy implications. In addition to the data constraints, estimates are based on a standard shift-share analysis that omits other important factors that may also be considered as 'structural change'; changes on the demand side of the economy; the possibility of increasing returns to scale in targeted industries; and inter-industry knowledge spillovers derived from innovation and technological breakthroughs or from newly created backward/forward linkages of intermediate inputs.

4.7 Summary and conclusions

This chapter aimed to re-examine an historical feature that has been a matter of recent discussions of industrial policy in Latin America: the impact of structural change on productivity under protectionism (namely 'import substitution'). The main rationale of these policies was the potential generation of a 'structural bonus' (positive externality) arising from protecting a sector/branch with a 'latent' comparative advantage.

Notwithstanding the limitations of the empirical methodology and data, our results have set this discussion into a broad country-case historical context using unexplored records of disaggregated statistical information for Mexico, Argentina, and Brazil. Evidence from this data shows that under this policy regime, although employment and productivity in many industries grew in real terms at unprecedented high levels with relatively high tariffs, little was accomplished to enhance structural change in the manufacturing productivity of these three major countries.

Reallocation of labor within the sector did not provide an extra bonus to aggregate productivity growth in addition to growth 'within' individual branches. Most of these branches (food and beverages; textiles and wearing apparel) were in nature labor-intensive

[207] Existent studies for Brazil and Mexico on this issue are only for the period prior to the 1930s. See a review in Haber (2006).

and contributed the most to overall productivity growth. Needless to say, one of the broad accomplishments of import substitution was the development of a productive 'light' manufacturing; however, despite the government incentives in protecting other more relatively sophisticated sectors (machinery, transport equipment, and chemicals) with capital-intensive technologies, productivity growth remained 'stuck' into traditional industrial activities.[208]

Williamson (2011) has documented how most of Latin American countries were catching up in aggregate manufacturing with the 'industrial core' during this period. Yet, by disaggregating productivity growth in the manufacturing sector this chapter found that growth was driven by traditional industries (low-technology intensity) and very sparsely by sophisticated ones (medium-high technology intensity). Ultimately the persistence of this *unbalanced* pattern in manufacturing throughout the years (1935-1975) was likely the fallout of the meager export performance and a 'chronic' balance of payments problem experienced in the wake of the 1980s debt crises. As the economist Clark W. Reynolds (1978) once quoted for the case of Mexico's stable growth pattern: "the *stabilizing development* was actually destabilizing".

A further debate exists on why these countries failed to move from a manufacturing industry dependent on tariffs to a 'Schumpeterian-type' industry characterized by continually introducing cost-reducing processes and technologies as their East Asian counterparts accomplished during the same period. Most of the explanations have focused on the poor design of national policies regarding tariff protection in Latin America.[209]

However, the question that should be addressed from a political economy perspective is why if the prevalent structure of protection did not generate structural change by the 1950s (as shown in this chapter) this was not re-arranged or reversed.[210] Instead these policies persisted for the following two decades up until the debt crises in the 1980s indicating the existence of an endogenous tariff protection.

In other words, tariff policies did not target adequately those activities with a potential comparative advantage. Instead, these might have been influenced by the desire to aid declining sectors or/and protect the interests of large unproductive firms. As noted by Taylor (1998), Latin American policymakers confused "support for industrialization

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[208] Although there is evidence suggesting that there were other more successful 'non-tariff' policies such as the Brazilian BEFIEX (Special Fiscal Benefits for Exports) scheme which provided incentives for exports of domestic manufactures, many studies have shown that in spite of the diversification of Brazilian exports, many of these products did not meet international quality standards.

[209] Numerous studies have shown that the imports-GDP ratio in these countries did not fall as intended. Countries' vertical integration of production had a heavy reliance on machinery imports and foreign capital, generating as a result an unsustainable position in their balance of payments. See Hirschman (1968) and Bruton (1998) for a general overview, and Katz and Kosacoff (2003) for the particular case of Argentina.

[210] During the military regime around the year 1976 Argentina lifted its protectionist measures in manufacturing, much earlier compared to Mexico and Brazil.

with support for industrialists" generating costly distortions for the long run.[211] This argument is inexorably associated to the issue of institutional quality and how developing good economic institutions may be a prerequisite for an effective industrial policy.

Evidently, the region is large and now also comprises other major countries that in recent years have been more successful in diversifying their economies and gaining speed in the 'productivity race' such as Chile, and Uruguay. A future step in cliometric research would be to explore whether their current industrial success was shaped by the accumulation of capabilities from earlier industrial policies such as import substitution.

[211] A. Taylor, 'On the costs', p. 20.

Appendix A to Chapter 4: Gross value added and employment

In order to make cross-country comparisons I re-ordered the industrial branches that matched the international classification described above. Therefore, for the case of the Brazilian industrial censuses (1939-1975) we excluded the mining branches referring to extractives industries (industrias extractivas) of mineral and vegetable products (productos minerais and productos vegetais) and focused only on manufacturing branches (industriais de transformação) which represented roughly 95-96% of coverage of all industrial censuses (total employment).

Adjustments to 'value added' figures

Mexico: The information in Mexican industry censuses does not report estimates of value added. However, the censuses have enough information to arrive at an estimate that is similar to the concept of value added of the 1993 SNA (System of National Accounts) and have a level of compatibility with Argentina and Brazil. Mexican gross value added was constructed directly from the census figures as the total value of products (producción total) *minus* the cost of raw materials (materias primas utilizadas), purchased fuel and electricity (combustibles y electricidad consumida) and other production expenses (Otros gastos de producción). For Brazil and Argentina, value added figures in their censuses followed the definitions in accordance the standards of the SNA.[212]

Employment:

Mexico: Mexican industry censuses only include paid workers. The censuses covered by this study took the employment figures by branch referred as 'Personal ocupado'. The branches included were the ones disaggregated in the sub-sector 'industrias de la transformación', and thus, excluding extractive industries, agriculture, fisheries and forestry. Brazil: Data refers to column to total sum of 'Pessoal occupado' and the branch selection is the same as the one chosen for value added described above. Argentina: Employment figures are derived from the total sum of 'Empleados'.

[212] Official exchange rates of 1975: Following Officer (2011) exchange rates for 1975, in Mexico the 'Peso' was 12.50 per dollar, Brazil's 'Cruzeiro' in January of the same year was 8.13 per dollar and for Argentina, we used the year's monthly average of 78 pesos per dollar.

4.1.A: Comparative benchmark of levels of gross value added per person employed in Mexico, Argentina, and Brazil in 1935/39
(Constant US dollars of 1975)

Industry	Mexico (1935)	Argentina (1935)	Brazil (1939)
Food, Beverages, and Tobacco	167	575	169
Textile, Textile Products, and Wearing Apparel	124	398	60
Leather, Leather and Footwear	98	468	420
Wood, Products of Wood, and Cork	99	334	138
Pulp, Paper, Printing and Publishing	204	684	196
Chemicals, Chemical Products, and Rubber	193	588	214
Non-metallic Mineral Products	202	514	158
Basic and Fabricated Metals	128	392	61
Electrical Machinery, Electrical Apparatus, and Prec. Instr.	98	179	648
Machinery and Transport Equipment	89	456	295
Other Manufacturing	151	301	175
Total	142	471	135

Source: Text of Appendix A.

4.1.B: Comparative benchmarks of levels of gross value added per person employed in Mexico, Argentina, and Brazil in 1947/49/50
(Constant US dollars of 1975)

Industry	Mexico (1950)	Argentina (1947)	Brazil (1949)
Food, Beverages, and Tobacco	498	609	292
Textile, Textile Products, and Wearing Apparel	262	593	188
Leather, Leather and Footwear	301	476	668
Wood, Products of Wood, and Cork	271	309	161
Pulp, Paper, Printing and Publishing	411	526	269
Chemicals, Chemical Products, and Rubber	781	764	417
Non-metallic Mineral Products	343	547	179
Basic and Fabricated Metals	808	440	300
Electrical Machinery, Electrical Apparatus, and Prec. Instr.	433	441	333
Machinery and Transport Equipment	408	388	273
Other Manufacturing	266	379	219
Total	445	519	249

Source: Text of Appendix A.

4.1.C: Comparative benchmark of levels of gross value added per person employed in Mexico, Argentina, and Brazil in 1974/1975
(Constant US dollars of 1975)

Industry	Mexico (1975)	Argentina (1974)	Brazil (1975)
Food, Beverages, and Tobacco	1,001	861	1,077
Textile, Textile Products, and Wearing Apparel	759	713	699
Leather, Leather and Footwear	2,132	862	2,749
Wood, Products of Wood, and Cork	567	391	652
Pulp, Paper, Printing and Publishing	1,282	867	1,290
Chemicals, Chemical Products, and Rubber	2,033	1,023	2,810
Non-metallic Mineral Products	1,047	599	853
Basic and Fabricated Metals	1,338	964	1,251
Electrical Machinery, Electrical Apparatus, and Prec. Instr.	1,037	878	1,436
Machinery and Transport Equipment	1,322	826	1,191
Other Manufacturing	839	470	948
Total	1,204	883	1,196

Source: Text of Appendix A.

Appendix B to chapter 4: Prices

Wholesale prices: indices of the *aggregate* wholesale prices for the three countries were taken from the historical series of Mitchell (2008). The original data series were re-based to the year of 1975. To check for consistency, I compare for Mexico its trend with Mexico City's wholesale price index (Índice de precios al mayoreo) provided by INEGI (Instituto Nacional de Estadística Geografía e Informática) from 1930-1960 and the Montevideo-Oxford Latin America dataset (MoxLaD) for 1960-1975. For Brazil I compare it with the IBGE (Instituto Brasileiro de Geografía e Estatística) series IPA (índice de preços por atacado).

Branch-specific wholesale price indices

Brazil: Indices were derived from the series of de Bulhões (1948) and inflation rates were re-based to 1938 as reference year. Data was originally disaggregated into six branches (Food & beverages, Textiles, Chemicals, Metals, Fuel, and Miscellaneous). These series were used to adjust census data for 1939 and 1949/1950.

Mexico: Disaggregated indices were based on estimates by the Bank of Mexico in *Series Históricas de Precios*, compiled by INEGI in 2009's *Estadísticas Históricas de México*. Original series had 1978 as base year, thus, these were also re-based into the year 1975 for consistency.

Table 4.2.A: Wholesale price indices, Brazil 1938-1947

Years	Mitchell's Wholesale price index for Brazil	Disaggregated price indices by branch						
	Brazil total	Total wholesale price index Bulhões (1948)	Food and beverages	Textile products	Metal products	Chemical products	Fuel	Miscellaneous
1938	100	100	100	100	100	100	100	100
1939	104	102	102	101	105	106	119	101
1940	107	107	108	104	144	115	137	110
1941	133	125	139	113	143	129	153	124
1942	159	148	158	136	201	173	196	143
1943	181	173	175	166	216	192	229	164
1944	193	206	208	206	220	190	241	178
1945	226	239	252	242	207	183	253	190
1946	263	285	306	295	186	176	255	219
1947	319	283	337	265	171	188	253	228

Source: Mitchell 2008; and Bulhões (1948)

Table 4.2.B: Wholesale price indices for Mexico by manufacturing branch 1939-1975

Years	Food & Beverages	Textiles & Apparel	Chemical Products	Non-metallic Mineral Products	Basic & Fabricated Metals	Electrical Machinery & Electrical Apparatus	Machinery & Transport Equipment	Miscellaneous
1939	10.43	10.21	10.98	7.96	9.52	23.39	11.04	12.94
1940	10.79	10.83	11.64	8.16	10.00	23.39	11.26	14.99
1941	11.33	10.83	11.80	8.98	10.81	25.48	12.39	16.43
1942	12.05	11.67	13.61	10.61	12.26	23.91	13.29	19.51
1943	14.39	14.17	13.61	13.27	13.39	26.00	13.51	24.44
1944	16.73	16.04	15.90	15.10	14.03	26.35	13.74	27.52
1945	19.06	18.75	14.43	16.12	13.87	26.35	13.74	28.34
1946	22.30	20.42	12.79	19.59	15.81	26.00	13.96	29.98
1947	23.20	21.67	17.21	19.80	19.03	28.45	18.24	30.18
1948	25.72	22.71	29.67	23.27	22.42	34.38	22.75	31.62
1949	26.44	25.21	34.10	25.92	27.74	46.25	32.43	32.85
1950	26.80	28.33	29.34	29.80	29.68	51.13	35.14	35.73
1951	31.47	31.25	38.85	40.41	32.58	54.28	38.51	60.16
1952	34.35	33.33	37.87	39.18	34.68	56.02	39.86	44.97
1953	34.35	33.33	31.48	38.57	35.00	58.12	40.09	44.35
1954	36.69	35.63	35.25	44.90	37.74	70.33	48.65	47.23
1955	39.93	40.63	42.79	50.20	40.48	78.53	56.08	50.31
1956	41.19	42.29	42.13	50.20	45.16	80.80	59.46	51.75
1957	42.27	43.75	41.31	50.20	48.39	82.72	64.19	54.83
1958	44.06	45.42	42.79	49.59	50.16	83.42	68.69	55.65
1959	46.04	45.83	44.59	46.73	50.16	84.29	72.52	59.96
1960	47.84	46.46	42.95	50.41	49.68	84.99	73.20	66.74
1961	48.56	48.75	42.95	51.02	50.32	85.51	73.42	61.40
1962	48.92	51.88	42.95	48.57	50.32	83.77	74.55	60.37
1963	49.10	51.67	42.95	49.59	50.16	83.07	75.00	61.40
1964	49.82	51.88	42.95	52.45	51.13	83.77	76.80	63.45
1965	50.90	54.17	42.95	53.06	52.26	83.60	77.03	65.71
1966	51.08	55.63	42.95	51.43	52.10	80.98	81.53	66.74
1967	50.72	57.08	42.95	52.04	52.58	80.80	81.76	67.76
1968	52.88	57.29	42.95	51.43	54.03	80.80	81.76	68.99
1969	54.50	59.58	42.95	53.67	55.00	80.80	81.76	69.82
1970	56.29	61.88	42.30	56.53	59.19	81.85	81.98	71.46
1971	66.37	63.13	44.92	55.51	60.00	82.20	81.98	71.66
1972	66.91	66.25	47.54	58.78	60.00	82.02	79.95	75.36
1973	69.42	75.42	52.95	84.08	61.45	84.64	84.46	80.70
1974	89.57	88.13	90.98	97.96	83.23	91.97	86.94	95.69
1975	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note: Original data labels of the categories were re-labelled from Spanish to English as follows: Food and beverages are 'Alimentos elaborados'; Textiles & apparel are 'No-alimentos de uso personal'; and Miscellaneous is 'otros'.
Source: Based on data from INEGI (2009).

Table 4.2.C. Wholesale price index of Mexico, Argentina, and Brazil (1975=100)

Year	Mexico	Argentina	Brazil
1934	6.06	0.02	
1935	6.06	0.02	
1936	6.39	0.02	
1937	7.60	0.03	0.05
1938	8.08	0.03	0.04
1939	8.00	0.03	0.05
1940	8.25	0.03	0.05
1941	8.89	0.03	0.06
1942	9.62	0.04	0.07
1943	11.64	0.04	0.08
1944	14.39	0.04	0.09
1945	15.76	0.05	0.10
1946	18.19	0.06	0.12
1947	19.16	0.06	0.14
1948	20.70	0.07	0.16
1949	22.64	0.08	0.18
1950	24.98	0.10	0.21
1951	30.80	0.15	0.25
1952	31.93	0.19	0.27
1953	31.45	0.22	0.31
1954	34.36	0.22	0.40
1955	39.05	0.24	0.45
1956	40.91	0.31	0.55
1957	42.68	0.38	0.61
1958	44.62	0.50	0.69
1959	45.11	1.17	0.95
1960	47.29	1.35	1.24
1961	47.70	1.46	1.72
1962	48.59	1.91	2.63
1963	48.83	2.46	4.56
1964	50.93	3.11	8.71
1965	51.90	3.85	13.24
1966	52.55	4.63	18.29
1967	54.08	5.78	22.82
1968	55.05	6.34	28.22
1969	56.51	6.74	33.97
1970	59.82	7.71	41.46
1971	62.09	10.72	50.17
1972	63.86	18.96	59.76
1973	73.89	28.50	68.47
1974	90.54	34.49	88.76
1975	100.00	100.00	100.00

Source: B. Mitchell, *International Historical Statistics.*

4.2.D Census aggregation into ISIC Classification rev. 3

Industry classification	ISIC	Description
Food, Beverages, and Tobacco	15-16	Manufacture of food products and beverages + Manufacture of tobacco products
Textile, Textile Products, and Wearing Apparel	17-18	Manufacture of textiles + Manufacture of wearing apparel; dressing and dyeing of fur
Leather, Leather and Footwear	19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness + Manufacture of footwear
Wood, Products of Wood, and Cork	20+30	Manufacture of wood and wood and cork products + Manufacture of furniture and fixtures + office furniture
Pulp, Paper, Printing and Publishing	21+22	Manufacture of paper and paper products + Publishing + Service activities related to printing
Chemicals, Chemical Products, and Rubber	23+24+25	Manufacture of coke oven products + Manufacture of refined petroleum products + Manufacture of basic chemicals + Manufacture of other chemical products + Manufacture of rubber and plastic products
Non-metallic Mineral Products	26	Manufacture of glass and glass products + Manufacture of non-metallic mineral products
Basic and Fabricated Metals	27+28	Manufacture of basic iron and steel + Manufacture of basic precious and non-ferrous metals + Casting of metals + Manufacture of structural metal products, and reservoirs and steam generators + Manufacture of other fabricated metal products; metalworking service activities
Electrical Machinery, Electrical Apparatus, and Precision Instruments	31+32+33	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy + electric motors, generators and transformers + Manufacture of electricity distribution and control apparatus + Manufacture of insulated wire and cable + Manufacture of electric lamps and lighting equipment + Manufacture of medical appliances and instruments and appliances for measuring + optical instruments and photographic equipment + Manufacture of watches and clocks
Machinery and Transport Equipment	29+34+35 (352+359)	Manufacture of general purpose machinery + special purpose machinery + Manufacture of motor vehicles + Manufacture of parts and accessories for motor vehicles and their engines + Manufacture of railway and tramway locomotives and rolling stock
Other Manufacturing	-	Manufacture of jewellery and related articles; musical instruments; sporting and athletic goods; and manufacturing industries not elsewhere classified

4.2.E: Manufacturing industries classified according their global technological intensity

Low-technology	ISIC
Wood and furniture; Paper, printing, publishing	20-22
Textiles and clothing	17-19
Food, beverages, and tobacco	15-16
Recycling	36-37
Medium-low-technology	
Rubber and plastic products	25
Shipbuilding	351
Non-ferrous metals	36
Non-metallic mineral products	26
Fabricated metal products & ferrous metals	27-28
Petroleum refining	23
Medium-high-technology	
Machinery and equipment	29
Motor vehicles	34
Electrical machinery	31
Chemicals	24
Other transport equipment	352+359
High-technology	
Aircraft/Spacecraft	353
Pharmaceuticals	2423
Medical and precision instruments	33
Computing machinery	30

Source: Hatzichronoglou (1997).

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Chapter 5

Catching Up, Falling Behind, and the Role of Institutions:

Explaining Productivity Growth in Latin America and Asia from a Sectoral Perspective

"...rather than achieve particular resource allocations per se, [...] the policy search must be for a set of institutions that will allocate resources appropriately over a wide range of circumstances and time".

R. Nelson and S. Winter (1977)

5.1 Introduction

The notion that institutions shape the pattern of long-term economic development is virtually an academic consensus. Numerous seminal studies have explored their vital importance for sustained growth (e.g. Hall and Jones, 1999; Glaeser *et al.*, 2004; Rodrik *et al.*, 2004; La Porta *et al.*, 2008). Recently the term 'appropriate institutions' has gained a central role in Schumpeterian growth models inspired by the influential work of Gerschenkron (1962) particularly his concept 'advantages of backwardness'. The premise is that given domestic absorptive capabilities, the further countries are behind the technology frontier, the higher is their growth potential to catch up. Since catching up is not immediate but a gradual context-dependent process, different types of institutions maximize growth at different stages of development (Aghion and Howitt, 2006; Acemoglu *et al.*, 2006).

The general message of these new growth models is that countries have a paradoxical 'need' for policies and institutions in order to catch up with the income levels of advanced economies; institutions and policies that are appropriate for leading economies

may not be 'growth-enhancing' for economies that are far away from the technology frontier, and vice versa. Recent empirical studies have found that countries endowed with institutions that effectively protect property rights and remove the barriers for the diffusion of new knowledge and technologies, experience higher productivity growth (e.g. Coe *et al*, 2009; Comin and Hobijn, 2009).

Furthermore, technology diffusion spills over to sectors of non-frontier countries; backward sectors in developing countries producing only a few innovations benefit from the transfer of knowledge and technologies developed in frontier countries.[213] However, the pace of this transfer is dependent on the existing institutions in the recipient country: backward sectors endowed with the 'appropriate' domestic institutions to allow for the absorption of the knowledge from advanced sectors experience higher productivity growth (Banerjee and Duflo, 2005; Acemoglu *et al.*, 2007).[214]

Thus, if non-frontier countries have been in a process of institutional change setting up the institutions to remove the barriers of technology diffusion, the spillover effect of these institutions on specific economic sectors can shed more light on the overall dynamics of 'catching up' or 'falling behind' to the frontier. Previous empirical studies such as Vandenbussche *et al.*, (2006) and Madsen (2014) have shown that catching up at the aggregate cross-country level depends on the interaction between human capital and the distance to the technology frontier. However, most of these studies have underscored the sectoral dynamics of non-frontier countries.

The main contribution of this chapter is to test empirically the hypothesis whether institutions have served as an absorptive capability to enable the sectors of non-frontier countries to catch up to the frontier. More specifically, this study produces econometric evidence on the spillover effects of a variety of economic institutions on sectoral productivity growth in Asia and Latin America. Employing sectoral labor productivity data for a set of countries of these regions, together with various disaggregated indicators of institutional quality, the analysis follows a re-arranged version of the 'Nelson-Phelps' model to indicate the growth effects of institutions on sectoral productivity.

Because of the unbalanced sectoral structure in non-frontier economies (e.g. several Latin American countries rely heavily on the extraction of natural resources), countries may experience a different convergence process at the sectoral level compared to relatively high-income countries that are already at the frontier or close to it. In other words,

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[213] Under the assumption that the cost to imitation in the non-frontier country is lower than innovation at the frontier. As a result, rather than innovate, a 'typical' entrepreneur in a follower country optimizes his/her profitability by adopting or engaging in the imitation of technologies from the frontier (see a theoretical exposition in Keller, 2004).

[214] A set of domestic policies such as product licensing and intellectual property laws also affect the pace of knowledge and technology transfer. However, in this study I encompass these policies interchangeably within a broad framework as those (institutions and policies) designed to influence economic agents in finding it profitable to make use of new knowledge and technologies (see for e.g. Nelson, 1994).

developing countries that are far from the technology frontier may not be catching up in aggregate terms (e.g. to the levels of real per capita GDP of the United States) but they may be doing so on a sectoral basis (e.g. to the sectoral value added per worker of the United States.) Hence, following the predictions of the Schumpeterian growth theory, different institutions and their interactions can maximize the catch up process at a sectoral level.

This analysis is of particular policy relevance for various 'catch-up' countries. For instance, broad comparisons of post-war East Asia and Latin America have become the typical narrative in recent years; seminal studies have illustrated how 'backward' economies that upgraded the quality of their institutions were able to catch up, whereas countries that experienced slow institutional change fell behind (e.g. Nelson and Pack, 1996; Taylor, 1998; Amsden, 2001). However, for Latin America in particular its post-1980s aggregate TFP (Total Factor Productivity) stagnation has largely dominated the economic growth literature (e.g. Pagés, 2010; Cole *et al.*, 2005) neglecting the sectoral growth dynamics and their interrelationships with institutional change.

Empirically, the literature analyzing the link between institutions and sectoral performance across countries is still incipient.[215] Notwithstanding data comparability issues, the link between institutions and sectoral productivity is not analytically straightforward. A recurring matter is the existence of different definitions, measurements, and classifications of institutions that often obscure their interpretation and empirical relationships. This study narrows the concept of institutions into a group that follows the four-type classification suggested by Rodrik (2005): *market-creating, market-regulating, market-stabilizing, and market-legitimizing* institutions.

The analysis takes as a benchmark the levels of the United States' sectoral productivity over time as the world's frontier. Our empirical approach relies on the framework proposed by Benhabib and Spiegel (2005) which is a re-arranged version of the Nelson-Phelps (1966) technology catch up model. Panel data estimates show that the interactions of different institutions with the distance to the frontier enhance labor productivity growth at the sectoral level. However, these effects are fundamentally different across sectors; some institutions are more important in magnitude in some sectors while others lose significance.

The results of this chapter point out different channels in which institutional quality impact on sectoral productivity growth: greater freedom in the legal structure and property rights, freedom from tight market regulations, greater access to sound money, and a small

[215] For instance, Acemoglu and Johnson (2005), Bhattacharyya (2009) and Manca (2010) have analyzed the effect of different types of institutions on the growth of GDP (Gross Domestic Product) and/or on TFP (Total Factor Productivity) growth. On the other hand, Crafts (2006) and Nicoletti and Scarpetta (2003) explored the impact of labour market regulations on multifactor productivity for a sample of high-income economies (OECD countries).

and a more efficient government, all in a different magnitude, affected positively the growth of sectoral productivity.

Estimates, however, are sensitive to the sample selection. The model predictions apply to the majority of the sectors in the Asian sample. On the other hand, most of Latin America's sectoral productivity is not statistically related to the quality of property rights and market regulations; only in the mining and construction sectors we can find a statistical relationship between productivity and the institutional indicators of size of government and access to sound money. The chapter is organized as follows: the next section analyzes the role of institutions in sectoral catch up. Section 5.3 explains the features of the model of productivity catch up. Section 5.4 describes the data sources. Section 5.5 analyzes the estimates and empirical results. Section 5.6 concludes.

5.2 The role of institutions in catching up

Unbundling 'appropriate' institutions

According to the prominent economic historian Moses Abramovitz (1986) the process of catching up is an opportunity taken only by countries ('followers') endowed with the appropriate characteristics ('social capabilities') to absorb the knowledge and modern technology from advanced countries ('leaders'). Moreover, he argued that "...the knowledge flows are not solely from the leader to followers. A satisfactory account of the catch up process must take into account multiple interactions" (Abramovitz, 1991; p.232).

Following the theory and evidence from Abramovitz and other authors, seminal studies have generally accepted institutions as the ultimate domestic capability determining the potential for catch up. Empirical analyses have demonstrated that indeed, institutions have largely dominated the process of growth in the long-run over other factors like geography or trade (e.g. Rodrik *et al.* 2004). In that premise, Acemoglu and Johnson (2005) discerned two types of institutions following Douglass North's (1981) distinction of institutions: 'contracting' and 'property rights'.

The first type refers to the rules and regulations governing contracting among citizens bounded by their legal systems. The second are rules and regulations that protect citizens against the power of elites and government expropriation, factors that are mainly influenced by the type of political and legal system.[216] For instance, firms are likely to continue to use obsolete technologies if the enforcement of property rights is not credible, leaving firms vulnerable to expropriation. Thus, technology adoption requires reliable

[216] In a later work, Acemoglu and Johnson (2012) framed institutions as 'extractive' and 'inclusive'. In the former, domestic political institutions are under the control of a small elite, which in turn can promote high productivity growth through an investment-based strategy but subsequently fail to maintain it because of the absence of incentives for innovation promoted by 'inclusive' institutions.

relationships that guarantee the legal right of a firm (or an individual) to obtain the revenues generated by their investments.

Rodrik (2005) considers the latter (property rights) as part of a category that can be simplified as *market-creating* institutions since markets either do not exist or perform poorly in their absence. On the other hand, he argues that sustained growth also requires the development of another set of institutions: *market-regulating* institutions to help dealing with externalities, economies of scale and imperfect information. Furthermore, countries would need *market-stabilizing* institution*s* to generate resilience to external and domestic shocks, minimizing macroeconomic and financial volatility. Lastly, *market-legitimising* institutions involve income redistribution and social protection, facilitating a socially acceptable fiscal shared-burden.

The quality of a diverse set of institutions may have a different impact within a country and these effects (of different institutions) could spill over in a different way among sectors. For instance, it has been argued that the catch up process occurs through sectoral systems of innovation and production, where some institutions 'obey' to the sectoral characteristics of the economy providing an environment more suitable for catch-up in certain sectors and not in others. In this case a set of institutions can determine the innovative potential of some sectors, and some of these can become predominant in terms of the overall impact on aggregate growth (Malerba, 2002).

Moreover, the enforcement of intellectual property rights, anti-trust policies, and the enforcement of tight or soft labor market regulations can also have different spillover effects across sectors. Consider the case of a strong enforcement of intellectual property rights in a 'high-tech' manufacturing sector; tight patent laws can act as a growth-enhancing institution fostering innovation by generating more incentives for investment due to the greater potential of the appropriation of profits derived from the blueprint and the following revenues from the introduction of an innovative product and/or service.

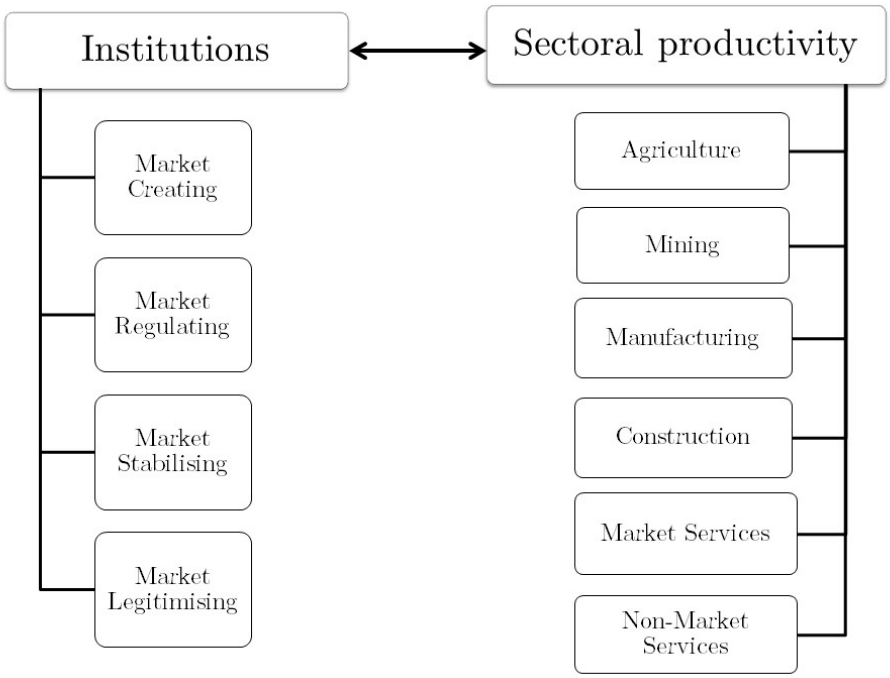
However, catching up to the frontier also depends on the ability of taking the advantage of low-cost blueprints from abroad. Consequently, a tight enforcement of these property rights could act as a barrie*r* as well for catch up in backward sectors by blocking the transfer of knowledge from advanced sectors.

Likewise, specific labor market regulations in different sectors are likely to influence the human resource strategy in an innovating firm by adjusting its workforce according to the wage bargaining system (Scarpetta and Tressel, 2002). Countries that have centralized their wage bargaining systems tend to have high firing and hiring costs, wages are more compressed, and firms (due to the difficulties to attract high-skilled workers) gain from training their own workers. Thus, these factors can induce firms to rely on the internal labor market and choose whether to innovate or import new technologies.

In general, economic institutions are often by policy design 'national' and not 'sector-specific'. This implies that institutions may bind uniformly within a country;

however, their enforcement can have a spillover effect that spreads differently across the sectors of the economy (Malerba and Nelson, 2012). To summarize previous examples, figure 5.1 illustrates a general picture of the set of different institutions and the sectoral disaggregation of the economy analyzed in this study.

Figure 5.1: Institutions for catching up at the sectoral level



Source: Based on Rodrik (2005) and data classification from section 5.4 of this chapter.

Sectoral productivity growth in Latin America and Asia

Rapid productivity growth facilitated by a combination of solid economic institutions and 'market-friendly' policies is often seen as the key element of the so-called 'East Asian miracle'.[217] Most of these East Asian economies have outperformed many developing countries in terms of productivity for almost half a century, yet the most impressive 'overtaking' took place *vis-à-vis* their Latin American counterparts as table 5.1 shows.

Since 1950 countries like Hong Kong and Taiwan, after starting from only a quarter and a tenth of the United States' productivity levels respectively, nearly closed the overall

[217] Although the debate over the sources of TFP growth in East Asia remains controversial, there is a broad agreement that the improvement across the board of the prevailing economic institutions in East Asian countries played a major role in creating the conditions to close the TFP gap relative to the United States. See a discussion in Stiglitz (2001).

gap by 2010 (particularly in terms of real GDP per worker). Although at a much slower pace, major Latin American countries also experienced an early catch up phase to the U.S. levels from 1950 to 1980. Evidently that growth trend was insufficient to catch up. Instead, after 1980 the gap with the United States has remained considerably large and in many cases the gap widened.

Table 5.1: Gross Domestic Product (GDP) per worker and per hour in selected Latin America and East Asian countries relative to the United States, 1950-2010

Year	Argentina	Brazil	Chile	Mexico	Hong Kong	Singapore	South Korea	Taiwan
GDP per worker								
1950	0.55	0.19	0.46	0.35	0.25	0.30	0.12	0.10
1980	0.57	0.31	0.49	0.50	0.57	0.50	0.28	0.33
2010	0.36	0.20	0.50	0.29	0.92	0.72	0.65	0.75
GDP per hour								
1950	0.31	0.11	0.21	0.17	0.10	0.13	0.06	0.04
1980	0.31	0.16	0.23	0.23	0.26	0.22	0.10	0.13
2010	0.16	0.11	0.25	0.13	0.40	0.31	0.31	0.36

Note: Figures are ratios of real GDP (1990 Geary–Khamis international dollars) per person employed and hours worked over the levels of United States.
Source: Total Economy Database, The Conference Board (accessed Jun-2013).

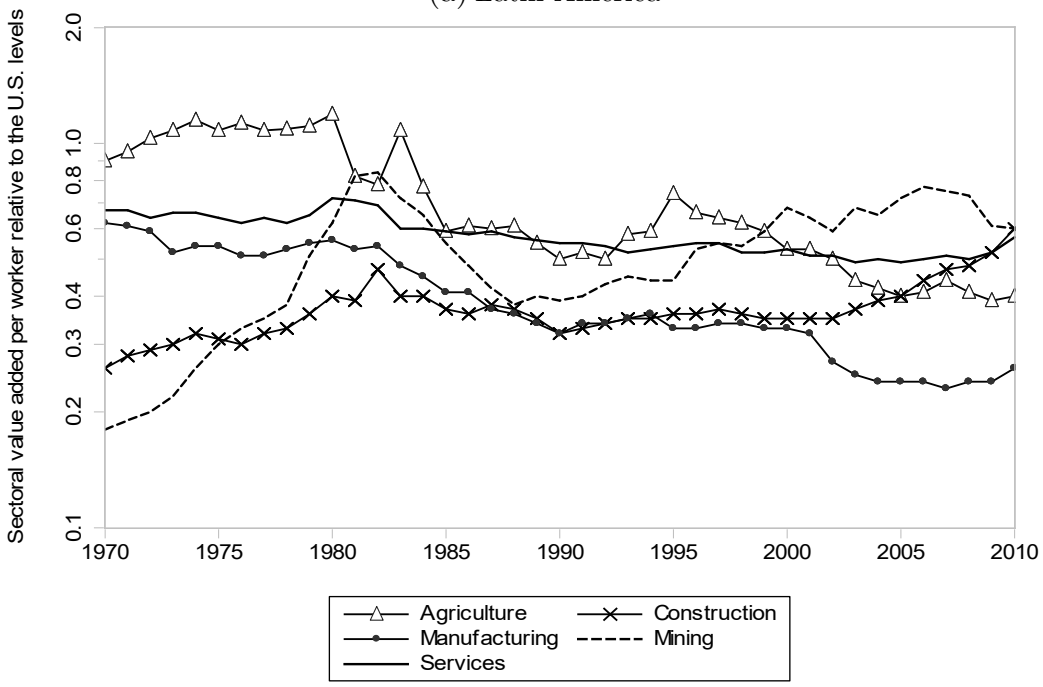
However, a breakdown at the sectoral level provides a more detailed look of the catch up dynamics in these regions. Figure 5.2 depicts a sectoral view of the distance to the U.S. labor productivity frontier. It shows that catching up (and 'taking over') at the sectoral level was already a feature in East Asia early on, when several sectors approached to the frontier (near to unity).

During the decade of the 1970s a number of economic sectors where catching up rapidly to the labor productivity levels of the U.S. (the service sector in East Asia took over briefly and thereafter remained close to the frontier).[218]

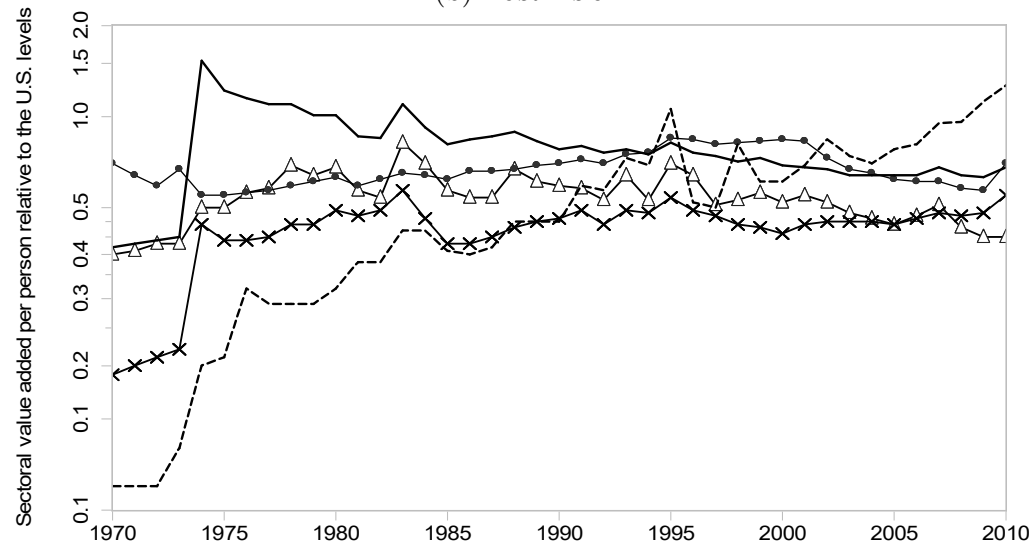
[218] See this particular aspect of East Asia's rise in sectoral labor productivity in these years in van Ark and Timmer (2003).

Figure 5.2: Sectoral value added per worker in (a) Latin America and (b) East Asia relative to the United States, 1970-2010
(Constant 2005 PPP dollars)

(a) Latin America



(b) East Asia



Note: Data refers to averages (unweighted) of sectoral value added per worker over the levels of United States (in constant 2005 PPP dollars; expenditure conversion factors of the 2011 ICP round) in the referred countries from table 5.1. For a better visualization the plot included data on only five major sectors (out of ten) on a logarithmic scale. Following table 5.1, the East Asia country-group refers only to unweighted averages figures of: Hong Kong, South Korea, Singapore, and Taiwan. For Latin America the group of countries is: Argentina, Brazil, Chile, and Mexico.
Source: Based on GGDC 10-sector database. See section 5.4.

Yet, whereas for East Asia the 1980s was a period of a labor productivity slowdown in most of its sectors; Latin America (in a manner similar to GDP measures) fell further behind the sectoral productivity frontier. Overall, many of these gaps have persisted until today and only a few sectors in Latin America have been able to regain their previous levels and catch up to the United States (e.g. mining and construction).[219]

By the mid-1980s and 1990s the majority of Latin American countries opened their economies and carried out a set of 'market-friendly' policies and institutional reforms similar to advanced high-income countries (a set of reforms known as the 'Washington Consensus').

Recently, renewed discussions have emerged related to a potential return to industrial policies aiming to emulate the pre-1980 period. The growth controversy has intensified in several of these countries after the disappointing productivity performance from economic reforms (Ocampo, 2004). Although it is generally acknowledged that after the 1980s, adjustment policies and trade liberalization delivered the required macroeconomic stability for the region, these changes also spurred a type of development that engendered a pattern of high 'heterogeneity' in labor productivity across sectors, causing a reversal in the sectoral composition of the structure of production.

In theory, this sectoral heterogeneity is considered as part of the intrinsic evolution of 'dual-labor' markets, where the reallocation of labor and capital from traditional to more modern activities may generate a bonus on aggregate productivity growth (as addressed in chapter 4). This ultimately affects the pace of productivity growth (average labor productivity) across sectors (Temple, 2005). Following that argument, McMillan *et al.*, (2014) found that the difference in productivity growth between Latin America and (East) Asia can be related to the different patterns of structural change.

In the view of these authors, natural resource-intensive countries in Latin America are 'trapped' in a pattern of growth-reducing structural change, where enclave sectors boosted by the trade patterns of globalization operate at very high productivity, but at the same time are unable to absorb the labor surplus from traditional sectors. The authors claim that the type of institutions and policies that promote less-flexible labor markets are ultimately generating sectoral barriers on aggregate productivity growth.

Table 5.2 depicts the large variation in the growth rates of sectoral labor productivity. As described by previous authors, high productivity growth rates in mining and construction are part of the 'stylized' structure of growth of emerging economies due to their inherent orientation towards natural resources-based and mass-scale production.

[219] See the findings of Castellacci *et al.*, (2014) regarding the observed sectoral heterogeneity employing similar productivity data.

Table 5.2: Productivity growth indicators in Asia and Latin America, 1970-2010 (average compound growth rates)

Region/ Country	Growth of real GDP per worker	Growth of physical capital per worker	Growth of Total Factor Productivity	Sectoral Labor Productivity Growth					
				Agriculture	Mining	Manufacturing	Public utilities	Construction	Services
Asia									
Hong Kong	4.03	4.38	1.36	1.58	12.28	7.43	7.26	0.98	0.61
Indonesia	3.30	5.27	0.92	2.04	-2.74	4.43	6.85	3.24	2.83
India	2.70	3.32	0.90	1.30	3.41	3.40	5.08	0.73	2.64
Japan	2.32	4.30	0.07	3.35	2.68	3.87	2.34	0.19	2.15
Korea	4.75	7.80	0.62	4.89	7.61	6.87	10.48	1.66	1.49
Malaysia	3.94	5.50	0.68	3.27	5.76	3.51	4.97	0.02	3.42
Philippines	0.99	1.45	-0.53	0.91	3.72	1.62	5.41	1.65	1.38
Taiwan	3.87	4.76	0.31	2.86	12.37	3.44	6.29	-2.17	2.11
Singapore	4.39	3.90	0.62	2.84	9.22	4.03	6.98	2.40	2.85
Latin America									
Argentina	0.21	0.27	0.64	2.88	1.53	1.82	5.42	1.18	0.77
Bolivia	0.23	-0.96	-0.46	3.24	4.85	-0.52	2.79	-1.63	-1.73
Brazil	1.09	1.48	-0.04	3.33	12.53	4.01	3.34	1.65	4.70
Chile	1.81	0.94	0.02	5.69	2.90	2.86	1.53	1.22	0.94
Colombia	0.52	0.75	-0.33	1.74	2.04	1.02	3.32	0.17	0.32
Costa Rica	1.58	2.12	-1.10	2.40	5.10	1.48	0.77	1.75	0.01
Mexico	0.63	1.18	-1.02	1.25	3.40	0.21	3.14	-2.44	-0.89
Peru	0.62	-1.88	-0.76	1.45	2.74	1.04	2.31	0.96	-0.48
Venezuela	-1.31	-1.81	-0.89	1.71	-4.23	0.08	4.01	-0.28	-0.68
United States	1.60	2.35	0.82	4.38	1.76	3.28	2.05	1.60	1.46

Note: Physical capital per worker is the total capital stock in 2005 constant prices over number of persons employed. The growth of Total factor productivity is the growth of the welfare-relevant TFP estimate reported in the Penn World Table 8.1. Details of the estimates of the growth of sectoral labor productivity are shown in section 5.4. All data are growth rates of level estimates of constant 2005 PPP dollars. *Source*: Penn World Table 8.1 (Feenstra, Inklaar, and Timmer, 2015) and 10-sector GGDC database.

The table (5.2) also indicates the large differences between other aggregate measures of productivity. For instance, unlike Asian countries, the growth rates of total factor productivity are nearly always negative for Latin American countries. As other studies have shown, average TFP estimates in Latin America were severely affected by the external shocks of the debt crises of the 1980s, thus, on average their regional productivity performance appears meager compared to Asia.

The paradox of productivity growth in Latin America

Although some Latin American countries have explicitly switched their growth policies to a more 'heterodox' type focused on reducing income inequality and stimulating the growth of domestic demand, little has been accomplished in enhancing growth and redistribution (see e.g. in Birdsall, 2008).[220] In general, most Latin American countries have shifted their attention to removing the market barriers that were still in place (e.g. lack of flexible labor markets, high bureaucratic costs, etc.) and which were regarded as the main obstacles to raise productivity growth (see, Cole *et al.*, 2005; Pagés, 2010).

However, the underlying development paradox for Latin American countries has to do with the question why in previous decades these economies experienced high productivity growth rates (1950-1970) in a less competitive environment, protectionist policies, and strong government intervention, whereas in advanced countries growth seems to have been promoted by higher competition, trade openness, and less government intervention.

In the growth models of Aghion and Howitt (2006) and Acemoglu, *et al.* (2006), this phenomenon is referred to as a middle-income 'non-convergence trap' in which the persistence of the same institutions and policies that generated high productivity growth in an earlier stage fail to deliver growth once the economy approaches the technology frontier. Maintaining a growth strategy (investment-based) with the same institutions for too long and failing to switch into an 'appropriate' set of institutions (innovation-based strategy) may generate a middle-income trap, or in this case a Latin American productivity trap.

Institutional persistence hampering productivity is not an unusual characteristic of developing countries. Many cliometric studies have studied how institutional persistence has been a fundamental factor determining the patterns of development. Latin American economic history has been used to illustrate the effects of 'path-dependence' in productivity growth.[221]

For instance, there is a strand in the literature that portrays colonial institutions as having perpetuated the centralized bureaucratic traditions carried over from the

[220] This is particularly the case for South American countries like Venezuela, Ecuador, and Bolivia.

[221] See an overview of the cliometric literature in N. Nunn (2014).

Spanish and Portuguese heritage. It is claimed that this type of institutional environment was prone to have schemes to evade taxes and circumvent courts and which were therefore detrimental to credible commitments, investment certainty, and economic growth (see for e.g. Coatsworth, 2005).

Although the idea of path-dependence of colonial institutions has been widely popularized in the economic literature, there is a growing criticism on the methods employed to test it. Many authors have suggested that the (econometric) instruments employed (e.g. settler mortality rates causing low institutional quality) to avoid endogeneity problems are not the most adequate ones since the cross-sectional evidence cannot capture intra-country dynamics (other than binary variables controls) and thus, do not provide a clear relationship between growth and the quality of institutions.

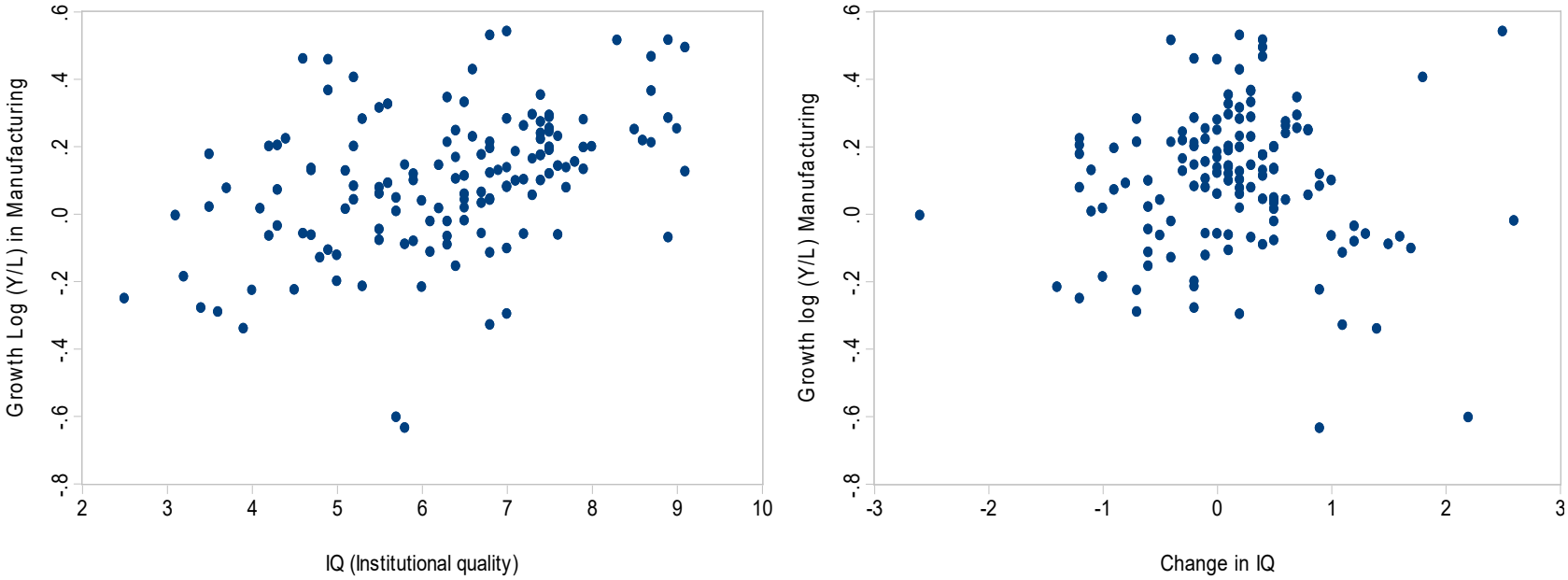
In this study tests a diversity of institutions which consist of standardized indicators of institutional quality scores of economic freedom (see section 5.4) in order to measure the effects of institutions on growth from a sectoral perspective (sectoral labor productivity growth).

Graphical evidence

The scatter plots in figure 5.3 depict an example of a trend in the relationship of productivity growth and institutions in a particular sector. Since the manufacturing sector has been historically one of the largest and leading 'engines' of growth in many countries far away from the frontier, it is relevant to mention some of its general features for subsequent econometric analysis. The left-side scatterplot shows a positive relationship between manufacturing labor productivity growth (five-year intervals) and institutional quality. This suggests that countries endowed with overall higher institutional quality experience higher productivity growth.

However, the scatterplot on the right side which depicts the change of institutional quality (five-interval change in the economic freedom index) and labor productivity growth shows no apparent trend. This may be related to the fact that institutional change (measured as the change in economic freedom) has been highly heterogeneous across the sample. Some countries experienced noticeable positive improvements over time but others have been through a reversal of institutional quality. Therefore, from these graphs is not possible to establish neither a direct relationship nor causality. An endogeneity bias may be present because countries with higher productivity growth could also develop better institutional quality. Thus, the initial positive relationship (in the left-side scatter plot) should be tested with the inclusion of lags (it is less likely that current productivity growth could affect the institutions of five years ago), time and country dummies, and other omitted variables that may potentially have affected productivity growth.

Figure 5.3. Manufacturing labor productivity growth, institutional quality, and change in institutional quality in Latin America and Asia, 1970-2010



Note: Institutional quality (IQ) is the summary index of economic freedom ranging from 0-10 where 0 corresponds to 'less economic freedom' and 10 to 'more economic freedom'. Labor productivity growth in the manufacturing sector and change in IQ are measured in five-year intervals from 1970 to 2010.
Source: See data source details in section 5.4.

The measurement of institutions for catch up in Latin America

The empirical analysis faces a similar challenge of previous studies attempting to measure a variety of institutions via Rodrik's four-way partition (e.g. Bhattacharyya 2009). However, aside from the issue of narrowing a country's institutional quality into this classification, the accurate measurement of the effects of institutional development over time in Latin America can also be in itself a quantitative issue. This is due to the fact that most policy changes (reforms) have time-lags on their targets; the effects of the changes in institutional quality on productivity are also not expected to be observed instantly but after a time interval. As mentioned, for most countries in the sample the initial year is 1970. Because of the nature of the econometric method employed (as explained in the ensuing section 5.3), lagged five-year variables (t-1, t-2) were introduced matching the timing of the beginning (years 1975 and 1980) and subsequent deepening of the institutional reforms (and demise of ISI policies) in the majority of Latin American countries.

According to several specialists, most of the institutional changes were already underway in the decade of the 1970s. The opening of the Latin American market to international trade and capital flows, the promotion and development of the private financial sector, and the reduction of the role of the government in the economy were considered an integral part of a 'new' growth strategy in the mid-1970s (e.g. Foxley 1983). The most explicit cases of this are the economic programs of the military governments in Chile (since 1973) and Argentina (since 1976). Apart from short-term macroeconomic goals, by the end of that decade, other major countries like Mexico gradually attempted to implement deep institutional reforms. These were characterized by exposing key sectors of the economy to market competition by removing barriers to international trade (Mexico attempted to join the GATT in 1979 ahead of other Latin American countries); legislating towards a *flexibilization* of the labor market; deregulating the use of urban and rural property, liberalization of the banking system, and reducing the size of the public sector by the privatizing state-owned industries.[222]

Thus, although economic reforms originated in the mid-1970s, their deepening was set forth during the mid-1980s (at the time of macroeconomic stabilization) and 1990s. These major changes are broadly encompassed in the standardized indices of Gwartney, et al. (2012) employed in this analysis (property rights; market regulation; sound money; size of government). Yet, although the continuous efforts in that direction were evident across Latin America, the intensity in which they were imposed differed across countries. Figure 5.3.A (in appendix 5) shows this feature. In spite of the large dispersion (by country and type of institution) and except for the case of Venezuela, most of the indices of institutional quality show a broad but gradual improvement since 1970.

[222] GATT stands for 'General Agreement on Tariffs and Trade'. For detailed case-by-case historical account of the institutional reforms in Latin America, see Corbo (1988).

From the analytical background it is possible to indicate tentatively *a priori* which institutions are more important to catch up at the aggregate level (as explored in previous policy research). One of the premises of the 'advantages of backwardness' approach is that if foreign backward countries are not endowed with the relevant institutions (capabilities) to absorb new knowledge, technology will not spill over across countries. One of the notions of why non-frontier countries fail to develop good institutions and catch up to the frontier is that incumbent governments may actually oppose to some sources of institutional change blocking the upgrading of institutions if these erode the economic and political advantages of the ruling elite.

Building on that notion, however, Acemoglu *et al.,* (2006) and Aghion and Howitt (2006) pointed to the context-dependent effects of different institutions on long-term growth. They argue that in early stages of development high productivity growth can be promoted through institutions that are not necessarily the same for frontier countries (institutions promoting innovation-based growth). Instead, institutions that promote the emulation of technologies developed elsewhere (imitation-based growth) can be productivity growth enhancing.

In broad terms, the latter can be a typology of institutional development in Latin America from the 1950s until the 1970s. Institutions under import substitution yielded high productivity growth rates in major countries (as seen in chapter 4). As part of the industrial strategy, institutions were crafted under a very uncompetitive environment looking to promote the accumulation of domestic technological capabilities. The freedom to trade internationally was restricted, business regulations were relatively high, and the size of the public sector was large. As showed previously in table 5.1 and figure 5.2, under these type of institutions several countries in Latin America managed to move to the productivity frontier; however, that development model collapsed in the 1970s. A new era of institutional development started thereafter (c.1970-onwards) based on market-oriented institutions, or in Schumpeterian terms, towards crafting the type of institutions that promotes innovation-based growth.

Several empirical studies have confirmed those dynamics employing aggregate data (e.g. Madsen 2014). At the sectoral level, however, the empirical examination is more challenging because channels through which technology diffusion takes place can be different since some sectors are intrinsically different from the aggregate economy (i.e. highly unbalanced structure of production), together with the institutions that promote this diffusion. According to several studies, international trade is a central factor that makes available new goods embodying foreign technologies and promoting absorptive capabilities. However, certain type of institutions like reducing barriers of entry (business regulations; e.g. low 'MR' index), low tax burden (i.e. low 'SG' index), and/or access to sound money can also spur the absorptive capabilities that promote high sectoral productivity growth and catch up.

In the present empirical examination, controlling for other determinants of productivity (education, physical capital, trade), the enhancing/reducing effects from upgrading institutions are confined in the interaction terms (institutions*sectoral productivities) included in the estimations. For Latin America, natural resource

intensive sectors are of specific relevance due to their well-known regional reliance on commodity trade (e.g. Venezuela, Bolivia, Chile, and Brazil). As mentioned, access to resource rents in these sectors may provide an incentive for governments to stay in power blocking institutional upgrading that threaten their power. Thus, several studies have found a negative statistical correlation between the size of the government and productivity growth in these sectors (Ross 2001), an effect that disappears under 'better' institutional environments (e.g. Haber and Menaldo 2011).

Given these a priori theoretical expectations (institutions, sectoral productivity, distance to sectoral frontier, and their interactions), a potential concern is the endogeneity of the estimators. A reversed causal relationship can emerge in the aforementioned cases when extraordinary productivity rates (i.e. natural resource based) affects institutional development and not vice versa as expected. Thus, to control for this, the econometric method employs lagged regressors (t-1, t-2) as internal instruments looking to attenuate the serial correlation bias. For example, the five-year interval spike in productivity in natural resource-intensive sector is less likely to influence the dynamic of institutional development of one or two periods (i.e. 5 or 10 years).

5.3 Empirical model

This section outlines the empirical setting of the theoretical model and its econometric specification. The idea of a baseline model of catching up dates back to Richard R. Nelson and Edmund Phelps (1966) who postulated an interaction between the level of education of a country and the rate at which it closes the technology gap. They hypothesized that differences in human capital explain the observed differences in the speed of convergence to the technology frontier. The explanation for this is that human capital yields higher technology levels not only domestically, but also by adapting ideas of countries from the technology frontier. This formulation has become the workhorse catch up model in the empirical literature (see, Benhabib and Spiegel, 2005).

Similarly to other model specifications, here it is argued that apart from human capital, the sectoral catch up process is enhanced by the diffusion of technology promoted by the economic institutions as described in the previous sections. I have re-arranged the functional catch up potential in the equation of a follower country to the variables of institutions.[223] Unlike other exercises testing institutions on growth, I consider a disaggregated set of institutions (four-type) hypothesizing that the spillover effect of their interactions with the distance to the frontier diffuses on different sectors of the economy. For each sector, the diffusion process is as follows:

[223] This equation re-arrangement was similarly formulated in previous econometric studies, however, these were focused on the aggregate total economy (e.g. Dollar and Kraay, 2003; Manca, 2010) and not at a sectoral level.

$$\Delta a_{ij} = b + \left(g + \frac{c}{\rho} \right) \bar{s}_i - \frac{c}{\rho} \bar{s}_i \left(\frac{A_{lj}}{A_{ij}} \right) + \varepsilon_{ij} \quad (1)$$

With an error ε_{ij} independently and identically distributed. Denoting i as the follower country, l represents the country leader (United States), and j is the specific sector.[224] Δa_{ij} is the average growth rate of productivity of sector j in country i. Aij and A_{lj} denote the sectoral productivity levels of the follower and leader country respectively. $\bar{s}_i$ represents the institutional quality in country i. The coefficients to be estimated are $g + \frac{c}{\rho}$ and $\frac{c}{\rho}$.

Equation 1 shows that the further a follower country is behind the leader, the higher is its productivity potential provided by the technological absorptive capacity driven by the institutional quality component.

However, not all countries are always on a catch up path. Benhabib and Spiegel (2005) suggest a 'catch up condition', in which there is a threshold level of the main independent variable. In our sectoral model, the set of institutions is the main independent variable, meaning that the country must be endowed with a certain quality of a particular type of institution in order to be on a catch up path to the sectoral level of the productivity leader. A level of institutional quality below that threshold would imply that the sector in that country would fall further behind the productivity frontier:

$$s_{i,t}^{*} = \exp\left(\frac{g\bar{s}_{l,t}}{g + c} \right) \quad (2)$$

where $s_{i,t}^{*}$ is the threshold level of institutional quality that the follower country must possess for the specific sector in order to be on the catch up path to the productivity leader. $\bar{s}_i$ is the institutional quality endowment of the leader.

Empirical specification

In hindsight, the country sample (Latin America and Asia) is highly heterogeneous and thus, it is very likely that their intercepts are quite different. In the sub-components of our institutional proxy, I explore their role for catch up at the aggregate level:

[224] As typically presented in the literature, the technology frontier refers to the (sectoral productivity) levels of United States. Selecting other countries' productivity levels as the overall frontier would be rather inadequate since they do not remain consistently over time as productivity leaders. For e.g. although in some short intervals the productivity levels in the mining and services sectors of the United States were surpassed by the levels of Hong Kong and Singapore, on average the United States remained the productivity leader in the majority of the sectors.

$$\Delta lp_{ijt} = \alpha_{ijt} + \beta_{it}\left(\frac{lp_{ijt}}{lp_{ljt}}\right) + \psi_{it}(X) + \delta_{it}\left(X * \frac{lp_{ijt}}{lp_{ljt}}\right) + C_{it} + \varepsilon_{ijt} \quad (3)$$

Where Δlp_{ijt} is the rate of growth of labor productivity in country i, sector j, in time t.

α_{ijt} denotes country and period fixed effects. The β_{it} coefficient captures the effect of the distance to the frontier (lp_{ijt}/lp_{ljt}) defined as the ratio of the follower country's labor productivity level (lp_{ijt}) relative to the country leader (lp_{ljt}) for a particular sector for each time interval. X is a vector of different institutions (sub-categories of institutional quality), ψ_{it} accounts for the effect of the set of institutions.

The interaction term is denoted by coefficient δ_{it} which implies the catch up potential due to the absorptive capacity promoted by the institutional quality and its different components. C_{it} is a vector of control variables, and ε_{ijt} represents the stochastic error term.

In general, this specification follows essentially the original predictions at the aggregate level of the Nelson and Phelps model. The difference relies in that at the sectoral level, the country's absorptive capabilities on sectors are measured indirectly (as externalities) since these variables (institutions) were constructed at a country level. Yet, this (sectoral) approach may provide a more comprehensive picture of the phenomenon of catch up growth and the role of institutions in non-frontier countries.

5.4 Data

Description: Sectoral labor productivity

The country coverage is based on eighteen countries: nine Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru and Venezuela), and nine Asian countries (Hong Kong, Japan, India, Indonesia, Malaysia, Philippines, Singapore, South Korea, and Taiwan). Conventionally, in empirical growth modeling, it is necessary to filter out random and cyclical fluctuations, thus regression models in this study are estimated in five-year interval panel data from 1970 to 2010.[225] For this reason the annual productivity data was expressed into five-year intervals calculated as average compound growth rates.

The data used for constructing the measures of labor productivity relied on the basis of the availability of information of gross value added and employment from the 10-sector database published by the Groningen Growth and Development Centre (www.ggdc.net).

The measures of sectoral labor productivity (Y/L) are real gross value added (Y) over the number of persons employed for each economic sector (L) in every year

[225] Sectoral data for Hong Kong and Malaysia is available for the period 1975-2010.

(1970-2010). Gross value added by sector was originally reported in local currencies, thus, the figures were adjusted into constant prices, first from current prices into local constant prices of 2005, and then converted into 2005 PPP US dollars using expenditures prices provided by the International Comparison Program (ICP) from the World Bank.[226]

Overall, the data covers ten different sectors of the economy; however, for parsimony, sectors related to the services sector were re-classified into a two-type classification: market services and non-market services. In total, our sectoral coverage was re-classified into six main sectors: (1) Agriculture; (2) Mining; (3) Manufacturing; (4) Construction; (5) Market services (which includes wholesale and retail trade, hotels and restaurants; transport, storage and communication; finance, insurance and business services; and (6) Non-market services (includes social and personal services, public utilities, and government services).

Description: Institutions

Although several empirical studies have used a wide variety of measures of institutional quality, most of them generally include at least a measure related to corruption or to the enforcement of the rule of law. As discussed previously, however, Rodrik (2005) has categorized a more 'inclusive' four-type grouping to facilitate the addition of other institutional factors that affect the efficient allocation of resources.

Aiming to approximate the aforementioned institutional classification I employed the measures of economic institutions based on data from Gwartney, Lawson, *et al.* (2012). Extensively used in previous growth studies, this data is considered as a representative scale to measure a country's endowments of 'market-based' institutions.[227] It measures in particular different areas of 'freedom' to engage in market transactions within a country over a relatively long period of time (1970-2010).

The dataset is jointly published by the Fraser Institute compiling indices to measure five components of economic freedom; (1) Legal structure and security of property rights, (2) Regulation of credit, labor, and business, (3) Access to sound money, (4) Freedom to trade internationally, and (5) Size of government.

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[226] A more accurate PPP conversion at the sectoral level should employ sector-output prices instead of aggregate expenditure prices. This is because expenditure prices do not include transport margins and intermediate goods. Inklaar and Timmer (2014) constructed the first estimates of sector-specific 2005 PPPs for a large set of countries; however, for our country sample that price data is very limited (only a half of our country-sample). Therefore, for cross-country consistency the adjustment of our labor productivity estimates follows the convention in factor conversion using expenditure-side PPPs as in Bernard and Jones (1996).

[227] See for instance the work of de Haan and Sturm (2000) for an application on this data on an aggregate cross-country growth framework. Also, see an historical exploration for OECD countries since 1870 following this methodology in the work of Prados de la Escosura (2014).

The indices are originally standardized on an 11-point ordinal scale, ranging from 0 to 10, where a higher value indicates greater economic freedom. Instead of using the five indices, this study focuses on only four of them. The reason behind this is that a control variable is included to account for openness or trade differences across countries (export share in GDP); therefore, the variable 'freedom to trade internationally' is excluded in the regression analysis since conceptually it has a collinear relationship with the control variable measuring openness.

In this empirical analysis these indices account for different dimensions of institutional quality which allows for their use in a disaggregated way (into four areas). The data matches the specific country and year sample unlike any other data on institutions publicly accessible. In general, these indices are linked in practical terms to the classification of institutions suggested by Rodrik (2005) as depicted in table 5.3.[228]

Table 5.3: Disaggregated economic institutions

Rodrik's four-type classification	Economic Freedom	
	Index	Content
Market creating institutions	Property Rights (PR)	Protection of property rights; Integrity of the legal system; Legal enforcement of contracts; Regulatory restrictions of sale of real property; Judicial independence; Impartial courts.
Market regulating institutions	Market Regulation (MR)	Credit market regulations; Private sector credit; Interest rate controls/Negative real interest rates; Labor market regulations; Minimum wage; Hiring and firing regulations; Centralized collective bargaining; Mandated cost of hiring; Mandated cost of worker dismissal; Conscription; Business regulations; Price controls; Bureaucracy costs; Starting a business; Cost of tax compliance
Market stabilizing institutions	Sound Money (SM)	Freedom to own foreign currency bank accounts; Standard deviation of inflation; Inflation in most recent year. Average annual growth of the money supply in the last five years
Market legitimising institutions	Size of Government (SG)	Government consumption spending as a % of Total Consumption; Transfers and subsidies as a % of GDP; Government enterprises and investment as a % of GDP; Top marginal tax rate; Top marginal income tax rate; Top marginal payroll tax rate

Source: Based on the classification of Rodrik (2005), and on the Economic Freedom of the World dataset of Gwartney, J., R. Lawson, *et al.* (2012).

[228] I have re-labeled each index into a short name (e.g. 'Regulation of credit, labor, and business' only into 'Market Regulation', likewise for 'Access to sound money' into the label of 'Sound Money').

To gain a better intuition related to the functional interpretation of these indices and how these are a proxy for different institutions, I simplify their ordinal connotation (from 0 to 10):

A higher value in the 'Property rights' index (PR) implies a greater protection, and vice versa. However, in the 'Market regulation' index (MR) a higher value implies more freedom from regulatory-government related restrictions, therefore, higher values of this index means less regulation and vice versa.

Likewise, higher values in the 'Sound Money' (SM) imply lower financial restrictions (e.g. a value of 10 means 'foreign currency bank accounts are permissible without restrictions and 'low money growth' and 'inflation rates'). Finally, a higher value in the 'Size of government' index (SG) corresponds to a relatively small government, that is low government consumption as a % of total consumption, few government enterprises, and low marginal tax rates.

The scores of the indices are significantly different for the total sample. In all categories the means of Asian countries are higher than in Latin America but in a different degree depending on the type of institution over time.[229]

Control variables

As mentioned before, productivity growth is likely to be influenced by factors other than institutions. Thus, there were included control variables following the overall findings of previous literature on the typical factors influencing economic growth in cross-country growth regressions (see Easterly and Levine, 1997). To include these, the analysis made use of aggregate country data from the Penn World Table 8.1 (Feenstra *et al.,* 2014).

The estimates control for the country differences in human capital (HC) across the country sample. The reason for including this has a theoretical logic. According to endogenous growth theory human capital is one of the core drivers of innovation and productivity growth (Aghion and Howitt, 1992). More educated people are likely to increase the chances of new discoveries, facilitate the adoption and use of new technologies, and thus, will be more productive relative to others endowed with less human capital. Therefore, the years of schooling combined with the returns from education as reported in the latest version of the Penn World Table were used as a 'proxy' of human capital.

In relation to that variable (HC), Vandenbussche *et al.*, (2006) have argued that human capital has a dual effect on the economy depending on the stages of technological development. Unskilled human capital facilitates imitation or the diffusion of existing technologies, and skilled human capital promotes the development of new technologies and innovation. They claim empirically that tertiary education

[229] See a test of differences in table 1.A. of the appendix

becomes more important and secondary and primary less important to catch up as countries move closer to the technology frontier.[230]

Another control included is the level of physical investment as a percentage of GDP (labeled as 'Invest'). This variable has been considered by the growth literature as one of the most robust determinants of growth across countries. This is because investment may influence growth through productivity externalities or directly through the production function (capital deepening).

The level of openness has also been considered an important driver of growth in empirical modeling. From seminal studies like Sachs and Warner (1995) to more recent analyses, the link between openness and economic growth has been a common denominator in testing growth differences across countries. It is commonly argued that the higher the openness of the economy, the higher is the absorption of technologies from abroad.

Additionally, firm-level studies have found a positive impact of trade on productivity growth through the reallocation of resources to the sector that is more open to export competition (for e.g. Melitz, 2003). To control for this productivity-enhancing effects arising from the openness of a country, I included the share of exports in GDP ('Export').[231]

Table 5.4 presents the summary statistics of all the variables employed in the study. As expected, averages of labor productivity growth and institutions differ significantly. For instance, the maximum value of mining labor productivity (growth and the distance values) surpassed at one point the level of the United States (a logarithm value above unity) and its standard deviation is the highest of the productivity variables.

The overall pairwise correlations are depicted in table 5.1.B (See the appendix). These show relatively low correlations between the independent variables, which gives an indication that the problem of multi-collinearity is not a serious issue to carry out the econometric analysis.[232]

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[230] To verify this prediction, it was checked as a robustness test in the final estimates the effect of adding as a control variable data on primary and tertiary schooling using the dataset from Barro and Lee (2010).

[231] Other studies have included the sum of imports and exports as share of GDP as an openness indicator. However, exports share (and not the imports share) is the variable that would capture more accurately the commodity booms driven by the rise of international prices of exported commodities. In addition, it is well-known that after the 1960s the pro-export orientation of Asian countries was a distinct policy feature in the region, which is a bias which I look to control in the estimates.

[232] This low pairwise correlation among institutions is a major advantage over other institutional data employed in related studies like Campos and Nugent (1999).

Table 5.4: Summary statistics

Variable	Average	SD	Minimum	Maximum
Δln(Y/L) in agriculture	0.10	0.18	-0.49	0.53
Δln(Y/L) in mining	0.12	0.44	-1.26	1.78
Δln(Y/L) in manufacturing	0.10	0.21	-0.64	0.54
Δln(Y/L) in construction	0.04	0.24	-0.84	0.79
Δln(Y/L) in market services	0.03	0.20	-0.71	0.54
Δln(Y/L) in non-market services	0.12	0.23	-0.84	0.75
ln(DTF) agriculture	-1.14	0.83	-2.76	0.82
ln(DTF) mining	-1.25	1.29	-3.59	1.93
ln(DTF) manufacturing	-0.84	0.75	-3.67	0.97
ln(DTF) construction	-1.22	0.66	-3.18	0.94
ln(DTF) market services	-0.79	0.64	-2.38	0.71
ln(DTF) non-market services	-0.99	0.86	-3.58	1.18
Overall institutional quality (IQ)	6.38	1.39	2.50	9.10
Property rights (PR)	5.47	1.63	1.60	8.50
Market regulation (MR)	6.14	1.32	3.30	9.40
Sound money (SM)	7.06	2.43	0.00	9.90
Size of government (SG)	6.65	1.24	4.00	9.70
Human capital (HC)	2.32	0.47	1.23	3.35
Investment share (Invest)	0.23	0.10	0.09	0.59
Export share (Export)	0.30	0.39	0.02	2.37

Note: Sample period: 1970–2010 for the level variables and 1975–2010 for the growth variables. Δln((Y/L) in each sector is measured as the natural logarithm of the five-year annualized change. ln(DTF) stands for 'distance to frontier' which is measured as the logarithm of the ratio between the levels in the specific country/sector and the level of the United States. Human capital (HC) is educational attainment measured in years of schooling (Barro and Lee, 2012) and returns to education (Psacharopoulos, 1994). Investment (Invest) and export (export) share is the investment share and exports to real GDP respectively.

5.5 Estimates and results

This section presents the estimates from equation (3) specified with its different institutional variables as described in sections 5.2 and 5.3. The unbalanced longitudinal dataset comprehends a maximum of (n x T) 162 country/sector observations (total panel observations vary according to the specification of the model). Following a

similar econometric strategy as in Madsen (2014), I compare the estimates under two different methods aiming to correct for correlated time-invariant factors and endogeneity bias. Baseline results are reported under fixed-effects (country and period effects) ordinary least squares (FE-OLS) and instrumental variables regressions (FE-IV).

The dependent variable refers to the growth of labor productivity in each sector of the economy, which in all regressions is specified as the change of the natural logarithm of sectoral value added per worker ($\Delta \ln Y/L$). Independent variables are the institutions in question (lagged), the (lagged) distance to frontier (DTF), and the interaction term between them (Institutions*DTF). As mentioned in the previous section, in empirical modeling it is necessary to control for other factors influencing productivity growth, thus, explanatory variables other than institutions (and distance to frontier) such as physical investment (Invest), level of openness (Export), and human capital (HC) are included systematically. For the case of the instrumental variables regressions, all instruments are internal; as long as they are proven to be orthogonal to the error term (exogenous), I employ their own lags (in two periods) as usually conducted in panel growth models (Durlauf *et al.*, 2005; p. 103).[233]

Baseline estimates and theory predictions

In terms of estimated coefficients of the empirical model, a negative coefficient on the distance to frontier is expected.[234] On the other hand, we may expect a positive sign on the coefficient of the interaction between institutions (e.g. Property Rights index) and distance to frontier as stated in the empirical specification. The effects of the legal structure and property rights (PR) on sectoral productivity growth are shown in table 5.5.

The sign of the estimates of the distance to frontier across sectors is negative as expected in the model. Although there may be other inherent factors that cause sectoral productivity differences (product and industry composition within the sector), these statistical differences are variations in line with the findings of previous studies

[233] Instruments are lagged values of the independent variables in two periods. Different sets of instruments with lags from 2 to 3 were tested. They showed that estimates are not very sensitive with respect to the choice of lags (2 and 3), thus, to preserve degrees of freedom, instruments were lagged with only two periods. Typical external instruments such as the log of savings and the log of education expenditures were additionally considered, however, these all proved to be insignificant individually and jointly in most of the estimations. Using the Generalized Method of Moments (GMM) instead of the standard IV could have been a better technique to deal with unobserved heterogeneity and serial correlation for a panel; however, because of the nature of the data employed in this study that method reduces significantly its efficiency (e.g. low range in our panel dimension).

[234] Other similar studies such as Griffith *et al.*, (2004) obtained a positive sign in this coefficient because the specification of their variable of distance to frontier is the inverse to ours, that is, they set the follower country on the numerator side. Instead, as mentioned, the analysis followed Benhabib and Spiegel (2005) and several others' standard specification (follower country on the denominator) as originally in Nelson and Phelps (1966).

on technology diffusion; technology diffuses at a different speed and unevenly across countries and sectors (Comin *et al.*, 2006).

The coefficients obtained under both methods (OLS and IV) are not much different from each other.[235] Although for the case of OLS they are highly significant for most of the specifications, endogeneity bias is suspected to be present under this method, thus, conducting a correction with an IV specification would entail more reliable estimates (unbiased) than those under the former.[236]

Except for the lack of statistical significance (in the IV specification) at 5% of institutions and the interaction term in the services sectors (market and non-market), in general, the baseline regressions of table 5.5 show the vital importance that the legal structure and property rights have for labor productivity growth across sectors.

The higher the interactions of property rights and distance to the frontier within a country, the higher the labor productivity growth in the respective sector. In other words, controlling for other factors affecting growth, the spillover effect of institutions materializes in sectors far away from the frontier and those countries endowed with better (higher score) legal structures and property rights.

[235] Both estimates were reported aiming to compare whether there are significant differences between them, but in general, the differences of OLS and IV, is that OLS estimates rely on all of the natural variation that exists across the sample, whereas IV estimates are derived only from the variation attributable to the instruments.

[236] The equations are exactly identified (exact number of endogenous variables and numbers of instruments). Thus, testing on whether the estimated equations are over-identified (employing a 'Sargan test') does not apply here. Although the identification of the current restriction is grounded on standard theory, Angrist and Pischke (2009) show that the presence of a bias due to weak instruments tends to be very small when the instruments and the endogenous variables are correlated around 0.1 (as a rule of thumb).

Table 5.5: Property rights (PR), distance to frontier (DTF), and interactions: 1970-2010

Variable/sector	Agriculture	Mining	Manufacturing	Construction	Market Services	Non-Market Services
			FE-OLS			
DTF_{t-1}	-0.38***(0.05)	-0.76***(0.06)	-0.53***(0.05)	-0.60***(0.06)	-0.46***(0.06)	-0.52**(0.07)
PR_{t-1}	0.04***(0.01)	0.05* (0.03)	0.04***(0.01)	0.07***(0.01)	0.03** (0.02)	0.01* (0.02)
(PR*DTF)	0.05***(0.01)	0.11***(0.01)	0.08***(0.01)	0.08***(0.01)	0.08***(0.01)	0.06*(0.01)
F-stat	5.34	11.73	11.03	7.86	6.11	3.67
Adj R^2	0.48	0.77	0.76	0.69	0.63	0.5
N	138	138	138	138	138	138
			FE-IV			
DTF_{t-1}	-0.51** (0.2)	-0.87**(0.20)	-0.53* (0.09)	-0.67***(0.18)	-0.31* (0.15)	-0.48* (0.2)
PR_{t-1}	0.05 (0.05)	0.04 (0.07)	0.04 (0.04)	0.04 (0.06)	-0.04 (0.8)	-0.06 (0.7)
(PR*DTF)	0.07***(0.02)	0.13***(0.01)	0.07***(0.01)	0.09***(0.01)	0.05* (0.02)	0.07*(0.02)
F-stat	3.34(0.00)	3.26(0.00)	7.99(0.00)	2.43(0.00)	2.26(0.00)	2.15(0.00)
χ^2	0.19(0.90)	0.17(0.45)	0.16(0.98)	0.02(0.69)	0.09(0.97)	0.25(0.59)
Adj R^2	0,41	0.87	0.77	0.71	0.33	0.45
N	120	120	120	120	120	120

Notes: Dependent variable is $\Delta\ln(Y/L)$ which is the change of the natural log of labor productivity in the respective economic sector in every 5-year interval. DTF_{t-1} is the natural logarithm of the distance to frontier lagged in one-time period. PR_{t-1} stands for Property Rights lagged in one-time period (t-1). PR is the index of the legal structure and security of property rights that ranges from 0–10 where 0 corresponds to "no judicial independence", "no trusted legal framework exists", "no protection of intellectual property", "military interference in rule of law", and "no-integrity of the legal system" and 10 corresponds to "high judicial independence", "trusted legal framework exists", "protection of intellectual property", "no military interference in rule of law", and "integrity of the legal system". Robust standard errors in parentheses. *, **, *** statistically significant at 10%, 5%, and 1% levels, respectively. *FE-OLS* and *FE-IV* refers to ordinary least squares with fixed effects (FE) and an instrumental variable regression respectively. Coefficients of the constant estimate, period and country dummies, and control variables (invest, export, and human capital) were calculated, however are not reported in the table for brevity. χ^2 is the Breusch-Godfrey test for first-order serial correlation under the null hypothesis of no serial correlation. Internal instruments for the IV model are the variables from the first stage regression lagged in two time periods (t-2).

Table 5.6: Market regulation (MR), distance to frontier (DTF), and interactions: 1970-2010

Variable/sector	Agriculture	Mining	Manufacturing	Construction	Market Services	Non-Market Services
			FE-OLS			
DTF_{t-1}	-0.58***(0.07)	-0.80***(0.04)	-0.77***(0.06)	-0.85(0.05)***	-0.68***(0.05)	-0.68 (0.07)
MR_{t-1}	0.06**(0.001)	0.10***(0.02)	0.05***(0.00)	0.07(0.01)**	0.05**(0.01)	0.03**(0.02)
(MR*DTF)	0.06***(0.007)	0.12***(0.00)	0.11***(0.00)	0.11(0.01)***	0.11***(0.00)	0.09**(0.01)
F-stat	6.29	20.19	13.65	13.99	10.35	5.04
Adj R^2	0.55	0.81	0.74	0.75	0.68	0.48
N	129	129	129	129	129	129
			FE-IV			
DTF_{t-1}	-0.73**(0.37)	-1.13**(0.53)	-0.81***(0.12)	-0.63(0.15)***	-0.46** (0.12)	-0.61 (0.012)
MR_{t-1}	0.06 (0.08)	0.03 (0.10)	0.02 (0.04)	0.002(0.04)	0.04 (0.04)	-0.03 (0.05)
(MR*DTF)	0.07*(0.03)	0.12***(0.01	0.10***(0.02)	0.08(0.01)***	0.06* (0.02)	0.03**(0.02)
F-stat	2.98	3.99	7.58	2.12	1.95	2.08
χ^2	0.13(0.94)	0.10(0.68)	0.11(0.98)	0.02(0.56)	0.03(0.89)	0.14(0.97)
Adj R^2	0.42	0.71	0.57	0.67	0.45	0.44
N	111	111	111	111	111	111

Notes: Dependent variable is $\Delta\ln(Y/L)$ is the change of the natural log of labor productivity in the respective economic sector in every 5-year interval. DTF_{t-1} is the natural logarithm of the distance to frontier lagged in one-time period. MR_{t-1} indicates 5-year lagged regulation of credit, labor and business index that ranges from 0-10 where 0 and 10 correspond to highest and lowest regulation, respectively. Robust standard errors in parentheses. *, **, *** statistically significant at 10%, 5%, and 1% levels, respectively. *FE-OLS* and *FE-IV* refers to ordinary least squares with fixed effects (FE) and an instrumental variable regression respectively. Coefficients of the constant estimate, period and country dummies, and control variables (invest, export, and human capital) were calculated, however are not reported in the table for brevity. χ^2 is the Breusch-Godfrey test for first-order serial correlation under the null hypothesis of no serial correlation Internal instruments for the IV model are the variables from the first stage regression lagged in two time periods (t-2).

Table 5.7: Sound Money (SM), distance to frontier (DTF), and interactions: 1970-2010

Variable/sector	Agriculture	Mining	Manufacturing	Construction	Market Services	Non-Market Services
			FE-OLS			
DTF_{t-1}	-0.29***(0.06)	-0.74***(0.05)	-0.48***(0.06)	-0.62(0.07)***	-0.48***(0.07)	-0.51**(0.06)
SM_{t-1}	0.02**(0.008)	0.04***(0.01)	0.03***(0.00)	0.02(0.02)**	0.02**(0.00)	0.006 (0.00)
(SM*DTF)	0.02***(0.004)	0.07***(0.00)	0.03***(0.00)	0.03(0.01)***	0.04***(0.00)	0.04***(0.00)
F-stat	3.21	12.99	7.44	4.65	4.66	3.89
Adj R^2	0.32	0.71	0.57	0.43	0.43	0.38
N	142	142	142	142	142	142
			FE-IV			
DTF_{t-1}	-0.35**(0.21)	-0.85***(0.25)	-0.71***(0.11)	-0.45(0.23)	-0.41(0.15)*	-0.47**(0.17)
SM_{t-1}	0.02 (0.02)	0.08 (0.02)	0.05***(0.01)	0.006(0.02)*	0.04(0.02)**	-0.02** (0.01)
(SM*DTF)	0.02**(0.01)	0.05***(0.00)	0.05***(0.01)	0.02(0.01)*	0.03(0.01)**	0.03**(0.03)
F-stat	2.23(0.00)	3.14(0.00)	7.48(0.00)	1.60(0.01)	2.12(0.00)	2.22(0.00)
χ^2	0.11(0.54)	0.29(0.19)	0.18(0.78)	0.09(0.84)	0.06(0.53)	0.31(0.66)
Adj R^2	0.34	0.74	0.54	0.39	0.34	0.35
N	124	124	124	124	124	124

Notes: Dependent variable is $\Delta\ln(Y/L)$ is the change of the natural log of labor productivity in the respective economic sector in every 5-year interval. DTF_{t-1} is the natural logarithm of the distance to frontier lagged in one-time period. SM_{t-1} stands for access to sound money index (SM) lagged in one-time period(t-1) that ranges from 0-10 where 0 corresponds to 'high annual money growth', 'high variation in the annual rate of inflation', 'high inflation rate', and 'restricted foreign currency bank accounts' and 10 corresponds to 'low annual money growth', 'low or no variation in the annual rate of inflation', 'low inflation rate', and 'foreign currency bank accounts are permissible without restrictions'. Robust standard errors in parentheses. *, **, *** statistically significant at 10%, 5%, and 1% levels, respectively. *FE-OLS* and *FE-IV* refers to ordinary least squares with fixed effects (FE) and an instrumental variable regression respectively. Coefficients of the constant estimate, period and country dummies, and control variables (invest, export, and human capital) were calculated, however are not reported in the table for brevity. χ^2 is the Breusch-Godfrey test for first-order serial correlation under the null hypothesis of no serial correlation Internal instruments for the IV model are the variables from the first stage regression lagged in two time periods (t-2).

Table 5.8: Size of government (SG), distance to frontier (DTF), and interactions: 1970-2010

Variable/sector	Agriculture	Mining	Manufacturing	Construction	Market Services	Non-Market Services
			FE-OLS			
DTF_{t-1}	-0.48***(0.06)	-0.83***(0.05)	-0.64***(0.018)	-0.75***(0.05)	-0.61***(0.05)	-0.59* (0.06)
SG_{t-1}	0.04** (0.01)	0.07***(0.02)	0.02* (0.102)	0.04***(0.01)	0.03** (0.01)	0.03 (0.06)
(SG*DTF)	0.06***(0.00)	0.10***(0.008)	0.08***(0.013)	0.09***(0.00)	0.09***(0.00)	0.08**(0.01)
F-stat	6.30	23.09	12.44	11.85	10.37	6.13
Adj R^2	0.53	0.82	0.70	0.69	0.66	0.52
N	142	142	142	142	142	142
			FE-IV			
DTF_{t-1}	-0.59**(0.24)	-0.92***(0.22)	-0.67***(0.14)	-0.71***(0.19)	-0.40***(0.17)	-0.89* (0.46)
SG_{t-1}	0.01 (0.10)	0.10 (0.12)	0.01 (0.07)	0.16 (0.14)	-0.05 (0.12)	0.20 (0.21)
(SG*DTF)	0.06***(0.01)	0.11***(0.010)	0.08***(0.017)	0.08**(0.01)	0.06** (0.01)	0.10 (0.03)
F-stat	15.67(0.00)	3.84(0.00)	8.70(0.00)	2.49(0.00)	2.92(0.00)	2.77(0.00)
χ^2	0.16(0.94)	0.09(0.97)	0.19(0.96)	0.13(0.98)	0.34(0.76)	0.30(0.98)
Adj R^2	0.4	0.82	0.72	0.50	0.46	0.03
N	124	124	124	124	124	124

Notes: Dependent variable is $\Delta\ln(Y/L)$ is the change of the natural log of labor productivity in the respective economic sector in every 5-year interval. Government size index (GS) ranges from 0-10 where 0 corresponds to 'large general government consumption', 'large transfer sector', 'many government enterprises', and 'high marginal tax rates and low-income thresholds', and 10 to 'small general government consumption', 'small transfer sector', 'few government enterprises', and 'low marginal tax rates and high income thresholds'. Robust standard errors in parentheses. *, **, *** statistically significant at 10%, 5%, and 1% levels, respectively. *FE-OLS* and *FE-IV* refers to ordinary least squares with fixed effects (FE) and an instrumental variable regression respectively. Coefficients of the constant estimate, period and country dummies, and control variables (invest, export, and human capital) were calculated, however are not reported in the table for brevity. χ^2 is the Breusch-Godfrey test for first-order serial correlation under the null hypothesis of no serial correlation. Internal instruments for the IV model are the variables from the first stage regression lagged in two time periods (t_{-2}).

Similar results hold with the effect of market regulation (MR) on sectoral labor productivity growth in the full sample as table 5.6 shows. Again, although the institutional variable alone is statistically non-significant in the IV estimation, its interaction (MR*DTF) is significant, pointing at the growth-enhancing effects on labor productivity when sectors are far-removed from the frontier and endowed with less market regulation (except for services sectors where there is a weak effect on the interaction term; no more than 5% of statistical significance).[237]

Results remain qualitatively and quantitatively comparable in table 5.7 on the effect of access to sound money (SM) on sectoral productivity growth (except for the construction sector; statistical significance only at 10%). Having a sound monetary policy (e.g. stable prices) does provide a positive productivity effect across sectors in the full sample. Furthermore, as shown in table 5.8, except for the low statistical significance in non-market services, there is a positive effect across sectors between the size of the government (SG) which according to this index implies an inverse relationship; a smaller government (e.g. may imply a more efficient bureaucracy) is related to a higher sectoral productivity (except for non-services sectors).

Estimates in a restricted sample

The results from the baseline regressions are consistent with the literature of the so-called New Institutional Economics; a well-designed structure of property rights, less distortions from market regulations, fewer unexpected monetary shocks, and a well-functioning bureaucracy, enhance overall productivity growth.[238]

However, although estimations from tables 5.5 to 5.8 show that there are positive and significant differences on the role of institutions across sectors, they may hide important regional dynamics not visible when using the full country-range (taking into account fixed effects).

In order to uncover these differences and to verify quantitatively whether the hypothesis and the general propositions of the model hold, it is necessary to restrict the country sample by region (Asia and Latin America separately). Although this estimation may reveal the high sensitivity of the estimators relative to the ones in the full country sample, it can also provide relevant additional information on the role of different institutions on productivity growth at the regional level.[239]

The sensitivity issue of restricting the sample is likely to arise because as was shown before, Asian countries' sectoral productivity levels were rapidly catching up to the frontier in an earlier period (1980s) unlike the productivity levels of Latin American

[237] Average marginal effects are depicted in figure 5.3.B of the appendix.

[238] See for an e.g. in T. Eggertsson, 'A quick guide to new institutional economics'

[239] Restricting the estimates into a lower country-range entails widening the confidence intervals for the regional regression analysis. Also, uncovering the specific mean difference in each estimator becomes more challenging when the sample distribution is not normal. Results on this regard however, indicate that through the 'Jarque-Bera' normality test (on the residuals) it was not possible to reject the null hypothesis that these are **n**ormally distributed (See in table 5.1.B from the appendix).

countries which fell behind during the same period. Yet, the variety of institutions could have been equally influential on sectoral productivity growth of both regions.

Since the parameters of interest are mainly the coefficients of the interaction terms (institutions*DTF) for the restricted sample, table 5.9 reports a re-estimation of these within an instrumental variable specification.[240] The results in the table 5.9 show that the previous baseline estimates are not entirely robust when the sample is restricted.

Although the results remained in line with the hypothesis that the variety of institutions affects sectors differently (in magnitude), several of the re-estimated coefficients lose explanatory power, predominantly in the Latin American sample. Intuitively, we could expect to find various inverse relationships with respect to the interactions terms (negative signs in coefficient across sectors) since some institutions as was hypothesized, could have hindered the diffusion of knowledge and thus, deter productivity growth. However, although these negative coefficients were present in the manufacturing and construction sectors (interacted with access to sound money) they are not statistically significant.

Overall, labor productivity growth in the majority of sectors (five out of six) in Asia appears positively and significantly 'enhanced' by the endowments of 'better' economic institutions in question (their interactions to the distance to the productivity frontier). In terms of statistical significance (at 5% and 1%) and the magnitude of the baseline results the coefficients remained within those intervals (0.04 to 0.11 across sectors).

However, the statistical significance for the estimates in the non-market service sectors is largely negligible in both country samples. Notwithstanding the weak statistical significance in various sectors of Latin America, table 5.9 pinpoints the channels in which institutions have promoted the acceleration (or deceleration) of sectoral productivity growth within the restricted sample:

The interaction regarding property rights (PR*DTF) has a statistically significant growth-enhancing effect on agriculture, mining, and manufacturing in Asia.

[240] Similarly to previous estimations (from table 5.5 to 5.8), instruments employed in the restricted sample were (verified for exogeneity with Hausman tests) the dependent variables lagged in two periods.

Table 5.9: Interaction terms across sectors and controls: Restricted sample for Asia and Latin America, 1970-2010
(Instrumental variable regression)

Variable	Agriculture		Mining		Manufacturing		Construction		Market Services		Non-Market Services	
	Asia	Latin America	Asia	Latin America	Asia	Latin America	Asia	Latin America	Asia	Latin America	Asia	Latin America
PR*DFT	0.07**	0.001	0.12***	0.20	0.10**	0.03	0.10	0.07	0.29	0.06	0.02	0.17
MR*DTF	0.09**	0.05	0.11***	0.10	0.11***	0.07	0.09***	-0.02	0.07**	0.04	0.04	0.10
SM*DTF	0.04**	0.01	0.09**	0.08***	0.08**	-0.03	-0.98	0.02	0.02	0.01	0.07	0.03
SG*DTF	0.08***	0.07	0.13***	0.10***	0.12***	0.04**	0.08***	0.08**	0.09***	0.05	-0.01	0.03
HC	0.006	0.15	-0.06	0.92	0.32**	-0.35**	-0.06	-0.12	0.17*	0.001	-0.06	-0.13
Invest	0.74**	0.95	-0.34	0.26	0.42***	0.25**	0.17	1.28	1.20**	0.42	1.55**	0.05
Export	-0.19***	0.52	-0.05	0.42*	0.12	0.61**	-0.06	0.67*	-0.03	0.04	0.20	1.09
F-stat	2.98	3.99	7.58	2.12	1.95	2.08	2.09	2.10	2.11	2.12	2.13	2.14
χ^2	0.16(0.9)	0.09(0.5)	0.35(0.9)	0.03(0.7)	0.10(0.4)	0.11(0.4)	0.12(0.9)	0.13(0.9)	0.67(0.9)	0.51(0.9)	0.00(0.2)	0.12(0.3)
Adj R^2	0.42	0.71	0.57	0.67	0.45	0.44	0.45	0.46	0.49	0.66	0.06	0.50
N	61	62	59	60	59	60	61	60	59	62	59	51

Note: The dependent variable is $\Delta\ln(Y/L)$ is the change of the natural log of labor productivity in the respective economic sector in every 5-year interval. PR*DTF, MR*DTF, SM*DTF, and SG*DTF are the separate interaction terms of Property rights, Market regulation, Sound money, and Size of government with the Distance to frontier (DTF). The symbols *, **, *** are statistical significant at 10%, 5%, and 1% levels, respectively. To avoid a repetitive display of estimates, individual coefficients of DTF, and the institutions are not shown. Similarly, the constant terms and period and country dummies were included but are not reported in the table for brevity. χ^2 is the Breusch-Godfrey test for first-order serial correlation under the null hypothesis of no serial correlation. Internal instruments in the IV regression are the variables from the first stage regression lagged in two periods (t-2).

On the other hand, except for non-market service sectors, the market regulation interaction (MR*DTF) in Asia reports a highly positive significant effect across sectors. Yet again, the positive effect of the interaction of sound money (SM*DTF) is valid for Asia across sectors with the exception of the service sectors.

For Latin America, interestingly, the estimates of institutions that maintained statistical validity are only the interactions with size of the government (SG*DTF) and sound money (SM*DTF); and solely in 3 sectors: mining, manufacturing and construction, with 'quinquennial' contributions on labor productivity growth of 0.10, 0.04, and 0.08% respectively.

Robustness checks and other growth determinants

A final element to support the empirical evidence presented is to check the magnitude of the control variables and their significance in driving the overall results in the restricted sample. An avenue that could have been taken was to include the interaction between human capital and institutions.

However, aside for the econometric issues arising from the loss of degrees of freedom, vast empirical research already documented the effects of human capital (and its different measurements) on catch up (e.g. Madsen, 2014). Since the aim of our specification was to isolate the effects in order to disentangle the ones from institutions we report them only to verify whether these controls are coherent with what previous works have found. Although estimates from tables 5.5 to 5.8 controlled for this, table 5.9 shows a more relevant picture on a restricted sample by region.

Factor accumulation (human and physical capital) appears as a significant growth factor in various sectors. For instance, the coefficient of investment (Invest) is significant for Asia in agriculture, manufacturing, and services (market and non-market). However, with exception of the manufacturing sector, surprisingly the effect of human capital (HC), although positive, is not significant for most of the sectors (and negative for the case of the construction sector). Results remain robust when we include an alternative variable of human capital and non-linear effects.[241] On the other hand, for the Asian sample trade (Export) appears as an important determinant of growth in most of the sectors as previous literature has found.

Asia and Latin America's productivity paradigms in perspective

Other works like Taylor (1998), and Campos and Nugent (1999) have also pointed out the importance of institutional differences on long-term growth. Taylor (1998) argues that productivity growth in Latin America was largely affected by various policy distortions (e.g. tariffs, and misaligned exchange rates). He claims that unlike Asia,

[241] Table 2B in the appendix confirms the magnitude of these estimates, showing that when employing tertiary schooling as a measure of human capital, the results do not change significantly.

these distortions generated relatively lower rates of capital accumulation (growth of physical investment) affecting ultimately overall per capita income growth.

However, although Taylor's evidence speculates on the presence of 'inefficient' institutions as a possible source of productivity differences, it does not address quantitatively the paradox of why if both regions followed similar policies they were only distortive for Latin America.

On the other hand, Campos and Nugent (1999) revealed statistical differences of various governance characteristics among the regions. Yet again, their analysis does not indicate the specific channels in which institutions affected productivity growth. Several others studies have helped understanding the growth dynamics in these regions, however, the drivers behind the differences in the regional patterns of productivity growth have remained unanswered.

The work of McMillan *et al.*, (2014) attempted to solve this question by decomposing the sectoral changes of aggregate productivity. It was found that Asian economies have been more successful than their Latin American counterparts in reallocating employment from traditional to modern activities. The authors tentatively indicate that policies that prevented currencies to become overvalued and that avoided placing large costs on firms to hire or fire workers facilitated a successful 'growth-enhancing' structural change in Asia (and not in Latin America).

The findings in this chapter are noticeably in line with the previous authors (and with McMillan *et al.* 2014) in the sense that their variables related to monetary policy (exchange rate) and less business regulations bear conceptually close resemblance to the type of institutions tested in the present study. In the results shown in the previous section, institutional components such as 'access to sound money' (SM) and 'market regulations' (MR) turned out to be important factors in enhancing labor productivity, particularly across the sectors for the sample in Asia.

However, in addition to other previous works, our results expanded the empirical scope in which institutions impacted on productivity growth. To restate our key findings, it is necessary to point out the transmission channels in which a greater institutional quality has impacted on the rate of productivity growth across sectors; controlling for human capital, physical capital, and trade openness, the estimates show that the quality of economic institutions, that is, countries with greater freedom in their legal system and property rights, freedom from tight market regulations, greater access to sound money, and a minimum and more efficient government has increased productivity growth for the period 1970-2010.

Although in most cases the coefficients show that these institutions *per se* did not augment directly the dependent variable (the growth of sectoral labor productivity) they did this through their interactions with the variable of the distance to the frontier within each sector. In hindsight, this particular channel (significance of interaction terms) shows that the 'catching up' notion of the role of institutions on long-term growth are measurable at the sectoral level: sectors far-removed from the levels of the

leader (frontier) caught up aided with a set of institutions. The exception to this was the sectoral productivity of non-market service sectors.[242]

However, the baseline results are not satisfactory when the sample is restricted. Once the sample is split up by region, into Asia and Latin America, the results' statistical power weakens.[243] As a consequence we get a sample that is too small to retain significant correlations for Latin America. The underlying explanation for this (as seen in the data description) is that on average, Latin American countries have been endowed with lower scores on the quality of their economic institutions relative to Asian countries. This directly affects the magnitude of the interaction coefficients, which is an indication that only in those sectors that are catching up, the sectoral gap is closing much slower than the ones in Asia. In other words, it can be said that unlike Asia, Latin American sectors did not exploit the catch up potential of having backward sectors (relative to the United States), instead, the productivity benefits of the improvement in institutional quality was transferred only towards natural resource-based sectors.

In relation to these findings, there is a key indication that for the mining and construction sectors, the 'size of government' (institutional endowment of less government involvement) has a positive growth effect on Latin America's sectoral productivity. Although this could be interpreted as a positive prospect for the region, catching up in sectors highly dependent on natural resources such as mining supplemented with less government 'involvement' could dangerously develop into an undesirable type of productivity growth in the long run. Cross-country research on the so-called 'natural resource curse' has found that the abundance of natural resources in countries with low institutional quality are detrimental for sustained growth.[244]

As for Asia, evidence indicates that with the exception of the service sector, there is an overwhelming positive effect of institutional quality on sectoral labor productivity growth; that is to say, on average the variety of the economic institutions analyzed have enabled different sectors to make better use of the knowledge and technologies from abroad, thereby raising labor productivity, and creating possibilities to catch up.

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[242] Since the activities within non-market services include government services and public utilities it is not surprising to find a non-significant relationship between institutions and productivity since these activities are not particularly exposed to market competition like other sectors.

[243] The loss of statistical power for splitting the country-sample is not a rare feature in growth regressions. Several seminal 'convergence' studies were confronted with this problem related to the size and general characteristics of the sample. For e.g. one of the pioneer works such as Baumol (1986) using aggregate cross-country data coined the term 'convergence clubs', that is, convergence can be found statistically significant only by splitting the sample into country-groups with similar characteristics.

[244] See for example the findings of Arezki and van der Ploeg (2011).

5.6 Conclusions and suggestions for future research

Simply lagging behind the leader is not sufficient to catch up. As Nelson (2008) has pointed out, the ability to absorb knowledge from abroad has been historically one of the most important elements determining the ability to catch up for lagging countries. This chapter addresses that idea providing new evidence on whether institutions play a role in the absorption of knowledge to accelerate productivity growth.

Using the Nelson and Phelps model, this study produces econometric evidence on the mechanisms through which a variety of institutions has functioned as a capability to foster labor productivity growth at the sectoral level. The empirical analysis uses a longitudinal sectoral dataset of eighteen countries together with disaggregated data of institutional quality in Latin America and Asia for the period 1970-2010.

Results suggest that controlling for other growth factors, institutions which interacted with the distance to the frontier affected positively and significantly the growth of labor productivity at the sectoral level. This indicates that backward sectors in countries endowed with higher institutional quality grow faster than in sectors of countries with lower institutional quality. Following the empirical specification, I analyzed the different effects that the same institutions have on sectors far-removed from the frontier. The results pointed to different channels through which institutional quality impact on sectoral productivity growth: greater freedom in the legal structure and property rights, freedom from tight market regulations, greater access to sound money, and a small and more efficient government, all in a different magnitude affected positively the growth of sectoral productivity.

In hindsight the results are in line with the body of literature of the so-called New Institutional Economics regarding the prominence of 'market-friendly' institutions in enhancing productivity growth in the long-run. However, in spite of controlling for country and time invariant factors, estimates are sensitive to the sample selection. The model predictions apply to the majority of the sectors in the Asian sample. On the other hand, sectoral productivity growth in Latin America is not statistically associated with the quality of property rights and market regulations; only in the mining and construction sectors, productivity is statistically associated with the improvement in the quality of institutions of size of government and access to sound money.

Overall findings of this study have relevant implications for the current debates in development policy. A number of policy reports have emphasized the need for Latin American countries to emulate the Asian growth strategy; removing the barriers for productivity by deepening institutional reforms. However, as this chapter has examined, the improvement in the quality of institutions affects countries and sectors differently. Whereas it has been markedly significant for Asia, for Latin America the

effect has been meager and, if significant, this has been in natural resource-based sectors, a positive dynamic that ultimately could also turn into a curse.

It is important to point out the limitations of this study so as to open new windows of opportunity for future research: regardless their wide use in several seminal articles, the data from Gwartney e*t al.*, (2012) is taken as if there was zero noise in the computation of the ranking score and the actual performance indicator. Relying on the solid accuracy of these indices over time can be a risky endeavor considering the great variety of unobserved institutional development. Also, as stated before, most of the 'contracting' institutions are national (e.g. rule of law) and not sectoral. However, considering the emerging literature on evolutionary economics highlighting the importance of national systems of innovation in creating learning processes specific to each sector, the construction of cross-country sectoral measures of institutions is imperative.

Furthermore, a common caveat in the methodology of panel growth regressions is the issue of omitted variables. There can be numerous unmeasured variables and initial conditions that have remained outside the scope of the study. Further research should explore other variables related to the country's specific resource endowments. This is the case with data on informal employment. It is of particular relevance for the case of Latin America since there is vast statistical evidence that this became a large share in total employment after the 1980s. Once this is accounted for in the measurement of labor productivity, it may reveal different results within the present framework.

Additionally, the possibility that economic sectors of frontier countries may react to the catch up dynamics of sectors in non-frontier countries remains as an unexplored theoretical and empirical issue. Leading productivity sectors may react to the competitive pressures; in order to remain ahead of the followers, leaders can upgrade sectoral policies and institutions in accordance with the competition. If that occurs, the issue of endogeneity in the conventional catch up framework is likely to arise.

Finally, looking at the concept of technology, a central limitation is that the measures of labor productivity growth are not the best to quantify the improvements of productivity related to technological progress. A more comprehensive and reliable measure embodying the advancements in technology should include the changes in capital and intangible inputs in particular if we look at post-1980s structural change. The construction of new time series of 'sectoral-specific' TFPs for the post-1950 period in Latin America should therefore also be put on the research agenda.

5.7. Appendix to chapter 5

5.1.A: Test of differences in means of institutions by region 1970-2010

Institution	Latin America	Asia
Overall index	5.667*	6.913*
Property rights & legal structure	4.546*	6.091*
Market regulation	6.033*	6.570*
Access to sound money	5.681*	8.015*
Size of government	6.508*	6.820*

Note: The test uses the analysis of variance of means (ANOVA). The symbol * indicates that the mean differences are significant at the 95% level.

Table 5.1.B. Normality test on estimated residuals from table 5.9

Sector	Region	Jarque-Bera	Probability
Agriculture	Asia	10.35	0.06
	Latin America	0.44	0.80
Mining	Asia	2.82	0.24
	Latin America	0.26	0.87
Manufacturing	Asia	0.79	0.67
	Latin America	1.84	0.39
Construction	Asia	0.40	0.97
	Latin America	0.96	0.61
Market Services	Asia	1.02	0.59
	Latin America	0.23	0.88
Non-Market Services	Asia	6.95	0.04
	Latin America	6.40	0.04

Note: The null hypothesis is that the estimated residuals are normally distributed (χ^2), symmetric and a kurtosis of 3.

Table 5.2.A: Pairwise correlation matrix

Variable	Δln(Y/L) agriculture	Δln(Y/L) mining	Δln(Y/L) manufacturing	Δln(Y/L) construction	Δln(Y/L) market services	Δln(Y/L) non-market services	Property rights (PR)	Market regulation (MR)	Sound money (SM)	Size of government (SG)
Δln(Y/L) agriculture	1.00									
Δln(Y/L) mining	0.20	1.00								
Δln(Y/L) manufacturing	0.29	0.09	1.00							
Δln(Y/L) construction	0.14	-0.06	0.28	1.00						
Δln(Y/L) market services	0.21	0.00	0.46	0.32	1.00					
Δln(Y/L) non-market serv.	0.16	0.26	0.25	0.03	0.08	1.00				
Property rights (PR)	-0.08	0.01	0.24	0.09	0.03	-0.01	1.00			
Market regulation (MR)	0.18	0.15	0.41	0.04	0.20	0.05	0.21	1.00		
Sound money (SM)	0.15	0.02	0.39	0.09	0.31	0.001	0.38	0.45	1.00	
Size of government (SG)	0.03	0.06	0.35	0.06	0.17	0.07	0.51	0.56	0.66	1.00

Table 5.2.B: Re-estimation using different human capital control (tertiary schooling) and non-linear effect (DTF^2), 1970-2010
(Instrumental variable specification)

Variable	Agriculture		Mining		Manufacturing		Construction		Market Services		Non-Market Services	
	Asia	Latin America	Asia	Latin America	Asia	Latin America	Asia	Latin America	Asia	Latin America	Asia	Latin America
PR*DFT	0.07**	0.001	0.12***	0.20	0.10**	0.03	0.10	0.07	0.29	0.06	0.02	0.17
MR*DTF	0.09**	0.05	0.11***	0.10	0.11***	0.07	0.09***	-0.02	0.07**	0.04	0.04	0.15
SM*DTF	0.04**	0.01	0.09**	0.05**	0.04**	-0.02	-0.98	0.02	0.02	0.01	0.07	0.01
SG*DTF	0.08***	0.07	0.12***	0.09***	0.12***	0.04**	0.08***	0.06*	0.08***	0.05	-0.01	0.02
DTF ^{2}(Sq)	0,38	0.31	0.25	0.19	0.24	0.45	0.25	0.14	0.35	0.24	0.36	0.22
HC (Tert)	0.001	0.02	0.19	0.75	0.11*	0.20**	-0.02	-0.13	0.17*	0.001	-0.06	-0.13
Invest	0.74**	0.95	-0.38	0.26	0.43*	0.24	0.17	1.28	0.46*	0.42	0.55*	0.05
Export	-0.19***	0.52	0.01	0.42*	0.12	0.61	-0.06	0.67*	-0.03	0.04	0.20	1.09
F-stat	2.90	4.95	9.71	3.12	2.97	3.08	2.09	2.10	2.11	2.12	2.13	2.14
χ^2	0.07(0.96)	0.29(0.89)	0.10(0.78)	0.18(0.56)	0.44(0.59)	0.02(0.16)	0.55(0.98)	0.41(0.88)	0.02(0.96)	0.03(0.98)	0.11(0.24)	0.08(0.52)
Adj R^2	0.42	0.71	0.57	0.67	0.45	0.44	0.45	0.46	0.47	0.48	0.49	0.50
N	61	62	61	60	61	60	61	59	61	62	61	62

Note: HC (Tert) refers to schooling at the tertiary educational level. DTF (Sq) refers to the square of the variable of distance to the frontier.
The dependent variable is $\Delta\ln(Y/L)$ is the change of the natural log of labor productivity in the respective economic sector in every 5-year interval. PR*DTF, MR*DTF, SM*DTF, and SG*DTF are the separate interaction terms of Property rights, Market regulation, Sound money, and Size of government with the Distance to frontier (DTF). The signs *, **, *** are statistical significant at 10%, 5%, and 1% levels, respectively. To avoid a repetitive display of estimates, individual coefficients of DTF, and the institutions are not shown. Similarly, the constant terms and period and country dummies were included but are not reported in the table for brevity. χ^2 is the Breusch-Godfrey test for first-order serial correlation under the null hypothesis of no s erial correlation. Internal instruments in the IV regression are the variables from the first stage regression lagged in two periods (t-2).

Figure 5.3.A: Indices of institutional quality in Latin America, 1970-2010
(Standarized average scores [0-10])

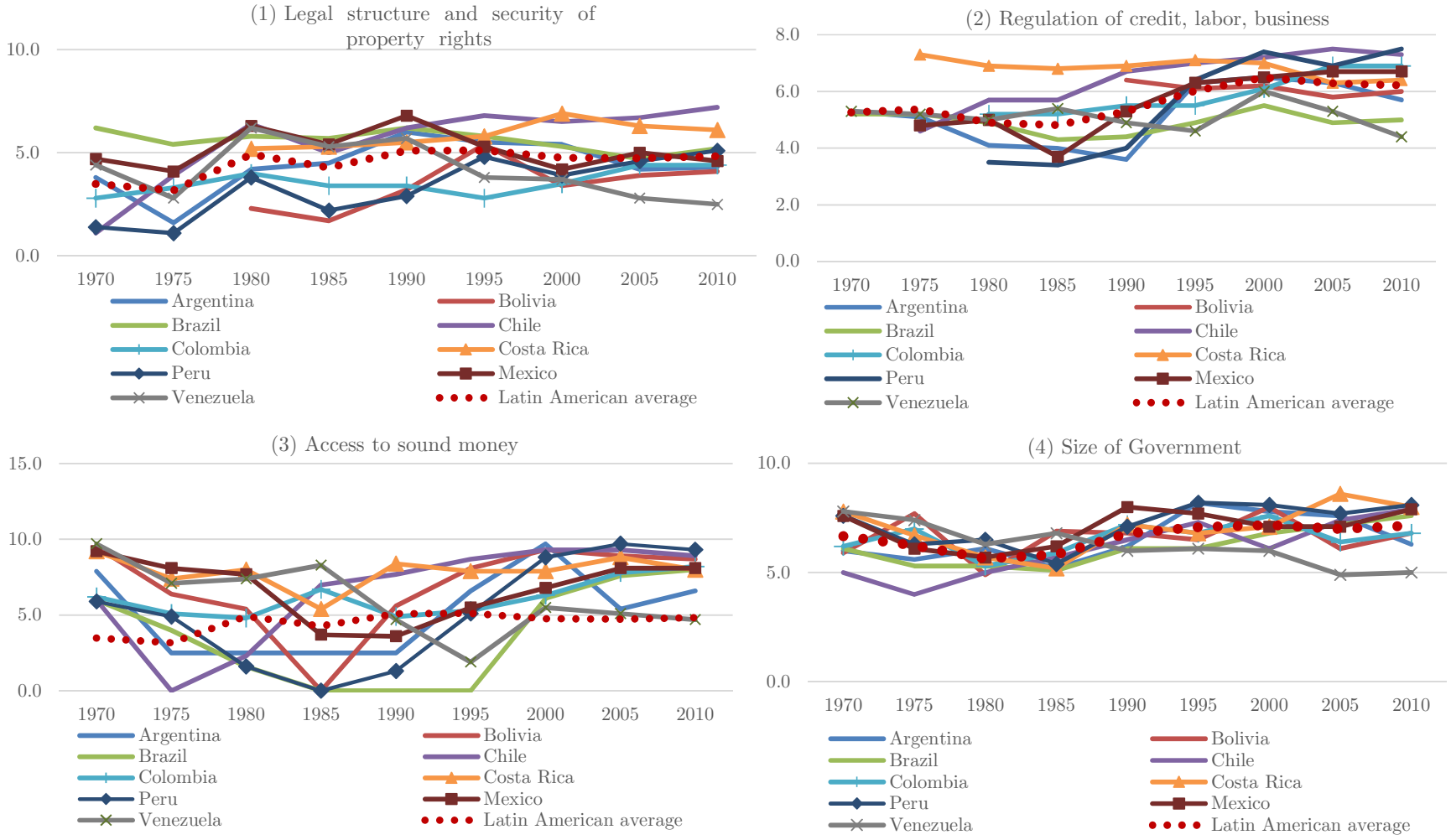
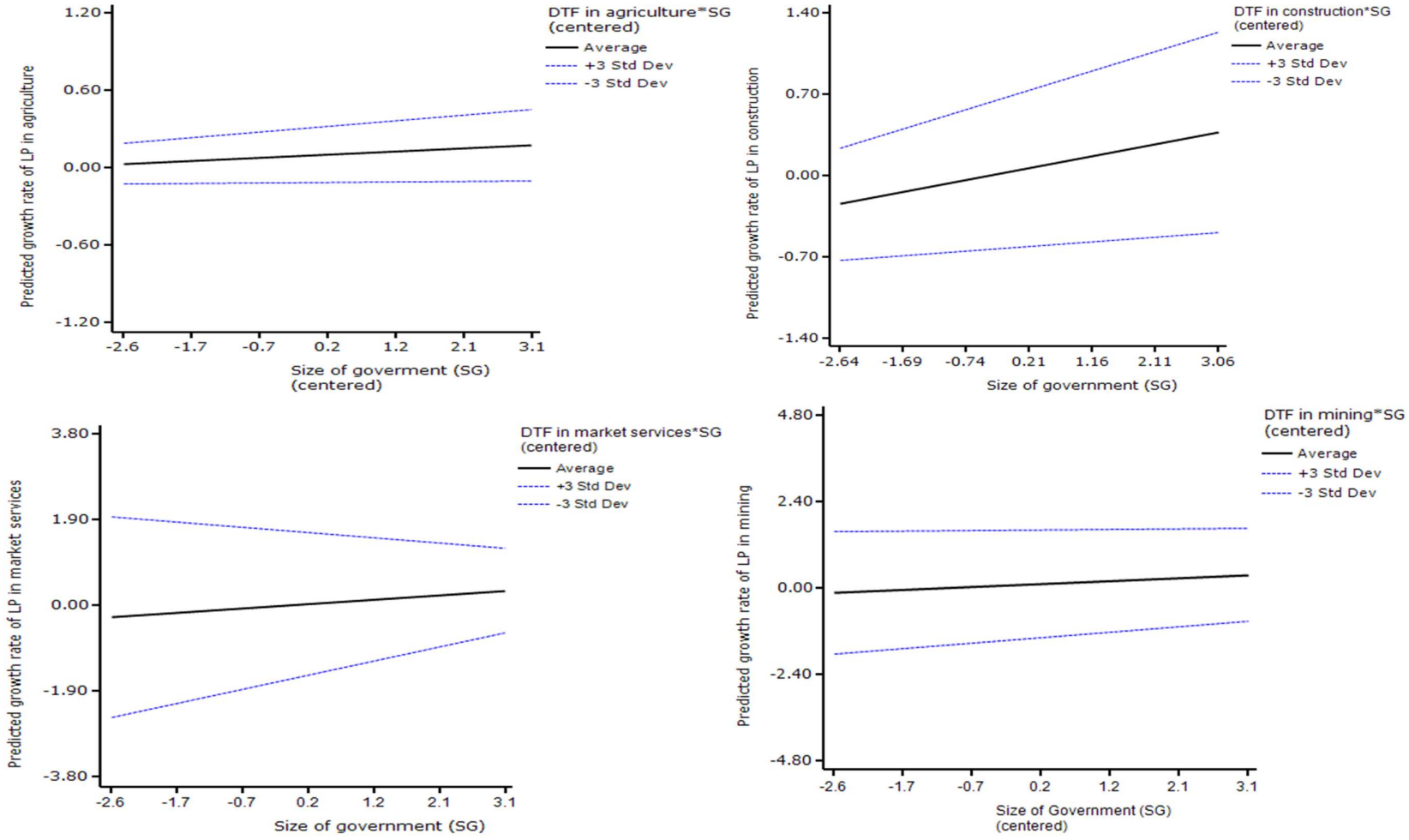
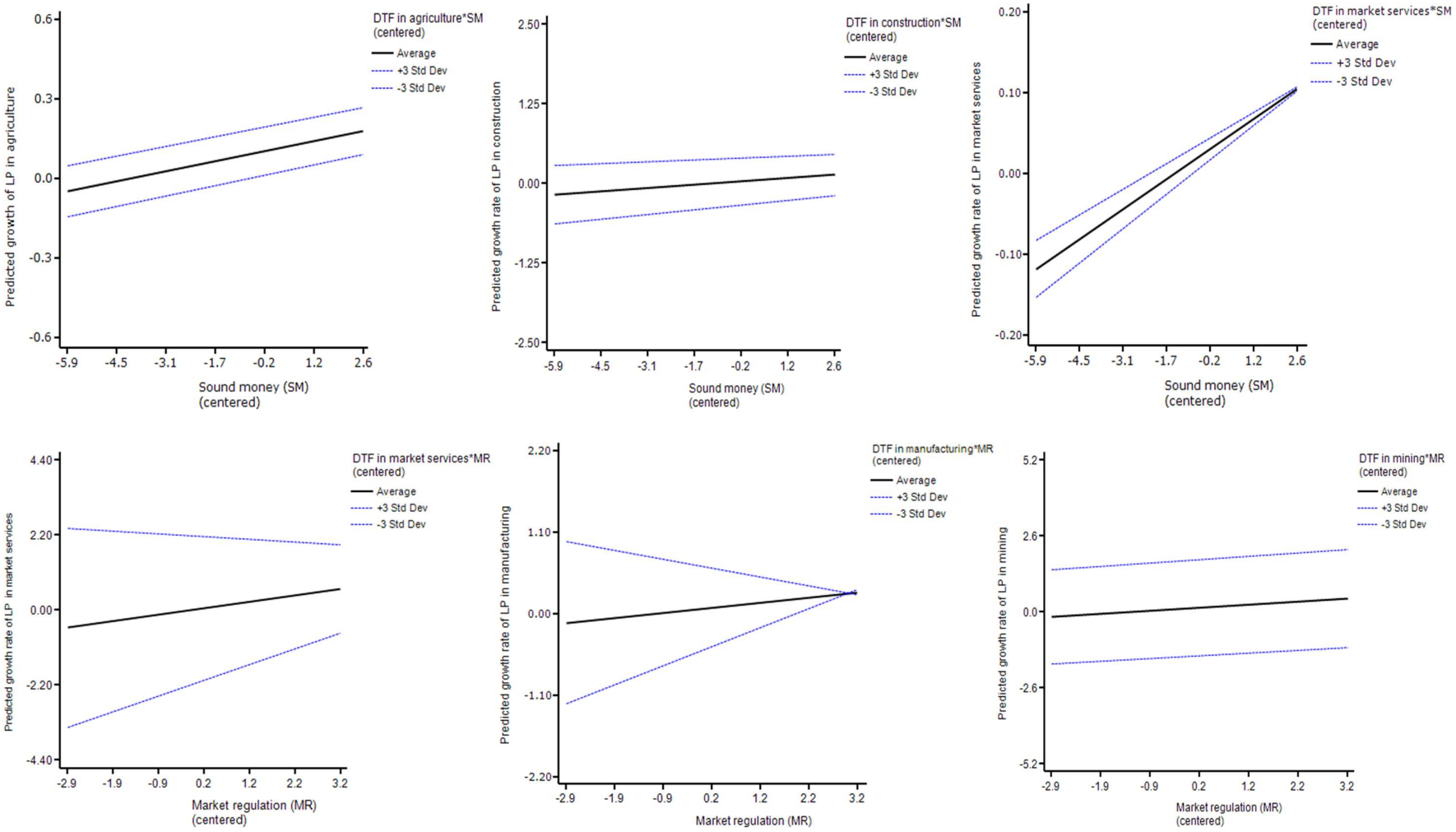


Figure 5.3.B Average marginal effects of interactions with distance to the frontier on labor productivity growth at different levels and types of institutions (based on interaction terms from tables 5.5 to 5.8)



Continuation of figure 5.3.B.



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Chapter 6

Conclusions

6.1. Summary

During the last decades, the use of statistical techniques and economic theory to explain Latin American history has produced a significant rethinking of the economic past. However, several fundamental questions have remained overlooked. Despite pioneering contributions by prominent economic historians, the poor quality or total absence of historical data and the limited use of economic theory have been factors hampering the progress in solving major historical questions in Latin America. Notwithstanding various data and methodological constraints, this dissertation was an effort in 'squaring the circle' quantitatively into four major questions:

- Was the colonial fiscal system in Spanish America unsustainable before 1810?
- Did a secular decline of real wages inspire the Mexican Revolution in 1910?
- Did import substitution promote structural change between 1935 and 1975?
- Did institutional change stimulate catching up in Latin America after 1970?

Regarding the first question**, Chapter 2** examined empirically the long-run fiscal sustainability of the colonial treasuries of Spanish America from c.1570 to c.1810. It introduced a basic macroeconomic framework of the government budget constraint into the historical case of the Spanish American finances to show statistical evidence on how these macroeconomic conditions changed over time in different colonies. Furthermore, it provided new estimates by adjusting the fiscal series of major colonial treasuries for inflation.

Findings suggest that the long-run fiscal performance of the treasuries can be misleading when inflation is not taken into account; the colonial finances of the largest caja for the Spanish empire, Mexico City, can be misrepresented for the period of 1760-1810. Also, for Peru when inflation is not considered, total revenues and expenditures in Lima's caja are undervalued for most of the seventeenth century.

Moreover, there was a shifting process of fiscal sustainability between the colonial treasuries across centuries. While the treasuries of New Spain were unsustainable during the 'Habsburg reign', Peru's treasuries experienced a sustainable

fiscal pattern. During the period of 'succession and transition', New Spain's treasuries restored their sustainability in contrast to Peru and Buenos Aires. And finally, in the period of the 'reformism and Napoleonic wars', the treasuries of New Spain deteriorated vastly reaching an unsustainable position, contrary to their counterparts in Peru and Rio de la Plata.

The ensuing general question in the thesis was addressed in **Chapter 3.** This chapter examined quantitatively the historical assumption of a relationship of a declining trend of real wages and the Mexican Revolution. The analysis conducted a re-estimation of real wages across Mexican regions from 1877 to c.1910. It showed that the estimated lower-bound regionally-adjusted wages remained relatively stable in most of the Mexican regions throughout the period. Although these wages followed divergent within-country patterns and although there was a slight declining trend in wages of the industrial sector of the Pacific South region, from a broader quantitative perspective there was no dramatic decline as the conventional literature argues. The present estimates indicate that the interpretation of a secular decline in workers' living standards in Mexico from 1877-1910 does not have strong quantitative foundations.

However, a pattern of real wage divergence across regions was a salient feature. The regions in the Center and Pacific South of the country experienced slower real wage growth relative to the North, Pacific-North, and Gulf generating wide sectoral wage gaps. A tension between the forces of regional convergence and divergence emerged in which prevalent labor market institutions in Mexico tended to promote regional divergence, keeping structural labor market barriers that prevented inter-regional labor mobility and income convergence within the country.

The third general question was examined in **chapter 4**. This was focused on one of the ultimate objectives of industrial policy, the "reallocation" of employment from traditional to modern economic activities in order to increase overall productivity, a feature broadly known as *structural change.* Using a higher degree of data disaggregation, the analysis assessed empirically the competing views on productivity and structural change during the period of 1935-1975 in three Latin American countries: Mexico, Argentina, and Brazil. It tested the existence of a *structural bonus/burden* within manufacturing industries on whether there were significant labor input shifts from less to more productive manufacturing branches induced by tariff policies. The analysis employed disaggregated data from official industrial censuses and produces new estimates of labor productivity for 1935/39, 1950, and 1975. Then, it decomposed the components of productivity growth in manufacturing industries by applying a shift-share analysis to this newly compiled data.

Estimates from the analysis were unable to find significant evidence of structural change within manufacturing in these countries over the period. The reallocation of labor within the sector did not provide an extra bonus to aggregate productivity growth in addition to growth within individual branches. Most of these branches (food and beverages; textiles and wearing apparel) were by nature labor-intensive and contributed the most to overall productivity growth. Needless to say, one of the broad accomplishments of import substitution was the development of a productive 'light'

manufacturing industry; however, despite the government incentives in protecting other more relatively sophisticated sectors (machinery, transport equipment, and chemicals) with capital-intensive technologies, manufacturing remained 'stuck' into traditional industrial activities.

The last question of the dissertation was addressed in **Chapter 5.** This investigated the role of a set of different institutions in the process of catching up at the sectoral level. Employing various indicators of institutional quality, it examined through a panel dataset the partial effects of a set of institutions on sectoral productivity growth. Drawing on the range of sectoral data from 1970 to 2010, the empirical analysis is based on nineteen 'catch up' economies and taking the United States as the technology leader.

The empirical approach relies on a re-arranged version of the Nelson-Phelps catch up model of technology diffusion. The analysis points out different channels in which institutional quality impacts sectoral productivity growth. Controlling for other growth factors, institutions which interacted with the distance to the frontier affected positively and significantly the growth of labor productivity at the sectoral level. This indicated that backward sectors in countries endowed with higher institutional quality grow faster than in sectors of countries with lower institutional quality.

Following the empirical specification, the chapter analyzed the different effects that the same institutions have on sectors far-removed from the frontier. The results pointed to different channels through which institutional quality impact on sectoral productivity growth: greater freedom in the legal structure and property rights, freedom from tight market regulations, greater access to sound money, and a small and more efficient government, all in a different magnitude affected positively the growth of sectoral productivity.

In hindsight the results were broadly in line with the body of literature of the so-called 'New Institutional Economics' regarding the prominence of 'market-friendly' institutions in enhancing productivity growth in the long-run. However, in spite of controlling for country and time invariant factors, estimates are sensitive to the sample selection. The model predictions apply to the majority of the sectors in the Asian sample. On the other hand, sectoral productivity growth in Latin America is not statistically associated with the quality of property rights and market regulations; only in the mining and construction sectors, productivity is statistically associated with the reduction in the size of government and with a better access to sound money.

6.2. Future research avenues and quantitative challenges

During the process of providing new answers to the aforementioned questions, new puzzles emerged. Regarding the first question on colonial fiscal sustainability (chapter 2) we still do not know how sustainable 'relative' to other major empires (for e.g. the British empire) those transatlantic fiscal policies were in Latin America. In order to advance in the debate of colonialism and on the issue of fiscal sustainability

in the very long-run, this fiscal data should be put on a broader global scale since colonialism was a global phenomenon.

Some of the questions have already started to be answered by ongoing quantitative research.[245] Still, new data should be rendered into a global context. As the historian Paul Kennedy argues, the 'Great Powers' can only be properly measured in relation to others. Thereby, a comprehensive comparative picture of the contribution of economic growth of the colonies to the empires (and vice versa) is essential to further expand the field of Latin American colonial history from a global economic perspective.

Regarding the second question addressed in **chapter 3** related to the standards of living of Latin Americans during the *belle époque* (1870-1913), particularly on the trends of Mexican real wages, the previous work by Williamson (1999) and Gómez-Galvarriato (1998) have already provided a global comparative view.[246] Overall, Mexican wages in this period appeared to move in tandem with the wage growth of the industrialized 'core'.

Although the empirical findings in the Mexican case show that the overall trend of real wages remained stable, wages increasingly diverged over time and across Mexican regions, and certainly did not approach a point of equalization (between regions) as the standard trade theory suggests. This finding is of particular importance in the so-called *New Economic Geography* theory which remarkably mirrors today's Mexico; the wage divergence generated by the 'Porfirian' economic policies can be seen as an historical parallel with present regional developments in Mexico. That is, the regional wage inequality in the late 19th century bears a close resemblance to the emergence of the regional wage inequality after the liberalization of trade in the late 20th century.[247]

Yet, the dramatic decline of Mexican worker's wages that according to various historians occurred from 1876 to 1910 and that may have spurred the sentiment against the dictatorial regime, cannot be observed in the estimated real wage data. While there was a slight deterioration in the southern regions relative to the northern ones, it is difficult to warrant this feature as a precursor for a widespread discontent that incited the Mexican Revolution. In fact, as has been widely documented in previous studies, the proliferation of mining protests and the formation of the armed revolutionary groups occurred mainly in the northern part of the country and to a lesser degree in the southern part where real wages were lower.

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[245] For instance, Arroyo Abad, L., & van Zanden, J. L. (2014). *Growth under extractive institutions? Latin American per capita GDP in colonial times* (No. 0061). Utrecht University, Centre for Global Economic History.

[246] Williamson, J. G. (1999). Real wages, inequality and globalization in Latin America before 1940. *Revista de Historia Económica/Journal of Iberian and Latin American Economic History (Second Series)*, *17*(S1), 101-142; Gómez-Galvarriato, A. (1998). The evolution of prices and real wages in Mexico from the Porfiriato to the Revolution. *Latin America and the World Economy Since 1800*, p. 347-78.

[247] See the dynamics of Mexican regional wages during the 1990s in the work of Hanson, G. H. (2003). What has happened to wages in Mexico since NAFTA? (No. w9563). National Bureau of Economic Research.

Nevertheless, in addition to answering these historical questions on regional development, more studies employing disaggregated data on physical and human capital are required to understand in depth the regional dynamics of the Mexican economy in the late-nineteenth century.[248]

As regards to the third question on whether import substitution promoted structural change, this inexorably this leads to the recent debate on protectionism and industrialization. Notable contemporary economists like Dani Rodrik, Justin Y. Lin, Joseph Stiglitz, and several others, have brought back the discussion on the role of the state in the promotion of industrialization via structural transformation. As was shown in **chapter 4**, although import substitution policies failed to induce structural change in manufacturing, it does not imply a definite rejection of active industrial policies to boost economic growth. While acknowledging the policy shortcomings to sustain productivity growth, the rates accomplished in the manufacturing sector have not been replicated since in any of these countries. Thereby, an unavoidable counterfactual surfaces in the light of this paradox: could import substitution have promoted structural change if tariff policies would have not been captured by vested interests of unproductive industries? That is to say, are 'good' institutions a prerequisite for an effective industrial policy?

Finally, in relation to the last question, **chapter 5** tackled the puzzle on whether 'good' institutions have stimulated productivity growth. Interestingly, the empirical results were not as satisfactory for the case of Latin America as the proponents of the traditional theory of institutions would like. They regard them as main drivers of long-term productivity growth. Unlike most of Asian countries, catching up in Latin America occurred in the natural-resource based sectors.

Furthermore, the types of institutions that were found statistically significant in stimulating productivity in these sectors are not the ones typically described in the seminal literature. Instead of institutions such as the protection of property rights and a 'good' regulatory structure, the empirical analysis showed that the institutions of sound access to money, and the reduction in the size government is associated with the enhancement of productivity in those sectors.

Although at first glance it may seem that any sort of boost in productivity growth represents a positive feature for the region, empirical research has shown an important exception. Some country case studies on developing regions have revealed that economic growth in natural resource-based sectors supplemented with institutions that promote the reduction in the size of government and minimal regulatory frameworks, has turned instead of a blessing into a curse.[249]

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[248] For instance, in relation to the agenda on historical regional development, recently the work of Melissa Dell has showed evidence of the role of the regional demands for land redistribution during the Mexican Revolution and subsequent economic development across Mexican states. See, Dell, M. (2012). Insurgency and long-run development: Lessons from the Mexican revolution. *Harvard University, mimeograph*.

[249] See for instance, Frankel, J. A. (2012). The natural resource curse: a survey of diagnoses and some prescriptions; Melham, H., Moene, K., & Torvik, R. (2006). Institutions and the resource curse. *The*

Considering these findings and the existent literature revealing the link between different stages of economic growth and environmental degradation (for e.g. the environmental Kuznets curve hypothesis), the possibility of a comeback of cliometrics in Latin American's scholarship can be a fruitful research avenue.[250] An interdisciplinary fusion between environmental history and institutional economics might not only be an emerging academic field but also a necessity for the public policy of the region.

Economic Journal, *116*(508), 1-20; and in Sala-i-Martin, X., & Subramanian, A. (2003). *Addressing the natural resource curse: An illustration from Nigeria* (No. w9804). National Bureau of Economic Research.

[250] As explored in Kander, A. (2016). "Economic environmental history." In *Structural Analysis and the Process of Economic Development*. Routledge: London & New York.

Samenvatting (Summary in Dutch)[251]

In de laatste decennia heeft de toepassing van statistische technieken en van economische theorie het begrip van de economische geschiedenis van Latijns Amerika significant veranderd. Echter, verschillende fundamentele vragen zijn tot op heden buiten schot gebleven. Ondanks het pionierswerk van vooraanstaande economisch historici, staat het gebrek aan betrouwbaar cijfermateriaal vaak in de weg van een antwoord op die grote vragen over de geschiedenis van Latijns Amerika. Deze thesis poogt een kwantitatieve bijdrage te leveren aan de volgende vier belangrijke vraagstukken:

- Werd het fiscaal systeem in koloniaal Spaans Amerika in de periode voor 1810 gekenmerkt door een gebrek aan fiscale solvabiliteit?
- Werd de Mexicaanse Revolutie in 1910 aangemoedigd door een seculiere achteruitgang van reële lonen?
- Leidde import substitutie tot structurele verandering tussen 1935 en 1975?
- Stimuleerde institutionele verandering in Latijns Amerika een economische inhaalslag na 1970?

Wat betreft het eerste vraagstuk, **Hoofdstuk 2** bestudeert empirisch de fiscale solvabiliteit van de koloniale schatkisten van Spaans Amerika over de lange termijn van 1570 tot 1810. Het onderzoek implementeert een standaard macro-economisch model van het overheidsbudget op de historische casus van de Spaans Amerikaanse financiën. Dit is gedaan in een poging om statistisch aan te tonen hoe zulke macro-economische condities veranderden over tijd en tussen verschillende koloniën. Daarnaast vormen de nieuwe schattingen een verdere bijdrage van het onderzoek, die mogelijk is gemaakt door de fiscale gegevens van de grootste koloniale schatkisten te corrigeren voor inflatie.

De resultaten suggereren dat de fiscale ontwikkeling van de schatkisten over de lange termijn een misleiden beeld kan geven van het fiscaal functioneren wanneer geen rekening wordt gehouden met inflatie. Zodoende kan de koloniale financiën van de grootste caja in het Spaanse rijk tijdens de periode 1760-1810, Mexico City, verkeerd worden geïnterpreteerd. Dat geldt ook voor Peru, waar de totale inkomsten en uitgaven in Lima's caja worden onderschat voor het grootste deel van de zeventiende eeuw wanneer geen rekening wordt gehouden met inflatie.

Daarnaast vond er over tijd tussen de verschillende koloniale schatkisten een verschuiving plaats van fiscale solvabiliteit. Terwijl de schatkisten van Nieuw Spanje niet houdbaar bleken tijdens het Habsburgse regime genoten Peru's schatkisten wel

[251] I am grateful to Joost Veenstra for the translation to Dutch of this section.

een houdbare fiscale situatie. Daarentegen, tijdens de periode van 'opvolging en overgang' – en in tegenstelling tot Peru en Buenos Aires – bewerkstelligde de schatkist van Nieuw Spanje's een solvabele positie. Als laatste, tijdens de periode van 'hervorming en de Napoleontische oorlogen' verslechterde het functioneren van de schatkisten van Nieuwe Spanje weer, hetgeen – wederom in tegenstelling tot Peru en Rio de la Plata – resulteerde in een niet houdbare positie.

Het tweede grote thema van deze thesis wordt geadresseerd in **Hoofdstuk 3**. Dit hoofdstuk biedt een kwantitatieve toets van de hypothese dat de Mexicaanse Revolutie gerelateerd was aan afnemende reële lonen. Reële lonen worden herschat voor Mexicaanse regio's tussen 1877 en 1910. De resultaten laten zien dat gedurende deze periode lonen relatief stabiel bleven in de meeste Mexicaanse regio's. Hoewel de loonontwikkeling divergeerde tussen regio's en ondanks een kleine daling van lonen in de industriële sector van de regio aan de zuidkust met de Stille Oceaan, geeft de brede tendens geen blijk van dramatische verslechtering, zoals in de conventionele literatuur wel wordt geschreven. Dit toont aan dat de notie van seculiere achteruitgang in het levenspeil van arbeiders in Mexico van 1877 tot 1910 geen sterke kwantitatieve basis heeft.

Wat wel opvalt is het patroon van divergerende reële lonen tussen regio's. De regio's in het midden van het land en in het zuidkustgebied van de Stille Oceaan ondervonden een langzamere groei van reële lonen dan in het noorden, het noordkustgebied van de Stille Oceaan en het kustgebied van de Golf van Mexico, hetgeen leidde tot grote regionale loonverschillen. Een spanning tussen de krachten van regionale convergentie en divergentie komt aan het licht, waarin de bestaande arbeidsmarktinstituties in Mexico tot divergentie neigden te leiden, een situatie die structurele arbeidsmarktbarrières – welke de interregionale mobiliteit en de inkomensconvergentie binnen het land in de weg stonden – in stand hield.

De derde grote vraag wordt bestudeerd in **Hoofdstuk 4**. Dit hoofdstuk richt zich op één van de belangrijkste doeleinden van industrieel beleid, namelijk de 'reallocatie' van werkgelegenheid van traditionele naar moderne economische activiteit om de algehele productiviteit te verhogen, een ontwikkeling die breed bekend staat als *structurele verandering*. Op een gedetailleerd niveau van aggregatie maakt de analyse een empirische afweging tussen concurrerende perspectieven op productiviteit en structurele verandering tijdens de periode 1935-1975 in drie Latijns Amerikaanse landen: Mexico, Argentinië en Brazilië. De analyse toetst het bestaan van een *structurele bonus/straf* in de industrie door te kijken of er – als gevolg van handelstariefbeleid – significante arbeidsverschuivingen plaats vonden van minder naar meer productieve branches van de industrie. Hiervoor maakt de analyse gebruik van sectorale data afkomstig van officiële industriële tellingen, hetgeen nieuwe schattingen van arbeidsproductiviteit mogelijk maakt voor 1935/39, 1950 en 1975. Vervolgens wordt de bijdrage van structurele verandering aan de algehele productiviteitsgroei berekend door de toepassing van een *shift-share analysis* op de nieuw verzamelde data.

De resultaten van deze analyse leveren geen significant bewijs van structurele verandering in de industrie in deze landen tijdens de bestudeerde periode. De reallocatie

van arbeid binnen de industrie realiseerde geen extra productiviteitsbonus – voor de gehele industrie – bovenop de groei binnen individuele branches van de industrie. Het merendeel van die branches waren van nature arbeidsintensief (voedsel- en drinkwaren; textiel en kleding) en leverden traditioneel de grootste bijdrage aan de algehele productiviteitsgroei. De importsubstitutie bewerkstelligde wel de ontwikkeling van een productieve 'lichte' industrie. Maar ondanks de overheidsbescherming van relatief complexe branches (machinebouw, transportmateriaal, en chemicaliën) met kapitaal intensieve technologieën, bleef het merendeel van de werkgelegenheid in de industrie vast zitten binnen traditionele industriële activiteiten.

Het laatste vraagstuk van deze dissertatie wordt geadresseerd in **Hoofdstuk 5**. Dit hoofdstuk onderzoekt de rol van een verzameling van verschillende instituties in het economisch inhaalproces dat zich afspeelde op sectoraal niveau. Aan de hand van een aantal indicatoren van de kwaliteit van instituties bestudeert het hoofdstuk het effect dat instituties hadden op sectorale productiviteitsgroei. De empirische analyse is gebaseerd op negentien 'inhaal' economieën plus de wereldleider op gebied van technologie, de Verenigde Staten van Amerika (VS).

De empirische aanpak leunt op een herschikte uitvoering van het Nelson-Phelps model van technologische diffusie. De analyse identificeert verschillende kanalen via welke de kwaliteit van instituties de sectorale productiviteitsgroei beïnvloedt. Wanneer rekening wordt gehouden met andere factoren die groei beïnvloeden, blijkt dat instituties die interacteerden met de afstand tot aan de VS een positief en significant effect hadden op sectorale arbeidsproductiviteitsgroei. Dit suggereert dat achtergestelde sectoren sneller groeien in landen met een hoogwaardige kwaliteit van instituties dan in landen met instituties van mindere kwaliteit.

Uit de empirische specificatie volgt een analyse van de uiteenlopende effecten die dezelfde instituties hebben op sectoren die ver achter lopen op de VS. De resultaten wijzen verschillende kanalen aan via welke de kwaliteit van instituties effect sorteert op sectorale productiviteitsgroei: meer vrijheid in de wetgeving, beter beschermde eigendomsrechten, vrijheid van strenge marktregulering, betere toegang tot financieel kapitaal, en een kleine doch efficiënte overheid hebben allemaal een positief effect op sectorale productiviteitsgroei, hoewel de omvang van dat effect verschilt.

Retrospectief passen de resultaten binnen de 'Nieuwe Institutionele Economie', waarin een prominente rol worden toegedicht aan 'markt vriendelijke' instituties in het productiviteitsgroeiproces over de lange termijn. Echter, ondanks de rekening die wordt gehouden met land en tijd specifieke factoren blijken de schattingen gevoelig voor variaties in de landensamenstelling van de steekproef. De voorspellingen van het model hebben toepassing op het merendeel van de sectoren wanneer de steekproef bestaat uit Aziatische landen. Daarentegen wordt sectorale productiviteitsgroei in Latijns Amerika niet statistische geassocieerd met de kwaliteit van eigendomsrechten en de mate van marktregulering; alleen in de mijnbouw en de bouwsector is productiviteit statistisch geassocieerd met de beperking van de overheidsomvang en met een betere toegang tot financieel kapitaal.