

The "*Mining-Led Growth*" in Bourbon Mexico, the Role of the State and the Economic Cost of Independence¹

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Introduction

The Spanish empire in America has always had, and it still has, a notoriously bad press. It is not easy to find many defenders of the Spanish colonial history among specialists or ordinary people. In fact, the former as well as the latter, if asked, would probably pronounce the unanimous opinion that many of the contemporary economic problems plaguing Latin America have their roots in the "colonial heritage". Central to this standpoint is the view that the colonial State was a factor of economic backwardness. In this paper we do not examine the general implications of this popular claim. On the contrary, we focus on the role of the State in the economic growth of Bourbon Mexico (New Spain) and on the economic cost of Independence.

In the early 18th century, "a great shift" [Klein (1995)] caused New Spain to substitute for Peru as the jewel of the Spanish Crown in America. By 1800, after decades of growth, the remittances of fiscal surplus from New Spain to the Peninsula and other Spanish colonies in the Caribbean reached a historical record and became the cornerstone of the imperial finances [Marichal y Souto (1994)]. In spite of a "pessimist" view about the economic performance of colonial Mexico in terms of modernization and convergence with the US [Coatsworth (1990 and 2003)], most indicators show that during the century preceding the start of the *Insurgencia* (1810) the GDP and the population of the Viceroyalty grew. Maddison (2001) has estimated a per capita GDP growth of one third.

¹ Short, somewhat informal, and slightly modified, English version of a previous article [Dobado and Marrero (2001)]. Please do not to quote without permission by the authors. Any comment will be welcome.

We find that changes in the role of the royal monopoly on mercury were a decisive factor in the growth of the mining sector that led the expansion of the rest of the economy. Taxation on an expanding mining-led economy proved to be a more efficient, and politically acceptable, way to increase fiscal revenue than maximizing monopoly income from mercury. Other measures (institutional creativity, tax exemptions, technical education, etc.) reinforced the positive consequences of that important change –from strict mercantilism to limited proto-liberalism- in the behavior of the State. The colonial State, aiming at increasing its fiscal revenue in New Spain, promoted genuine economic (pre-industrial) growth through, in particular, its policy on the mining sector.

The decades after the Independence are unanimously considered a period of economic and demographic decline [Coatsworth (1990), Maddison 2001, Cárdenas (1997 and 2003) and Salvucci (1997)]. The divergence of Mexico with respect to the Atlantic economies was especially important in this period. Why did the economic potential of Independence fail to materialize? [Bulmer-Thomas (1994)]. If the economic burden of the colonial relationship with an absolutist State and a relatively stagnant economy was heavy [Coatsworth (1990)], should not Independence bring with it a new era of growth? Coatsworth's answer emphasizes the cost of "gaining the Independence", that was dramatically high in Mexico (devastating wars and subsequent human and physical capital destructions, disruption of economic networks, fiscal crisis, etc.), while he regards the Independence as having benefits only. However, it might be interesting to explore the possibility that the colonial relationship provided benefits in some particular, although not irrelevant, economic domains as well. Some benefits has been already suggested by Bulmer-Thomas (1994). Others have probably been overlooked by the specialized literature.

The results of our tentative estimation of the economic cost of the Independence support the idea that Mexico paid a big price for the violent and long-lasting interruption of the colonial "*mining-led growth*" from 1810 on.

Therefore, in this paper, three main propositions will be defended:

- 1) A process of pre-industrial economic growth that may be described as "*mining-lead growth*" took place in colonial Mexico during the 18th century.
- 2) The Spanish colonial state played a protagonist role in the "*mining-lead growth*" through innovative policies and institutional creativity.
- 3) Independence itself, and not only because of the costly way in which it was gained, imposed a very important economic burden on Mexico.

Silver, mercury and Bourbon reformism

It is widely accepted that silver production grew in Bourbon Mexico at an unprecedented rate during the 18th century.² Even though there was no lack of short and medium term crisis, the long time span of the mining growth is nonetheless remarkable –see Figure 1. The average yearly rate of growth between 1690 and 1809 was 1.3%.³ By 1800, New Spain's silver production represented almost two thirds of the world output.⁴ In the postcolonial period, Mexico continued to be the main silver producer in the world during most of the 19th and 20th centuries. However, it never recovered the share of world production it had held in colonial times. Thus, as Wright and Czelusta (2002) have observed with regard to the US case, and confining their conclusion to silver production, "*no other country exploited its geological potential to the same extent.*"⁵

In spite of the extraordinary abundance of silver deposits in numerous locations within the Mexican geography, the sustained growth of the New Spain's mining sector is particularly surprising. It took place in the context of a backward economy. It was based on a "nonrenewable"

² New Spain mining sector basically consisted in extracting and refining silver minerals. Gold production was significant but much lower. Production of other minerals (quarries excluded) and metals was almost negligible in comparison with silver [Humboldt (1991)]. However, it satisfied domestic demand [Elhuyar (1825)].

³ This rate is higher than that as estimated by Crafts (1994) for the British industry during the 18th century (1,1%).

⁴ Mexico's share of world silver production was 64.4% in 1781-1800 and 62.4% in 1801-1810 [Schmitz (1979)].

resource. Besides, *ceteris paribus*, the uninterrupted exploitation of a given underground mineral deposit inevitably leads to the appearance, sooner or later, of diminishing returns. Random increases in the metal content of the ores, new discoveries, vertical integration of firms or technological innovations may counterbalance that unavoidable tendency of the mining sector. In this regard, New Spain's mining sector was far from being an exception. But, as we will see later on, the Spanish colonial state could, and it actually did, contribute repeatedly to the postponement of the moment when silver production would finally become stagnant. Its contribution included, but was not limited to, very close versions of two of the elements that David and Wright (1997) identify in the rise of American mineral production between 1870 and 1910: 1) "*an accommodating legal environment*"; and 2) "*education in mining, minerals, and metallurgy*".⁶

Assessing the "*mining-led growth*" and the role played by the State in its achievement requires some additional information. Two alternative techniques permitted the refining of silver mineral: smelting and amalgamation. The first one was traditionally used in Europe; the second one, particularly in its variety known as "*beneficio de patio*", was a genuine metallurgical innovation in response to the specific conditions of silver mining in New Spain (low-grade ores, massive deposits and high price of fuel). An important difference between the European method (smelting) and the "*beneficio de patio*" was that the latter needs a rare and very expensive metal: mercury. But, fortunately enough for "*mineros*" –owners of mining firms-, and for the Crown, Spain was the uncontested main producer of mercury in the world. Moreover, Almadén mines, the richer mercury deposit ever exploited was a Spanish Crown property. Commercialization of mercury was a King's monopoly. Mercury was sold to miners through the network of *Reales Cajas* (fiscal offices established in every miner center and other important towns). Their accounts has been reconstructed by TePaske and Klein (1986) and, in particular, Klein (1998) studied them exhaustively in order to describe the economic and demographic evolution of the main Viceroyalties of the Spanish Empire between 1680 and 1809. Thus, the Spanish Crown controlled the supply of an indispensable input in the silver

⁵ Wright and Czelusta (2002), p. 6.

⁶ Wright and Czelusta, 2002, p. 6.

production process for which there was not substitute. This control implied not only a mechanism for assuring the “*devotion*” of the powerful mining lobby but also an instrument for reducing fiscal evasion.⁷ Other things being equal, it was in the interest of the Spanish Crown that amalgamation were the technical choice of mining firms.⁸ Actually, mining firms tended in the long run to opt for amalgamation, albeit not without medium term fluctuations,⁹ in response to changes in mercury supply –see Table 1 and Figure 2. Not surprisingly, the trend of silver production, whether through amalgamation or total, closely resembles that of mercury sold to miners by *Cajas Reales* –see Figure 3.¹⁰ Consumption of mercury was also sensible to price –see Figure 4.¹¹

⁷ In every mining center there was set a “*correspondido*” (mercury/silver technical ratio) which might eventually fluctuated over time in response to the grade of the silver ore extracted by mining firms. In accordance with the specific “*correspondido*” in force in a given mining center, firms were compelled to “*manifestar*” –to present- to the *Reales Cajas* a certain amount of silver proportional to the mercury they had previously bought. Depending on circumstances (climate, altitude, type of minerals, etc.) it usually took from several weeks to several months to complete the amalgamation process of big quantities of silver ore. The capital requirements of the process and the scale economies of the “*beneficio de patio*” explain the higher concentration of firms in the metallurgical phase of the productive process than in the mining phase as well as the vertical integration of both phases into big mining firms, which were only a small part of the total number. Obviously, however inexpensive the “*correspondido*” was not a perfect device and it may be regarded as a cheap byproduct of the fiscal infrastructure. Notwithstanding, it reduced fiscal evasion to an acceptable level.

⁸ Unless incurring in important information costs, it was simply impossible to control in a comparable way the production of silver through smelting.

⁹ The choice of metallurgical technique had a random component: the type of mineral extracted from new discoveries. In some cases, it was richer enough to be smelted.

¹⁰ *Circa* 1800, the naval warfare with Great Britain interrupted the regular communications between the Peninsula and New Spain. Desperate efforts by the Spanish Navy to transport mercury across the Atlantic failed to secure a normal supply. That is why some important mining centers partially substituted smelting for amalgamation. Besides, as a means of overcoming the crisis, miners obtained exemptions or postponements of taxes from the fiscal authorities. When they finally paid, the entry on the official books was dated as of the current year. Both circumstances help to explain why the decrease in mercury consumption around 1800 was not paralleled by that of silver production.

¹¹ The estimation (OLS) in first differences (variables in logs) of a simple model of demand in which $HGCONSUMPTION_t = f(HGSTOCK_t, HGPRICE_t)$ yields the following results:

$$HGCONSUMPTION_t = -0.004 + 0.703*HGSTOCK_t - 1.151*HGPRICE_{t-2} + \varepsilon_t$$

(-0.110) (8.010) (-1.835)

Adjusted R-squared = 0.425

Durbin-Watson statistic = 2.632

It was the growing tendency of mercury production in Almaden mines –a government-managed and owned firm- what made it possible to increase supply and consumption of mercury, which ultimately permitted the expansion of silver production. But this expansion would not have been so great if the increase in mercury supply had not been accompanied by reductions in prices.

Contrary to what most specialists claim, Bourbon reformism started in the first half of the 18th century. In 1717, the *Superintendencia General de Azogues* was created with the aim of centralizing the decisions about mercury in the Peninsula as well as in New Spain and of giving more power to the officers of *Indias* -“Ministry of Colonies”. In 1723, taxes on silver production were reduced substantially: 50% (from one fifth to one tenth).¹² By the middle of 1720’s, the trend of mercury production in Almaden curved irreversibly upwards while its volatility and that of exports were reduced. After 1739, transportation of mercury was exempted from the general, too restrictive, rules governing the commerce between the Peninsula and the Spanish America with the subsequent increase of flexibility in the supply of mercury to silver producers. However, it was in the early 1740’s when the trend of mercury production reached an historical record high and a minimum threshold for the rest of the century. The reason is twofold: 1) a series of significant increases in the budget of Almaden –see Figure 5; and 2) first steps along a process of technological innovation that culminated in the introduction of steam power into Spain, for the first time in civilian applications, in the late 1780’s and of an original system for mining vertical deposits of mineral at the end of the century. Neither of these factors converted Almaden into an example of productive efficiency. But they permitted a substantial increase in the volume and the regularity of mercury supply to New Spain mining firms.

In spite of these important changes in the policy on silver and mercury, production in New Spain decreased from the early 1750’s, when record levels were reached, to the late 1760’s. It was then when an almost revolutionary measure was adopted in order to invert the current trend of

¹² This measure had been previously adopted in 1710 in Zacatecas, the main mining center in New Spain. According to Elhuyar (1825), fiscal revenue not only

silver production. What made it possible was a deep transformation in the mentality of colonial officers at both shores of the Atlantic. Until then, the royal monopoly on mercury was considered, not without good reasons, an essential component of the Crown's revenues in New Spain. Afterwards, it was seen as an instrument to propel the "*mining-led growth*" and its fiscal implications [Dobado (2002)].

"*Mining-led growth*" is simply a model of pre-industrial growth in which mining played a key role as the driving force of the expansion of the whole –backward– economy and of its mercantile, more dynamic, sector in particular.¹³ The concept is an adaptation to nowadays economic jargon of information and opinions taken directly from the most relevant contemporary observers (Humboldt¹⁴ and Elhuyar¹⁵, i. e.) and from a huge amount of historical documents preserved in archives of Spain and Mexico. In open contrast with the "resources curse" hypothesis, the concept recognizes the singular importance of the backward linkages of mining in New Spain economy and the impossibility that other sector could replace it. Given the conditions of New Spain economy, among which internal transportation problems¹⁶ and distance to main world markets are extremely important and should be taken into account, silver was probably the only possible exportable product of the mining sector because of its high value per unit of weight. For most regions in the highlands of the central

did not decrease but increased. Colonial government deserves some credit for discovering an early ad hoc version of the Laffer curve.

¹³ The important subsistence sector –mostly associated with indigenous peoples– of New Spain economy stood aside the "*mining-led growth*".

¹⁴ "*El laboreo de las minas lejos de ser contrario a la agricultura, ha favorecido los desmontes en las regiones más desiertas.*" (Humboldt, 1991, p. 566).

¹⁵ "*En comparación a las ventajas que (...) proporciona la minería, debe estimarse en poco el valor de dichos preciosos metales. ¿Qué son en efecto veinte ni veinte y siete millones [de pesos] a que ha llegado la acuñación de este reino, respecto de lo que importa su tráfico interior, debido en la mayor parte al impulso de las minas? ¿Qué es su alucinante (...) riqueza, respecto de la que presentan los floridos valles, vegas y dilatadas llanuras cultivadas, las selvas y potreros cubiertas de ganados, las numerosas poblaciones esparcidas en la vasta extensión de su suelo, las manufacturas, artes y oficios que en ellas se ejercen, y en fin el considerable número de habitantes que cuenta en su seno y que igualmente son deudores de su floreciente estado al influjo y transcendencia del propio ramo que todo lo ha vivificado y sigue sosteniendo y fomentando?*" (Elhuyar, 1825, p. 16).

¹⁶ In reference to 19th century, Coatsworth highlights that, in Mexico, "*the geography conspires against the economy*" (Coatsworth, 1984. p. 19). Elhuyar (1825) and Ward (1981) also emphasized the negative influence of Mexican geography on inter-regional trade and specialization.

plateau and in the remote and arid northern steppes, there was simply no economic alternative (agriculture or manufactures) to silver production that were capable of entering into the world market. In fact, modern Mexico has been shaped by mining expansion across its rather hostile geography –see Map 1. Mining contributed as no other economic activity to regional integration and to urban expansion in so wide a country as no other economic activity ever did. From the viewpoint of the endowment of natural resources in Mexico and its related economic choices in the 18th century, the question of whether or not it was a Spanish colony becomes doubtfully relevant. In other words, colonial Mexico silver exports did not only respond to the Spanish Crown will but to economic rationality. In the post-independence period silver continued being one of the main economic activities and the most important exportable product in Mexico.

Besides, contrary to what Acemoglu, Johnson and Robinson (2001) seem to believe, silver mining was far from being a typical case of extractive institution. Their hypothesis about the “reversal of fortune” and the role of European colonialism in explaining the striking differences in world distribution of income might or not be true, but it does not apply to New Spain’s mining sector. First of all, silver production was exclusively based on free labor. Those numerous mining centers located away from the valley of Mexico could only develop through migration of free workers. As in most mining centers there were not dense societies from which labor could be easily extracted, silver miners had bargaining power and were very well paid. According to Humboldt, the Mexican miner was “*the best paid among all miners*”.¹⁷ Although some owners of mines were incredibly rich and prone to sumptuary expenses, most mining firms were of medium, small or minimum size. Ownership of mines was not very unequally distributed. The real picture of mineral wealth in New Spain differs from that of extreme inequality suggested by Engerman and Sokoloff (2002) for Latin America.

It also probably unknown that the institutional framework of mining in New Spain was very close to the type referred as “private property” by Acemoglu, Johnson and Robinson (2002). In particular after the promulgation in 1783 of the *Reales Ordenanzas* –mining code-, access to property rights of mineral deposits was easy and cheap and its protection

was guaranteed. In 1778, owners of mining firms in all regions were authorized to be organized in a peculiar representative institution called *Real Tribunal General de la Minería*. The mining lobby was thus given an instrument to increase its influence on the economic decision-making process. By a royal order, the *Real Tribunal* was financed by means of a transfer from the taxes collected by the State on silver production and minting. The *Real Tribunal* permitted a more efficient defense of mining firms interests, even though it was not fairly equitable and was managed with criteria that may be criticized. It was also in charge of the Escuela de Minas (Mining School) established in the capital in 1792. Humboldt (1991) praised this scientific and educational center. Quoting this qualified contemporary observer, Klein (1995) reckons that the fiscal pressure exerted on mining was lower than the European average.¹⁸ General or particular fiscal exemptions on the purchase of certain taxed inputs or with a view to promoting new discoveries or re-exploiting old abandoned deposits were common during the last decades of the 18th century. Therefore, there was not any predator colonial State confiscating the results obtained by the individuals from their productive efforts in New Spain's mining sector. Not surprisingly, for some time, a variety of documents reflects a lasting "honey moon" between mining firms and the Spanish Crown. The institutional creativity and adaptive behavior of the colonial State is not independent of this peculiar estate of affairs.

Among the main changes that may be included within this "second wave" of reforms initiated in response to the stagnation of silver production by the middle of the 18th century is the above-mentioned reorientation of the goals set by the royal monopoly on mercury. Two consecutive decreases in mercury prices (1767 and 1776) halved the cost of this strategic input for mining firms in New Spain –see Figure 4. The positive effects of this measure did not take long to appear –see Table 1. Lower prices of mercury, combined with an increasing supply, made possible the rise in rates of growth of silver production as shown in Table 1. It is interesting to note that the shift in the traditional behavior of the royal monopoly on mercury was

¹⁷ Humboldt, 1991, p. 370.

¹⁸ The estimation of the fiscal pressure with original data leads to the same conclusion.

not aimed at increasing its income but to maximize the total fiscal revenue in New Spain –see Table 2. In fact, the decrease in prices was not followed by an increase in the royal monopoly income, as it might be expected given its market power and the elasticity of demand for mercury. Until 1777, benefit per unit of mercury sold in New Spain was fabulous. Afterwards, price of mercury was not only lower than in Spain and the international market but also it ceased to provide significant profits. However, the losses associated to the “political prices” charged by the monopoly were counterbalanced in excess by the substantial increases in taxes on silver production and minting and in total taxes collected –see Table 2.

For the Crown, the essence of the “*mining-led growth*” may be described by means of the following fundamental economic relationship:

$$\begin{aligned} \Delta \text{ MERCURY CONSUMPTION} &\Rightarrow \Delta \text{ PRODUCTION SILVER} \Rightarrow \\ &\Rightarrow \Delta \text{ ECONOMIC ACTIVITY} \Rightarrow \Delta \text{ TAX COLLECTION} \Rightarrow \\ &\Rightarrow \Delta \text{ FISCAL SURPLUS} \end{aligned}$$

The co-evolution of mercury consumption with fiscal surplus remittances from New Spain to the Peninsula and other colonies in the Caribbean is simply amazing –see Figure 6. Long term relationship (1720-1800) between mercury consumption and fiscal surplus remittances may be captured by a cointegration equation [Dobado (2001)]. Besides, an additional short term relationship may be captured by an error-correction model [Dobado (2001)].

Explaining the active mining policy adopted by the Spanish Crown in New Spain does not need to assume philanthropic motivations. On the contrary, two simple assumptions will suffice: 1) rational pursuit of self-interest; and 2) capacity of improving perceptions of the economic process. Efficient governmental actions towards New Spain’s mining sector were encouraged by the open political and military conflict between Spain and Great Britain existing all along the 18th century in the international arena. In spite of being lost by Spain, this conflict may be interpreted as a sort of selective pressure upon the efficiency of the Spanish State. In other words, the imperial rivalry –various costly wars in different oceans, islands and

continents included- between both monarchies would have finished earlier and with bigger losses for the Spanish Crown if reforms –limited as they were- in the State would not have been introduced. The renovation of political and bureaucratic elites resulting from the change of dynasty also had favorable consequences on the management of the economic affairs by the Spanish State.¹⁹ Increasing the fiscal revenue was necessary to sustain the war efforts. Economic prosperity appeared as a less conflictive way to augment the fiscal base of the Empire than its alternative –increasing the fiscal pressure. Coherent with the political and military goals of the Bourbon State, the economic policy experienced a gradual change from interventionist mercantilism towards some form of limited proto-liberalism with a bigger potential to promote pre-industrial growth.

Proposition 1: A process of pre-industrial economic growth that may be described as "*mining-lead growth*" took place in colonial Mexico during the 18th century.

Our argument in favor of this proposition consists of showing the existence of a significant relationship between silver production and tax collection. Our analysis distinguishes between short and long term relationships. The economic assumption underlying this argument is that tax collection paralleled economic activity. As the flexibility of the fiscal structure of colonial Mexico with respect to economic conjuncture may be questioned, we have worked on the series constructed with data provided by TePaske and Klein (1986) in order to eliminate all entries on the fiscal accounts that might be uncorrelated with the level of activity of New Spain's economy. Thus, we are taking into account criticism of an incautious confidence in fiscal sources as proxies of economic activity [Brading (1985), Pérez Herrero (1996) and Klein (1994)]. The result is the series INGORD1: ordinary receipts of the Crown in the three main *Cajas Reales* (1711-1800). To prevent the bias that mining taxes and mercury sales might introduce in the analysis, we have deducted them from INGORD1. The new series (INGORD2) includes all receipts except those depending directly from the

¹⁹ Bourbons substituted for Austrians at the beginning of the 18th century.

mining sector. An additional series (INGORD3) has also been calculated to test the robustness of the results regarding different definitions of fiscal receipts. INGORD3 excludes the *tributo indígena* (a capitation tax paid by every native adult male). This series is very likely to proxy those economic activities that took place in the market. The coevolution of silver production with the three series of fiscal receipts is depicted in Figure 7. The results of the cointegration analysis are shown below. In all three cases, we reject H_0 at the 1% level of signification. Therefore we accept the hypothesis of cointegration. Results are shown below.²⁰

Cointegration equation between silver production and ordinary receipts of the Crown in New Spain, 1711-1800.				
	α	β	ρ	T_ρ
INGORD1	-11.26	1.69	-0.50	-5.15
INGORD2	-7.43	1.42	-0.68	-6.78
INGORD3	-9.52	1.52	-0.62	-6.13

A significant and stable long term relationship between silver production and ordinary receipts is not rejected at 5% level of significance. β is interpreted as an estimation of the elasticity between silver production and ordinary receipts throughout the long term equilibrium path. In all cases, it is higher than 1 which seems to suggest a multiplier effect of the mining sector on the non-mining receipts and hence on the level of activity of non-mining sector.

The cointegration analysis supports the hypothesis about the "*mining-led growth*" in colonial Mexico as a long term relationship. To check whether or not this relationship is reinforced by an additional short term relationship, we have estimated an error-correction models between silver production

²⁰ In all three cases we contrast $H_0: \rho=0$, against $H_1: \rho \neq 0$, in the model $u_t = \rho u_{t-1} + \sum_{i=1}^k \pi_i \nabla u_{t-i} + w_t$, where u_t is the residual (OLS) of the cointegration equation $\ln(Y_t) = \alpha + \beta \ln(X_t) + u_t$, where Y_t is INGORD1, INGORD2 or INGORD3 and X_t is silver production. k is taken big enough as to allow for w_t being white noise. The statistic of contrast is $T_\rho = \rho / \sigma_\rho$, which is compared with critical values in Engle y Yoo (1987).

and the three definitions of ordinary fiscal receipts. The results are shown below.²¹

Error-correction models of silver production and ordinary receipts of the Crown in New Spain, 1711-1800.					
	δ_{x0}	δ_{y1}	ϕ	\bar{R}^2	DW
INGORD1	0.43	-0.38	-0.24	0.33	2.11
INGORD2	0.53	--	-0.58	0.29	2.08
INGORD3	--	--	-0.49	0.26	2.23

The estimation of the ECM models implies that a change in ordinary receipts responds to contemporary changes in silver production and to past changes in receipts. Additionally, deviations of receipts from their long term equilibrium relationship with silver have a negative effect on their growth rates.

Our interpretation of these results is that mining led the growth of the economic activities from which ordinary taxes were collected. These activities belonged to the mercantile, most dynamic, sector of New Spain's economy. In sum, the "*mining-led growth*" hypothesis is the least improbable explanation of the narrow relationship observed between silver production and fiscal income.

Proposition 2: Spanish State –metropolitan and colonial- had a protagonist role in the "*mining-lead growth*" through innovative policies and institutional creativity.

This proposition is based on abundant historical evidence shown in the second section of this article. Besides, we offer statistical support in favor of this proposition. To this goal, we specify and estimate a dynamic model that relates silver production (AGPROD) to which policy variables –price of

²¹ All parameters are significant to the 5% level. For every ordinary receipts definition (Y_t), the ECM model is as follows:

$$\nabla \ln Y_t = \sum_{i=1}^{p_y} \delta_{yi} \nabla \ln Y_{t-i} + \sum_{j=0}^{p_x} \delta_{xj} \nabla \ln X_{t-j} + \phi u_{t-1} + \varepsilon_t, \text{ where } X_t \text{ is silver production and } u_{t-1} \text{ shows the extent to which the relationship between } Y_t \text{ and } X_t \text{ differs in the}$$

mercury (HGPRICE) and budget of Almaden mines (ALMADENBUDGET)- and the stock of mercury in New Spain (HGSTOCK). These variables (ALMADENBUDGET, HGPRICE and HGSTOCK) try to capture the effects of the important changes in the State's behavior during the 18th century on silver production (AGPROD). As the mining sector interacted with the agricultural sector, we have also included the price of corn (CORNPRICE) in the specification of the model. Corn was the main agricultural input for silver mining. We agree with Salvucci (1994) on the idea that unproductive Mexican agriculture constituted an important impediment to growth.

Our first step has consisted in contrasting the hypothesis of cointegration between AGPROD and the explanatory variables. We find that cointegration is not rejected at 5% level of significance.²² We have then proceeded to analyze the short term dynamic of the model by specifying and estimating the following error-correction model:

$$\nabla \ln(\text{AGPROD}) = \alpha + \beta_1 \nabla \ln(\text{HGSTOCK} (-1)) + \beta_2 \nabla \ln(\text{ALMADENBUDGET} (-2)) + \beta_3 \nabla \ln(\text{HGPRICE}(-1)) + \beta_4 \nabla \ln(\text{CORNPRICE}) + \delta \text{RESIDUALSCOINT}(-1) + \omega_t$$

The time span of our different specifications –see below- respond to hypothetically influential facts. The period 1720-1805 is justified by the availability of reliable data. In 1732, the Mint of Mexico, to which silver the legally produced was sent for minting, started to be administrated directly by the Crown. In 1753, mines of Almaden's budget was substantially increased by the Ministry of Finances and the beginning of a tendency towards higher corn prices becomes perceptible. Dummies capture the influence of abnormal and specially influential values that might bias the estimation of the relevant parameters of the equation. The results of the estimation are shown below:

previous year from the long term equilibrium. R^2 is the adjusted coefficient of determination; DW is the Durbin-Watson statistic.

²² The cointegration equation is:

$$\ln(\text{AGPROD}) = 14,5 + 0,03 \ln(\text{HGSTOCK}) + 0,15 \ln(\text{ALMADENBUDGET}) - 0,05 \ln(\text{HGPRICE}) - 0,04 \ln(\text{CORNPRICE})$$

Error-correction models of AGPROD and explanatory variables.				
	1	2	3	4
	1720-1805	1720-1805	1732-1805	1753-1805
HGSTOCK (-1)	0.05 (**) (0.03)	0.06 (*) (0.03)	0.07 (0.03)	0.05 (*) (0.02)
ALMADENBUDGET(-2)	0.07 (*) (0.03)	0.09 (0.03)	0.12 (0.04)	0.47 (0.14)
HGPRICE (-1)	-0.04 (*) (0.02)	-0.04 (0.01)	-0.04 (0.01)	-0.04 (0.01)
CORNPRICE	-0.05 (**) (0.03)	-0.06 (*) (0.03)	-0.06 (*) (0.03)	-0.14 (0.04)
RESIDUALSCOINT (-1)	-0.44 (0.09)	-0.31 (0.08)	-0.29 (0.09)	-0.33 (0.11)
Dummy 1736-37	--	0.29 (0.07)	0.30 (0.06)	--
Dummy 1772	--	0.25 (0.09)	0.25 (0.09)	0.30 (0.09)
Dummy 1774	--	-0.33 (0.09)	-0.34 (0.09)	-0.35 (0.09)
R ²	0.33	0.54	0.61	0.67
DW	2.28	2.22	2.19	2.38
P-valor (residuals normality test)	0.66	0.18	0.32	0.31
P-valor (Q-LjungBox)	0.94	0.89	0.49	0.27

Coefficients are significant at 1% level unless otherwise indicated; (**) significant at 10%; (*) *idem* at 5%; standard deviations in brackets.

Our interpretation of these results is that colonial State innovative policies had positive consequences on silver production while backward the agricultural sector, whose tendency towards higher prices was accompanied by recurrent crisis of subsistence (1770-1774, 1780-1781, 1785-1787, etc.), became an important factor that limited the potential growth of silver production. The State's passivity with respect to agriculture openly contrasts with its active policies on mining. In spite of the restrictions that geography impose on Mexican agricultural productivity, institutional change in agriculture had an important role to play that was never tried.

Proposition 3: Independence itself, and not only because of the costly way in which it was gained, had a very important economic cost for Mexico.

Estimates of Mexican GDP, per capita or total, during the post-colonial period are unanimously somber [Coatsworth (2003), Maddison (2001) and Salvucci (1997)]. By the middle of 19th century Mexican per capita GDP would be either equal or, more probably, lower than that of *circa* 1800.

We identify the economic cost of Independence with the interruption of the "*mining-led growth*" in Mexican economy. By 1860, silver production had not still recovered the maximum level reached in the last years of the Spanish colonial rule in Mexico –see Figure 1. The violence associated with the *Insurgencia* (1810) did not only cause an enormous temporary damage to the mining sector. Extremely important as it was, this damage could have been overcome sooner or later. What made the interruption of the "*mining-led growth*" to have a long-lasting effect in terms of per capita GDP was the inability of the post-colonial Mexican State to recreate the conditions in which silver production had flourished before Independence. State intervention in decisive adverse conjunctures was able to increase the growth of silver production above its "natural" rate: expanding the supply of mercury in the 1740's and lowering its price in the late 1760's and 1770's in particular –see Figure 8.²³ The gap between the silver production forecast for 1809 and its real trend is especially noticeable. Therefore we believe that the absence of a "selfish" State, although rational and effective in the pursuit of its interest, has to be seriously taken into account in order to explain the crisis of mining after the beginning of the process of Independence and its very negative consequences on Mexican economic performance during five decades.

Neither the Mexican state nor the foreign mining firms that started to operate in Mexico shortly after the Independence proved to be able of taking advantages of the supposedly great opportunities that the rupture of the colonial relationship offered. In fact, some British mining ventures failed to restore the previously buoyant state of some mining centers [Velasco *et al.* (1988)].²⁴ In some way, it is ironic that companies from the uncontested

²³ The contrast is clear even if the rate of increase of silver production would have been close to zero from 1809, which is a very implausible hypothesis if the pre-1810 colonial State, or something similar, would have continued existing.

²⁴ In January 1824, the share price in London of the British company Real del Monte was 1,479 sterling pounds, compared with a nominal value of 400 while, by late

world economic leader of the moment were not able to get almost any positive result from their organizational, financial and technological superiority over the rest of the world.

Our tentative estimation of the cost of Independence is based on accepting the existence of a long term stable relationship between silver production and economic activity in New Spain –see Proposition 1 above. It is possible then to calculate a conjectural Mexican GDP as a function of silver production from 1810 to 1860.²⁵ Thus, we compare the evolution of this Mexican GDP with a counterfactual, which is based on the hypothesis that the “*mining-led growth*” might have continued unaffected by Independence after 1810. Ponzio (1998) has convincingly argued against the Coatsworth’s pessimist view on the mining sector prospects in the years before the *Insurgencia* (1810). Our conjectural GDP (CONJGDP) is based on the assumption that the share of the mining sector was 10% until 1815 and then, in response to the profound crisis of silver production, decreased to 5%.²⁶ Thus, we have calculated CONJGDP as a proportion of actual silver production from 1810 to 1860 -see Figure 9.²⁷ This conjectural path of Mexican GDP is compared with three counterfactuals: 1) MINGDP, “pessimist” (no growth); 2) MAXGDP, “optimist” (yearly average growth rate of 1.28%);²⁸ and 3) INTGDP, “intermediate” (yearly average growth rate of 0.64 %). Except in the improbable case of no growth after 1809, Independence proves to be very costly in economic terms.²⁹ The most probable path of Mexican GDP is only occasionally above its potential level.

However, in order to make more realistic our numerical exploration of the economic cost of Independence we also need to take its benefits into

1848, it fell to 0.63 pounds [Randall (1977)]. This case is probably exceptional but it illustrates the sad difference between expectations and achievements with regard to Mexican mining after the Independence.

²⁵ Salvucci (1997) had estimated a GDP of 227,5 pesos *circa* 1800, which is the average of available estimations. Mining share was 10%.

²⁶ This assumption –no increase of mining share in GDP in spite of the silver production recovery since the middle of the 1820’s- is biased the result against our hypothesis about the casuse of economic stagnation in independent Mexico.

²⁷ It is reassuring that our calculation is very close to those of Salvucci (1997) for 1840 (-1.4%) and of Coatsworth (1990) (7,2%).

²⁸ This rate is obtained as the forecast for 1810-1860 of the univariant model of the silver production trend (estimated using the Hodrick-Prescott filter) from 1700 to 1809. More details in Dobado and Marrero (2001).

²⁹ In yearly average, MAXGDP is 64.8% higher than CONJPIB. The difference decreases to 35% for INTGDP.

account. Coatsworth (1990) had estimated the cost of the surplus fiscal remittances and commercial restrictions imposed by Spanish Crown between 1790 and 1820 at 7.2% of New Spain's GDP. We consider this estimation a genuine cost of Mexico's colonial relationship with Spain and therefore a benefit of Independence. We identify the cost of Independence with the respective differences (%) between CONJGDP and the three hypothetical paths depicted in Figure 9. Aiming at biasing the results of this numerical exercise on the cost-benefit analysis of Mexican Independence against our Proposition 3, we have also examined the hypothesis that the cost of the colonial relationship were 100% higher than estimated by Coatsworth (1990). The results are shown in Table 3 and may be interpreted as a numerical confirmation of the idea underlying Proposition 3. It is our guess that the most probable real economic cost of Independence might amount to some figure between a yearly average of 27.8% of Mexican –"non-independent"- potential GDP and 50%.

Thus, the main origins of Mexican comparative backwardness does not date from the 18th century, as it might be deduced from the inadequate comparison with the exceptional case of the US. Instead, it really dates from the 19th century, which was the time when most European economies -Spain and other more comparable countries than the US- started to experience conspicuous modern economic growth. In the meantime, Mexico did not only fail to grow at similar rates but it also needed several decades to simply recover the GDP reached at the end of the colonial period.

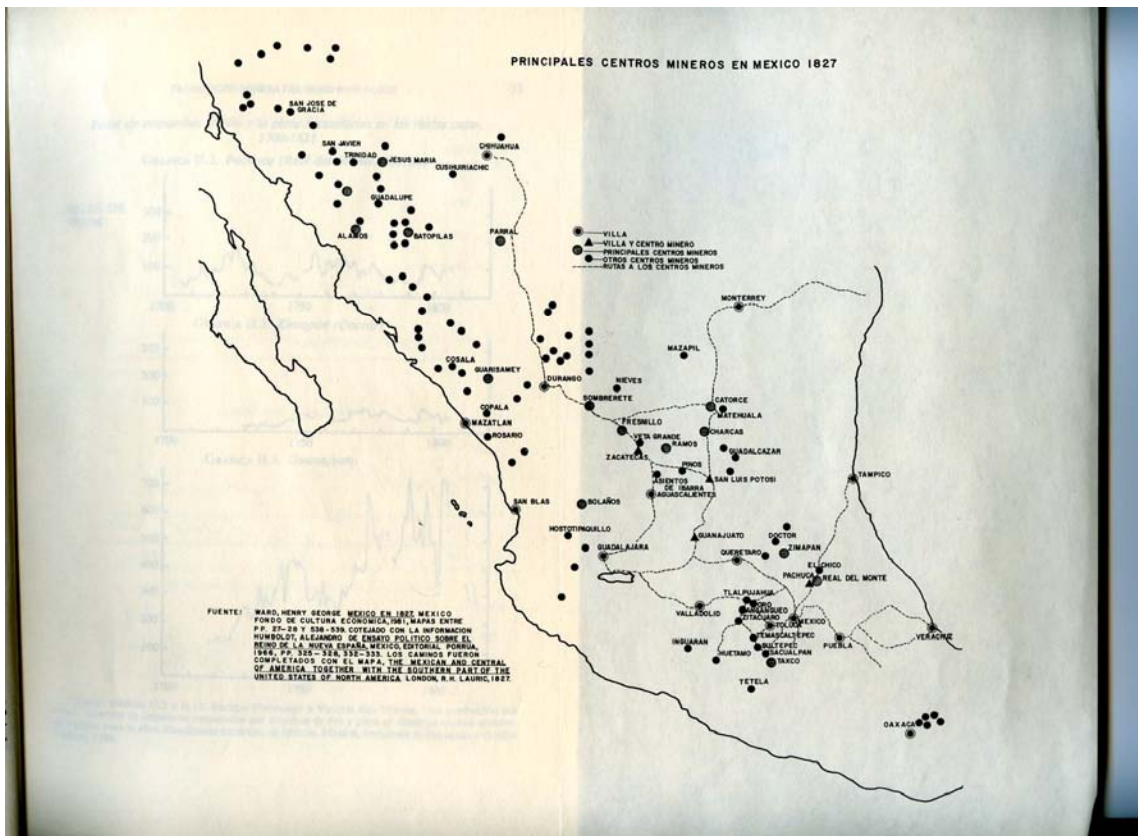
Mexico's economic development in the 19th-20th centuries was not affected by any supposed "resources curse" or by an insurmountable "colonial heritage" but by several "lost decades" of growth in both centuries.

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Map 1:



Figures

Figure 1: Silver production in México, 1690-1860.

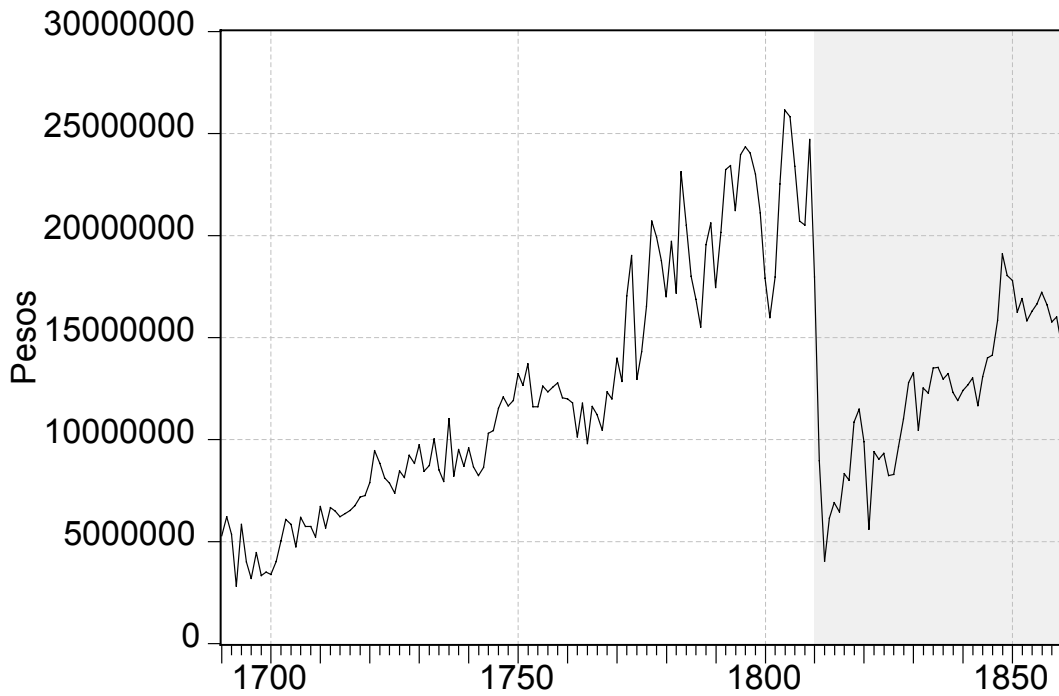
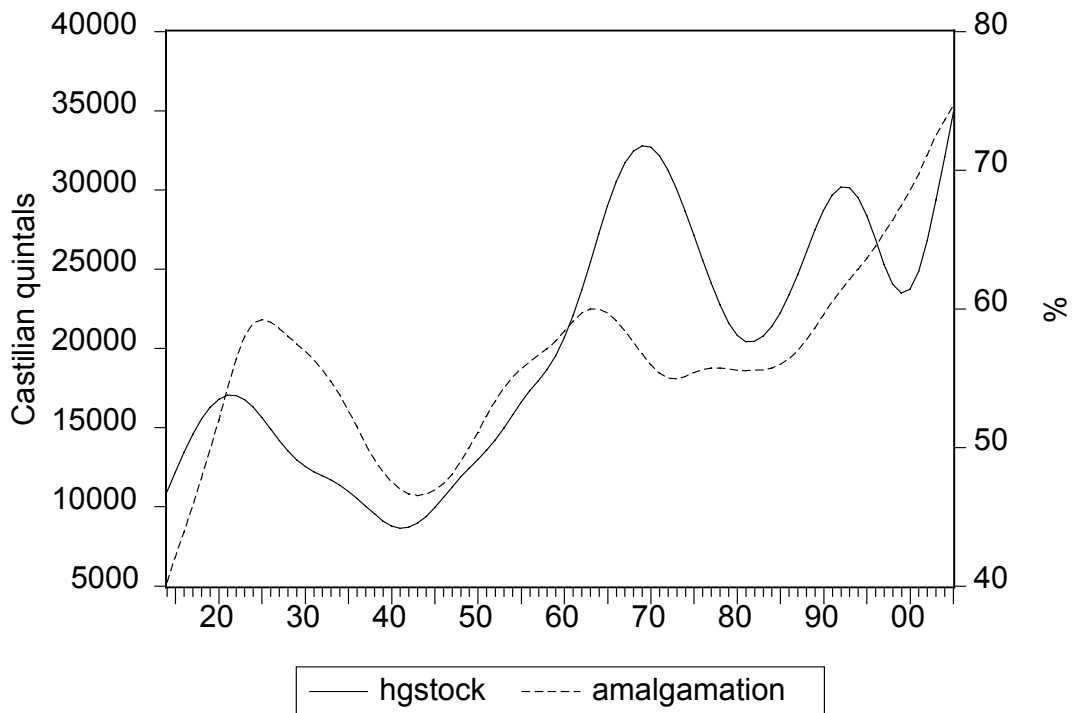


Figure 2: Proportion of silver produced by amalgamation and stock of mercury in New Spain, 1714-1805.³⁰



³⁰ Hereinafter, trends are calculated with the Hodrick-Prescott filter.

Figure 3: Trends of silver production (by amalgamation and total) and mercury consumption, 1714-1805.

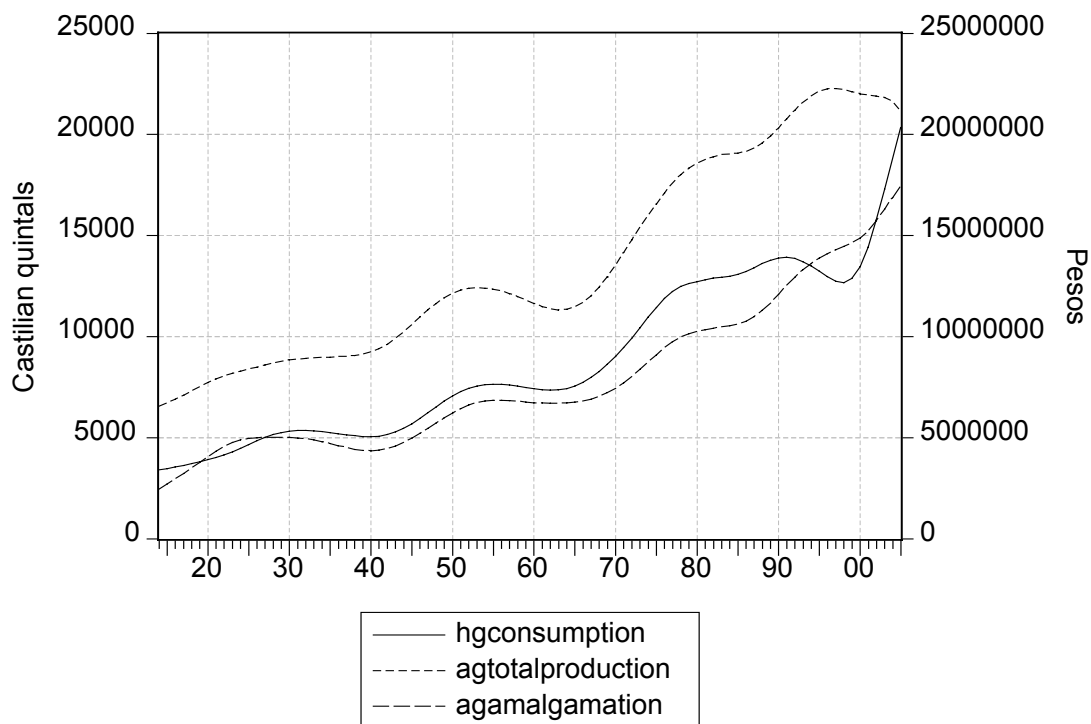


Figure 4: Price and consumption, stock, and production (trends) of mercury, 1714-1805.

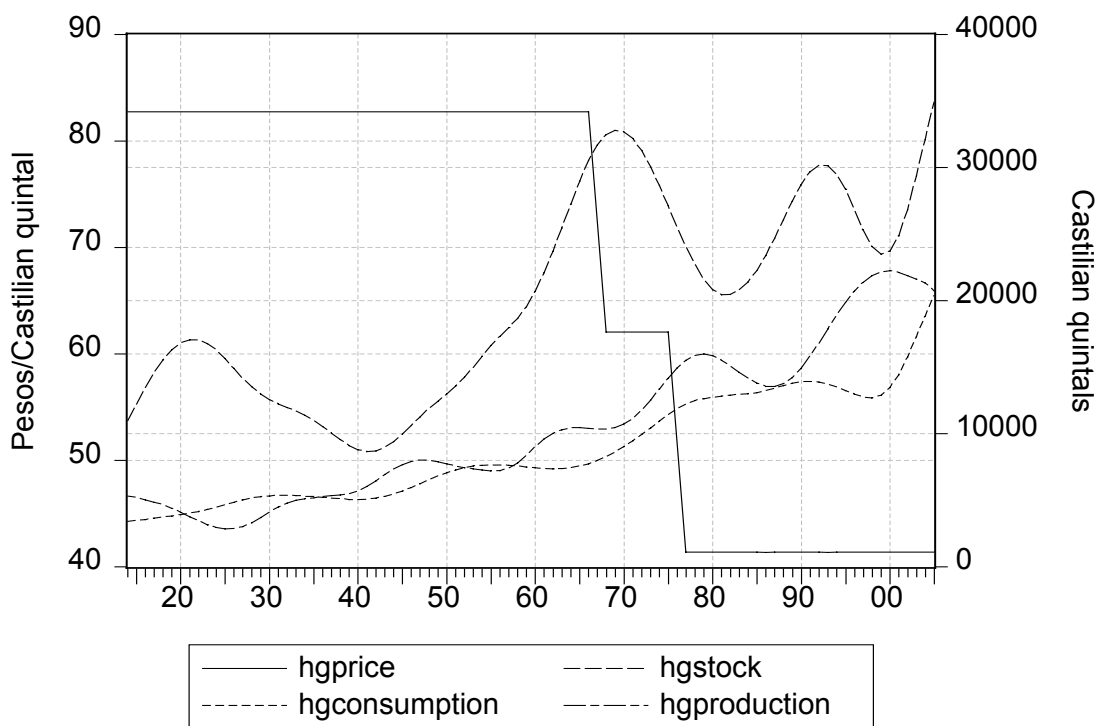


Figure 5: Trends of Almaden's budget and of production of mercury, 1700-1805.

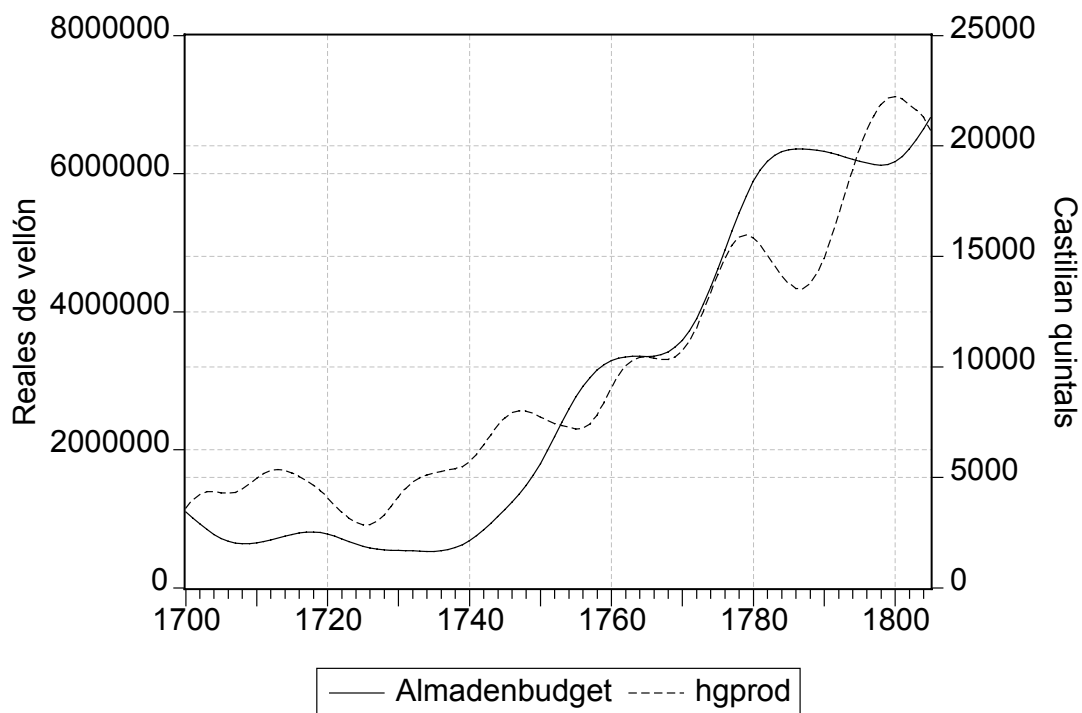


Figure 6: Mercury consumption and fiscal surplus remittances, 1723-1797.

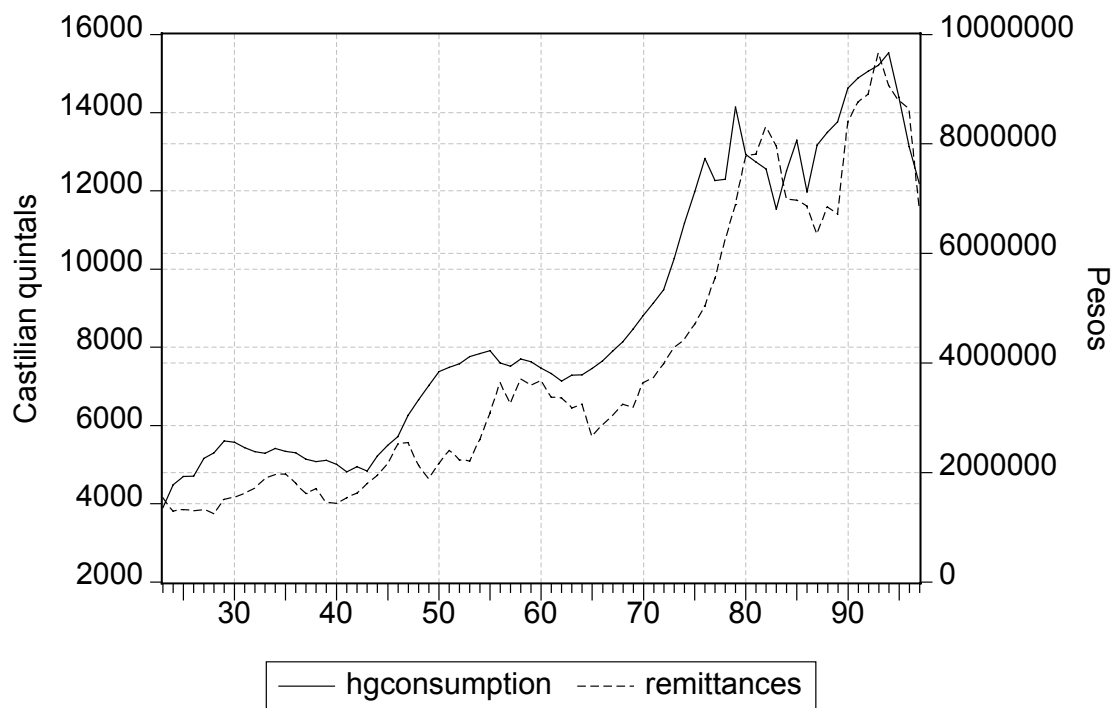


Figure 7: Trends of silver production and of fiscal receipts, 1711-1800.
Pesos.

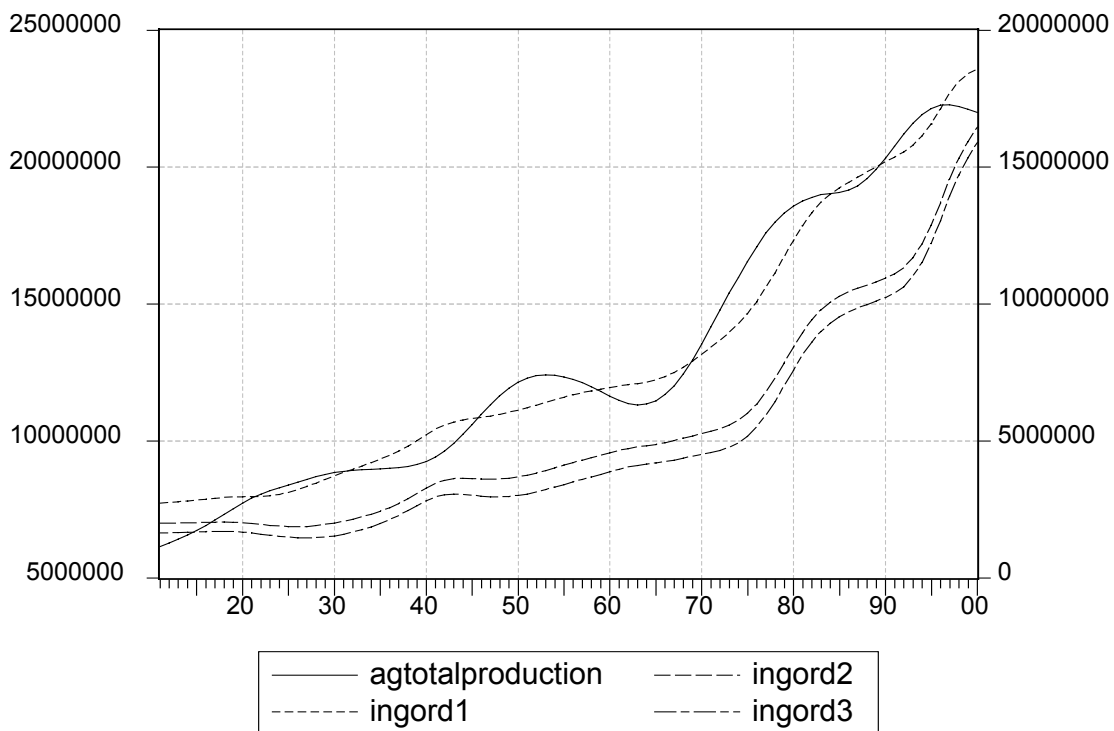


Figure 8: Real trend of silver production and forecasts for selected years, 1690-1860.

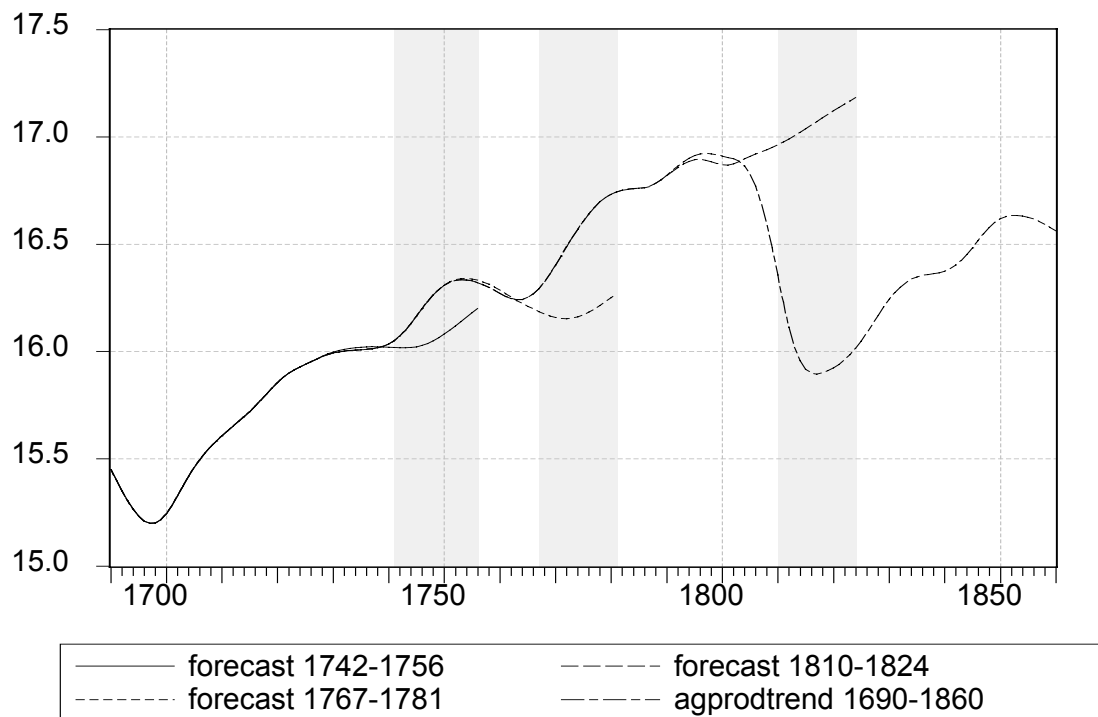
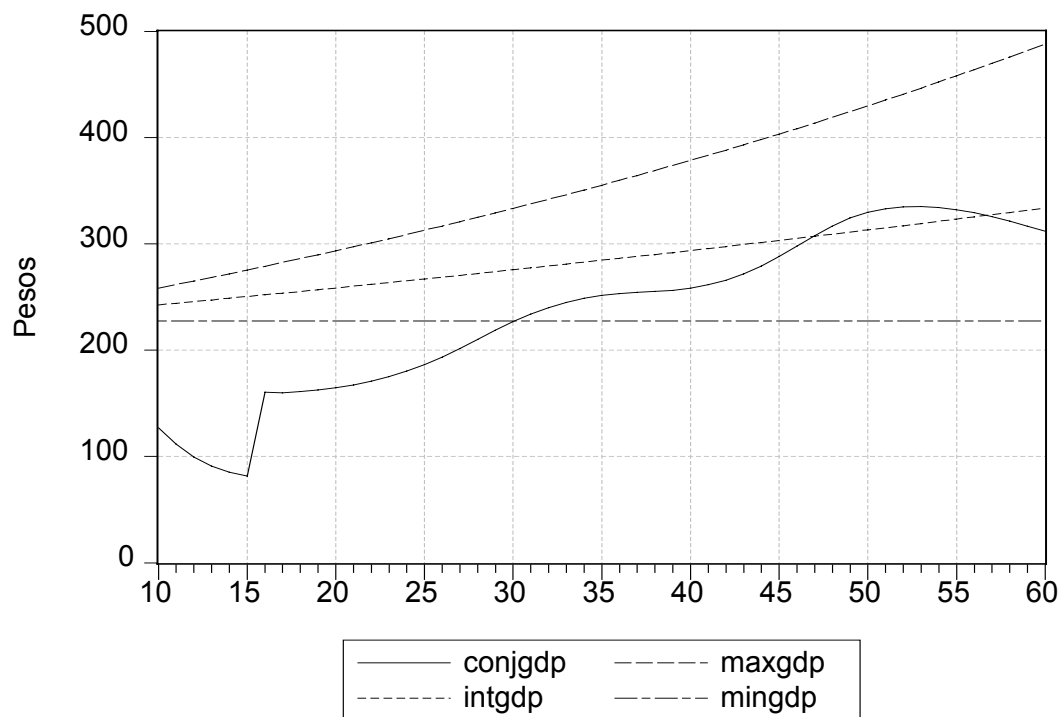


Figure 9: Alternative paths of growth of Mexican GDP, 1810-1860.



Tables

Table 1: Yearly (%) rates of growth, 1715-1805.³¹

	1715-1805	1715-1767	1768-1805
Total silver production (New Spain)	1,56	0,97	2,37
Amalgamated silver production (New Spain)	2,04	1,47	2,83
Mercury production (Almaden, Spain)	1,83	1,20	2,71
Stock of mercury (New Spain)	1,61	2,57	0,28
Mercury consumption (New Spain)	1,64	0,80	2,83

Source: Dobado (1989 and 1997) and Heredia (1978)

Table 2: Yearly average

Panel I: Mercury sales			
	I	II	III = II/I
	Castilian quintals	Pesos	Price
1750-1759	7.750	640.000	82,6
1760-1767	7.300	610.000	83,6
1768-1777	10.400	630.000	60,6
1778-1785	12.900	505.000	39,1
Panel II: Gross Crown's receipts			
	IV	V = IV + I	VI
1750-1759	1.210.000	1.850.000	5.640.116
1760-1767	1.235.000	1.845.000	5.770.435
1768-1777	1.495.000	2.125.000	7.712.095
1778-1785	1.780.000	2.285.000	12.327.517
I: Castilian quintals; II: Pesos; III: Price (pesos/quintal); IV: Taxes on silver (pesos); V: Pesos; VI: Total taxes collected in Guanajuato, México and Veracruz (pesos).			
Source: TePaske and Klein (1986) and Dobado (1990)			

³¹ Average of first differences of variables in logs.

Table 3: Tentative calculation of economic costs (+) or benefits (-) of Independence, 18101-1860: Yearly (%) average of GDP.

Panel A		
	Hypothesis A: Non-Independence cost of 7,2%	Hypothesis B: Non-Independence cost of 14,4%
PIBMIN	-4.3	2.9
PIBINT	27.8	20.6
PIBMAX	57.6	50.4
Panel B		
	First year of net benefit appearance	
PIBMIN	1829	1827
PIBINT	1845	1834
PIBMAX	Post 1860	Post 1860
Source: Dobado y Marrero (2001).		