Colonies*

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Abstract

In many developing countries, the institutional framework governing economic life has its roots in the colonial period, when the interests of European settlers clashed with those of the native population or imported slaves. We examine the the economic implications of this conflict in a framework where institutions are represented by the number of people with property-rights protection, i.e., "gun owners." In the model, gun owners can protect their own property, they can exploit others who do not own guns, and they may decide to extend property rights by handing out guns to previously unarmed people. The theory generates a "reversal of fortune" between colonies with many and few locals: income per capita is initially highest in colonies with many locals that can be exploited by gun owners, but later on excessive concentration of economic power becomes a hindrance for development.

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1 Introduction

A growing historical and empirical literature documents a "reversal in fortune" among former European colonies, i.e., countries that were economically successful initially were overtaken by others (such as the U.S. and Canada) that started out relatively poor (see Sokoloff and Engerman 2000 and Acemoglu, Johnson, and Robinson 2002). Table 1, adapted from Sokoloff and Engerman (2000), displays the basic pattern. In 1700, GDP per capita in economies such as Barbados and Cuba was at least 50 percent larger than in the colonies that were to become the United States. In 1800, both Argentina and Cuba were still ahead of the U.S. in terms of income per capita. Over the next 200 years, however, the initially successful countries fell behind latecomers such as the U.S. and Canada. Today, GDP per capita in the U.S. exceeds the level in Barbados, Cuba, or Argentina by a factor of two or three.

A number of authors argue that this pattern is due to institutions; in particular, institutions that were set up in the initially successful colonies turned out to be a hindrance for development later on. While there is empirical and historical support for this hypothesis, the argument raises a number of important questions for economic theory. First of all, one would like to know why different institutions were set up in different colonies in the first place, even though in many cases the colonizing power was the same European country. Second, one wonders why it was the institutions that were associated with the initially successful colonies that ultimately became a barrier to growth. The third, and arguably most important question is why differences in institutions were so persistent, despite the significant costs that inappropriate institutions imposed in terms of slowing economic growth. Put differently, if bad institutions really were the main culprit for former colonies' failure to develop at the same pace as the leading industrial nations, what prevented these countries from changing their institutions and reaping the enormous resulting growth benefits?

The aim of this paper is to outline possible answers for these questions in a theoretical framework that puts the spotlight on property rights institutions. In our theory, property right institutions are represented as a state variable given by the

	1700	1800	1900	1997
Argentina	–	102	52	35
Barbados	150	–	–	51
Brazil	–	50	10	22
Chile	–	46	38	42
Cuba	167	112	–	–
Mexico	89	50	35	28
Peru	–	41	20	15
Canada	–	–	67	76

Table 1: "Reversal of Fortune" in the Americas: Income per capita relative to U.S. (Sokoloff and Engerman 2000).

number of people with power in a country, i.e., "gun owners." Gun owners can protect their own property, they can trade with other gun owners in a standard market economy, and, crucially, they can exploit and expropriate others who do not own guns. In the words of Piccione and Rubinstein (2003), our economy is thus ruled by a combination of the "invisible hand of the market" and the "iron hand of the jungle." An important advantage of this framework is that property rights are represented as a continuous variable, given by the fraction of people in a country whose property rights are protected. We can therefore trace out the entire evolution of an economy from something close to a pure dictatorship with a small class of gun owners to a standard market economy with full property rights protection. This would be difficult to accomplish in a theory with a discrete set of distinct institutions that may be adopted.

Based on our representation of property rights institutions, a simple theory of colonization is developed where the colonizing power optimally determines the number of gun-owning settlers to be sent to each colony, where a colony is characterized by its technology and factor endowments, including the number of (unarmed) locals already present. After the initial colonization stage, political control passes to the gun owners in each colony. The key decision collectively taken

by the gun owners is emancipation: they can decide to issue guns to some or all of the oppressed locals, and thereby issue them with property rights. The incentives for doing so stem from the fact that free labor is assumed to be complementary to physical capital, which, in turn, is owned by the existing gun owners.

Optimal colonization leads to an initial outcome where income per capita is highest in the colonies with the highest ratio of the unarmed to gun-owning settlers. Subsequently, capital accumulation leads to a rise of the industrial sector, with an associated increase in the demand for free labor. In the long run, emancipation takes place in all colonies. Emancipation proceeds faster, however, in colonies that start out with relatively few of the the oppressed locals. Intuitively, there is a complementarity between a large population with property rights protection today and free labor tomorrow. People whose property rights are protected accumulate more capital, which in turn makes it attractive to issue even more property rights in the future in order to raise the return on this capital. The result is a reversal of fortune: Through faster emancipation, the initially poor colonies overtake the richer colonies in terms of income per capita.

The mechanism described here confirms the view of Sokoloff and Engerman (2000) that inequality is the key variable that lends persistence to institutions. When deciding on emancipation, the gun owners face a tradeoff between exploitation and efficiency. Freeing an oppressed worker entails a loss of rents, but also improves the overall efficiency of the economy. In colonies with relatively few gun owners relative to the local population, the rents from exploitation are particularly large, so that substantial efficiency gains may be forgone in order to continue exploitation. Comparing across countries, gun owners in a colony with many oppressed locals can be much better off than gun owners in a country with mostly free people, even if income per capita (i.e, income divided by the sum of gun owners and locals) is substantially lower.

The next section outlines the basic theoretical framework. In Section 3, we analyze outcomes during the initial colonization stage. Section 4 discusses the further evolution of a colony after political control passes to the local gun owners. Section 5 illustrates the results via simulations for a parameterized model economy, and Section 6 concludes.

2 The Model

The model economy consists of a number of different locations or "colonies" which are distinguished by the size of the native population already present. There is a single colonizing power that is sending settlers to each of the colonies. In economic terms, the key difference between the settlers and the local population in a given colony is property rights protection. Some of the inhabitants of an economy are "gun owners." Gun owners can protect their own property, and participate in standard market exchange with other gun owners under full property-rights protection. In addition, owning a gun enables a gun owner to exploit or expropriate others who do not have guns and consequently do not enjoy property-rights protection. Using the terminology of Piccione and Rubinstein (2003), our economy is ruled by a combination of the "invisible hand of the market" and the "iron hand of the jungle."

During the initial colonization phase, all settlers and none of the locals own guns. Later on during the development of a colony, the existing gun owners may choose to issue guns to some or all of the locals, and thereby endow them with property rights. People without guns who are exploited by gun owners only receive subsistence consumption $\underline{w}$. Since any surplus wealth above this subsistence level is expropriated, unarmed people have no incentives for savings, investment, or exerting high effort when working. The lack of economic incentives for unarmed people causes an efficiency loss, which in turn provides a potential motive for issuing guns to unarmed people.

A key assumption of the model is that the efficiency loss from a lack of property rights differs across production technologies. There are two modes of production in our economy, agriculture and industry, where agriculture uses manual labor and land and industry used skilled labor and capital. In agriculture, the efficiency loss of from lack of property rights is small. Here we think a plantation system, where it is relatively easy to monitor forced labor and to extract information on effort. The effective labor input of an oppressed worker (who only receives subsistence consumption) relative to a free worker (who receives the full marginal product of his labor effort) is given by ϕ_A, where $0 < \phi_A \leq 1$. We denote the total

efficiency units of manual labor that are used in agriculture as N, and the land input is denoted as X. The agricultural production function is given by:

$$Y = N^{\alpha} X^{1-\alpha}$$

In the industrial technology, in contrast, the efficiency loss from lack of property rights is high. Intuitively, industrial production is a multi-stage production process, where the contribution of each worker is harder to measure than, say, the amount of crops harvested by each worker on a plantation. This raises monitoring cost and lowers the efficiency of oppressed workers. An alternative interpretation is that industrial production requires additional skills, in which the oppressed have no incentive to invest, since all their surplus is extracted. In the model, the relative efficiency of an oppressed worker in supplying skilled labor to the industrial sector is ϕ_I, where $0 \leq \phi_I < \phi_A$. The total efficiency units of skilled labor are denoted as H, and the supply physical capital is given by K. The industrial production technology is:

$$Y = AH^{\theta} K^{1-\theta}.$$

At the beginning of the colonization period, no physical capital is available in any of the colonies, thus only agriculture is used. Subsequently, the colonizers start to save in the form of physical capital, which triggers the introduction of the industrial technology. The oppressed locals do not save, since any savings would be immediately confiscated by a gun owner. As a consequence, aggregate savings and the scale of the industrial technology are larger if there are many free gun owners.

It is assumed that the productivity of the industrial technology improves over time:

$$A' = (1 + g)A.$$

For simplicity, we assume that there is no productivity growth in agriculture. What matters for the results is that the productivity of industry improves relative to agriculture over time.

In addition to the direct efficiency loss from using forced labor, oppression is also

costly in the sense that the gun owners have to use some of their time to monitor the oppressed. The monitoring time for a single gun owner oppressing o locals is given by λo^{η}, where $\lambda > 0$ and $0 < \eta < 1$. As each gun owner has only one unit of time available, the maximum number of people $\bar{o}$ that a single gun owner can oppress is given by:

$$\bar{o} = \left(\frac{1}{\lambda}\right)^{\frac{1}{\eta}}.$$

If there are G gun owners and O oppressed locals, there are O/G locals to be oppressed by each of the G gun owners. As long as $O/G \leq \bar{o}$, the total time M needed for monitoring the oppressed is given by:

$$M = G\lambda \left(\frac{O}{G}\right)^{\eta} = \lambda G^{1-\eta} O^{\eta}.$$

If $O/G > \bar{o}$, the gun owners will spend all their time on monitoring, and some of the locals will escape from oppression. For simplicity, we assume that the same λ applies to monitoring in both agriculture and industry.[1]

People live for a single period (i.e., one generation), and each person has a single child. Preferences are defined over consumption c and a bequest b left to the child:

$$U(c, b) = c^{1-\beta}\, b^{\beta}. \tag{1}$$

While all people would like to leave bequests to their children, only gun owners do so in equilibrium, because any bequests left by an unarmed person would be expropriated by a gun owner.

The evolution of the colonies described so far unfolds in two stages. Initially, a certain number of settlers is sent to each colony, in addition to the unarmed local population already present. The decision on how many settlers are sent to each location is made by the colonizing power, to be described in more detail in the following section. Once each colony is settled, events unfold fully under local control. In addition to personal economic decisions, at the political level the gun owners (who are in power) have to decide how many, if any, locals they want

[1]The effect of λ varying across sectors is similar to what is now accomplished by having different labor efficiencies ϕ_A and ϕ_I of the oppressed in the two sectors.

to free (i.e., issue with guns) in any given period. This process is analyzed in Section 4.

3 The Colonization Stage

We start our analysis from an initial stage when a set of potential colonies has just been discovered. In all colonies, the same production technologies (as outlined in the previous section) are available, but the colonies differ in terms of factor endowments, i.e., the amount of land X and the size of the local population O (the future oppressed). There is a single colonizing power that sends gun-owning settlers G to each of the colonies. The motive of the colonizing power is trade: A fraction of the output of each colony is sold overseas. The colonizing country reaps gains from trade, and possibly makes additional profits by levying duties on imports that are sent on to other countries. Rather than model the gains of the colonizing power in detail, we assume that a fixed fraction τ of the output of each colony accrues as revenue to the colonizing power.

Colonization is limited by the cost of sending gun owners to the colonies. We assume that there is a fixed cost of s for sending each settler to a specific colony. This cost includes the direct shipping cost, and also indirect costs such as military spending needed to secure shipping lanes and fend off competing colonizers.

We assume that the colonizer aims to maximize the surplus during the initial colonization period. While we could, at the cost of significant complication, also consider the discounted surplus from future periods, the results are likely to be dominated by the initial tradeoffs, because a period is interpreted as a generation and thus any future payoffs are heavily discounted. The colonizer's optimization problem in choosing how many gun owners G to send to a given colony is then given by:

$$\max_{G} \left\{ \tau N^{\alpha} X^{1-\alpha} - sG \right\}$$

subject to:

$$N = \phi_A O + G - M,$$
$$M = \lambda G^{1-\eta} O^{\eta},$$

where, to reiterate, G are gun owners, O are (oppressed) locals, M is the total monitoring time, and N is the effective labor supply in agriculture. The maximization problem is written out under the assumption that the colonizer send sufficiently many gun owners to exploit all the locals, i.e., $O/G \leq \bar{o}$. Also, notice that during this initial stage industrial production is not available, since no industrial capital yet exists in the colony. The first-order condition for an interior solution of this problem is given by:

$$s = \tau\alpha \left(\frac{X}{N}\right)^{1-\alpha} \left(1 - \lambda(1-\eta)\left(\frac{O}{G}\right)^{\eta}\right)$$

Here the left-hand side is the marginal cost of sending one more settler to the colony, while the right-hand side is the marginal benefit accruing to the colonizing power. The term $\tau\alpha(X/N)^{1-\alpha}$ is the marginal product of labor multiplied by the colonizer's share τ. The second term (in brackets) is the fraction of time the marginal settler spends working, as opposed to monitoring and oppressing locals. The colonizing power is interested in the total output of the colony, but does not have a direct gain from the expropriation activities of the gun owners that merely redistribute income within the colony. Hence, oppression of locals lowers the value of an additional settler from the colonizer's perspective.

The condition implies that in the optimum, the marginal product of labor will be highest in the colonies with the highest number of locals relative to the amount of land. Colonies with few or no locals will receive relatively more gun-owning settlers per unit of land. For the colonizer, their lower marginal product is made up for by the fact that in a local-free colony all time is used for production instead of oppression. What this implies for income per capita (i.e., output divided by the sum of gun owners and locals) depends on the locals' agricultural efficiency ϕ_A. In particular, if the local's efficiency is similar or identical to that of the gun owners ($\phi_A = 1$), the higher marginal product of labor in local-rich colonies directly

translates into higher income per capita.

Proposition 1 (Income per Capita at Colonization Stage) *After the initial colonization is completed, the marginal product of labor $\alpha(X/N)^{1-\alpha}$ is an increasing function of the ratio of locals to land O/X. If $\phi_A = 1$, income per capita $N^{\alpha}X^{1-\alpha}/(G+O)$ is an increasing function of O/X as well.*

Our theory is thus able to capture one of the main features in Table 1, namely that colonies with a lot of forced labor (such as the Caribbean sugar islands) initially had a higher income per capita. To be sure, our stylized theory does not provide a particular detailed representation of economic conditions in the colonies. For instance, we assume that agricultural technologies where the same across colonies, while in reality production methods in the Caribbean where quite different from, for example, farming in the New England states. In addition, much of the forced labor in the colonies consisted of imported slaves, whereas we focus on a local population that is already present at the start of colonization. Despite these limitations, we believe that our theory captures an important potential motive for restricting settlement of colonies with a particularly uneven distribution of property rights, namely that exploitation activities have no value per se from the colonizers perspective.

An alternative mechanism that would work in a similar fashion would be migration restrictions that are imposed by the settlers themselves, as opposed to the colonizing power. Gun owners in colonies with many locals derive rents from oppression that they, presumably, would not want to share with newly arriving gun owners. In contrast, in an economy with free labor and an abundance of land, competition for rents between old and new immigrants would be less of an issue. This mechanism has been emphasized by Engerman and Sokoloff (1997), among others.

4 Industrialization and Emancipation

After the initial settlement of a colony, political control passes to the local gun owners. The further evolution of economic outcomes is driven by the accumula-

tion of physical capital and the rise of industrial production. Once the industrial sector starts to be used, gun owners can freely allocate their labor between the two sectors, implying that wages will be equalized as long as at least some gun owners work in each sector. In addition, gun owners can collectively decide to free (i.e., issue with guns) some or all of the oppressed locals.

The potential motive for emancipating the locals is twofold. First, the accumulation of capital leads to a rising marginal product of labor in the industrial sector. If the return to working in this sector is sufficiently high, gun owners may be willing to forgo the gains from exploiting and monitoring locals in order to supply more time to the market. Thus, one motive is to free up time that otherwise has to be used for monitoring purposes. In addition, the gun owners also gain because they own all the capital in the economy, and capital is complementary to free labor (recall that we assume that ϕ_I is small). Emancipating some or all of the locals thus raises the return on the capital held by the gun owners.

We assume that each generation of gun owners decides on how many locals F to free in order to maximize the existing gun owners' total income Y_G. We focus for now on the case where ϕ_I is sufficiently small for it to never be optimal to use a local in production (because the monitoring cost is higher than the additional output). Once the F locals are freed, they enjoy full property rights protection, and thus receive the market wage. The freed do not own any capital of their own yet because their parents (who would have wanted to leave them a bequest) were oppressed. However, they will leave a bequest to their own children just like all the other gun owners.

We formulate the gun owner's collective planning problem of choosing the number G_I of existing gun owners who should work in the industrial sector, and the number F of of oppressed to be armed.[2] The maximization problem is:

$$\max_{0\leq G_I\leq G,\, 0\leq F\leq O} \left\{ N^{\alpha} X^{1-\alpha} + A H^{\theta} K^{1-\theta} - \underline{\mathbf{w}}(O-F) - wF \right\} \equiv Y_G, \tag{2}$$

[2]Equivalently, the decision on G_I could be decentralized through a standard labor market.

where the maximization is subject to the constraints:

$$N = G - G_I - M + O - F, \tag{3}$$

$$H = G_I + F, \tag{4}$$

$$M = \lambda(O - F)^{\eta}(G - G_I)^{1-\eta}, \tag{5}$$

$$G - G_I \geq M, \tag{6}$$

$$w = A\theta \left(\frac{K}{H}\right)^{1-\theta}. \tag{7}$$

The first two terms in (2) are the outputs of the agricultural and industrial sector, respectively. The third term is the subsistence consumption level that is paid to each of the remaining $O - F$ oppressed locals (O denotes the number of locals at the beginning of the period, before F of them are armed). The term wF represents the market wage that has to be paid to each of the free workers. Constraints (3) and (4) give the effective labor supply N in agriculture and H in industry. Since locals are freed precisely so that they can raise the return on capital, it is already assumed that all F new gun owners will work in industry. Constraint (5) is the monitoring requirement for the remaining oppressed, constraint (6) states that sufficiently many gun owners have to remain in agriculture to monitor all remaining locals, and constraint (7) states that the new gun owners have to be paid the market wage, which is the marginal product of labor in industry.

The following proposition sums up our main results regarding optimal emancipation.

Proposition 2 (Emancipation Decision) *The optimization problem* (2) *has the following properties:*

1. *Emancipation does not occur as long as the monitoring constraint is not binding:*

$$G - G_I > M \implies F = 0.$$

2. *For a given G and O, once the monitoring constraint is binding the number of new gun owners F is increasing in capital K.*

Intuitively, it is initially more costly from the gun owners' perspective to free a local rather than move an gun owner from the agricultural to the industrial sector, because freeing a local leads to the additional cost $w - \bar{w}$ of having to pay market wages instead of subsistence consumption. Thus, as long as additional gun owners are available, no locals will be freed. At some point, however, the number of gun owners in agriculture will be reduced so far that all remaining gun owners are using all their time for monitoring locals. From this point on, emancipating locals becomes attractive. Notice that it is never optimal to simply withdraw additional gun owners from agriculture without arming the locals which now would go unmonitored: unmonitored locals contributed nothing to the gun owners' income, whereas emancipated locals can work in industry and thereby raise the return on the gun owners' capital.

To summarize, emancipation in the colony is ultimately driven by the accumulation of physical capital, which is complementary to free labor. Emancipation starts only after the only gun owners remaining in agriculture are monitoring locals full time. The dynamic evolution of the colony is driven by the following laws of motions:

$$G' = G + F, \tag{8}$$

$$O' = O - F, \tag{9}$$

$$K' = \beta(Y_G + wF), \tag{10}$$

$$A' = (1 + g)A. \tag{11}$$

Here G' denotes the number of gun owners in the next generation, and O' is the remaining number of oppressed locals. The law of motion for capital (10) follows from the optimal allocation of income between consumption and bequest of capital given the utility function (1), and equation (11) reflects productivity growth at rate g in the industrial sector. Notice that the newly freed locals leave bequests as well, thus the term wF in the law of motion for capital (Y_G is the income of the original gun owners, excluding the newly freed).

The evolution of each colony is driven by the complementarities between property rights protection, capital accumulation, and free labor.

Proposition 3 (Evolution of the Economy) *Consider a set of colonies that differ in terms of the initial ratio O/G of locals to gun owners. The optimization problem* (2) *together with the laws of motion* (8) *to* (11) *leads to the following results:*

1. *Colonies with relatively fewer locals accumulate more capital per capita.*
2. *In colonies with relatively fewer locals emancipation starts earlier and proceeds faster.*

5 A Computed Example

In this section we present a simple computed example that illustrates the results obtained so far. The simulation is not meant to closely match empirical features of some real-world country; rather, it is intended to clarify the main qualitative features of the model.

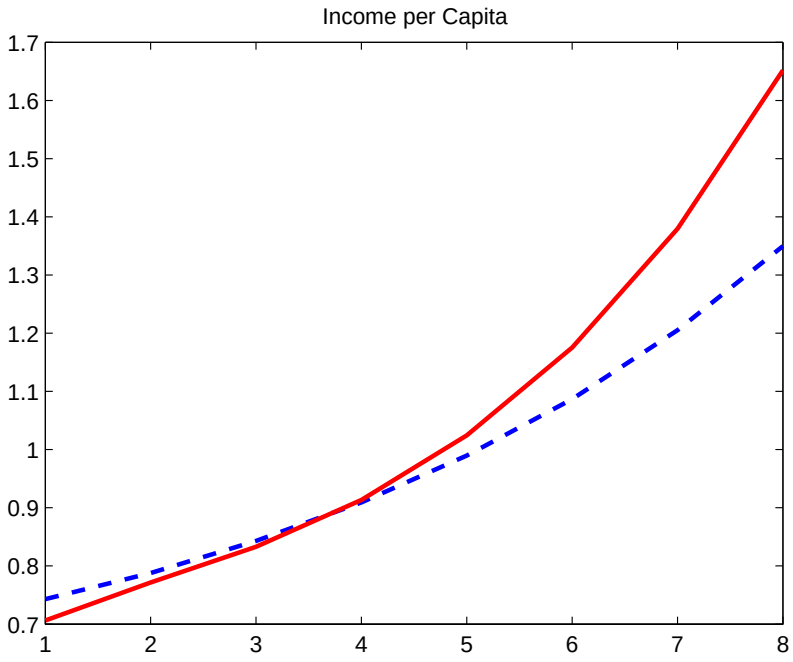

Figure 1: Income per Capita in First Periods. Dashed: $O = 1$, solid: $O = 0$.

The following parameter values were used for the computations:

$$\begin{aligned}
\alpha = \theta &= 0.6,\\
\lambda = \eta &= 0.5,\\
\beta &= 0.2,\\
\underline{\mathrm{w}} &= 0,\\
s &= 0.1,\\
\tau &= 0.1,\\
g &= 0.15.
\end{aligned}$$

Figures 1 to 4 compare outcomes through from the colonization stage on in two colonies which have the same amount of land $X = 1$, but are distinguished by the number of locals. In particular, one colony, "New England," does not have any locals at all, $O = 0$, while in the other colony, "Barbados," we have $O = 1$.

Consistent with Proposition 1, initial income per capita is higher in Barbados. Almost three times as many settlers are sent to New England as to Barbardos, resulting in a lower marginal product of labor in New England. However, as described by Proposition 3, the larger number of free people in New England leads to fast capital accumulation, so that after a few generation New England closes the gap to Barbardos in terms of income per capital, and ultimately moves ahead (see Figure 1).

The overtaking takes place long before emancipation starts to take hold in Barbardos. Given the relatively small number of gun owners, only little capital is accumulated, thus the demand for free labor rises only slowly. The gap between New England and Barbados continues to widen for some time, as New England has a much larger industrial sector and thus reaps more benefits from productivity growth in that sector.

Ultimately, productivity growth pushes the marginal product of labor in industry to a level where emancipation in Barbardos begins to take hold. As Figure 2 shows, from period 11 on an increasing number of locals is set free.

After emancipation takes hold, the two colonies start to resemble each other more

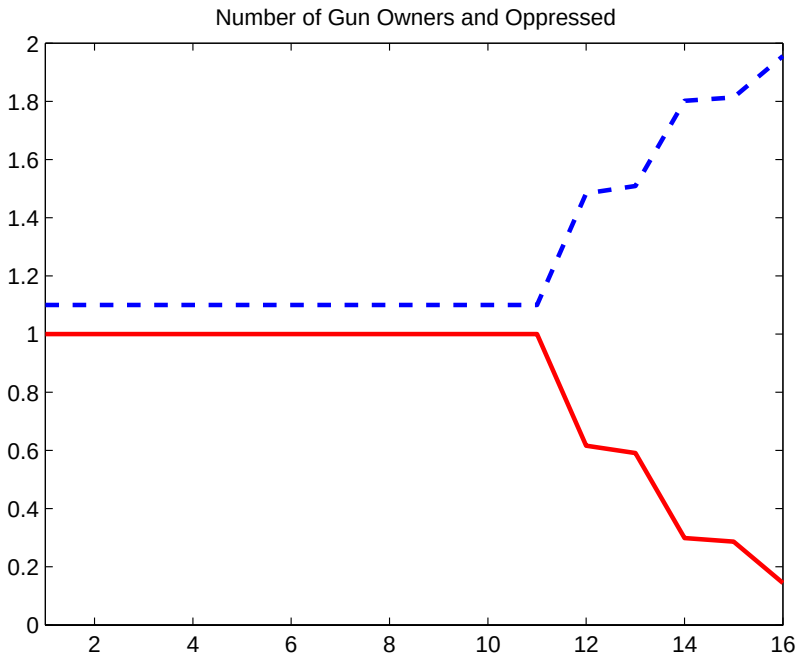

Figure 2: Number of Gun Owners and Oppressed in Barbados. Dashed: G, solid: O.

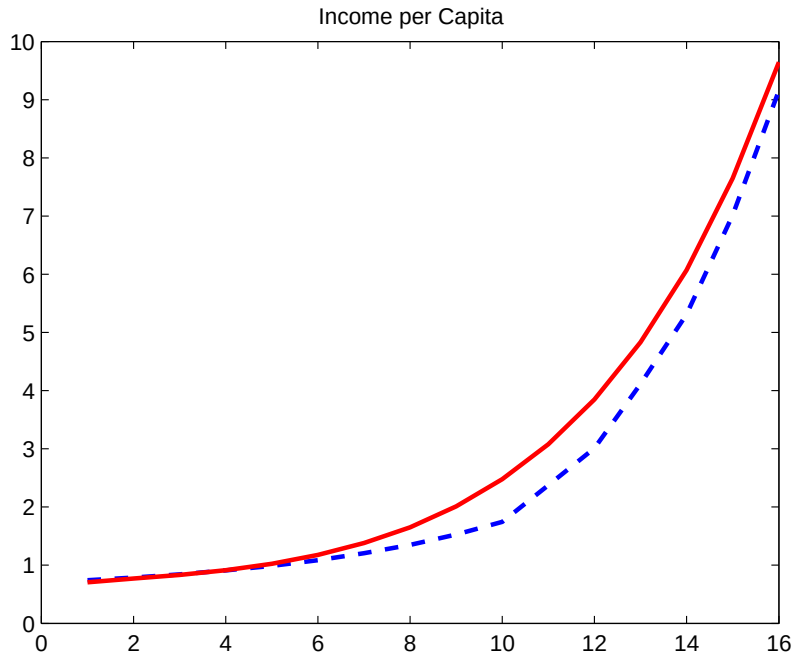

Figure 3: Income per Capita over Longer Term. Dashed: $O = 1$, solid: $O = 0$.

closely. The increased extent of property rights protection fosters capital accumulation, which reduces the gap between the two colonies. In the limit, the model behaves like a Solow growth model, and the two colonies converge to the same balanced growth path. However, as Figure 3 shows convergence is achieved only at a slow pace. Emancipation starts in period 12, but the there is still a sizable gap in income per capita between New England and Barbados four generations later.

So far, we have focused on income per capita, and disregarded the distribution of income within each colony. Political decisions, however, are driven not by a concern for income per capita, but a concern for the gun owner's income. To highlight this dimension, Figure 4 displays income per gun owner in the two colonies over time. Despite falling behind in income per capita from period 4 onwards, income per gun owner is higher in Barbardos throughout most of the transition. After the start of emancipation, the figure masks heterogeneity among the gun owners themselves, as the dynasties of the original settlers remain richer than the descendants of freed locals, who start out with zero capital. The upshot

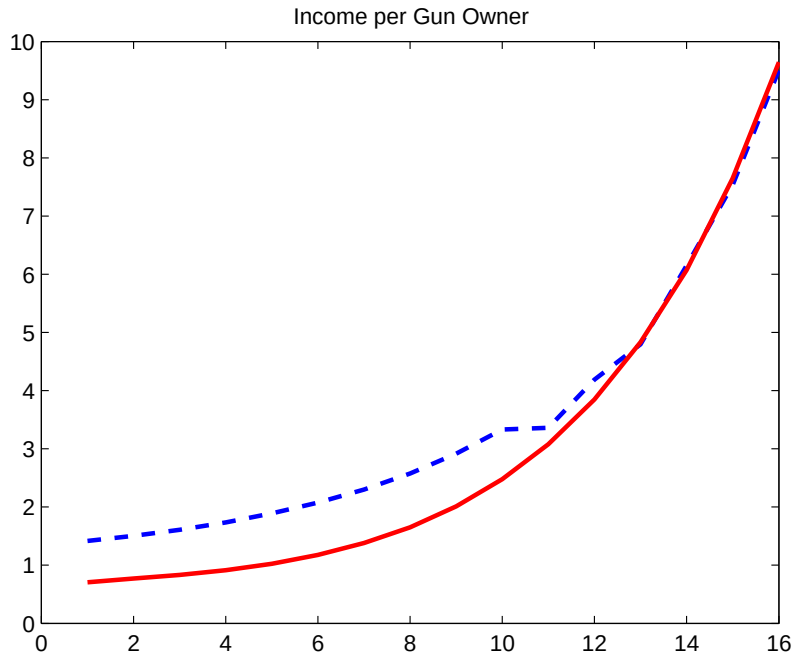

Figure 4: Income per Gun Owner. Dashed: $O = 1$, solid: $O = 0$.

is that through the entire transition, a descendant of one of the original Barbardos settlers is better of than a descendant of a New England settler. The cost of delayed development is thus born by the locals, not the gun owners.

6 Conclusions

In this paper, we present a simple theory that can rationalize the "Reversal of Fortunes" that can be observed among former European colonies in the Americas. The theory suggests that such a reversal is a fairly natural outcome in a model with an exploitation-efficiency tradeoff. Our theory is preliminary, and a number of questions and applications have yet to be explored. A natural, and empirically relevant, extension concerns the role of slavery. In many colonies in the Americas, most if not all of the forced labor was imported. We conjecture that our basic conclusions will remain intact in a model that allows for the import of oppressed labor, but this remains to be verified. As far as emancipation is concerned, the

model identifies the demand for free labor as a key factor. We plan to go back to the political debates on the issue in the U.S. and other countries to assess the historical plausibility of this factor.

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