Economic Development in Latin America, 1801-2015: Did the 19th Century Wars Foil Expansion of Education?

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Abstract

Using data from seven Latin American countries for over the past two centuries, this article studies the role of military expenditure on crowding out education that effected development of human capital and R&D. 19th century Latin America was characterized by continuous wars and conflicts and a big percentage of public spending was devoted to military spending. Based on the demand side crowding out theory, this study found a negative relationship for military expenditure with human capital and R&D. Our findings are robust to different identification strategies and estimations. We further analyse why Latin America challenged the paradigm of "wars making states hypothesis" and establish that the underlying factor for failure to state building and economic development is the high levels land inequality existing from the colonial times in the region.

Keywords: Military expenditure, education and economic development, crowding out, state capacity, Latin America.

1. Introduction

From the time of colonial independence to almost the middle of the 20th century, most of the Latin American countries were at continuous state of wars and conflicts and had disproportionately very large composition of military expenditure in the public sector. Although wars have often been linked to higher productivity especially from the OECD perspective, but for developing economies it can be quite detrimental. The defence burden can reduce economic growth for potential crowding out effect. The theory suggests that there is a trade-off between productive (e.g. capital and education) and unproductive (defence outlays) government spending. With limited resources and inadequate government and financial sectors, the magnitude of the crowding out effect can be larger than the possible demand side positive effect of the Keynesian multiplier (see Alptekin and Levine (2012) for more details).

Growth theories have somewhat provided theoretical insight into proximate factors that may have been responsible for growth throughout history. However, what are the underlying factors of productivity for Latin America has been very limited if not none. When it comes to Latin America, the growth analysis have been under a constant debate. Different factors such as inflation, import substitution policies, inequality have empirically discussed. However, with an average of around 70% (for more details, see Centeno, 1997) of the public expenditure attributed to military spending in LA, it is almost imperative to analyse the effect of war, military spending and the potential consequences. Wars have often been characterized as expression of state building and political power and some of the European countries have benefitted from wars. However, these nations did not spend a disproportionate share of public spending for wars like Latin America. In addition, the pre-requisites to rip the benefits of wars were not similar in the LA case.

This study looks upon the role of military expenditures for the approximate determinant of growth and what is the growth implication of it using a newly constructed unique annual dataset for seven Latin American countries over the period from 1801 to 2015. The long historical data set is not only ideal for addressing the temporary or permanent growth effects; it also

overcomes the cross-country comparison problems especially associated with schooling surveys and schooling enrolment data across countries (see Madsen 2014 for details). In addition, the parameter estimates in this study are, largely identified by the time variation in the data. This stands in contrast to almost all other studies in which the parameter estimates are, to a large degree, driven by the cross-section variations in the data and in which outliers are often influential for the results (see, e.g., Temple, 1999). High military spending in the 19th century can have a persistent effect on human capita and R &D where the initial crowding out of the growth factors is related to the long run growth nexus.

This study makes different major contributions. First, as discussed, a new long panel dataset is constructed from back to 1801 that allows us to make long-term assessment for Latin America. To understand the long run development, it requires historical data for empirical investigations, which are not available directly but constructed from different national sources. In addition, econometrically, the benefits of using long panel data are that the country specific and time effects estimator becomes more consistent as the sample grows. Second, the possible crowing out of growth- productive spending because of military expenditures for wars and conflicts that persisted from the early 19th century is empirically studied through models of innovations, investment, and education. This approach has several advantages over the reduced form approach where productivity is regressed on potential growth determinants. Sianesi and Van Reenen (2003), for example, argue the fundamental factors through which it affects growth is neglected in the empirical literature. Third, it focuses on the channel effect of military spending on growth. Military spending may have fallen in the later part of the 20th century; however, the initial crowding out effect may have a persistent effect on growth through education, fertility decision, research and capital stock.

The paper is organized as follows. The next section gives a historical overview of Latin America. The model and the empirical specifications are presented in section 3. Section 4, illustrates the data and different results to identify if there is a possible crowding out effect of military spending on education. Empirical evidence and underlying cause of poor development and failure of state building in the region are discussed in section 5 and section 6 concludes the paper.

2. Historical Background

Post-colonial independence, Latin America's most of the 19th century and early 20th century is characterized by wars and conflicts either securing independence, fighting neighbours, civil issues or establishing state controls (Centeno, 1997). All the countries in this study had at least two other wars other than the independence war within the period of the study. As seen in table 1, most of the 19th century is devoted to war. The colonial regimes of Spain and Portugal left poor defining territorial borders, which made territorial conflicts a common occurrence in LA. In addition, population increase around the border areas, coupled with movements of refugees, drug traffickers, and political exiles have contributed to increase in unrest in the region (Child, 1988). Moreover, most Latin American countries are endowed with natural resources. Existing studies often have stressed on the relationship between resources and conflicts (Ross, 2004; Humhreys,2005). The burden of resources especially for oil around the poorly defined border regions along with increasing population made a plausible cause for interstate conflicts or wars. The conflict inducing qualities of the oil producing countries are no different for Latin America where they had high rates of government and separatist conflicts (Ross, 2014)

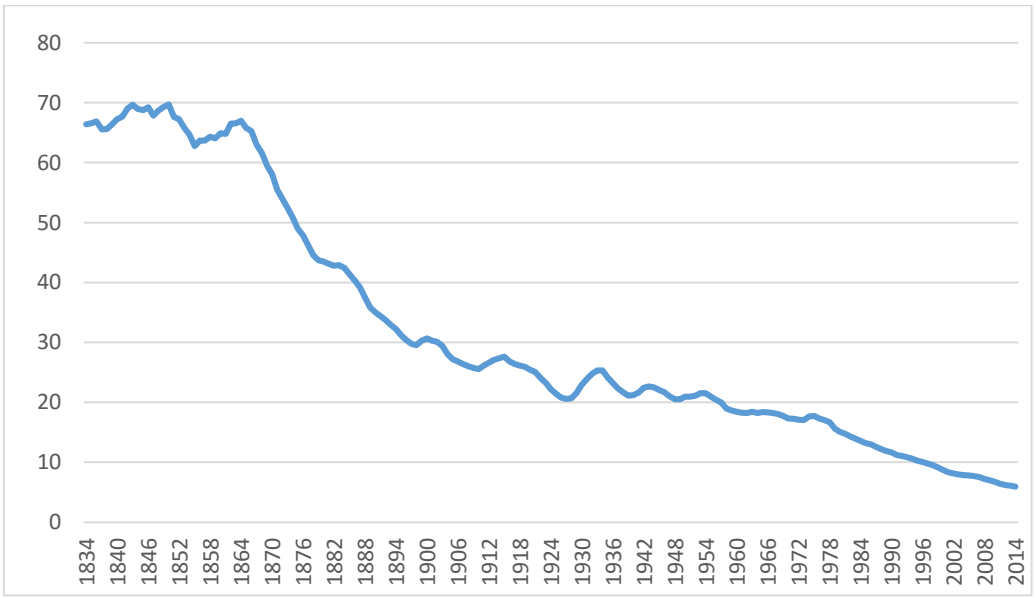

Fig 1: military expenditure as a percentage of total government revenue

With continuous conflicts, these LA countries were almost devoted to war. The public expenditure were devoted to an imbalanced military and debt spending. Figure 1 illustrates the unweighted average military expenditure as percentage of public budget for the seven LA nations used in this study. It shows that the military expenditures encompass a massive portion of the budget in the early 1800s. It was around 70% of the total budget contributed to defence spending and in fact, countries for example Argentina, Brazil and Mexico have had much higher proportion (around 90% of total budget) (for more details see appendix, table .). This is a contrast to the European or the OECD counterparts (quote the average here), who spent much smaller fraction of the public expenditure in military. War supports the development of a nation is often widely accepted in political economics. The European paradigm is set as an example of how war can lead to state building. Finer (1975) explain the relationship between war and state building as the extraction coercion cycle. It is explained as the link between military spending and political establishment where the organizations adapt innovative skills to acquire resources to finance expensive capital for war. War supporting institutional development is extensively accepted theory and historically the development of technology was often linked with the military and war. War generates greater need for resources that gives the capacity to tax the economy's civilians (Cambell 1993; Tilly 1990) and military conflicts made the states rely on domestic sources of revenue rather than inelastic custom taxes. Also, for the European cases, they represented unity, where representatives of the monarchy, the landed oligarchy, or the bourgeoisie were all willing to bear part of the burden, or were able to impose that obligation on unruly social sectors (Centeno,1997). From a theoretical perspective, military spending and war is explained to have favourable demand side effect that contributes to output. An increase in military spending increases demand and, if there is spare capacity, increases utilisation and reduces unemployment of resources (Dunne et al. 2005). In addition, it can provide public infrastructure and protections against extortions, increase aggregate demand and employment in the public sector.

For Latin America, wars and military spending necessarily does not mean it generated the same results. Latin America did not have the pre-requisites necessary for the institutional development to rip the benefits of war. The states did not have the financial capacity and in

addition, there were absence of administrative mechanisms to extract domestic revenues. These economies have lower government quality and more corrupt governments than the European counterparts (La Porta at al., 1999). Political tensions was a norm in Latin America and associated high levels of military expenditure tend to retard growth in the presence of such disruptions. It leads a devoting disproportionate share of resources to military adversely affecting the composition of government expenditure, which is clearly reflected by the high percentage of military spending. The opportunity cost of military expenditure can be sufficiently large in such insecure regions with lack of strong financial sector and coherent states. The military spending can lower the efficiency of resource allocation, and crowd out productive activities such as R&D, and investment in physical and human capital. In addition, timing of the wars were also important factor. As seen in table 1, throughout the 19th century, Latin America had major wars. Most of the nation got their independence in the early 19th century but prolonged unrest and wars persisted in that region. In addition, the post-independence period were not suitable for state growth. The independence wars already exhausted the economies and left them indebted. They were not developed politically or structurally to benefit from further wars. On top of that, they lacked internal unity unlike the European counterparts.

The extent of distortionary effect of military spending depends on the proportion of public spending and exactly how it is being financed. Most Latin American countries relied on excessive money printing and borrowing from domestic and international sources. The debt continued to increase and unlike the European countries, they never had their fiscal reckoning to meet the obligations (Centeno, 1997). Without the creation of a stable financial system, high risk and interest rate remains, which spirals down to reduction of growth and further distortionary effects Knight et al. (1996). Thus in this insecure region, military expenditure is thought to be a major opportunity cost. The disproportionate share of the scarce resources to military reduce the efficiency of resource allocation, and can crowd out productive activities such as R&D, and investment in physical and human capital. The crowding out hypothesis has already been discussed somewhat in the literature (Smith, 1980; Pryor, 1968; Russett, 1969). High military spending exerts a negative impact on the rate of investment in productive capital-physical and human. This occurs because of well-known crowding-out effects: an increase in

military spending may be financed either by raising current taxes or by borrowing (Knight et al. 1996). Alternatively, high military spending may just be followed by low public investment in economically productive factors.

In defence spending economics, most studies focused on the defence-growth relationship (Joerding ,1986, Loayza et. al , 1999; Alptekin and Levine, 2012). With different theoretical frameworks, econometric techniques and countries, the empirical evidence have not come down to a clear consensus. The possible reason for no clear consensus can be due to the different channels through which military spending can affect growth. Low levels of education continue to be singled out as one of the main obstacle to higher productivity in the Latin America. Educational is the key to provide citizens access to knowledge, to the opportunity to participate in the creation of wealth and to the opportunity to prosper. There is no doubt that human capital is as an important determinant of growth both theoretically and empirically. Since the emergence of endogenous growth theory in late 1980s, role of human capital got prominence in explaining economic growth. Studies focused on role of human capital as a factor of production based on the Lucas (1988) and the extended neoclassical growth model such as Mankiw et al. (1992). Lucas (1988) also pointed out a second role of human capital, i.e., the level of human capital as a source of positive externality to have an impact on growth. Earlier than these, Nelson and Phelps (1966) have also focused on the role of human capital as a facilitator of domestic innovation and technology catch-up .Even though theoretically and empirically human capital is considered of great importance, for Latin America it had a low priority from the colonial period (Hofman, 2000). Almost for all the countries, the rural population during the colonial period was completely illiterate (Hofman, 2000). The first half of the 19th century most of the form of investment in human capital were commonly in slavery.

Table 1: Major Wars in 19-20th-Century Latin America

Argentina	
Independence	1810-1818
Civil Wars	1814-1880
Argentina-Uruguay war of la plata	1836
Guerra grande	1838
Northwest Province instability	1863
Triple Alliance	1864
Dirty war	1976-1983
Brazil	
Independence	1821-1825
Ragamuffin War	1835-1845
Argentina-Uruguay war of la plata	1836
Guerra grande	1838
War of Canudos	1896-1897
Contestado War	1912-1916
Chile	
Independence	1810-1826
Civil war	1829-1830
War of the Confederation	1836-1836
Peruvian Spanish war	1865
War of the Pacific	1879-1884
Colombia	
Independence	1810-1819
Gran Colombia-Peru War	1828-1829
Civil war	1860-1862
Civil war	1884
La violencia	1948-1958
Mexico	
Independence	1810-1821
Spanish reconquest attempts of Mexico	1821-1829
Conflict over Texas	1835
Mexican-America war	1846-1848
Franco Mexican War	1861-1867
Victorio's War	1879-1881
Mexican Revolution	1910-1920
Mexico-Gautemala Conflict	1958-1959
Peru	
Independence	1810-1821
War of the confederation	1836-1839
War of the Pacific	1879-1884
Ecuadorian-Peruvian War	1941-1942
Venezuela	
Independence	1811-1823
Federal War	1859-1863
Civil War	1868
Dutch-Venezuela War	1908

Source: Centeno, 1997

The institutional setting for investment in human capital were less than adequate in the and the supply of skilled labour was constrained by a primary-school system (Bulmer-Thomas, 2003). Adult illiteracy rates of more than 80 percent were not uncommon until the First World War. Even larger countries Brazil and Mexico did not have satisfactory primary education or even skilled labour required for technological progress. Based on the simple Barro-Lee data on education, in 2000 the average years of schooling for most Latin American countries is around 6 years while for USA, Canada and Sweden is around 12 years (Duryea and Pages 2002). Proactive production sector strategies seems to have been missing in the public policies of Latin America which requires active technology policies, educational advancement and reducing the shortcomings of the education system in terms of quality (Ocampo, 2004). In this scenario, military spending is likely to be at the expense of education and human capital for Latin America. High public military expenditure would reduce government spending on health and education, and can redistribute skilled people away from more 'productive' occupations, which lowers the overall aggregate productivity of human capital. Eventually, the demographic transition lowering the birth rate is thought to spread the educational opportunities. However, this transition happened relatively later for Latin America compared to the European counterparts and it takes years to suffice. Hence, the public policies required to be attentive towards their educational and inventive potential that is unlikely with high military spending.

Latin America lags behind when it comes to investment in research and development. The World Intellectual Property Organization (WIPO) publishes its main statistics on Intellectual Property (IP) annually. As of 2016, only 2.2 % of all registration came from the entire Latin American region. Almost all of the LA countries do not even spend 1% of the GDP portion on R & D. The patent law established in some countries were very late as well, for instance Venezuela's patent law establishment was as late as 1955. These are all reflective of need of stronger public policies allocating more resources for R & D innovations. From theoretical perspective, the endogenous growth theories (Lucas, 1998; Romer, 1990; Howitt, 1999) have

changed the perspective of modelling technological progress. The absorptive capacity constraints in productivity can be reduced through technological innovation that is aided by training and skill formation. In most cases, the impact of fundamental factors for technological change is assumed as given. One side of theoretical literature predicts that military spending in general deters growth by crowding out innovation. Explaining from the supply side effect, along with other civilian sector components like labour and capital, military spending also competes for market-oriented technology. Hence, the resources used in military are not available for civilian use and thus exerts the opportunity costs, which depletes R&D activities (Yakolev, 2007). There are also theories advocating for military R & D that is often the first to introduce modern technology and to train its personnel in working with new sophisticated equipment that can spill over into the private sector. But Dunne *et al.* (2005) point out that training and technology in the armed forces are not compatible with the civilian productive sector and thus in terms of opportunity costs, these positive effects are not so evident.

3. Crowding out transmission

Focusing on the crowding out components, this study emphasized on the accumulation channels – physical, human, and knowledge capital – which are also identified as the key determinants of long-term economic growth. These channels play a central role in the neoclassical growth model (e.g. Solow 1956), extensions to this model (e.g. Mankiw *et al*., 1992), endogenous growth models (e.g. Romer, 1990), and Schumpeterian growth theory (Aghion and Howitt, 2006). For example, human capital accumulation plays a fundamental role in these theories. Human capital is postulated to increase the productivity of labor and capital, and to favorably affect technological progress; human capital is said to increase a nation's capacity to innovate and its ability to adopt technological advances from other nations, which then increases growth (Aghion and Howitt 1998). Technological progress is especially important in these theories in determining long run growth and, hence, it is imperative to give attention to this channel.This section briefly outlines how military spending effects investment, human capital and R& D and under which conditions it can have temporary or permanent

productivity growth effects. Consider the following constant returns to scale Cobb-Douglas production function:

$$Y = AK^{\alpha}H^{1-\alpha} = AK^{\alpha}(hL)^{1-\alpha}, \quad (1)$$

where Y is output, A is total factor productivity (TFP), K is capital stock, H is the total quantity of human capital used to produce output, L is employment, h is human capital per worker, and α is capital's share of income.

Human capital is computed following the Mincerian approach:

$$h = \exp(\theta \cdot sc) \quad (2)$$

where θ is the returns to education and sc is years of schooling (educational attainment). Following the spirit of the Solow model, Mankiw *et al*. (1992) show that in steady state the economy evolves as:

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(t) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}lns_k + \frac{\beta}{1-\alpha-\beta}lns_h, \quad (3)$$

where n is growth in the labor force, g is technological progress, δ is the depreciation rate of fixed capital stock, s_k is the fraction of income invested in fixed capital, and s_h is the fraction of income invested in education.

Technological progress is determined by the following ideas production function (Ulku, 2007; Peretto and Valente, 2011):

$$g_A = \left(\frac{\dot{A}}{A}\right) = \lambda\left(\frac{X}{Q}\right)^{\sigma}A^{\phi-1}, \quad 0 < \sigma \leq 1,\ \phi \leq 1,\ \ Q \propto L^{\eta} \text{in steady state}, \quad (4)$$

where X is R&D researchers, Q is product variety, L is employment or population, λ is a research productivity parameter, σ is a duplication parameter (0 if all innovations are duplications and 1 if there are no duplicating innovations), ϕ is returns to scale in knowledge, and η is the coefficient of product proliferation. The ratio X/Q is referred to as research intensity.

This ideas production function extends first-generation models of knowledge production to allow for product proliferation and decreasing returns to knowledge stock, as highlighted in

second-generation models of economic growth (see Peretto, 1998; Aghion and Howitt, 2006). R&D expenditure is divided by product variety following the Schumpeterian paradigm in which R&D spreads more thinly across the variety of products as the economy expands. Since, in steady state, product variety is growing at the same rate as population or the labor force, it follows that the growth rate of knowledge, g_A, cannot increase in response to an increase in the number of researchers that keeps the number of researchers in fixed proportion to population.

Extending the knowledge production function to allow for the influence of FD yields:

$$g_A = \lambda \left(\frac{X}{Q}\right)^{\sigma} MS^{\pi} A^{\phi-1}, \quad (5)$$

where MS is military spending and π is a positive constant. From Eq. (5) it follows that research intensity and *FD* have only permanent growth effects if there are scale effects in ideas production, i.e., $\phi = 1$.

The simple framework presented here shows that military spending can influence productivity growth through the three principal channels considered in this paper. Temporary growth effects can be expected from the investment and schooling channels, given that they transmit to output through the production function under the assumption of diminishing returns to physical and human capital. Military spending will have permanent growth effects, if it feeds through ideas production with scale effects. Based on the crowding out hypothesis and the transmission channels, the following empirical framework is used to test for the influence of military spending on investment, human capital and ideas production:

$$lnGER_{it} = \beta_0 + \beta_1 lnMS_{it} + \beta_2 lnfertility_{it} + \beta_3 lne_{it}^{10} + \varepsilon_{2,it} \quad (6)$$

$$ln\,Pat_{it} = \gamma_0 + \gamma_1 lnMS_{it} + \gamma_2 lnPat_{it}^{S} + \gamma_3 lnHC_{it} + \gamma_4 DTF_{it}.lnHC_{it} + \varepsilon_{3,it} \quad (7)$$

where, MS is the proportion of military spending of public expenditure. *GER* is the gross enrollment rate: the fraction of the school age population that is enrolled in primary, secondary

and tertiary schooling. Fertility is the general fertility rate measured as the total number of live births per 1,000 females of reproductive age between 15 to 44 years in a population per year. e^{10} is life expectancy at age 10, *Pat* is patent granted by domestic residents, Pat^{s} is the patent stock, *R/Y* is the domestic R&D intensity measured by the ratio of patent/research stock to GDP, HC is the human capital measured as the secondary and tertiary education attainment and DTF is the distance to the technology frontier and finally ε is a random error term. Subscripts *i* and *t* refer to country *i* and year *t*. Time and country dummies are included in all regressions to account for unobserved country specific factors and shocks that affect all LA nations, such as the Great Depression.

The GER in Eq. (6) is assumed to be a positive function of life expectancy at schooling age. Schooling depends on life expectancy at the age at which the student enters secondary and tertiary education and not life expectancy at birth because the expected returns from schooling are positively related to life expectancy at the age at which the decision for secondary schooling is made .Fertility rate is assumed to have a negative relation with enrolment. Crucially, *GER* is used as the dependent variable as opposed to educational attainment of the working age population because it reflects schooling at the time when the schooling decisions are made. Crucially, *GER* is used as the dependent variable as opposed to educational attainment of the working age population because it reflects schooling at the time when the schooling decisions are made. Eq. (7) is the logarithm of ideas production given by Eq. (4) extended with military spending and knowledge spillovers. With endogenous TFP, international knowledge spillover has been empirically analyzed extensively in the literature (Grossman & Helpman (1994), Coe & Helpman (1995), Lee (2006), Madsen (2010)). To incorporate the interaction network structure, an interaction between the absorptive capacity and the distance to the technology frontier is used based on the Nelson & Phelps (1966) model. The frontier meaning the world technology leader, which is taken as USA and UK in this study. Absorptive capacity is explained as a domestic variable, which amount the strength of the technology absorption. In the Nelson & Phelps (1966) model, the absorptive capacity is accounted as the level of human capital. Therefore, under the Nelson-Phelps approach, higher level of human capital increases productivity through faster innovation and through imitation that facilitates technological catch-up to the technology advanced economies, and thus contributes to growth.

4. Data and empirical results

4.1 Data

As stated already, the models are estimated for the following seven Latin American countries: Argentina, Brazil, Chile , Colombia, Mexico, Peru and Venezuela. Military spending variable is calculated as the percentage of military spending in the government budget. The data sources are detailed in the data appendix. Gross enrolment rate is measured as the weighted sum of primary, secondary and tertiary GERs, where the weights are the number of years at each educational level. The GER at each level is measured as the number of students enrolled divided by the population in the age groups of each level. Educational attainment at each educational level is computed as:

$$h_{t,n}^{P} = \frac{\sum_{i=0}^{49}\left[Pop_{n,15+i}\sum_{j=3}^{8} GER_{n,t-i-j}^{P}\right]}{\sum_{i=0}^{49} Pop_{n,15+i}}, \quad (9)$$

$$h_{t,n}^{S} = \frac{\sum_{i=0}^{46}\left[Pop_{n,18+i}\sum_{j=0}^{4} GER_{n,t-i-j}^{S}\right]}{\sum_{i=0}^{49} Pop_{n,15+i}}, \quad (10)$$

$$h_{t,n}^{T} = \frac{\sum_{i=0}^{41}\left[Pop_{n,23+i}\sum_{j=0}^{4} GER_{n,t-i-j}^{T}\right]}{\sum_{i=0}^{49} Pop_{n,15+i}}, \quad (11)$$

where h^P, h^S, and h^T are educational attainment at the primary, secondary and tertiary levels, Pop_{15+i} is the size of the population aged 15+i, and GER^P, GER^S and GER^T are gross enrollment rates at the primary, secondary and tertiary levels . The term $Pop_{15+i}\sum_{j=2}^{8} GER_{t-i-j}^{P}$, for example, in the numerator of the first right-hand-side-term Eq. (17), is the primary educational attainment of the 15+i age cohort in at time t. The computations are data intensive because they

require data for population distributed on ages and for school enrollment data back in time. For instance, for a 64 year old in 1815, the primary educational attainment is the sum of GER^P over the period 1757-1764. Further details are provided in the data appendix. The general fertility rate, *Fert*, is calculated as the crude birth rate (birth per 1000 population). In the absence of historical data on general fertility rate, crude birth rate is used instead of the total number of live births per 1,000 women of reproductive age between 15 and 44 years in a population. Domestic stock of knowledge, Pat^s, is computed using the perpetual inventory method for patent applications with a depreciation rate of 15%.

4.2 Empirical results

4.2.1 Human Capital:

The estimations are conducted for each schooling levels: primary, secondary and tertiary separately and also with the weighted average of all three of them. The reason for the disaggregation is to understand the role of military spending for each levels. Generally, it could be expected that crowding out of human capital is relevant mainly for primary enrolment as among the different levels of education, primary education has been found to yield the highest social rates of return, especially in developing countries (Psacharopoulos and Patrinos, 2004). In addition, with the international development target of achieving primary education for all, it seems relatively more of a pressing matter than the other education levels for the public sector. However, secondary and tertiary education also are very important in terms of social returns and for innovations, thus it is pertinent to inspect the effect for all different levels. From table 2, the coefficient of military spending is negative indicating signs of crowding out human capital. Note that for regressions for GER (regressions 2,3,4), life expectancy at the age 10 is taken as schooling depends on life expectancy at the age at which the student enters secondary and tertiary education and not life expectancy at birth because the expected returns from schooling are positively related to life expectancy at the age at which the decision for secondary schooling is made. But for primary enrolment (regression 1), life expectancy at birth is taken. The coefficients of life expectancy are positive and significant as theory implies and also indicates that it is not influenced by mortality rates beyond working age. The estimation periods

are different in the unrestricted regressions as the fertility lags for taken different for each enrolment levels (average 6-13 for primary enrolment, 14-18 for secondary enrolment, 19-23 for tertiary enrollment and) . The negative effect of fertility on GERs reinforces the important role of the fertility transition as predicted by the transition from the post-Malthusian growth regime to the modern growth era.

4.2.2 Innovation:

Turning to the estimations of the knowledge production function presented in table 2, there are some insightful implications. First, along with the common usual crowding out hypothesis for education, military spending is also crowding out innovations through education. In addition, the significance of research intensity in ideas production has two important implications. First, it implies that R&D intensity has permanent, or at least highly persistent, growth effects. Thus, productivity is growing at a constant rate in steady state due to R&D as long as R&D is kept to a constant fraction of GDP. Second, military spending has persistent productivity growth effects through ideas production – a crucial result that implies that the permanent growth effects of military spending are initiated from ideas production. This result is important as it offers a solution to the contradiction that military spending is often assumed to crowd out only physical and human investment and thus affect growth only through these channels. However, it can have a permanent persistent growth effects due to non-diminishing returns to R&D. The coefficients of educational attainment at secondary and tertiary levels, HC^{ST}, and their interaction with the distance to the frontier, *DTF*, are significantly positive as well. This indicates that HC^{ST} has been highly influential for the increasing innovative activity based on the Nelson-Phelps model. Additionally, through the interaction term, HC^{ST}*DTF*, patents has boosted innovation further. As long as LA remains well below the technology frontier and there is only weak productivity convergence technology spill overs will remain a significant source of innovations because the effective costs of innovations and imitation remain low. Hence again it proves that education is a key factor for economic development and innovation and the crowding out of education can result in permanent growth effects.

Table 2: Estimates for crowding out channels.

VARIABLES	(1) $lnGER_{it}^{P}$	(2) $lnGER_{it}^{S}$	(3) $lnGER_{it}^{T}$	(4) $lnGER_{it}^{WAE}$	(5) $ln\,Pat_{it}$
$lnMS_{it}$	-0.208***	-0.127***	-0.160***	-0.371***	-0.0841***
	(-10.39)	(-8.853)	(-8.724)	(-15.94)	(-7.242)
lne_{it}^{10}	0.801***	0.342***	0.703***	0.535***	
	(44.96)	(8.158)	(38.41)	(20.47)	
$lnfertility_{it}$	0.173***	-0.195***	-0.0916***	-0.0172	
	(11.47)	(-8.617)	(-6.968)	(-1.029)	
$lnPat_{it}^{S}$					0.712***
					(59.00)
$lnHC_{it}$					0.327***
					(20.03)
$DTF_{it}.lnHC_{it}$					0.0662***
					(5.327)
Observations	1,462	1,407	1,367	1,456	1,498
R-squared	0.808	0.908	0.817	0.713	0.919

Notes. The numbers in parentheses are absolute *t*-statistics. $GER_{it}^{P}, GER_{it}^{S}, GER_{it}^{T}$ *and* GER_{it}^{WAE} are the primary, secondary, tertiary and weighted average gross enrollment rates respectively. Life expectancy is used at the age of ten for all the regressions 2, 3 and 4 expect for 1 where life expectancy at birth is used. Constants, country and time dummies are included in all regressions but their coefficients are not reported. ***,** and *.signify statistical significance at the 1% level and for 5% and 10%.

4.3 Identification strategy

The percentage of military expenditure, *DCP*, and the democracy index of the neighboring bordering countries, *PLR*, are used as instruments for military expenditure to deal with feedback effects from the outcome variables to military expenditure and factors outside the model that may simultaneously influence military expenditure and the outcome variables. Common for these instruments is that military expenditure somewhat influenced by the relative characteristics of the neighbouring countries. Collier & Hoeffler (2007) and many others indicated that the need for security is one of the central reasons among others for spending

scarce government budgets on military force. Different theoretical models such as Richardson, 1960; Sandler & Hartley, 2001 propose that security spending is influenced by the defence burden and other variables in the neighbouring countries. Beside civil or internal conflicts, the biggest threat is perceived to come from the behaviour of the neighbours and their intentions of wars and thus military spending. In addition, it can also be as a regional behaviour or imitation process where, if the neighbours are spending a particular share of public expenditure on defence, then the government may be induced to spend in a similar fashion for their own country (Dunne & Perlo-Freeman, 2003).

The democracy variables is used as an instrument in the light of the institutional determinants of military spending. The notion is democratic economies allocate fewer resources to the military than relatively more autocratic economies (Ross 2001, Hewitt, 1991,Brauner, 2015,Kimenyi and Mbaku (1995)). Gartzke (2007) discusses that democracy harmonizes with peace and thus does not, by itself, lead countries to be conflict prone. In addition, relatively more autocratic nation are more likely to rely on the military to retain their power (Dunne & Perlo-Freeman, 2003) and more likely to face uprising. Also more autocratic nations may engage in rent seeking activities using military force and burden the general population with the cost of military burden (Nordhaus, Russet and Oneal (2012). Democratic nations are considered less likely to go to wars. According to philosopher Kant (1970), democracies do not go to war with other democracies, which have been further empirically analysed too (Doyle 1986). Based on the cost-benefit analysis, the gains from wars is much higher for an autocratic nation than a democratic one, as for democratic leaders, they face the fear of losing and thus being voted out. Based on these theories, military spending has been instrument with democracy empirically. However, for this study, nation's own democracy value does not serve the purpose of a good instrument. Theoretically, we know that democracy is relatively higher in countries with higher levels of human capital, investment and even R & D and hence it has a feedback effect which does not make the democracy variable exogenous. Democracy affect human capital and R&D as well along with military spending and wars, so the exclusion restriction is being violated. Thus, keeping in line with the existing theories and neighbouring countries arms-race idea, instead of own nation's democracy, average of neighbouring countries democracy index is used as an instrument for military expending.

Table 3: 2SLS estimates with military expenditure instrumented with the percentage of military expenditure *DCP* of the neighboring bordering countries.

VARIABLES	(1) $lnGER_{it}^{P}$	(2) $lnGER_{it}^{S}$	(3) $lnGER_{it}^{T}$	(4) $lnGER_{it}^{WAE}$	(5) $ln\,Pat_{it}$
$lnMS_{it}$	-0.272***	-0.479***	-0.751***	-0.266***	-0.367***
	(-7.497)	(-13.26)	(-13.01)	(-8.060)	(-11.25)
lne_{it}^{10}	-0.227***	0.325***	0.339***	-0.116***	
	(-3.694)	(8.331)	(8.935)	(-2.684)	
$lnfertility_{it}$	-0.0802***	-0.146***	-0.0313	-0.122***	
	(-3.179)	(-6.447)	(-1.595)	(-4.896)	
$lnPat_{it}^{S}$					0.704***
					(33.95)
$lnHC_{it}$					0.516***
					(18.56)
$DTF_{it}.lnHC_{it}$					0.0257
					(0.982)
Observations	1,462	1,407	1,367	1,456	1,498
R-squared	0.878	0.874	0.562	0.897	0.935

Notes.. The numbers in parentheses are absolute *t*-statistics. $GER_{it}^{P}, GER_{it}^{S}, GER_{it}^{T}\ and\ GER_{it}^{WAE}$ are the primary, secondary, tertiary and weighted average gross enrollment rates respectively. Life expectancy is used at the age of ten for all the regressions 2, 3 and 4 expect for 1 where life expectancy at birth is used .The instrument is the percentage of military expenditure, *DCP* of the neighboring bordering countries. Constants, country and time dummies are included in all regressions but their coefficients are not reported. ***,** and *.signify statistical significance at the 1% level and for 5% and 10%.

Table 4: 2SLS estimates with military expenditure instrumented with and the democracy index *PLR* of the neighboring bordering countries.

VARIABLES	(1) $lnGER_{it}^{P}$	(2) $lnGER_{it}^{S}$	(3) $lnGER_{it}^{T}$	(4) $lnGER_{it}^{WAE}$	(5) $ln\,Pat_{it}$
$lnMS_{it}$	-0.329***	-0.386***	-0.520***	-0.571***	-1.481***
	(-4.669)	(-10.12)	(-12.01)	(-11.78)	(-2.708)
lne_{it}^{10}	-0.145***	0.475***	0.473***	0.430***	
	(-2.728)	(15.98)	(14.00)	(12.34)	
$lnfertility_{it}$	-0.111***	-0.149***	-0.0408***	0.00943	
	(-7.296)	(-10.06)	(-2.666)	(0.505)	
$lnPat_{it}^{s}$					0.655***
					(11.01)
$lnHC_{it}$					0.691***
					(6.908)
$DTF_{it}.lnHC_{it}$					-0.0547
					(-0.587)
Observations	1,462	1,407	1,367	1,456	1,498
R-squared	0.794	0.792	0.694	0.688	0.476

Notes.. The numbers in parentheses are absolute *t*-statistics. $GER_{it}^{P}, GER_{it}^{S}, GER_{it}^{T}$ *and* GER_{it}^{WAE} are the primary, secondary, tertiary and weighted average gross enrollment rates respectively. Life expectancy is used at the age of ten for all the regressions 2, 3 and 4 expect for 1 where life expectancy at birth is used .The instrument is the democracy index, *PLR* of the neighboring bordering countries. Constants, country and time dummies are included in all regressions but their coefficients are not reported. ***,** and *.signify statistical significance at the 1% level and for 5% and 10%.

5. Land Inequality and the failure of state capacity

Thus far, we have been concerned only about the crowding out effects of military spending on the human capital and have not considered the contribution to failure of state building. There is an intuitive logic that war-making leads to state building. Finer (1975) notions this as the extraction-coercion cycle. Wars require capital and to facilitate it, there should be institutional and structural development. The innovations and development that occurs during wars does not disappear with the end it. The key variables representing the state buildings through wars

usually are taxation or institutional development. War is widely perceived as increasing the capacity of a state to tax its population (Tilly 1990; Campbell 1993; Peacock and Wiseman 2004). In addition, not only that state revenue increases after war but that the structure of taxation also changes. For example, wars led both the British state in the 18th century and the American in the 19th and 20th centuries to both increase the amount of revenue (which never returned to pre-war levels). When the fiscal system depends more on financially challenging domestic sources of revenue instead of administratively simple custom taxes, it requires development of strong financial institutions. Contrary to the Europe's post 1500 success to state building from wars, Latin America experience is rather different. From the previous section, it is evident that wars and military expenditure have crowded out the human capital and mass education. There is an ongoing debate among economists and historians about why war did not operate in Latin America as it did in early modern Europe. Centeno (2002) points out that geographical, social, and racial division in Latin America prevented the emergence of a unified, centralized state able to take advantage of the stimulus provided by war. In addition, Centeno (2002) emphasizes that there are pre-requisites to benefit from war. First, economies must be able to turn inward in order to overcome the financial challenges of war, which would imply having strong financial institutions. In addition, adequate administrative structure must be in place to provide check and balance for operations. Without the pre-requisites, wars and excessive military spending would lead to chaos and backwardness.

What caused the inefficient institutional settings for benefitting from wars for Latin America? Engerman and Sokoloff (1997, 2000) claim that the land inequality stemming from the colonial times is the underlying factor that caused the poor economic performance in the region. Thus the colonial history of Latin America provides an important piece of the puzzle that connects all dimensions. It is evident wars, military spending crowded out mass education that resulted in the long run effect on economic performance. And the inability to state building and stems out from the initial high land inequality that was persistence in the region. The concentration of land were in the hands of few elites. Frankema (2005) explains land inequality in colonial latin America is rooted in its social, political and economic rules and land inequality has a significant influence in the Latin American economy. One explanation is the land inequality steams from the policies of the colonial motherland. In Spanish-Portugese America, the Crown

monopolized the vast sources of unoccupied land and restricted the land market. Land grants were allocated in reward for support of the administration rather than through a free and competitive land market. The Catholic Church also played a vital role in the system of starting colonial land governance in Latin America. In return for extending Iberian settlements to new areas and supporting the local colonial administration, the church obtained land grants from the Crown and had the right to trade sacraments and salvation in return for land grants of church members (Frankema, 2005). All these resulted in separation of land from the general population towards private persons, institutes or elites. In addition, for the Iberian nobilities, land ownership was the ultimate sign of social status and land used to be granted to those who show political support. Literature have proposed the indirect effect of the land inequality on approximate determinants of growth. Parente and Prescott (2000), Acemoglu, Johnson, and Robinson (2006), and Engerman and Sokoloff (2002) all have all pointed out the important role that land inequality plays in determining the evolution of institutions and approximate factors of growth.

To test this hypothesis, in this section we investigate if the key variables for state building and eventually economic development were stunted because of land inequality. We measure the influence of land inequality on fiscal and legal dimensions of state capacity. For land inequality measure, we use family farm data from Vanhanen (1997). As financial indicator, we combine contract-intensive money, *CIM* and taxation capacity, *Tax*. For legal and administrative institutions, we used executive constraints from the Polity IV dataset. Contract-intensive money is measured as $CIM = (M2\text{-}H0)/M2$, where $M2$ is broad money supply and $H0$ is the monetary base; *Tax* is measures as one minus the share of trade duties and royalties of commodity production in total government revenue. Lower the value of *CIM* and *TAX*, less efficient are the financial and administrative systems. For executive constraints (*EXE*), it is defined as the extent of institutionalized constraints on the decision-making powers of chief executives, whether individuals or collectives (Eckstein and Gurr ,1975). The value ranges from 1 to 7 where higher the number, higher is the degree of constraints that the accountability groups can exert and better is the administrative system. All measures of state capacity are usually highly collinear and endogenous, so using principle component analysis; we also combined all the three variables together into one index to test the hypothesis.

Table 5: Estimates for effect of land inequality on state building variables.

VARIABLES	(1) *CIM*	(2) *EXE*	(3) *TAX*	(4) *PCA*
Land Inequality	0.497***	0.344***	0.239***	0.625***
	(13.95)	(6.381)	(9.608)	(13.59)
Observations	1,090	1,190	1,190	1,190
R-squared	0.820	0.365	0.675	0.486

Notes: Constants, country and time dummies are included in all regressions but their coefficients are not reported. ***,** and *.signify statistical significance at the 1% level and for 5% and 10%.

All the estimations include country and time fixed effects. The estimations from table 5 show that the coefficients for land inequality is positive and statistically significant at 1% level for all the cases indicating that land inequality have a lasting effects on the state capacity variables. Since our land measure is percentage of family farms, which implies higher the percentage for family farm, lower should be the overall land inequality, which is the reason for the positive relationship. Hence, the results support the hypothesis that history and land inequality have a lasting impact on both fundamental and approximate determinates of economic development.

6. Conclusion

Based on a newly constructed dataset for seven Latin American countries over more than 200 years, this paper has tested the channels through which military expenditures influences growth. Ideas production and human capital are examined as the principal transmission channels, following the predictions of endogenous growth models and crowding out of education. Data is constructed far back in time thus ensuring that the parameter estimates are not driven by unobserved cross-country heterogeneity. Previous literature focused on institutional impact on growth and the proximate determinants of growth, however the potential channels through which military expenditures can influence growth was missing.

Thus, it can be concluded that military expenditure have crowded out mass education and thus affected the approximate determinants of economic growth. The impact is far-reaching and widespread, working through numerous dimensions. The results also have important macroeconomic implications. The finding of negative effects of military expenditure on gross enrolment rates implies that military expenditure with a considerable time lag through this channel, since schooling first influences productivity when a student cohort joins the workforce, an effect that is difficult to capture in standard growth regressions, affect productivity growth. Second, the findings of significant effects on ideas production and constant returns to ideas production reinforce the evidence of permanent growth effects of military expenditures through this channel as opposed to human capital alone.

We further concluded that land inequality has a lasting impact on Latin America. The crowding out of education and failure to state building all roots out from the high levels of land inequality that hinder institutional development that is required for high levels of economic performance.

Reference

Acemoglu, D., Johnson, S. and Robinson, J., 2006. Understanding prosperity and poverty: Geography, institutions and the reversal of fortune. *Understanding poverty*, pp.19-36.

Aghion, P. and Howitt, P., 2006. Appropriate growth policy: a unifying framework. *Journal of the European Economic Association*, *4*(2-3), pp.269-314.

Aghion, P., Howitt, P., Howitt, P.W., Brant-Collett, M. and García-Peñalosa, C., 1998. *Endogenous growth theory*. MIT press.

Alptekin, A. and Levine, P., 2012. Military expenditure and economic growth: A meta-analysis. *European Journal of Political Economy*, *28*(4), pp.636-650.

Brauner, J., 2015. Military spending and democracy. *Defence and Peace Economics*, *26*(4), pp.409-423.

Bulmer-Thomas, V., 2003. *The economic history of Latin America since independence*. Cambridge University Press.

Campbell, J.L., 1993. The state and fiscal sociology. *Annual review of sociology*, *19*(1), pp.163-185.

Centeno, M.A., 1997. Blood and debt: War and taxation in nineteenth-century Latin America. *American Journal of sociology*, *102*(6), pp.1565-1605.

Centeno, M.A., 2002. *Blood and debt: War and the nation-state in Latin America*. Penn State Press.

Child, J., 1988. Interstate relations in Latin America: peaceful or conflictual?. *International Journal*, *43*(3), pp.378-403.

Coe, D.T. and Helpman, E., 1995. International r&d spillovers. *European economic review*, *39*(5), pp.859-887.

Collier, P. and Hoeffler, A., 2007. Unintended consequences: does aid promote arms races?. *Oxford Bulletin of Economics and Statistics*, *69*(1), pp.1-27.

Doyle, M.W., 1986. Liberalism and world politics. *American political science review*, *80*(4), pp.1151-1169.

Dunne, J.P. and Perlo-Freeman, S., 2003. The demand for military spending in developing countries: A dynamic panel analysis. *Defence and Peace Economics*, *14*(6), pp.461-474.

Dunne, J.P. and Perlo-Freeman, S., 2003. The demand for military spending in developing countries: A dynamic panel analysis. *Defence and Peace Economics*, *14*(6), pp.461-474.

Dunne, J.P., Smith, R.P. and Willenbockel, D., 2005. Models of military expenditure and growth: A critical review. *Defence and peace economics*, *16*(6), pp.449-461.

Duryea, S. and Pagés, C., 2002. Achieving high labor productivity in Latin America: Is education enough?. *Washington, DC, United States: Inter-American Development Bank. Mimeographed document*.

Eckstein, H. and Gurr, T.R., 1975. *Patterns of authority: A structural basis for political inquiry*. Wiley-Interscience.

Engerman, S.L. and Sokoloff, K.L., 1997. Factor endowments, institutions, and differential paths of growth among new world economies. *How Latin America Fell Behind*, pp.260-304.

Engerman, S.L. and Sokoloff, K.L., 2002. *Factor endowments, inequality, and paths of development among new world economics* (No. w9259). National Bureau of Economic Research.

Frankema, E.H.P., 2005. *The colonial origins of inequality: Exploring the causes and consequences of land distribution*(No. 119). Discussion papers//Ibero America Institute for Economic Research.

Gartzke, E., 2007. The capitalist peace. *American journal of political science*, *51*(1), pp.166-191.

Grossman, G.M. and Helpman, E., 1994. Endogenous innovation in the theory of growth. *Journal of Economic Perspectives*, *8*(1), pp.23-44.

Hewitt, M.D.P., 1991. *Military expenditure: econometric testing of economic and political influences*. International Monetary Fund.

Hofman, A.A., 2000. *The economic development of Latin America in the twentieth century*. ECLAC.

Howitt, P., 1999. Steady endogenous growth with population and r. & d. inputs growing. *Journal of Political Economy*, *107*(4), pp.715-730.

Humphreys, M., 2005. Natural resources, conflict, and conflict resolution: Uncovering the mechanisms. *Journal of conflict resolution*, *49*(4), pp.508-537.

Kant, I., 1970. *Perpetual peace: A philosophical sketch* (Vol. 1991). Cambridge: Cambridge University Press.

Kimenyi, M.S. and Mbaku, J.M., 1995. Female headship, feminization of poverty and welfare. *Southern Economic Journal*, pp.44-52.

Knight, J.C., Birks, T.A., Russell, P.S.J. and Atkin, D.M., 1996. All-silica single-mode optical fiber with photonic crystal cladding. *Optics letters*, *21*(19), pp.1547-1549.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A. and Vishny, R., 1999. The quality of government. *The Journal of Law, Economics, and Organization*, *15*(1), pp.222-279.

Lee, J.D., 2007. Technology and teen drivers. *Journal of safety research*, *38*(2), pp.203-213.

Lucas Jr, R.E., 1988. On the mechanics of economic development. *Journal of monetary economics*, *22*(1), pp.3-42.

Madsen, J.B., 2010. The anatomy of growth in the OECD since 1870. *Journal of Monetary Economics*, *57*(6), pp.753-767.

Madsen, J.B., 2014. Human capital and the world technology frontier. *Review of Economics and Statistics*, *96*(4), pp.676-692.

Mankiw, N.G., Romer, D. and Weil, D.N., 1992. A contribution to the empirics of economic growth. *The quarterly journal of economics*, *107*(2), pp.407-437.

Nelson, R.R. and Phelps, E.S., 1966. Investment in humans, technological diffusion, and economic growth. *The American economic review*, *56*(1/2), pp.69-75.

Nordhaus, W., Oneal, J.R. and Russett, B., 2012. The effects of the international security environment on national military expenditures: A multicountry study. *International Organization*, *66*(3), pp.491-513.

Ocampo, J.A., 2004. Latin America's growth and equity frustrations during structural reforms. *Journal of Economic Perspectives*, *18*(2), pp.67-88.

Peacock, A.T., 2004. The growth of public expenditure. In *The encyclopedia of public choice* (pp. 594-597). Springer, Boston, MA.

Peretto, P.F. and Valente, S., 2011. Resources, innovation and growth in the global economy. *Journal of Monetary Economics*, *58*(4), pp.387-399.

Peretto, P.F., 1998. Technological change and population growth. *Journal of Economic Growth*, *3*(4), pp.283-311.

Prescott, E.C. and Parente, S.L., 2000. *Barriers to riches*. MIT Press.

Pryor, F.L., 1968. *Public expenditures in communist and capitalist nations*. RD Irwin.

Psacharopoulos, G. and Patrinos*, H.A., 2004. Returns to investment in education: a further update. *Education economics*, *12*(2), pp.111-134.

Richardson, L.F., 1960. *Arms and insecurity: A mathematical study of the causes and origins of war*. Boxwood Press.

Romer, P.M., 1990. Endogenous technological change. *Journal of political Economy*, *98*(5, Part 2), pp.S71-S102.

Ross, M., 2014. Conflict and Natural Resources: Is the Latin American and Caribbean Region Different from the Rest of the World?. *TRANSPARENT GOVERNANCE*, p.109.

Ross, M.L., 2001. Does oil hinder democracy?. *World politics*, *53*(3), pp.325-361.

Ross, M.L., 2004. How do natural resources influence civil war? Evidence from thirteen cases. *International organization*, *58*(1), pp.35-67.

Russett, B.M., 1969. Who pays for defense?. *American Political Science Review*, *63*(2), pp.412-426.

Sandler, T. and Hartley, K., 2001. Economics of alliances: The lessons for collective action. *Journal of economic literature*, *39*(3), pp.869-896.

Sianesi, B. and Reenen, J.V., 2003. The returns to education: Macroeconomics. *Journal of economic surveys*, *17*(2), pp.157-200.

Sokoloff, K.L. and Engerman, S.L., 2000. Institutions, factor endowments, and paths of development in the new world. *Journal of Economic perspectives*, *14*(3), pp.217-232.

Sokoloff, K.L. and Engerman, S.L., 2000. Institutions, factor endowments, and paths of development in the new world. *Journal of Economic perspectives*, *14*(3), pp.217-232.

Solow, R.M., 1956. A contribution to the theory of economic growth. *The quarterly journal of economics*, *70*(1), pp.65-94.

Temple, J., 1999. The new growth evidence. *Journal of economic Literature*, *37*(1), pp.112-156.

Tilly, C., 1990. *Coercion, capital, and European states, AD 990*. Cambridge: Basil Blackwell.

Tilly, C., 1990. *Coercion, capital, and European states, AD 990*. Cambridge: Basil Blackwell.

Ulku, H., 2007. R&D, innovation, and growth: evidence from four manufacturing sectors in OECD countries. *Oxford Economic Papers*, *59*(3), pp.513-535.

Yakovlev, P., 2007. Arms trade, military spending, and economic growth. *Defence and peace economics*, *18*(4), pp.317-338.

Appendix

A: Data appendix

School Enrolment:

Argentina: Primary: 1801-1823 backdated using literacy rates derived gross enrolment rates (GERs). 1824 and 1869 enrolment from Newland, C. (1991). La educacion elemental en Hispanoamerica: Desde la independencia hasta la centralizacion delos sistemas educativos nacionales. *The Hispanic American Historical Review*, Vol. 71, No. 2 (May 1991), pp. 335-364. 1885, 1892-1988, 1990-1991, 1993-1996 from Mitchell, B, R. (2013), *International Historical Statistics, 1750-2010*, online database, Palgrave Macmillan: New York. 1997-2015 from UNESCO (2018). *UIS Statistics. Data.uis.unesco.org*. Retrieved 25 March 2018, from http://data.uis.unesco.org/Index.aspx. **Secondary :**1801-1905 GERs backdated using the primary and tertiary regression method. 1906, 1911, 1913-15 from Banks, A., & Wilson, K. A. (2016). *Cross-National Time-Series Data Archive*. Jerusalem: Databanks International. 1917, 1928-29, 1934-1957, 1959-1988, 1994, 1996, 1998-1999 Mitchell (2007) *op cit*. 1996-2015 from UNESCO (2018) *op cit*. **Tertiary:** 1801-1856 enrolment from National University of

Cordoba, sourced from de la Universidad Nacional de Córdoba Estadísticas, data obtained by direct correspondence. 1821-1882 enrolment for University of Buenos Aires obtained by estimating that 10 students were enrolled at the founding of the University in 1821. 1822-1900 obtained by direct correspondence from the University of Buenos Aires. Total enrolment for the period 1821-1900 is thus the sum of enrolments for the University of Buenos Aires and the University of Buenos Aires. 1900, 1902, 1904, 1909, 1911-1915, 1917 Banks and Wilson (2016) *op cit*. 1918-1920, Mitchell (2013) *op cit*. 1923-24, 1926, 1928 Banks and Wilson (2013) *op cit*. 1930-1987, 1991-92, 1994, Mitchell (2013) op cit. 1998-2015 from UNESCO (2018) *op cit*.

Brazil: Primary:1801-1856 backdated using literacy rates derived gross enrolment rates (GERs). 1857, 1869 and 1878 from Leff, N. H. (1972). Economic Retardation in Nineteenth-Century Brazil. *The Economic History Review*, *25*(3), 489-507. 1871-1876, 1882-1884, 1888, 1907, 1920, 1927-1993 from Michell (2013) *op cit.* 1994-2013 from Instituto Brasileiro de Geografia e Estatística, data obtained by direct correspondence. 2014-2015 from UNESCO (2018) *op cit*. **Secondary:**1801-1900 GERs backdated using the primary and tertiary regression method. 1890, 1907 total enrolment from Wilkie, J. W. (2002). *Statistical Abstract of Latin America* (Vol. 27). E. Alemán, & J. G. Ortega (Eds.). UCLA Latin American Center Publications. 1933-1994 from Mitchell (2013) *op cit*. 1995-2013 from Instituto Brasileiro de Geografia e Estatística, data obtained by direct correspondence. 2014-2015 from UNESCO (2018) *op cit*.**Tertiary:**1801-1887 backdated by assuming an average of 100 students enroled at the Instituto Militar de Engenharia (1792) and Universidade Federal do Rio de Janeiro (1792) respectively. 1888 and 1890 total enrolment from Wilkie (2002) *op cit*. 1933-1980 from Mitchell (2013) *op cit*. 1981-2015 from Instituto Brasileiro de Geografia e Estatística, data obtained by direct correspondence.

Chile: Primary:1801-1812 backdated using literacy rates derived gross enrolment rates (GERs). 1813 from Newland (1991) *op cit.* 1852-2010 from Díaz, J .;Lüders.R. and Wagner, G. (2016). *Chile 1810 - 2010. The Republic in figures, Historical Statistics*. Santiago: Catholic University of Chile Editions http://www.economia.puc.cl/cliolab], enrolment is calculated as sum of private and public schools and all gaps are growth interpolated. 2011-2015 from

UNESCO (2018) *op cit*. **Secondary:**1801-1905 GERs backdated using the primary and tertiary regression method. 1901-2010 enrolment from Diaz and Wagner (2016) *op cit*., calculated as sum of public and private schools and all gaps are growth interpolated. 2011-2015 from UNESCO (2018) *op cit*. **Tertiary:**1801-1841 GERs backdated by splicing using Argentina in 1842. 1842-1851 enrolment is based on estimated enrolment for the University of Chile (founded in 1842) and the University of Santiago (founded in 1849). 1852-2010 enrolment from Diaz and Wagner (2016) *op cit*., calculated as sum of public and private universities and all gaps growth interpolated. 2011-2015 from UNESCO (2018) *op cit*.

Columbia: Primary: 1801-1811 backward extrapolated using growth interpolation. 1812-1826 backdated using literacy rates derived gross enrolment rates (GERs). 1827, 1833, 1839, 1843-1845, 1847-1848, 1850-1851, 1874, 1881-1882 enrolment from Ramírez, M. T., & Salazar, I. (2007). The Emergence of Education in the Republic of Colombia in the 19th Century: Where Did We Go Wrong?. In *International Seminar on the Economic History of Colombia in the 19th Century, organized by the Banco de la República, Bogotá, August* 15-16; Table 1 (primary, p 7) and Table 3 (primary, p 18). 1886-1933 from Banks (1971) *op cit*. 1934-1977 from Mitchel (2007) *op cit*. 1978-2015 from UNESCO (2018) *op cit*.**Secondary:** 1801-1905 GERs backdated using the primary and tertiary regression method. 1901-1931 enrolment from Banks and Wilson (2016) *op cit*. 1934-1989, 1991-1996, 1998-2002 from Mitchell (2007) *op cit*. 2004-2015 from UNESCO (2018) *op cit*.**Tertiary:** 1801-1834 enrolment backdated by splicing the total enrolment in 1835 with the average number of universities that operated during the period. The following universities (and corresponding founding dates) existed: Universidad de Santo Tomas de Aquino (1580), Pontifical Xavierian University/Pontificia Universidad Javeriana (1623), The Universidad del Rosario (1653), Universidad de San Buenaventura (1708), University of Antioquia (1803), University of Cartagena (1827) and University of Cauca (1827). 1835-1839, 1842-1848, 1850, 1852, 1869, 1881, 1897 from Ramirez and Salazar (2007) *op cit*. 1897, 1558, 1914, 1917, 1934-1989, 1991, 1993-1999 from Mitchell (2007) *op cit.* 2000-2015 from UNESCO (2018) *op cit*.

Mexico: Primary: 1801-1869 backward extrapolated using growth interpolation. 1870, 1882, 1887, 1890, 1893 enrolment from Ramirez and Salazar (2007) *op cit*. 1894-1899 from Wilkie, J. W. (2002). *Statistical Abstract of Latin America* (Vol. 27). E. Alemán, & J. G. Ortega (Eds.). UCLA Latin American Center Publications. 1900-1907, 1921, 1925-2012 from the Ministry of Education, Mexico data obtained by direct correspondence. 2013-2015 from UNESCO (2018) *op cit*.**Secondary:**1801-1900 GERs backdated using the primary and tertiary regression method. 1900-1907, 1925-1931, 1935, 1949-2012 from the Ministry of Education, Mexico, data obtained by direct correspondence. 2013-2015 from UNESCO (2018) *op cit*.**Tertiary:**1801-1881 based on estimated average enrolment from the 4 universities (with corresponding founding dates) that the existed during the period: Université nationale autonome du Mexique (1551), Benemérita Universidad Autónoma de Puebla (1578), Université de Guadalajara (1791) and Université Juarez de l'État de Durango (1872). 1882, 1890, 1900-1905 from Wilkie (2002) *op cit*. 1906-1907, 1925-1931, 1935, 1949-2012 from the Ministry of Education, Mexico, data obtained by direct correspondence. 2013-2015 from UNESCO (2018) *op cit*.

Peru: Primary1801-1805 backward extrapolated using growth interpolation. 1806-1885 backdated using literacy rates derived gross enrolment rates (GERs). 1886-1939, 1946-1980 enrolment from Banks and Wilson (2016) *op cit*. 1940-1943, 1945, 1981-2009 from Mitchell (2007) *op cit*. 2010-2015 from UNESCO (2018) *op cit*. **Secondary :** 1801-1900 GERs backdated using the primary and tertiary regression method. 1901-1934, 1938, 1940-1943, 1946-1960, 1964-1998, 2000-2009 from Mitchell (2007) *op cit*. 2010-2015 from UNESCO (2018) *op cit*. **Tertiary:** 1801-1896 enrolment backdated by splicing the total enrolment in 1897 with the average number of universities that operated during the period. 1897-1997, 2000-2005 from Mitchell (2007) *op cit*. 2006-2012 from Instituto Nacional de Estadistica e Informatica (INEI). 2014. *Matricula escolar en el sistema educativo, segun nivel y modalidad*. INEI. Retrieved 1 April 2014, from http://www.inei.gob.pe/estadisticas/indice-tematico/sociales/, Table 5.5. 2013-2015 growth extrapolated.

Venezuela: Primary:1801-1805 backward extrapolated using growth interpolation. 1806-1839 backdated using literacy rates derived gross enrolment rates (GERs). 1839-1840, 1847,

1870, 1872 enrolment is derived from Martínez, E. (2006). La educación de las mujeres en Venezuela (1840-1912). *Caracas, Venezuela: Fondo Editorial de Humanidades. Universidad Central de Venezuela*. Pages 122, 154-155. The data is available as the sum of primary and secondary enrolment and is therefore spliced with the sum of actual primary enrolment in 1889. 1886-1913, 1921-1939 primary enrolment from Banks and Wilson (2006) *op cit.* 1940-1892, 1994-1997, 2000-2010 from Mitchell (2013) *op cit*. 2010-2015 from UNESCO (2018) *op cit*. **Secondary:** 1801-1900 GERs backdated using the primary and tertiary regression method. 1893 enrolment from Ortal, J. C. (2002). *Educational Enrollment History* in Wilkie (2002) (ed.) *op cit.* 1937-1986 Mitchell (2013) *op cit*. 1986-1992, 1999-2015 from UNESCO (2018) *op cit*.**Tertiary:**1721-1779 based on estimated enrolment of 50 students at the founding of Universidad Central de Venezuela in 1721. The figure growth interpolated with actual enrolment in 1779. 1779 total enrolment for Universidad Central de Venezuela from Remedios Ferrero Mico, R. F. (1994). La Universidad en Venezuela durante el periodo colonial. Bibliografia, critica, metodologia y estado de la cuestion. *Estudios de historia social y economica de America, No. 11*, pg 109-122. 1810 from Ortal (2002) *op cit*. 1937-1991, 1999, 2001-2003, 2007, 2008 from Mitchell (2013) *op cit*. 2009-2015 growth extrapolated.

Population:

The population distributions are classified according to the following age groups: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80+. Principal data sources used were Mitchell, B, R. (2013), *International Historical Statistics, 1750-2010*, online database, Palgrave Macmillan: New York., United Nations (UN) .(2017). World Population Prospects 2017, retrieved on 15th of March 2017 from, http://esa.un.org/wpp/Excel-Data/population.htm. All total population data up to 2010 is from Maddison, A. (2010). *Historical Statistics of World Economy: 1-2008AD*. Organization for Economic Cooperation and Development: Paris, thereafter updated using UN (2017) *op cit*. All intervening years in the data growth interpolated. The following are the detailed sources for population age distributions.

Argentina:1801-1870 backdated as constant. 1869 is from Mitchell (2013) *op cit*. The 20-80+ age groups are decomposed to the default age distributions using 1895 proportions as proxy.

1895, 1914, 1948, 1960, 1970, 1980, 1990, 1995 and 2000 is obtained from Mitchell (2013) *op cit*. 2000-2015 is from UN (2017) *op cit*. **Brazil:**1801-1869 backdated as constant. 1870-1871 growth extrapolated. 1872 is from Mitchell (2013) *op cit*. The 30-80+ age groups are decomposed to the default age distributions using 1873 proportions as proxy. 1873, 1900, 1920, 1940, 1950, 1960, 1970, 1980, 1990, 1996 and 2002 is from Mitchell (2007). The 30-80+ age groups for 1900 and 1920 are distributed using proportions from 1940 as proxy. 2003-2015 from the UN (2017) *op cit*.**Chile:**1801-1869 backdated as constant. 1870-1894 was backdated using age distributions from Argentina as proxy and total population from Maddison (2010) *op cit*. 1895, 1907 and 1920 are from Mitchell (2007). The original age distributions from 30-80+ in Mitchell are decomposed to the default classifications using the 1920 proportions as proxy. 1930, 1940, 1952, 1960, 1970, 1982, 1991, 1997 and 2002, Mitchell (2013) *op cit*. 2003-2015 from UN (2017) *op cit*.**Columbia:**1801-1869 backdated as constant. 1870-1918 backdated using age distributions from Argentina as proxy and total population from Maddison (2010) *op cit*. 1938, 1950 from Mitchell (2013) *op cit*. 1951-2015 from UN (2017) *op cit*.**Mexico:**1801-1869 backdated as constant. 1870-1894 was backdated using age distributions from Brazil as proxy and total population from Maddison (2010). 1895 and 1900 0-4, 5-9, 10-14- and 15-19-year age groups are from Mitchell (2013) *op cit*. 20-89+ age groups for 1900 were decomposed to the default distributions using 1910 as a proxy year, while 1895-1899 for 20-80+ was growth interpolated. 1921, 1930 and 1940 is from Mitchell (2013) *op cit.* Age groups from 60-80+ for 1921 and 1930 are distributed using 1940 as proxy, while those for 1940 are based on the 1950 age distributions. 1950, 1960, 1970, 1980, 1990, 1995 and 2000 is from Mitchell (2013) *op cit*. 2001-2015 from UN (2017) *op cit*.**Peru:**1801-1869 backdated as constant. 1870-1939 backdated using age distributions from Argentina as proxy and total population from Maddison (2010) *op cit*. 1940, 1950 from Mitchell (2013) *op cit*. 1951-2015 from UN (2017) *op cit*.**Venezuela**1801-1869 backdated as constant. 1870-1950 backdated using age distributions from Argentina as proxy and total population from Maddison (2010) *op cit*. 1951-2015 from UN (2017) *op cit*.

Fertility rate:

Argentina: 1801-1859: Assumed to be constant at 1860's value. 1860-1910: Birth Rates in Latin America: New Estimates of Historical trends and fluctuations by o. Andrew Collver (1965). 1910-1993: B.R. Mitchell. 2010. International historical statistics: the Americas, 1750–2000. 1993-2015: "Demographic Yearbook System". *Unstats.un.org*.**Brazil:** 1801-1859: Assumed to be constant at 1860's value. 1860-1899: spliced back with the average of Argentina and Chile.1900-1950: Birth Rates in Latin America: New Estimates of Historical trends and fluctuations by o. Andrew Collver (1965). 1950-2015: *"World Population Prospects - Population Division - United Nations"*. *esa.un.org*. **Chile:** Assumed to be constant at 1848's value. 1848-1993 B.R. Mitchell(2010). International historical statistics: the Americas, 1750–2000.1994-2015 http://www.deis.cl/estadisticas-poblacion/.**Mexico:** Assumed to be constant at 1860's value. 1860-1896: spliced back with the average of Argentina and Chile. 1897-1942: Birth Rates in Latin America: New Estimates of Historical trends and fluctuations by o. Andrew Collver (1965).1943-2015: "Instituto Nacional de Estadística y Geografía - Temas estadísticos". **Colombia:** 1801-1859: Assumed to be constant at 1860's value. 1860-1900: spliced back with the average of Argentina and Chile. 1900-1957: Birth Rates in Latin America: New Estimates of Historical trends and fluctuations by o. Andrew Collver (1965). 1958-2015: *"World Population Prospects - Population Division - United Nations"*. *Esa.un.org*.**Peru:** 1801-1859: Assumed to be constant at 1860's value. 1860-1926: spliced back with the average of Argentina and Chile. 1927-1960: Birth Rates in Latin America: New Estimates of Historical trends and fluctuations by o. Andrew Collver (1965). 1960-2015: World Population Prospects - Population Division - United Nations". *esa.un.org*. Retrieved October 4, 2017.**Venezuela:** 1801-1859: Assumed to be constant at 1860's value. 1860-1872: spliced back with the average of Argentina and Chile. 1873-1992: Birth Rates in Latin America: New Estimates of Historical trends and fluctuations by o. Andrew Collver (1965). 1993:2015 :*Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2010 Revision Archived 6 May 2011 at the Wayback Machine*.

R & D / Innovation:

Calculated as Patent granted divided by population. **Argentina**: 1801-1865: spliced back to 1801 with the population data using 1866 patent/population ratio.1965-2015: WIPO-World Intellectual Patent Organization. 1866-1964: Frederico (1964). **Brazil :** 1801-1881, spliced back to 1801 with the population data using 1882 patent/population ratio .1966-2015: WIPO-World Intellectual Patent Organization. 1882-1964: Frederico (1964). **Chile**: 1801-1839, spliced back to 1801 with the population data using 1840 patent/population ratio. 1840-1962: Frederico (1964).1963-2015: WIPO-World Intellectual Patent Organization. **Colombia**: 1801-1861, spliced back to 1801 with the population data using 1862 patent/population ratio. 1881-1962: Frederico (1964).1963-2015: WIPO-World Intellectual Patent Organization. **Peru:** The number of patent granted was very less(approximately 1) in 1911, hence we assumed the number of patent granted in 1869(first patent law established)is 1 and have interpolated the data between 1869 and 1911 and have assumed the patent granted to be zero before 1869. 1911-1946: Historia de las patentes e invenciones en el Peru. 1947-1962: Frederico (1964). 1972-2015: WIPO-World Intellectual Patent Organization. **Venezuela**: The first patent law was effective in 1955. So using averages of Argentina, Brazil, Mexico and Chile, it is spliced back to 1854 and assumed constant before that. 1947-2015: WIPO - World Intellectual Patent Organization.

Contract Intensive Money:

Argentina: From 1851 back to 1801, it is assumed to be constant at 1852's value .1852-162: spliced with Brazil's data.1863-1999: Dos Siglos De Economia Argentina by Ferreres (2013). 2000-2015: World Development indicators (WDI). 1852-162: spliced with Brazil's data**. Brazil:** From 1851 back to 1801, it is assumed to be constant at 1852's value .1852-1999: International historical statistics : the Americas by B. R. Mitchell, 2010. 2000-2015: World Development indicators (WDI).**Chile**: From 1859back to 1801, it is assumed to be constant at 1860's value .1860-1999: Economía Chilena 1810-2000 **by** Díaz, Lüders, and Wagner, 2010. 2000-2015: World Development indicators (WDI).**Columbia:** From 1801-1852: it is kept constant at 1851's value.1852-1919: it is spliced using averages of Brazil, Argentina and Chile. 1920-1999: International historical statistics: the Americas by B. R. Mitchell, 2010. 2000-2015: World Development indicators (WDI).**Mexico:** 1801-1852: it is kept constant at 1851's value. 1852-1889: it is spliced using averages of Brazil, Argentina and Chile. From 1801-1852:

it is kept constant at 1851's value. 1890-1999: Historia de la Iglesia en México by Casillas, J.G., 1974. 2000-2015: World Development indicators (WDI).**Peru**: 1801-1852: it is kept constant at 1851's value.1852-1919: spliced using averages of Brazil, Argentina and Chile. 1920-1999: International historical statistics : the Americas by B. R. Mitchell, 2010. 2000-2015: World Development indicators (WDI).**Venezuela:**1801-1852: it is kept constant at 1851's value. 1853-1912: spliced using averages of Brazil, Argentina and Chile. 1913-1999: Bases cuantitativas de la economia venezolana. 2000-2015: World Development indicators (WDI).

Military Expenditure:

Argentina: Data from 1990 to 2015 retrieved from the World development indicators. From 1938 to 1965, the data is from Table 5 in Latin American Defence Expenditures, 1938-1965 by Joseph E. Loftus. From 1966 to 1989 the data is interpolated. Data is further spliced to 1882 using the percentage of military expenditure calculated using military expenditure () and government expenditure (). From 1882, the data is spliced back to 1822 using data from Blood and Debt: War and Taxation in Nineteenth- Century Latin America by Centeno MA (1997), Table2. **Brazil:**Data from 1980 to 2015 retrieved from the World development indicators. From 1979, it is spliced back to 1900 using Brazil: A Handbook of historical statistics- Armin K. Ludwig. From 1828 to 1886, it is retrieved from Blood and Debt: War and Taxation in Nineteenth- Century Latin America by Centeno MA (1997), Table2. The missing data from 1887 to 1899 is interpolated. From 1938 to 1957, the data is from Table 5 in Latin American Defence Expenditures, 1938-1965 by Joseph E. Loftus. The missing data from 1966 to 1996 is interpolated. **Chile :** Data from 1973 to 2015 retrieved from the World development indicators. From 1938 to 1957, the data is from Table 5 in Latin American Defence Expenditures, 1938-1965 by Joseph E. Loftus. The missing data from 1958 to 1972 is interpolated. From 1937 to 1931, data is further spliced using the percentage of military expenditure calculated using military expenditure () and government expenditure (). From 1930, it is spliced back to 1890 using Historical Statistics of Chile-Government Services and Public Sector and a Theory of services, Volume-6 , Table-5.15. (). From 1889, the data is spliced back to 1833 using data from Blood and Debt: War and Taxation in Nineteenth- Century Latin America by Centeno MA (1997), Table2. **Colombia:** Data from 1997 to 2015 retrieved from the World development

indicators. . From 1938 to 1965, the data is from Table 5 in Latin American Defence Expenditures, 1938-1965 by Joseph E. Loftus. The missing data from 1966 to 1996 is interpolated. From 1937, it is spliced back to 1899 using the percentage of military expenditure calculated using military expenditure () and government expenditure (). From 1898 it is further spliced back to 1832 using data from Blood and Debt: War and Taxation in Nineteenth-Century Latin America by Centeno MA (1997), Table2. **Mexico:** Data from 1963 to 2015 retrieved from the World development indicators. It is spliced back to 1925 using Estadisticas Historicas Mexico. From 1924 to 1880,it is spliced using the percentage of military expenditure calculated using military expenditure () and government expenditure ().From 1879 it is further spliced back to 1822 using data from Blood and Debt: War and Taxation in Nineteenth-Century Latin America by Centeno MA (1997), Table2. **Peru:** Data from 1973 to 2015 retrieved from the World development indicators. From 1972, it is spliced back to 1879 using Compendio Estadistico del Peru 1900-1990. From 1878, it is spliced back to 1826 using Blood and Debt: War and Taxation in Nineteenth- Century Latin America by Centeno MA (1997), Table2. **Venezuela:** Data from 1988 to 2015 retrieved from the SIPRI Military Expenditure Database. From 1938 to 1965, the data is from Table 5 in Latin American Defence Expenditures, 1938-1965 by Joseph E. Loftus. The missing data from 1966 to 1987 is interpolated. From 1937 to 1872,it is spliced using the percentage of military expenditure calculated using military expenditure () and government expenditure ().From 1871 it is further spliced back to 1831 using data from Blood and Debt: War and Taxation in Nineteenth-Century Latin America by Centeno MA (1997), Table2.

Land inequality/ Family farm: Vanhanen, Tatu, Prospects of Democracy 1810-1970. From 1970-2015 the data is interpolated. 1801-1809: assumed constant at 1810's value.

Democracy Index:

Vanhanen, Tatu, Measures of Democracy 1810-2012. From 2012-2015 the data is interpolated. 1801-1809: assumed constant at 1810's value.

Tariff/Government Revenue:

Argentina: 1801-1822: kept constant at 1823's value. 1823-1863: table-3 by Centeno, M. A. , 1997. 1864-1898: Dos Siglos De Economia Argentina 1810 – 2010, table 7.1.1 &7.2.1. 1899-

1992 : International historical statistics : the Americas by B. R. Mitchell, 2010. 1993-2015: World Development indicators (WDI).**Brazil:** 1801-1826: kept constant at 1827's value. 1827-1900 : table 10.1by -Bordo & Cortes-conde, 2002. 1901- 1993: International historical statistics : the Americas by B. R. Mitchell, 2010. 1994-2015:World Development indicators (WDI).**Chile:** 1801-1832: kept constant at 1833's value. 1833-1864: table-3 by Centeno, M. A. , 1997. 1865-1894: table 3.19 of Historical statistics of Chile, by Mamalakis, M , 1978. 1895-2000 : International historical statistics : the Americas by B. R. Mitchell, 2010. 2001-2015: World Development indicators (WDI).**Colombia:** 1801-1832: it is kept constant at 1833's value. 1833-1898 : table 7 & 9 in La evolution economica de Colombia . 1905-1997: International historical statistics : the Americas by B. R. Mitchell, 2010. 1998-2015: World Development indicators (WDI).**Peru:** 1801-1826: kept constant at 1827's value. 1827-1898: Compendio de historia del peru by José Antonio del Busto, 1973. 1899-1993 : International historical statistics : the Americas by B. R. Mitchell, 2010. 1993-2015 : World Development indicators (WDI).**Venezuela**: 1801-1829: kept constant at 1830's value. 1830-1894: table-3 by Centeno, M. A. , 1997. 1895-1989 : International historical statistics : the Americas by B. R. Mitchell, 2010. 1990-2015: World Development indicators (WDI).

Life expectancy at the age 10:

Argentina: Assumed constant before 1914. 1914-1999: Length of life , a study of the life table, by Louis I. Dublin, Afred J. Lotka, Mortimer Spiegelman, published by the ronald press company, New York. 1961: World Population, An Analysis of Vital Data, by Keyfitz and Flieger. Assumed constant before 1914. 2000-2015: world health organization (WHO) downloaded from http://apps.who.int/gho/data/view.main.60050. **Brazil:** Assumed constant before 1872. 1872-1960: New Life Tables for Latin American Populations in the Nineteenth and Twentieth Centuries, by Eduardo E. Arriaga. Published by Institute of International Studies, University of California, Berkeley. 1960-2008: Human Lifetable Database, (www.lifetable.de). 2008 - 2010: WHO data, downloaded from http://apps.who.int/gho/data/view.main.60220?lang=en.**Chile:** Assumed constant before 1906. 1907-1959: New Life Tables for Latin American Populations in the Nineteenth and Twentieth Centuries, by Eduardo E. Arriaga. Published by Institute of International Studies, University of California, Berkeley. 1960-2000: Human Lifetable Database,

(www.lifetable.de). 2001-2010: WHO data, downloaded from http://apps.who.int/gho/data/view.main.LT62010?lang=en.**Mexico:** Assumed constant before 1895. 1895-1960: New Life Tables for Latin American Populations in the Nineteenth and Twentieth Centuries, by Eduardo E. Arriaga. Published by Institute of International Studies, University of California, Berkeley. 1960- 1985: Human Lifetable Database, (www.lifetable.de). 1985-2010: WHO data, downloaded from http://apps.who.int/gho/data/view.main.61060?lang=en.**Colombia, Peru and Venezuela:** Assumed constant before 1914. Backdated to 1914 using Argentina, Brazil, Chile, Colombia and Mexico. Assumed constant before 1914. Backdated to 1914 using Argentina, Brazil, Chile, Colombia and Mexico. 1960-2015 :World Development indicators (WDI).