

## **Failure to Launch? Transition Delay, Institutions, and Divergence**

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## Abstract

Recent work in the growth literature has focused on identifying the determinants of growth take-offs. Various theories suggest that the timing of take-off depends on fundamental determinants, such as geography, mortality, trade openness, ethnic fractionalization, property rights institutions, constraints on the executive, land inequality, and culture. Further, conditional on these fundamental determinants, the delay in take-off should be inversely related to initial per worker income. In this paper we investigate three issues: (1) we study the factors that determine the timing of takeoffs using duration analysis, (2) we investigate whether the delay in take-off affects long-run economic performance after we control for the other fundamental growth determinants, and (3) we ask whether the delay in take-off affects growth sustainability, measured in terms of macroeconomic volatility and the chances of experiencing a growth reversal, after controlling for the other fundamental determinants. We find that, as predicted by theory, higher initial per worker income positively affects the potential for take-off, but so too do better property rights institutions. We also find that long-run economic performance, as well as its sustainability, depends positively on property rights institutions, ethnic fractionalization, and the probability of taking off. Our results lend support to the growing body of work; e.g., Howitt-Mayer-Foulkes (2005), Chamon and Kremer (2006), that suggests that the sequencing of growth take-offs is predictive of future growth outcomes.

## 1. Introduction

In the last two centuries the world economy is characterized by the transition from stagnation in living standards to sustained growth, as well as by the related phenomenon of the Great Divergence. The evolution of the economic growth first advanced by Galor and Weil (2000) in the context of the unified growth theory is described by the Malthusian Epoch, the Post Malthusian Regime, and the Sustained Growth Regime. During the Malthusian Epoch, technological progress and population growth were insignificant by modern standards, the level of income per capita was positively related with population, whereas the long-run average growth rate was negligible due to the slow pace of technological progress and the counterbalancing effect of population growth. In the Post Malthusian Regime, the pace of technological process and the growth rate of per capita income increased significantly, but the positive relationship between population and income per capita is still maintained. The Sustained Growth Era is characterized by steady growth in both income per capita and the level of technology whereas the positive relationship between population growth and average growth rate is reversed.

Based on historical evidence, the first country which experienced a takeoff was England, around 1870, followed by the rest of European countries and Western Offshoots. As depicted in Figure I, where we present the evolution of urbanization rates, an alternative measure of economic prosperity across regions (Acemoglu, Johnson and Robinson, 2002a), Western Offshoots and Europe had relatively the highest urbanization rates comparing to Asia, Africa and Latin American countries. The crucial question at this point is what accounts for the takeoff for some countries and the existence of persistence stagnation in others? Why England experienced a takeoff before 1900, whereas other countries are still “trapped” in the Post Malthusian Era?

One of the earliest writers on the subject, Thomas Malthus in his “Essay on the Principle of Population” in 1798, provides a very simple explanation of the Malthusian Stagnation: the population growth is an increasing function of income per capita. As a result, a growth takeoff occurs when the positive relationship between population and income does not longer exist. Historically, the positive relationship between population and per capita income indeed reversed triggering for many countries to an economic takeoff. In a phenomenon known as the demographic transition, fertility, mortality and population growth were low, whereas the growth rate of income per capita was remarkable. In recent years, an intensive research in the growth literature attempt to uncover the factors that caused the demographic transition. In particular, geographical, institutional, cultural, political, as well as social factors have been extensively investigated.

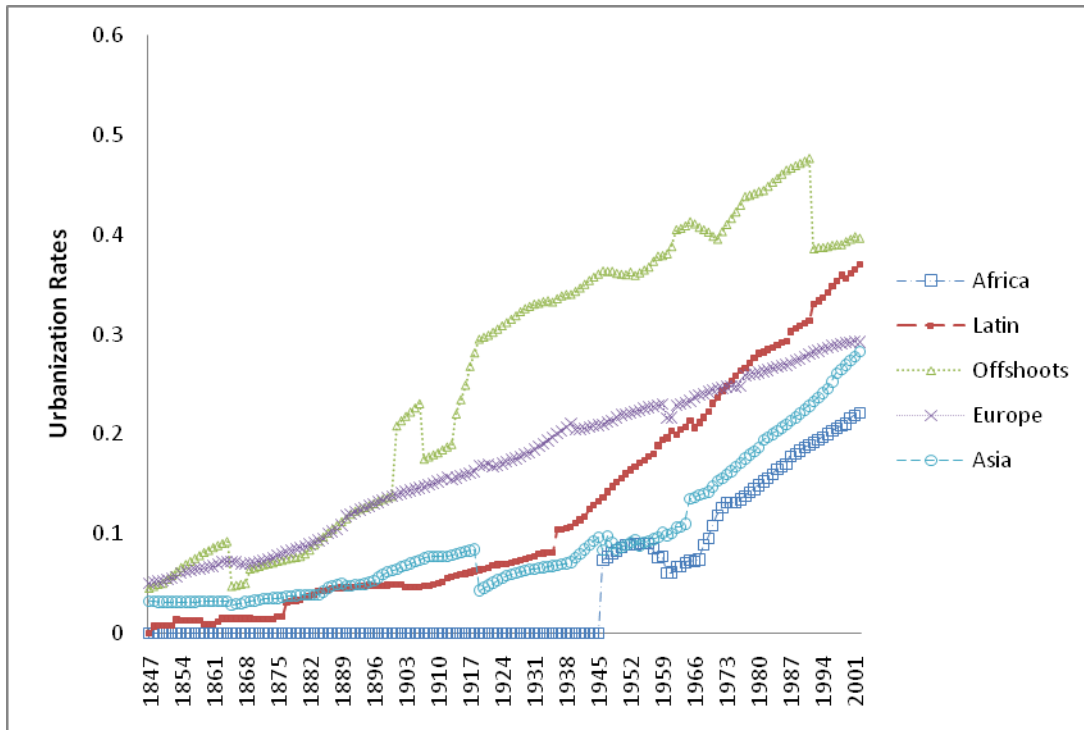


Figure I :Urbanization rates in cities of 100.000 and over per capita  
Source: Banks Arthur (1999)

Galor and Weil (2000), suggest that technological progress is the answer behind economic takeoffs. The acceleration of productivity increases the return to education, and triggers parents to choose less, but more educated children (quantity-quality tradeoff). In a similar context, proposed by Fernandez-Villaverde (2001) and Dopke (2004), the introduction of skill-intensive production technologies raise the return to education, and therefore, induce parents to educate their children. Doepke and Zilibotti (2005), show that parent's fertility decisions are affected by changes in child-labor and education laws, triggered by skill-biased technological change. In a similar point of view, Galor and Weil (1996), support that an increase in the capital intensity increases women's relative wages, along with the cost of raising children, decreasing fertility rates at the same time.

Galor and Mountford (2006, 2008) on the other hand, suggest that the expansion of international trade in the second phase of industrialization was a significant determinant not only of the demographic transition, but also of the phenomenon of the great divergence. The development of international trade had asymmetric effects on industrial and non industrial economies, because they focused on the production of skill-intensive and non-skill-intensive goods respectively, and therefore, the industrial economies experienced increased demand for skilled labor, which fostered the investments in human capital and an early demographic transition, in contrast with non-industrial countries. In a similar context, Baldwin, Martin and Ottaviano (2001) underline the importance of exogenous trade costs (transportation costs and market opening initiatives) for takeoffs.

Desmet and Parente (2009) emphasize that, the transition from the Malthusian Regime is achieved through markets and competition, and in particular, if markets reach a critical threshold and competition is sufficiently strong. Larger markets make goods more substitutable, raise price elasticity of demand and lower mark-ups. With lower mark-ups firms become larger in order to break even, which raises the return to innovation making them able to cover their fixed costs. Morgan Kelly (1997) also examines the role of markets. His findings showed that, geographical expansion of markets encourages specialization and in turn, economic growth.

A different explanation of the transition is given by Voigtlander and Voth (2009) based on an exogenous increase of mortality, due to epidemics. The occurrence of plague in Europe in 1347, caused millions of deaths, and along with higher urbanization rates due to the increased demand for manufacturing goods, wars and the further dispersion of diseases through the expansion of international trade, lead to significant increase in per capita income. Other authors, like Kalemli-Oczan (2002) and Soares (2005), have also emphasized the importance of the declining mortality rates.

The significant role of interest groups is pointed out by Parente and Prescott (2000) and Acemoglu and Robinson (2002b). In particular, landed aristocracy and monopolies block the introduction of new technologies and institutions in order to protect their power and profits, delaying at the same time the industrialization process. However, the complementarity between human capital to industrial activity increases future gains from industrialization, discouraging blocking by the elites.

In Galor, Moav and Vollrath (2009) land inequality affects negatively the implementation of educational reforms. In particular, due to the low complementarity of human capital and land, an increase in the level of human capital, increases productivity in industry more than the agricultural sector, causing a decrease in the returns to land and a rise in wages. Consequently, landowners have no incentive to support any educational reforms. Galor and Moav (2006) suggest that in contrast to aristocracy, monopolies and landowners, capitalists not only allow for the introduction of new capital specific technologies, but because of the complementarity of physical capital and skills, they support the presence of public education and educational reforms in general which enhance the investment in human capital.

A different prospective for economic stagnation is the presence of the fixed factor land. Consequently, a structural change that decreases the role of land might cause a takeoff. In Hansen and Prescott (2002) the role of land declines endogenously over time, as observed historically, when firms in response to exogenous technological progress focus on less land intensive production.

Howitt and Mayer-Foulkes (2005) propose an alternative theory in the context of a Schumpeterian growth theory. Specifically, a country's ability to acquire the skills used intensively in technology investment depends on its level of development, relative to the global technological frontier from which it draws new ideas. Therefore, as the world's

technological frontier advances, a country that does not keep pace will find it increasingly difficult to catch up by absorbing foreign knowledge, because its skill levels will not be keeping up with the frontier. As a result its technology investments will become increasingly ineffective. This *erosion of absorptive capacity* that takes place when a country falls behind weakens the force of technology transfer that is tending to bring about parallel convergence. An important assumption is that all countries with sufficient skill levels to engage in R&D also have the institutions required to support R&D. If this is not the case then, once R&D takes hold in some leading economies, other economies may have a finite *window of opportunity* in which to establish the necessary institutions, and therefore to join the leading club. If this window is missed, absorptive capacity may erode to such an extent that the country will become trapped in technological implementation or even stagnation, and it will then take more than the right institutions to rejoin the leaders. In Clark and Feenstra (2001), divergence is ultimately a consequence of the inability of the poor countries not to access technology, but rather, to use it efficiently.

In this context, in a first stage we investigate the determinants which trigger takeoffs, and in a second stage, we analyze the long-run performance of the countries that experienced takeoffs, as well as their sustainability, by evaluating the probability of growth reversals and growth volatility.

The rest of the paper is structured as follows. Section 2 introduces the basic framework of our model whereas in Section 3, we evaluate empirically the potential of takeoff, the long-run performance and the sustainability of the countries, using advanced econometric techniques proposed by the literature. Conclusions are presented in Section 4.

## 2. The Model

- **To be completed** -

## 3. Empirical Analysis

In this section, we consider the contribution of the various takeoff theories in the context of duration models. In particular, we are interested in the hazard function on the basis of semiparametric (Cox, 1972 and Han, Hausman, 1988) and parametric (Exponential, Log Logistic, Weibull) continuous duration models, where we evaluate the role of alternative covariates.

$$\lambda(t|W_i;\theta) = \frac{f(t|W_i;\theta)}{S(t|W_i;\theta)} = \lambda_0(t) \exp(W_i^T \theta) \quad (1)$$

Furthermore, we control for the presence of unobserved individual or group heterogeneity parametrically and non parametrically. Following Lancaster (1990), we assume Gamma or Inverse Gaussian distribution, whereas for the non parametric context we allow for the presence of a discrete mixture as Heckman and Singer (1984) proposed.

In a second stage, we evaluate the long-run steady state, considering an augmented Acemoglu Johnson and Robinson (2001) model. According to equation (2) we include the fitted hazard rates from the previews section, to investigate whether the delay in takeoff affects the long-run economic performance, after we control for various fundamental growth determinants proposed by the literature.

$$y_{i,T} = Z_i \gamma + \phi \hat{\lambda}_{T_i} + \varepsilon_i \quad (2)$$

Also, including measures of growth volatility as the depended variable, we examine the growth sustainability and the probability of growth reversals (Ben-David and Papell, 1998).

Finally, following Volinsky, Madigan, Raftery and Kronmal (1997), we consider the presence of model and parameter uncertainty, and consequently, we estimate Bayesian Model Averaging models (BMA).

### 3.1 Data

Table I in the Appendix presents briefly the dependent variables used in the survival analysis, as well as the related covariates. Delay in the implementation of compulsory schooling, delay in 1900 GDP per capita, as well as cutoffs in primary enrollments and urbanization rates, represent the dependent variables which indicate the transition from the Malthusian trap, to the Sustained Growth Era. Institutions, mortality rates, land inequality, religion shares, colony dummies, openness, as well as initial income, are the basic covariates of our analysis. Figures II-V present the duration in years for the 30% threshold in primary schooling, against land gini, executive constraints, lcr100km and mortality rates. According to the graphs there is a negative relationship between the duration in years for the 30% threshold, and the executive constraints index, lcr100km and infant mortality. A country with good institutions and expanded trade is more likely to experience a takeoff. Also, in line with the literature considering the role of the mortality rates in the demographic transition, high mortality rates, trigger a country to

enter the Sustained Growth Regime via the quantity-quality tradeoff. However, land inequality delays takeoff as Galor, Moav and Vollrath (2009) suggest.

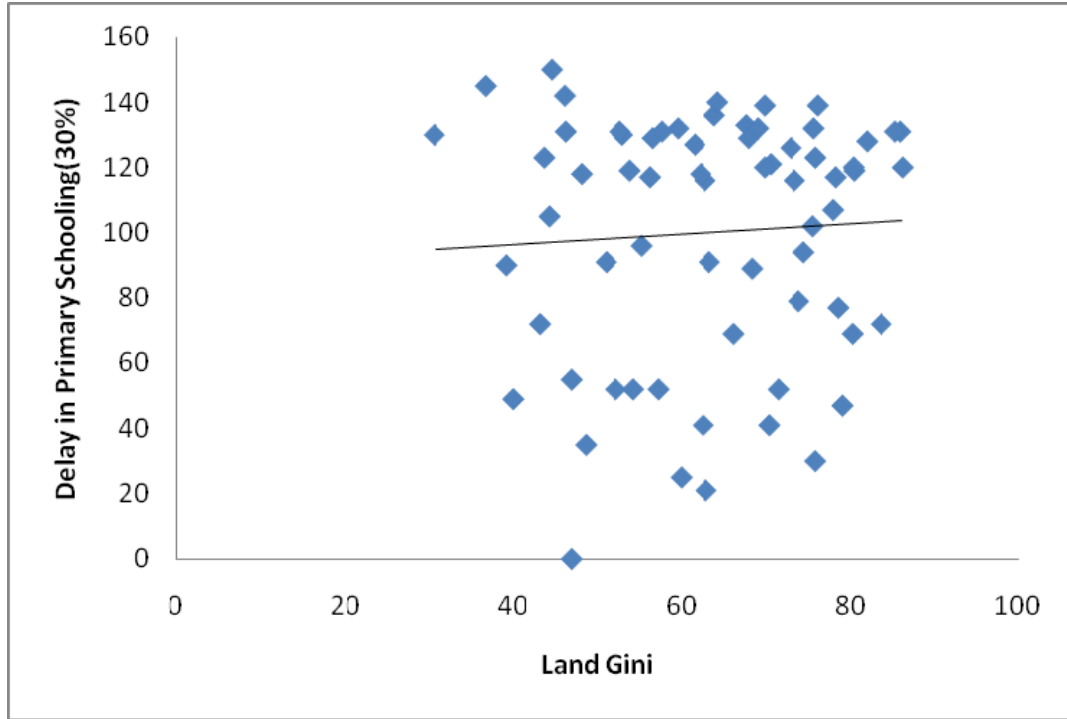


Figure II: Relationship between Delay in Primary Schooling and Land Gini

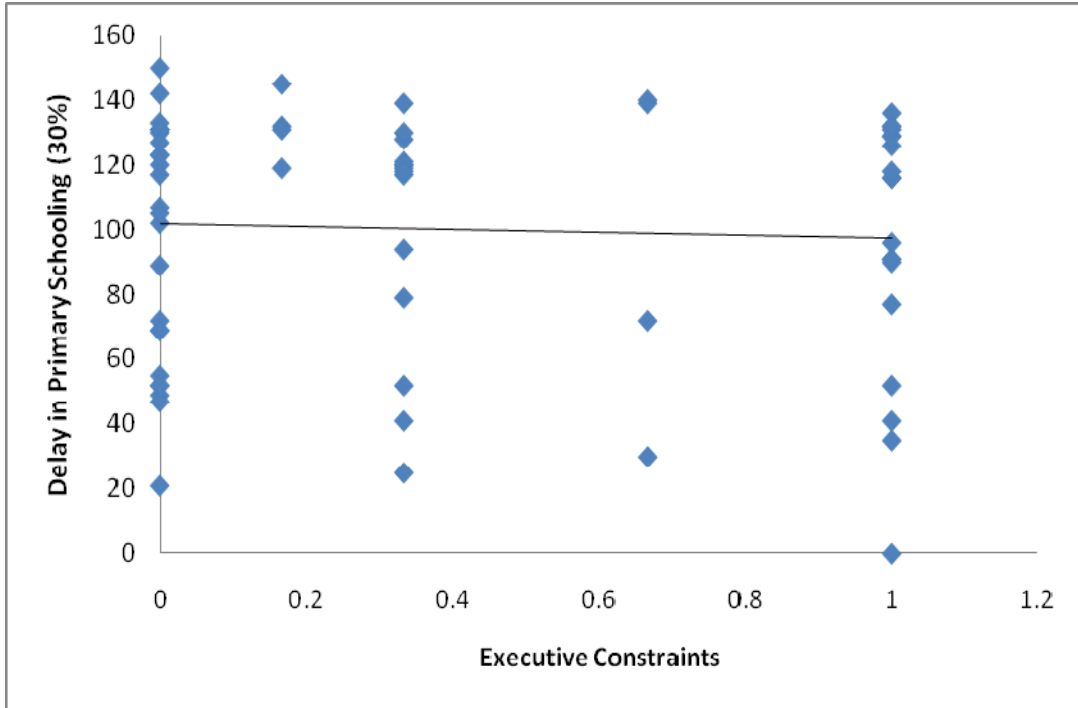


Figure III: Relationship between Delay in Primary Schooling and Land Executive Constraints

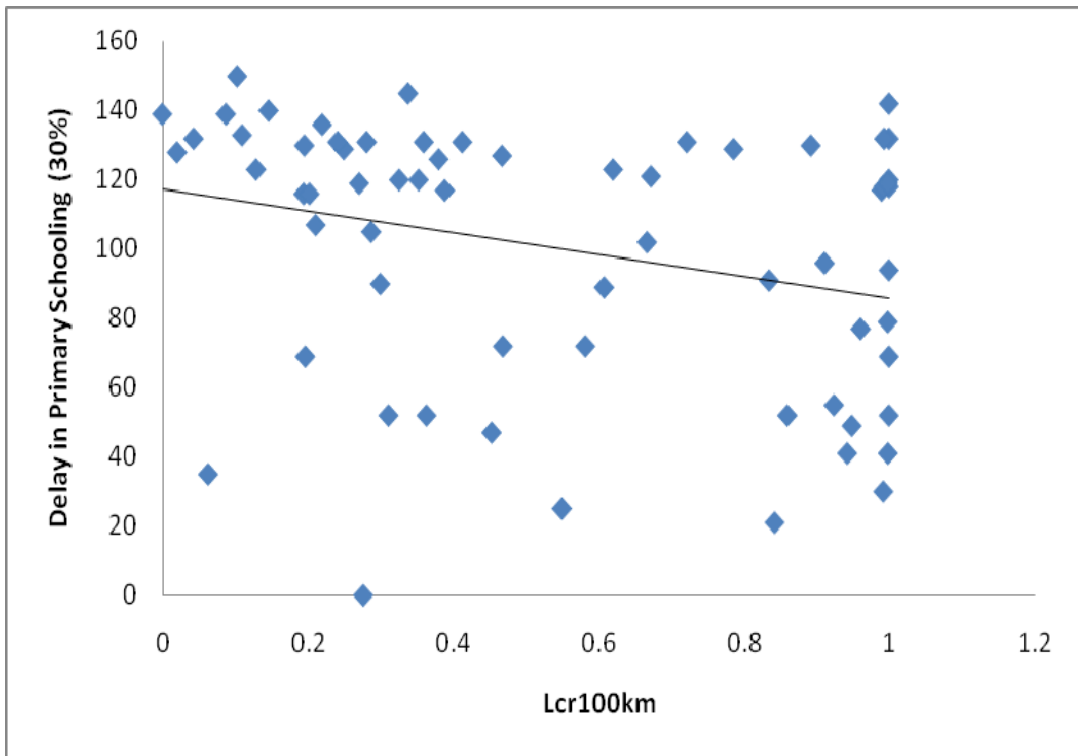


Figure IV: Relationship between Delay in Primary Schooling and Lcr100km

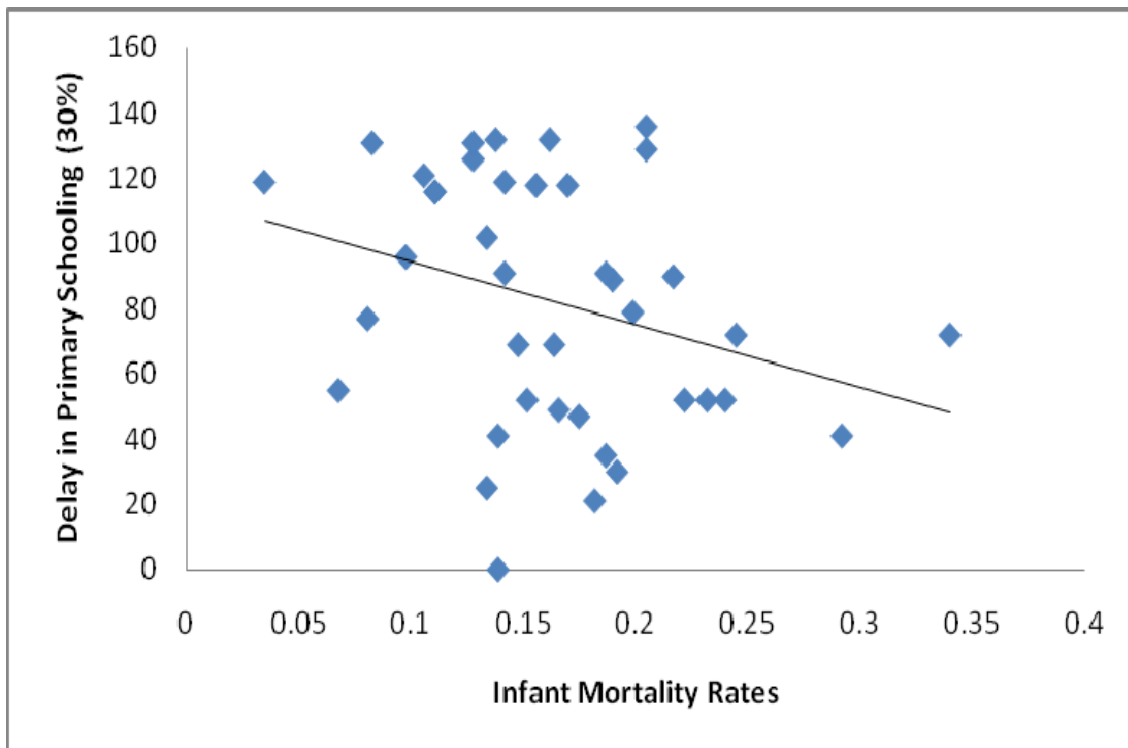


Figure V: Relationship between Delay in Primary Schooling and Infant Mortality Rates

To evaluate the impact of takeoffs in the long run performance of a country, we consider an augmented Acemoglu Johnson and Robinson (2001) model. As shown in Table II, the 1995 real per capita income is the depended variable, whereas the explanatory variables include ethnic fractionalization, various measures of trade openness, institutions, colony dummies, and the fitted hazard rates from the previews analysis. Finally, including growth volatility as the depended variable measured as the standard deviation of the average growth rates for the period 1965-1994, or dummies for the countries who experienced takeoffs, slowdowns and meltdowns as suggested by Ben-David and Papell (1998), we examine the we evaluate the likelihood of growth reversals.

### 3.2 Estimation Results

Table I represents the role of various (historical) factors for takeoffs using a Cox Proportional Hazards model under different covariate specifications. In particular, we include a total colony dummy for the presence of any colony, with religion shares or state religion dummies, or dummies for the presence of a British, French, and Spanish/Portuguese colony with religion shares or state religion dummies. Finally, we estimate interactions of the total colony variable with the rest of the covariates.

**Table I: Duration in Stagnation Analysis**

Covariate Specification / Dependent Variable	Colony (Total), Religion Shares	British, French, Spanish/ Portuguese Colony and Religion Shares	Colony (Total), State Religion Dummies	British, French, Spanish/ Portuguese Colony, State Religion Dummies	Colony (Total), Religion Shares/ Interactions	Colony (Total), State Religion Dummies/ Interactions
Delay in Schooling 30%	Income(3.052***, 0.709) Land Gini(-0.052**, 0.025) Exconsq(-4.418*, 2.590)	Income(3.058***, 0.760) Land Gini(-0.052**, 0.026)	Income(2.857***, 0.644) Land Gini(-0.059**, 0.026) Exconsq(-4.595*, 2.697)	Income(2.901***, 0.652) Land Gini(-0.057**, 0.027)	Col(-31.561***, 11.543) Col*Income(4.832**, 1.945) Col*Mort(20.066*, 11.845)	Col(-28.238**, 13.932) Excon(8.564**, 4.348) Exconsq(-8.986**, 4.296) Col*Income(4.165*, 2.228) Col*Mort(21.677**, 10.568)
Delay in Urbanization 10%	Income(2.562***, 0.620)	Income(2.721***, 0.653)	Income(3.087***, 0.693) Catholics Dum(0.942*, 0.575)	Income(3.380***, 0.764)	Lcr100km(8.652***, 2.213) Protestant Dum(4.570**, 1.972) Col*Income(5.394**, 2.189) Col*Land Gini(-0.196*, 0.107)	Income(6.142***, 2.263) Lcr100km(8.077***, 2.286) Catholics Dum(2.899*, 1.692) Col*Exconsq(-13.443*, 7.258)

					Col*Excon(11.667*, 7.062)  Col*Excon sq(-16.380**, 7.622)  Col*Lcr100 km(-12.790***, 2.950)	Col*Lcr100 km(-12.165***, 2.958)
Delay in GDP per capita in 1900	Income(4.818***, 1.071)  Mort(-6.631*, 3.794)	Income(5.110***, 1.132)  Mort(-9.585**, 4.262)	Income(4.953***, 1.008)  Mort(-6.793*, 3.859)	Income(5.114***, 1.053)  Mort(-8.782**, 4.213)	Income(4.779***, 1.819)  Protestant Dum(3.489**, 1.767)  Col*Excon sq(-17.595**, 8.900)	Income(5.582***, 1.983)

According to the results, higher income, lower land inequality, and better institutions affect positively the potential of take-off in schooling. Income is also important for takeoffs in per capita GDP and urbanization. The results are robust for alternative thresholds and for different (parametric) duration models.

Table II provides an answer to the question whether the delay in take-off affects long-run economic performance as measured by the log GDP per capita in 1995, controlling for various fundamental growth determinants and the fitted hazard rate from the delay in GDP per capita in 1900 model.

**Table II: Long- Run Performance Analysis**

Covariate Specification	Colony (Total), Religion Shares	British, French, Spanish/ Portuguese Colony and	Colony (Total), State Religion Dummies	British, French, Spanish/ Portuguese Colony,	Colony (Total), Religion Shares/ Interactions	Colony (Total), State Religion Dummies/
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Model		Religion Shares		State Religion Dummies		Interactions
No interactions	Exprop (2.777***, 0.459)	Exprop (2.841***, 0.463)	Exprop (2.860***, 0.460)	Exprop(2.887***, 0.460)	Exprop (2.599***, 0.411)	Exprop (2.805***, 0.458)
	Col(-0.274**, 0.115)	Brit(-0.252**, 0.117)	Col(-0.275**, 0.116)	Brit(-0.237**, 0.118)	Col(-0.294***, 0.101)	Col(-0.223*, 0.116)
	HR(0.096**, 0.021)	HR(0.091**, 0.020)	HR(0.111**, 0.025)	HR(0.105**, 0.024)	HR(0.061**, 0.010)	HR(0.097**, 0.021)
	Elf60(-0.425**, 0.205)	Elf60(-0.398*, 0.208)	Elf60(-0.439**, 0.209)	Elf60(-0.432**, 0.209)	Elf60(-0.464**, 0.182)	Elf60(-0.543***, 0.210)
Interactions in expropriation risk and elf60	Col(-0.301**, 0.118)	Brit(-0.278**, 0.121)	Col(-0.301**, 0.121)	Brit(-0.262**, 0.122)	Col(-0.313***, 0.105)	Col(-0.248**, 0.120)
	HR(0.097**, 0.021)	HR(0.091, 0.021)	HR(0.111**, 0.025)	HR(0.105**, 0.024)	HR(0.061**, 0.010)	HR(0.097**, 0.021)
	Exprop(2.325***, 0.657)	Exprop(2.429***, 0.666)	Exprop(2.448***, 0.663)	Exprop(2.489***, 0.665)	Exprop(2.294***, 0.583)	Exprop(2.404***, 0.657)

The results show that long run performance is affected positively by Expropriation Risk, Ethnic Fractionalization, and the fitted hazard rates.

**Table III: Sustainability Analysis**

Covariates	Colony (Total), Religion	British, French, Spanish/	Colony (Total), State	British, French, Spanish/	Colony (Total), Religion	Colony (Total), State
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Model	Shares	Portuguese Colony and Religion Shares	Religion Dummies	Portuguese Colony, State Religion Dummies	Shares/ Interactions	Religion Dummies/ Interactions
Least Squares estimation for Standard Deviation Of Growth Rates for 1965-1994	Exprop (-0.049***, 0.016) Kgatrst(-0.014*, 0.006) HR(-0.001*, 0.000)	Exprop (-0.050***, 0.016) Kgatrst(-0.014*, 0.007) HR(-0.001*, 0.000)	Exprop (-0.048***, 0.016) Kgatrst(-0.017**, 0.007) HR(-0.001**, 0.000)	Exprop (-0.049***, 0.016) Kgatrst(-0.017**, 0.007) HR(-0.001**, 0.000)	Exprop (-0.053***, 0.017)	Exprop (-0.047**, 0.016) Kgatrst(-0.017**, 0.007) HR(-0.001**, 0.000)
Probit Estimation for Meltdown Countries	Exprop(-6.890*, 3.682)	Exprop(-6.964*, 3.695)	Exprop(-6.614*, 3.558)	Exprop (-6.664*, 3.557)	Exprop(-7.143*, 3.824)	Exprop(-6.521*, 3.609)

In Table III where the growth sustainability results are presented, growth volatility is affected negatively by Expropriation Risk and the fitted hazard rates, whereas the probability of growth reversal is negatively related with Expropriation Risk.

#### 4. Conclusion

- **To be completed** -

## APPENDIX

**Table I: Duration in Stagnation Variables**

Variable	Description	Reference
Delay in the implementation of compulsory schooling	The time it takes for each country to introduce compulsory schooling comparing to the first country who introduce compulsory schooling.	
Delay in Schooling, 30%-50%, 70%. (Mitchell B. R., 1998, Banks A., 1999)	The time it takes for each country to first reach 30% and 50% in primary schooling minus the time of the first country who passed the threshold	Galor, Moav, Vollrath (2009), Doepke (2004), Galor, Weil (2000)
Delay in GDP per capita in 1900 (Maddison A.)	Delay (measured in years) for a country to reach the highest level of GDP per capita in 1900	
Delay in Urbanization, 10%, 15%, 20%. (Banks A., 1999)	The time it takes for each country to first reach 10% and 15% in urbanization minus the time of the first country who passed the threshold	Acemoglu, Johnson, Robinson (2002a, 2002b)
Colony Dummies (CIA Factbook)	Coded zero or one. One indicates that country was colonized by Britain, France, Spain or Portugal.	

**Table I : Duration in Stagnation Variables (cont.)**

<b>Variable</b>	<b>Description</b>	<b>Reference</b>
Executive Constraints (Polity IV)	Institutional variable with the lowest value 0 indicating unlimited executive authority and 1 executive parity or subordination. We use the earliest date available for non-colonies and for colonies the value on or after the independence day.	Acemoglu, Johnson, Robinson(2001)
GDP per capita in 1900 (Maddison A.)	Log of GDP per capita 1900.	
Infant Mortality Rate (Mitchell B. R., 1998)	Earliest value available for all countries.	Kalemli-Ozcan (2002), Voiglander, Voth (2009)
Land Gini (Frankema E., 2006)	The gini coefficient of the size distribution of land. For all countries we use the earliest observation available.	Galor, Moav, Vollrath (2009), Engerman and Sokoloff (2002)
LCR100km (The Center for International Development at Harvard University)	Percentage of a country's land area within 100km of an ice- free coast.	Gallup, Sachs, Mellinger (1998)
Openness (Banks, A., 1999)	Earliest date available for Import plus Exports to GNI.	Galor and Mountford (2006)
Religion Shares (1900) (World Christian Encyclopedia 1982, 2001)	Percentage of population who expressed adherence to some religion (Catholics and Protestants)	Barro(1996), Barro and McCleary(2003)
State religion Dummy in 1900 (Barro and McCleary, 2003)	Dummy for the presence of state regulation of religion in 1900.	Barro and McCleary(2003, 2005)

**Table II: Long- Run Performance and Sustainability Variables**

<b>Variable</b>	<b>Description</b>	<b>Reference</b>
GDP per capita in 1995 (Maddison A.)	Log of GDP per capita in 1995.	
Standard Deviation of growth rates (Maddison A.)	Standard Deviation of growth rates for the period 1965-1994.	Ramey and Ramey (1995)
Dummies for the countries experienced takeoffs, Slowdowns and Meltdowns. (David, Papell, 1998)	Dummy variables for the countries who experienced takeoffs (bigger growth rate after the break), slowdowns (smaller but positive growth rate after the breaks), or meltdowns (positive growth rate before the break, and negative afterwards) for the period 1950-1990.	David, Papell, (1998)
Elf60 (Mauro, 1995)	Ethno-Linguistic fractionalization index which measures the probability in 1960 that two randomly selected people from a given country will not belong to the same ethno-linguistic subgroup.	Easterly and Levine(1997)
Expropriation Risk (International Country Risk Guide)	Risk of "outright confiscation and forced nationalization" of property. Rescaled, from 0 to 1, with a higher score indicating higher less risk of expropriation. Expropriation Risk for 1985-1994.	Acemoglu, Johnson, Robinson(2001)
KGATRSTR (The Center for International Development at Harvard University)	Percentage of land area classified as tropical and subtropical via the Koeppen-Geiger system.	Gallup, Sachs, Mellinger (1998)

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**Table III: List of Colonies and Non Colonies**

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**British Colonies**

Australia  
Bangladesh  
Barbados  
Canada  
Cyprus  
Egypt  
Ghana  
Guyana  
India  
Iraq  
Ireland  
Israel  
Jamaica  
Jordan  
Kenya  
Kuwait  
Lesotho  
Malaysia  
Malta  
Mauritius  
Myanmar  
N. Zealand  
Pakistan  
Sierra Leone  
Singapore  
South Africa  
Sri Lanka  
Swaziland  
Trinidad & Tobago  
Uganda  
USA  
Zambia

**French Colonies**

Algeria  
Burkina Faso  
Cameroon  
CAR  
Cote d'Ivoire  
Dom. Rep  
Guinea  
Haiti  
Laos  
Mali  
Morocco  
Senegal  
Syria  
Tunisia  
Vietnam

**Spanish/Portuguese Colonies**

Argentina  
Brazil  
Chile  
Colombia  
Costa Rica  
Ecuador  
El Salvador  
Guatemala  
Honduras  
Mozambique  
Nicaragua  
Panama  
Paraguay  
Peru  
Philippines  
Uruguay  
Venezuela

**Other Colonies**

Belgian  
Congo -ZAR  
Indonesia  
Liberia  
Puerto Rico  
Taiwan

**Non Colonies**

Austria  
China  
Czechoslovakia  
Denmark  
Estonia  
Ethiopia  
Finland  
France  
Germany  
Greece  
Iran  
Italy  
Japan  
Korea Rep.  
Latvia  
Lithuania  
Nepal  
Netherlands  
Norway  
Poland  
Portugal  
Romania  
Saudi Arabia  
Slovenia  
Spain  
Sweden  
Switzerland  
Thailand  
Turkey  
UK

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