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The Institutional Environment for Infrastructure Investment

Witold J. Henisz

The Wharton School
2021 Steinberg Hall - Dietrich Hall
University of Pennsylvania
Ph.: (215)-898-0788
Fax: (215)-898-0401
henisz@wharton.upenn.edu

Abstract:

The empirical evidence that links the structure of a nation's political institutions and the distribution of the preferences of the actors that inhabit them to economic outcomes such as an improved policy environment, investment behavior and economic growth has grown dramatically in recent years. However, due to data limitations, virtually all of this analysis is undertaken using data from the past three decades. This paper extends this empirical framework backwards in time and performs a two century long historical analysis of the determinants of infrastructure investment in a panel of over one hundred countries. The results demonstrate that political environments that limit the feasibility of policy change are an important determinant of investment in vital economic infrastructure not only in recent years but also at the inception of these technologies in the nineteenth century.

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1 Introduction

The empirical evidence that links the structure of a nation's political institutions and the distribution of the preferences of the actors that inhabit them to economic outcomes such as an improved policy environment, investment behavior and economic growth has grown dramatically in recent years. However, due to data limitations virtually all of this analysis is undertaken using data from the past three decades. The relatively small number of years available for analysis presents serious limitations for the interpretation of the results of these studies. Specifically, it is often difficult to separate the effect of unobserved country characteristics which may be correlated with or cause cross-national variation in political institutions from the effect of the institutions themselves.

While some progress has been made in addressing this concern using generalized method of moment estimators (Caselli, Esquivel and Lefort, 1996), this article adopts a second path. It extends the empirical framework backward in time and performs a more than century-long historical analysis of the determinants of infrastructure investment in a panel of over one hundred countries. The results demonstrate that political environments that limit the feasibility of policy change are an important determinant of cross-national variation in investment in vital economic infrastructure (the number of telephone handsets and megawatts of electrical generation)¹ not only in recent years but also at the inception of these technologies in the nineteenth century. The effect of cross-national and

¹ While main telephone lines and megawatts of generating capacity would be preferable variables, they are unavailable prior to the middle of the twentieth century.

intertemporal variation in political institutions is shown to be independent of unobserved country-level and/or temporal variation as well as country-specific economic conditions.

Adopting an historical approach offers sufficient time series duration to separately identify this effect at the cost of sacrificing the richness of data available in studies that examine more recent, shorter and/or less diverse samples. However, in conjunction with related work that finds similar effects within more limited samples of countries, regions, industries and time periods (Mansfield, 1994; Campos and Nugent, 1998; Markusen, 1998; Dawson, 1999; Rose-Ackerman and Rodden, 1999), this article provides additional evidence that the ability of a nation to credibly commit to a given policy environment is an important component in explaining investment levels within that country.

These results have important ramifications for the expected diffusion rates of both the vital components of an economy's infrastructure examined here as well as the diffusion of more recent innovations including digital communications networks. Regardless of the relevant socioeconomic, demographic or policy related factors that may be thought to lead to rapid diffusion of these or other new technologies, countries lacking a credible policy regime will be at an extreme disadvantage when competing against other countries for infrastructure investment. From the perspective of the investor, analysis of the opportunity posed by a given country for private infrastructure investment that neglects a sophisticated analysis of the institutional environment will more likely result in an opportunity for the government to expropriate the investor than an opportunity for that investor to earn a fair return on their investment.

2 Theory²

2.1 *Infrastructure Stock and Returns to Capital*

Although the main emphasis of this paper is on the manner in which political institutions affect the level of investment in telecommunications and electrical infrastructure in a given country, the analysis of political factors must also take into account the initial level of infrastructure stock already in place in that country. The current analysis thus shares with the macroeconomic growth literature (rooted in the models of Solow (1956) and Koopmans (1965)) the insight that a country's existing level of capital stock—or in this case, infrastructure penetration, determines the level of marginal returns available from additional capital deployment and thereby influences the growth rate of the stock—or in this case, infrastructure penetration (see Barro (1992)).

Counterintuitively for sectors commonly viewed as having "network" characteristics, diminishing marginal returns to capital are likely to be observed in panel data on infrastructure investment such as employed in this study. Within a single country over time, investment is likely to take place first in the highest return geographical areas (urban population centers) and then slowly spread to the remainder of the country. At a moment in time across a sample of countries, those countries at the frontier of infrastructure penetration must experiment with new technologies and invest not just in deployment of infrastructure but also in the development of new mechanisms for infrastructure supply and new products that may lead to additional demand. Laggard

² For an expanded discussion of the link between political institutions and investment in infrastructure see (Henisz and Zelner, 1999) and (Zelner and Henisz, 1999).

countries may, to some extent "free-ride" on the investment and experience of the countries that have preceded them.

The link between the assumption of diminishing marginal returns to capital and the proposition of an inverse relationship between infrastructure stock and infrastructure growth is the concept of transitional disequilibrium: countries cannot instantaneously attain their desired infrastructure stock levels given changes to the political or economic environment. Therefore, when these environmental conditions change over time or vary across countries, countries further ahead on the diffusion curve will experience less rapid growth than "laggard" countries.

Another prominent technological driver of cross-national variation in infrastructure investment is the effect of the passage of time. Infrastructure growth rates, like patterns of growth and diffusion of many other products and technologies (Romeo, 1975; Benvignati, 1982; Gort and Klepper, 1982; Oster, 1982; Quirmbach, 1986; Levin, Levin and Meisel, 1987; Rose and Joskow, 1990; Pennings and Harianto, 1992; Abrahamson and Rosenkopf, 1993; Jovanovic and MacDonald, 1994, likely display an age dependence. Examining patterns of historical diffusion (see Figures 1 and 2) one observes relatively low to moderate growth rates in the initial decades after the initial penetration of infrastructure services followed -- in some countries -- by a rapid acceleration of growth and -- in a handful of countries -- a downward trend in penetration beginning in just the past few years. While some of this pattern may correspond to variation over time in the environmental variables described below, the similarity to patterns of diffusion of other technologies points to a role for technology as well. Specifically, it may take some time after the availability of new infrastructure prior to

widescale adoption and reorganization of economic organization to take advantage of the ubiquitous supply of these producers (David, 1989). Later, growth rates may stabilize or even become negative as demand is saturated, more efficient consumption is realized and/or alternative products (e.g., cellular handsets) arrive in the marketplace.

2.2 *Political Institutions and Investment*

The relationship between the stock of a country's infrastructure and the growth rate of that infrastructure will be conditional on a set of country characteristics. Chief among these will be the country's ability to provide a credible policy environment for investors. Theoretical support for the economic impact of political institutions has expanded dramatically in the quarter century since (North and Thomas, 1973) first outlined a "transaction cost view of economic history." The crucial economic role played by socio-political factors which reduce the costs of bargaining, contracting, monitoring and enforcement has achieved the status of conventional wisdom in economic history (North and Weingast, 1989; Root, 1989; North, 1990; De Long and Shleifer, 1993; Mokyr, 1993; Landes, 1998) and development (Nelson, 1989; Nelson, 1990; North, 1990; Bates and Krueger, 1993; Campos and Lien, 1994; Brunetti and Weder, 1995; Haggard and Kaufman, 1995; Knack and Keefer, 1995; Sachs and Werner, 1995; World Bank, 1995; Olson, 1996; World Bank, 1996; World Bank, 1997). Scholars in both these domains agree that a government's ability to credibly commit not to interfere with private property rights is instrumental in obtaining the long term capital investments required for countries to experience rapid economic growth.

While these arguments are most transparent and likely strongest when considering private investors, so long as public sector managers with control over investment also

engage in subgoal pursuit, in particular, the maximization of discretionary income streams, it is still reasonable to expect that the institutional environment will affect the incentives that managers of public sector organizations face to deploy capital. Like private sector managers, public sector managers face mechanisms that limit the extent to which they can pursue their subgoals at the expense of their political and financial principals. However, these mechanisms are relatively weak and leave public sector managers with substantial latitude to pursue subgoals. Specifically, both oversight (monitoring) and incentive-based measures that are operative in the private sector are less binding on public sector managers (Cameron and Duignan, 1984; Vining and Boardman, 1989; Scott, Bushnell and Sallee, 1990).

Because of the long time horizon, economies of scale and scope and highly political nature of the investment, investment in infrastructure will be especially sensitive to a country's institutional environment (Williamson, 1976; Levy and Spiller, 1994; Spiller and Vogelsang, 1996; Savedoff and Spiller, 1997; Bergara Duque, Henisz and Spiller, 1998; Caballero and Hammour, 1998). Empirical work that has, to date, primarily adopted a case study approach provides strong support for this hypothesis (Grandy, 1989; Daniels and Trebilcock, 1994; Crain and Oakley, 1995; Levy and Spiller, 1996 ; Ramamurti, 1996; Savedoff and Spiller, 1997; Dailami and Leipziger, 1998) including two examples delving into economic history by examining the construction of the Spanish (Keefer, 1996) and New Jersey (Grandy, 1989) railways. Two recent efforts to extend this logic to panel datasets in telecommunications (Henisz and Zelner, 1999) and electricity (Zelner and Henisz, 1999) have also found strong support for the hypothesis that political institutions that fail to constrain arbitrary behavior by political actors

dampen the incentive for infrastructure providers to deploy capital and, *ceteris paribus*, yield lower levels of per capita infrastructure investment.³

2.3 Economic Characteristics

In addition to the political forces described above, economic conditions are also likely to play an important role in the pattern of infrastructure investment across countries and over time. Data limitations of the century-long panel prohibit the inclusion of variables such as the composition of production of the economy, the cost of construction and the demographic characteristics of the population. However, some of these factors may be captured by examining cross-national variation in the level of income and in the rate of economic growth and allowing the effect of these variables on infrastructure growth to vary by country.

3 Measurement and Data

3.1 Political Constraints

The measure of political constraints employed in this paper estimates the feasibility of policy change (the extent to which a change in the preferences of any one actor may lead to a change in government policy) using the following methodology. First, extracting data from political science databases, it identifies the number of independent

³ In the case of electricity, the positive effect of political constraints on infrastructure investment is shown to be operative only in the presence of substantial political competition from industrial users of electricity (Zelner and Henisz, 1999).

branches of government (executive, lower and upper legislative chambers)⁴ with veto power over policy change in up to 160 countries in every year from 1800 to the present. The preferences of each of these branches and the status quo policy are then assumed to be independently and identically drawn from a uniform, unidimensional policy space. This assumption allows for the derivation of a quantitative measure of institutional hazards using a simple spatial model of political interaction.

This initial measure is then modified to take into account the extent of alignment across branches of government using data on the party composition of the executive and legislative branches. Such alignment increases the feasibility of policy change. The measure is then further modified to capture the extent of preference heterogeneity within each legislative branch which increases (decreases) decision costs of overturning policy for aligned (opposed) executive branches. Detailed information on the construction of this variable along with a pair of sample derivations and mean values for each country for each decade are provided in Appendix 1.

3.2 *Other Independent Variables*

Data on infrastructure and other non-political factors that may be thought to influence infrastructure investment including real per capita income, population levels, geographic area and macroeconomic aggregates are taken from Mitchell (1992;

⁴ Previous derivations of the political constraint index described here have included an independent judiciary and sub-federal political entities for a total of five potential veto points. Data limitations preclude their inclusion here. The effect of their omission will be to diminish the variance among countries with relatively high levels of political constraints thereby dampening the magnitude of the observed effect.

1993; 1995) and updated using *The World Development Indicators, 1998* (World Bank, 1998).

4 Initial Investment

What are the determinants of the timing of a country's initial investment in infrastructure? Once the technology to transmit voice messages had been demonstrated by Alexander Graham Bell in 1876 or to centrally generate electric power for transmission by Thomas Edison in 1882, many countries quickly followed the United States and adopted these technologies. However, outside of the United States and a core set of European countries, adoption times lagged into the decades and infrastructure growth rates after adoption are noticeably slower. While the level of economic development and the relationship between a country and the core set of industrialized nations clearly play a role, the theoretical arguments developed above also point to an important relationship between political constraints and time to adoption.

4.1 Specification

In order to test this hypothesis, a discrete time logit model is employed to examine the determinants of the transition from having no infrastructure investment to having some positive quantity.

Let $H(t)$ equal the probability of adoption for a country at time t . According to our hypotheses there exist a set of country-level independent variables (w) that determine $H(t)$.

$$H(t) = (w(t))$$

So as to insure that $H(t)$ (the probability of adoption) is bounded by 0 and 1 in the empirical results, one commonly takes a logistic transformation:

$$\text{Log}(H(t)/1-H(t)) = (w(t))$$

Next, a separate observation record is created for every unit of time. Thus, if a country does not have its first telephone handset until 1883, that country has a record in each year after 1877 (the year after adoption by the United States) with a dependent variable equal to zero (no adoption) in each year until 1883 whereafter the dependent variable equals one (adoption). The full sample (including multiple observations for the same entry) is then estimated using a maximum likelihood estimator for the traditional logit specification. This technique addresses both the problems of censoring and time-varying explanatory variables.

Of the 6901 observed country-years with zero infrastructure penetration in telecommunications and the 5754 in electricity, less than three hundred cases possess data on the macroeconomic conditions. Unfortunately, this limited sample precludes independent testing of economic and political effects in this analysis. The independent variables included in the vector $w(t)$ are therefore limited to:

$(YEAR - YR_INIT_INF_x)$	Year since the initial adoption by any country of infrastructure of type x where $x \in \{0, 1\}$ [telephone headsets, megawatts of electricity generated]; ⁵
$COLONY$	Dummy variable if country was a colony in year t ; ⁶

⁵ Nonlinearities in the effect of the time trend on infrastructure growth rates were explored including the potential for a dependence on the level of political constraints but one can not reject the hypothesis of a linear effect. Examination of Figures 1 and 2 reveals that few countries have stabilized their infrastructure growth rates and only a handful have experienced negative growth.

⁶ The effect of various colonial heritages (British, French, Belgian, Spanish, Dutch, German, Chinese, American, Japanese and other) was explored but one was unable to reject the null hypotheses that the effects of colonial origin were insignificantly different from zero.

<i>POLCON</i>	Political Constraint Index described in Section 3.1 and in Appendix 1;
REGDUM	A vector of regional dummies.

4.2 Results

Table 1 displays the estimation results. With the exception of the regional dummies for Latin America & the Caribbean in the full telecommunications specification, all variables are individually significant at a p-value of .01 or less. Additionally, an F-test confirms that the regional dummies as a group are jointly significant at a p-value of 0.01. The inclusion of the political constraint index offers a substantial improvement upon the specification in which regional dummy variables, a time trend and colonial status enter alone.⁷ In the case of telecommunications, the full model correctly predicts 93.4 per cent of non-adopting years and 93.6 per cent of adopting years or an 85.7 per cent improvement over a constant probability assumption. Similarly, in the case of electricity, the full model correctly predicts 89.1 per cent of non-adopting years and 92.5 per cent of adopting years for and 78.3 per cent improvement over a constant probability assumption.

Table 2 displays the actual and predicted (both with and without the political constraint index) year of adoption of telecommunications and electrical generation infrastructure for each country in the sample. The improvement in the latter case is marked. Specifically, the average error in the predicted year of initial adoption declines

⁷ The F-statistics of 1039 in the case of telecommunications and 456 in the case of electricity and log-likelihood ratios of 335.3 and 183.3 respectively reject the null hypothesis of the redundancy of the political constraint index with a p-value of less than 0.0001.

from 16.3 years to 13.1 years in the case of telecommunications and from 9.2 to 7.6 years in the case of electricity.

Ceteris Paribus, ten years after the initial adoption by any country, an African country that is not a colony with political constraints one standard deviation above the mean is more than four times as likely (2.7 vs. 0.8 per cent) to engage in their initial investment in telecommunications infrastructure and almost twice as likely (9.7 vs. 5.0 per cent) to undertake their initial investment in electrical generating capacity than a country with political constraints at the mean. The magnitude of this effect declines moderately over time to approximately three hundred per cent (15.9 vs. 5.2 per cent) and fifty per cent (43.7 vs. 25.8 per cent) twenty-five years after the initial adoption by any country. While other unobserved country characteristics that are correlated with political constraints may be driving these results, this initial test at least lends preliminary support to the notion that the credibility of a government's policymaking apparatus plays an important role in the diffusion process of infrastructure.

5 Subsequent Investment

In order to attempt to take this alternate hypothesis into account, this section exploits post-adoption variation in the data to examine the determinants of cross-national and intertemporal variation in infrastructure growth rates. The unbalanced panel data sets contain up to 129 countries for as many as 119 years.

5.1 Specification

The econometric specification employed is:

$$\Delta INFPC_{x,i,t} = b_{0i} + b_1 \ln INFPC_{x,i,t-1} + b_2 POLCON_{it} + b_3 (YEAR - YEAR_INIT_INF_{x,i,t}) + b_4 COLONY + b_5 \ln RGNPPC_{i,t-1} + b_{6i} \Delta RGNPPC_{i,t-1} + b_{7t} TIMEDUMS + e_{it}$$

where subscripts i and t are cross-sectional (country) and time period indices, the notation Δ signifies a percentage change and \ln signifies the natural logarithm. Variable definitions follow from Section 4 with the addition of:⁸

$INFPC$	=	Per capita infrastructure of type x where $x = 0$ [telephone headsets, megawatts of electricity generated].
$RGNPPC$	=	Real per capita income expressed in 1990 U.S. dollars.
$TIMEDUMS$	=	Annual time dummies.

5.2 Estimation

I pool across time periods and countries with the exception of (1) the constant term, which is pooled across time periods only; (2) the growth in real GNP measure, which is also pooled across time periods only; and (3) the annual time period dummies, which are necessarily pooled across countries only.

Two econometric issues arise in estimating this equation. First, because the sample is a panel consisting of repeated observations on a broad cross-section of countries, the error term exhibits within-group serial correlation. I model the autocorrelation process as AR(1) and estimate the resulting transformed equation using nonlinear least squares.⁹ The advantage of using this procedure rather than more

⁸ Once again, potential nonlinearities in the effect of income and infrastructure stock including the potential for nonlinearities that are dependent on the level of political constraints were explored but one can not reject the null assumption of a linear relationship in each case.

⁹ Using Eviews 3.1.

traditional two-stage procedures such as Cochrane-Orcutt or Prais-Winsten is that, in addition to being asymptotically efficient, the nonlinear estimator is also robust to the inclusion of a lagged dependent variable on the RHS.¹⁰

Second, the sample exhibits groupwise heteroskedasticity. I correct for heteroskedasticity by applying weights to the data. These weights are inversely related to the within-group variance of the NLS residuals. I also report heteroskedasticity-consistent standard errors (White, 1980).¹¹

5.3 Results

Table 3 reports the estimation results. With the exception of the dummy for colonies and some of the time and country-specific GDP growth coefficients, each variable is correctly signed and individually significant at a p-value of 0.01 or less. Additionally, F-tests confirm that the time- and country-specific GDP growth regressors are both, as a group, jointly significant at a p-value of 0.01 or less. The Durbin-Watson statistic ranges from 1.86 to 2.10 across the various specifications indicating that the

¹⁰ See (Davidson and Mackinnon, 1993): 331-332 & 151-152) and (Fair, 1984).

¹¹ Future drafts will attempt alternate estimation techniques including the use of five-year panels to smooth out relatively "noisy" annual data as well as the use of a robust covariance matrix estimator based on that developed by Newey and West (Newey and West, 1987; Greene, 1997:503-506). This covariance matrix estimator is consistent in the presence of within-unit serial correlation up to a specified lag and heteroskedasticity of unknown form. Compared with the alternative procedure of estimating one or more $AR(n)$ terms, the use of the robust covariance matrix estimator has several advantages. First, it is computationally simpler. Not only does it easily accommodate autocorrelation that is of higher order than one, but it also simplifies estimation of models that are nonlinear in the parameters. The latter feature is especially advantageous in the current context because two of the three models used are nonlinear. Second, the robust covariance matrix estimator does not rely on an assumption that the different cross-sectional units share common autocorrelation parameters. Failure to make this assumption in the estimation of $AR(n)$ models creates a need to estimate many additional parameters, which reduces the efficiency of the point estimator. Third, it is not necessary to drop observations from one or more time periods when using the robust covariance matrix estimator. The estimator differs from the original Newey-West version in that it is constructed for use in a panel setting rather than a conventional time-series setting (see Driscoll and Kraay (1998) and Froot (1989)).

inclusion of the AR(1) term mitigates the effects of autocorrelation. The adjusted R^2 figure is, in each case, above 0.998.

The magnitude of the economic effect of the political constraint index is moderate in size. A one standard deviation in the political constraint index (0.25) leads to a predicted increase in infrastructure penetration growth of 0.2 percentage points in the case of telecommunications and 0.4 percentage points in the case of electricity. Recall that these are annual growth rates excluding time period specific, country specific effects and the effects of income levels and growth rates with the latter estimated separately for each country. Previous research has demonstrated that political constraints are likely an important determinant of economic growth and, therefore, over the century-long period under examination here, income levels. The magnitude of the direct economic effect computed here should therefore be considered a lower bound on the total economic effect of political constraints on infrastructure growth. Nevertheless, an increase in 0.2 (or 0.4) per cent per annum, through compounding would yield a difference in levels of 3.9 (or 7.8) per cent after 20 years and 10.3 (or 20.6) per cent after fifty years.

6 Conclusion

By demonstrating that a sophisticated incorporation of the institutional environment improves the power of models that predict both the initial year of infrastructure adoption by a country and the subsequent rate of growth of that infrastructure, this paper attempt to address the critiques that unobserved country-level heterogeneity may be driving much of the reported correlation between the structure of a nation's political institutions and a broad set of economic outcomes. Since initial adoption decisions can not, by definition, be influenced by the existing level of infrastructure

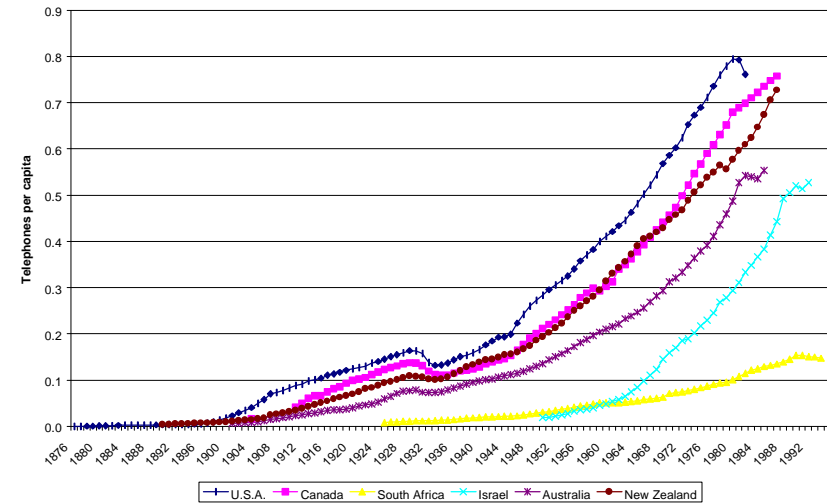
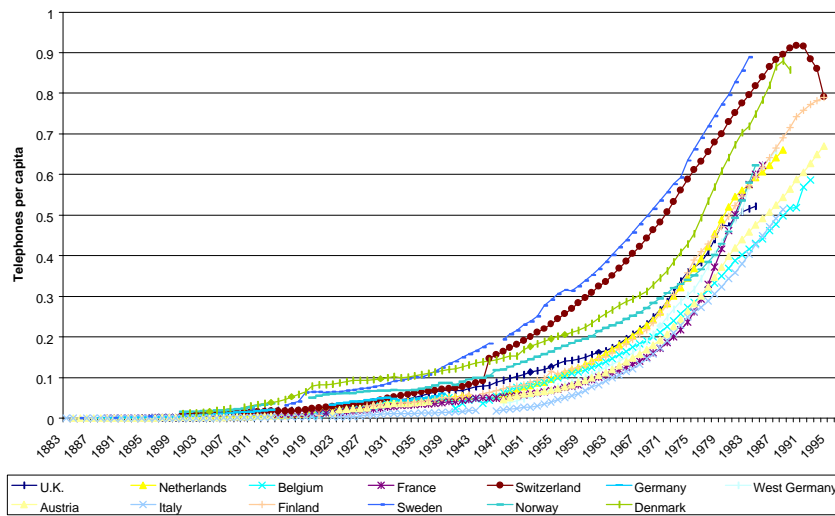
stock, concerns regarding the role of initial conditions combined with path dependency in explaining observed outcomes are somewhat alleviated by the adoption results reported here. Similarly, the reported results showing a statistically and economically significant link between political institutions and infrastructure growth rates even in a specification that includes country- and time-specific effects as well as country-specific slopes with respect to income growth, should alleviate concerns regarding unobserved country-level heterogeneity.

Of course, these results are unable to account for a host of alternate economic explanations that may play an important role. However, in conjunction with other studies that study a shorter time period and are therefore able to control for these effects, the evidence arguing for a sophisticated treatment of political institutions in the study of cross-national variation in economic outcomes appears increasingly strong.

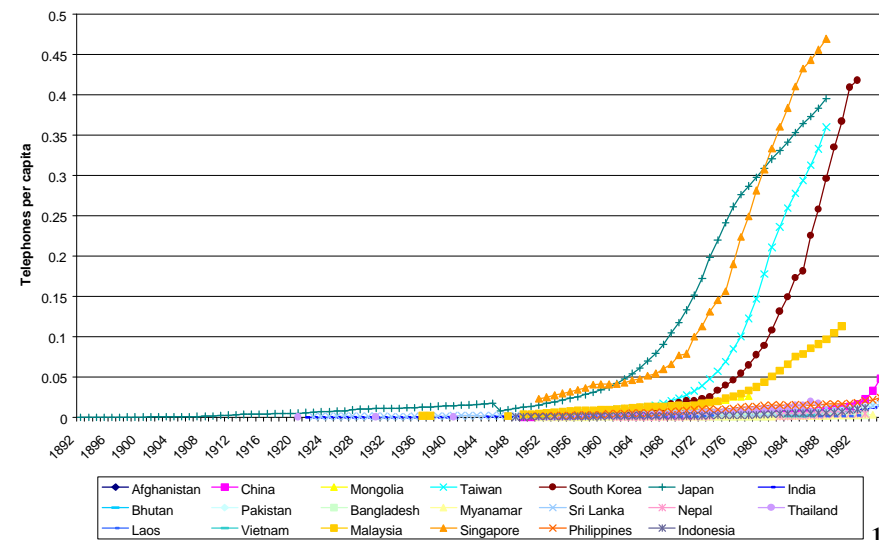
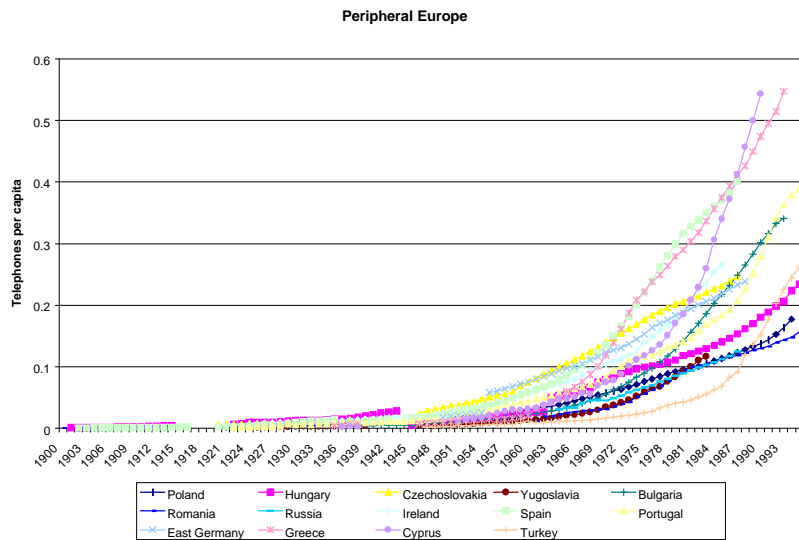
Policymakers seeking to attract investment in vital infrastructure sectors should pay careful attention to the structure of the political institutions in their country and, if necessary, design mechanisms to compensate for institutional shortcomings.

Analogously, investors should analyze not just the demand for new infrastructure but also the credibility of any and all explicit and implicit government pledges necessary to receive a fair rate of return on the investment in that infrastructure.

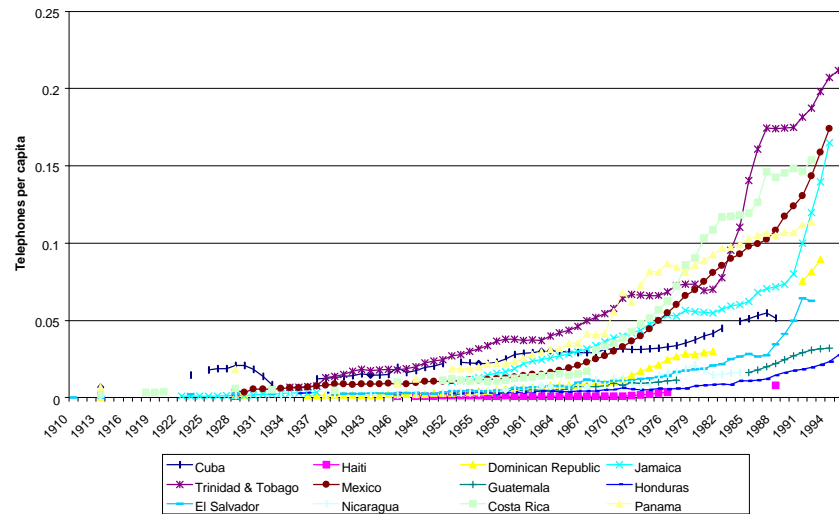
Figure 1: Diffusion of Telecommunications Infrastructure



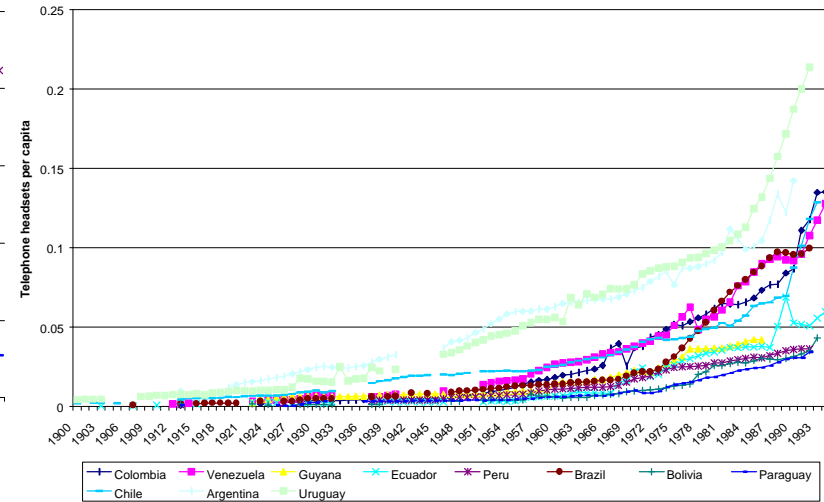
Asia



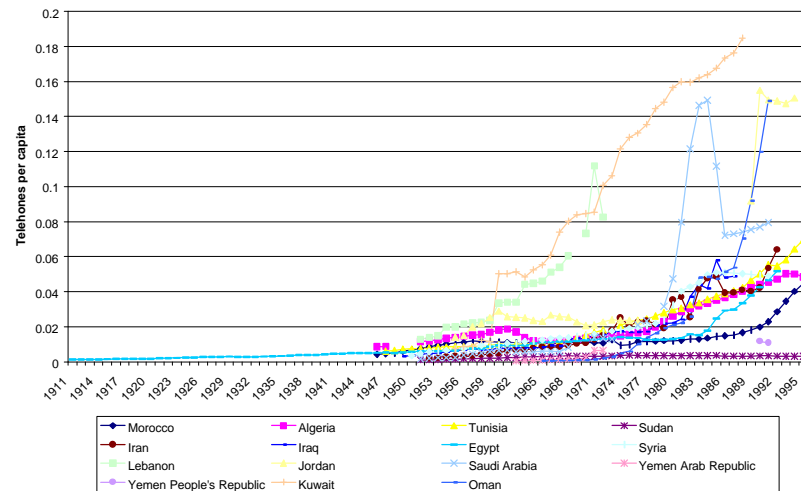
Latin America & the Caribbean



South America



Middle East



Africa

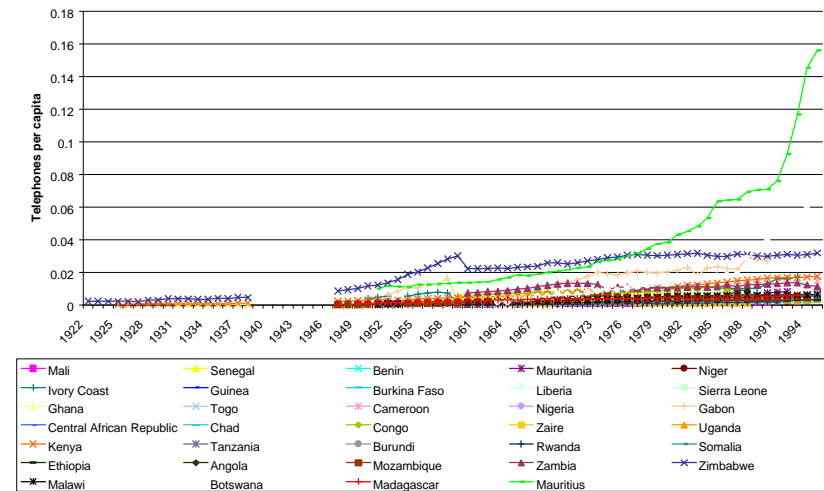
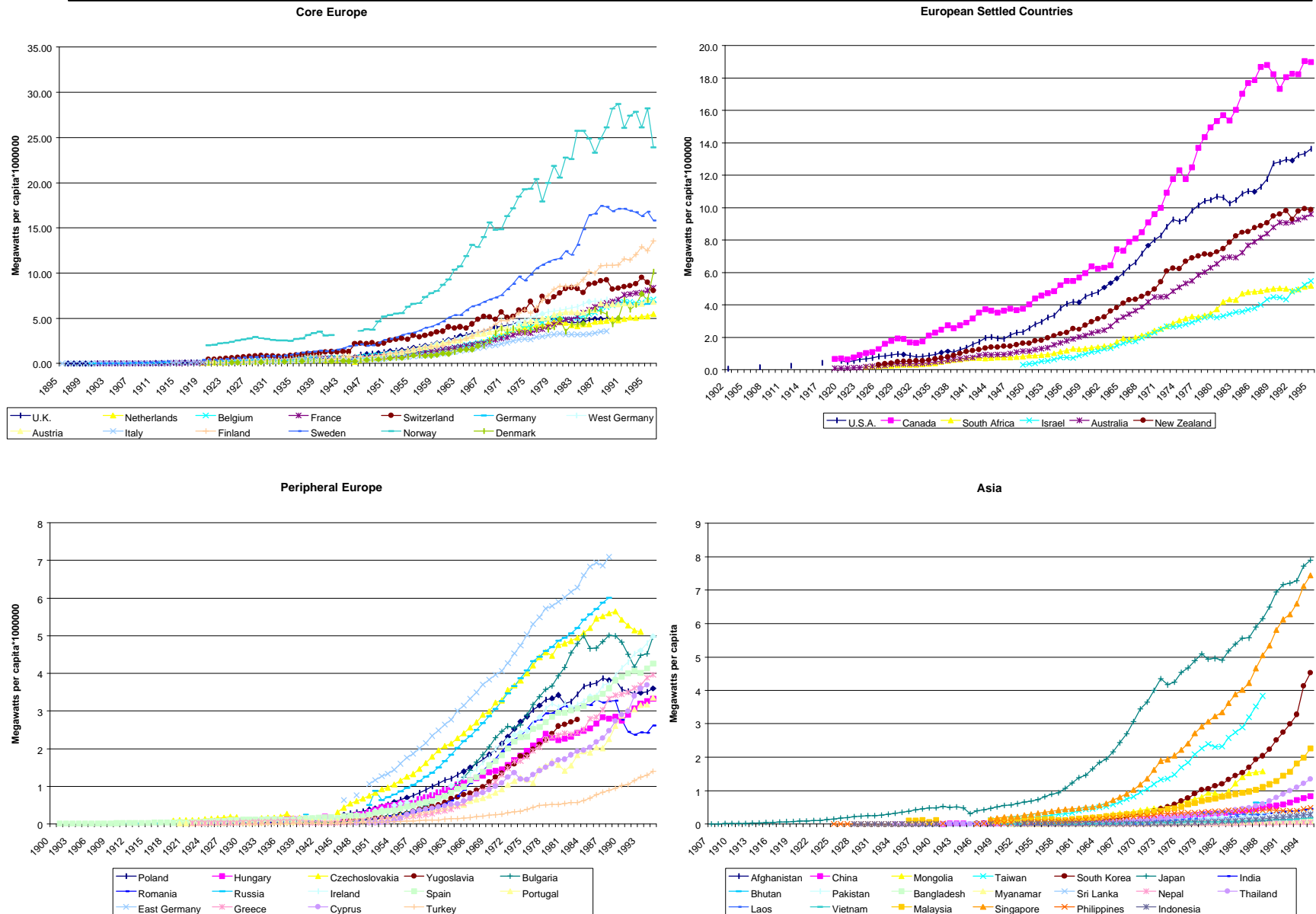
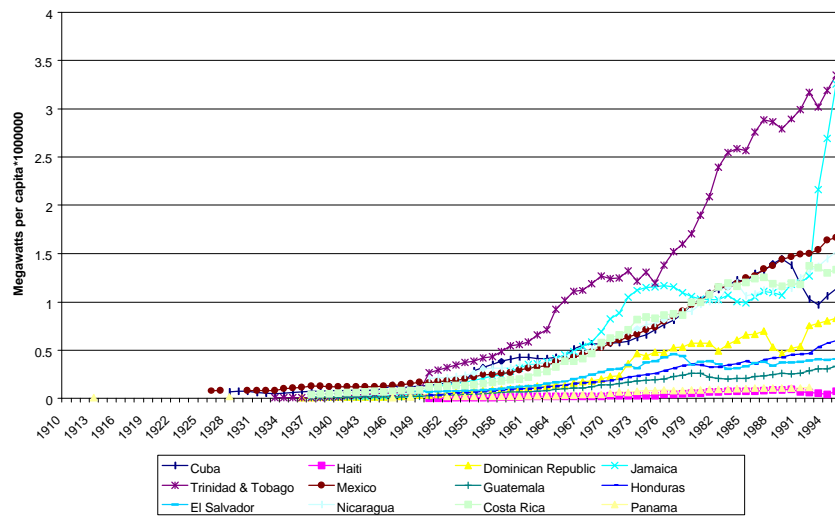


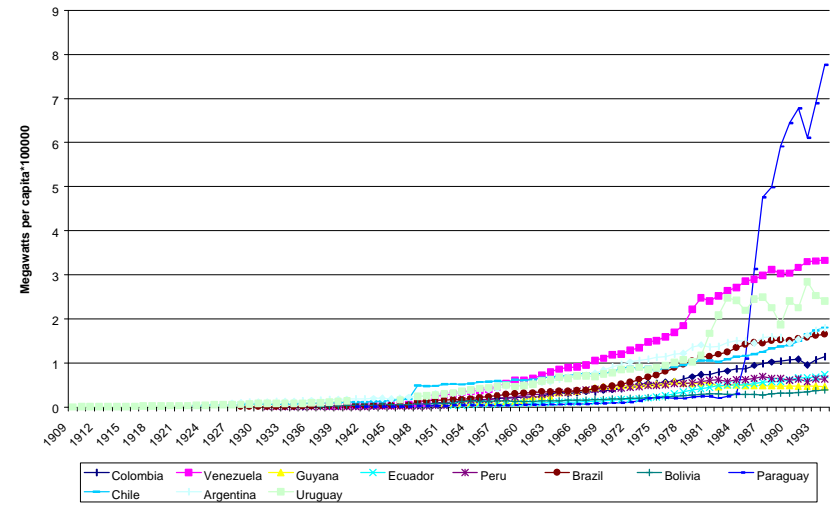
Figure 2: Diffusion of Electrical Infrastructure



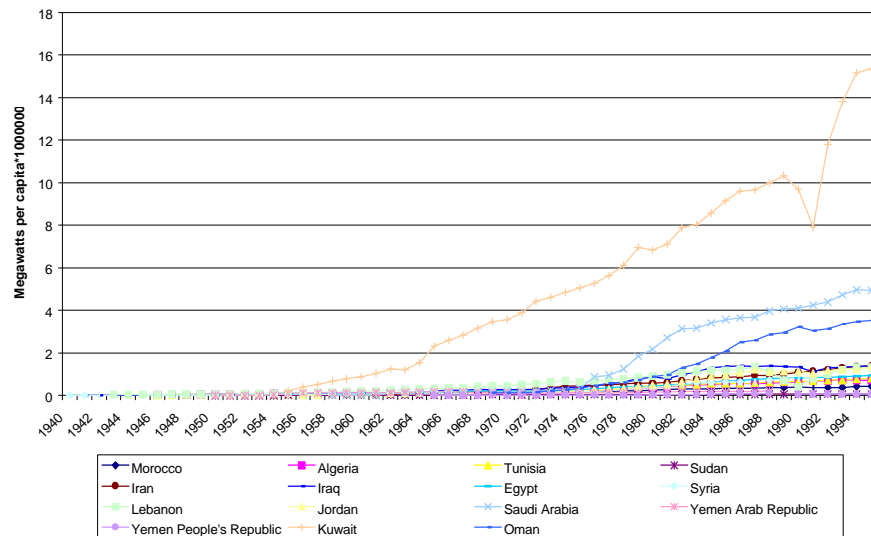
Latin America & the Caribbean



South America



Middle East



Africa

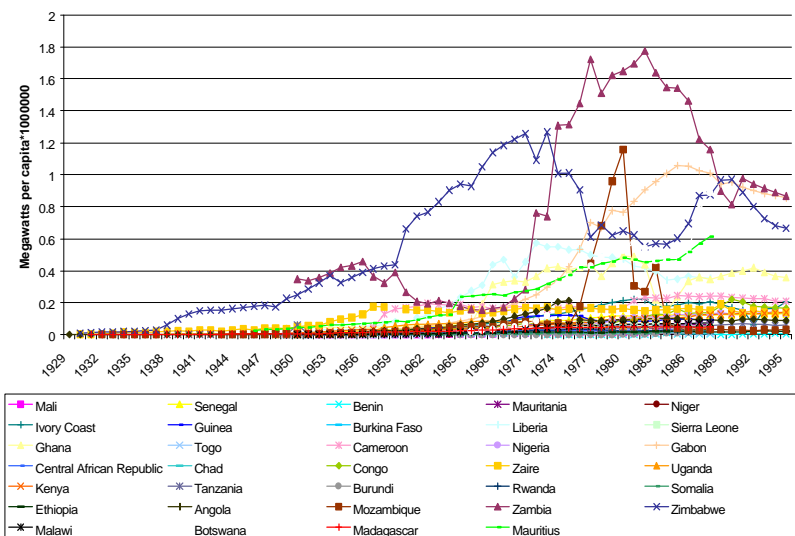


Table 1: Estimation Results for Initial Investment in Infrastructure

Variable	Telecommunications		Electricity	
C	-2.66 (0.00)	-4.50 (0.00)	-2.10 (0.00)	-3.06 (0.00)
POLCON		5.59 (0.00)		3.21 (0.00)
COLONY	-1.60 (0.00)	-1.30 (0.00)	-0.95 (0.00)	-0.77 (0.00)
Time Trend	0.11 (0.00)	0.12 (0.00)	0.12 (0.00)	0.12 (0.00)
European Settled	-0.65 (0.00)	-0.77 (0.00)	-1.30 (0.00)	-1.41 (0.00)
Eastern Europe	-2.26 (0.00)	-1.79 (0.00)	-3.03 (0.00)	-2.32 (0.00)
Latin America	-0.61 (0.00)	0.36 (0.09)	-2.24 (0.00)	-1.72 (0.00)
South America	-1.11 (0.00)	-0.05 (0.00)	-2.98 (0.00)	-2.15 (0.00)
Middle East	-5.16 (0.00)	-4.46 (0.00)	-4.10 (0.00)	-3.39 (0.00)
Asia	-4.11 (0.00)	-3.47 (0.00)	-3.52 (0.00)	-2.91 (0.00)
Africa	-4.36 (0.00)	-3.83 (0.00)	-3.29 (0.00)	-2.65 (0.00)
N	15250	13859	13624	12552
Log Likelihood	-3212	-2322	-3316	-2820
McFadden R-squared	0.69	0.76	0.64	0.67
Per cent Dep = 1	54.7%	54.8%	57.8%	59.3%
Correctly Predicted	91.5%	93.5%	90.4%	91.2%
Per cent Gain	81.3%	85.7%	77.3%	78.3%

**Table 2: Actual and Predicted Years of Initial Investment in Infrastructure
Both Omitting (1) and Including (2) the Index of Political Constraints**

Country	Telecommunication			Electricity		
	Actual	Predicted (1)	(2)	Actual	Predicted (1)	(2)
Afghanistan	1951	1949	1951	1951	1948	1949
Algeria	1946	1963	1961	1946	1956	1955
Angola	1947	1956	1956	1929	1949	1949
Argentina	1913	1907	1913	1927	1933	1927
Australia	1901	1908	1901	1919	1925	1922
Austria	1884	1902	1884	1920	1914	1918
Bangladesh	1972	1954	1953	1951	1951	1952
Belgium	1896	1902	1898	1920	1914	1909
Benin	1959	1956	1956	1949	1949	1949
Bhutan	1972	1939	1972	1973	1943	1973
Bolivia	1913	1907	1899	1937	1933	1928
Botswana	1963	1956	1956	1966	1949	1949
Brazil	1907	1907	1907	1928	1933	1935
Bulgaria	1902	1923	1902	1924	1939	1940
Burkina Faso	1959	1956	1956	1947	1949	1949
Burma	1951	1948	1951	1951	1948	1951
Burundi	1963	1956	1956	1965	1949	1949
Cambodia				1950	1949	1949
Cameroon	1950	1956	1956	1950	1949	1949
Canada	1904	1908	1906	1919	1925	1922
Central African Republic	1959	1956	1956	1954	1949	1949
Chad	1959	1956	1956	1953	1949	1949
Chile	1900	1907	1900	1923	1933	1923
China, PR	1949	1939	1943	1941	1943	1945
Colombia	1913	1907	1913	1933	1933	1928
Congo	1959	1956	1956	1957	1949	1949
Costa Rica	1913	1912	1913	1950	1939	1931
Cote d'Ivoire	1950	1956	1956	1950	1949	1949
Cuba	1913	1912	1915	1928	1939	1939
Cyprus	1936	1922	1931	1948	1932	1939
Czechoslovakia	1920	1923	1925	1919	1939	1919
Denmark	1900	1902	1901	1920	1914	1911
Dominican Rep.	1913	1912	1915	1936	1939	1928
East Germany	1949	1923	1929	1946	1939	1940
Ecuador	1903	1907	1903	1948	1933	1935
Egypt	1911	1949	1951	1950	1948	1949
El Salvador	1905	1912	1905	1950	1939	1939
Ethiopia	1951	1942	1946	1950	1942	1943
Finland	1920	1916	1917	1923	1918	1917
France	1889	1902	1894	1901	1914	1909
Gabon	1952	1956	1956	1952	1949	1949
Germany	1888	1902	1910	1900	1914	1919
Ghana	1931	1956	1956	1948	1949	1949
Greece	1935	1902	1922	1922	1914	1922
Guatemala	1913	1912	1915	1937	1939	1939
Guinea	1958	1956	1956	1950	1949	1949
Guyana	1913	1922	1922	1951	1940	1942
Haiti	1928	1912	1925	1950	1939	1950
Honduras	1906	1912	1915	1950	1939	1931
Hungary	1901	1923	1929	1923	1939	1940
India	1921	1948	1948	1939	1948	1948
Indonesia	1948	1945	1945	1928	1945	1945
Iran	1952	1949	1952	1954	1948	1952
Iraq	1949	1949	1951	1941	1948	1949
Ireland	1924	1916	1922	1929	1922	1922

Country	Telecommunication			Electricity		
	Actual	Predicted (1)	(2)	Actual	Predicted (1)	(2)
Israel	1950	1908	1931	1949	1932	1939
Italy	1883	1902	1883	1895	1914	1912
Jamaica	1922	1927	1925	1937	1947	1945
Japan	1892	1939	1892	1907	1943	1907
Jordan	1955	1949	1955	1956	1948	1949
Kenya	1925	1956	1956	1938	1949	1949
Kuwait	1955	1962	1961	1955	1956	1955
Laos	1955	1950	1950	1951	1950	1950
Lebanon	1951	1949	1951	1943	1948	1949
Liberia	1955	1942	1946	1950	1942	1946
Libya				1953	1951	1951
Madagascar	1947	1956	1956	1931	1949	1949
Malawi	1951	1953	1953	1950	1949	1949
Malaysia	1936	1954	1953	1936	1951	1952
Mali	1960	1956	1956	1949	1949	1949
Mauritania	1959	1956	1956	1963	1949	1949
Mauritius	1951	1956	1956	1946	1949	1949
Mexico	1913	1912	1915	1926	1939	1939
Mongolia	1960	1939	1943	1957	1943	1945
Morocco	1946	1956	1956	1946	1956	1955
Mozambique	1947	1956	1956	1932	1949	1949
Nepal	1961	1939	1943	1953	1943	1945
Netherlands	1900	1902	1896	1919	1914	1908
New Zealand	1890	1908	1890	1926	1925	1922
Nicaragua	1913	1912	1913	1948	1939	1931
Niger	1959	1956	1956	1950	1949	1949
Nigeria	1951	1956	1956	1948	1949	1949
North Yemen	1962	1949	1951	1950	1948	1949
Norway	1900	1906	1905	1920	1914	1910
Oman	1965	1949	1951	1969	1948	1949
Pakistan	1951	1947	1951	1951	1947	1951
Panama	1913	1912	1913	1937	1939	1930
Paraguay	1913	1907	1911	1941	1933	1928
Peru	1913	1907	1913	1931	1933	1935
Philippines	1950	1946	1950	1925	1946	1935
Poland	1921	1923	1922	1923	1939	1923
Portugal	1922	1902	1922	1920	1914	1920
Romania	1900	1923	1900	1923	1939	1940
Russia	1964	1923	1929	1912	1939	1940
Rwanda	1962	1956	1956	1948	1949	1949
Saudi Arabia	1951	1949	1951	1958	1948	1949
Senegal	1959	1956	1956	1950	1949	1949
Sierra Leone	1955	1956	1956	1950	1949	1949
Singapore	1951	1954	1953	1948	1951	1952
Somalia	1968	1956	1956	1954	1949	1949
South Africa	1925	1910	1910	1924	1925	1921
South Yemen	1990	1949	1951	1965	1948	1949
Spain	1902	1902	1914	1901	1914	1922
Sri Lanka	1922	1948	1948	1935	1948	1948
Sudan	1951	1956	1954	1950	1949	1949
Sweden	1885	1902	1885	1901	1914	1910
Switzerland	1900	1902	1882	1920	1914	1903
Syria	1950	1949	1951	1940	1948	1944
Taiwan	1955	1946	1946	1948	1946	1946
Tanzania	1953	1956	1956	1938	1949	1949
Thailand	1920	1939	1936	1934	1943	1936
Togo	1949	1956	1956	1948	1949	1949
Trinidad&Tobago	1934	1927	1925	1933	1947	1945
Tunisia	1947	1957	1957	1946	1956	1955
Turkey	1947	1949	1931	1930	1948	1933

<i>Country</i>	<i>Telecommunication</i>		
	<i>Actual</i>	<i>Predicted</i>	
		<i>(1)</i>	<i>(2)</i>
Uganda	1952	1956	1956
United Kingdom	1894	1902	1894
Uruguay	1900	1907	1900
USA	1876	1908	1887
Venezuela	1912	1907	1911
Vietnam	1950	1954	1953
West Germany	1947	1902	1914
Yugoslavia	1924	1923	1924
Zaire	1947	1956	1956
Zambia	1951	1954	1954
Zimbabwe	1922	1956	1923

	<i>Electricity</i>	
	<i>Actual</i>	<i>Predicted</i>
		<i>(1)</i> <i>(2)</i>
	1948	1949 1949
	1896	1914 1910
	1909	1933 1909
	1902	1925 1919
	1938	1933 1935
	1950	1951 1952
	1946	1914 1922
	1929	1939 1940
	1930	1949 1949
	1950	1949 1949
	1930	1949 1930

Table 4: Estimation Results for Growth in Infrastructure Stock

Variable	Telecommunications				Electricity			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
$\ln(\text{INFPC}_{x,i,t})$	-0.025 (0.000)	-0.024 (0.000)	-0.031 (0.000)	-0.027 (0.000)	-0.055 (0.000)		-0.043 (0.000)	
POLCON		0.012 (0.000)	0.004 (0.066)	0.008 (0.000)			0.0166 (0.000)	
COLONY	-0.002 (0.549)	-0.003 (0.306)	-0.014 (0.000)	-0.011 (0.000)	-0.003 (0.217)		-0.026 (0.000)	
Time Trend	0.000 (0.000)	0.000 (0.000)	0.001 (0.000)	0.000 (0.000)	0.003 (0.000)		0.002 (0.000)	
$(\text{Time Trend})^2$					-0.000 (0.000)		-0.000 (0.000)	
$\ln(\text{GDPPC}_{t-1})$			0.012 (0.000)	0.010 (0.000)			0.010 (0.000)	
$\ln(\text{RGDPPC}_{t-1})$			0.040 (0.000)				0.177 (0.000)	
p	0.087 (0.000)	0.116 (0.000)	0.263 (0.000)	0.253 (0.000)	0.073 (0.000)		0.083 (0.000)	
Year Dummies	Yes	Yes	Yes	Yes	Yes		Yes	
Fixed Effects	Yes	Yes	Yes	Yes	Yes		Yes	
Country-specific Real GDP growth effects	No	No	No	Yes	No		No	
N	5878	5412	3619	3622	6654		3975	
Durbin Watson	1.90	1.93	2.06	2.06	1.91		1.95	
Adjusted R-squared	0.999	0.999	0.999	0.999	0.998		0.998	

Appendix 1: Deriving and Constructing the Political Constraints Index¹²

Deriving the measure of political constraints

In order to construct a structurally-derived internationally comparable measure of political constraints, the structure of political systems must be simplified in a manner which allows for cross-national comparisons over a wide range of countries while retaining the elements of that structure which have a strong bearing on the feasibility of policy change. Here, I will focus on two such elements: the number of independent veto points over policy outcomes and the distribution of preferences of the actors that inhabit them. Without minimizing their importance, I set aside questions of agenda setting power, decision costs (Spiller, 1992; Schwartz, Spiller and Urbiztondo, 1994; Spiller and Tiller, 1997) and the relative political authority held by various institutions for subsequent extensions of the admittedly simplistic modeling framework presented here.

Political actors will be denoted by E (for executive), L1 (for lower house of legislature), L2 (for upper house of legislature).¹³ Each political actor has a preference, denoted by X_I where $I \in [E, L1, L2]$. Assume, for the time being, that the status quo policy (X_0) and the preferences of all actors are independently and identically drawn from a uniformly distributed unidimensional policy space $[0,1]$. Data on actual preference distributions of political actors will subsequently be incorporated into the analysis loosening this assumption. The utility of political actor I from a policy outcome X is assumed equal to $-|X - X_I|$ and thus ranges from a maximum of 0 (when $X = X_I$) to a minimum of -1 (when $X = 0$ and $X_I = 1$ or vice versa). Further assume that each actor has veto power over final policy decisions. While these are, admittedly, strong assumptions, the incorporation of more refined and realistic game structures and preference distributions presents severe complications for analytic tractability. It is hoped that, mirroring the development of the domestic positive political theory literature, the strength of the results obtained using the simple framework presented here will provide an impetus for future research.

The variable of interest to investors in this model is the extent to which a given political actor¹⁴ is constrained in his or her choice of future policies. This variable is calculated as $(1 - \text{the level of political discretion})$. Discretion is operationalized as the expected range of policies for which all political actors with veto power can agree upon a

¹² This section draws heavily from (Henisz, 1998).

¹³ Data limitations of the panel preclude the inclusion of other veto points such as an independent judiciary, sub-federal units of power, administrative agencies and the like.

¹⁴ Without loss of generality, the remainder of the paper refers to changes in executive preferences. Note that since the preferences of all actors and the status quo policy are drawn identically from the same distribution, each actor, including the executive, faces the same constraints in changing policy. Allowance for the likelihood of multiple actors changing preferences simultaneously is made by incorporating information on alignment of preferences across the various branches of government later in the analysis.

change in the status quo. For example, regardless of the status quo policy, an unchecked executive can always obtain policy X_E and is guaranteed their maximum possible utility of 0. Investors face a high degree of uncertainty since the executive's preferences may change or the executive may be replaced by another executive with vastly different preferences. Therefore this is categorized as a polar case in which political discretion = 1 and political constraints equals 0 ($1 - 1$).

As the number of actors with independent veto power increases, the level of political constraints increases. For example, in a country with an effective unicameral legislature (L1), the executive must obtain the approval of a majority of the legislature in order to implement policy changes. The Executive is no longer guaranteed the policy X_E as the legislature may veto a change from the status quo policy. The Executive can, at best, achieve the outcomes closest to X_E that is preferred by the legislature to the status quo. Without additional information on the preferences of the Executive and the legislature it is impossible to compute the exact outcome of the game. Nor is the expected magnitude of the effect on political discretion of adding this additional veto point immediately clear. However, one of the virtues of the simple spatial model outlined above is that it provides a more objective insight into the quantitative significance of adding an additional veto point.

Given the assumption that preferences are drawn independently and identically from a uniform distribution, the expected difference between the preferences of any two actors can be expressed as $1/(n+2)$ ¹⁵ where n is the number of actors. Assuming that there exist two political institutions with veto power (the Executive (E) and a unicameral legislature (L1)), the initial preference draw yields an expected preference difference equal to $1/(2 + 2) = 1/4$. There are six possible preference orderings in this game (see Appendix Figure 1) that we will assume are equally likely to occur in practice.¹⁶

In ordering (1), no change in executive preferences which retains the initial ordering of preferences yields a change in policy. The executive ($X_E = 1/4$) prefers all policies between $1/2 - \epsilon$ and $0 + \epsilon$ to the status quo ($X_0 = 1/2$) while the legislature ($X_{L1} = 3/4$) prefers all policies between $1/2 + \epsilon$ and $1 - \epsilon$ to X_0 . As the executive and the legislature cannot agree on a change in policy, political discretion (the feasibility of policy change) equals 0 and political constraints equal 1. The same argument is true by symmetry for ordering (2). In the remaining orderings, both the executive and legislature agree on a direction in which policy should move relative to the status quo X_0 . These cases have closed form solutions other than the status quo policy. Their exact values depend on the assumption as to who moves first (or last) and the relative costs of review by each party.

¹⁵ See Rice (1995:p. 155). The intuition for this result is that the expectation of any single draw is equal to $1/2$ but there exists variation across draws. Given a uniform distribution, the expected distance between any two adjacent positions declines proportionally to the number of additional draws. The exact formula is $1/(\# \text{ of draws} + 1)$.

¹⁶ For expositional convenience, I center each of the preference distributions on the unit line. As long as the expected difference between any two preferred points remains $1/4$, the quantitative results are insensitive to the absolute location of these points. For example, were the leftmost (rightmost) point in each distribution to be placed at 0 (1) rather than $1/4$ ($3/4$), the quantitative results would be unchanged.

However, in the absence of knowledge on the rules of the game in each country, the range of outcomes over which both parties can agree to change the status quo is used as a measure of political discretion. As this range expands, there exists a larger set of policy changes preferred by both political actors with veto power. The existence of such a set reduces the credibility of any given policy and therefore decreases the level of political constraints. In ordering (3), the executive ($X_E = 1/2$) prefers policies between $1/4 + \epsilon$ and $3/4 - \epsilon$ to the status quo ($X_0 = 1/4$) while the legislature ($X_{L1} = 3/4$) prefers all policies greater than $1/4 + \epsilon$. There exists a range of policies approximately equal to $1/2$ (between $1/4 + \epsilon$ and $3/4 - \epsilon$), which both actors agree are superior to the status quo. The political discretion measure for this ordering therefore equals $1/2$ yielding a political constraints measure equal to $1/2$. The same is true in orderings (4), (5) and (6). The expected level of political constraints for the game $\{X_E, X_{L1}\}$ based on the number of veto points alone is the average of the political constraint measures across the six possible preference orderings: $(1 + 1 + 1/2 + 1/2 + 1/2 + 1/2)/6 = 2/3$.

Note that this initial measure of political constraints is based solely on the number of de jure veto points in a given polity maintaining the strong and unrealistic assumption of uniformly distributed preferences. However, neither the Constitutional existence of veto power nor its prior exercise provide a de facto veto threat in the current period. Specifically, loosening the assumption of uniformly distributed preferences by allowing for preference alignment (i.e., majority control of the executive and the legislature by the same party) would be expected to expand the range of political discretion and thereby decrease the level of political constraints. In order to allow for this effect, the purely institutional measure of political constraints described above is supplemented with information on the preferences of various actors and their possible alignments. For example, if the legislature were completely aligned with the executive, the game would revert back to our simple unitary actor discussed above with a constraint measure of 0. The same exercise of determining constraints given the assumption of either completely independent or completely aligned actors was conducted for all observed institutional structures yielding the values for political constraints displayed in Appendix Table 1.

Further modifications are required when other political actors are neither completely aligned with nor completely independent from the executive. In these cases, the party composition of the other branches of government are also relevant to the level of constraints. For example, if the party controlling the executive enjoys a majority in the legislature, the level of constraints is negatively correlated with the concentration of that majority. Aligned legislatures with large majorities are less costly to manage and control than aligned legislatures that are highly polarized.

By contrast, when the executive is faced with an opposition legislature, the level of constraints is positively correlated with the concentration of the legislative majority. A heavily fractionalized opposition may provide the executive with more discretion due to the difficulty in forming a cohesive legislative opposition bloc to any given policy. Information on the partisan alignment of different government branches and on the difficulty of forming a majority coalition within them can therefore provide valuable information as to the extent of political constraints.

Suppose, for example, that the party controlling the executive completely controls the other branch(es) of government (100%¹⁷ of legislative seats). In this case, the values displayed in the appropriate right-hand column of Appendix Table 1 are utilized. However, as the executive's need for coalition building and maintenance increases (his or her majority diminishes), and under the assumption that the same party controls both branches, the values converge to the levels displayed in the left-most column. For the case in which the branches are controlled by different parties, the results are reversed. Now, complete concentration by the opposition (100% legislative seats) leads to the assignment of the values in the left-most column. As the opposition's difficulty of forming coalitions increases, the values converge to the levels displayed in the appropriate right-hand column. Following an extensive body of literature in political science on the costs of forming and maintaining coalitions, the rate of convergence is based upon the extent of legislative (or judicial) fractionalization (Rae and Taylor, 1970).

The fractionalization of the legislature (or court) is equal to the probability that two random draws from the legislature or court are from different parties. The exact formula is:

$$1 - \sum_{i=1}^n \left[\frac{(n_i - 1) \frac{n_i}{N}}{N - 1} \right]$$

where n = the number of parties, n_i = seats held by nth party and N = total seats.

The final value of political constraints for cases in which the executive is aligned with the legislature(s) is thus equal to the value derived under complete alignment plus the fractionalization index multiplied by the difference between the independent and completely aligned values calculated above. For cases in which the executives party is in the minority in the legislature(s), the modified constraint measure equals the value derived under complete alignment plus (one minus the fractionalization index) multiplied by the difference between the completely independent and dependent values calculated above. In cases of mixed alignment, a weighted (equally) sum of the relevant adjustments is used.

For example, in the case described above the constraint measure equaled 0 if the legislature was completely aligned and 2/3 if it was completely independent. However, if the same party controls the executive and the legislative chamber and the probability of two random draws from the legislature belonging to different parties equals 1/4 (the executive has a large majority in Parliament) then the modified constraint measure equals $0 + 1/4 * (2/3 - 0) = 1/6$. By contrast, if the executive relied on a heavily fractionalized coalition in which the probability that any two random draws were from different parties was 75%, the modified constraint measure would equal $0 + 3/4 * (2/3 - 0) = 1/2$. In the case where the opposition controls the legislature the values would be reversed. A heavily concentrated majority by the opposition would lead to a value of $0 + (1 - 1/4) * (2/3 - 0)$

¹⁷ I assume that as the majority diminishes from this absolute level the difficulty in satisfying the preferences of all coalition or faction members increases thus increasing the level of political constraints.

= 1/2 while a fractionalized legislature would receive a score of $0 + (1 - 3/4) * (2/3) = 1/6$.

This measure of political constraints has one important virtue that also yields several weaknesses. The strength of the measure is that it is structurally derived from a simple spatial model of political interaction which incorporates data on the number of independent political institutions with veto power in a given polity and data on the alignment and heterogeneity of the political actors that inhabit those institutions. The first weakness of the measure is that its validity is based upon the validity of the assumptions imposed upon the spatial model in order to generate quantitative results. Another weakness is that many features of interest are left out of the model including agenda setting rights, decision costs, other relevant procedural issues, the political role of the military and/or church, cultural/racial tensions, and other informal institutions which impact economic outcomes.

Constructing the measure of political constraints

Construction of a measure of political constraints based on the above methodology requires three types of data. First, information regarding the number of institutional players in a given polity; second, data on partisan alignments (including coalitions) across institutions; and, finally, data on the party composition of legislatures. All countries were assumed to have an executive. Data on the existence of other political actors (unicameral or bicameral legislatures¹⁸) with substantive veto power was taken from the Polity database and Derbyshire and Derbyshire (1996).

The above data sources were then supplemented by various issues of *The Political Handbook of the World* and *The Statesman's Yearbook* to note the party distribution of the legislature(s): specifically, whether the executive enjoy a majority in one (or both) legislature(s) and how many seats in each legislature were controlled by each party. Based on this information, the values of institutional constraints were modified to form a measure of political constraints using the methodology described in the previous section.

Sample Calculation

Like the hypothetical example above, in 1990 Guyana had two veto points (an independent executive and a single legislative chamber). However, the same party (the People's National Congress) controlled the presidency and held 42 of the 53 legislative seats, with the remaining seats distributed among three other parties. The probability that two random draws from the legislature would be from different parties (the fractionalization index) was 35.4 percent. As a result, the initial constraint measure of 2/3 was scaled downwards to 0.237 to take into account the (imperfect) alignment of the legislative chamber with the executive branch. (Specifically, the final measure of 0.237 is

¹⁸ Effective legislatures possess "significant governmental autonomy ... including, typically, substantial authority with regard to taxation and disbursement, and the power to override vetoes of legislation." A classification of partially effective is assigned when "the effective executive's power substantially outweighs but does not completely dominate that of the legislature." (Gurr, 1990:p. 51)

35.4% of the distance between the measure with no veto points or perfect alignment (0.000) and the value of the measure with one veto point and perfect opposition (2/3)).

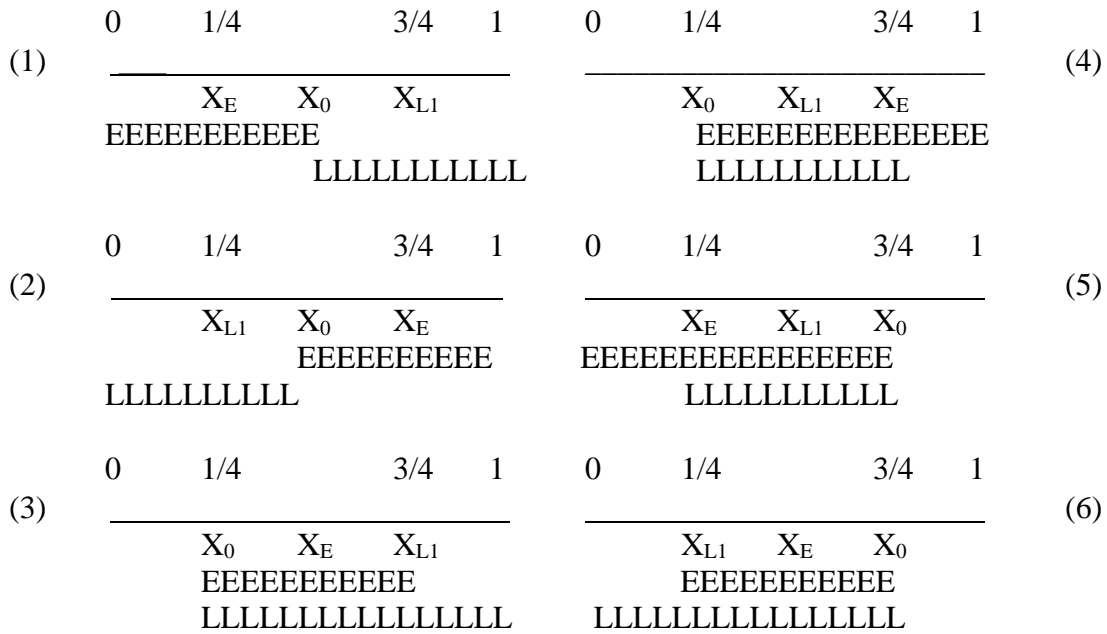
In 1993, Guyana held an election in which the People's Progress Party won the Presidency and the majority in the legislature. The new distribution of seats was 35 for the People's Progress and 27 for the People's National Party, with the remaining parties' seat totals unchanged. In this case, the probability that two random draws from the legislature would belong to different parties increased to 54.5 percent, making it relatively more difficult for the new governing party to steamroll the legislature in comparison to their immediate predecessor (i.e., their majority was slightly more tenuous). The political constraint measure thus rose from 0.237 to 0.365 (or 54.5 percent of the distance between the value with no veto points or perfect alignment and the value with one veto point and perfect opposition). Appendix Table 2 reports the decade average of the result of the analogous calculation for each country where the necessary data exist.

Appendix Table 1: Political Constraints with Complete Independence/Alignment

<u>Independent</u> <u>Political Actors</u>	<i>Entities Completely Aligned with Executive</i>		
	<u>None</u>	<u>(L1 or L2)</u>	<u>L1&L2</u>
E	0		
E, (L1 or L2)	2/3	0	
E, L1, L2	4/5	2/3	0

Note: E = executive, L1 = lower legislature, L2 = upper legislature

Appendix Figure 1: The Six Possible Preference Ordering of the Game $\{X_E, X_{L1}\}$



Note : E indicates the range of outcomes preferred by the executive to the status quo X_0
L indicates the range of outcomes preferred by the legislature to the status quo X_0

Appendix Table 2 : Decade Averages for Political Constraint Index

COUNTRY	1880-89	1890-99	1900-09	1910-19	1920-29	1930-39	1940-49	1950-59	1960-69	1970-79	1980-89	1990-98
Afghanistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Algeria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Angola	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Argentina					0.66	0.48	0.57	0.08	0.00	0.00	0.49	0.52
Australia	0.00	0.00	0.41	0.34	0.47	0.59	0.49	0.44	0.55	0.60	0.51	0.50
Austria		0.06	0.06	0.13	0.43	0.20	0.15	0.46	0.42	0.42	0.61	0.66
Bangladesh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.34
Belgium	0.38	0.37	0.47	0.48	0.52	0.58	0.60	0.49	0.57	0.67	0.69	0.63
Benin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Bhutan	0.00	0.00	0.00									0.00
Bolivia		0.29	0.73		0.71	0.00	0.16	0.07	0.12	0.00	0.33	0.56
Botswana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.23	0.15	0.24
Brazil	0.00	0.00			0.06	0.00	0.00	0.61	0.18	0.00	0.35	0.62
Bulgaria	0.00				0.20	0.08	0.00	0.00	0.00	0.00	0.00	0.32
Burkina Faso	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Burma	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Burundi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00
Cambodia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Cameroon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Canada	0.30	0.33	0.32	0.32	0.46	0.65	0.46	0.44	0.56	0.39	0.60	0.41
Central African Rep.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Chad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chile					0.00	0.23		0.69	0.65	0.20	0.00	0.62
China	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colombia	0.00	0.00	0.00		0.37	0.67	0.73	0.26	0.54	0.55	0.55	0.40
Congo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
Costa Rica	0.00	0.00			0.25	0.31	0.35	0.35	0.32	0.40	0.38	0.32
Cuba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyprus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.32
Czech Republic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35
Czechoslovakia	0.00	0.00	0.00	0.00	0.27	0.65	0.00	0.00	0.00	0.00	0.00	0.10
Denmark	0.42	0.27	0.39	0.43	0.57	0.69	0.29	0.53	0.49	0.53	0.54	0.47
Dominican Republic	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.10	0.30	0.52	0.52
Ecuador	0.00	0.00	0.00		0.00	0.00			0.00	0.00	0.27	0.13
Egypt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Salvador	0.00	0.00	0.00			0.00	0.00		0.10	0.27	0.27	0.40
Ethiopia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.14	0.52	0.50	0.50	0.53	0.54	0.55	0.54	0.48
France	0.26	0.42	0.51	0.55	0.59	0.74	0.70	0.71	0.70	0.67	0.67	0.60
Gabon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East Germany							0.00	0.00	0.00	0.00	0.00	
West Germany							0.05	0.44	0.39	0.49	0.40	
Germany	0.11	0.10	0.09	0.15	0.56	0.13						0.38
Ghana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.04	0.00
Greece					0.21	0.26	0.00	0.38	0.26	0.18	0.36	0.34
Guatemala		0.00	0.00	0.00		0.00	0.07	0.07	0.00		0.20	0.29
Guinea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Guyana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.33	0.25	0.29
Haiti	0.00			0.00	0.00	0.00		0.16	0.00	0.00	0.00	0.13
Honduras	0.00	0.00	0.00	0.00	0.28	0.10	0.00	0.04	0.26	0.07	0.21	0.31
Hungary	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.37
India	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.34	0.42	0.46	0.59
Indonesia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Iran	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iraq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.40	0.58	0.42	0.45	0.42	0.40	0.41	0.42
Israel	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.55	0.54	0.48	0.49	0.48
Italy		0.50	0.45	0.33	0.07	0.00	0.10	0.57	0.48	0.47	0.49	0.45

COUNTRY	1880-89	1890-99	1900-09	1910-19	1920-29	1930-39	1940-49	1950-59	1960-69	1970-79	1980-89	1990-98
Ivory Coast	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Jamaica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.39	0.37	0.24	0.23
Japan	0.00				0.71	0.71	0.00	0.48	0.46	0.52	0.52	0.50
Jordan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kenya	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26
Kuwait	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laos	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lebanon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.12	0.04	0.10
Liberia							0.00	0.00	0.00	0.00	0.00	0.00
Libya	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Madagascar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.00	0.26
Malawi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
Malaysia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.38	0.48	0.28
Mali	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Mauritania	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mauritius	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.43	0.37	0.27
Mexico	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.12	0.19	0.33
Mongolia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
Morocco	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.19	0.16
Mozambique	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Nepal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
Netherlands	0.41	0.42	0.52	0.55	0.58	0.66	0.66	0.74	0.62	0.68	0.66	0.59
New Zealand		0.35	0.32	0.38	0.41	0.38	0.34	0.37	0.33	0.32	0.34	0.32
Nicaragua		0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.25	0.04	0.00	0.33
Niger	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
Nigeria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.05	0.00
North Korea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Yemen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.32	0.38	0.37	0.45	0.52	0.48	0.46	0.44	0.46	0.48	0.45	0.46
Oman	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pakistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.10	0.50
Panama	0.00	0.00	0.00		0.27	0.34	0.21	0.20	0.22	0.00	0.00	0.23
Paraguay	0.00	0.00	0.00	0.00	0.30	0.04	0.00	0.00	0.00	0.00	0.00	0.17
Peru	0.00			0.00	0.00	0.00	0.00	0.21	0.19	0.00	0.17	0.06
Philippines	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.38	0.52	0.10	0.10	0.55
Poland	0.00	0.00	0.00	0.01	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.61
Portugal			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.43	0.35
Romania					0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.42
Russia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Rwanda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Saudi Arabia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Senegal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serbia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37
Sierra Leone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.14	0.06	0.00
Singapore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.02	0.04
Somalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00
South Africa	0.00	0.00	0.00	0.42	0.42	0.32	0.50	0.41	0.28	0.32	0.20	0.31
South Korea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.04	0.20
South Vietnam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Yemen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.12	0.46	0.47
Sri Lanka	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.50	0.41	0.20	0.36
Sudan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00
Sweden	0.32	0.39	0.38	0.45	0.51	0.56	0.52	0.53	0.45	0.47	0.47	0.44
Switzerland	0.72	0.72	0.73	0.72	0.71	0.71	0.70	0.70	0.70	0.70	0.70	0.63
Syria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taiwan	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.22	0.19	0.31
Tanzania	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Thailand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.53	0.26
Togo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18

COUNTRY	1880-89	1890-99	1900-09	1910-19	1920-29	1930-39	1940-49	1950-59	1960-69	1970-79	1980-89	1990-98
Trinidad& Tobago	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.34	0.40	0.47
Tunisia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turkey	0.00	0.00	0.00	0.00	0.00	0.57	0.55	0.20	0.39	0.38	0.26	0.33
Uganda	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.07
United Kingdom	0.40	0.44	0.42	0.46	0.36	0.33	0.37	0.37	0.34	0.36	0.35	0.32
Uruguav					0.73	0.52	0.51	0.68	0.51	0.22	0.21	0.52
USA	0.67	0.58	0.39	0.53	0.43	0.38	0.46	0.57	0.44	0.63	0.70	0.59
Venezuela	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.59	0.58	0.54
Vietnam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yugoslavia	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Zaire	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zambia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zimbabwe	0.00	0.00	0.00	0.00	0.00					0.00	0.21	0.00

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