Democracy, Technological Change and Economic Growth

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Abstract

This paper investigates whether democracy affects technological change and economic growth. The paper presents a model where dictators can restrict civil liberties and diffusion of information, which increases dictators' probability of surviving in office but also reduces their personal consumption. The main empirical implication from the model is that dictatorships will experience slower technological change than democracies, and therefore also have lower economic growth rates. Thereafter, the paper presents statistical analysis on the effect of democracy on technological change and on economic growth, drawing on panel data for more than 150 countries with time series going back to the nineteenth century for some countries. The analysis finds that democracy produces higher technology-induced economic growth, and that democracy enhances economic growth also more in general. The results hold even when taking into account country-fixed effects, the endogeneity of democracy, and selection bias stemming from systematically missing data.

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1 Introduction

Historically, democratic regime characteristics have correlated positively with economic growth.[1] When operationalized as regimes that score ≥ 6 on the Polity Index (*PI*), democracies have, on average, consistently had about equal to or higher growth rates than dictatorships (PI< 6) over the last century and a half, despite the dramatically changing composition of the democracy club. From 1855 to 1913 democratic economies' GDP per capita grew 1.7% annually on average whereas dictatorial economies' grew 1.2%, according to data from Maddison (2006). From 1914 to 1945 the corresponding numbers were 1.5% and 1.1%. From 1946 to 2003 the average growth rate for democracies was 2.3%, whereas it was 1.7% for dictatorships. But, does democracy actually enhance economic growth? There is no consensus, neither among academics nor among policy makers, on the answer to this question.

Despite the correlation noted above, several academics and policy makers seem to believe firmly in the "Lee Thesis" (Sen 1999, 15), credited to former Singaporean PM Lee Kuan Yew. The Lee Thesis postulates that particularly in developing countries, a strong authoritarian regime is necessary in order to promote economic development. The East Asian Tiger-states, Pinochet's Chile and present-day China are considered decisive empirical evidence for this assertion. A second position on the effect of democracy on economic growth is the "agnostic position", which is backed up by more systematic evidence than the Lee Thesis (e.g. Przeworski and Limongi 1993; Burkhart and Lewis-Beck 1994; Helliwell 1994; Brunetti 1997; Przeworski et al. 2000). For example, Przeworski and Limongi (1993) surveyed early empirical studies and found that studies claiming positive, negative or no effect of democracy on economic growth were about equal in numbers. Przeworski et al. (2000) conducted a thorough

[1] Democracy is defined as a political system with high degrees of popular control over public decision making and political equality (see e.g. Beetham 1999). Free and fair elections are crucial for securing popular control over politics, but it also follows from this definition that political and civil rights, and various institutional checks on rulers' behavior, are essential for ensuring a democratic regime. I have elsewhere (Reference removed) argued that the Freedom House Index may be a decent operationalization of such a substantive and broad democracy concept. However, in this paper I use the Polity Index mainly because of the long time series associated with the Polity data.

statistical study and found no robust effect of democracy on GDP growth.[2] These results have convinced many in the scholarly community: Diamond (2008, 96), for example, asserts the "evidence is murky" for the hypothesis that democracy spurs economic development, while Tsebelis (2002, 70) reports it as a surprising fact that there is no evidence of democracies producing superior economic outcomes. Although a number of relatively recent studies indicate that democracy is indeed beneficial for economic growth (e.g. Leblang 1997; Baum and Lake 2003; Bueno de Mesquita et al. 2003; Halperin, Siegle and Weinstein 2005; Feng 2005; Papaioannou and Siourounis 2008; Doucouliagos and Ulubasoglu 2008), the results on democracy's effect on growth vary quite a lot between different studies, and the jury is still out on the question.

Two points should be noted in this regard: First, studies reporting insignificant effects of democracy on growth have often studied only the direct effect, as they have controlled for variables constituting the main channels through which democracy likely affects growth, like human capital (see e.g. Tavares and Wacziarg 2001; Baum and Lake 2003; Doucouliagos and Ulubasoglu 2008). More generally, many previous statistical studies on democracy and growth have relied on problematic model specifications, for example neglecting the possibility of country-specific factors and the endogeneity of democracy influencing estimates. Second, the time dimension and other sample characteristics influence results (Doucouliagos and Ulubasoglu 2008). Studies based on longer time series are presumably more reliable, and the vast majority of studies have been based on data from no more than four decades. Additionally, many dictatorships with poor economic track-records, like North Korea, Myanmar, Cuba and Eritrea, are often either unwilling or unable to provide infrastructure for data collection, whereas both fast-growing dictatorships and almost all democracies provide data (Halperin, Siegle and Weinstein 2005, 32-33). Thus, methodical factors may underly the diverging results in the literature.

This study incorporates a very large number of country-year observations, including more than 150 countries with time series going from 1820 to 2003 for some countries, and presents

[2]However, Przeworski et al. (2000) did find indications of a positive effect on GDP per capita growth, which is a more relevant measure of welfare than aggregate GDP growth.

analyses taking into account the possible endogeneity of democracy and that country-specific factors may influence both regime type and economic performance. The study also utilizes multiple imputation techniques (see Honaker and King 2010) to further mitigate selection bias stemming from specific countries not having data on critical variables. Hence, the relatively robust results presented in this paper constitute a compelling case for a positive effect of democracy on growth.

This paper also elaborates on one important channel through which democracy likely enhances growth, namely technological change. The literature on democracy's economic effects has mostly focused on how democracy affects growth through physical (e.g. Przeworski and Limongi 1993; Tavares and Wacziarg 2001) and human capital accumulation (e.g. Baum and Lake 2003; Stasavage 2005).[3] However, the economic growth literature considers technological change *the* central determinant of long-run growth (e.g. Nelson and Winter 1982; Romer 1990; Klenow and Rodriguez-Clare 1997). This paper finds quite robust evidence for the hypothesis that democracy enhances technological change-induced economic growth, and this to a large extent explains why democracies grow faster than dictatorships.

Section 2 presents a review of arguments from the literature on why and how democracy affects growth. Section 3 develops a formal model showing how self-interested dictators have incentives to conduct policies that slow down technological change. Section 4 presents the data, and Section 5 presents the empirical results for the effect of democracy on technological change and the effect on economic growth. Section 6 concludes.

2 Literature review

As is the case for the empirical results on democracy and growth, the theoretical arguments proposed on the relationship are many, varied, and point in different directions. Several related

[3] There are some exceptions. Przeworski et al. (2000) conducted growth accounting on data from 1950 to 1990, and their results indicated that democracies may do better on technological change, but only among rich countries. Pinto and Timmons (2005) also investigated the relationship, but relied on problematic proxies of technological change, like foreign direct investment and trade.

arguments point out that dictatorship may enhance economic growth because of dictatorial governments' abilities to conduct economic policies without being highly influenced by popular pressures (e.g. Huntington 1968; Haggard 1990; Sirowy and Inkeles 1990; Przeworski and Limongi 1993). Scholars have particularly linked some Asian dictatorships' economic performance to these dictatorial states' autonomy from their citizens and insulation from special interest groups (e.g. Wade 1990; Leftwich 2000). In contrast, democracies may be prone to capture by special interest groups (Olson 1982), which may lead to policies that sacrifice economic growth for the protection of specific business sectors or pivotal voters whose interest is not aligned with growth. Microeconomic reforms, land reforms or trade reforms may improve efficiency, but certain privileged groups may lose out. Under democracy, these potential losers may be "veto players" (Tsebelis 2002), and block reform. Thus, dictatorial regimes may, *if* they are more autonomous from interest group pressure *and* key players within the regime have incentives to conduct proper policies, enhance efficiency through promoting policies that are politically difficult to enact in democracies.

Furthermore, dictatorial regimes may be able to enhance physical capital accumulation through increasing savings rates (e.g. Przeworski and Limongi 1993; Przeworski et al. 2000; Tavares and Wacziarg 2001). First, dictatorships often suppress freedom of association, thus crippling the organization of independent unions. In the absence of independent unions, wages are likely lower, and capital-owners earn more (Rodrik 1999*a*). Thus, if savings rates increase with income (the Kaldor hypothesis), aggregate savings rates will likely be higher in dictatorships. Furthermore, dictatorships lack free and fair elections, which reduces popular pressure on leaders to channel resources to public consumption. Instead, dictators can push different savings-enhancing policies, like banning luxury consumption or restricting consumer loans (see e.g. Wade 1990; Chang 2006). However, in some contexts self-interested dictators may not want to pursue policies that lead to investment-induced growth, as this may reduce their personal consumption or probability of surviving in office (e.g. Acemoglu and Robinson 2006*a*; Bueno de Mesquita et al. 2003). Moreover, some studies find that democracy increases inward foreign direct investment (e.g. Busse and Hefeker 2007), which partly mitigates dictatorships' capital accumulation advantage stemming from higher domestic savings rates.

Protection of property rights is vital for economic growth (see e.g. North 1990; Knack and Keefer 1995; Acemoglu, Johnson and Robinson 2001). Political economic models indicate more progressive property redistribution under democracy, as the median voter is assumed to be poorer than those who set policy under dictatorship (e.g. Meltzer and Richards 1981; Boix 2003; Acemoglu and Robinson 2006*b*). Nevertheless, empirical analyses find that democracy actually enhances property rights protection (e.g. Leblang 1996; Adsera, Boix and Payne 2003; Clague et al. 2003; Knutsen 2011). There are good reasons for why this is the case; the threat to property rights may not necessarily come from the poor and redistribution is not necessarily progressive. Because of poor political accountability and concentration of power, dictatorial elites can confiscate property, from both rich and poor, more easily (North and Weingast 1989; North 1990; Knutsen 2011). Moreover, in democracies the government's supporters are many, and thus internalize much of the negative effects of property rights violation on incentives for productive activity (Olson 1993). Also, redistribution of property as private goods to political supporters is relatively cheaper in dictatorships, where the rulers' winning coalitions are smaller (Bueno de Mesquita et al. 2003). Under democracy, rulers motivated by political survival will have greater incentives to provide the public good of universal property rights protection.

Autonomy from the broader masses of the citizenry, often assumed to be beneficial for economic performance, can thus be used by dictatorial regimes for expropriating property. More generally, "autonomous" dictatorial regimes may promote different types of policies to their own benefit, but to the detriment of the national economy (see e.g. Robinson 1998; Bueno de Mesquita et al. 2003; Acemoglu and Robinson 2006*a*). Historically, examples of such policies vary from Louis XIV's Versailles-project to Mao Tse Tung's "Great Leap Forward" to Mobutu Sese Seko's funneling of money to private foreign bank accounts. In democracies, leaders who try to engage in such activities are more likely to be detected because of free media, more likely to be checked by the legislature and courts, and are likely thrown out of office in the next election. Democratic institutional features thus provide checks on predatory behavior (e.g. Ferejohn 1986; North and Weingast 1989). Democratic institutions also produce incentives for politicians to enact specific policies that benefit the masses of the people, and which are also conducive to economic growth (Bueno de Mesquita et al. 2003). Examples of such policies are related to provision of universal education and basic health care. For example, Lindert (2005) finds a strong positive effect of franchise expansion on the broadening of coverage and improvement in quality of education in Western Europe. Furthermore, Stasavage (2005) finds that democracy increases primary education spending in Africa. Indeed, several studies find that the effect of democracy on human capital is among the most important channels through which democracy enhances growth (e.g. Tavares and Wacziarg 2001; Baum and Lake 2003; Doucouliagos and Ulubasoglu 2008)

Democracy may affect growth also through other channels: Feng (2005) argues that democracy increases growth through enhancing political stability. In addition, democracy, or at least consolidated democracy, likely reduces corruption (e.g. Rock 2009). Moreover, Rodrik (1999*b*) argues that democracies may better handle exogenous shocks in open economies, like terms-of-trade shocks. As Acemoglu and Robinson (2006*b*) and Wintrobe (1990) point out, dictatorships also spend more resources on repressive apparatuses, which takes away resources from other productive projects. In conclusion, most arguments above indicate an economic growth advantage for democracy. There is, however, another and surprisingly overlooked channel through which democracy may enhance economic growth, namely technological change.

3 Technological change

3.1 Technological change and economic growth

Already in the 1950s Abramowitz (1956) and Solow (1957) found that technological change contributed more than capital accumulation and labor growth to economic growth in the US, and some years later Denison (1968) found the same pattern for European countries. More recently, for instance Easterly (2001) has argued that technological change is key to growth also for poorer countries. Some empirical estimates indicate that differences in technological efficiency explain the bulk (about $\frac{9}{10}$) of cross-national variation in income globally (Klenow and Rodriguez-Clare 1997).

Several "new growth models" have focused on the importance of innovation for economic growth (e.g. Lucas 1988; Romer 1990; Grossman and Helpman 1991; Aghion and Howitt

1992), but also the diffusion of technologies and ideas are crucial: An idea can be used by several actors without diminishing its value for others, and this is one reason why open flows of ideas, both within countries and across borders, is vital for generating economic growth (Romer 1993). Technological change therefore not only contributes to growth in rich countries at the technological frontier but also in less developed countries, as these countries can adopt technological (and organizational) improvements developed elsewhere. Understanding why some countries are better at adopting production and organization techniques, and diffusing them throughout their economies, is thus crucial for understanding income level and growth differences. Below, I argue that policies related to the restriction of civil liberties constitute one such factor.

3.2 Civil liberties, information flows and technological change

A dynamic economy "is the outcome of a constant interaction between variety and selection" (Verspagen 2005, 496). Civil liberties, such as freedom of speech, press and travel, allow for the introduction and diffusion of new ideas. Civil liberties also allow for comparison of different ideas, thus allowing for the more efficient to win out. Hence, civil liberties enhance both variety and selection; the introduction of new ideas, but also learning processes, rely on the possibility of collecting and processing information in a fairly unrestricted manner. In other words, open debate and free flows of ideas are crucial for efficient decision-making by firms, bureaucrats and politicians, as the different actors are better able to discover, compare and evaluate different production and organization techniques.

As already indicated, changes in efficiency stem not only from product innovations, but also from introduction of new policies and changes to economic institutions and organizations (North 1990). North (2005) argues that the inherent uncertainty about policy and organizational effects necessitates a process of trial and error, with proper feedback from society (see also Evans 1995). Open systems, associated with democratic government and civil liberties, are crucial for such processes, as "open access orders more readily generate a range of solution to problems; they more readily experiment with solutions to problems; and they more readily discard ideas and leaders who fail to solve them" (North, Wallis and Weingast 2009, 134).

The opportunity for actors outside government to freely opine on political reforms therefore improves organizational and policy efficiency. Restrictions on the freedoms of speech and media hurt efficiency, as important problems are not reported and alternative viewpoints on economic policies are either not forthcoming to the political rulers or properly debated. Civil liberties, but also open political competition among self-interested elites (see North, Wallis and Weingast 2009), ensure that various ideas are put forth, and properly debated.

In dictatorships, elites often seek to limit the variety and diffusion of ideas in order to retain power. Such practices hurt not only idea exchanges of a political nature, but likely also the diffusion of ideas and knowledge with relevance for economic efficiency. One illustrative example relates to communication technologies: "The Internet presents a dilemma to leaders of authoritarian states and illiberal democracies. It promises enticing commercial advantages, such as transaction cost reductions, e-commerce possibilities, and foreign trade facilitation. Yet, by giving citizens access to outside information and platforms for discussion and organization, the Internet can also help politically empower populations and potentially threaten regimes" (Hachigian 2002, 41). Cell-phone technology also present both political problems and potential economic gains to dictators. Bans on cell-phones have been imposed in Cuba and Turkmenistan, for example. Historically, one dictatorial regime generating technological and economic stagnation was imperial Quing-China. China experienced a dramatic relative economic decline compared to Western Europe, especially from the 19th century (see e.g. Landes 2003; Mokyr 1990). The Chinese empire was characterized by the ruling dynasty's concentration of power and its closed nature in terms of foreign relations. Political rulers neglected and even outlawed new and more effective organization techniques and production technologies, and this extreme economic conservatism may have been pursued in part to consolidate the existing hierarchical political regime (e.g. Mokyr 1990).

3.3 A model of dictatorship and technological change

In the model below, self-interested dictators restrict information flows by curbing civil liberties. This, in turn, reduces technological change. The model thus focuses on political institutional characteristics that "frame the struggle between the proponents of change and their opponents, and thereby affect the ability of countries to innovate and to implement new technologies" (Helpman 2004, 112). The model is part of a larger class of models, where self-interested dictators may have incentives to take actions with negative consequences for their national economies (e.g. Wintrobe 1990; Olson 1993; Bueno de Mesquita et al. 2003; Acemoglu and Robinson 2006*a*).

3.3.1 The economy

I use an adjusted neo-classical production function to model the economy (see Mankiw, Romer and Weil 1992): $Y = F(TL, K, H)$, where Y is output, T technology level, L labor input, K physical capital input and H human capital input. F is increasing, but concave, in all inputs. Furthermore, $\frac{\partial Y}{\partial T} = L \cdot \frac{\partial F}{\partial TL} > 0$: output increases in technological efficiency. For simplicity, I use a Cobb-Douglass specification:

$$Y = F(K, L, H, T) = K^{\alpha} H^{\beta} (TL)^{1-\alpha-\beta}. \quad (1)$$

Technology is considered endogenous. However, this model does not analyze firms' incentives to generate novel technology as do contributions from "new growth theory" (Romer 1990; Grossman and Helpman 1991; Aghion and Howitt 1992). Generation of cutting-edge technology in increasing-returns-to-scale sectors is mostly relevant for large and rich countries. However, for most countries the global technological frontier is largely exogenous, and the diffusion (and local adaptation) of international technology is key for level of efficiency. Thus, one can focus on technology diffusion when modeling cross-country differences in technology-induced economic growth.

In the model, domestic technological change is a function of how many new techniques national economic actors adopt, denoted A_t. More specifically, the rate of change in technology is $\frac{\dot{T}}{T} = \omega(A_t)$. The number of new techniques developed each year globally is A_t^*, and treated as exogenous. In accordance with the discussion above, domestic information flows, i, determine the degree to which a country utilize new, globally developed ideas to generate technological change. i comes in two pure types, politically and economically relevant information, i_e and i_p. However, there is also non-pure information, i_{ep}, of both economic and political relevance.

Only i_e and i_{ep} affect technological change. Hence, A_t is a function of A_t^* , i_e and i_{ep}. I normalize so that $i_e + i_{ep}$ varies between 0 and 1, with 0 indicating a country that restricts all economic information flows and 1 indicating free flow of economic information. I assume that $A_t = (i_e + i_{ep})A_t^*$. Hence,

$$\frac{\dot{T}}{T} = \omega((i_e + i_{ep})A_t^*). \tag{2}$$

It can be shown, through taking logarithms and differentiating the production function, that

$$\frac{\dot{Y}}{Y} = (1 - \alpha - \beta)\frac{\dot{T}}{T} + \alpha\frac{\dot{K}}{K} + \beta\frac{\dot{H}}{H} + (1 - \alpha - \beta)\frac{\dot{L}}{L} \tag{3}$$

When inserting Equation 2 into Equation 3, I obtain the following expression:

$$\frac{\dot{Y}}{Y} = (1 - \alpha - \beta)\omega((i_e + i_{ep})A_t^*) + \alpha\frac{\dot{K}}{K} + \beta\frac{\dot{H}}{H} + (1 - \alpha - \beta)\frac{\dot{L}}{L} \tag{4}$$

Equation 4 shows that GDP growth rates depend on growth rates of physical capital, human capital and labor, changes in the global technological frontier and the information flows in national economies. If countries are in their steady states (see e.g. Barro and Sala-i Martin 2004), income in countries with free information flows will grow with the global technology frontier's rate of change. Elsewhere, steady-state growth rates will be weighted down with the degree of information flow-restrictions. A country where very little information is allowed, like North Korea, will have very low long-run growth rates.

3.3.2 Political decision making

Restrictions on information flows are endogenous. To simplify the argument, I assume that all types of information are allowed in democracies, and I therefore focus on dictatorial regimes. More specifically, I consider a dictator, D, in a two-period model. D maximizes a utility function, $U = U(c, q)$, dependent on personal consumption, c, and political survival probability in the second period, q. $U(c, q)$ is increasing and concave in both arguments. D receives a fixed share, λ, of Y, and therefore, ceteris paribus, wants to increase the economy's size to increase personal consumption. D's consumption is given by

$$c_t \leq \lambda Y_t = \lambda K_t^{\alpha} H_t^{\beta} (T_t L_t)^{1-\alpha-\beta} \tag{5}$$

Since there is no saving in the model and $U'(c) > 0$, Expression 5 holds with equality. I manipulate the utility function, to analyze how D's utility depend on consumption growth rate. I assume an exogenously given Y_0, and thus c_0, in period 0. Change in consumption, Δc, is therefore given by

$$\Delta c = c_t - c_0 = \lambda K_t^{\alpha} H_t^{\beta} (T_t L_t)^{1-\alpha-\beta} - \lambda K_0^{\alpha} H_0^{\beta} (T_0 L_0)^{1-\alpha-\beta} \tag{6}$$

For simplicity, and without loss of generality, I assume that $K_t = K_0$, $H_t = H_0$, $L_t = L_0$, so that Δc is only a function of changes in T. Further, if one holds λ constant and uses Equation 4, one finds that D's consumption growth rate $\frac{\Delta c}{c_0}$, denoted g_c, is given by

$$g_c = (1 - \alpha - \beta)\omega((i_e + i_{ep})A_t^*) \tag{7}$$

Since c_0 is exogenous, and $U'(c) > 0$, $U'(\Delta c) > 0$, and therefore $U'(g_c) > 0$.

As indicated above, information flows are affected by policies for example related to restrictions on the freedoms of speech, media and travel and investment in public goods related to communication technology. These are the actual policies set by a dictator, but I model their consequence, information flows, as choice variables to simplify. It is difficult for dictatorial governments to screen each act of communication, travel and meeting, and governments therefore need to establish general rules. Hence, information activities are banned under uncertainty of their contents; civil liberties restrictions may not only reduce political communication, but also economically relevant communication. This is captured by $i_{ep} > 0$.

D sets policy ($i_e; i_p; i_{ep}$) in the first period. D has a probability $(1-q)$ of losing power in the second period. Before the revelation of whether D loses power or not, he receives his income which is used for consumption. I assume that D consumes whether he loses power or not. q is endogenous to information flows. The probability of dictatorial survival decreases in i_p and

i_{ep}, but is unaffected by i_e.[4] That is $\frac{\partial q}{\partial i_p} < 0$, $\frac{\partial q}{\partial i_{ep}} < 0$ and $\frac{\partial q}{\partial i_e} = 0$. I model the relationship with the simple, linear function:

$$q = (1 - (\gamma i_p + \eta i_{ep})) \tag{8}$$

Here, $\gamma > 0$, $\eta > 0$ and $0 \leq \gamma i_p + \eta i_{ep} \leq 1$; the probability of survival varies between 1 when no political and mixed political-economic information is allowed, and 0, which results from a high level of political or mixed political-economic information flow.

If one inserts for Equations 7 and 8 in D's transformed utility function, $U(g_c, q)$, one obtains:

$$U(g_c, q) = U((1 - \alpha - \beta)\omega((i_e + i_{ep})A_t^*), (1 - (\gamma i_p + \eta i_{ep}))) \tag{9}$$

From Equation 9, one may see that D minimizes i_p and maximizes i_e: D cracks down on all information flows that are politically dangerous but irrelevant for economic efficiency, and opens up for information that improves economic efficiency but is irrelevant for political survival. This can be shown more stringently:

$$\frac{\partial U}{\partial i_p} = -\gamma \frac{\partial U}{\partial q} < 0 \tag{10}$$

$$\frac{\partial U}{\partial i_e} = \frac{\partial U}{\partial g_c} \cdot (1 - \alpha - \beta) A_t^* \omega'(A_t) > 0 \tag{11}$$

Equations 10 and 11 show it is always rational for the dictator to reduce i_p, as $\frac{\partial U}{\partial i_p} < 0$, and increase i_e, as $\frac{\partial U}{\partial i_e} > 0$. Thereby i_e and i_p will be set at their maximum and minimum levels respectively. The interesting trade-off in the model relates to i_{ep}. D on the one hand wants to allow i_{ep} because it increases efficiency and thus private consumption growth. But, on the other,

[4] One way to explicitly model the relationships between q and i_p and i_{ep} would be to assume an opposition consisting of several individuals, all desiring to overthrow D. The probability of overthrowing D, $(1-q)$, depends on opposition coordination. As collective action problems are solved and opposition-members coordinate, $(1 - q)$ increases. The ability of the opposition to coordinate depends on their ability to use communication tools, assemble without harassment or detention, gain access to media and travel freely. Therefore, restrictions on civil liberties that reduce, i_p and i_{ep}, reduce the opposition's ability to coordinate and thus $(1 - q)$.

he wants to restrict i_{ep} because it puts his political survival at risk. The first-order condition is given by:

$$\frac{\partial U}{\partial i_{ep}} = \frac{\partial U}{\partial g_c} \cdot (1 - \alpha - \beta) A_t^* \omega'(A_t) - \eta \frac{\partial U}{\partial q} = 0 \tag{12}$$

Hence, the dictator will set i_{ep}, so that:

$$\frac{\partial U}{\partial g_c} \cdot (1 - \alpha - \beta) A_t^* \omega'(A_t) = \eta \frac{\partial U}{\partial q} \tag{13}$$

Equation 13 shows that in optimum, the dictator will balance increase in marginal utility from consumption against the expected marginal utility-decrease from reduced survival probability, when setting i_{ep}. Hence, some i_{ep} will be restricted in dictatorships; restrictions on free and open exchange of information and debate will have effects not only in terms of stifling political opposition in dictatorships, but also in terms of reducing economic dynamism. The model thus indicates that dictatorships will experience slower technological change than democracies that protect civil liberties and have relatively free flows of information.[5]

4 Data

This study is based on data from more than 150 countries, and incorporates data from 1820 (for some countries) to 2003. I use the Polity Index (*PI*) from Polity IV as democracy measure. The PI ranges from -10 (most dictatorial) to 10 (most democratic). The index' dimensions are competitiveness and openness of executive recruitment, constraints on the chief executive, and competitiveness and regulation of political participation. I leave out country-years in interregnum-periods (Marshall and Jaggers 2002, 17), mainly periods of internal anarchy

[5]Several other propositions could be deduced from the model. For example, dictators ruling over economies with high capital shares or in periods with slow global technological change, and dictators with a weak hold on power or who expect reduced consumption after losing power will restrict civil liberties more harshly. Moreover, one may presume that dictatorships with higher bureaucratic capacity (b) are better able to design policies that enable separation of politically and economically relevant information; $i_{ep} = i_{ep}(b)$, where $i'_{ep}(b) < 0$. Thus, a positive effect of democracy on technological change should decrease in level of bureaucratic capacity.

or civil war. I also leave out country-years coded as "foreign interruption", mainly registering foreign occupation.

Data on GDP and population are collected from Maddison (2006), and these time series extend back to the early 19th century for some countries. Different sources and procedures have been used to estimate the population and GDP data (see Maddison 2006, 169-228). The GDP data are PPP-adjusted (US 1990$), and thus take into account local price levels. Several of the time series are interrupted in the Maddison data set. Hence, I include around 800 country-years where data on GDP per capita growth or level or population level is constructed by interpolation, assuming constant growth rates, in instances where at least 90% of the years missing between two observation-years have the same PI score. The average growth rates in the interpolated time periods are correct by construction, but the procedure introduces an additional source of measurement error among others for the dependent variable, GDP per capita growth. If this error is unsystematic, it will be more difficult to find significant regression coefficients, for example for the PI.

One widely used proxy for technological change is Total Factor Productivity (TFP) growth. TFP is calculated as a residual, where economic growth stemming from changes in physical capital, human capital and labor are subtracted from total growth (see e.g. Barro and Sala-i Martin 2004; Baier, Dwyer and Tamura 2002). I utilize the extensive TFP data from Baier, Dwyer and Tamura (2006), covering 145 countries, with 24 countries having time series longer than 100 years. The TFP data are estimated with uneven intervals, approximately averaging a data point every tenth year for most countries. The authors use data from multiple sources and calculate TFP using income per worker rather than per person. They assume Hicks-neutral technology and a capital share of $1/3$. I interpolate these time series, assuming constant TFP growth rates within periods.

There are several potential biases in TFP, especially when considered a measure for technological change but also as a measure for the narrower concept "technology-induced economic growth" (see e.g. Rodrik 1997; Verspagen 2005; Nelson 2005). Among others, TFP may underestimate technology-induced economic growth since investment likely increases when technology level increases. If so, technological change is a cause of capital accumulation, but growth will be assigned to capital accumulation in the growth accounting. Nevertheless, there is no obvious reason why such biases should critically influence the relationship between democracy and TFP growth.

Technological change and economic growth are not only functions of regime type. I therefore control for several variables in the regression models below. Because of probable convergence effects (e.g. Barro and Sala-i Martin 2004) from levels on posterior growth rates, *log TFP level* is controlled for in TFP growth regressions, and *log GDP per capita level* in GDP per capita growth regressions. I also control for *log population level* (POP), taken from the Maddison dataset. Population size may for example affect the degree of specialization in markets, and thus efficiency and productivity growth (e.g. Mokyr 1990; Romer 1990), and may enhance productivity through increased economies of scale in some sectors (e.g. Krugman 1979). Although democracy may enhance growth through stabilizing polities and institutions (Feng 1997, 2005), I control for political stability to be on the safe side: Political stability is systematically related to regime characteristics (see e.g. Gates et al. 2006), and may also affect economic growth (Alesina et al. 1996; Feng 1997, 2005). All regression models therefore include *log (regime duration + 1)*, based on data from the Polity IV data set. Furthermore, there could be negative economic effects from having a high degree of ethnic fractionalization (see e.g. Easterly and Levine 1997), and ethnic heterogeneity may impact on the design of political institutions (see e.g. Lijphart 1999). The *Ethnic Fractionalization Index* from Alesina et al. (2003), ranging from 0 to 1, is therefore entered as a control variable. Specific geographical factors, for example related to climate and soil-quality, may affect both growth and political institutions (e.g. Engerman and Sokoloff 1994). Cultural or political-historical aspects are also broadly related to geographic regions, and these may be important for political institutions and for economic outcomes (e.g. Hall and Jones 1999; Acemoglu, Johnson and Robinson 2001). I therefore enter geographic *region dummies* as control variables. I also add *decade dummies* to control for global trends affecting both degree of democracy and economic outcomes. Different periods of modern history have been associated both with varying global economic growth rates and technological innovation patterns (e.g. Maddison 2007) and varying patterns of democratization (Huntington 1991).

5 Empirical analysis

Below, I first investigate the effect of democracy on TFP growth. Thereafter, I turn to democracy's effect on GDP per capita growth.

5.1 Technological change

I employ country-year as the unit of analysis, and as baseline model I use Ordinary Least Squares with Panel Corrected Standard Errors (OLS PCSE) (see Beck and Katz 1995), which draws on information from both cross-country and within-country comparisons. OLS PCSE takes into account heterogeneous standard errors and contemporaneous correlation between panels, and AR(1) autocorrelation within panels. There is likely a lag in effect of regime type on TFP growth and GDP per capita growth (see e.g. Papaioannou and Siourounis 2008). I thus run regressions with 5-year lags on all independent variables as a baseline specification. This also reduces potential endogeneity problems related to growth rates influencing regime type.

The model in the leftmost column of Table 1 incorporates all the control variables discussed in Section 4. In order to check the results' robustness, I also run a second model that includes dummies for *identity of colonizer* and *plurality religion*.[6] According to both OLS PCSE models there is very good support for the hypothesis that dictatorship reduces TFP growth relative to democracy; the PI has the expected positive sign and is significant at the 1% level. The coefficients indicate an estimated effect of about 0.6 to 0.7 percent extra TFP growth per year when going from most dictatorial to most democratic. This is actually slightly higher than the productivity growth rate differential between the United States and the Soviet Union in the 1960s and 70s. When taking a long view, say 100 years, a country with a 0.7 percent higher TFP growth rate than another country would be *twice* as rich as the other at the end of the period if starting out equally rich and having similar patterns of capital accumulation and labor growth. If democracies in addition grow more because they enhance human capital accumulation (see e.g. Tavares and Wacziarg 2001; Baum and Lake 2003), democracies likely have a quite substantial growth advantage on dictatorships because of knowledge-related factors.

[6]Protestantism includes Anglicanism. Buddhism, Taoism and Confucianism are combined. For a closer description of how these dummies are coded, see Reference removed.

Despite the many control variables entered in the OLS with PCSE models, there may still be country-specific characteristics biasing the results. Political-historical and other trajectories may generate a systematic and positive correlation between democracy and economic performance (e.g. Acemoglu et al. 2008). Hence, I run fixed effects (FE) models to mitigate omitted variable bias. The FE results, also presented in Table 1, indicate that the results in the PCSE model were not driven by country-specific effects; the PI coefficient in the FE model has a t-value of 5.4, and the coefficient size is quite similar to those of the PCSE models.

[Table 1 about here.]

However, omitted variable bias is not the only possible source of bias for the estimated effect of democracy: The correlation between democracy and TFP growth may also result from democracy being endogenous to technological change, or factors that correlate with such change. Hence, the rightmost columns in Table 1 present panel data 2SLS models that can deal with the endogeneity of democracy.

I utilize two instruments for democracy, namely a 15-year lag of the PI (*PILAG*), as suggested by Helliwell (1994), and an instrument-dummy based on whether or not the last regime change a country experienced was within one of Huntington's (1991) "reverse waves of democratization", as suggested by Knutsen (2011). Hence, country-years where the reigning regime, according to the Polity IV data set, originated in the periods $\langle \leftarrow, 1827]$, $[1922, 1942]$, $[1958, 1975]$, $[1998, 2003]$ are scored a 1 on *WAVE*. There is little a priori reason to expect WAVE to violate the exclusion restriction, when conditioning on the other variables in the model like decade dummies and log regime duration. Whether a regime was adopted in one of Huntington's (reverse) waves or not taps exogenous influences on the probability of democratizing or sliding into dictatorship, like geopolitical factors and trends (like the allied victory in World War II) or transmission effects from neighboring countries (for a discussion, see Knutsen 2011). *PILAG* could be more problematic, as there may be effects of a country's democratic history on its economic performance (Gerring et al. 2005). Nevertheless, Knutsen (2011) found that the two instruments are strong predictors of democracy *and* satisfy the exclusion restriction when property rights protection is the dependent variable. Also the first stage regressions for the 2SLS models reported in Table 1 on TFP growth show that PILAG (t-values between 10 and 15) and particularly WAVE (t-values around -40) are strong instruments. However, overidentification tests indicate that the instruments do not satisfy the exclusion restriction with TFP growth as the dependent variable. The hypothesis stating that the instruments are uncorrelated with the error term and correctly excluded from the second stage equation is rejected at the 5% level. Hence, the instruments may be problematic in this particular model setting, and the 2SLS models may generate inconsistent results.

Still, I ran two different panel data 2SLS models, one random effects (RE) version and one FE version. As seen from Table 1, the PI coefficients are positive in both models, but they are not significantly different from zero. However, Hausman tests show that one cannot reject the hypothesis that the RE 2SLS result is significantly different from the result of a more efficient structurally similar RE model at conventional levels of significance. The latter model shows a positive and significant effect of democracy on TFP growth. But, the 2SLS results, despite the problems with the utilized instruments, should indicate some caution with concluding on a positive effect of democracy on TFP growth.

I conducted several tests to investigate the robustness of the positive effect of democracy reported above.[7] For example, the results were quite robust to substituting the 5-year lag with other lag specifications on the independent variables, although regressions using 2-year lags often yielded insignificant results. Moreover, the results were also relatively robust to controlling for other factors, such as absolute latitude and the Frankel-Romer trade index. The theoretical model in Section 3 indicated that dictators' survival probability, and thus regime duration, is endogenous to policies that impact on diffusion of technologies. I therefore ran models excluding log regime duration, but the results were very similar. I also conducted a more general sensitivity analysis, leaving out one independent variable or set of dummies at a time from the models reported in Table 1. If anything, the positive effect of democracy was even more marked in these regressions, for example indicated by some 2SLS models yielding significant effects.

However, the interpolation conducted above may be problematic, as it expands the number of data points and introduces additional measurement error. Therefore, I calculated average annual TFP growth rates between time-points where Baier, Dwyer and Tamura (2006) provide

[7] Tables with results from various robustness checks can be found at ADDRESS REMOVED.

TFP estimates. Some of these periods are as short as four years, and I include periods of up to twenty years. The large majority of periods are ten years in duration (581 of 795). One period counts as one observation. For the control variables I used values at the start of the time period, but I calculated the average of the PI over the five years prior to the period and all years within the period except the five latest years to account for the effect-lag on TFP growth. Also according to these regressions democracy enhances TFP growth. Independent of whether one controls for country-fixed effects or not, the effect is significant at least at the 5% level.

Finally, I utilized the newly developed imputation techniques incorporated in the AMELIA II software (see Honaker, King and Blackwell 2010) to further test the robustness of the above results. As noted by Honaker and King (2010) listwise deletion of cases that lack values on one or more variables in a regression may generate problematic results. In particular, there may be selection bias if characteristics that affect the probability of missing data are correlated with variables in the regression model. As Halperin, Siegle and Weinstein (2005) show, dictatorships more often lack data on a range of variables than democracies do, and there are indications that the economically worst-performing dictatorships in particular lack data. This could generate a negative bias for the estimated effect of democracy on growth, and imputation may hence be especially important in this subject area. Indeed, Honaker and King (2010) show that Baum and Lake's (2003) results on democracy's positive effect on human capital are substantially strengthened when imputation techniques are employed. Thus, although the data coverage for the analyses in this paper is more extensive than in previous empirical studies, imputation may be an important operation.

The imputation procedure generates predicted values for missing values based on algorithms taking into account the cross sectional – time series structure of the data. As Honaker and King (2010) note, one should include extra variables, in addition to those in the original regression, in the imputation model to increase predictive power. Besides the variables in the extensive PCSE model, I thus added log GDP per capita, GDP per capita growth, and a set of variables from Hall and Jones (1999), namely latitude, absolute latitude, the fraction of English speakers, the fraction speaking other major European languages and the (log) Frankel-Romer (exogenous trade) index. Since the TFP data, in contrast with the GDP data, lack observations in subsequent years for any country, I had to include the interpolated TFP data used in the analysis above as a basis for the imputation. The imputation models are computed using a second-order polynomial of time, and the time trends are interacted with the cross-section units in order to allow for country-specific trends (see Honaker, King and Blackwell 2010). I set the minimum and maximum values as bounds for restricted indexes such as the PI and ethnic fractionalization index, and values close to the empirically observed minimum and maximum for unrestricted variables such as log TFP and log GDP.

[Table 2 about here.]

I computed five different data sets from this imputation model, to check for robustness. I thereafter ran the various regressions on data samples restricted to covering only the country-years with an observed value on the PI, so to not generate estimates based on a data set for example including country-years for a country before it ever existed. Still, the regression models based on the imputed data sets include about twice as many observations as the models reported in Table 1 (12 230 for the 5-year lag PCSE and FE models).

The results based on the imputed data sets strongly reinforce the result that democracy significantly enhances TFP growth. Indeed, the results are generally stronger when incorporating the imputed data. Table 2 shows the results based on one of the five data sets, and the effect of democracy is significant at the 1% level not only in the PCSE and FE models, but also in the 2SLS models. Hence, according to these results, democracy enhances TFP growth even when taking into account country-fixed effects *and* the endogeneity of regime type. Similar results were also produced on the basis of the other four data sets: The effect of democracy is always significant at least at the 5% level in the FE and 2SLS models. Only one data set generates an insignificant result at the 10% level, and this result is based on the PCSE model including religion and colonizer dummies. The positive effect of democracy is generally also robust to other lag specifications on the independent variables.

To sum up, there is quite robust evidence for the hypothesis that democracy enhances TFP growth. Hence, the results above are seemingly in line with the main implication drawn from the theoretical model in Section 3. Since TFP growth is the most important source of long-term economic growth rates, there is also reason to expect that democracy enhances GDP per capita growth. I investigate this empirically below.

5.2 Economic growth

The empirical results in this section are based on very extensive data material, indeed the most extensive in the literature on democracy and economic growth. Some of the models draw on almost 9000 observations, which is for example about twice the number of observations in Przeworski et al. (2000). The number is increased further to around 12 000 observations in models based on imputed data sets. I utilize structurally similar models to those in Section 5.1, with an exception for the dependent variable and the substitution of log TFP with log GDP per capita as control variable.

As in Section 5.1, I first ran OLS PCSE models, which utilize both cross section and time series variation when estimating the effect of democracy. The results from these models are presented in the leftmost columns in Table 3. Both the baseline model and the model including religion and colonizer dummies show a positive and significant (1% level) effect of democracy on economic growth. The estimates indicate that a change in regime from least to most democratic increases annual GDP per capita growth with about 0.7 to 0.8 percentage points. Such a growth differential produces large disparities in income over the long run. To illustrate, in 1900 Argentina and Canada were about equally rich, with GDP per capita being close to 3000 US dollars (1990 prices). Over the next century, Canada grew with an average growth rate that was 0.9 percentage points higher than that of Argentina. In 2000, Canada's GDP per capita was more than 22 000 dollars, whereas Argentina's was about 8500 dollars.

However, as for the TFP growth regressions, there may be country-specific factors biasing the PCSE results, and this may be corrected by controlling for country-fixed effects. The FE model reported in Table 3 does not show a significant effect of democracy, although the estimated effect is positive. But, when I substitute the decade dummies with dummies that capture broader time period effects (1871-1913, 1914-1945, 1946-1972, 1973-2003), the FE results are also significant at the 1% level, and the estimated effect is larger than for the OLS PCSE models.

[Table 3 about here.]

I also investigated whether endogeneity of regime type might drive the results reported above. One way to investigate this is through simple Granger tests, and such tests indicate that the estimated positive effect of democracy is not due to endogeneity: Democracy in $t-1$ was estimated to have a positive, significant effect (1% level) on growth in t, even when controlling for growth in $t-1$. When democracy in t was entered as a function of democracy in $t-1$ and growth in $t-1$, the estimated effect of growth was actually negative and significant at the 5% level. Hence, one should actually expect that the models above underestimate the positive effect of democracy on growth.

To further investigate the effect of democracy on growth, taking into account the endogeneity of regime type, I ran panel data 2SLS models. As in the previous section on TFP growth, 15-year lagged PI values (PILAG) and the dummy based on whether the current regime change originated in one of Huntington's (1991) reverse waves of democratization or not (WAVE) were used as instruments for the PI. Also for the economic growth models, I conducted empirical tests to check the validity of the instruments, and these tests indicate that WAVE and PILAG are indeed valid instruments when economic growth is the dependent variable: The first-stage regressions indicate that WAVE and PILAG are strong instruments, with absolute t-values around 40 for WAVE and around 25 for PILAG. Moreover, overidentification tests indicate that also the exclusion restriction holds. The hypothesis stating that the instruments are uncorrelated with the error term and correctly excluded from the second stage equation cannot be rejected at the 10% level, neither in the RE 2SLS nor in the FE 2SLS model (the p-values are quite high, in the 0.3 to 0.5 range). In contrast with the TFP growth regressions above, there are good reasons to believe that the 2SLS models generate consistent estimates of democracy's effect on economic growth.

The rightmost columns in Table 3 show results for 2SLS models using 5-year lagged independent variables, and these results clearly indicate a positive effect of democracy on economic growth. Even in the restrictive FE 2SLS model, the effect of democracy on growth is significant at the 1% level. Thus, democracy is reported to increase growth rates, also when taking into account the endogeneity of democracy *and* the possibility of country-specific factors affecting regime type and growth. Indeed, the estimated effects are larger in the 2SLS models than in the OLS with PCSE models, indicating an effect of going from least to most democratic of about two percentage points extra annual GDP per capita growth.

I tested various time lags for the models applied above, and the results are quite robust to this operation although some models using 3-year lags find non-significant effects. Furthermore, I conducted a sensitivity analysis, sequentially leaving out one variable or set of dummies from the models in Table 3. The result was somewhat weakened for models excluding log GDP per capita as a control, with the PI only significant at the 10% level in the PCSE and RE 2SLS models. But, all other model specifications yielded quite similar or stronger results when compared to those reported in Table 3; for example, some of the FE models produced significant results. I also relaxed the assumption that democracy's effect on growth is linear: I estimated the average treatment effect (ATE) of democracy on growth with non-parametric, nearest neighbor matching. Replacement was allowed in the estimation procedure, and I used robust standard errors (see Abadie and Imbens 2002). The calculation of these standard errors are based on 1 match with relatively similar units having similar values on the treatment variable. The PI was dichotomized, and I tested two different cut-off points for democracy (≥ 0 and ≥ 4). I also tested different numbers of matches (one, three, five and ten closest matches). All the obtained democracy coefficients were positive and significant at the 5% level, and almost all were significant at the 1% level. The matching results indicate an even larger effect of democracy than the linear models; in some models the estimated ATE of democracy was higher than 2 percentage points extra GDP per capita growth.

[Table 4 about here.]

Finally, I ran the various models on the Amelia-imputed data sets to mitigate the selection bias problem discussed above. I used the five imputed data sets described in Section 5.1, and the results reported in Table 4 are based on the same data set used for the models reported in Table 2.[8] The results presented in Table 4 show a robust and substantially large positive

[8]In contrast with the TFP growth data, which had to be interpolated by necessity, the GDP per capita growth data used as dependent variable do not include any interpolated values, only actual and imputed values, although interpolated growth entered as a predictor in the imputation

effect of democracy on economic growth: The PI coefficient from the FE 2SLS model, which incorporates both country-fixed effects and the possible endogeneity of democracy, indicates that going from least to most democratic enhances annual growth rates by about 2 percentage points.

Generally, the results based on the imputed data sets are very strong for the PCSE and 2SLS models, with democracy having a significant effect *at least* at the 5% level in all models based on the different data sets. The results are also robust to the choice of different lag structures. The results vary more for the FE models; the five data sets generate one coefficient significant at the 5% level, one at the 10% level, and three insignificant coefficients. However, the FE results are stronger when for example 2-year lags are used rather than 5-year lags, and they are far stronger when the decade dummies are replaced with dummies for the longer time periods described above. Hence, the results from the imputed data sets seem to confirm the result above of a positive effect of democracy on economic growth.

Previous studies have shown that there is large variation in growth rates among democracies (e.g. Persson and Tabellini 2003) and especially among dictatorships (Rodrik 2000; Przeworski et al. 2000; Besley and Kudamatsu 2007). The effect of regime type on growth is likely contingent on other factors, such as the leader's personal characteristics, existence of alternative institutional or non-institutional checks on political elites, characteristics of the regime's core supporters, and type of security threat facing the regime (see e.g. Jones and Olken 2005; Wintrobe 1990; Olson 1993; Przeworski et al. 2000; Gandhi 2008; Bueno de Mesquita et al. 2003; Besley and Kudamatsu 2007; Acemoglu and Robinson 2006*a*). Nevertheless, the results reported here indicate that, in general, relatively democratic regimes tend to produce better economic performances than their more dictatorial counterparts. The very thorough meta-study conducted by Doucouliagos and Ulubasoglu (2008) shows that sample characteristics influence results on democracy and growth. To my knowledge, this study draws on the longest time series, and the largest number of observations, yet utilized in the literature. Additionally, some of the results above are based on quite stringent procedures of inference, taking into account both the endogeneity of regime type and country-fixed effects.

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model.

6 Conclusion

The empirical analysis conducted in this article indicates that democracy has a positive impact on economic growth. The results above reinforce the results in for example Baum and Lake (2003) and Doucouliagos and Ulubasoglu (2008), which have recently challenged the widely held "agnostic position" on democracy's effect on growth. These authors point out that increased human capital accumulation is among the main reasons why democracy enhances growth. However, the theoretical model presented above indicates an additional important reason: In dictatorships, technology diffusion is slowed down because dictators manipulate civil liberties and promote policies that inhibit idea diffusion. Although dictators in an optimal world may have wanted to promote technological change to increase personal consumption, they in practice restrict technological change as they are unable to perfectly separate politically dangerous from economic efficiency-enhancing information. Empirical results based on a very extensive data material corroborated this hypothesis; democracies likely produce higher TFP growth rates.

Dictatorship may increase savings rates, and thus enhance investment (Tavares and Wacziarg 2001; Przeworski and Limongi 1993). However, this probably only has a transitional effect on economic growth (Solow 1956; Barro and Sala-i Martin 2004), whereas more rapid technological change increases also long-term growth rates (Romer 1990; Barro and Sala-i Martin 2004). In the long run, therefore, democracies should prosper more than dictatorships, and the empirical results presented in this paper also indicate that they do: The above analysis presents solutions to the most pressing problems for empirical studies on the economic effects of democracy, namely omitted variable bias, the endogeneity of democracy and the missing data problem, and the results clearly indicate that democracy enhances economic growth.

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	PCSE		PCSE		FE		2SLS (RE)		2SLS (FE)	
	b	(t)	b	(t)	b	(t)	b	(t)	b	(t)
Polity	0.035***	(3.97)	0.029***	(3.42)	0.035***	(5.24)	0.018	(1.28)	0.004	(0.30)
Ln TFP	-2.378***	(-4.55)	-2.345***	(-4.45)	-4.017***	(-25.21)	-2.609***	(-16.60)	-3.288***	(-18.94)
Ln popul.	-0.140*	(-1.79)	-0.118	(-1.48)	-2.801***	(-19.09)	-0.836***	(-9.37)	-2.593***	(-16.70)
Ln reg. dur.	0.019	(0.69)	0.013	(0.49)	-0.147***	(-5.14)	-0.073**	(-2.34)	-0.110***	(-3.43)
Ethn. fract.	-1.044*	(-1.89)	-0.935*	(-1.80)			-1.726***	(-2.69)		
E.E.-Soviet	-2.839***	(-4.62)	-2.049***	(-4.03)			-1.696***	(-2.64)		
Africa	-2.504***	(-4.48)	-1.659**	(-2.47)			-3.975***	(-7.12)		
Asia	-1.685***	(-3.62)	-1.658**	(-2.11)			-1.818***	(-3.64)		
MENA	0.368	(0.85)	1.365*	(1.74)			-1.010*	(-1.88)		
Lat. Am.	-0.949**	(-2.02)	-1.726**	(-2.01)			-2.404***	(-5.16)		
British			0.154	(0.47)						
French			0.178	(0.70)						
Portuguese			-0.670	(-0.74)						
Spanish			0.418	(0.55)						
Belgian			-2.781**	(-2.35)						
Sunni			-0.486	(-0.50)						
Shia			-1.546	(-1.34)						
Catholic			1.067	(0.89)						
Protestant			0.456	(0.43)						
Orthodox			-1.380	(-1.27)						
Hindu			-0.123	(-0.11)						
Buddhist+			0.637	(0.59)						
Indigenous			-0.963	(-0.88)						
1830s	-0.613	(-0.97)	-0.768	(-1.22)	-5.036***	(-4.05)	-2.035*	(-1.66)	-4.887***	(-3.92)
1840s	-0.662	(-1.22)	-0.842	(-1.56)	-4.945***	(-7.61)	-1.997***	(-3.11)	-4.819***	(-7.13)
1850s	-0.673	(-1.30)	-0.852*	(-1.65)	-5.565***	(-13.90)	-2.388***	(-6.09)	-5.319***	(-11.85)
1860s	-0.641	(-1.32)	-0.809*	(-1.67)	-5.195***	(-14.87)	-2.160***	(-6.07)	-4.932***	(-12.00)
1870s	-0.429	(-0.91)	-0.575	(-1.23)	-5.281***	(-15.84)	-2.045***	(-6.43)	-4.919***	(-12.89)
1880s	-0.228	(-0.49)	-0.370	(-0.80)	-4.668***	(-15.10)	-1.688***	(-5.91)	-4.374***	(-12.62)
1890s	-0.037	(-0.08)	-0.171	(-0.38)	-4.370***	(-15.36)	-1.556***	(-6.10)	-4.074***	(-12.97)
1900s	0.112	(0.25)	0.007	(0.02)	-4.206***	(-15.74)	-1.699***	(-7.20)	-4.036***	(-13.88)
1910s	0.234	(0.54)	0.162	(0.38)	-4.039***	(-16.24)	-1.561***	(-7.19)	-3.690***	(-13.83)
1920s	0.435	(1.03)	0.365	(0.87)	-3.014***	(-13.08)	-0.713***	(-3.41)	-2.707***	(-10.62)
1930s	0.581	(1.48)	0.508	(1.29)	-2.551***	(-12.10)	-0.568***	(-2.90)	-2.307***	(-9.86)
1940s	0.913**	(2.47)	0.858**	(2.30)	-1.330***	(-6.60)	0.369*	(1.93)	-1.240***	(-5.50)
1950s	1.096***	(3.26)	1.068***	(3.11)	-0.045	(-0.27)	1.348***	(8.35)	0.040	(0.21)
1960s	1.001***	(3.39)	0.995***	(3.25)	0.793***	(5.86)	1.539***	(10.95)	0.631***	(4.04)
1970s	0.630***	(2.62)	0.614**	(2.51)	0.269**	(2.25)	0.327**	(2.47)	-0.156	(-1.12)
1980s	0.310*	(1.76)	0.290	(1.64)	-0.011	(-0.10)	-0.040	(-0.35)	-0.212*	(-1.88)
Constant	13.543***	(5.09)	12.568***	(4.12)	46.569***	(25.52)	22.443***	(16.37)	41.538***	(20.98)
N	6636		6636		6636		5628		5699	

Table 1: Results from OLS PCSE, FE and panel data 2SLS models with 5-year lags on independent variables and TFP growth as dependent variable. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

	PCSE		PCSE		FE		2SLS (RE)		2SLS (FE)	
	b	(t)	b	(t)	b	(t)	b	(t)	b	(t)
Polity	0.022***	(3.75)	0.019***	(3.09)	0.024***	(4.43)	0.035***	(2.86)	0.037***	(2.78)
Ln TFP	-0.049	(-1.42)	-0.051	(-1.47)	0.041	(0.86)	0.073	(1.47)	0.047	(0.94)
Ln popul.	0.040*	(1.73)	0.037	(1.58)	-0.021	(-0.53)	-0.070*	(-1.91)	-0.095**	(-2.09)
Ln reg. dur.	0.043*	(1.74)	0.050**	(2.03)	0.032	(1.43)	0.048**	(2.02)	0.039	(1.59)
Ethn. fract.	-1.585***	(-9.47)	-1.007***	(-5.49)			-1.942***	(-5.52)		
E.E.-Soviet	0.079	(0.56)	0.197	(1.18)			-0.319	(-1.00)		
Africa	-0.261	(-1.47)	0.224	(0.98)			-0.081	(-0.24)		
Asia	-0.356***	(-2.65)	-0.171	(-0.55)			0.104	(0.33)		
MENA	-0.671***	(-4.42)	0.336	(1.24)			-0.639*	(-1.81)		
Lat. Am.	0.001	(0.01)	-0.737***	(-2.74)			-0.178	(-0.59)		
British			0.390***	(2.58)						
French			0.617***	(3.58)						
Portuguese			0.196	(0.62)						
Spanish			0.359	(1.34)						
Belgian			-1.685***	(-3.33)						
Sunni			-1.078	(-1.25)						
Shia			-1.753**	(-2.01)						
Catholic			0.274	(0.31)						
Protestant			-0.216	(-0.24)						
Orthodox			-0.167	(-0.18)						
Hindu			-0.777	(-0.86)						
Buddhist+			0.019	(0.02)						
Indigenous			-1.828**	(-2.02)						
1820s	1.471***	(6.52)	1.587***	(7.12)	1.725***	(8.64)				
1830s	1.423***	(7.04)	1.527***	(7.64)	1.561***	(8.57)	1.798***	(6.53)	1.683***	(5.85)
1840s	1.211***	(6.34)	1.303***	(6.89)	1.345***	(7.84)	1.461***	(6.98)	1.354***	(6.06)
1850s	1.121***	(6.02)	1.233***	(6.69)	1.264***	(7.58)	1.326***	(6.75)	1.222***	(5.81)
1860s	1.025***	(5.59)	1.146***	(6.32)	1.090***	(6.80)	1.168***	(6.28)	1.067***	(5.37)
1870s	1.173***	(6.52)	1.294***	(7.27)	1.316***	(8.39)	1.404***	(7.88)	1.301***	(6.82)
1880s	1.256***	(7.03)	1.370***	(7.75)	1.320***	(8.66)	1.332***	(7.81)	1.235***	(6.81)
1890s	1.020***	(5.71)	1.127***	(6.38)	1.108***	(7.34)	1.190***	(7.13)	1.096***	(6.21)
1900s	0.843***	(4.77)	0.955***	(5.46)	1.014***	(6.82)	1.057***	(6.52)	0.962***	(5.60)
1910s	0.738***	(4.19)	0.842***	(4.82)	0.760***	(5.19)	0.833***	(5.39)	0.736***	(4.53)
1920s	0.774***	(4.61)	0.891***	(5.34)	1.077***	(7.99)	1.178***	(8.39)	1.083***	(7.33)
1930s	0.724***	(4.31)	0.827***	(4.96)	1.019***	(7.61)	1.072***	(7.32)	0.981***	(6.34)
1940s	1.199***	(7.02)	1.314***	(7.78)	1.694***	(12.51)	1.804***	(12.23)	1.729***	(11.15)
1950s	1.561***	(9.65)	1.675***	(10.47)	2.116***	(17.07)	2.204***	(16.86)	2.122***	(15.50)
1960s	1.227***	(8.13)	1.299***	(8.78)	1.729***	(15.77)	1.802***	(15.52)	1.739***	(14.38)
1970s	0.167	(1.15)	0.181	(1.27)	0.400***	(3.82)	0.488***	(4.23)	0.430***	(3.61)
1980s	-0.149	(-1.14)	-0.147	(-1.14)	-0.154	(-1.51)	-0.071	(-0.66)	-0.123	(-1.12)
Constant	-0.226	(-0.71)	-0.460	(-0.49)	-1.099**	(-2.39)	-0.061	(-0.12)	-0.466	(-0.90)
N	12 236		12 236		12 236		11 184		11 184	

Table 2: Results based on an imputed data set: OLS PCSE, FE and panel data 2SLS models with 5-year lags and TFP growth as dependent variable. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

	PCSE		PCSE		FE		2SLS (RE)		2SLS (FE)	
	b	t	b	t	b	t	b	t	b	t
Polity	0.038***	(2.83)	0.036***	(2.65)	0.020	(1.33)	0.080***	(2.69)	0.105***	(2.90)
Ln GDP pc	-0.390*	(-1.76)	-0.631***	(-2.67)	-3.054***	(-12.85)	-1.136***	(-5.51)	-3.249***	(-11.29)
Ln popul.	0.012	(0.21)	-0.005	(-0.09)	-1.608***	(-6.21)	-0.272***	(-2.81)	-1.757***	(-5.97)
Ln reg. dur.	-0.064	(-1.01)	-0.038	(-0.62)	-0.012	(-0.19)	-0.002	(-0.03)	0.067	(0.91)
Ethn. fract.	-1.000***	(-2.71)	-0.604	(-1.63)			-1.414**	(-2.27)		
E.E.-Soviet	0.275	(0.73)	0.289	(0.78)			-0.146	(-0.22)		
Africa	-1.587***	(-3.16)	-1.720***	(-2.94)			-2.548***	(-3.68)		
Asia	-0.119	(-0.28)	-1.430*	(-1.70)			-0.238	(-0.41)		
MENA	-0.090	(-0.22)	0.570	(1.01)			-0.253	(-0.40)		
Lat. Am.	-0.558*	(-1.94)	-2.429***	(-4.24)			-1.332***	(-2.67)		
British			0.210	(0.78)						
French			-0.550*	(-1.73)						
Portuguese			1.174**	(2.19)						
Spanish			1.591***	(2.88)						
Belgian			-0.030	(-0.03)						
Sunni			-0.942	(-1.53)						
Shia			-3.046***	(-3.12)						
Catholic			-0.279	(-0.34)						
Protestant			-0.529	(-0.70)						
Orthodox			-0.942	(-1.05)						
Hindu			-0.395	(-0.44)						
Buddhist+			1.238	(1.44)						
Indigenous			-1.667**	(-2.46)						
1820s	-2.282**	(-2.28)	-2.759***	(-2.70)	-12.158***	(-11.22)				
1830s	-1.862*	(-1.91)	-2.334**	(-2.34)	-11.270***	(-10.98)	-2.763**	(-2.44)	-9.871***	(-7.25)
1840s	-1.586	(-1.64)	-2.012**	(-2.04)	-10.241***	(-10.28)	-2.713***	(-3.29)	-9.531***	(-8.60)
1850s	-1.408	(-1.61)	-1.855**	(-2.07)	-9.722***	(-10.98)	-2.779***	(-3.85)	-9.103***	(-9.14)
1860s	-1.260	(-1.57)	-1.732**	(-2.10)	-9.234***	(-11.27)	-2.586***	(-3.94)	-8.623***	(-9.38)
1870s	-1.803**	(-2.45)	-2.252***	(-2.99)	-9.051***	(-12.23)	-2.816***	(-4.88)	-8.506***	(-10.13)
1880s	-1.940***	(-2.64)	-2.370***	(-3.17)	-8.700***	(-12.33)	-2.905***	(-5.40)	-8.263***	(-10.61)
1890s	-1.139	(-1.57)	-1.542**	(-2.09)	-7.598***	(-11.31)	-2.163***	(-4.25)	-7.300***	(-9.93)
1900s	-1.540**	(-2.12)	-1.903***	(-2.59)	-7.498***	(-11.87)	-2.407***	(-4.99)	-7.234***	(-10.46)
1910s	-0.924	(-1.27)	-1.274*	(-1.73)	-6.673***	(-11.07)	-1.978***	(-4.18)	-6.434***	(-9.81)
1920s	-1.643**	(-2.34)	-1.987***	(-2.80)	-6.668***	(-12.42)	-2.398***	(-5.67)	-6.406***	(-10.70)
1930s	-1.006	(-1.47)	-1.336*	(-1.92)	-5.657***	(-11.14)	-1.790***	(-4.38)	-5.393***	(-9.52)
1940s	0.271	(0.41)	-0.028	(-0.04)	-3.820***	(-7.98)	-0.302	(-0.77)	-3.448***	(-6.53)
1950s	0.385	(0.70)	0.222	(0.40)	-2.762***	(-7.04)	0.289	(0.84)	-2.229***	(-4.98)
1960s	0.718	(1.56)	0.705	(1.53)	-0.944***	(-3.05)	0.997***	(3.30)	-0.628*	(-1.70)
1970s	-0.830*	(-1.85)	-0.833*	(-1.85)	-1.840***	(-7.02)	-0.671**	(-2.40)	-1.263***	(-3.97)
1980s	-1.653***	(-3.74)	-1.680***	(-3.80)	-2.018***	(-8.55)	-1.372***	(-5.55)	-1.626***	(-6.25)
Constant	6.149***	(3.10)	8.807***	(4.00)	43.543***	(12.90)	15.262***	(7.25)	46.359***	(11.92)
N	8822		8822		8956		7243		7341	

Table 3: Results from OLS PCSE, FE and panel data 2SLS models with 5-year lags and GDP per capita growth as dependent variable. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

	PCSE		PCSE		FE		2SLS (RE)		2SLS (FE)	
	b	(t)	b	(t)	b	(t)	b	(t)	b	(t)
Polity	0.036***	(3.39)	0.034***	(3.04)	0.022*	(1.78)	0.094***	(3.73)	0.099***	(3.18)
Ln GDP pc	-0.221**	(-2.07)	-0.325***	(-2.92)	-0.707***	(-6.07)	-0.697***	(-5.56)	-1.027***	(-7.21)
Ln popul.	-0.030	(-0.69)	-0.044	(-0.96)	-0.177**	(-2.07)	-0.203***	(-3.27)	-0.203**	(-2.00)
Ln reg. dur.	-0.047	(-0.99)	-0.029	(-0.60)	-0.039	(-0.78)	0.008	(0.15)	0.033	(0.57)
Ethn. fract.	-1.108***	(-3.96)	-0.893***	(-3.00)			-1.538***	(-3.32)		
E.E.-Soviet	0.142	(0.57)	0.120	(0.41)			0.685	(1.56)		
Africa	-1.103***	(-3.42)	-0.933**	(-2.23)			-1.437***	(-2.95)		
Asia	0.006	(0.02)	-0.900	(-1.63)			0.479	(1.13)		
MENA	0.236	(0.92)	0.640	(1.50)			0.494	(1.01)		
Lat. Am.	-0.203	(-1.13)	-1.306***	(-2.82)			-0.415	(-1.11)		
British			0.107	(0.46)						
French			-0.591**	(-2.27)						
Portuguese			0.523	(0.94)						
Spanish			0.899*	(1.95)						
Belgian			-0.241	(-0.22)						
Sunni			-0.680	(-1.08)						
Shia			-1.760**	(-2.08)						
Catholic			-0.292	(-0.40)						
Protestant			-0.637	(-0.89)						
Orthodox			-0.625	(-0.81)						
Hindu			-0.138	(-0.19)						
Buddhist+			0.830	(1.11)						
Indigenous			-1.333*	(-1.85)						
1820s	-2.088***	(-4.81)	-2.260***	(-5.14)	-3.393***	(-6.97)				
1830s	-1.689***	(-4.19)	-1.881***	(-4.60)	-3.122***	(-6.96)	-2.615***	(-4.40)	-3.120***	(-4.77)
1840s	-1.424***	(-3.65)	-1.611***	(-4.07)	-2.667***	(-6.33)	-2.021***	(-4.50)	-2.487***	(-4.83)
1850s	-1.534***	(-4.08)	-1.720***	(-4.51)	-2.805***	(-6.88)	-2.176***	(-5.16)	-2.602***	(-5.37)
1860s	-0.976***	(-2.68)	-1.160***	(-3.14)	-2.150***	(-5.52)	-1.604***	(-4.03)	-1.997***	(-4.36)
1870s	-1.315***	(-3.71)	-1.481***	(-4.12)	-2.430***	(-6.45)	-1.959***	(-5.14)	-2.312***	(-5.28)
1880s	-0.891**	(-2.56)	-1.038***	(-2.95)	-1.867***	(-5.15)	-1.505***	(-4.10)	-1.813***	(-4.35)
1890s	-1.015***	(-2.95)	-1.160***	(-3.33)	-1.952***	(-5.50)	-1.577***	(-4.37)	-1.859***	(-4.59)
1900s	-1.079***	(-3.19)	-1.195***	(-3.50)	-1.883***	(-5.44)	-1.603***	(-4.58)	-1.851***	(-4.71)
1910s	-0.979***	(-2.91)	-1.114***	(-3.28)	-1.759***	(-5.20)	-1.431***	(-4.24)	-1.650***	(-4.42)
1920s	-1.325***	(-4.12)	-1.428***	(-4.39)	-2.056***	(-6.60)	-1.963***	(-6.36)	-2.144***	(-6.29)
1930s	-1.168***	(-3.64)	-1.269***	(-3.92)	-1.862***	(-6.09)	-1.593***	(-5.16)	-1.737***	(-5.01)
1940s	0.495	(1.51)	0.412	(1.25)	-0.171	(-0.56)	0.069	(0.22)	-0.022	(-0.06)
1950s	0.473	(1.56)	0.393	(1.29)	0.000	(0.00)	0.214	(0.77)	0.115	(0.37)
1960s	0.799***	(2.89)	0.791***	(2.86)	0.809***	(3.35)	0.951***	(3.87)	0.972***	(3.63)
1970s	-0.814***	(-3.03)	-0.842***	(-3.14)	-1.015***	(-4.43)	-0.795***	(-3.22)	-0.718***	(-2.69)
1980s	-1.671***	(-6.42)	-1.697***	(-6.52)	-1.724***	(-7.74)	-1.581***	(-6.69)	-1.488***	(-6.03)
Constant	4.930***	(4.86)	6.387***	(5.07)	9.871***	(7.88)	10.502***	(8.27)	12.264***	(8.34)
N	12 236		12 236		12 236		11 184		11 184	

Table 4: Results based on an imputed data set: OLS PCSE, FE and panel data 2SLS models with 5-year lags and GDP per capita growth as dependent variable. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$