INCOME, EDUCATION AND DEMOCRACY*

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Abstract

This paper puts forth a unified theory of growth and polity in which economic development affects a country's polity and polity affects its development. Education crucially impacts both trajectories, first by moving resources out of the traditional sector and decreasing incomes of the landed class and second, by increasing the *de facto* power of the masses. An autocrat aligned with the landed class will try to retard education of its citizens but eventually will relinquish power when the transfers needed to prevent the masses from revolting become too large. At this point society democratizes and the economy's growth path is determined by the median voter. The model is calibrated to the economic and political histories of Britain from 1200-2000 and used to quantify the role of education, land inequality, constraints on the executive, and school curricula for the timing of modernization and democratization. The effects of these factors are found to be large, on the order of centuries. The paper also contributes to the empirical literature by showing that support for the *modernization hypothesis* based on System General Method of Moments estimation is more robust than previous research suggests and by showing that only primary education predicts democracy in this estimation method. *JEL* Codes: D72, O41, O47, P16, Q15.

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I. Introduction

> "As centuries of dictators have known, an illiterate crowd is the easiest to rule; since the craft of reading cannot be untaught once it has been acquired, the second-best recourse is to limit its scope."
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> — Manguel (1996, p. 319).

This paper puts forth a unified theory of growth and polity that allows economic development to affect a country's polity and polity to affect a country's economic development. In this theory, education is crucial for the evolution of both variables. Education is pivotal for economic development by causing a rise in living standards and a decline in both the size of the land-dependent traditional sector and the incomes of the landed class. It is also pivotal for a country's political development by giving the masses *de facto* power and thereby raising the cost of maintaining power to an autocratic regime aligned with the landed class. An autocracy will try to retard the education of it citizens but once the *de facto* power of the masses becomes too great and land rents too low it relinquishes power. At this point society democratizes and policies that favor the masses dictate the economy's subsequent growth path.

We illustrate our theory in a model that combines elements from work on unified growth and political economy. The growth component of our theory is based on Hansen and Prescott (2002) but altered so as to include an education sector where households acquire the skills needed to work in the modern sector. Exogenous increases in total factor productivity (TFP) of the modern technology eventually give some workers enough incentive to go to school, at which time the modern sector takes off at the expense of the traditional one. The political component is based on the game-theoretical model of Acemoglu and Robinson (2006) but altered so as to allow education to affect the probability that a revolt against the regime succeeds. As such, a more educated citizenry increases the transfers that the ruling party must make to deter workers from revolting, making it more likely that the autocratic regime cedes power.

By adding the growth element, the payoffs to the political game of Acemoglu and Robinson (2006) change over time on account of changes in the income distribution. In particular, as the importance of the traditional sector decreases, the gap in income between the landed class and the worker class decreases, facilitating the transition to democracy for two reasons. First, the decrease in land rents makes it more difficult for the autocratic regime to pay the transfers necessary to deter revolt. Second, the landed class has less to lose under democracy as there is a smaller difference in the income gap relative to the median voter. These distributive effects are at work independently of any change in the *de facto* power of the masses, meaning that education undermines the autocracy on multiple levels.

To assess the plausibility of our theory, we calibrate the model to replicate Britain's economic and political paths. Using historical estimates of the population, landed elite and land acreage, we assign growth rates of TFP in the traditional and modern technologies to match literacy rates and living standards over the 1200-2000 period. We then consider how various factors impact the date at which the economy modernizes and the date at which it democratizes. There are a number of important lessons to take away from these exercises. First, our theory suggest a large quantitative role for education in the timing of democracy through its effect on the *de facto* power of the masses. Sans this effect, democracy in Britain would have been delayed for nearly a century. Second, it suggests that income only affects democracy when growth is fueled by modernization rather than by traditional sectors. Third, it shows how greater land equality hastens democratization and provides a theoretical justification for the primogeniture system as a way by which the landed class could maintain political control for centuries. Fourth it suggests that democratization is more likely to be delayed when autocrats are either extremely weak or extremely strong in their ability to block modernization. Fifth, it justifies the attempts by some autocratic regimes to use non-secular or nationalistic curricula that are antithetical to the principles of democracy so as to create a more obedient population and delay democratization up to a century.

It is obvious from our choice of theory that we subscribe to the *modernization hypothesis* rather than the *critical junctures hypothesis*. Proponents of the modernization hypothesis, also known as the Lipset/Aristotle hypothesis, argue that higher income and modernization bring about democratization whereas advocates of critical junctures argue that some third, unspecified factor that may exist at only one point in time, jointly determines a country's income and polity trajectories. The empirical literature has gone back and forth on which of these two hypothesis is more plausible, sowing much confusion. Following the seminal paper of Lipset (1959), a large body or work favors the modernization hypothesis, by showing that income and/or education are conducive to democracy.[1] In a series of influential papers, however, Acemoglu, Johnson, Robinson, and Yared (2005, 2008) show that once time and country fixed effects are added to the regressions the positive correlations between education and democracy and income and democracy vanish, which they interpret as evidence in favor of critical junctures. In the last decade, however, their findings have been subjected to substantial scrutiny by Bobba and Coviello (2007), Heid, Langer, and Larch (2012), and Benhabib, Corvalan, and Spiegel (2013) for methodological reasons and by Cervellati, Jung, Sunde, and Vischer (2014) for not considering the possibility of heterogeneous effects across former colonies and non-colonies. Whereas the

[1]Key contributions in this vast literature include Huntington (1991), Barro (1999), Boix and Stokes (2003), Glaeser, La Porta, Lopez-de Silanes, and Shleifer (2004), Glaeser, Ponzetto, and Shleifer (2007), Castelló-Climent (2008), Papaioannou and Siourounis (2008a, 2008b), Murtin and Wacziarg (2014) and Treisman (2015).

issue may never be fully settled, it is fair to say that today the modernization hypothesis has again assumed center stage.

Although the main contribution of this paper is theoretical in nature, it does contribute to the empirical debate in a number of ways. In particular, it replicates the main finding of this literature with the specific goal of showing how the modernization and critical junctures debate has been shaped by the choice of econometric strategy. In doing so, it strengthens the findings of Bobba and Coviello (2007) that education predicts democracy, first, by showing that one does not need to add additional controls in the System General Method of Moments (SGMM) beyond the two key tenets of the modernization hypothesis, namely income and education, to recover the positive relation between education and democracy, and second, by delivering plausible p-values in the test of over identifying restrictions when further controls are included. Additionally, it shows that only primary education predicts democracy in the SGMM.

Whereas the idea that income and education are conducive to democracy has received much attention in the literature, the idea that education affects the *de facto* power of the masses is novel. Evidence from distinct strands of literature, however, suggests that education is likely to have this effect. First, education makes it more likely that individuals learn and understand the benefits of democratic rule. At a fundamental level, literacy rates are clearly crucial for the dissemination of democratic ideas, but evidence also suggests that more educated individuals are more pro-democratic. For example, using data from the World Values Survey, Chong and Gradstein (2015) show that preferences for democracy are positively correlated with levels of education after controlling for a range of personal characteristics. Second, education is positively correlated with social participation as documented by Glaeser and Sacerdote (2008) and Glaeser et al. (2007). The same holds true for political participation as shown in numerous papers.[2] Putnam (1995, p. 68), in fact, labels education as the "best individual predictor of political participation". Third, educated workers are more likely to take to the streets in protest. Campante and Chor (2012) argue that the Arab Spring was preceded by substantial increases in average levels of schooling, which, accompanied by limited job opportunities, spurred protests against the dictators in power. Although revolt is not an equilibrium outcome of our model, our mechanism is similar in spirit in suggesting that educated workers hold their leaders to a higher standard and may thus be perceived as threatening to the regime.

Conceptually, we imagine the average level of education affecting society's stock of *democratic capital*.[3] In the model, we specifically assume that the current stock is a function of past education decisions, with the

[2] See Campante and Chor (2012) for such a review.

[3] The term was coined by Persson and Tabellini (2009) ,who think of democratic capital as comprising civic and social assets conducive to democracy and stemming from the country's own history and the democratic experience of neighboring countries.

idea that each generation passes this knowledge on to the next. This assumption, which greatly simplifies the game theoretical structure, is supported by earlier work and data. For example, Davies (1965) argues that political views are primarily shaped by the parents, at home. Jennings, Stoker, and Bowers (2009) use data from four waves of surveys over the period 1965-1997 to assess the persistence of political views across generations and find that children are indeed likely to adopt their parents' political views, in particular if the parents are highly politicized. In addition, our novel empirical finding regarding primary education is consistent with this view that early life experiences are conducive to democratization.

To the best of our knowledge, our paper is the first to consider the effect of education on polity through social participation within a unified growth framework. There are several papers that model the effect of education on social participation, but do not allow for the simultaneous determination of growth and polity as we do. For example, Glaeser et al. (2007) model the decision of households to participate in society and show that education may serve as a catalyst for revolt against authoritarian rule and Campante and Chor (2012), in an unpublished appendix provide a simple model to study the effect of initial conditions on the education choices of the autocrat. Bourguignon and Verdier (2000) do allow education to effect social participation and allow growth and polity to affect each, but do not do so within the context of a unified growth model. The economic side of their model is rather stark, and so does not deliver a rich set of trajectories for growth and polity. Moreover, the elite in their model consists of the country's educated citizenry who face a trade-off in determining how many people to educate on account of an externality in the spirit of Lucas (1988) that increases their income. This is very different than our model where education threatens the elites and implies that income concessions may be required if the autocrat wishes to stay in power.

A number of other papers in addition to Bourguignon and Verdier (2000) likewise have political elites make concessions to the masses, not because they are implicitly forced to, but because they choose to. For the most part, these other papers attempt to understand the emergence of public education systems and not the emergence of democracy. For example, Galor and Moav (2006) suggest that elites will eventually implement a public education system once the economy industrializes and they have accumulated sufficient physical capital on account of a capital-skill complementarity that raises the demand for skilled workers. Ashraf, Cinnirella, Galor, Gershman, and Hornung (2018) argue that this increased demand for skilled labor may even have fostered labor emancipation. In the wake of industrialization, protecting worker rights encouraged workers to acquire skills, thereby boosting elite income by raising the returns to capital. Two papers that endogenize the supply side of education in unified growth models are Boucekkine, de la Croix, and Peeters

(2007) and Galor, Moav, and Vollrath (2009). In Boucekkine et al. (2007), a rise in population density leads to the creation of skills whereas in Galor et al. (2009), the elite eventually choose to create a public education system. In contrast, whereas our model assumes the education technology is available from the onset, it endogenizes the political regime.

Our paper is clearly related to the literature on unified growth, comprising the pioneering contributions by Goodfriend and McDermott (1995), Galor and Weil (2000) and Galor and Moav (2002). With the exception of Seim and Parente (2013) and Huang (2012), none of the papers in this literature allows for growth to affect polity. Seim and Parente (2013) is very similar to our paper in using the Hansen and Prescott (2002) model, but focuses on heterogeneity in autocratic types and not education. Huang (2012) models the joint evolution of income and polity but lets relative income, rather than education determine the probability of the autocrat holding on to power.

The rest of the paper is organized as follows. Section II revisits the empirical literature on income, education and democracy. The economic structure of the unified growth model is presented in Section III. Section IV introduces the sequential game between the ruling autocrat and workers. The model is solved in Sections IV.C and V. The calibration and the results from numerical experiments using the calibrated structure are presented in Section VI. Section VII concludes.

II. The Empirics of Income, Education and Democracy

This section replicates the empirical analysis of some of the key papers that have examined the relation between income, education and democracy with the specific goal of showing how the modernization and critical junctures hypotheses debate has been shaped by the choice of econometric strategy. In addition to providing perspective to this debate, this section makes two important contributions. First, it strengthens the findings of Bobba and Coviello (2007) by showing that one does not need to add additional controls to the System GMM to recover the correlation between education and democracy when controlling for income, and by placing restrictions on the number of used instruments so that it delivers plausible p-values in the test of over identifying restrictions. Second it uses the System GMM framework to examine whether some forms of education are more important for predicting democracy, finding that only primary education matters in this regard.

II.A Econometric Model

We start our discussion with the basic econometric model studied by Acemoglu et al. (2005, 2008), namely,

$$d_{it} = \beta_1 d_{it-1} + \beta_2 e_{it-1} + \beta_3 y_{it-1} + \zeta X_{it-1} + \lambda_i + \lambda_t + \varepsilon_{it}, \tag{1}$$

where d_{it} denotes the Freedom House democratic index normalized to a range between 0 and 1 in country i at time t; e_{it-1} is lagged years of schooling, measured as the total average years of schooling of the population aged 25 and over; y_{it-1} is the lagged log real GDP per capita, and X_{it-1} are additional controls, namely log population and variables that reflect the age structure. The country and time fixed effects are denoted by λ_i and λ_t, and the error term is denoted by ε_{it}. The coefficient of main interest in this discussion is β_2 as it reflects the association between education and democracy after controlling for income.[4]

Four main approaches have been used to estimate (1): Pooled OLS, Fixed Effects, Difference GMM, and System GMM.[5] Pooled OLS is a natural approach, but is importantly limited because it exploits the *between* variation, and therefore not in line with the main tenant of the modernization hypothesis. Fixed Effects (FE) is much more appropriate as a test of the modernization hypothesis as it exploits *within* variation. The "Difference" GMM estimator of Arellano and Bond (1991) (DGMM) and the "System" GMM estimator of Blundell and Bond (1998) (SGMM) address the endogeneity issues that arise from the inclusion of the lagged dependent variable in the regression, something that the FE does not do. The DGMM and SGMM differ importantly in that the former uses lagged levels of d_{it} as valid instruments for differences $\Delta d_{it} = d_{it} - d_{it-1}$ whereas the latter uses differences, Δd_{it}, as further instruments for equations in levels d_{it} after relaxing the assumption of strict exogeneity of the independent variables. Therefore, with highly persistent data, the additional moment conditions in the SGMM bring levels as informative in cases when first differences are weak instruments. In practice, the SGMM does not depend on assuming that additional regressors are strictly exogenous, which is particularly important with high persistence covariates, such as education and income. In contrast, with the DGMM one needs to assume strict exogeneity, which is highly almost surely inappropriate due to education being highly persistent, implying a close projection from lagged values to

[4] We use the 5-year unbalanced panel from 1960 to 2000 employed by Acemoglu et al. (2008), unless otherwise stated. (For the details of the data sources, we refer the reader to their appendix.)

[5] A relevant paper in this debate that does not fit into his classification scheme is Benhabib et al. (2013) who argue that the linear model approach of Acemoglu et al. (2005, 2008) is not a good empirical approximation in the case of censored and bimodal data. Another relevant paper that is not discussed but that does fit into this classification scheme is Cervellati et al. (2014) who include a time invariant country specific feature that reflects whether the country is a former colony or not.

current ones.

Pooled OLS generates results in support of the modernization hypothesis. Acemoglu et al. (2005) use FE to challenge this finding and show that the correlation between education and democracy vanishes once fixed effects are included. In a closely related paper, Acemoglu et al. (2008) show that the correlation between income and democracy likewise vanishes when controlling for country fixed effects. As a robustness check, they show the same results hold for the DGMM estimator, which has the advantage in that it allows them to circumvent the endogeneity problem inherent in the FE estimation. From this, they conclude that the positive association observed in the cross-country data between income and democracy can be driven by a third factor influencing both, namely a critical juncture about 500 years ago.

Bobba and Coviello (2007) and Heid et al. (2012) apply the SGMM after concluding that the traditional DGMM is not a proper methodology with highly persistent data. For example, Bobba and Coviello (2007) show that education is highly persistent with an autoregressive coefficient of 0.66, suggesting that using lags of education as in Acemoglu et al. (2005) is inadequate for considering this regressor as strictly exogenous. They argue that the SGMM is more appropriate in these situations as it relaxes some of the orthogonality conditions allowing the use of more moment conditions. Under a weak exogeneity assumption, Bobba and Coviello (2007) show that education predicts democracy and Heid et al. (2012) show that income recovers its predictive power toward democracy. These papers support the modernization hypothesis at the expense of the critical junctures hypothesis.

II.B Results

Tables I and II present the results of estimating equation (1) under the four strategies discussed above. We include time effects in *all* the estimations. Table I reports estimation results when income and democracy are considered separately, whereas Table II reports estimation results when both education and income are simultaneously considered and other controls are added. By presenting both sets of results, we are able to show the effect of education on democracy, when controlling for income and not controlling for income.

[TABLE I ABOUT HERE]

Beginning with Table I, the first three columns are similar to the results presented by Bobba and Coviello (2007), although the point estimates are different since we restrict our sample to replicate some of the results from Acemoglu et al. (2008). Column 1 shows a strong and positive correlation between education and democracy whereas Column 2 shows that once one controls for country fixed effects, the correlation

vanishes, (although the point estimate of education on democracy is negative). The DGMM estimates shown in Column 3 confirm the absence of correlation.[6] As expected, after instrumenting Δd_{it} with lagged values of d_{it}, the estimate for $\hat{\beta}_1$ lies between the OLS and FE estimates. The Hansen J Test of over-identifying restrictions does not reject the null hypothesis of the validity of instruments, and the AR(2) test shows that the disturbance term in differences does not present serial correlation beyond the first lag, validating second lags and above as valid instruments.

Column 4 of Table I presents the results of the SGMM. We follow Roodman (2009) and leave the number of lags used in the SGMM unrestricted as long as the number of instruments is less than the number of countries to avoid weaker Hansen J Tests with implausible large p-values. With education no longer considered being strongly exogenous, the SGMM with its additional moment conditions needed to identify β_2 finds a positive, and statistically significant effect of education on democracy. The effect is sizable; if the average years of education were to increase by one standard deviation (2.8 years in our sample), the Freedom House Index would increase by 0.08 in the short run and by 0.23 after the full dynamic adjustment has taken place, which is statistically significant as the χ^2 of the long run effect is equal to 48.1. The Hansen J Test does not reject the null hypothesis of the validity of instruments, and the AR(2) null hypothesis is likewise not rejected, suggesting no further serial autocorrelation of the disturbances in differences.

The last four columns of Table I examine the relation between income and democracy. Columns 5, 6 and 7 replicate the main results of Acemoglu et al. (2008): The positive relation between income and democracy obtained with pooled OLS (Column 5) vanishes when fixed effects are included (Column 6) and there is a large but negative effect of income on democracy at the 10% significance level with the DGMM estimation (Column 7), which is clearly at odds with the modernization hypothesis. The last column, Column 8 presents the SGMM estimates. In line with Heid et al. (2012), it shows a large positive effect of lagged income on democracy once we relax the assumption that this covariate is strictly exogenous in the system. More importantly, the sign of the estimate accords with the modernization hypothesis. The Hansen J Test supports the validity of additional instruments, and the AR(2) test shows no serial autocorrelation.

Next we study the effect of education on democracy when first controlling for income and then after adding additional controls for the size and age structure of the population, as proposed by Acemoglu et al. (2008). Thus, for each approach there are two relevant columns. These results are shown Table II. Columns 1 and 2 correspond to the OLS. The estimates $\hat{\beta}_2$ and $\hat{\beta}_3$ are of similar order of magnitude with and

[6] Tables I and II only report the one step Difference and System GMM estimations so as to compare our results with Acemoglu et al. (2008). However, the conclusions from two step GMM estimations are equivalent. These results are available upon request.

without the additional controls, although the F-test does not support the use of these additional covariates in the estimation. Columns 3 and 4, which correspond to the FE estimation, show no role for education in determining democratic outcomes after controlling for income, and/or for the additional controls. Moreover, Column 4 shows that these controls are not jointly different from zero. Columns 5 and 6 pertain to the DGMM estimates. Column 5 shows no correlation between education and democracy, although income is negatively associated at the 1% level, casting further doubt on the DGMM estimation. Column 6, however, shows that this negative result is not robust to the inclusion of further controls, in spite of the fact that these additional controls are not jointly significant. The Hansen J Test is not rejected in Column 5, but it is rejected in Column 6 at the 10% level. The AR(2) test suggests no further serial autocorrelation.

[TABLE II ABOUT HERE]

Finally, Columns 7 and 8 present the SGMM estimations. Since we include additional regressors, we restrict the number of lags to avoid implausibly large p-values for the Hansen J Test that plague Bobba and Coviello (2007).[7] Column 7 shows that whereas education is strongly correlated with democracy, income is no longer statistically significant once education is considered, suggesting that the effect of income on democracy is through education. Importantly, it shows a positive and significant effect for education after controlling for income, in contrast to Bobba and Coviello (2007) who find an effect only after additionally controlling for population and investment. It is for these two reasons that we argue that our analysis strengthens the findings of Bobba and Coviello (2007). The short run and long run effects of increasing education are sizable, being essentially the same as in Column 4 of Table I. Column 8 shows that the effect of education on democracy is robust to the additional controls and the coefficient of interest $\hat{\beta}_2$ is precisely estimated in the SGMM. For this estimation we also restrict the number of lags to reach a number of instruments less than the number of countries. The p-values of the Hansen J Test and the AR(2) Test do not reject the null hypothesis.

II.C Components of Education on Democracy

As a last exercise, we attempt to gain greater insight into the mechanism by which education affects democracy. This analysis follows Barro (1999) by using the average total year of schooling in primary, secondary and tertiary education in the population over 25, but does so for the four different econometric approaches.

[7] Bobba and Coviello (2007) report p-values of 0.99 in the estimations that include additional controls as covariates.

[TABLE III ABOUT HERE]

Table III presents the results of estimating (1) when average total years of primary, secondary and tertiary schooling enter as separate regressors. In the estimations we control for income. We do not present the estimations with additional controls since they demand more restrictions in terms of lags to avoid an explosion in the number of instruments, and also because they do not alter significantly the results of these estimations.

Column 1 of Table III is in line with an important finding of Barro (1999): whereas levels of primary schooling are positively correlated with democracy, upper levels of schooling do not seem to have any predictive power on democratic outcomes. Also, Column 1 shows that income is positively correlated. Importantly, although not shown in the Table, secondary and tertiary schooling still remain insignificant even when income is omitted as an additional covariate. Similar to our previous analysis, Columns 2 and 3 show this effect vanishes when using the FE and DGMM methodologies. Column 4 shows that once we address the persistency of the covariates in the estimation of the dynamic panel, the effect illustrated in Column 1 is recovered, although the effect of primary schooling is more than two times greater compared to the OLS estimate. The effect of income is similar in Columns 1 and 4, but only significant at the 10% level in the latter. This finding suggests that in the long run, increasing the average years of primary schooling by one standard deviation (2 years in our sample) would have an impact on the democracy index of 0.24, which is statistically significant (the χ^2 of the long run effect is 11.9), and slightly larger than the effect of total years of education since upper schooling is not statistically related to changes in democracy. This effect alone represents about a quarter of the entire index explained by an increment of one standard deviation in the average years of primary schooling.

II.D Summary

Although the primary purpose of this section was to show how the *modernization* and *critical junctures hypotheses* debate has been shaped by the choice of econometric strategy, nevertheless, we think that it has value added by showing that some potential criticisms of the SGMM estimation of Bobba and Coviello (2007) are not reasons for concern. In doing so, this section has strengthened the case for the *modernization hypothesis*. Moreover, using the same SGMM method, it has shown that primary education is the only component of education that predicts democracy, something that echoes back to the findings of Barro (1999). In retrospect, Barro (1999) seems prophetic in writing, "Given the strength of this empirical regularity (of the

Lipset/Aristotle hypothesis), one would think that clear-cut theoretical analyses ought also to be attainable." This is the goal of the rest of the paper.

III. Economic Structure

Our model embeds a sequential game between an autocratic ruler and workers threatening to revolt, into a unified growth model. In terms of the novel mechanism we propose for how growth affects polity, the sequential game structure is critical. Nevertheless, we begin by describing the growth structure of the model as the game is more easily understood once this part of the model is explained. Looking ahead, the events described in this section take place in the final stage of the game, occurring once policies have been chosen. The equilibrium allocations herein derived thus constitute the payoffs of the game introduced in Section IV.

The economic construct is loosely based on the Hansen and Prescott (2002) growth model that allows firms to either use a traditional Malthus technology or a modern Solow technology to produce the economy's single, final good. We modify their model in several ways. On the household side, we first assume one-period lived agents who consume their entire income. Thus, there is no saving or physical capital accumulation in the model. Second, we allow for heterogeneous households in that some are endowed with land and others with time. Third, since we are not particularly interested in generating a Malthusian steady state, we treat population growth as exogenous and not as a function of per capita consumption.

On the technology side, since we abstract from physical capital, the traditional technology is modified to be a constant returns to scale function of land and raw labor. The modern technology is likewise modified, but to be a linear function of skilled labor. We also add an education sector where households may spend some of their time acquiring the human capital used in the modern technology. In addition to human capital, we introduce *democratic capital* in the model. Democratic capital is a by-product of education and is passed on from one generation to the next.

Industrialization in our model comes about for the same reason as in Hansen and Prescott (2002). A worker household either supplies raw labor to traditional firms, or spends part of its time in school and then uses whatever time remains producing the final good using the modern technology. As long as TFP in the modern sector starts out at a sufficiently low level, all workers choose to work in the traditional sector initially. However, with enough technological change in the modern technology, there is some date when some workers choose to become educated, initiating modernization and growth. Over time, more worker households become educated and so the traditional sector loses importance in the economy.

Policy, treated parametrically in this section, consists of a 6 dimensional vector $\Phi_t \equiv (\tau_{Lt}, \tau_{Ht}, \rho_{Lt}, \rho_{Ht}, g_t, \pi_t)$, where τ_{Lt} is a tax on land rental income, τ_{Ht} is a tax on labor income, ρ_{Lt} is a lump-sum transfer to landed households, ρ_{Ht} is a lump-sum transfer to worker households, g_t is government expenditures, and π_t is a barrier that reduces TFP in the modern sector by the proportion $1 - \pi_t$. The specifics of the economy's structure are described in the next two subsections.

III.A Households

All households live for a single period. There are two household types: a landed household, indexed by the subscript L, and a worker household, indexed by the subscript H. The measure of each household type alive in period t is given by N_{it}. Population is exogenous with the total population denoted by $N_t = N_{Ht} + N_{Lt}$.

Landed households are endowed with the economy's stock of land, denoted by L_t . Land is equally distributed so that each landed household is endowed with $l_t \equiv L_t/N_{Lt}$ units. A worker household is endowed with 1 unit of time he can spend either working as an unskilled laborer for a traditional firm or going to school and subsequently working as a skilled laborer in the modern sector. A worker who chooses the schooling option effectively becomes self-employed. We allow the measure of each type of household as well as the stock of land to exogenously change over time. These exogenous changes are only relevant for the model calibration in Section V.

Preferences

Preferences are identical across household types. As households live a single period and there is a single good in the economy, we assume utility is linear in consumption, i.e., $u(c_{it}) = c_{it}$, where c_{it} is consumption of household $i = L, H$.

Education

Human capital is acquired by a worker household spending some of its time in school. Letting e_t denote the time allocated to schooling, the amount of human capital a worker household acquires, h_t, is

$$h_t = e_t. \tag{2}$$

We do not introduce a technology variable in this sector because as we shall show, a household's decision to go to school depends on the product of TFP in the education sector and TFP in the modern sector. Thus, introducing a TFP measure in this sector would simply imply a re-normalization of TFP in the modern sector, and is hence omitted for simplicity.

Democratic Capital

We model democratic capital as a state variable, reflecting the economy-wide prevalence of pro-democratic ideas and support for a democratic cause. Educational attainment is assumed to affect the evolution of democratic capital in the economy. Let D_t denote society's stock of democratic capital in period t and N_{Mt} denote the measure of households that obtain an education in period t. Aggregate democratic capital in period $t+1$ is then given by

$$D_{t+1} = (1-\delta)D_t + N_{Mt}A_D e_t, \tag{3}$$

where δ is the depreciation rate and A_D is productivity in the accumulation of democratic capital. We think of A_D as determined by a number of factors, such as the extent to which pro-democratic ideas appear in school curricula. We assume that the economy is not endowed with any democratic capital initially, i.e., $D_0 = 0$, so the stock of democratic capital will be zero until the first period after which some households go to school. In this formulation, democratic capital is effectively passed on from parents to children as a bequest, which is suggested by Davies (1965), that shows that political beliefs are primarily shaped at home by parents, and by Jennings et al. (2009) that shows political views are persistent across generations. It is also consistent with our empirical findings reported in Section II that early life experiences are correlated with subsequent democratization.

Democratic capital will play a key role in the political game of Section IV by giving the masses greater *de facto* power. Technically, it will be mapped into the probability that a revolt succeeds. By implicitly exerting pressure on the ruling autocrat, the level of democratic capital will thus affect his decisions over policy and polity. However, as increases in democratic capital are treated as a pure externality of schooling according to (3), it does not affect the education decision of individual households and hence does not affect the economic layer of the model.

III.B Firms

The consumption good in the economy can be produced using one of two technologies. The first is a traditional technology, indexed by the letter T, that uses land and unskilled labor inputs. The second is a modern technology, indexed by the letter M, using skilled labor input only.

Traditional Sector

Firms using the traditional technology employ land and unskilled labor according to the following CRS function:

$$Y_{Tt} = A_{Tt} N_{Tt}^{\alpha} L_t^{1-\alpha}, \tag{4}$$

where $\alpha \in (0,1)$, Y_{Tt} is output, N_{Tt} is labor input, L_t is land, and A_{Tt} is TFP that is taken as exogenous and grows at rate $\gamma_{Tt} \geq 0$.

Modern Sector

The modern technology is linear in quality-adjusted units of labor. Without loss of generality, we assume that each skilled household operates as a self-employed unit. The output of a self-employed household, y_{Mt}, is

$$y_{Mt} = (1 - \pi_t) A_{Mt} h_t (1 - e_t) \tag{5}$$

where A_{Mt} is the technology component of TFP, $(1 - \pi_t)$ is the policy component of TFP and $h_t(1 - e_t)$ is quality-adjusted units of labor. We allow for exogenous increases in the technology component so that $A_{Mt+1} = (1 + \gamma_{Mt}) A_{Mt}$, with $\gamma_{Mt} \geq 0$. This exogenous increase in TFP is the catalyst for modernization and sustained growth.

III.C Optimal Behavior

The final good is the economy's numeraire, meaning that all prices are expressed in terms of final output.

Households

As utility is linear in consumption, the relevant problem of each household type is to maximize its after tax income.

Landed Households Landed households have no maximization problem to solve. They simply eat their entire income, which consists of land rental income net of taxes and lump-sum transfers. Specifically,

$$c_{Lt} = (1 - \tau_{Lt}) r_t l_t + \rho_{Lt},$$

where r_t is the rental rate on land.

Worker Households Worker households likewise eat their entire after tax and transfer income but must choose between spending their entire time endowment working for a traditional firm or allocating some fraction of this time to schooling and the remaining time to producing output with the modern technology. A worker household that chooses employment in the traditional sector obtains the wage w_t and a household that opts for education followed by self-employment obtains the income y_{Mt} given by (5). Both types of incomes are taxed at rate τ_{Ht}. In addition to labor income, the worker may also receive transfers ρ_{Ht} from redistribution. The problem of the worker household is given by:

$$\max_{e_t} \Big\{ (1 - \tau_{Ht}) w_t, (1 - \tau_{Ht})(1 - \pi_t) A_{Mt} h_t (1 - e_t) \Big\} + \rho_{Ht},$$

subject to (2). The worker chooses to get an education and produce the final good himself if

$$w_t < \max_{e_t} \big((1 - \pi_t) A_{Mt} h_t (1 - e_t) \big).$$

Using (2), the above condition can be written as:

$$w_t < \max_{e_t} \Big\{ (1 - \pi_t) A_{Mt} e_t (1 - e_t) \Big\}.$$

Differentiating the right hand side of this condition with respect to e_t, it follows that a household that chooses to educate selects $e_t = 1/2$. Thus, a self-employed worker household spends half the time in school and the other half working. Substituting $e_t = 1/2$ into (2), we obtain a self-employed worker's optimal

human capital, namely, $h_t = 1/2$. Hence, in the case the worker opts for education and self-employment, his consumption is given by:

$$c_{Ht} = (1 - \tau_{Ht})(1 - \pi_t)\frac{A_{Mt}}{4} + \rho_{Ht}.$$

Allowing for the possibility that the worker will instead work as an unskilled laborer in the traditional sector, the general expression for worker consumption is given by:

$$c_{Ht} = \max\left\{(1 - \tau_{Ht})w_t, (1 - \tau_{Ht})(1 - \pi_t)\frac{A_{Mt}}{4}\right\} + \rho_{Ht}. \tag{6}$$

Firms

The market for the economy's only final good is perfectly competitive. Firms either use the traditional technology or the modern technology.

Traditional Firms Firms using the traditional technology are price takers and face the following maximization problem

$$\max_{N_{Tt}, L_t} A_{Tt} N_{Tt}^{\alpha} L_t^{1-\alpha} - w_t N_{Tt} - r_t L_t.$$

Maximization yields the following input demand functions:

$$w_t = \alpha A_{Tt}\left(\frac{L_t}{N_{Tt}}\right)^{1-\alpha}, \tag{7}$$

and

$$r_t = (1 - \alpha)A_{Tt}\left(\frac{L_t}{N_{Tt}}\right)^{-\alpha}. \tag{8}$$

Modern Firms Modern firms are self-employed worker households who use their own human-capital adjusted time to produce the economy's final good according to (5). As such, there are no FOCs. The relevant maximization decision pertains to the worker household choosing whether or not to go to school. As education is only valuable in the modern sector, the measure of self-employed households is just the measure of educated household, namely, N_{Mt}.

The Modernization Date

Characterizing the economy's development path is trivial except for determining the period in which the modern technology is first used. To determine this date, note that prior to the modern technology being used the entire workforce is employed in the traditional sector, so that $N_{Tt} = N_{Ht}$, and $N_{Mt} = 0$. In this state, the real wage is:

$$w_t = \alpha A_{Tt}\Big(\frac{L_t}{N_{Ht}}\Big)^{1-\alpha}. \tag{9}$$

Using (9) with (6) implies that workers begin to educate themselves the first period in which

$$\alpha A_{Tt}\Big(\frac{L_t}{N_{Ht}}\Big)^{1-\alpha} < (1-\pi_t)\frac{A_{Mt}}{4}. \tag{10}$$

This equation implies that the barrier to modern-sector TFP is important for determining the date an economy first modernizes, i.e., first uses the modern technology. This implication will be relevant when we extend the model so as to endogenize policy.

III.D Equilibrium Prices and Allocations

We next characterize the equilibrium prices and allocations before and after the modernization date identified by (10) with the explicit purpose of deriving the equilibrium consumption levels of the two household types. These levels will be the relevant payoffs in the political game presented in Section IV.

Pre-modernization prices

Prior to modernization, we have established that all households are employed in the traditional sector and that w_t is given by (9). The land rental price, therefore, is:

$$r_t = (1-\alpha)A_{Tt}\Big(\frac{L_t}{N_{Ht}}\Big)^{-\alpha}. \tag{11}$$

Post-modernization prices

Once the modern technology is in use, (10) is violated so that the equilibrium wage in the economy is given by:

$$w_t = (1 - \pi_t)\frac{A_{Mt}}{4}. \tag{12}$$

To determine the rental price, it is first necessary to solve for employment in the traditional sector, N_{Tt}, using the above equation and labor demand. This yields

$$N_{Tt} = \left(\frac{(1 - \pi_t)A_{Mt}}{4\alpha A_{Tt}}\right)^{-\frac{1}{(1-\alpha)}} L_t. \tag{13}$$

The remaining measure of worker households are self-employed, i.e., $N_{Mt} = N_{Ht} - N_{Tt}$. The rental rate on land is given by equation (8), evaluated at (13).

Equilibrium consumption

In equilibrium, the consumption and income levels of the households are given by

$$c_{Lt} = (1 - \tau_{Lt})r_t l_t + \rho_{Lt} \tag{14}$$

and

$$c_{Ht} = (1 - \tau_{Ht})w_t + \rho_{Ht}, \tag{15}$$

where w_t and r_t are given by (9) and (11) pre-modernization and (12) and (8) post-modernization. These expressions represent the payoffs of the players participating in the game described in Section IV.

Resource Constraints

In equilibrium, total consumption plus government expenditures must equal total output. Thus,

$$N_{Lt}c_{Lt} + N_{Ht}c_{Ht} + g_t = Y_t.$$

Additionally, the sum of workers employed by traditional firms and self-employed individuals must total the number of worker households, so that

$$N_{Mt} = N_{Ht} - N_{Tt}. \tag{16}$$

Pre-modernization, $N_{Ht} = N_{Tt}$, $N_{Mt} = 0$, and Y_t is given by

$$Y_t = Y_{Tt} = A_{Tt} N_{Ht}^{\alpha} L_t^{1-\alpha}.$$

Post-modernization, N_{Tt} is given by (13), N_{Mt} is given by (16), and Y_t is given by

$$Y_t \equiv Y_{Tt} + Y_{Mt} = A_{Tt} N_{Tt}^{\alpha} L_t^{1-\alpha} + (1 - \pi_t) \frac{A_{Mt}}{4} (N_{Ht} - N_{Tt}),$$

since output produced in the modern sector is $Y_{Mt} = y_{Mt} N_{Mt}$.

Although it is not relevant for the actions of economic agents, the law of motion for the stock of democratic capital (3) determines D_{t+1}. As mentioned earlier, democratic capital is zero until the first period following the date of modernization.

Policy Feasibility

Policy, although treated as exogenous at this stage, must be feasible. In particular, total tax receipts must equal total outlays, i.e.,

$$\tau_{Lt} r_t L_t + \tau_{Ht} w_t N_{Ht} = \rho_{Lt} N_{Lt} + \rho_{Ht} N_{Ht} + g_t.$$

IV. Political Structure

We next describe the political layer of the model, i.e., the sequential game between the ruling autocrat, aligned with the landed class, and the workers of the economy. The game is based on Acemoglu and Robinson (2006) who emphasize the *de facto* power of the masses in the form of revolt. The basic idea of the model is that, by increasing the level of democratic capital in the economy, education triggers a mounting threat of revolt. By making concessions to the masses through income transfers, the autocrat can prevent workers from initiating a revolt and can retain power. At the date that keeping the masses at bay becomes too

expensive, the autocrat instead opts for democracy and peacefully relinquishes power.[8]

The game is replayed every period, but since households live a single period, every generation plays the game only once. We assume that at the beginning of each period, a ruler is randomly chosen from the set of landed households. The ruler either chooses to hold on to power or to democratize the country. If the autocrat chooses to democratize, economic policies in line with the preference of the median voter are implemented.[9] As we assume that $N_{Ht} > N_{Lt}$ in all periods, the median voter is always a worker household.

We now describe the game in detail.

IV.A The Game

The structure of the game is shown in Figure I. At the beginning of each period and before the game begins, the state of the economy is characterized by the set $\{L_t, N_{Lt}, N_{Ht}, A_{Tt}, A_{Mt}, D_t\}$. Within each period t, the following events take place.

1. The game begins with the landed autocrat choosing the country's polity, i.e., deciding whether to maintain power or democratize. This choice is represented by the first node in Figure I. Letting ψ_t denote the decision of the autocrat, we define

$$\psi_t = \begin{cases} 1 & \text{if democracy,} \\ 0 & \text{if autocracy.} \end{cases}$$

2. Next, the ruler sets a vector of policies, $\Phi_t \equiv (\tau_{Lt}, \tau_{Ht}, \rho_{Lt}, \rho_{Ht}, g_t, \pi_t)$. If $\psi_t = 0$, the landed autocrat sets policies. If $\psi_t = 1$, policies favored by the median voter, i.e., a worker household, are implemented. In the case that $\psi_t = 1$, the game ends, agents solve the maximization problems described in Section III and markets clear.

3. As long as $\psi_t = 0$, worker households decide whether or not to revolt. This choice is represented by

[8] A key feature of our model is that modernization and development give rise to peaceful democratization by the ruling autocrat. Some papers that are similar in this regard are Lizzeri and Persico (2004), Fleck and Hanssen (2006), and Paltseva (2008), but they consider different mechanisms by which the elite extend the franchise. A larger strand of literature, comprising Przeworski and Limongi (1997) and Przeworski, Alvarez, Cheibub, and Limongi (2000) study the role of income in democratic consolidation following exit from autocracy.

[9] Assuming that once the autocrat relinquishes power, the economy immediately becomes completely democratic, is not implausible. Treisman (2015) argues that once a dictator loses power, a window of opportunity opens up, within which substantial regime liberalization is likely. Prominent examples include the death of Franco in 1975, the death of Hitler in 1945, the overthrowing of Papadopoulos in 1973 and the death of Brezhnev in 1982, which were all followed by surges in polity scores.

the second node in Figure I. Letting μ_t denote this decision, we define

$$\mu_t = \begin{cases} 1 & \text{if revolt,} \\ 0 & \text{if no revolt.} \end{cases}$$

The decision to revolt is based on the probability that the revolt succeeds, which we assume depends on the stock of democratic capital in the economy at the time of the revolt decision. If workers choose not to revolt, the game ends, agents solve their relevant maximization problems and markets clear under the policies set by the autocrat in Stage 2.

4. If workers decide to revolt, i.e., $\mu_t = 1$, the revolt either succeeds with probability $\phi(D_t)$ or fails with probability $1 - \phi(D_t)$. This event is illustrated at the third node in Figure I. To uniquely identify each outcome, we introduce an indicator variable

$$\kappa_t = \begin{cases} 1 & \text{if revolt succeeds,} \\ 0 & \text{if revolt fails.} \end{cases}$$

If the revolt fails, the autocrat's policies from Stage 2 are implemented, with the exception that transfers originally earmarked to worker households are instead used up in the conflict, meaning that workers get zero transfers should they revolt. If the revolt succeeds, a democracy is formed and the policy preferred by the median voter is implemented. In both cases, the game ends, agents solve their relevant maximization problems and markets clear.

[FIGURE I ABOUT HERE]

Note that unlike Acemoglu and Robinson (2006), a revolt does not reduce the economy's output. Although it is easy to introduce this feature into the model, it is not necessary for generating the result that an autocrat eventually relinquishes power. What is more important for the purpose of generating this result is to have the consumption levels of each household type differ substantially between the case when revolt fails and when it succeeds. This is done by imposing constraints on the policies that are possible under democracy and autocracy. These constraints are described in Section IV.C.

The indicator functions defined above are used to identify the payoffs at the end of the branches of the game tree with the payoff for each household type being written as $c_{it}(\psi_t, \mu_t, \kappa_t)$. As there are four branches to the tree, there are four relevant vectors of indicators. For notational convenience, we introduce shorthand

notation for the four possible outcomes, namely peaceful democracy, $\mathcal{P}^{\mathcal{D}} \equiv (1, \cdot, \cdot)$; peaceful autocracy, $\mathcal{P}^{\mathcal{A}} \equiv (0, 0, \cdot)$; successful revolt, $\mathcal{R}^{\mathcal{S}} \equiv (0, 1, 1)$ and failed revolt, $\mathcal{R}^{\mathcal{F}} \equiv (0, 1, 0)$.[10]

IV.B Democratic Capital and the Probability of Successful Revolt

The probability that a revolt succeeds, $\phi(D_t)$, is increasing in society's stock of democratic capital where D_t is determined by (3). In addition to assuming $\phi' \geq 0$, we assume that $\phi(0) = 0$ so that workers will never attempt to overthrow the autocrat pre-modernization. This latter assumption is useful in establishing some theoretical results, but not a computational issue as the game can still be solved when $\phi(0) > 0$. Recall that the revolt decision precedes the education decision by assumption.[11] This implies that, although individuals may develop pro-democratic ideas at school, it does not affect their decision to revolt. It will affect the next generations' decisions and the future polity path of the country. Importantly, since the increase in democratic capital brought on by education is a pure by-product of education, this period's generation does not internalize the effects of their education decision on the revolt decision of next period's generation.

There are several rationales for why the probability that a revolt in period t succeeds should be increasing in the stock of democratic capital inherited from the previous generation. First, as discussed in the introduction, parents are known to have a large impact on the ideological views of their children. Consequently, children of parents with pro-democratic ideas are likely to be more motivated to participate in an attempt to overthrow the regime and therefore more likely to exert effort in a revolt. Second, the larger the population share being raised by educated parents, and therefore the share of pro-democratic worker households, the more likely it is that ideas about democracy spread to the population raised by non-educated parents. This is particularly plausible in light of the finding that education and social participation are positively correlated as in Glaeser and Sacerdote (2008). If children of educated households are raised to become socially active individuals, they are likely to have large social networks and will be able to disseminate pro-democratic ideas effectively and convincingly. Third, historical accounts certainly suggest that the ideas and writings of older individuals have inspired younger cohorts of the population, more suited to physically engage in revolts. Examples include Benjamin Franklin, who was 70 years old at the time of the American revolution and the exiled Ayatollah Rouhollah Komeini who was in his 70s during the Iranian revolution.

[10] In the case of peaceful democracy, the values of μ and κ are irrelevant since there is no decision to revolt. In the case of peaceful autocracy, the value of κ is irrelevant as workers choose not to revolt. The irrelevance of these arguments is highlighted by the use of "$\cdot$" in the outcome vectors.

[11] Changing the structure of the game so that the education decision precedes the revolt decision would render the model much more complex but add very little value.

IV.C Policy Constraints

Optimal policy is either determined by the polity in charge in Stage 2, or in Stage 4 in the event of a successful revolt. Policy must further be feasible, in that total outlays must be covered by total tax receipts. Although both autocratic and democratic leaders choose tax rates, transfers and barriers, we assume that they face slightly different policy constraints that, in addition to differing across polity types, can differ on account of the outcome of a revolt. The one policy that is constrained identically across regimes, is the technology barrier that is restricted by an upper bound, so that $\pi_t \in (0, \bar{\pi}]$. We next describe the constraints that apply to each of the four branches of the game, from left to right, in Figure I.

Peaceful Democracy ($\mathcal{P}^{\mathcal{D}}$)

Should the autocrat peacefully relinquish power in Stage 1 of the game, the policies preferred by a median voter are implemented. As for constraints on these policies, we assume that under democracy, the same tax rate is levied on both types of households and everyone receives the same transfers from the tax revenue that ensues. Policies must satisfy the government budget constraint and there is an upper bound, $\bar{\tau}$, on the tax rate that the democratic leader can implement.[12] The government expenditure is set to zero. Formally, these constraints are:

$$\tau_{Ht}(\mathcal{P}^{\mathcal{D}}) = \tau_{Lt}(\mathcal{P}^{\mathcal{D}}) \equiv \tau_t(\mathcal{P}^{\mathcal{D}}) \in [0, \bar{\tau}], \tag{17}$$

$$\rho_{Ht}(\mathcal{P}^{\mathcal{D}}) = \rho_{Lt}(\mathcal{P}^{\mathcal{D}}) \equiv \rho_t(\mathcal{P}^{\mathcal{D}}) = \frac{\tau_t(\mathcal{P}^{\mathcal{D}})[r_t(\mathcal{P}^{\mathcal{D}})L_t + w_t(\mathcal{P}^{\mathcal{D}})N_{Ht}]}{N_t}, \tag{18}$$

and

$$g_t(\mathcal{P}^{\mathcal{D}}) = 0. \tag{19}$$

Notice that the rental rates in these expressions are indexed by the branch of the game as the competitive equilibrium prices and allocations characterized in Section III depend on the policies implemented.

[12] As shown in Section (IV.C), the reason we need to establish an upper bound on the tax rate is that as long as the rental income of a landed household exceeds the wage, a democracy will find it optimal to tax income at the highest rate possible.

Peaceful Autocracy ($\mathcal{P}^{\mathcal{A}}$)

If the landed autocrat chooses to stay in power and peace is maintained, his preferred policy vector is implemented in Stage 2 of the game. We assume that the autocrat only taxes the landed class and never redistributes income to this group. The rationale for this simplifying assumption is that we wish to exclusively focus on the role of transfers in deterring revolt; allowing the autocrat to tax worker income would complicate the model by giving the autocrat another type of incentive to maintain power. Policy must further be feasible in that the government budget constraint must be satisfied. The government expenditure is set to zero. The policy constraints under peaceful autocracy are thus:

$$\tau_{Ht}(\mathcal{P}^{\mathcal{A}}) = 0, \tag{20}$$

$$\tau_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0, 1], \tag{21}$$

$$\rho_{Ht}(\mathcal{P}^{\mathcal{A}}) = \frac{\tau_{Lt}(\mathcal{P}^{\mathcal{A}}) r_t(\mathcal{P}^{\mathcal{A}}) L_t}{N_{Ht}}, \tag{22}$$

$$\rho_{Lt}(\mathcal{P}^{\mathcal{A}}) = 0, \tag{23}$$

$$g_t(\mathcal{P}^{\mathcal{A}}) = 0. \tag{24}$$

Successful Revolt ($\mathcal{R}^{\mathcal{S}}$)

In a democracy born from a successful revolt, the policies preferred by the worker household are implemented in Stage 4 of the game. As in the peaceful democracy, the same tax rate is levied on both types of households and everyone receives the same transfers. However, the upper bound on the tax rate, $\bar{\bar{\tau}}$, is assumed to be higher after a revolt than in a peaceful democracy, i.e. $\bar{\tau} < \bar{\bar{\tau}}$. We make this assumption to give workers sufficient incentive to revolt, but it is plausible that workers hold enough political power after overthrowing the autocratic government, that they can levy higher taxes. As in a peaceful democracy, the government expenditure is set to zero and the government budget constraint is satisfied. The constraints on

optimal policies are

$$\tau_{Ht}(\mathcal{R}^{\mathcal{S}}) = \tau_{Lt}(\mathcal{R}^{\mathcal{S}}) \equiv \tau_t(\mathcal{R}^{\mathcal{S}}) \in [0, \bar{\bar{\tau}}], \tag{25}$$

$$\rho_{Ht}(\mathcal{R}^{\mathcal{S}}) = \rho_{Lt}(\mathcal{R}^{\mathcal{S}}) \equiv \rho_t(\mathcal{R}^{\mathcal{S}}) = \frac{\tau_t(\mathcal{R}^{\mathcal{S}})[r_t(\mathcal{R}^{\mathcal{S}})L_t + w_t(\mathcal{R}^{\mathcal{S}})N_{Ht}]}{N_t}, \tag{26}$$

and

$$g_t(\mathcal{R}^{\mathcal{S}}) \equiv 0. \tag{27}$$

Failed Revolt $(\mathcal{R}^{\mathcal{F}})\pi_t$

A subgame perfect equilibrium is a pair of strategies, one for each household type, such that the strategy of each household type is the best response to the other type's strategy and vice versa.[13] In solving for the subgame perfect equilibria of the model, it will prove useful to consider the pre-modernization and post-modernization stages of the economy separately.

IV.D Pre-modernization

In the Malthusian era, the probability that a revolt succeeds is zero on account of $D_0 = 0$, so workers will never want to revolt under any circumstances. Consequently, Stages 3 and 4 of the game are irrelevant and the only two possible subgame equilibria are peaceful autocracy and peaceful democracy. To see if either is a subgame perfect equilibrium, we first solve for the optimal policies set in Stage 2, and then compare the payoffs of the landed household under the two branches to determine the optimal regime choice of the autocrat in Stage 1. By the analysis in Section III the payoffs of the two household types are given by (14) and (15), where w_t and r_t are given by (9) and (11).

[13] Formally, we may denote the actions of the landed autocrat by $\sigma_t^L \equiv \{\psi_t, \Phi_t^L(\psi_t = 0)\}$ and the actions of workers by $\sigma_t^H \equiv \{\Phi_t^H(\psi_t = 1), \mu_t(\psi_t = 0, \Phi_t^L(\psi_t = 0)), \Phi_t^H(\psi_t = 0, \mu_t = 1, \kappa_t = 1)\}$ where $\Phi_t^i \equiv (\tau_{Lt}, \tau_{Ht}, \rho_{Lt}, \rho_{Ht}, g_t, \pi_t)$ is the policy vector set by ruling class i. A subgame perfect equilibrium is a pair of strategies, $(\tilde{\sigma}_t^L, \tilde{\sigma}_t^H)$ such that for each subgame, $\tilde{\sigma}_t^L$ is the best response of a landed household to $\tilde{\sigma}_t^H$ and vice versa.

Stage 2: Policy Choice

Peaceful Autocracy Since a landed household receives no transfers, its consumption under peaceful autocracy is:

$$c_{Lt}(\mathcal{P}^{\mathcal{A}}) = [1 - \tau_{Lt}(\mathcal{P}^{\mathcal{A}})]r_t(\mathcal{P}^{\mathcal{A}})l_t,$$

where $\tau_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0, 1]$. Since $D_t = 0$, and hence the probability of successful revolt is zero, it follows trivially that the autocrat never taxes land rents in this era so that

$$c_{Lt}(\mathcal{P}^{\mathcal{A}}) = r_t(\mathcal{P}^{\mathcal{A}})l_t. \tag{28}$$

With no transfers, the consumption of workers is given by:

$$c_{Ht}(\mathcal{P}^{\mathcal{A}}) = w_t(\mathcal{P}^{\mathcal{A}}). \tag{29}$$

Turning to the policy barrier to modern-sector TFP, $c_{Lt}(\mathcal{P}^{\mathcal{A}})$ is maximized when r_t is maximized. Since $\partial r_t(\mathcal{P}^{\mathcal{A}})/\partial N_{Tt} > 0$ according to (8), land rents are maximized when the entire worker population is employed in the traditional sector. Therefore, the autocrat will block modernization as long as possible. In particular, once the switch condition given by (10) is met with no barrier in place, the autocrat will set π_t so that (10) holds with equality, assuming that this can be done, i.e., $\pi_t \leq \overline{\pi}$.

Peaceful Democracy Under democracy, the representative worker's consumption is:

$$c_{Ht}(\mathcal{P}^{\mathcal{D}}) = [1 - \tau_t(\mathcal{P}^{\mathcal{D}})]w_t(\mathcal{P}^{\mathcal{D}}) + \frac{\tau_t(\mathcal{P}^{\mathcal{D}})[r_t(\mathcal{P}^{\mathcal{D}})L_t + w_t(\mathcal{P}^{\mathcal{D}})N_{Ht}]}{N_t}. \tag{30}$$

(30) implies there is no interior solution for the optimal tax rate as

$$\frac{\partial c_{Ht}(\mathcal{P}^{\mathcal{D}})}{\partial \tau_t(\mathcal{P}^{\mathcal{D}})} > 0 \Leftrightarrow \frac{r_t(\mathcal{P}^{\mathcal{D}})L_t + w_t(\mathcal{P}^{\mathcal{D}})N_{Ht}}{N_t} > w_t(\mathcal{P}^{\mathcal{D}}).$$

The expression implies that the distribution of income determines whether the democrat would tax income at the lower or upper bound. More specifically, the democratic leader sets $\tau_t(\mathcal{P}^{\mathcal{D}}) = \bar{\tau}$ if the wage is below

per capita income, as this makes the workers net beneficiaries of taxation, and zero otherwise, i.e., :

$$\tau_t(\mathcal{P}^{\mathcal{D}}) = \begin{cases} \bar{\tau} & \text{if } r_t(\mathcal{P}^{\mathcal{D}})l_t > w_t(\mathcal{P}^{\mathcal{D}}), \\ 0 & \text{otherwise.} \end{cases}$$

It is straightforward to show that a necessary and sufficient condition for $r_t l_t > w_t$ in the pre-modernization era is $N_{Ht}/N_t > \alpha$. Assuming this condition always holds, it follows that $\tau_t(\mathcal{P}^{\mathcal{D}}) = \bar{\tau}$. Using this result with (14), we obtain the consumption of an elite household under peaceful democracy:

$$c_{Lt}(\mathcal{P}^{\mathcal{D}}) = (1-\bar{\tau})r_t(\mathcal{P}^{\mathcal{D}})l_t + \frac{\bar{\tau}[r_t(\mathcal{P}^{\mathcal{D}})L_t + w_t(\mathcal{P}^{\mathcal{D}})N_{Ht}]}{N_t}. \tag{31}$$

Additionally, we need to assess whether the democratic government would ever block modernization once the modern technology is profitable to use. Equation (30) suggests that the barrier has counteracting effects on the consumption of worker households; imposing a barrier lowers the wage but increases the rental rate on land, which increases the redistributive transfers received by workers. We may, however, show that the former effect typically dominates the latter and prove the following lemma.

Lemma 1. *Under reasonable parameter assumptions,* $\partial c_{Ht}(\mathcal{P}^{\mathcal{D}})/\partial \pi_t < 0$.

Proof. Given in Appendix I.A. □

Lemma 1 suggests that the democratic leader sets the barrier $\pi_t(\mathcal{P}^{\mathcal{D}}) = 0$.

Stage 1: Polity Choice

In the first stage of the game, the autocrat opts for democracy if and only if

$$c_{Lt}(\mathcal{P}^{\mathcal{D}}) > c_{Lt}(\mathcal{P}^{\mathcal{A}}). \tag{32}$$

The main result on polity choice in this era is formalized in the following proposition.

Proposition 1. *The pre-modernization subgame perfect equilibrium is always peaceful autocracy.*

Proof. The proof is by contradiction. Suppose that the autocrat democratizes. The autocrat will choose democracy if and only if condition (32) is met. Prior to modernization, the rental price of land and the wage rate will be the same across polities unless the autocrat needs to put a barrier in place so that no worker

gets educated. In this case, the rental price under autocracy would be strictly greater than the rental price under democracy. Using this result with equations (28) and (31) implies that the autocrat democratizes if

$$(1-\bar{\tau})r_t(\mathcal{P}^{\mathcal{D}})l_t + \frac{\bar{\tau}[r_t(\mathcal{P}^{\mathcal{D}})L_t + w_t(\mathcal{P}^{\mathcal{D}})N_{Ht}]}{N_t} > r_t(\mathcal{P}^{\mathcal{A}})l_t \geq r_t(\mathcal{P}^{\mathcal{D}})l_t.$$

Using the definition of the total population and simplifying, the condition becomes

$$\frac{N_{Lt}}{N_t}\Big[r_t(\mathcal{P}^{\mathcal{D}})l_t - w_t(\mathcal{P}^{\mathcal{D}})\Big] > r_t(\mathcal{P}^{\mathcal{D}})l_t - w_t(\mathcal{P}^{\mathcal{D}}),$$

implying that $N_{Lt}/N_t > 1$, a contradiction. □

We thus conclude that the autocrat never relinquishes power pre-modernization and that the only sub-game perfect equilibrium is peaceful autocracy.

IV.E Post-modernization

Once condition (10) holds at $\overline{\pi}$, workers start to educate themselves and subsequently take up production using the modern technology. The consumption levels of the two household types are still given by (14) and (15), with w_t and r_t now given by (12) and (8). Once the modern technology is in use, the stock of democratic capital starts to increase as well, which in turn increases the probability of a successful revolt. With a large enough stock of democratic capital, overthrowing the autocrat becomes a viable option to the workers. Additionally, with the traditional sector shrinking, the rental price of land falls meaning that the income of a member of the landed class will decline and at some date be less than the income of the worker household. Below, we solve the full model, when all stages of the game are relevant, again via backward induction.

Stage 4: The Outcome of the Revolt

In Stage 4, the revolt either succeeds or fails and the implied leader implements his preferred policies. If the revolt fails, the autocrat remains in power and his policy choices from Stage 2 are implemented along with the additional required expenditures and transfers associated with restoring the rule of law. Imposing the relevant constraints on policy, the payoff to a landed household is:

$$c_{Lt}(\mathcal{R}^{\mathcal{F}}) = [1-\tau_{Lt}(\mathcal{R}^{\mathcal{F}})]r_t(\mathcal{R}^{\mathcal{F}})l_t + \rho_{Lt}(\mathcal{R}^{\mathcal{F}}). \tag{33}$$

As worker households are not taxed under autocracy and receive no lump sum transfers in the case the revolt fails, their payoff is:

$$c_{Ht}(\mathcal{R}^{\mathcal{F}}) = w_t(\mathcal{R}^{\mathcal{F}}). \tag{34}$$

If the revolt is successful, democracy ensues and the worker household chooses the policy that maximizes his income subject to the constraints given by (25) and (26). Substituting these constraints into (14) and (15) implies:

$$c_{Lt}(\mathcal{R}^{\mathcal{S}}) = [1 - \tau_t(\mathcal{R}^{\mathcal{S}})]r_t(\mathcal{R}^{\mathcal{S}})l_t + \frac{\tau_t(\mathcal{R}^{\mathcal{S}})[r_t(\mathcal{R}^{\mathcal{S}})L_t + w_t(\mathcal{R}^{\mathcal{S}})N_{Ht}]}{N_t}, \tag{35}$$

and

$$c_{Ht}(\mathcal{R}^{\mathcal{S}}) = [1 - \tau_t(\mathcal{R}^{\mathcal{S}})]w_t(\mathcal{R}^{\mathcal{S}}) + \frac{\tau_t(\mathcal{R}^{\mathcal{S}})[r_t(\mathcal{R}^{\mathcal{S}})L_t + w_t(\mathcal{R}^{\mathcal{S}})N_{Ht}]}{N_t}. \tag{36}$$

A would-be democratic leader chooses $\tau_t(\mathcal{R}^{\mathcal{S}}) \in [0, \bar{\bar{\tau}}]$ to maximize worker consumption given (36). As in Section IV.D, there is no interior solution to this problem and the optimal tax rate is a corner solution. Re-tracing the steps of the analysis in that section, we obtain the following modified result for the case of successful revolt:

$$\tau_t(\mathcal{R}^{\mathcal{S}}) = \begin{cases} \bar{\bar{\tau}} & \text{if } r_t(\mathcal{R}^{\mathcal{S}})l_t > w_t(\mathcal{R}^{\mathcal{S}}), \\ 0 & \text{otherwise.} \end{cases}$$

In addition to the tax and transfer policy component, the payoffs of each household under failed and successful revolts will differ on account that the democratic leader will set the barrier to zero whereas the autocrat will set it at the upper bound.

Stage 3: The Decision to Revolt

In Stage 3, workers choose to revolt if the expected utility of doing so exceeds the status quo, represented by peaceful autocracy. The consumption of workers should they abstain from rebelling is obtained by plugging (20) and (22) into (15). It follows that:

$$c_{Ht}(\mathcal{P}^{\mathcal{A}}) = w_t(\mathcal{P}^{\mathcal{A}}) + \frac{\tau_{Lt}(\mathcal{P}^{\mathcal{A}})r_t(\mathcal{P}^{\mathcal{A}})L_t}{N_{Ht}}. \tag{37}$$

Workers choose not to revolt if the following condition holds:

$$c_{Ht}(\mathcal{P}^{\mathcal{A}}) > \phi(D_t)c_{Ht}(\mathcal{R}^{\mathcal{S}}) + (1-\phi(D_t))c_{Ht}(\mathcal{R}^{\mathcal{F}}).$$

Using (34), (36) and (37) the condition may be written:

$$w_t(\mathcal{P}^{\mathcal{A}}) + \frac{\tau_{Lt}(\mathcal{P}^{\mathcal{A}})r_t(\mathcal{P}^{\mathcal{A}})L_t}{N_{Ht}} > \phi(D_t)\Big[(1-\tau_t(\mathcal{R}^{\mathcal{S}}))w_t(\mathcal{R}^{\mathcal{S}}) + \frac{\tau_t(\mathcal{R}^{\mathcal{S}})(r_t(\mathcal{R}^{\mathcal{S}})L_t + w_t(\mathcal{R}^{\mathcal{S}})N_{Ht})}{N_t}\Big] + (1-\phi(D_t))w_t(\mathcal{R}^{\mathcal{F}}). \tag{38}$$

Stage 2: Policy Choice

In Stage 2, the autocrat sets policies that maximize the consumption of a landed household. In doing so, the autocrat knows that if (38) is violated, there will be a revolt. He therefore has the option to prevent a revolt by choosing $\tau_{Lt}(\mathcal{P}^{\mathcal{A}})$ so that (38) holds with equality. Intuitively, he can concede some of the landed class's income to workers by taxing land rents and transferring the receipts to workers. To determine the tax rate to implement, however, the autocrat needs to take into account that the democratic leader chooses $\tau_t(\mathcal{R}^{\mathcal{S}})$ should the revolt succeed.

With this knowledge, we can solve for the $\tau_{Lt}(\mathcal{P}^{\mathcal{A}})$ that satisfies (38). This is:

$$\tau_{Lt}(\mathcal{P}^{\mathcal{A}}) = \Bigg[\phi(D_t)\Big\{(1-\tau_{Lt}(\mathcal{R}^{\mathcal{S}}))w_t(\mathcal{R}^{\mathcal{S}}) - w_t(\mathcal{R}^{\mathcal{F}}) + \Big(r_t(\mathcal{R}^{\mathcal{S}})L_t + w_t(\mathcal{R}^{\mathcal{S}})N_{Ht}\Big)\frac{\tau_{Lt}(\mathcal{R}^{\mathcal{S}})}{N_t}\Big\} + w_t(\mathcal{R}^{\mathcal{F}}) - w_t(\mathcal{P}^{\mathcal{A}})\Bigg]\frac{N_{Ht}}{r_t(\mathcal{P}^{\mathcal{A}})L_t}. \tag{39}$$

The autocrat will deter revolt as long as

$$c_{Lt}(\mathcal{P}^{\mathcal{A}}) > \phi(D_t)c_{Lt}(\mathcal{R}^{\mathcal{S}}) + (1-\phi(D_t))c_{Lt}(\mathcal{R}^{\mathcal{F}}), \tag{40}$$

where $c_{Lt}(\mathcal{P}^{\mathcal{A}}) = (1-\tau_{Lt}(\mathcal{P}^{\mathcal{A}}))r_t(\mathcal{P}^{\mathcal{A}})l_t$, and $\tau_{Lt}(\mathcal{P}^{\mathcal{A}})$ is given by (39). By assuming a sufficiently large value of $g_t(\mathcal{P}^{\mathcal{A}})$, we can ensure that (40) is always satisfied.

Stage 1: Polity Choice

The autocrat chooses to democratize if condition (32) is met. The autocrat therefore needs to know what consumption the landed household realizes under peaceful democracy. The reasoning above makes this

issue trivial. The autocrat knows that a democracy will tax at the upper bound if the income of a landed household is above the median level and zero otherwise. Elite income under peaceful democracy is:

$$c_{Lt}(\mathcal{P}^{\mathcal{D}}) = (1-\tau(\mathcal{P}^{\mathcal{D}}))r_t(\mathcal{P}^{\mathcal{D}})l_t + \frac{\tau(\mathcal{P}^{\mathcal{D}})[r_t(\mathcal{P}^{\mathcal{D}})L_t + w_t(\mathcal{P}^{\mathcal{D}})N_{Ht}]}{N_t}. \tag{41}$$

It follows that an autocrat peacefully concedes power if:

$$(1-\tau(\mathcal{P}^{\mathcal{D}}))r_t(\mathcal{P}^{\mathcal{D}})l_t + \frac{\tau(\mathcal{P}^{\mathcal{D}})[r_t(\mathcal{P}^{\mathcal{D}})L_t + r_t(\mathcal{P}^{\mathcal{D}})N_{Ht}]}{N_t} > [1-\tau_{Lt}(\mathcal{P}^{\mathcal{A}})]r_t(\mathcal{P}^{\mathcal{A}})l_t,$$

where $\tau_{Lt}(\mathcal{P}^{\mathcal{A}})$ is given by (39) and

$$\tau_t(\mathcal{P}^{D}) = \begin{cases} \bar{\tau} & \text{if } r_t(\mathcal{P}^{\mathcal{D}})l_t > w_t(\mathcal{P}^{\mathcal{D}}), \\ 0 & \text{otherwise.} \end{cases}$$

We are now in the position to state the implications of the above analysis. We start by proving the following lemma.

Lemma 2.

(i.) If the worker household's payoff under peaceful autocracy exceeds the expected payoff under revolt $\forall$ $\tau_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0,1]$*, then the unique subgame perfect equilibrium of the game is peaceful autocracy.*

(ii.) If $\exists\ \tau^*_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0,1]$ *such that the worker is indifferent between peaceful autocracy and revolt, then the unique subgame perfect equilibrium of the game is peaceful autocracy if* $c_{Lt}(\mathcal{P}^{\mathcal{A}}) > c_{Lt}(\mathcal{P}^{\mathcal{D}})$ *and peaceful democracy otherwise.*

(iii.) If the worker household's expected payoff under revolt exceeds the payoff under peaceful autocracy $\forall \tau_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0,1]$*, then the unique subgame perfect equilibrium of the game is peaceful democracy.*

Proof. Given in Appendix I.B. □

Lemma 2 suggests that revolt is never a subgame perfect equilibrium. If workers prefer peaceful autocracy to revolt as in case (i), this is obvious. If workers favor revolt over peaceful autocracy in the absence of income redistribution from the landed class, the autocrat compensates them by means of income transfers to make them indifferent between the status quo and revolting, as in case (ii). When compensating workers becomes too costly, the autocrat prefers to relinquish power since both a failed revolt and a successful revolt impose

losses on the landed class. If there is no tax rate that can dissuade workers from revolting, as in case (iii), the autocrat also opts for a peaceful transition to democracy. We summarize these insights in the following proposition.

Proposition 2. *The post-modernization subgame perfect equilibrium is either peaceful autocracy or peaceful democracy.*

Proof. The Proposition follows trivially from Lemma 2. □

Whereas Proposition 1 suggests that democratization always occurs after modernization as long as $\phi(0) = 0$, Proposition 2 suggests that democratic transitions are peaceful. Once the economy is modernized, it is optimal for the autocrat to either prevent revolt by means of income transfers to worker households, or, if the state of the economy is such that revolt cannot be prevented, to peacefully relinquish power. Since transitions to democracy are peaceful, democracy is an absorbing state. Once democratic, there are no groups that have an incentive to try to reinstate the autocracy, and hence there will be no attempts to overthrow the democratic regime.[14]

A relevant point to make before examining the quantitative predictions our theory is that peaceful autocracy may still be the subgame perfect equilibrium of the game even when the income of the landed household is below the average. The reason for this is that although the landed household would not be taxed in a peaceful democracy under this scenario, the rental price of land is always higher under an autocratic rule since the autocrat sets the barrier at its upper bound whereas the democracy does not implement one. This result is not likely, unless the probability of successful revolt is so low that the landed class need not make large transfers to the population to prevent them from revolting.

V. Model Calibration

In this section, we calibrate the model to match key features of Britain's political and economic developments from 1200 to 2000, and use this calibrated structure for the dual purpose of better understanding the mechanics of the model and quantifying the importance of various factors for Britain's modernization and democratization. Before assigning parameter values, it is necessary to identify the dates when Britain modernized and democratized. This task is not trivial as historical events are subject to interpretation.

[14] Diamond (1996) argues that to avoid the reverse waves of democratization described in Huntington (1991), consolidating existing democracies is key. In his view, this entails achieving a system of institutions such that all significant political actors (elites and masses) believe in the superiority of democracy over any other regime imaginable. Such a state will indeed prevail in our model.

Whereas thirty years ago economic historians almost universally agreed that living standards were constant prior to 1750, today a growing number of researchers, including Crafts and Harley (1992), Maddison (2007) and Broadberry, Campbell, Klein, Overton, and van Leeuwen (2015), argue that there was some growth, albeit weak, going back to 1200. For the purpose of the calibration, we take this revisionist view of Britain's development, but do not identify 1200 as the period in which Britain first modernized. Instead, we use the English literacy rates reported by Boucekkine et al. (2007) that are based on the research of Cressy (1980). They document that the literacy rate in England increased steadily from 10% of the adult population in 1530 to roughly 75% in 1860. In light of this, we interpret the first date that the modern technology is used to be the first part of the 16th Century, specifically the year 1530.

As for Britain's political development, there is an ongoing debate on whether Britain's democratization was peaceful and voluntary, or just peaceful. Acemoglu and Robinson (2006), for example, argue that fear of revolution was critical for extending the franchise in Britain whereas Lizzeri and Persico (2004) argue the opposite. As our model is an extension of Acemoglu and Robinson (2006), we subscribe to their interpretation of British political history. There is also much debate as to when Britain became a democracy. Britain clearly did not turn democratic overnight. There were three voting reforms in the 19th Century, *The First Reform Act of 1832*, *The Second Reform Act of 1867*, and *The Third Reform Act of 1884*, and another two in the first part of the 20th Century, *The Peoples Representation Act of 1918* and *The Peoples Representation Act of 1928*, implying equal franchise. Although it took until 1928 before the entire adult population had the right to vote, 60% of the adult male population were eligible to vote following the passage of *The Third Reform Act of 1884*.[15] In light of these events, we identify the date that Britain democratizes to be around 1890 and interpret the first two reform acts of the 19th century as concessions from the political elite to worker households.[16]

V.A Parameterization

In order to assign parameter values we must identify the empirical counterpart of the length of a model period as well as the initial period, $t = 0$. Given that each generation lives for a single period, the empirical counterpart of a model period is taken to be 30 years. The choice of starting period is not particularly

[15] *The First Reform Act of 1832* expanded the franchise from 492,700 to 806,000 individuals, which was about 15 percent of the population. *The Second Reform Act of 1867* extended the franchise from 1.36 million to 2.48 million. *The Third Reform Act of 1884* extended the franchise to roughly 60 percent of the adult male population. *The Peoples Representation Act of 1918* extended the franchise to all men over the age of 21 and most women over 30. *The People's Representation Act of 1928* extended the franchise to all women over the age of 21.

[16] Acemoglu and Robinson (2006) argue that the *The First Reform Act of 1832* was more of a concession than an attempt of establish a democratic society.

important but since data on population, GDP, and real prices are available from 1200 onwards, we choose this as our starting date.

Starting with parameters associated with the demographic side of the model, the initial population is normalized to 100. Thereafter the population is set to match the actual population growth of England from 1200 to 2010. The population data from 1200 to 1860 are taken from Clark (2010), whereas the more recent data are taken from *Census Population Estimates*. The measure of landed households is based on estimates of the number of families that belonged to the class of great landlords and gentry in the 1550-1790 period as reported by Mingay (1963) and Rosenheim (1998). To arrive at a number of landed elites, we multiply the number of families by the average family size of 4.75 as reported by Rosenheim (1998, p. 16). For model periods prior to 1550, we assume that the number of landed households is such that the ratio of landed households to the total population remains at its 1550 value of 2%. For model periods after 1790, we assume that the absolute size of the landed class remains at its 1790 value.

In terms of endowments, the stock of land is set equal to the total arable land acreage reported by Mingay (1963) for 1715 and 1815 and by Bateman (1878) for 1877. Land per landed household in the model is the total arable acreage divided by the number of landed households yielding 230 acres in 1715, 284 acres in 1815 and 296 acres in 1877. For years before 1715, the total stock of land is set to its 1715 value and for years after 1877, it is kept at its 1877 value.

On the technology side, TFP in the traditional sector is normalized to one, as we are free to choose the units in which output is measured. For modern-sector TFP, its 1530 value is set to ensure that 1530 is the first period that the modern technology is used. Prior to 1530, the level of TFP in the modern sector is unimportant and simply kept low enough that the switch condition (10) is not met. Between 1530 and 1860, TFP growth in the modern sector is calibrated to roughly match adult population literacy rates over that period. After 1900, the modern sector TFP growth rates are calibrated to match growth rates of GDP per capita for Britain as reported by Maddison (2007). The growth rates of TFP in the traditional sector are set to match the growth of GDP per capita in England from 1200 to 1700 as reported by Broadberry et al. (2015) and from 1700 to 1900 as reported by Maddison (2007). Thereafter, the growth rate of modern sector TFP is kept at its 1900 value. The reason we switch strategy for assigning the TFP growth rates in the modern and traditional sectors in the year 1900 is that literacy rates were near 100% in Britain in 20th century, and hence provide very little guidance in restricting the growth rate of TFP in the modern sector. The logarithms of TFP levels for the traditional and modern technologies from 1200 to 2010 are displayed in Figure II. Finally, the share parameter in the traditional technology, α, is set to 2/3, which is roughly the

relative share of land and labor in the pre-1700 period as reported by Clark (2010).

[FIGURE II ABOUT HERE]

Turning to the law of motion for democratic capital, given that the empirical counterpart of a model period is 30 years we set $\delta = 1$. This implies that the democratic capital of the next generation depends entirely on the number of worker households that went to school in the previous period. This is advantageous for two reasons. First, it implies that the empirical counterpart of democratic capital in the model is the lagged education level of the population. Second, it leads to a very natural choice for the functional form of $\phi(D_t)$, the probability the revolt succeeds. Recall, that we require that $\phi(0) = 0$, so as to prove that peaceful autocracy is the only sub-game perfect equilibrium pre-modernization, and we require that $\phi'(D_t) > 0$ so that education increases *de facto* power. Additionally, we require the probability of successful revolt to be one when the entire labor force is educated. As democratic capital per worker household is $.5A_D$ when all worker households are educated, a simple function that satisfies these three conditions is

$$\phi(D_t) = \frac{.5A_D - (.5A_D - D_t/N_{Ht-1})^{\eta}}{.5A_D} \tag{42}$$

where $\eta > 0$ ensures $\phi'(D_t) > 0$. Given the specification (42), $\phi(0) = 0$ requires $A_D = 2.0$ for any value $\eta > 0$ other than $\eta = 1$. To restrict the value of η, we match the democratization date predicted by the model to 1890, the closest model date to the passage of *The Third Reform Act of 1884*. This implies $\eta = 1.75$.

On the policy side, we set the upper bound on the barrier to $\bar{\pi} = 0.01$. Since the product $(1 - \pi_t)A_{Mt}$ is what matters for determining the date of modernization, choosing some other value for $\bar{\pi} > 0$ would only mean resetting the value of A_{Mt} in the period corresponding to 1530. As we shall want to explore how a greater ability to erect barriers affects a country's development and polity trajectories, we set this upper bound to a low number rather than a high number to allow for greater differences in this regard. The assignment of a low upper bound for the barrier in the benchmark is consistent with the hypotheses of several economists and historians such as North and Thomas (1973) that argue the rulers of Britain, at least after the *Glorious Revolution* in 1688, were far more constrained in their ability to enact growth-inhibiting policies than rulers in other countries.[17]

We set the upper bound on the income tax rate under peaceful democracy, $\bar{\tau}$, to .71, to match the sum of the income tax plus the surtax on the top income marginal tax rate in England in the first part of the 20th

[17] We do not use $\bar{\pi} = 0$ for the simple reason that it implies no differences in land rental prices or wages between the two polities.

Century. For the corresponding upper bound in the case of a successful revolt, it is assumed to be twenty percent higher than the maximum rate under peaceful democracy, i.e., $\bar{\bar{\tau}} = 1.2\ \bar{\tau} = .85$. As this assignment is not based on data, we shall want to examine the sensitivity of the results to alternative values for $\bar{\bar{\tau}}$. This completes the calibration.

In light of the calibration strategy, it is not possible to use the modernization- and democratization date predictions to assess the plausibility of our theory. Nor can we use growth rates of per capita GDP or literacy rates as these observations likewise were used in the parameterization. We can, however, use rental rates, wages, tax rates and the probability of revolts for this purpose.

Wage rates and land rental rates predicted by the model are shown in Figures III and IV. For comparison, time series data on English real wages and real rents from Clark (2002) and (2007) are plotted alongside the predictions.[18] All four series are normalized to one in 1800. Whereas the model performs poorly on a period by period basis, it is consistent with the general long run trends. Its ability to match the data is most problematic in the pre-1550 period, as it fails to generate the large increase in real wages and the large decline in land rental rates that followed the *Black Death*.[19]

[FIGURES III AND IV ABOUT HERE]

Turning to the political side of the model, Figure V depicts the probability that revolt succeeds along the equilibrium path. As shown, this probability increases from 0% before 1560 to 75% by 1860, the last period of autocracy. Judging the plausibility of the model along this dimension is obviously difficult for lack of a real world statistical counterpart and in light of the aforementioned debate on whether Britain's democratization was voluntary or not. The interpretation of British political history given by Acemoglu and Robinson (2006) does suggest a very high threat of revolt in the 19th century.

Finally, Figure VI depicts the time path of the tax rate for the economy. Prior to 1890, the tax rate is set by the autocrat and applies only to land rents. As can be seen, the model predicts a tax rate of 0% up until 1530. This follows from the assumption that $\phi(0) = 0$. In 1560, the first period in which there is a positive chance that revolt succeeds, the tax rate is 13%. As workers become more educated, this tax rate rises to 24% in 1620, 36% in 1740, 53% in 1800, and 61% in 1860, which is the last model period the country is autocratic. In terms of the record of historical tax rates, those who occupied land were subject to a land

[18] The real wages and real rent data prior to 1550 are actually taken from Hansen and Prescott (2002), which are based on Clark (1998).

[19] One thing to consider in making these comparisons is that the accounts used by Clark (2013) when constructing these series are consistent with a stagnant British economy between 1200 and 1650. This stands in sharp contrast to Broadberry et al. (2015), whose estimates of GDP are used in the model calibration. The fact that our model does not match the estimates by Clark (2013) for wages and rents is therefore not particularly surprising.

tax, initiated in 1692, poor law taxes, initiated in 1572, and a window tax, initiated in 1707. Although rates for each of these three types of taxes are not readily available, Clark (2010) reports indirect taxes from 1200 to 1860, which include the aforementioned taxes as well as taxes on commodities such as beer, wine and candles, to name a few. Thus, the indirect taxes reported by Clark (2010) constitute an upper bound on taxes on landed households. Dividing indirect taxes by the land rents in Clark (2010), yields an average tax rate of 0% prior to 1550, which then steadily rises for the next three centuries, to 2.6% in 1600, 19% in 1700, 64% in 1800 and to 70% in 1860. Thus, the model tends to slightly over predict the tax rate on land rents, particularly in the period 1560 to 1700. Still, given the simplicity of the model, it is rather surprising that the model does this well on this dimension.

[FIGURES V AND VI ABOUT HERE]

VI. Comparative Development and Polity Paths

We next undertake a series of numerical exercises with the dual purpose of better understanding the mechanics of the model and quantifying the importance of various factors for Britain's modernization and democratization. We begin by eliminating the channel by which education affects the *de facto* power of the masses by assuming that ϕ is a constant for all time starting in 1200. We recompute the political and economic equilibrium of the model keeping all other parameters fixed at their benchmark levels. Although the date of modernization is clearly unaffected by this change, the date of democratization is. Democratization dates are shown in Table IV. In the extreme case where $\phi(D_t) = 0$ for all $D_t \geq 0$ we find the country never democratizes. This is not entirely surprising. If revolt is sure to fail, the autocrat never has to transfer any income to the masses. Moreover, the consumption of the landed household is always greater under peaceful autocracy than peaceful democracy, even when its income is below the average as it is in 1980, on account that the barrier ensures that the rental rate on land is always greater under peaceful autocracy. For $\phi > 0$, democratizes happens in finite time. For constant probabilities less than .30 , democratization is delayed 90 years, i.e., three model periods. Absent the *de facto* power channel of education, the probability of a successful revolt would have to be 75% to generate an 1890 democratization date. Taken as a whole, these findings suggest a large quantitative role for the *de facto* power channel of education as contrasted with the income channel that works by altering the income distribution.

[TABLE IV ABOUT HERE]

We next study the implications of shutting down growth in the modern sector. The results are dramatic in suggesting that a country never democratizes. Without growth in modern-sector TFP, the population never acquires any human or democratic capital, implying that the masses never gain any *de facto* power. Compared to the experiment above, however, land rental income continues to rise as there is population growth, and so at no date does the income of a landed household fall to a point where it is below the average income of the economy, implying that landed households are always net contributors to the tax and transfer system under democracy. Therefore, there is no income channel effect of education in play, meaning that peaceful democracy is far less likely to be a subgame perfect equilibrium of the game even in the case where $\phi(0) > 0$, as studied above. As growth fueled by the traditional sector does not lead to democratization, this result suggests that increases in income alone are not sufficient for democratic transitions to occur.

Next, we assess the effects of changes in land inequality, a factor that has been identified by a number of researchers as crucial for democratization.[20] We consider changes in land inequality under two different scenarios. In the first, we keep the population, N_t, the same in each period, but assume a greater fraction for N_{Lt}/N_{Ht}. In the second, we keep the proportion of landed and working households, N_{Lt}/N_{Ht}, the same as in the benchmark, but assume a larger total population, N_t, in each period. The stocks of land L_t are kept at the benchmark values in both experiments. The implications for modernization dates and democratization dates are shown in Table V. Panel (a) shows the results as N_{Lt}/N_{Ht} is increased, keeping N_t the same, whereas panel (b) displays the results as N_t is increased keeping N_{Lt}/N_{Ht} at the benchmark values. The first row in both panels is the benchmark.

[TABLE V ABOUT HERE]

Panel (a) reveals that greater land equality associated with having more landed households and fewer worker households tends to delay the modernization date but has no effect on the democratization date. In contrast, panel (b) shows that greater land equality associated with having more landed households as well as more worker households hastens both the democratization date and modernization date. Understanding these results is straightforward. Starting with panel (a), where the total population is unchanged, a greater fraction of landed households increases the wage paid by Malthusian firms and lowers the rental rate of land. The higher wage implies an increase of the left-hand side of the switch condition (10), thereby delaying the date of modernization (or, if not delaying the modernization date as in rows 2 &3, resulting in a smaller fraction of households migrating). The democratization date is not affected, however. Income of a landed

[20] See, for example, ? (?) and references therein.

household is lower in each period, as land holdings per landed household and total land rents are smaller. However, because there are fewer workers, less income has to be transferred to deter worker households from revolting. Moreover, when modernization is delayed, the stock of democratic capital is lower in each period, meaning that the threat of revolt is weaker and that smaller concessions are needed to deter revolt. The results suggest that these effects cancel out so that the democratization date is unaffected.

In the alternative case shown in panel (b), the first effect is not present. Instead, as the population of worker households increases in proportion to the population of landed household, the marginal product of labor in Malthus falls when all worker households are employed there, whereas the marginal product of land increases. Therefore, the left-hand side of the switch condition (10) decreases, implying that modernization happens earlier. Democratization also happens earlier for three reasons. First, even though total land rents are higher, income per landed household will be lower on account of there being more elites. Second, there are more workers requiring transfers not to revolt. Third, since modernization happens earlier, the probability of revolt is higher in any given period post-modernization, meaning that each worker will require a larger transfer. All three forces are conducive to democratization. Taken together, our results support the hypothesis emphasized by a number of researchers such as ? (?) that the primogeniture system, by preserving land inequality, was an effective way by which the landed class was able to maintain power for centuries in a world with a growing population.

Next, we consider how the modernization and democratization dates depend on the ability of the autocrat to slow down modernization, as reflected by the upper bound on the barrier, $\bar{\pi}$. The results, displayed in Table VI, reveal that greater barriers delay the modernization and democratization dates with potentially large consequences. In the case when $\bar{\pi} = .90$, for instance, modernization occurs in 2010 and democratization in 2040. The relation in the table is monotonic, but this is not always the case. In fact, a non-monotonic relation is apparent in the case that η is calibrated to a 1920 democratization date ($\eta = 1.0$) and a 1950 democratization date ($\eta = 0.25$). These findings are displayed in Table VII. A slightly stronger autocrat, who is able to delay modernization longer, can actually hasten democratization. For both $\eta = 1.0$ and $\eta = 0.25$, democratization happens one period earlier for all $.05 \leq \bar{\pi} \leq .04$ than in the weakest case when $\bar{\pi} = .01$. For stronger autocracies, $\bar{\pi} > .40$, the date of democratization is increasing in $\bar{\pi}$.

[TABLES VI AND VII ABOUT HERE]

The intuition for this non-monotonicity is as follows. Although a larger barrier can delay modernization and lower the *de facto* power of the masses and hence the probability of revolt, it translates into a larger

differential in the wage the worker household realizes under successful revolt relative to failed revolt. When $\bar{\pi} = 0.01$, the differential is practically non-existent. For a given probability of successful revolt, $\phi(D_t)$, the expected income of the worker is therefore higher for a larger barrier, implying that the landed class must transfer more of their income to deter revolt. When the probability of successful revolt is sufficiently high, the amount of transfers needed to maintain peaceful autocracy can be so large that the autocrat prefers to relinquish power at an earlier date, compared to when he has almost no ability to erect barriers to the modern sector. This possibility can only arise for relatively small barriers, however. For barriers so large that they delay modernization until after the democratization date that would prevail under $\bar{\pi} = 0.01$, this can never happen because the probability of successful revolt is zero for all periods before and including the date of modernization. The wage differentials between successful and failed revolt do not matter when $\phi(D_t) = 0$. This applies in Table VI for $\bar{\pi} \geq .4$. Notice that, for $\bar{\pi} \geq .4$, democratization happens the first period that $\phi(D_t) > 0$. In Table VII, this applies for $\bar{\pi} \geq .5$ in the case $\eta = 1.0$ and for $\bar{\pi} \geq .7$ in the case $\eta = .25$. [21]

Table VII also shows how our results depend on the curvature parameter, η, in the probability function of a successful revolt (42). Reading across rows, Table VII shows the democratization date happens earlier when we have a strictly convex function as opposed to either a linear or strictly concave one. These findings are intuitive as a larger value for η is associated with a more rapid increase in the *de facto* power of the masses. Because the switch condition is unaffected by the probability of a successful revolt, the modernization date is obviously unaffected.

Next we vary the upper bound on the tax rate that can be implemented under democracy, $\bar{\tau}$. We first do this maintaining the assumption that $\bar{\bar{\tau}} = 1.2\bar{\tau}$, then relax it so as to keep the value $\bar{\bar{\tau}} = .85$, which is the benchmark. Tax rates clearly do not enter the switch condition, and hence the modernization date is not affected by any changes to these upper bounds. Moreover, only non-proportional changes in the tax rates lead to a change in democratization dates. For this reason, Table VIII only reports the results for the second experiment. As the table reveals, increasing the gap between the tax rates under peaceful democracy and successful revolt leads to earlier democratization. For example, keeping $\bar{\bar{\tau}} = .85$ while lowering $\bar{\tau}$ to .25 makes democratization occur 9 model periods earlier, corresponding to the year 1620. The intuition for these results is as follows. A higher $\bar{\bar{\tau}}$, ceteris paribus, increases the worker household's expected return to revolt

[21] It is important to note that these results depend importantly on the *de facto* power of the masses being an increasing function of democratic capital. If we were to shut down this channel, as we did earlier by assuming $\phi(D_t) = 0$ for all $D_t \geq 0$, the non-monotonic association disappears. Moreover, there are much greater differences between the dates of modernization and democratization when the upper bound of barriers is greater. For example, for $\bar{\pi} = .80$, modernization still occurs in 1980, but democratization is pushed back 4 model periods to 2010.

and hence increases the concessions the autocrat must make to deter revolt, lowering the payoff of the landed elite under peaceful autocracy, and making it more likely that the autocrat will relinquish power. A higher $\bar{\tau}$, ceteris paribus, lowers the consumption a landed household realizes under peaceful democracy, making it less likely that the autocrat will relinquish power. When both upper bounds are adjusted in proportion, the two forces tend to offset each other so that democratization dates remain the same. However, when only the upper bound under peaceful democracy is increased, democratization is delayed, as only the second effect is present.

[TABLE VIII ABOUT HERE]

Lastly, we consider how democratic transitions are shaped by the education system by varying the productivity parameter A_D. This experiment is motivated by numerous researchers such as Guriev and Treisman (2015) who suggest that some autocratic leaders have used school curricula to create a more obedient population by emphasizing nationalistic or religious values. Specifically, Guriev and Treisman (2015) note that, rather than relying on oppression, many modern autocrats, such as Russian president Putin, Turkish president Erdoğan and former Venezuelan president Chávez, have stayed in power by signaling competence in ruling, as conveyed to the public through various channels. They recognize (p. 4) that one possibility is making school curricula more patriotic and sending the message that the ruler is ideally suited to protect the country from foreign threats. Such policies would be reflected in a lower value for A_D.

Given that we have imposed the condition $\phi(0) = 0$, we need to slightly alter the probability function when considering alternative values of A_D. It is natural to interpret the benchmark $A_D = 2.0$ as an upper bound on this parameter, associated with an educational system conducive to democratic ideas. To allow for the possibility that $A_D < 2.0$, we consider the following probability function:

$$\phi(D_t) = \frac{.5\tilde{A}_D - (.5\tilde{A}_D - D_t/N_{Ht-1})^{\eta}}{.5\tilde{A}_D} \tag{43}$$

where $\tilde{A}_D = 2.0$ and $D_t = A_D N_{Mt-1} e_{t-1}$. Table X shows the modernization and democratization dates for this alternative probability function as we consider $A_D < 2$. For the reasons discussed above, the modernization date is unaffected by changes in A_D. The democratization date is affected, however, with almost a century delay for $A_D < .5$.

[TABLE X ABOUT HERE]

There are a number of important lessons to take away from these exercises. First, our theory suggest a

large quantitative role for education in the timing of democratization by affecting the *de facto* power of the masses. Without this effect, democracy would be delayed for century. Second, it suggests that high income alone is no panacea for democratization: income and democracy are only positively related when economic growth is fueled by skill-based, rather than traditional, sectors. Third, it shows how greater land equality hastens democratization and provides a theoretical rationale for the primogeniture system as a way by which the landed class could maintain political control . Fourth, it suggest that democratization is more likely to happen later with extremely weak and extremely strong autocratic rulers. Fifth, it justifies the educational and nationalistic reforms implemented in such countries as Saudi Arabia, Russia, Turkey, and Venezuela as a quantitatively important manner to delay the demographic transformation by almost a century.

VII. Concluding Remarks

This paper has put for a unified theory of growth and polity whereby education plays a key and novel role in determining a country's development and political trajectories. Education hastens the date at which an autocracy peacefully transitions to democracy by changing the distribution of income and the *de facto* power of workers. By calibrating the model to Britain's economic and political developments going back to 1200, it has quantified the importance of education on Britain's democratization date. Through the *de facto* power channel, the computational experiments suggest that education hastened democratization by a century or more in Britain's case. It has also shown that growth generated by the traditional sector is not likely to hasten democratization, suggesting that income is not always a good predictor of democracy. This finding may be particularly relevant for understanding the difficulty of democracy to take hold in many Latin American countries whose economies have been dependent on the export of agricultural goods and precious medals. It has further shown the quantitative importance of land inequality and the primogeniture system in particular in delaying democratization until the last two centuries. Additionally, it has shown how manipulation of the educational curricula to favor nationalistic or religious ideals can be an effective way by which autocratic regimes can maintain power for an additional century. In addition to providing insight for the lack of democratic progress in some moderately developed countries including Russia, Turkey, and Venezuela, this last result may also be useful in understanding the rich and enigmatic China with its Confuscianistic emphasis on obedience to the state. Finally, the paper has contributed to the empirical literature by strengthened the findings of Bobba and Coviello (2007) that education predicts democracy and by showing that only primary education predicts democracy matters in this regard.

There are a number of directions for future research. First, it may be desirable to introduce physical capital to the model for the purpose of extending the calibration exercise. Second, it might be interesting to exploit the within period heterogeneity of worker households with regard to education for the purpose of generating conflict under democracy. Those with education would constitute a new political base - the industrial elite. With heterogeneity across worker households, there is the possibility that rural and urban households have different preferences over taxes and barriers. It is easy to think that educated workers, to the extent that they reside in urban areas and government centers, could take control of the polity, even though they might represent less than 50 percent of the working population. Naturally, this political constituency would erect barriers to education, in a sort of insider/outsider set-up. This added feature of an educated urban worker class may prove useful for developing a theory of why some countries transition back from democracy to autocracy. Another possible extension is to allow for democratic capital to be affected by other factors besides education such those proposed by Persson and Tabellini (2009). Trust and cooperation may be natural factors to consider in this regard. It could be that a history of autocratic policies that hurt the worker population reduce democratic capital and increase political polarization. One could imagine that this could give rise to violent democratizations and unstable democracies. There are also some obvious empirical tests of our theory to undertake, such as examining whether extremely weak and extremely strong autocratic countries have democratized later. These are some of the issues we hope to address in the near future.

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Figures

FIGURE I: THE GAME

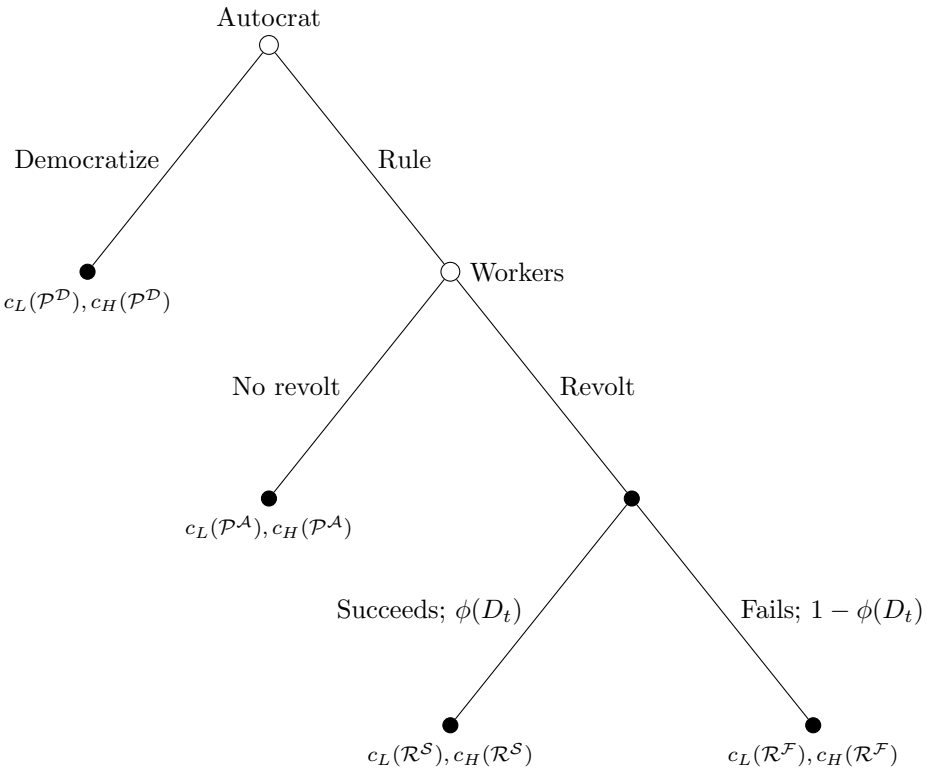


FIGURE II: TIME PATHS (LOGS) FOR TRADITIONAL (A_T) AND MODERN (A_M) TFP

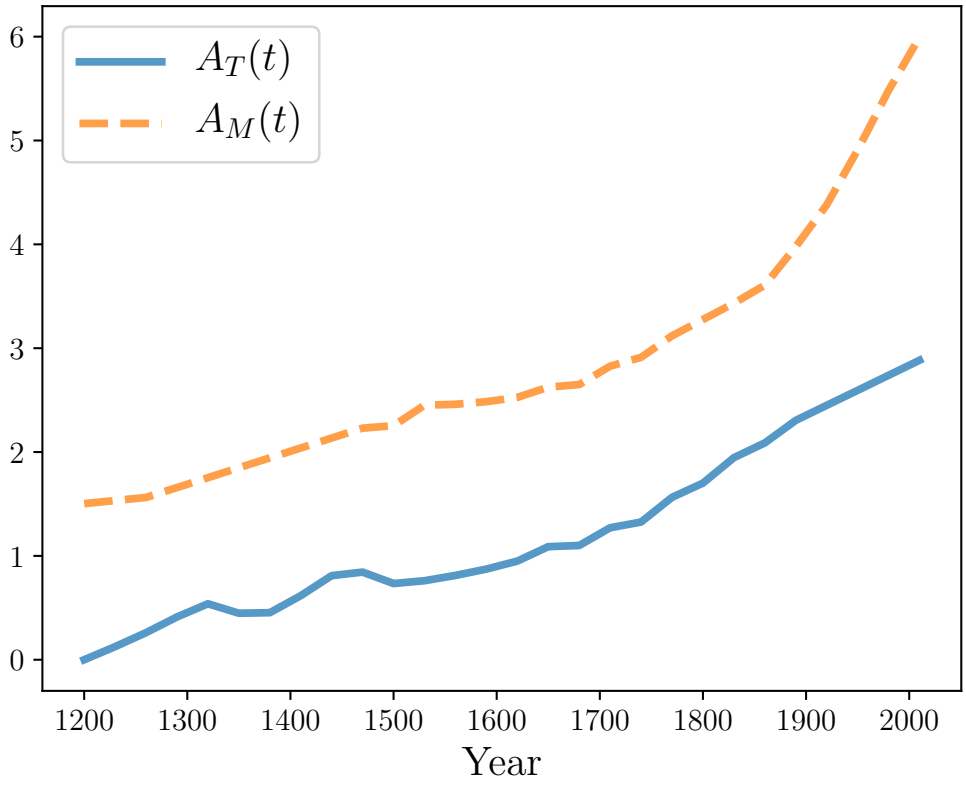


Figure III: Model vs. Data for Wages

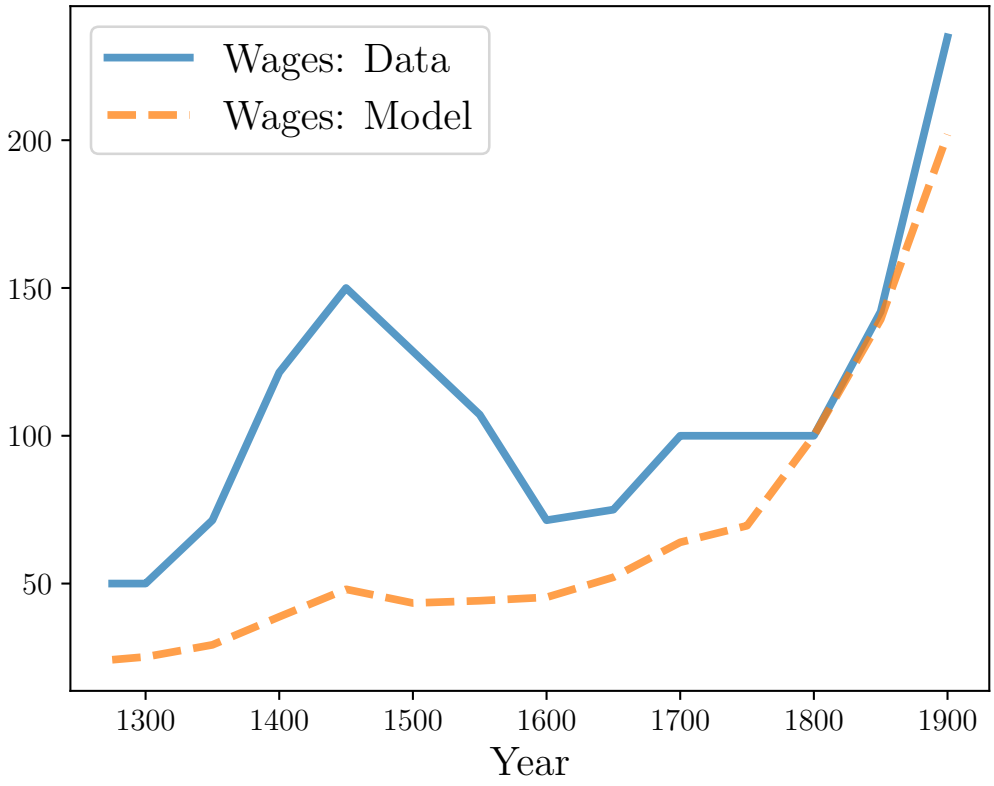


FIGURE IV: MODEL VS. DATA FOR RENTS

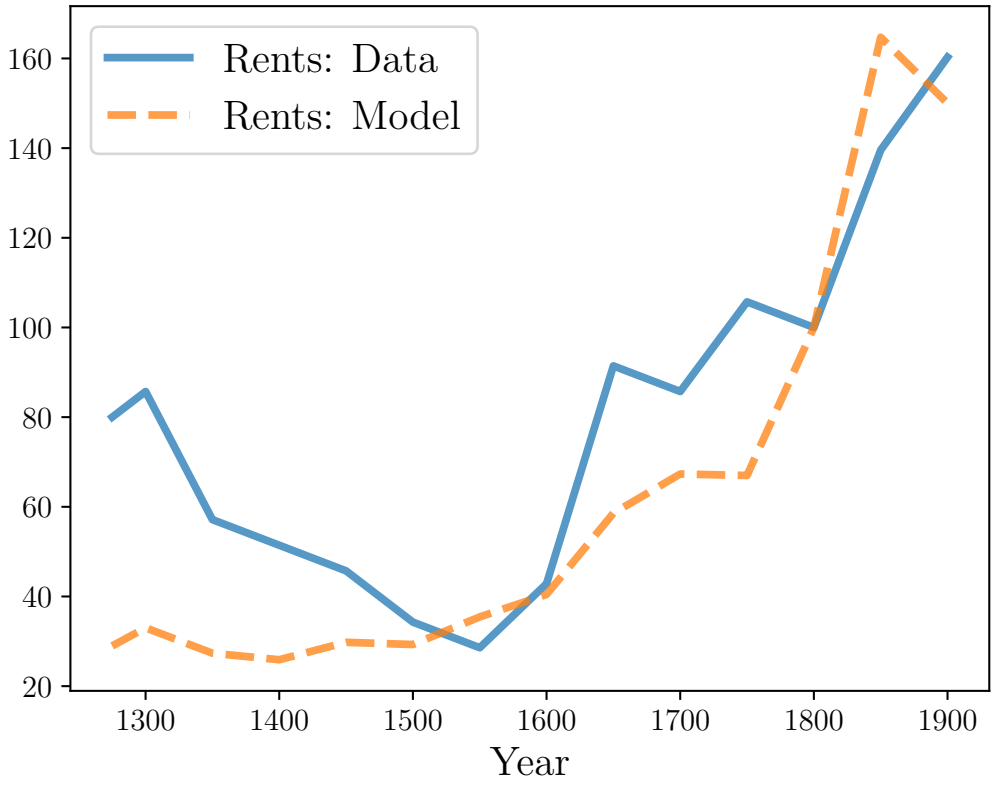


Figure V: Probability of Success

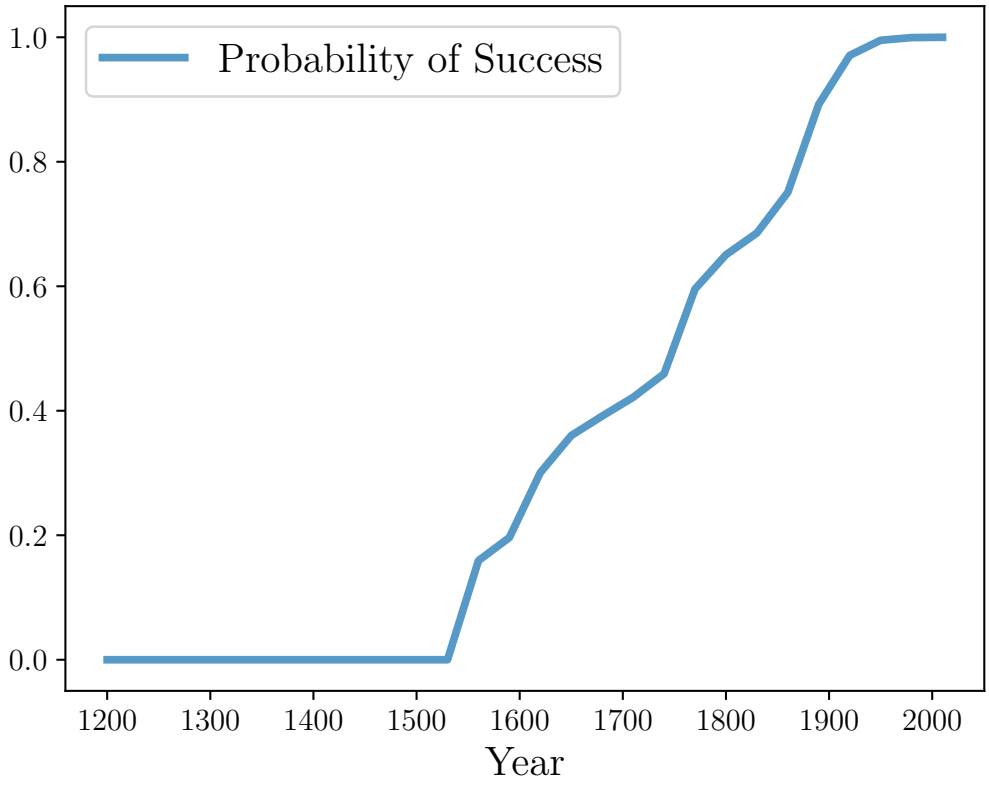
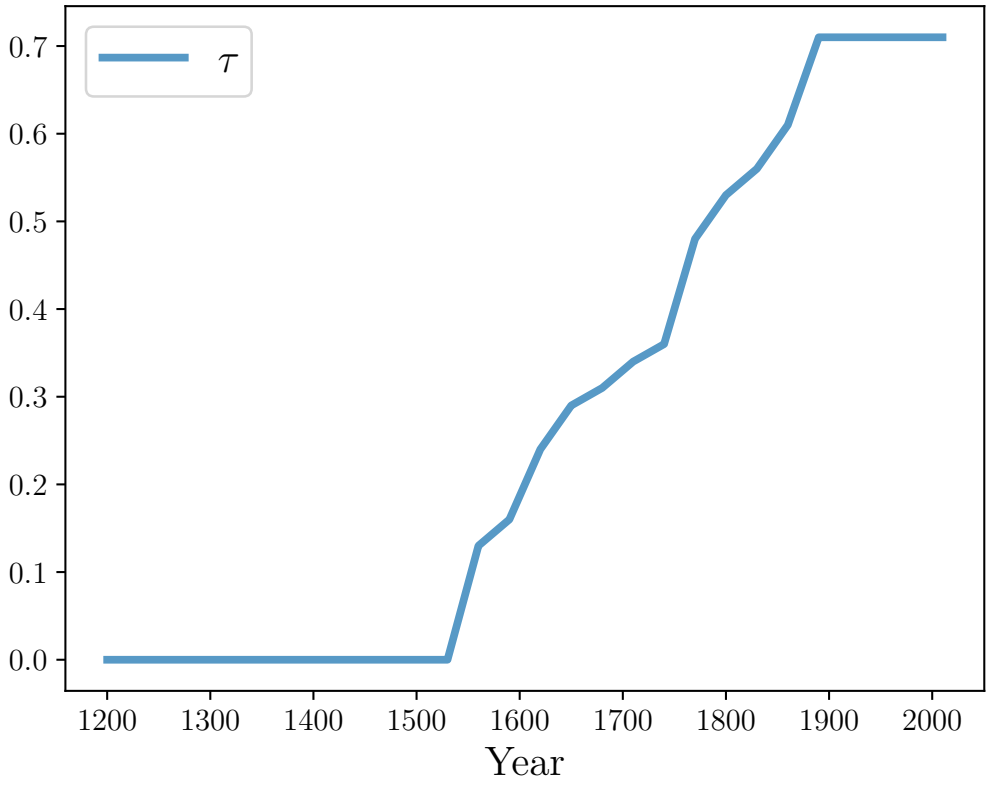


FIGURE VI: TAXES (τ)



Tables

TABLE I: Freedom House [0,1] Measure of Democracy as Dependent Variable

	(1) OLS	(2) FE	(3) DGMM	(4) SGMM	(5) OLS	(6) FE	(7) DGMM	(8) SGMM
Democracy $_{t-1}$	0.709***	0.385***	0.507***	0.628***	0.706***	0.379***	0.489***	0.565***
	(0.035)	(0.053)	(0.096)	(0.056)	(0.035)	(0.051)	(0.085)	(0.054)
Education $_{t-1}$	0.027***	-0.005	-0.017	0.030***				
	(0.004)	(0.019)	(0.022)	(0.007)				
Log GDPpc $_{t-1}$					0.072***	0.010	-0.129*	0.116***
					(0.010)	(0.035)	(0.076)	(0.017)
Hansen J Test [p]			[0.2]	[0.15]			[0.26]	[0.16]
AR(2) Test [p]			[0.8]	[0.63]			[0.45]	[0.3]
Obs.	765	765	667	765	945	945	838	945
No. of countries	108	108	104	108	150	150	127	150
No. of instruments			50	93			55	118
Adj. R^2	0.71	0.74			0.72	0.75		

Notes:

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE II: Freedom House [0,1] Measure of Democracy as Dependent Variable. Additional Controls

	(1) OLS	(2) OLS	(3) FE	(4) FE	(5) DGMM	(6) DGMM	(7) SGMM	(8) SGMM
Democracy $_{t-1}$	0.634***	0.625***	0.369***	0.351***	0.510***	0.499***	0.598***	0.561***
	(0.042)	(0.044)	(0.054)	(0.055)	(0.094)	(0.097)	(0.054)	(0.059)
Education $_{t-1}$	0.015***	0.012**	-0.012	-0.007	-0.013	-0.020	0.025**	0.033**
	(0.005)	(0.005)	(0.019)	(0.020)	(0.026)	(0.026)	(0.013)	(0.014)
Log GDPpc $_{t-1}$	0.054***	0.047**	-0.012	-0.001	-0.187*	-0.121	0.015	-0.011
	(0.017)	(0.020)	(0.042)	(0.049)	(0.110)	(0.182)	(0.035)	(0.044)
Hansen J Test [p]					[0.31]	[0.09]	[0.20]	[0.10]
AR(2) Test [p]					[0.96]	[0.87]	[0.79]	[0.92]
Add. Controls	NO	YES	NO	YES	NO	YES	NO	YES
F-Test [p]		[0.10]		[0.28]		[0.33]		[0.22]
Obs.	684	676	684	676	595	589	684	676
No. of countries	97	95	97	95	93	92	97	95
No. of instruments					51	57	91	78
Adj. R^2	0.69	0.69	0.72	0.72				

Notes:

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Additional controls: Log population $_{t-1}$, median age $_{t-1}$ and different age ranges (fractions) $_{t-1}$.

TABLE III: Freedom House [0,1] Measure of Democracy as Dependent Variable. Components of Education

	(1) OLS	(2) FE	(3) DGMM	(4) SGMM
Democracy $_{t-1}$	0.673***	0.399***	0.534***	0.525***
	(0.038)	(0.053)	(0.092)	(0.064)
Primary Education $_{t-1}$	0.024***	-0.012	0.031	0.057***
	(0.006)	(0.025)	(0.034)	(0.017)
Secondary Education $_{t-1}$	-0.010	-0.009	-0.006	-0.022
	(0.010)	(0.025)	(0.027)	(0.020)
Tertiary Education $_{t-1}$	-0.001	-0.062	-0.065	0.028
	(0.047)	(0.088)	(0.150)	(0.072)
Log GDPpc $_{t-1}$	0.056***	-0.000	-0.073	0.056*
	(0.014)	(0.039)	(0.122)	(0.029)
Hansen J Test [p]			[0.53]	[0.34]
AR(2) Test [p]			[0.95]	[0.87]
Obs.	825	825	746	825
No. of countries	122	122	106	122
No. of instruments			58	100
Adj. R^2	0.73	0.75		

Notes:

Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

TABLE IV: Comparative Statics for Different (Constant) Values of $\phi(D_t)$

$\phi(D_t)$	Democratization
0.0	∞
0.1	1980
0.2	1980
0.3	1950
0.4	1950
0.5	1950
0.6	1920

TABLE V: Comparative Statics for Different Values of Land Inequality

Panel (a)	N_L/N	Modernization	Democratization
	2%	1530	1890
	4%	1530	1890
	8%	1530	1890
	16%	1590	1890
	32%	1650	1890
Panel (b)	N_0	Modernization	Democratization
	100	1530	1890
	200	1500	1710
	400	1200	1560
	800	1200	1470

TABLE VI: Comparative Statics for Different Values of $\bar{\pi}$

$\bar{\pi}$	Modernization	Democratization
0.01	1530	1890
0.05	1590	1890
0.1	1710	1890
0.2	1830	1890
0.3	1860	1920
0.4	1890	1920
0.5	1920	1950
0.6	1920	1950
0.7	1950	1980
0.8	1980	2010
0.9	2010	2040

TABLE VII: Non-monotonic relation of $\bar{\pi}$ for different values of η

	$\eta = 1.0$		$\eta = 0.25$	
$\bar{\pi}$	Modernization	Democratization	Modernization	Democratization
0.01	1530	1920	1530	1950
0.05	1590	1890	1590	1920
0.1	1710	1890	1710	1920
0.2	1830	1890	1830	1920
0.3	1860	1920	1860	1920
0.4	1890	1920	1890	1950
0.5	1920	1950	1920	1950
0.6	1920	1950	1920	1950
0.7	1950	1980	1950	1980
0.8	1980	2010	1980	2010
0.9	2010	2040	2010	2040

TABLE VIII: Comparative Statics for Different Values of $\bar{\tau}$

$\bar{\tau}$	Modernization	Democratization
0.71	1530	1890
0.67	1530	1890
0.5	1530	1770
0.33	1530	1650
0.25	1530	1620
0.1	1530	1560

TABLE IX: Comparative Statics for Different Values of A_D

A_D	Modernization	Democratization
2	1530	1890
1.5	1530	1920
1	1530	1980
0.5	1530	1980
0.25	1530	1980

TABLE X: Comparative Statics for Different Values of A_D

A_D	Modernization	Democratization
2.0	1530	1890
1.5	1530	1890
1.0	1530	1920
0.5	1530	1950
0.25	1530	1980
0.10	1530	1980

Appendices

I. Proofs and Derivations

I.A Proof of Lemma 1

Differentiating (30) with respect to π_t, taking into account that w_t and r_t depend on the barrier, we obtain:

$$\frac{\partial c_{Ht}(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} = \Big(1 - \bar{\tau} + \bar{\tau}\frac{N_{Ht}}{N_t}\Big)\frac{\partial w_t(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} + \bar{\tau}\frac{L_t}{N_t}\frac{\partial r_t(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t}.$$

Using $N_t = N_{Lt} + N_{Ht}$ and re-arranging, we obtain:

$$\frac{\partial c_{Ht}(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} = \frac{\partial w_t(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} - \bar{\tau}\frac{N_{Lt}}{N_t}\Big(\frac{\partial w_t(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} - l_t\frac{\partial r_t(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t}\Big). \tag{I.1}$$

Equation (12) implies:

$$\frac{\partial w_t(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} = -\frac{A_{Mt}}{4}.$$

To compute $\partial r_t(\mathcal{P}^{\mathcal{D}})/\partial \pi_t$, we need to solve for r_t in reduced form. Plugging (13) into (8) we obtain:

$$r_t(\mathcal{P}^{\mathcal{D}}) = (1-\alpha)A_{Tt}\left(\frac{(1-\pi_t)A_{Mt}}{4\alpha A_{Tt}}\right)^{-\frac{\alpha}{(1-\alpha)}}.$$

This implies:

$$\frac{\partial r_t(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} = \left(\frac{(1-\pi_t)A_{Mt}}{4\alpha A_{Tt}}\right)^{-\frac{1}{(1-\alpha)}}\frac{A_{Mt}}{4}.$$

Using these expressions in (I.1) and re-arranging, we obtain

$$\frac{\partial c_{Ht}(\mathcal{P}^{\mathcal{D}})}{\partial \pi_t} = -\frac{A_{Mt}}{4}\left[1 - \bar{\tau}\frac{N_{Lt}}{N_t}\left(1 + l_t\Big(\frac{(1-\pi_t)A_{Mt}}{4\alpha A_{Tt}}\Big)^{-\frac{1}{(1-\alpha)}}\right)\right].$$

Since N_{Lt}/N_t is a small number, we may assume that the term within square brackets is positive, which suggests that $\partial c_{Ht}(\mathcal{P}^{\mathcal{D}})/\partial \pi_t < 0$ under reasonable assumptions. This suggests that $\pi_t(\mathcal{P}^{\mathcal{D}}) = 0$. □

I.B Proof of Lemma 2

Consider first case (i), when $c_{Ht}(\mathcal{P}^{\mathcal{A}}) > \phi(D_t)c_{Ht}(\mathcal{R}^{\mathcal{S}}) + (1-\phi(D_t))c_{Ht}(\mathcal{R}^{\mathcal{F}})\ \ \forall \tau_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0,1]$ so that there is no threat of revolt to the autocratic regime. The autocrat will maintain power as long as $c_{Lt}(\mathcal{P}^{\mathcal{A}}) > c_{Lt}(\mathcal{P}^{D})$. As long as $\bar{\pi} > 0$, $r_t(\mathcal{P}^{\mathcal{A}}) > r_t(\mathcal{P}^{D})$ because a democracy never erects a barrier whereas an autocrat does, (unless using the modern technology is not profitable to use with no barrier in place, which is not the case considered here). As long as $r_t(\mathcal{P}^{\mathcal{A}})l_t > w_t(\mathcal{P}^{A})$, a landed household is a net payer of taxes so that clearly $c_{Lt}(\mathcal{P}^{\mathcal{A}}) > c_{Lt}(\mathcal{P}^{D})$. In the opposite case, they will not face any tax under democracy or receive any transfers. However, $c_{Lt}(\mathcal{P}^{\mathcal{A}}) > c_{Lt}(\mathcal{P}^{D})$ since $r_t(\mathcal{P}^{\mathcal{A}}) > r_t(\mathcal{P}^{D})$.
In case (ii), $\exists\ \tau^*_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0,1]$ such that $c_{Ht}(\mathcal{P}^{\mathcal{A}}) = \phi(D_t)c_{Ht}(\mathcal{R}^{\mathcal{S}}) + (1-\phi(D_t))c_{Ht}(\mathcal{R}^{\mathcal{F}})$. This means that the autocrat is able to deter revolt by setting the tax rate $\tau^*_{Lt}(\mathcal{P}^{\mathcal{A}})$, according to (39). If the autocrat sets $\tau_{Lt}(\mathcal{P}^{\mathcal{A}}) < \tau^*_{Lt}(\mathcal{P}^{\mathcal{A}})$, the workers will choose to revolt. Suppose by way of contradiction that revolt is a subgame perfect equilibrium of the game. Since the autocrat can always deter revolt, it must be that his

expected payoff under revolt is greater than that under peaceful autocracy, namely,

$$c_{Lt}(\mathcal{P}^{\mathcal{A}}) < \phi(D_t)c_{Lt}(\mathcal{R}^{\mathcal{S}}) + (1-\phi(D_t))c_{Lt}(\mathcal{R}^{\mathcal{F}}). \tag{I.2}$$

Additionally, since the autocrat can always transfer power, it must be that his expected utility under revolt exceeds his utility under peaceful democracy, namely,

$$c_{Lt}(\mathcal{P}^{\mathcal{D}}) < \phi(D_t)c_{Lt}(\mathcal{R}^{\mathcal{S}}) + (1-\phi(D_t))c_{Lt}(\mathcal{R}^{\mathcal{F}}). \tag{I.3}$$

We know that, since the autocrat does not re-optimize with respect to policies if the revolt fails and, additionally, incurs the cost of restoring law and order after a failed revolt, i.e., $g_t > 0$, the autocrat always prefers peaceful autocracy to failed revolt, i.e.

$$c_{Lt}(\mathcal{P}^{\mathcal{A}}) > c_{Lt}(\mathcal{R}^{\mathcal{F}}). \tag{I.4}$$

Re-arranging (I.2) we obtain:

$$c_{Lt}(\mathcal{P}^{\mathcal{A}}) - c_{Lt}(\mathcal{R}^{\mathcal{F}}) < \phi(D_t)\big[c_{Lt}(\mathcal{R}^{\mathcal{S}}) - c_{Lt}(\mathcal{R}^{\mathcal{F}})\big]. \tag{I.5}$$

Since (I.4) suggests that the left-hand side of (I.5) is positive, it must be the case that also the right-hand-side of (I.5) is positive, i.e.

$$c_{Lt}(\mathcal{R}^{\mathcal{S}}) > c_{Lt}(\mathcal{R}^{\mathcal{F}}). \tag{I.6}$$

However, subtracting $c_{Lt}(\mathcal{R}^{\mathcal{S}})$ from both sides of (I.3) yields:

$$c_{Lt}(\mathcal{P}^{\mathcal{D}}) - c_{Lt}(\mathcal{R}^{\mathcal{S}}) < (1-\phi(D_t))\big[c_{Lt}(\mathcal{R}^{\mathcal{F}}) - c_{Lt}(\mathcal{R}^{\mathcal{S}})\big]. \tag{I.7}$$

Since the democracy can tax elite income at a higher rate if the revolt succeeds, landed elite can do no worse under peaceful democracy than democracy stemming from a revolt so that $c_{Lt}(\mathcal{P}^{\mathcal{D}}) \geq c_{Lt}(\mathcal{R}^{\mathcal{S}})$. (As long as the income of the landed elite is above the median voter, then the inequality would be strict.) This suggests that the left-hand side of (I.7) is non-negative, which implies that also the right-hand-side is non-negative, i.e.

$$c_{Lt}(\mathcal{R}^{\mathcal{F}}) \geq c_{Lt}(\mathcal{R}^{\mathcal{S}}). \tag{I.8}$$

Since (I.8) contradicts (I.6) it is clear that in case (ii), revolt cannot be a subgame perfect equilibrium. Specifically, the autocrat will choose the tax rate according to (39) deter revolt, unless this is deemed to costly, in which case (32) obtains and the autocrat democratizes the country.

Finally, consider case (iii), when $c_{Ht}(\mathcal{P}^{\mathcal{A}}) < \phi(D_t)c_{Ht}(\mathcal{R}^{\mathcal{S}}) + (1-\phi(D_t))c_{Ht}(\mathcal{R}^{\mathcal{F}})$
$\forall\ \tau_{Lt}(\mathcal{P}^{\mathcal{A}}) \in [0,1]$. In this case, there is no tax rate that can deter revolt under peaceful autocracy, and the options to the autocrat are revolt and peaceful democracy. When proving case (ii) above, we showed that for the autocrat to prefer revolt to democracy, condition (I.8) must be met. However, comparing (33) and (35), keeping in mind that $\rho_{Lt}(\mathcal{R}^{\mathcal{F}}) \leq 0$ in (33), suggests that $c_{Lt}(\mathcal{R}^{\mathcal{F}}) < c_{Lt}(\mathcal{R}^{\mathcal{S}})$, thus violating (I.8). We conclude that, should the autocrat be unable to deter revolt, he opts for peaceful democracy. This completes the proof. □