CORPORATE GOVERNANCE AND INDUSTRIALIZATION

Maurizio Iacopetta

Pietro F. Peretto

SCIENCES PO OFCE WORKING PAPER n° 14/2020

CONTACT US

OFCE
10 place de Catalogne | 75014 Paris | France
Tél. +33 1 44 18 54 24

www.ofce.fr

WORKING PAPER CITATION

This Working Paper:
Maurizio Iacopetta and Pietro F. Peretto
Corporate Governance and Industrialization
Sciences Po OFCE Working Paper, n° 14/2020.
Downloaded from URL: www.ofce.sciences-po.fr/pdf/dtravail/WP2020-14.pdf
DOI - ISSN

ABOUT THE AUTHORS

Maurizio Iacopetta, SKEMA Business School and Sciences Po-OFCE
Email Address: maurizio.iacopetta@sciencespo.fr
Pietro F. Peretto, Duke University
Email Address: peretto@econ.duke.edu

ABSTRACT

Corporate governance distortions delay or even halt a country's transformation into a modern innovation economy. We investigate the mechanism through a growth model that allows for agency issues within firms. Governance distortions raise the cost of investment and depress the incentives to set up new firms. Modest differences in governance account for large gaps in income: A 32 percent investment cost differential can explain the secular decline of Latin America income relative to that of the USA, and implies an industrialization delay of a third of a century. We obtain similar results for a large number of countries and macro-regions.

KEY WORDS
Corporate Governance, Income Differences, Secular Transition, Modern Growth.

JEL
D58, 014, 016, 043, 057.

Corporate Governance and Industrialization*

Maurizio Iacopetta, SKEMA Business School and OFCE Sciences Po
Pietro F. Peretto, Duke University

March 27, 2020

Abstract

Corporate governance distortions delay or even halt a country's transformation into a modern innovation economy. We investigate the mechanism through a growth model that allows for agency issues within firms. Governance distortions raise the cost of investment and depress the incentives to set up new firms. Modest differences in governance account for large gaps in income: A 32 percent investment cost differential can explain the secular decline of Latin America income relative to that of the USA, and implies an industrialization delay of a third of a century. We obtain similar results for a large number of countries and macro-regions.

JEL Classification: D58; O14; O16; O43; O57

Keywords: Corporate Governance; Income Differences; Secular Transition; Modern Growth

*We thank for useful comments Philippe Aghion, Angus Chu, Antonio Fatas, Domenico Ferraro, Elie Gray, Giammario Impullitti, David Le Bris, Florencio Lopez de Silanes, Rafael Matta, Raoul Minetti, and participants at the 2019 Conference of Georgetown Center of Economic Research, Washington DC, the 10th IBEO Conference, Alghero, the Growth and Structural Change Workshop, Toulouse Business School, the 2019 Royal Economic Society Annual Conference, Warwick, the INSEAD Economics and Political Science Seminar Series (Fontainebleau, Singapore, and Abu Dhabi), Duke University Macro Seminar Series, the 2017 Workshop "Innovation, Economic Growth and Corporate Governance" (OFCE-SKEMA Business School), the Conference on "Finance and Economic Growth After the Crisis," University of Milan, the 2017 Meetings of the French Economic Association (Nice, France), the Meetings of the Southern Economic Association (Tampa, Florida, USA), the Zhejiang University Economics Seminar Series (Hangzhou, China), the NAU-IUD Innovation Economics Workshop (Nanjing, China). All remaining errors are ours. E-mail address of corresponding author: peretto@econ.duke.edu.

1 Introduction

Corporate innovation is a major driver of modern growth. The centrality of the corporation in the growth process, however, is relatively recent. In Prussia in the middle of the 19th century, Ernst Werner Siemens started up what would become one of the world's largest manufacturing and innovative company. In the USA in the second half of the 19th century, Thomas Edison established one of the most prolific industrial research and development lab, whose operations were closely related to his manufacturing enterprises. Similar undertakings occurred in several industries, giving birth to companies such as General Electric, AT&T and General Motors, to name a few, that are still thriving today. This cluster of events marks a profound qualitative change in the mode of growth. First, the rise of the innovative corporation brings to the forefront issues of corporate governance due to separation of ownership from control, and more generally misalignment of interests among stakeholders, that in previous times where not as salient. Second, the increasing importance of corporate innovation accelerated the process of divergence of different communities (provinces, regions, countries). Figure 1 reports the first growth acceleration for 155 countries. For 22 of these countries it occurred sometimes between 1820 and 1870 and for 51, 38 and 35 countries in, respectively, the 1870-1900, 1900-1950 and 1950-1975 periods.[1] Figure 1 also correlates the countries' growth accelerations with the Rule of Law score, which, of the six World Bank Worldwide Governance Indicators, is the one that measures how confident people are in property rights, contract enforcement and the quality of courts — arguably essential ingredients of good corporate governance.[2] The pattern suggests that industrialization delays are considerably longer in countries that have a low governance score.

To explore the role of corporate governance in the determination of such pattern, we integrate corporate governance distortions due to principal-agent problems in a model where growth is driven by investments of incumbent firms and entry of new firms. We characterize the rise of the industrial economy as the acceleration of the rate of formation of new firms that market new intermediate inputs and the intensification of firms' in-house knowledge accumulation. We use the model to evaluate how corporate governance distortions affect the growth of the individual firm, the evolution of industry, the timing of the economy's transition to modern growth and thereby the secular path of national income.

In the model, the source of corporate governance distortions is the ability of managers to

[1] We consider growth acceleration a period characterized by an annual average growth rate of per capita income of at least 0.72%; this corresponds to that of the USA in the period 1700-1820 (period 1). This is lower than the 2% threshold employed by Hausmann et al. (2005) who, however, are interested in episodes of post-WWII growth spurts.

[2] For instance, in a review of 67 countries Doidge et al. (2007) find that where the rule of law is stronger, the resulting lower agency costs allow firms to take better advantage of growth opportunities.

divert the firm's resources to private benefits; see, among others, Nikolov and Whited (2014) and Shleifer and Wolfenzon (2002). Specifically, managers divert cash flow and planned investment funds to their own consumption. The former reduces the distribution of dividends to shareholders and has first-order effects on the incentive to set up firms. The latter raises the cost of investing in the growth of the firm. Shareholders can partially discipline managers through incentive compensation contracts and by hiring monitoring agents (e.g., directors).

The economy starts with a given number of firms. Initially, market expansion fueled by population growth is the only source of income growth via Smithian economies of scale. Under some conditions, such market expansion eventually triggers entry of new firms and, later, in-house investment by incumbent firms. The timing of the two events has long-lasting consequences for the path of income per capita. We investigate how the governance structure of firms, an equilibrium outcome of our analysis, affects the macroeconomic equilibrium and results in different histories. Because both the rate of entry and the rate of in-house innovation rise as the economy converges to its steady state, an economy with more severe corporate governance distortions enters the modern growth phase later and exhibits poorer productivity performance throughout the transition. In this sense, the timing of the take-off "imprints" on the whole subsequent evolution of the economy.

To assess how well corporate governance accounts quantitatively for the observed cross-country income dynamics, we calibrate the model to the USA for the period 1700-2008, taking 1800 as the beginning of modern growth (see, among others Lucas, 2000) and assuming the USA to be at a 10% distance from a distortion-free economy (see Iacopetta et al., 2019). Using the USA as a benchmark, we then calculate how over the same period variations in corporate governance explain the timing of the transition to modern growth and the performance afterwards of several other countries and some macro regions. The key to this exercise is that, differently from the USA, we let the model determine endogenously the take-off date for these units. We find, for instance, that the magnitude of the difference in corporate governance distortions to account for the decline of the income per capita of Latin America relative to the USA, from one to one fourth, is the equivalent of a 32 percent higher cost of in-house investment in Latin America. We also calculate that such a distortion delays modern growth by approximately a third of a century, a delay that accounts well for the end-of-period (2008) income gap.

To validate the model, we perform three types of tests under the assumption that the institutional environment stays the same over the three centuries. The first test correlates the two endogenous variables of the model that represent corporate governance distortions, the shareholders appropriation factor (a) and the in-house cost of innovation (q), with the World Bank rule of law index. In both cases the correlation is strong and of the right sign. The two variables a and q are central to our analysis because they determine the economy's waiting times before the transitions to the variety expansion and quality innovation phases of development. The second test compares the model-predicted take-off dates to the timing of the first growth accelerations shown in Figure 1. The agreement between model's prediction and data for the countries that started growing in the 19th century is quite strong. The model, however, tends to underestimate the take-off dates of countries, like Japan and China, that started growing in the 20th century and went through very rapid growth accelerations. The third test compares the model-generated time series of per capita income of individual countries to the Maddison data. The model fits the data remarkably well for today's rich economies and the large Latin America economies. There are, in contrast, visible deviations between model and data for fast growing Asian countries: the model underestimates the date of the first acceleration and the steepness of the subsequent growth path of these countries. However, once we allow the quality of governance to improve in the post-war period, due to underlying institutional changes, we find that the model fits the data better for these countries but not that for Western economies. This result suggests that, under the assumption of stable corporate governance, the model fails precisely where it should because it neglects, for example, the drastic institutional transformation of Japan after WWII and the reforms in China in the 80s that unshackled the economies of those two countries.

Our paper contributes to the large literature that attributes the fortunes of modern economies to the process of creation of technical knowledge (Chu et al., 2014; Peretto, 2015; Chu et al.; 2019; and Madsen et al., 2019). Like this literature, we stress that take-off events are accelerations of income growth along the transition to the modern innovation-economy stage. However, we expand the perspective to new dimensions because we focus on corporate governance and on the arrival on the scene of the Schumpeterian innovative firm.

Similarly, the paper contributes to the literature that links corporate governance to macroeconomic performance and that, more specifically, investigates the long-run implications for aggregate productivity and welfare of within-firm contractual frictions and of financial markets imperfections; see, e.g., Celik and Tian (2019), Iacopetta et al. (2019), Lopez and Vives (2019), Terry (2017), Aghion, Howitt and Mayer-Foulkes (2005), Cooley and Quadrini (2001). While the analytical framework that we use is similar to that of Iacopetta et al. (2019), here we expand the perspective in three dimensions.[3] First, we consider both advanced countries and countries at earlier stages of the process of secular growth and transformation. In particular, we account for the phase transitions that bring about the key *qualitative* changes in the structure of the economy, including the internal structure of firms. Second, we allow for misuse not only of cash but also of planned investment. This

[3] Iacopetta et al. (2019) studies the effects of managers' ability to (a) divert the firm's cash flow to private benefits and (b) nurture their empire bulding ambitions. The focus is on advanced economies and local dynamics around the balanced-growth steady state.

type of diversion has acquired prominence in the literature recently. Terry (2017), for example, argues that managers' ability to divert investment funds to short-term objectives have important ramifications for macroeconomic performance. Third, we postulate a board of directors that supervise the manager, following recent developments in the financial literature (Page 2018, Balsmeier et al. 2017) that stress the importance of monitoring for good corporate governance. Celik and Tian (2019), in particular, provide evidence that directors discipline executive officers through incentives and supervision.[4]

More broadly, our analysis complements the literature that investigates how institutions, the government as well as legal and social norms, drive cross-country income differences. Several scholars argue that in Western Europe the rule of law was already taking hold in the Middle Ages, while in other regions it developed much later and in some it never did. In other words, the conditions for the formation of the modern innovative firm emerged unevenly around the world. In places where the rule of law was not sufficiently advanced, business communities developed alternative arrangements based on trust that allowed production and commerce to thrive (Greif, 2006). Trust is a powerful ingredient in promoting investment because even in a sophisticated contractual environment a party's future choice is not necessarily contractible (Lins et al. 2017, Fukuyama 2014). Augmenting this historical perspective, there is now established evidence that corporate governance affects the investment of incumbent firms and the formation of new firms; see, e.g., Aghion, Van Reenen and Zingales (2013), Morck, Wolfenzon and Yeung (2005) and Fulghieri and Suominen (2012). Most importantly, such evidence highlights differences across countries in corporate governance due to differences in the local institutional environments.

The paper is organized as follows. Section 2 reviews the basic growth model. Section 3 augments the model with corporate governance and derives the main microeconomic results. Sections 4 and 5 develop the macroeconomic implications of corporate governance. Section 6 calibrates the model and performs several quantitative exercises. Section 7 evaluates the fit of the model to the data. Section 8 concludes.

[4] Our concept of stealing-monitoring Nash Equilibrium, developed formally in Section 3, complements the Celik-Tian approach and extends the perspective on the interaction between executives and directors. They postulate a board that makes decisions subject to CEO influence, which they capture in reduced from with a parameter representing the weight of the CEO's preferences in the board's maximization problem. We postulate direct strategic interaction between directors and executives in specific dimensions of the firm's oparations. The two approaches are complementary and suggest that future work will likely develop a comprehensive characterization of corporate governance embedded in dynamic macroeconomic models.

2 The basic growth model

The model builds on the literature that integrates endogenous market structure in the theory of economic growth. The framework provides a natural way to exploit insights from Industrial Organization to understand how corporate governance frictions affect innovation-driven growth. In this section we set up the model abstracting from frictions, which we introduce later. Time is continuous and infinite. All variables are functions of time but to simplify the notation we omit the time argument unless necessary to avoid confusion. The economy is closed. The production side consists of a final sector producing a homogeneous good and an intermediate sector producing a continuum of differentiated non-durable goods.

2.1 Final producers

A competitive representative firm produces a final good that can be consumed, used to produce intermediate goods, invested in the improvement of the quality of existing intermediate goods, or invested in the creation of new intermediate goods. The final good is our numeraire. The production technology is

$$Y = \int_0^N X_i^\theta \left(Q_i L_i^\gamma \Omega^{1-\gamma}\right)^{1-\theta} di, \quad 0 < \theta, \gamma < 1 \tag{1}$$

where N is the mass of non-durable intermediate goods and L_i and Ω are, respectively, services of labor and a fixed factor (e.g., land). The parameters θ and γ govern the output elasticity to intermediate inputs and to labor, respectively. The technology features dilution of labor across intermediate goods, reflecting the property that both labor and intermediate goods are rival inputs. The fixed factor is non-rival across labor and intermediate products. Quality, Q_i, is the good's ability to raise the productivity of the other factors. Let P_i be the price of intermediate good i, w the wage and p the price of the fixed factor. The profit maximization problem yields that the final producer demands each intermediate good according to

$$X_i = \left(\frac{\theta}{P_i}\right)^{\frac{1}{1-\theta}} Q_i L_i^\gamma \Omega^{1-\gamma}. \tag{2}$$

Moreover, the final producer pays

$$\int_0^N P_i X_i di = \theta Y, \quad wL = \int_0^N w L_i di = \gamma (1-\theta) Y, \quad p\Omega = (1-\gamma)(1-\theta) Y \tag{3}$$

to, respectively, suppliers of intermediate goods, labor and the fixed factor.

2.2 Intermediate producers

In line with Schumpeterian theory, we view firms as complex organizations that develop and apply specialized knowledge. Therefore, we model quality as

$$Q_i = Z_i^{\alpha} Z^{1-\alpha}. \tag{4}$$

In words, the contribution of good i to factor productivity downstream depends on the knowledge of firm i, Z_i, and on average knowledge, $Z = \int_0^N (Z_j/N)\, dj$. The firm requires one unit of final output per unit of intermediate good produced and a fixed operating cost, $\phi Z_i^{\alpha} Z^{1-\alpha}$, also in units of final output. The firm accumulates knowledge according to

$$\dot{Z}_i = I_i, \tag{5}$$

where I_i is in-house investment in units of final good. Using (2) and (4), we write the firm's gross cash flow (revenues minus production costs) as

$$F_i \equiv (P_i - 1)\, X_i - \phi Q_i = \left[(P_i - 1) \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} L_i^{\gamma} \Omega^{1-\gamma} - \phi \right] Z_i^{\alpha} Z^{1-\alpha}. \tag{6}$$

In this expression α is the elasticity of the firm's gross cash flow with respect to its own knowledge. The dividend flow is $\Pi_i = F_i - I_i$ and the value of the firm is

$$V_i(t) = \int_t^{\infty} e^{-\int_t^{\tau} r(v) dv} \Pi_i(\tau) d\tau. \tag{7}$$

Creating a new firm costs βX units of final output, where $X = \int_0^N (X_i/N)\, di$ is average intermediate output. The resulting free-entry condition is $V_i = \beta X$. Because of this sunk entry cost, the new firm cannot supply an already existing good in Bertrand competition with the incumbent monopolist but introduces a new intermediate good that expands product variety. The firm enters at the average knowledge level and hence at average size (this simplifying assumption preserves symmetry of equilibrium at all times, see below).

2.3 Households

The economy is populated by a representative household with $L(t) = L_0 e^{\lambda t}$, $L_0 \equiv 1$, members, each endowed with one unit of labor. The household has preferences

$$U(t) = \int_t^{\infty} e^{-(\rho-\lambda)(\tau - t)} \log \left(\frac{C(\tau)}{L(\tau)} \right) d\tau, \quad \rho > \lambda \geq 0 \tag{8}$$

where t is the point in time when the household makes decisions, ρ is the discount rate and C is consumption. The household supplies labor inelastically and has budget constraint

$$\dot{A} = rA + wL + p\Omega - C, \tag{9}$$

where A is assets holding and r is the rate of return on assets. The intertemporal consumption plan that maximizes (8) subject to (9) consists of the Euler equation

$$r = \rho - \lambda + \dot{C}/C, \tag{10}$$

the budget constraint (9) and the usual boundary conditions.

3 Corporate governance

We now allow for frictions arising from separation of ownership and control. The literature describes managers as individuals who pursue personal goals rather than shareholder value. To capture such a misalignment of interests, we focus on two flows of resources that managers can divert to personal gain: cash flow and planned investment.

3.1 Governance: Set up

Our typical firm has three constituencies with different interests. The first consists of individuals who supply the resources to set up the firm. For convenience we refer to this group in the singular as the *founder*.[5] His objective is to maximize the value of the firm. The second constituency is the firm's management. We refer to this group as the *manager*. The third constituency, which we call the *director*, consists of individuals who monitor the managers' activities. The manager's and the director's objectives are to maximize their own utility.

The governance scheme is the following. The founder hires the manager, to whom he delegates production and pricing decisions and the implementation of the investment plan, and the director, to whom he delegates monitoring the manager. The founder formulates the investment plan, which specifies a time path of expenditure on product quality improvement. Misalignment of interests arises because the manager can divert planned investment funds and/or cash flow to his own private benefit. We consider two devices at the founder's disposal to control such moral hazard. The first is hiring the director, who can reduce directly the manager's ability to divert resources. The second is the compensation package: the founder offers a contract that grants remuneration tied to the firm's increment of the stock of knowledge (actual investment) and to the cash flow available for dividend distribution (actual cash flow or the cash flow net of diversion).[6]

[5] While each of the constituencies is typically a plurality of individuals, possibly with different preferences and constraints, it is easier to describe the setup assuming homogeneity within each group.

[6] To keep the exposition simple we use only contracts that compensate the manager and the director in proportion to the resources subject to diversion. Other schemes are possible, of course, but they complicate matters without necessarily adding insight.

The assumption that the founder formulates the investment plan while the manager only executes it might seem restrictive. It is nevertheless convenient in our contest for two reasons. First, it allows us to emphasize that even when the manager controls only routine operations his actions may harm the interests of shareholders. Second, it makes the formal analysis simpler and much more transparent than the alternative of letting the manager formulate the investment plan. Indeed, precisely because the founder proposes a compensation package and maintains control of the investment plan, we can see within a coherent dynamic optimization problem the interaction between the compensation package decision and the investment choice.

To summarize, at the foundation of the firm, the principal, our founder, makes three decisions. First, he hires two agents, the manager and the director, offering compensation that takes into account their incentives and constraints. Second, he specifies the investment plan with full understanding that there will be a wedge between planned and actual investment. Third, he decides whether to set up the firm, with full understanding that there will be a wedge between the profit generated by the firm and what he receives as dividend.

3.2 Manager (agent)

The manager can divert a share $S_i^F\left(M_i^F, D_i^F; \Sigma\right)$ of cash flow, F_i, at utility cost $c_M^F(M_i^F; \Sigma) \cdot F_i$. The share $S_i^F\left(M_i^F, D_i^F; \Sigma\right)$ is increasing in the manager's effort M_i^F and decreasing in the director's effort D_i^F. The function $c_M^F(M_i^F; \Sigma)$ is increasing in M_i^F. The manager can also divert a share $S_i^I\left(M_i^I, D_i^I; \Sigma\right)$ of planned investment, I_i, at utility cost $c_M^I(M_i^I; \Sigma) \cdot I_i$, where the functions $S_i^I(.)$ and $c_M^I(.)$ have the same properties as the functions $S_i^F(.)$ and $c_M^F(.)$, and M_i^I and D_i^I are, respectively, the manager's and the director's efforts. Actual investment is thus

$$\dot{Z}_i = \left[1 - S_i^I\left(M_i^I, D_i^I; \Sigma\right)\right] \cdot I_i. \tag{11}$$

The term Σ denotes the set of parameters that govern the cost-benefit calculations of our agents through the functions described above and thus connects the model's micro structure to the concept of "quality of institutions" discussed in the introduction. Specifically, measures like the World Bank Rule of Law score combine a variety of elements of a country's institutional, social and cultural environment into a single number that is then used as a summary statistic of the country's "quality of institutions". Our analytical structure proposes that such multiple dimensions manifest themselves as country-specific costs and benefits faced by principal and agents and thereby determine the internal governance of the firm. For concreteness, henceforth we refer to Σ as the "institutional environment".[7] Considering

[7] Because it contains the parameters of the utility cost of diversion, our concept of institutional environment is quite broad and allows not only for things like the importance of the rule of law, the expectations

two types of diversion efforts, one targeted at cash flow and the other at planned investment, allows the emergence of different corporate governance structures across institutional environments and depending on the size of the firm (more on this in Section 5).

The manager's contract specifies as compensation fractions m_i^I and m_i^F of the resources that he can divert. The manager fully consumes his income and thus his utility flow is

$$\begin{aligned} u_i^{\text{manager}} &= \left\{m_i^F\left[1-S_i^F\left(M_i^F,D_i^F;\Sigma\right)\right]+\left[S_i^F\left(M_i^F,D_i^F;\Sigma\right)-c_M^F(M_i^F;\Sigma)\right]\right\}F_i \\ &+\left\{m_i^I\left[1-S_i^I\left(M_i^I,D_i^I;\Sigma\right)\right]+\left[S_i^I\left(M_i^I,D_i^I;\Sigma\right)-c_M^I(M_i^I;\Sigma)\right]\right\}I_i. \end{aligned}$$

At time t, he chooses for $\tau\in[t,\infty)$ the paths of price, $P_i(\tau)$, and efforts, $M_i^F(\tau)$, $M_i^I(\tau)$, that, given the paths of $m_i^F(\tau)$ and $m_i^I(\tau)$, maximize

$$V_i^{\text{manager}}(t)=\int_t^\infty e^{-\int_t^\tau r(v)dv}u_i^{\text{manager}}(\tau)\,d\tau. \tag{12}$$

This expression makes clear that the manager's objective is not the maximization of the value $V_i(t)$ in equation (7). Since this problem does not have a dynamic constraint, it reduces to a sequence of identical intratemporal problems. The first-order conditions with respect to P_i, M_i^F and M_i^I are:

$$\frac{\partial(P_i-1)X_i}{\partial P_i}=0\Rightarrow P_i=\frac{1}{\theta}; \tag{13}$$

$$\left(1-m_i^J\right)\frac{\partial S_i^J\left(M_i^J,D_i^J;\Sigma\right)}{\partial M_i^J}=\frac{\partial c_M^J(M_i^J;\Sigma)}{\partial M_i^J},\quad J=F,I. \tag{14}$$

The compensation shares m_i^F and m_i^I discourage diversion because the manager's costly effort would be partly directed at stealing from himself.

3.3 Director (agent)

The director can mitigate the manager's diversion of resources but, because of his utility cost, requires incentives of his own (Celik and Tian 2019, Page 2018, Balsmeier et al. 2017). The director's compensation is a fraction d_i^F of gross cash flow and a fraction d_i^I of planned investment. The effort costs are $c_D^F(D_i^F;\Sigma)F_i$ and $c_D^I(D_i^I;\Sigma)I_i$, where D_i^F and D_i^I are, respectively, the efforts targeted at gross profit and at investment. The cost functions have the same mathematical properties as those of the manager. The director fully consumes his income and thus his utility is

$$\begin{aligned} u_i^{\text{director}} &= \left\{d_i^F\left[1-S_i^F\left(M_i^F,D_i^F;\Sigma\right)\right]-c_D^F(D_i^F;\Sigma)\right\}F_i \\ &+\left\{d_i^I\left[1-S_i^I\left(M_i^I,D_i^I;\Sigma\right)\right]-c_D^I(D_i^I;\Sigma)\right\}I_i. \end{aligned}$$

that contracts are secure because enforced by the courts, opacity in accounting that makes diversion of funds easier, but also things like cultural and social stigma toward cheating and self-restraint driven by the individual internalization of similar cutural and social norms.

At time t, given the paths $P_i(\tau)$, $M_i^F(\tau)$, $M_i^I(\tau)$, $d_i^F(\tau)$ and $d_i^I(\tau)$ for $\tau \in [t, \infty)$, the director chooses the paths $D_i^F(\tau)$ and $D_i^I(\tau)$ to maximize

$$V_i^{\text{director}}(t) = \int_t^\infty e^{-\int_t^\tau r(v)dv} u_i^{\text{director}}(\tau) d\tau. \tag{15}$$

This problem as well reduces to a sequence of identical intratemporal problems and yields

$$-d_i^J \frac{\partial S_i^J\left(M_i^J, D_i^J; \Sigma\right)}{\partial D_i^J} = \frac{\partial c_D^J(D_i^J; \Sigma)}{\partial D_i^J}, \quad J = F, I. \tag{16}$$

The compensation shares d_i^F and d_i^I determine the director's effort for the straightforward reason that doing so he protects his own income flow.

3.4 The diverting-monitoring Nash equilibrium

We think of the first-order conditions (14) and (16) as reaction functions that at time $\tau \geq t$ yield a Nash equilibrium in a simultaneous moves game between manager and director. Our first formal result is thus the following.

Proposition 1 *(Diverting-Monitoring NE) For $J = F, I$ assume*

$$\frac{\partial}{\partial D_i^J}\left(\frac{\partial S_i^J\left(M_i^J, D_i^J; \Sigma\right)}{\partial M_i^J}\right) \leq 0 \quad \textit{and} \quad \frac{\partial}{\partial M_i^J}\left(-\frac{\partial S_i^J\left(M_i^J, D_i^J; \Sigma\right)}{\partial D_i^J}\right) \geq 0. \tag{17}$$

There exists a stealing-monitoring NE, consisting of the two functions $D_i^J\left(m_i^J, d_i^J; \Sigma\right)$ and $M_i^J\left(m_i^J, d_i^J; \Sigma\right)$ with the property:

$$\begin{aligned}
\frac{\partial M_i^J\left(m_i^J, d_i^J; \Sigma\right)}{\partial m_i^J} &< 0, \quad \frac{\partial D_i^J\left(m_i^J, d_i^J; \Sigma\right)}{\partial m_i^J} < 0; \\
\frac{\partial M_i^J\left(m_i^J, d_i^J; \Sigma\right)}{\partial d_i^J} &< 0, \quad \frac{\partial D_i^J\left(m_i^J, d_i^J; \Sigma\right)}{\partial d_i^J} > 0.
\end{aligned}$$

Accordingly, there exists the function $S_i^J\left(M_i^J\left(m_i^J, d_i^J; \Sigma\right), D_i^J\left(m_i^J, d_i^J; \Sigma\right)\right) = S_i^J\left(m_i^J, d_i^J; \Sigma\right)$ with the property:

$$\frac{\partial S_i^J\left(m_i^J, d_i^J; \Sigma\right)}{\partial m_i^J} < 0 \quad \textit{and} \quad \frac{\partial S_i^J\left(m_i^J, d_i^J; \Sigma\right)}{\partial d_i^J} < 0.$$

Proof. See the Appendix. ■

This result summarizes the interaction between our two agents. Equations (14)-(16) define in implicit form the reaction functions of the manager and the director. The properties of these reaction functions follow solely from the concavity of the function $S_i^J\left(M_i^J, D_i^J; \Sigma\right)$ with respect to each argument, holding the other constant, and the convexity of the effort cost functions $c_M^J(M_i^J;\Sigma)$ and $c_D^J(D_i^J;\Sigma)$. To characterize the NE we need restrictions on the second cross-partial derivatives. We thus assume that monitoring (weakly) reduces the marginal benefit of resource diversion, the first restriction in (17), obtaining that the reaction function of the manager is (weakly) decreasing in monitoring. A well-defined, stable, NE then only requires that in $\left(M_i^J, D_i^J\right)$ space the reaction function of the manager be steeper than that of the monitor. A *sufficient* condition for this to be the case is that the reaction function of the monitor be (weakly) increasing, that is, that the marginal benefit of monitoring be (weakly) increasing in the manager's effort. This is the second restriction in (17).

To summarize, for $J = F, I$ the first-order conditions of the manager and the director yield a pair of actions (M_i^J, D_i^J) that depends on the contractual incentives $\left(m_i^J, d_i^J\right)$. We thus can write diversion as the function $S_i^J\left(M_i^J\left(m_i^J, d_i^J; \Sigma\right), D_i^J\left(m_i^J, d_i^J; \Sigma\right)\right) = S_i^J\left(m_i^J, d_i^J; \Sigma\right)$.

3.5 Founder (principal)

Households finance the foundation of intermediate firms covering the entry cost. Because of this role we identify them as the founder (the principal in the principal-agents part of the model). Due to the price, diversion and monitoring decisions that yield Proposition 1, the founder receives the dividend flow

$$\begin{aligned}\Pi_i^{\text{founder}} &= \left\{\left[1 - S_i^F\left(d_i^F, m_i^F; \Sigma\right)\right]\left[1 - \left(d_i^F + m_i^F\right)\right]\right\} F_i \\ &\quad - \left\{1 + \left(d_i^I + m_i^I\right)\left[1 - S_i^I\left(d_i^I, m_i^I; \Sigma\right)\right]\right\} I_i,\end{aligned}$$

and over horizon $\tau \in [t, \infty)$ chooses the paths of planned investment $I_i(t)$ and of the contractual instruments $m_i^F(t)$, $d_i^F(t)$, $m_i^I(t)$, $d_i^I(t)$, to maximize

$$V_i^{\text{founder}}(t) = \int_t^{\infty} e^{-\int_t^{\tau} r(v)dv}\, \Pi_i^{\text{founder}}(\tau)\, d\tau, \tag{18}$$

subject to the demand and technology constraints discussed above and to the participation constraints of the two agents

$$V_i^{\text{manager}}(t) \geq 0 \quad \text{and} \quad V_i^{\text{director}}(t) \geq 0.$$

The founder also decides whether to set up the firm. That is, he satisfies the participation constraint

$$V_i^{\text{founder}}(t) \geq \beta X(t), \tag{19}$$

which we argued holds with equality and yields the free-entry condition that we use to characterize the economy's dynamics. The difference between the frictionless value of the firm in equation (7) and that in equation (18) is the distorted dividend flow Π_i^{founder} in the latter, which differs from $\Pi_i = F_i - I_i$.

The founder's Hamiltonian is (dropping the time argument τ for simplicity):

$$\begin{aligned} H_i^{\text{founder}} &= \left\{\left[1 - S_i^F\left(d_i^F, m_i^F; \Sigma\right)\right]\left[1 - \left(d_i^F + m_i^F\right)\right]\right\} F_i \\ &\quad - \left\{1 + \left(d_i^I + m_i^I\right)\left[1 - S_i^I\left(d_i^I, m_i^I; \Sigma\right)\right]\right\} I_i + q_i\left[1 - S_i^I\left(d_i^I, m_i^I; \Sigma\right)\right] I_i, \end{aligned}$$

where q_i is firm i's shadow value knowledge. The expression on the right of q_i corresponds to $\dot{Z}_i$ (see eq. 11). The first-order conditions with respect to the contractual terms that deliver interior solutions are:

$$1 - S_i^F\left(d_i^F, m_i^F; \Sigma\right) = -\frac{\partial S_i^F(m_i^F, d_i^F; \Sigma)}{\partial m_i^F}\left(1 - d_i^F - m_i^F\right); \tag{20}$$

$$1 - S_i^F\left(d_i^F, m_i^F; \Sigma\right) = -\frac{\partial S_i^F(m_i^F, d_i^F; \Sigma)}{\partial d_i^F}\left(1 - d_i^F - m_i^F\right); \tag{21}$$

$$1 - S_i^I\left(d_i^I, m_i^I; \Sigma\right) = -\left[q_i - \left(d_i^I + m_i^I\right)\right]\frac{\partial S_i^I(m_i^I, d_i^I; \Sigma)}{\partial m_i^I}; \tag{22}$$

$$1 - S_i^I\left(d_i^I, m_i^I; \Sigma\right) = -\left[q_i - \left(d_i^I + m_i^I\right)\right]\frac{\partial S_i^I(m_i^I, d_i^I; \Sigma)}{\partial d_i^I}. \tag{23}$$

If any one of these conditions fails, the founder sets the corresponding decision variable at zero. The left-hand side of equation (20) is the marginal cost of increasing the manager's compensation; the right-hand side is the marginal benefit, that is, the reduction in the manager's resource diversion. Similarly, the left-hand side of equation (21) is the marginal cost of increasing the director's compensation, while the right-hand side is the marginal benefit, that is, the reduction in the manager's resource diversion due to the director's monitoring effort. Dividing (20) by (21) and (22) by (23) we obtain

$$\frac{\partial S_i^J(m_i^J, d_i^J; \Sigma)}{\partial m_i^J} = \frac{\partial S_i^J(m_i^J, d_i^J; \Sigma)}{\partial d_i^J}, \quad \text{for } J = F, I, \tag{24}$$

which says that the founder is indifferent between achieving a reduction in diversion through incentives to the manager and to the director. In this sense, the condition says that the founder plays the two agents against each other.

For future use, we define the *appropriation factor* representing the share of cash flow, F_i, that accrues to the founder:

$$a_i \equiv \left[1 - S_i^F(d_i^F, m_i^F; \Sigma)\right]\left(1 - d_i^F - m_i^F\right). \tag{25}$$

The founder's first-order conditions with respect to I_i and Z_i are:

$$q_i = \frac{1}{1 - S_i^I\left(d_i^I, m_i^I; \Sigma\right)} + d_i^I + m_i^I; \tag{26}$$

$$r = r_{Zi} \equiv \frac{a_i}{q_i}\frac{\partial F_i}{\partial Z_i} + \frac{\dot{q}_i}{q_i}. \tag{27}$$

The first equation says that the value of the marginal unit of knowledge is equal to its production cost. For convenience, therefore, in the following exposition we refer to q_i as the cost of investment of the firm. The second equation says that the return to investing in the firm's knowledge accumulation, r_{Zi}, must equal the market interest rate, r. The return to knowledge accumulation consists of the dividend/price ratio, where the dividend is the marginal cash flow $a_i \cdot (\partial F_i/\partial Z_i)$ and the price is q_i, plus the appreciation/depreciation of the marginal unit of knowledge, $\dot{q}_i/q_i$. These expressions capture the distortion of the founder's investment decision due to the anticipated resources diversion of the manager and the associated cost of incentivizing manager and director: the first says that the founder faces higher investment costs, the second that he obtains a lower return from investment.

3.6 Governance: equilibrium outcome

We now bring all the elements derived above together, characterize the internal governance structure of the firm as an equilibrium outcome and develop its implications.

3.6.1 General solution

If all of the first-order conditions (20)-(23) hold, the key result concerning the firm's corporate governance structure is as follows.

Proposition 2 *(Compensation and Investment Cost) The solution of the incentive-contract part of the founder's problem yields the following features:*

- *the founder offers a contract that consists of compensation shares m_i^F, d_i^F, m_i^I and d_i^I that depend only on the institutional environment Σ and on whether the firm invests or not (i.e., whether $I_i = 0$ or $I_i > 0$);*

- *consequently, the shares S_i^F and S_i^I as well depend only on the institutional environment Σ and on whether the firm invests or not (i.e., whether $I_i = 0$ or $I_i > 0$);*

- *hence, the founder's share of cash flow (appropriation factor), a_i, depends only on the institutional environment Σ and on whether the firm invests or not (i.e., whether $I_i = 0$ or $I_i > 0$);*

- *moreover, the cost of investment, q_i, depends only on the institutional environment Σ and matters only when the firm invests (i.e., only for $I_i > 0$).*

Proof. See the Appendix. ∎

This proposition states in general terms the logic of corporate governance as an equilibrium outcome. Given the institutional environment, at the foundation of the firm the founder determines the forward-looking path of the components of the contracts that he offers to the manager and to the director. Our main assumption is that the founder always hires the manager (whom we thus treat as an essential input) while he can decide to not hire the director. Similarly, the founder anticipates that his desired corporate-governance structure depends on whether he wants the firm to invest or not.

The property that the agents' problems are not dynamic, and thus that their behavior depends only on the institutional environment and on the contractual terms offered by the founder, produces a very tractable structure where the contractual terms that the founder offers depend only on the institutional environment and the decision whether to invest or not. Analytically, this property follows from the fact that the founder's decisions about the manager's and the director's compensation do not depend on F_i and I_i. They are thus time-separable and depend only on the parameters of the agent's moral hazard problem. While it has its limitations, this structure has the advantage that it allows us to obtain a clean analytical characterization of the model's general-equilibrium dynamics.

3.6.2 Corner solutions: Limited or No Monitoring

A notable property of corporate governance as an equilibrium outcome is that important corner solutions exist. One occurs when, regardless of whether the founder wants to invest or not, he sets $d_i^F = 0$ because equations (21)-(24) do not intersect in the positive quadrant of $\left(m_i^F, d_i^F\right)$ space. Another corner solution occurs when the founder plans to invest, $I_i > 0$, but sets $d_i^I = 0$ because equations (23)-(24) do not intersect in the positive quadrant of $\left(m_i^I, d_i^I\right)$ space. In either case the intuition is that the cost of curbing resource diversion via monitoring is not worth bearing and therefore the founder does not hire the director but uses only the contractual incentives m_i^F and m_i^I to discipline the manager.

Generalizing further, this reasoning says that a more powerful corner solution exists when the founder sets $I_i = 0$ because investing in the firm is return-dominated by the alternative, i.e., when $r > r_{Zi}$. Noting that the general solution above implies that the cost of investment, q_i, is time-invariant, this corner solution occurs when equation (27) fails and we have

$$r > r_{Zi} = \frac{a_i}{q_i} \cdot \alpha \frac{(P_i - 1) X_i}{Z_i}, \tag{28}$$

that is, either when the founder anticipates low quality-adjusted sales, X_i/Z_i, or when, for given anticipated quality-adjusted sales, the corporate governance distortions are too severe (a_i/q_i too low). In this case, the founder sets $m_i^I = d_i^I = 0$.

We will show that this property implies that the model produces an *endogenous change of corporate governance* when along the transition path firms start investing in-house. This change entails both additional executive tasks for managers, the implementation of the investment plan, and additional components of their compensation packages. Associated to the latter is a level-change in their overall compensation that has important consequences for dividend distribution.

3.6.3 An analytical example

To illustrate how the corporate governance structure emerges endogenously from the institutional environment, Σ, we construct a simple example based on the functional forms that we use in the quantitative analysis. Consider first the situation where the founder sets $I_i = 0$. The functions representing cash flow diversion and the utility costs of diversion and monitoring are, respectively:

$$S^F\left(M_i^F, D_i^F; \Sigma\right) = \sigma_1^F M_i^F - \sigma_2^F D_i^F; \tag{29}$$

$$c_M^F(M_i^F; \Sigma) = \sigma_3^F \left(M_i^F\right)^{\sigma_4^F}, \quad c_D^F(D_i^F; \Sigma) = \sigma_5^F \left(D_i^F\right)^{\sigma_6^F}. \tag{30}$$

The parameter σ_1^F governs the effectiveness of the manager's effort to divert the cash flow to private benefits, for given monitoring effort. The parameter σ_2^F governs the effectiveness of the director's monitoring effort, for given diversion effort. The parameters $\left(\sigma_3^F, \sigma_4^F\right)$ and $\left(\sigma_5^F, \sigma_6^F\right)$ govern the utility cost of, respectively, diversion and monitoring.

In institutional environments where the board of directors has autonomy, firms practice transparent accounting, voluntarily or under the pressure of industry associations or to comply with stock market regulations and/or to comply with national or international laws, it is easier for the director to uncover fraudelent understatement of cash flow by the manager and report it to the shareholders. In our scheme, such environments have high σ_2^F and low σ_5^F and σ_6^F. Figure 2 plots equations (21)-(24) in (m_i^F, d_i^F) space and represents such a situation as the interior solution. The corner solution with $d_i^F = 0$ is a situation of worse institutional environment with low σ_2^F and high σ_5^F and/or σ_6^F. In this case, the founder relies only on the incentive-pay mechanism to discipline the manager.

Now consider the situation where the founder plans $I_i > 0$. The manager's payment can be tied not only to the cash flow but also to effective investment, while the director can be hired to monitor cash flow diversion and/or proper use of investment funds. Let the functions representing investment funds diversion and the utility costs of diversion and monitoring be, respectively:

$$S^I\left(M_i^I, D_i^I; \Sigma\right) = \sigma_1^I M_i^I - \sigma_2^I D_i^I; \tag{31}$$

$$c_M^I(M_i^I;\Sigma) = \sigma_3^I \left(M_i^I\right)^{\sigma_4^I}, \quad c_D^I(D_i^I;\Sigma) = \sigma_5^I \left(D_i^I\right)^{\sigma_6^I}. \tag{32}$$

The interpretation of the parameters is similar to that provided for cash flow diversion. We can have an interior solution with $m_i^I > 0$ and $d_i^I > 0$ or a corner solution $m_i^I > 0$ and $d_i^I = 0$. The former obtains when σ_3^I is sufficiently large relative to σ_5^I and σ_6^I , the latter when the reverse is true.

To summarize, the corporate governance structure with $m_i^F > 0$, $d_i^F > 0$, $m_i^I > 0$, $d_i^I > 0$ emerges when the firm operates in an environment where financial information is transparent and/or where social and legal norms lead managers and directors to report truthfully to shareholders and discourage managers from misusing the firm's resources. Moreover, it emerges when macroeconomic conditions result in large quality-adjusted sales. Conversely, with weaker institutions d_i^F or d_i^I or both may be zero even when the firm invests. Finally, when the firm anticipates a low volume of small quality-adjusted sales, corporate governance features $d_i^I = m_i^I = 0$ because planned investment is zero.[8]

3.7 Summary and interpretation

With an eye to the analysis of the macroeconomic equilibrium, our core results about corporate governance are as follows. Since q_i is time-invariant, equation (27) reduces to

$$r_Z = \frac{a_i}{q_i} \cdot \frac{\partial F_i}{\partial Z_i}. \tag{33}$$

The founder's participation constraint (19) yields the free-entry condition $V_i^{\text{founder}}(t) = \beta X(t)$. Taking logs and time derivatives yields the return to entry

$$r_N = \frac{\Pi_i^{\text{founder}}}{V_i^{\text{founder}}} + \frac{\dot{V}_i^{\text{founder}}}{V_i^{\text{founder}}} = \frac{1}{\beta}\frac{\Pi_i^{\text{founder}}}{X} + \frac{\dot{X}}{X}, \tag{34}$$

where

$$\Pi_i^{\text{founder}} = \underbrace{\left(1 - S_i^F\right)\left(1 - d_i^F - m_i^F\right)}_{a_i} \cdot F_i - \underbrace{\left(\frac{1}{1 - S_i^I} + d_i^I + m_i^I\right)}_{q_i} \cdot \underbrace{\left(1 - S_i^I\right) I_i}_{\dot{Z}_i}.$$

According to these expressions, corporate governance distortions affect the rates of return to in-house knowledge accumulation and entry only through the appropriation factor $a_i < 1$ and the cost-of-investment factor $q_i > 1$.

The key property of our structure, therefore, is that the effects of the agents' moral hazard reduce to two sufficient statistics, a_i and q_i, that exhibit level-changes when the firm

[8] Table 1 in the Appendix summarizes the conditions associated with each type of governance structure discussed in this section.

transitions from an internal equilibrium with $I_i = 0$ to one with $I_i > 0$. As stated, this property follows from the fact that the founder's decisions concerning corporate governance do not depend on the size of the cash flow or on the amount of planned investment (when positive) but depend only on the institutional environment, that we hold constant throughout the analysis, and on whether planned investment is zero or positive.

4 General equilibrium

We now turn to the general equilibrium of our economy.

4.1 Structure of the equilibrium

Models of this class have symmetric equilibria in which firms charge the same price, $P = 1/\theta$, and have the same quality level at all times.[9] Also, as they receive $NPX = \theta Y$ from the final producer, we have $X = \theta^2 Y/N$. Writing the production function (1) under symmetry and using this result to eliminate X, we obtain

$$Y = \theta^{\frac{2\theta}{1-\theta}} Z N^{1-\gamma} L^{\gamma} \Omega^{1-\gamma}. \tag{35}$$

This reduced-form representation of final production shows that both the mass of firms, N, and average quality, Z, drive total factor productivity. Next, we use the definition of cash flow (6) to write the returns (33)-(34) as:

$$r_Z = \frac{\alpha a}{q}\left[\left(\frac{1}{\theta} - 1\right)\frac{X}{Z} - \phi\right]; \tag{36}$$

$$r_N = \frac{1}{\beta}\frac{a[(\frac{1}{\theta} - 1)X/Z - \phi] - q\dot{Z}/Z}{X/Z} + \frac{\dot{X}}{X} \tag{37}$$

These expressions show that the returns depend on the quality-adjusted *firm size*, X/Z. They thus suggest that we use $x \equiv X/Z$ as our stationary state variable in the analysis of dynamics since in this model steady-state growth is driven by exponential growth in intermediate product quality. Using (35), we have

$$x \equiv \frac{X}{Z} = \frac{1}{P} \cdot \underbrace{\frac{\theta Y}{Z}}_{\text{market size}} \cdot \underbrace{\frac{1}{N}}_{\text{market share}} = \left(\frac{\theta}{P}\right)^{\frac{1}{1-\theta}}\left(\frac{L}{N}\right)^{\gamma}\Omega^{1-\gamma}. \tag{38}$$

[9] See Peretto (2015) for a review of the formal arguments. The conditions for symmetry in this model are: (i) the firm-specific return to in-house innovation is decreasing in Z_i (this follows from $\alpha < 1$); (ii) entrants enter at average quality Z. The first condition implies that if one holds constant the mass of firms and starts the model from an asymmetric distribution of firm size, then the model converges to a symmetric distribution. The second assumption ensures that entrants do not perturb such symmetric distribution.

This expression shows the equilibrium determinants of quality-adjusted firm size. Henceforth, we call x "firm size" for short.

To conclude this characterization, we subtract the costs of intermediate production and the fixed costs of operating firms from final output, Y, and obtain Gross Domestic Product (GDP) per capita (worker) as:

$$\frac{G}{L}=\left(\frac{\theta}{P}\right)^{\frac{\theta}{1-\theta}}\left[1-\frac{\theta}{P}\left(1+\frac{\phi}{x}\right)\right]N^{1-\gamma}Z\left(\frac{\Omega}{L}\right)^{1-\gamma},\quad P=\frac{1}{\theta},\tag{39}$$

where G denotes GDP. This expression decomposes GDP per capita in four terms. The first captures the role of the pricing decision in locating firms on their demand curve, thus determining their scale of activity. The second captures the role of static economies of scale, which imply that larger firms produce at lower average cost. The third captures the role of product variety and product quality, which evolve over time according to the behavior dictated by the returns discussed above. The last term captures diminishing returns to labor due to the presence of the fixed factor. Next, we highlight the two channels through which corporate governance affects household wealth, $A=\int_0^N V_i^{\text{founder}}di$. First, the dividend flow Π_i^{founder} in the valuation equation (18) depends on the micro-level, principal-agent equilibrium internal to the firm: the worse corporate governance frictions, the lower the dividend flow accruing to the founder. Second, in equilibrium the interest rate r itself depends on corporate governance frictions through their effects on the returns r_Z and r_N.

4.2 The dynamical system

We now derive the main building blocks of the economy's equilibrium system. In particular, we characterize all the needed macroeconomic variables as functions of firm size x only, a property that makes the analysis of the general equilibrium dynamics remarkably simple. Incentives to innovate and the associated evolution of market structure in the intermediate goods sector are as follows.

Lemma 1 *(Rates of Return and Firm Size Dynamics) With the definition of x in (38), the returns to innovation in (36) and (37) become:*

$$r_Z=\frac{a}{q}\alpha\left[\left(\frac{1}{\theta}-1\right)x-\phi\right];\tag{40}$$

$$r_N=\frac{a}{\beta}\left[\left(\frac{1}{\theta}-1\right)-\frac{\phi+\frac{q}{a}z}{x}\right]+\frac{\dot{x}}{x}+z.\tag{41}$$

Firm size obeys the differential equation

$$\frac{\dot{x}}{x}=\gamma\left(\lambda-n\right).\tag{42}$$

Proof. We use the definition $x \equiv X/Z$, noting that it yields $\frac{\dot{x}}{x} = \frac{\dot{X}}{X} - z$, to rewrite (36)-(37) as (40)-(41). Next we log-differentiate (38) with respect to time to obtain (42). ■

Equations (40)-(41) highlight the role of moral hazard: *worse corporate governance, captured by lower a and/or higher q, reduces the returns to innovation, r_Z and r_N.* They also reproduce the growth model's main property: decisions to invest depend on firm size, x. The evolution of firm size, in turn, is driven by the difference between population growth, λ, which drives the growth of the market for intermediate goods, and product proliferation, n, which fragments the market for intermediate goods in smaller submarkets (local monopolies) and thus reduces the profitability of the individual firm. Moreover, from the perspective of the firm, innovation entails a sunk cost that is economically justified only when the anticipated revenue flow is sufficiently large. Specifically, the non-negativity constraint on variety growth, $n \geq 0$, implies that there is a threshold of firm size below which entry is zero because the return is too low. The value of the threshold depends on whether entrants anticipate that in the post-entry equilibrium $z > 0$ or $z = 0$ since it affects the dividend that they expect to earn. Similarly, the non-negativity constraint on quality growth, $z \geq 0$, implies that there is a threshold of firm size below which incumbents do not invest because the return is too low. The value of the threshold depends on whether $n > 0$ or $n = 0$ since it affects the reservation interest rate of the household. We focus on the case where the threshold for variety innovation, denoted x_N, is smaller than the threshold for quality innovation, denoted x_Z. The threshold x_N has a special role that the following lemma states formally. The next lemma describes the household consumption behavior net of the resources consumed by managers and auditors.[10]

Lemma 2 *(Household Consumption) There are two regimes, one with no entry and one with entry. The consumption behavior of the household in the two regimes is*

$$c(x) = \begin{cases} 1 - \theta + a\theta^2 \left(\frac{1}{\theta} - 1 - \frac{\phi}{x}\right) & \frac{\phi}{\frac{1}{\theta}-1} < x \leq x_N \\ 1 - \theta + (\rho - \lambda)\beta\theta^2 & x > x_N \end{cases}. \tag{43}$$

Proof. See the Appendix. ■

[10] The Appendix derives the all-inclusive consumption ratio that accounts for the consumption of managers and directors. Recall that for simplicity we separated the agents (managers and directors) from the household, as the provider of labor and of startup funds, and assumed that managers and directors consume instantly their income flow. Given the calibration procedure described in the next section, we solved numerically the model under the assumption that agents confer their income to a consolidated household budget and participate in a complete consumption-sharing scheme. We found that quantitatively the behavior of the economy is only marginally different from that presented here. We thus decided to focus on the setup with segregated budgets because it yields analytical results that make the paper's key mechanism transparent.

This result says that the ratio of consumption to final output, c, is an increasing function of firm size, x, up to the threshold that triggers entry, where it becomes constant. The reason is that when entry is zero incumbents earn rents that increase with firm size. Since such rents are distributed to the household as dividends, they fuel the rise of the consumption ratio. When entry is positive, in contrast, such rents are competed away and the ratio of consumption to final output is constant throughout the transition as well as in steady state. Of note is the role of the appropriation factor a. In the regime with no entry, corporate governance distortions that result in $a < 1$ depress the household's consumption-output ratio because they divert resources to managers and directors. In the regime with entry, instead, such frictions do not affect the consumption-output ratio. Given these two regimes, the equilibrium interest rate and growth rate are as follows.

Lemma 3 *(Interest Rate and Growth) Denote $n \equiv \dot{N}/N$, $z \equiv \dot{Z}/Z$ and $g \equiv \dot{G}/G - \lambda$. Denote the elasticity of GDP per capita with respect to firm size*

$$\xi(x) \equiv \frac{\theta^2 \phi / x}{1 - \theta^2 (1 + \phi / x)}.$$

At any point in time, the interest rate is

$$r = \begin{cases} \rho - \lambda + \frac{(1-\theta)(1+a\theta)x}{(1-\theta)(1+a\theta)x - a\theta^2\phi}\gamma\lambda & \frac{\phi}{\frac{1}{\theta}-1} < x \leq x_N \\ \rho + z + (1-\gamma)(n-\lambda) & x > x_N \end{cases}. \tag{44}$$

At any point in time, the growth rate of GDP per capita is

$$g = \begin{cases} [\xi(x)\gamma - 1 + \gamma]\lambda & \frac{\phi}{\frac{1}{\theta}-1} < x \leq x_N \\ z + [1 - \gamma - \gamma\xi(x)](n-\lambda) & x > x_N \end{cases}. \tag{45}$$

Proof. See the Appendix. ■

The activation thresholds and innovation rates are as follows.

Lemma 4 *(Innovation Rates and Thresholds) The thresholds of firm size that activate, respectively, variety and quality innovation are:*

$$x_N = \frac{\phi}{\frac{1}{\theta} - 1 - \frac{\beta(\rho-\lambda)}{a}}; \tag{46}$$

$$x_Z = \frac{\phi\frac{\alpha}{q} + \left(\frac{1}{\theta}-1\right)\frac{1-\gamma}{\beta} + \frac{\gamma\rho}{a} + \sqrt{\left[\phi\frac{\alpha}{q} + \left(\frac{1}{\theta}-1\right)\frac{1-\gamma}{\beta} + \frac{\gamma\rho}{a}\right]^2 - 4\left(\frac{1}{\theta}-1\right)\frac{\alpha}{q}\phi\frac{1-\gamma}{\beta}}}{2\left(\frac{1}{\theta}-1\right)\frac{\alpha}{q}}. \tag{47}$$

Focus on the case $x_N < x_Z$ and assume

$$\beta x > (1-\gamma)\, q \quad \forall x > \phi, \tag{48}$$

i.e., $\beta\phi > (1-\gamma)\, q$. Then, for $x > x_N$ the equilibrium rates of innovation are:

$$n(x) = \begin{cases} \frac{a}{\beta}\left(\frac{1}{\theta} - 1 - \frac{\phi}{x}\right) - \rho + \lambda & x_N < x \leq x_Z \\ \frac{a}{\beta}\left(\frac{1}{\theta} - 1 - \frac{\phi + \frac{q}{a} z(x)}{x}\right) - \rho + \lambda & x > x_Z \end{cases}; \tag{49}$$

$$z(x) = \begin{cases} 0 & x_N < x \leq x_Z \\ \frac{\left[\left(\frac{1}{\theta}-1\right)x - \phi\right] a \left(\frac{\alpha}{q} - \frac{1-\gamma}{\beta x}\right) - \gamma\rho}{1 - \frac{(1-\gamma)q}{x\beta}} & x > x_Z \end{cases}. \tag{50}$$

Proof. See the Appendix. ■

The analysis developed so far provides all the elements needed to address the paper's main research question. In the next section we characterize the evolution of the economy through three phases, starting from a phase of no innovation to becoming a modern *innovation economy*. The key feature of the dynamics is that at two critical junctures the economy may be trapped in stagnation because the corporate governance distortions are too severe.

5 Transition to Industrialization

This section characterizes the rise of the industrial economy as the acceleration of the rate of formation of new firms and the intensification of existing firms' in-house knowledge accumulation. The analysis emphasizes the role of corporate governance as a key determinant of whether, when and how the economy crosses the thresholds leading to the innovation economy. The model produces a path consisting of three phases:

1. an initial phase where there is no innovation and the economy grows only because of exogenous population growth;

2. an intermediate phase where the economy turns on the Schumpeterian engine of endogenous innovation in response to population-led market expansion;

3. a terminal phase where economic growth acquires the features associated with the modern *innovation economy*.

5.1 Phase 1: stagnation or take-off

In the first phase there is no entry, no in-house investment and all dividends are consumed. As said, the economy grows only because of exogenous population growth. Because of its stark simplicity, this phase highlights the role of corporate governance distortions as a potential cause of stagnation: when cash flow diversion is severe, founders delay the creation of new firms or give it up altogether. The following proposition formalizes this result.

Proposition 3 *(Stagnation or Take-off) In the first phase firm size evolves according to $\dot{x}/x = \gamma\lambda$. The expression for x_N in equation (46) yields two scenarios.*

- ***Stagnation**. For $a \leq \beta(\rho - \lambda) / \left(\frac{1}{\theta} - 1\right)$ the activation threshold x_N is infinite and the economy remains forever in the regime with no innovation.*
- ***Take-off**. For $a > \beta(\rho - \lambda) / \left(\frac{1}{\theta} - 1\right)$ the activation threshold x_N is finite and the economy crosses it in finite time. Specifically, starting from initial condition $x_0 < x_N$ firms size follows the process $x(t) = e^{\gamma\lambda t} x_0$ and reaches $x(t) = x_N$ at time*

$$T_N = \frac{1}{\gamma\lambda} \log\left(\frac{x_N}{x_0}\right) = \frac{1}{\gamma\lambda} \log\left(\frac{\phi}{\frac{1}{\theta} - 1 - \frac{\beta(\rho-\lambda)}{a}} \frac{1}{\theta^{\frac{2}{1-\theta}} \left(\frac{L_0}{N_0}\right)^{\gamma} \Omega^{1-\gamma}}\right). \tag{51}$$

Proof. See the Appendix. ■

Equation (51) provides a key analytical insight on how the activation of Schumpeterian innovation, the model's first phase-transition, depends on the interaction between corporate governance distortions and other fundamentals of the economy, such as the population growth rate, λ, and the fixed factor endowment, Ω. On the one hand, faster population growth favors more rapid market expansion and thus reduces the time that it takes for the economy to enter the second phase. On the other hand, for given population growth, the timing of the first phase transition depends on the gap between the activation threshold, x_N, and the initial position of the economy, x_0. While an improvement in corporate governance brings forward in time the first phase transition by reducing the ratio x_N/x_0, it does not trigger an immediate take-off if the ratio x_N/x_0 remains larger than one. Similarly, economies that take off earlier are not necessarily economies with better corporate governance. An economy with bad corporate governance can cross the threshold x_N earlier than economies with better corporate governance if it has a larger endowment Ω that supports a larger market for intermediate goods and thereby makes entry profitable earlier.

Because we focus on a sequence in which product-variety expansion sets in before in-house innovation, corporate governance distortions affect the first phase transition only through the appropriation factor, a. Accordingly, the quantitative analysis of Section 6 explains the initial income divergence across countries only through differences in diversion of cash flow. Diversion of planned investment funds becomes relevant only after the second phase transition. As discussed, this transition entails a substantial change in the internal organization of firms and of the contracts they offer to managers and directors.

5.2 Phase 2: variety expansion only or full transition

Substitution of the top line of equation (49) into equation (42) yields the law of motion of firm size in Phase 2 as the linear process

$$\dot{x} = \bar{\nu} \cdot (\bar{x}^* - x), \tag{52}$$

where:

$$\bar{\nu} \equiv \gamma \left[\left(\frac{1}{\theta} - 1 \right) \frac{a}{\beta} - \rho \right]; \quad \bar{x}^* \equiv \frac{a\gamma\phi}{\beta} \frac{1}{\bar{\nu}} = \frac{\phi}{\frac{1}{\theta} - 1 - \frac{\rho\beta}{a}} > x_N.$$

By construction $\bar{x}^*$ is the steady state that the economy reaches if it never activates in-house innovation. We thus have the following result.

Proposition 4 *(Transition to In-house Innovation) In the second phase firm size evolves according to $\dot{x} = \bar{\nu} \cdot (\bar{x}^* - x)$. The expression for x_Z in equation (47) yields two scenarios.*

- ***Variety Expansion Only.*** *If $\rho \leq \frac{a}{\beta} \left(\frac{1}{\theta} - 1 - \frac{\phi}{x_Z} \right)$ the activation threshold x_Z is larger than the steady state $\bar{x}^*$ and the economy remains forever in the regime with only variety expansion.*

- ***Full Transition.*** *If $\rho > \frac{a}{\beta} \left(\frac{1}{\theta} - 1 - \frac{\phi}{x_Z} \right)$ the activation threshold x_Z is smaller than the steady state $\bar{x}^*$ and the economy crosses it in finite time. Specifically, firms size follows the process*

$$x(t) = x_N e^{-\bar{\nu}(T_N - t)} + \bar{x}^* \left(1 - e^{-\bar{\nu}(T_N - t)} \right). \tag{53}$$

and reaches $x(t) = x_Z$ at time

$$T_Z = T_N + \frac{1}{\bar{\nu}} \log \left(\frac{\bar{x}^* - x_N}{\bar{x}^* - x_Z} \right). \tag{54}$$

Proof. See the Appendix. ■

The expressions for $\bar{x}^*$ and x_Z in, respectively, equations (52) and (47) show how these two critical values of firm size vary with technology and preference parameters and with corporate governance distortions. Using those expressions, we can write the condition $\bar{x}^* > x_Z$ that determines whether the date T_Z is finite as

$$\frac{\phi\frac{\alpha}{q} + \left(\frac{1}{\theta}-1\right)\frac{1-\gamma}{\beta} + \frac{\gamma\rho}{a} + \sqrt{\left[\phi\frac{\alpha}{q} + \left(\frac{1}{\theta}-1\right)\frac{1-\gamma}{\beta} + \frac{\gamma\rho}{a}\right]^2 - 4\left(\frac{1}{\theta}-1\right)\frac{\alpha}{q}\phi\frac{1-\gamma}{\beta}}}{2\left(\frac{1}{\theta}-1\right)\frac{\alpha}{q}} < \frac{\phi}{\frac{1}{\theta}-1-\frac{\rho\beta}{a}}.$$

This inequality says that parameters and corporate governance distortions are such that $\dot{x} > 0$ for $x = x_Z$, that is, that firm size is strictly increasing in the whole range $[x_N, x_Z]$ and, consequently, the economy crosses the threshold x_Z in finite time. If the inequality fails, the economy never reaches the activation threshold x_Z (regardless of whether it is finite or infinite) and converges to the steady state $\bar{x}^* < x_Z$ where there is only variety expansion and the growth rate of income per capita is $\bar{g}^* = 0$. The condition shows that such premature stopping can result from severe corporate governance distortions, especially a high cost of in-house investment. One could build a locus in (a, q) space that identifies a region in which the transition to in-house innovation occurs and one in which it does not. The location and shape of the locus depends on the micro parameters characterizing moral hazard. In this sense, the pair (a, q) propagates the micro-interactions between founder, manager and director throughout the macroeconomy, including whether it progresses to the third phase.

The analytical solution for the activation date T_Z in equation (54) is richer than that for T_N in equation (51) because it compounds the diversion of cash flow with the diversion of planned investment funds. Section 5.4 illustrates how each distortion (cash and investment) affects the dynamics of the economy. Section 6 shows how quantitatively the interaction between the two distortions affects the dynamics. The interaction produces a variety of transition patterns, including episodes of overtaking and of permanent divergence.

5.3 Phase 3: the modern innovation economy

Substitution of the bottom line of equation (49) in equation (42) yields that in the third phase the economy follows the nonlinear differential equation

$$\dot{x} = \frac{\gamma}{\beta}\left[\beta\rho x - a\left(\left(\frac{1}{\theta}-1\right)x + \phi\right) + qz(x)\right], \tag{55}$$

where $z(x)$ is given by the second line of equation (50). The following proposition states the main result formally.

Proposition 5 *(Transition to Modern Innovation Economy) Assume:*

$$a > \frac{\beta(\rho-\lambda)}{\frac{1}{\theta}-1}; \tag{C1}$$

$$\rho > \frac{a}{\beta}\left(\frac{1}{\theta} - 1 - \frac{\phi}{x_Z}\right); \tag{C2}$$

$$\frac{(1-\alpha)\frac{a}{q}}{\rho} > \frac{\beta}{\left(\frac{1}{\theta}-1\right)q} > \frac{1}{\phi}. \tag{C3}$$

Then, there is a unique equilibrium path: given $x_0 < x_N$ *the economy goes through Phase 1, Phase 2, Phase 3 and converges to the steady state*

$$x^* = \frac{(1-\alpha)a\phi - q\rho}{(1-\alpha)a\left(\frac{1}{\theta}-1\right) - \beta\rho} > x_Z. \tag{56}$$

The rates of growth of quality, variety and GDP per capita are, respectively:

$$z^* = \frac{a}{q}\alpha\left[\left(\frac{1}{\theta}-1\right)x^* - \phi\right] - \rho = \frac{\alpha}{q}\frac{\phi\beta\rho - \left(\frac{1}{\theta}-1\right)q\rho}{(1-\alpha)\left(\frac{1}{\theta}-1\right) - \frac{\beta\rho}{a}} - \rho > 0; \tag{57}$$

$$n^* = \left(\frac{\dot{N}}{N}\right)^* = \lambda; \tag{58}$$

$$g^* = \left(\frac{\dot{G}}{G}\right)^* - \lambda = \left(\frac{\dot{Y}}{Y}\right)^* - \lambda = z^*. \tag{59}$$

Proof. See the Appendix. ■

Condition C1 ensures that the economy crosses the threshold x_N and activates horizontal innovation (entry). Condition C2 ensures that the economy makes the transition to the third phase with in-house quality innovation. Condition C3 ensures that the steady state x^* exists because both the numerator and the denominator of equation (56) are positive. To complete the characterization of this scenario, note that since the transition features rising firm size, x, it features a rising rate of variety innovation, $n(x)$. Under conditions C2-C3, the economy crosses the threshold x_Z at time T_Z, displays rising rates of variety and quality innovation, $n(x)$ and $z(x)$, and converges from below to the growth rate $g^* = z^*$.

To understand better the properties of the steady state, note that the household's saving behavior yields $r = \rho + z$. Substituting this expression in the returns to investment (40) and to entry (41) we obtain:

$$z = \frac{a}{q}\alpha\left[\left(\frac{1}{\theta}-1\right)x - \phi\right] - \rho; \tag{CI}$$

$$z = \frac{a}{q}\left[\left(\frac{1}{\theta}-1\right)x - \phi\right] - \frac{\beta}{q}\rho x. \tag{EI}$$

The first linear relationship describes the steady-state investment rate that incumbents choose given the firm size that they expect to achieve in equilibrium; the second describes the steady-state investment rate of incumbents that equalizes the return to entry and the return to in-house investment, given the value of firm size that both entrants and incumbents expect to achieve in equilibrium. The steady state is the intersection of these two lines in (x, z) space. Existence and stability require the intercept condition that the EI line starts out below the CI line and the slope condition that the EI line be steeper than the CI line. Together they say that one intersection exists, with the EI line cutting the CI line from below. The restrictions on the parameters that guarantee this configuration are those that yield the global stability of the economy's dynamics (see the Appendix for more).

The CI line says that the return to in-house innovation is given by the marginal effect of knowledge accumulation on the firm's cash flow times the wedge a/q. The cost of investment, q, seemingly enters the EI locus twice but in fact the expression captures a single effect. To see this, we write the return to entry as

$$\rho + z = \frac{a}{\beta}\left[\left(\frac{1}{\theta} - 1\right) - \frac{\phi + \frac{q}{a}z}{x}\right] + z,$$

where on the left-hand side we have the household's reservation interest rate. Here the cost of investment, q, raises the anticipated expenditure on in-house innovation and thereby reduces the dividend flow distributed to shareholders. The stability conditions imply that the effect of q on the EI line dominates, yielding that for given x worse diversion of planned investment reduces firm growth on both the EI and CI margins. Whether such a deterioration causes a rise or a decline of equilibrium growth depends on the relative magnitude of the shifts of the two lines. Our closed-form solutions (56) and (57) show the net effect of such shifts and identify the channels: (i) q reduces the growth rate, z, for given firms size, x; (ii) q reduces firm size, x. Thus, the larger cost of investment produces an equilibrium market structure with a larger mass of smaller firms that invest less. Similarly, the solutions say that because stability requires $q < \beta\phi/\left(\frac{1}{\theta} - 1\right)$ the net effect of the appropriation factor, a, on both firm size, x, and firm growth, z, is negative. That is, the larger appropriation factor produces an equilibrium market structure with a larger mass of smaller firms that invest less.

To appreciate the micro-to-macro of corporate governance at the heart of our model, it is useful to see explicitly how the appropriation factor, a, and the cost of investments, q, vary with the parameters of equations (29)-(32). Using the parameter values in Table 1, Figure 3 illustrates this key channel and the consequent steady-state macroeconomic propagation. The appropriation factor a is increasing in the marginal utility cost of cash flow diversion $\partial c_M^F(M^F)/\partial M^F$ and is thus increasing in, e.g., σ_4^F. Consequently, if σ_4^F falls, a falls and both rates of return to innovation fall for all values of x. In general equilibrium, then, both rates of innovation fall for all values of x. In steady state, the lines CI and EI shift to the left in (x, z) space; see the left graph of Figure 3b. Because the EI line responds relatively more, firm size falls and firms invest less, i.e., both x and z fall. Similarly, the cost of investment q is decreasing in the marginal utility cost of planned investment diversion $\partial c_M^I(M^I)/\partial M^I$ and is thus decreasing in, e.g., σ_4^I. Therefore, as σ_4^I rises, q rises, driving up both lines, but the CI line shifts relatively more and the economy moves to a situation where both firm size and firm investment are smaller, i.e., both x and z fall.

5.4 Corporate Governance and Industrialization: An Illustration

Figures (5)-(6) illustrate the interaction between institutional environment, the evolution of corporate governance and the timing of industrialization. They plot the behavior of the main macroeconomic and industry variables (firm size, firm value, innovation rate, entry rate, rates of return to innovation and to entry) both in phase diagrams with respect to the state variable of the dynamical system, x, and against time. They contrast a baseline economy with one that has poorer institutions. Both economies have fundamentals and institutions that produce a full transition to the innovation economy phase.

In Figure 5 the instituional environment operates only through the investment channel. The economy with poorer institutions has higher diversion, S^I, compensation for manager and director, $\left(m^I, d^I\right)$, and thus higher cost of capital, q. The appropriation factor, a, is the same as that of the baseline economy. The left-top plot of Figure 5.a shows that firm-size growth slows down as the economy transits from phase 1 to phase 2 because of the entry of new firms. The two economies look alike until the baseline economy enters phase 3 and they start diverging in several aspects. The economy with poorer institutional environment remains in phase 1 while the other accelerates further its growth. Even after entering phase 2 and then 3, and thus adopting a modern corporate structure, the more distorted economy looks different from the baseline economy: in phase 3, for instance, it invests less in in-house innovation (lower z) and more in entry (higher n). The difference is due to the higher cost of investment, q. The more distorted economy has lower market valuation of incumbent firms; see the bottom-right plot of Figure fig5.b. However, the value-revenue ratio, $v(x) = V/PX$ (see Appendix for its analytical derivation), is the same in the two economies since such ratio is determined by the free-entry condition; see the bottom-right plot of Figure 5.a. The two economies have different interest rates in phase 3 because of the different cost of investment. In phase 2, in contrast, the interest rate is the same since in-house innovation is not active.

In Figure 6 the institutional environment operates only through the cash diversion channel. The more distorted economy has higher diversion, S^F, compensation of manager and director, (m^F, d^F), and thus lower appropriation factor, a. The most significant divergence in corporate governance structure emerges when the baseline economy crosses the innovation-economy threshold and enters phase 3. When that happens, $d^F > 0$ in the baseline economy and $d^F = 0$ in the other. Because cash flow diversion affects relatively more entry than in-house innovation, in the more distorted economy firms are relatively larger and starti investing in-house earlier and, when they do, invest more than in the baseline economy; compare the two top-right plots of panels A and B in Figure 6.

To summarize: worse investment diversion delays the transition to phase 3; worse cash flow diversion delays the transition to phase 2 and then the transition to phase 3. In both cases, corporate governance in the economy with worse institutional environment remains longer in the configuration with $m_i^I = d_i^I = 0$. Finally, while worse investment diversion yields lower interest rate and lower in-house innovation, worse cash flow diversion yields lower in-house innovation only when we hold firm size constant. Accounting for the faster growth of firm size, worse cash flow diversion yields earlier and faster in-house innovation.

We presented the planned investment and cash flow diversion channels separately. More realistically an economy with weak institutions experiences both of them at the same time. We study this case in the analysis that follows.

6 Corporate governance and income dynamics[11]

In this section we provide a quantitative assessment of the ability of corporate governance to explain the empirical observations discussed in the introduction. We first calibrate the model's parameters to the USA over the period 1700-2008. We then assign those parameters to several countries and a few macro regions to compute the corporate governance distortions, relative to the USA, that allow the model to fit the Maddison data for those units.

6.1 Calibration to the US economy

Table 2.a shows the calibrated parameters. The rate of population growth, $\lambda = 1.03\%$, is the average since 1880. In the model's steady state the entry rate, n, is equal to λ. Lee and Mukoyama (2015, p. 24) and Hathaway and Litan (2014, p. 2), among many others, report that this is the case in the data: the long-run entry rate in US manufacturing is statistically equal to the population growth rate. Thus, although we do not target the long-run entry rate, the model replicates it well. We set the elasticity of profit with respect to own knowledge at $\alpha = 0.33$. This implies knowledge spillovers, $1 - \alpha = 67\%$, in line with the estimates reported in the literature; see Baumol (2002) for an extensive discussion. We set $\theta = 0.769$ to obtain a mark-up of 30%, within the range for manufacturing reported in the literature (Christopoulou and Vermeulen, 2012), which gives us price $P = \frac{1}{\theta} = 1.3$. We

[11] A detailed guide on how to replicate all the results presented in this section is available upon request.

set the discount rate at $\rho = 3\%$. We follow Iacopetta et al. (2019), who use data discussed in Nikolov and Whited (2014) to set the appropriation factor at $a = 0.9$.

To set the remaining parameters $(\phi, \beta, \gamma, q, \Omega)$ and the initial conditions (Z_0, N_0, L_0) we follow a procedure (discussed in detail in the Appendix) that reflects the highly nonlinear shape of the transition path. We set without loss of generality $L_0 = N_0 = 1$ and determine $(\phi, \beta, \gamma, q, \Omega, Z_0)$ asking the model to generate data that satisfy the following criteria.

1. The model-generated income in 1700 matches the value in the Maddison data.[12]

2. The activation of horizontal innovation (i.e., $n > 0$) occurs in 1800. In choosing this date, we follow the literature, e.g., Lucas (2000) and many others.

3. The model-generated long-run saving rate is within the range observed for the USA in recent decades. Our target is 11.8%; see Table 2b and the Appendix for a discussion.

4. The model-generated long-run labor share (aggregate labor income over GDP) is within the range observed for the USA in recent decades. Our specific target is 59%; see Table 2b and the Appendix for a discussion.

5. The procedure minimizes the sum of squared deviations between model-generated data and the Maddison data over the period 1990-2008. (From a geometrical point of view, this part of the calibration fits a line to the data for log-income and uses the regression's slope to obtain a constraint that the parameters must satisfy.)

6. The model-generated income in 2008 matches the value in the Maddison data (2008 is the final year of the data set).[13]

The procedure yields a value of long-run income growth $g = 2.21\%$. This is also the in-house investment rate, z, or, equivalently, the growth rate of incumbent firms. The implied interest rate is $r = \rho + g = 5.21\%$. While these values were not pre-set targets for the calibration, they are in line with the values typically found in the literature. Finally, the procedure yields a value $q = 1.0720$ for the cost of in-house investment.[14]

[12] There is nothing special about the choice of 1700, other that this is the only year prior to 1820 for which Maddison reports the level of income for a large number of countries. Except for the value of Ω (see below), our calibration would not change if it started at some other year.

[13] Using as a moment the income of any year in the 1990-2008 period or a moving average over the same period changes the results only marginally.

[14] Recall that we set $a = 0.9$ from outside sources. In light of the micro-to-micro analysis of the previous subsection, which is based on the fact that both a and q are endogenous objects, we need to make clear how we reconcile the two levels of discipline for (a, q). The obvious constraint that one faces in using our structure to address cross-country questions is the lack of micro data consistent in both quality and coverage across

Initial conditions play an important role in the timing of the first phase transition. It is thus worth discussing how we meet the target year 1800 for the activation of horizontal innovation (point 2). Given (ϕ, β, γ), which are tied to other moments, and $(\lambda, \rho, \theta, a)$, which are calibrated from outside sources, we start the simulation at $t = 1700$ and let equation (51) determine the value of Ω that yields $T_N = 100$. We say that we can set $L_0 = N_0 = 1$ without much loss of generality because equation (51) cannot disentangle the roles of (Ω, N_0, L_0) since the three enter through $x_0 = \theta^{\frac{2}{1-\theta}} (L_0/N_0)^{\gamma} \Omega^{1-\gamma}$. Nevertheless, one should note that the triplet (Ω, N_0, L_0) affects the income path. To see this, recall that population follows the process $L(t) = L_0 e^{\lambda t}$ and write income as

$$\frac{G(t)}{L(t)} = \theta^{\frac{2\theta}{1-\theta}} \left[1 - \theta^2 \left(1 + \frac{\phi}{\theta^{\frac{2}{1-\theta}} \left(\frac{L_0 e^{\lambda t}}{N(t)} \right)^{\gamma} \Omega^{1-\gamma}} \right) \right] \frac{N(t)^{1-\gamma} Z(t)}{\left(e^{\lambda t}\right)^{1-\gamma}} \left(\frac{\Omega}{L_0} \right)^{1-\gamma}. \tag{60}$$

Finally, we stress that given T_N and parameters, equation (54) of proposition 4 generates *endogenously* $T_Z = 112$ for the activation of in-house innovation. This activation time, which is not a target of the calibration, determines when the bulk of the growth acceleration begins and thus drives the determination of the cost of in-house investment, q.

Figure 7a compares the model-generated income series to the Maddison data. Figure 7b shows the two main drivers of the dynamics: when variety innovation, n, and, later, quality innovation, z, turn positive, the series become steeper as growth accelerates. The model matches quite well the data for the second half of the 20th century. For example, in the years 1950, 1975, 1990, and 2005, the model predicts 97%, 97%, 94%, and 103% of the data. It does less well in the 19th century, however, underpredicting the data by 10%-20% on average (see the last column of table 9).

6.2 Relative income dynamics around the world

Our main objective is to understand to what extent cross-country income differences are attributable to delays in industrialization caused by corporate governance distortions. The exercise described in this section estimates the differences in the cost of capital, q, and in the founder's appropriation, a, that can explain the income gap of a given country relative to the USA. Channels other than corporate governance contribute to cross-country income

countries. We are able to use micro sources only for the a of the USA and obtain q from the model. For the other countries we obtain the pair (a, q) from macro data as described here. For the USA we check that there exist reasonable micro parameters that produce those values following the micro-to-macro procedure. The first row of Table 1 reports the values of the micro parameters for the functional forms in equations (29)-(32) consistent with $a = 0.9$ and $q = 1.0720$.

difference and thus, to the extent that we do not account for them explicitly, our estimates of q and a are upper and lower bounds, respectively, of the actual ones.

We discipline our cross-country exercise in two ways. We discipline the exercise in two ways. First, we use the same set of parameters for all countries, allowing them to differ only by corporate governance and, possibly, by initial level of technology, Z_0, and endowment, Ω. Second, in determining the pair (a, q) we impose that the growth rate of income 2.21% is the same for all countries. To see the role of this constraint, we use equation (57) to construct the corporate governance loci

$$q\left(a\right)=\frac{\alpha\phi\beta\rho}{\left(g^{*}+\rho\right)\left[\left(1-\alpha\right)\left(\frac{1}{\theta}-1\right)-\frac{\beta\rho}{a}\right]+\left(\frac{1}{\theta}-1\right)\alpha\rho}. \tag{61}$$

This expression says that q is decreasing in a; Figure 8 illustrates the quantitative relation that we obtain with our calibrated parameters for a range of values of g^*. The loci is downward sloping because, as we discussed in Section 5, the appropriation factor, a, raises the incentives to enter and thus produces an equilibrium market structure with a larger mass of smaller firms that invest less. Accordingly, our exercises postulate that better a is associated to a compensatory change in q that keeps constant the long-run growth rate. Therefore, they identify and isolate the activation dates T_N and T_Z as the channels through which corporate governance shapes the path of income. The figure also suggests that allowing long-run growth to differ across countries would not change the results by much unless such differences are very large.

6.2.1 Example: Latin America vs. USA

We begin with a simple exercise that gives a clear first assessment of the potential of corporate governance to explain quantitatively the dynamics of income differences. In the early 18th century income in Latin America is on average about the same as in the USA. Three centuries later it is only a quarter. While many factors caused the divergence, we ask how far we can go in accounting for it with corporate governance.

We assume that Ω and Z_0 are the same in both economies so that the initial income ratio is one. The pair (a, q) that matches the observed income expansion in Latin America is $(0.68, 1.39)$. For the USA we obtained $(0.9, 1.07)$; see table 3. The associated delays in crossing the activation thresholds are, respectively, $\Delta T_N = 14$ and $\Delta T_Z = 35$ years. We also obtain a strong out of sample prediction: the income ratio will decline further along the transition to the steady state, from 0.24 in 2008 to 0.16. We stress again that because we are using the same set of parameters, reported in table 2a, and we assumed the same initial condition, Z_0, and endowment Ω for the two economies, the difference in income dynamics is explained exclusively by the difference in corporate governance distortions.

This example gives a good preview of a central theme emerging from our results: frictions and delays that are seemingly relatively small can produce large income differences over time because they drive long-lasting differences in growth rates.

6.2.2 General analysis

We consider several countries and a few macro-regions. We assign to each economy the parameters of the USA (Table 2.a) but allow for economy-specific initial condition, Z_0, and endowment, Ω. We then use the model to infer for each country the magnitude of the deviation of the pair (a, q) from that of the USA that explains the evolution of relative income in the 1700-2008 Maddison data. Accordingly, we express an economy's income, corporate governance distortions (a, q) and activation dates (T_N, T_Z) as relative to the USA.

Table 5a reports that in 1700 all European countries had higher income than the USA. Variations in endowment, Ω, and/or initial condition, Z_0, account for such differences. In the theoretical model, the endowment captures features like the amount and quality (e.g., fertility) of land, the availability of fresh water, navigable rivers, access to seaports and so on. One may also conjecture that in the USA in 1700 the level of technology of intermediate firms was lower than in Europe. Aside from such details of interpretation, however, our procedure stresses that Ω and Z_0 have different implications for the timing of the take-off and for the calibrated values of the corporate governance distortions (a, q). Specifically, everything else equal, an economy with relatively large Ω reaches the first activation threshold, x_N, relatively early. The value of Z_0, on the other hand, does not affect the take-off time but affects the determination of the values of a and q because it plays an important role in shaping the entire income path, including the crossing of the activation threshold x_Z that marks the onset of the in-house innovation phase. To explore thoroughly the role of initial conditions and assess the robustness of our results, we consider three cases.

Common endowment and initial technology We assume first that Ω and Z_0 are the same in all countries. Because there are no differences in preferences, technologies, endowments and initial conditions, the initial income ratio is one. In this specification, therefore, the differences in income, corporate governance distortions (a, q) and activation dates (T_N, T_Z) are driven by the income differences in the final period 1990-2008. On average, in Western Europe the differences in a and q are -0.07 and 0.07, respectively, and the differences in T_N and T_Z are 4 and 7, respectively. Table 4 reports our results for several Western European countries and for some macro regions. The results for Latin America (panel b.i), are the same as those reported in Table 3 because the initial income ratio in the data is one. The African region, whose income has diverged the most, exhibits the largest gaps in a, q,

T_N, and T_Z: -0.35, 0.87, 28 and 113, respectively.

Common endowment, country-specific initial technology We assume now that the initial endowment Ω is the same across countries and that initial differences in income are due to differences in Z_0. Specifically, all countries start in 1700 with the same Ω and a country's Z_0 relative to that of the USA is equal its income ratio in 1700. Because it allows for such differences in initial income, this specification *enriches* the role of corporate governance in accounting for the data. Specifically, if a country starts with income ratio above one, the calibrated differences in (a, q) are larger, while if the initial income ratio is below one, the calibrated differences in (a, q) are smaller. Table 4a.ii reports the results. The insight is clear: countries that start out ahead of the USA *must* have worse governance for the model to replicate the fact that they end up behind the USA at the end of the sample period. For Western Europe, for instance, the differences in a, q, T_N, and T_Z are, respectively, -0.18, 0.23, 10, and 25. In Africa the corresponding figures are -0.33, 0.74, 25, 91, quite similar to the ones for the scenario with common Z_0 across countries (Table 4b.ii).

Common initial technology, country-specific endowment Finally, we assume that Ω differs across countries while Z_0 is the same (i.e., we assign to all countries the Z_0 of the USA). A country with larger endowment is closer to the activation threshold x_N. Moreover, the higher the initial income, the smaller the expansion between 1700 and 2008 to be accounted for by the model. As a result, the calibrated corporate governance distortions tend to be worse (lower a, higher q) than in the previous case. Thus, the endowment Ω has two opposite effects on the take-off time: it reduces T_N by increasing the initial condition x_0; it raises T_N by generating a lower appropriation factor, a. To decompose the two effects, we first calculate (a, q) and (T_N, T_Z) with the income ratio observed in the data and then recalculate (T_N, T_Z) under the same pair (a, q) but using the Ω of the USA. Tables 5b and 8b report the results. The corporate governance distortions for Western Europe appear similar to those in the previous exercise with differences in a and q of -0.19 and 0.25. The difference in T_N is now -17, meaning that Western Europe starts the transition earlier than the USA by 17 years because of the initial advantages. More specifically, the direct effect of the endowment moves European industrialization earlier in time by 28 years, whereas the poorer corporate governance delays it by 11 years. The net effect is the -17 years reported. Figure 9 visualizes the earlier take-off of the UK due to the larger endowment and the subsequent takeover by the USA due to the better corporate governance, especially the lower cost of investment q. In particular, while the UK's larger endowment moves the take-off earlier in time by 39 years, the worse corporate governance raises T_N and T_Z by 14 and 35 years, respectively. The net effect is that the UK and the USA enter the third phase at about the same time but the USA grows faster and eventually pulls ahead.

7 Model vs. data

Technological progress has been an unrelenting force fueling income expansion over the last three centuries. Yet, political upheavals, revolutions, civil wars, global conflicts and other events, like plagues and natural disasters, disturbed the smooth transition to modern growth. The model abstracts from these factors. It is thus instructive to check how the model fares with respect to the cross-sectional evidence summarized in Figure 1, which shows that the quality of governance is negatively associated with the waiting time for the first growth acceleration, and with respect to time-series evidence on income per capita. We focus on the prediction of the model with common Z_0 and country-specific endowment Ω.

7.1 Governance and income

Figure 4.A documents a strong positive correlation (0.72) between our estimates of the appropriation factor, a, and the World Bank governance index for the year 2017 (the quality of contract enforcement and the strength of property rights are two key components of the index, see Kaufmann et al. 2010).[15] Similarly, Figure 4.B documents a strong negative correlation (-0.64) between the World Bank governance index and our estimates of the cost of investment, q. This pattern suggests that the model is on the right track with respect to the motivational evidence provided in Figure 1.

Figure 1 also stresses the large differences in take-off times across groups of countries. Propositions 3 and 4 state that countries with worse corporate governance cross the variety-expansion and quality-innovation thresholds with some delay. Panels C and D of Figure 4 report the average delays in crossing the thresholds x_Z and x_N relative to the USA for each group of countries by period of take-off reported in Figure 1. The objective is to compare the model to the data in this key dimension of our exercise. We focus on the delay measured by T_Z as this characterizes the transition to the innovation economy. Relative to the 155 countries of Figure 1, we leave out a few countries for which the model predicts $T_Z \to \infty$, i.e., they converge to the steady state with $z = 0$.[16] For countries that take off in period 2 (between 1820 and 1870), the model predicts an average delay of about 17 years. For countries that take off in period 3 (1870-1900), the predicted average delay is approximately 52 years. Since the model predicts that in the USA quality-innovation starts in 1812 (see

[15] While the governance index is available as far a back as 1996, it is has a more limited coverage. For instance, for the year 1996 no data is provided for Argentina, Australia, and Switzerland, among others.

[16] The note of fig. 4 provides a complete list of the excluded countries.

table 2), the average delays of 17 and 53 years imply the years 1829 and 1865, respectively, as the take-off times for the countries that take off in periods 2 and 3. Hence for the period 3 the model's prediction is 5 years short of the beginning of the time interval 1870–1900.

With the exception of Italy, by the turn of the century all major Western economies have experienced the first growth acceleration. The period 1900-1950 covers the two world wars and the great depression. Our model predicts, on average, a 60 years lag for the group of countries that took off in this period and thus underpredicts their delay by about 30 years. Similarly it underpredicts the delay of the group of countries that took off in the post-war period 1950-1975. Section 7.2 discusses well-known Asian economic miracles and whether postulating a level-change in the quality of governance accounts for the longer-than-predicted wait time to take-off.

Finally, we turn to the comparison of predicted and observed income time series. Tables 9-12 report the income produced by the model as a percentage of the Maddison data for selected countries and macro regions. We present the comparison by macro-regions.

Western Europe. The model replicates quite closely (within a range of 20 percent deviation) the data since 1870 for the UK, Germany and France with the noticeable exception of the post World War II decade. One way to frame this feature is that the model fails exactly where it should. For instance, in 1900, two centuries into the simulation, the model predicts income for the UK, France and Germany that is 79%, 112% and 110% of the data (see Table 9 and Figures 10 and 11). The model overpredicts the income of Continental European countries in 1820 by 20-30 percent on average. It underpredicts the income of the UK and the USA by 1 and 12 percent, respectively. The overprediction in 1820 is arguably due to the fact that in Table 5b for all countries the income ratio in 1700 is fully accounted for by the endowment. Figure 11 shows an interesting outlier: the model overpredicts by a substantial margin Italy's income both in the 19th century and in the first half of the 20th century. Italy starts in 1700 with an income about twice as large as that of the USA, but then has a relatively poor growth performance until the end of World War II. The slow process of state formation since unification may have played a role in such dynamics (see the next section). A similar type of discrepancy between model and data occurs in countries that experienced high growth rates after WWII, such as Singapore, Japan and South Korea.

Latin America. The frequent macroeconomic crises that have characterized Latin America resulted in a less regular income time series than that of Western Europe or of the USA. Figure 12 shows that for Chile the model matches well the data in 1870 and 1950 but overpredicts 1820 and underpredicts 1900. A similar result occurs for Argentina, except that in 1950 the observed income is higher than the predicted one. In the case of Mexico the decline of income in the 19th century is likely due to the prolonged internal conflict between conservatives and liberals that followed the war of independence (Coatsworth, 2005). The model then realigns with the Mexican data in 1900 during the Porfiriato. Brazil's state formation was also achieved through independence wars that caused economic disruption (1822-25), which likely explain why its income data in the 19th century exhibit an inverted-U shape similar to that of Mexico.

Asia. Matching the time profile of income in countries such as Japan, South Korea, Singapore and China (see Figure 13 and Tables 7 and 11) is challenging because of the almost vertical take-off, never before seen in the history of the world. While our model generates rising growth rates over the transition, it predicts a more gradual transition than the data. The pattern is therefore clear: the model lacks the elements required to delay even further the take-off and then generate an even more dramatic acceleration post take-off. This is another example of the model failing precisely where it should because in our exercises we keep the fundamental parameters constant throughout and do not allow for discontinuities. Therefore, we do not allow for the removal of the forces that kept these economies stagnant. For example, we do not allow for the policies, much discussed in the literature (see, e.g., Ang and Madsen 2011), whose removal in recent decades accounts for the timing of the take-off and the extraordinary burst of income growth that we see in the data. The next section proposes an exercise that sheds further light on this component of our mechanism.

7.2 Where the model fails: Improved corporate governance?

In the post-WWII period several countries experienced transformations that arguably affected corporate governance. For instance, the USA imposed the dismantling of the ziabatsu system in Japan. As a result, several family-dominated companies were dissolved and interlocking directorships were outlawed. Such a radical reform increased accountability and reduced agency frictions. To explore this hypothesis, we allow for a shock that improves corporate governance in 1950. Specifically, we introduce unanticipated and permanent changes to the parameters of the equations describing the costs of resource diversion that result in an increase of a by 0.1 and a decrease of q by 0.1. Because we implement this change under the constraint that both the growth rate and the level of income at the end of the simulation remain the same, we are asking the model to produce a longer period of stagnation, because of bad corporate governance before 1950, and a more drastic acceleration of growth after 1950 due to the improvement in corporate governance. Figure 14a shows the main result: allowing post-war Japan to experience better corporate governance improves the fit, narrowing the gap between model and data by more than 10 percentage points.

We perform similar exercises for other countries, allowing for two shocks that raise a by either 0.05 or 0.1, respectively, and reduce q by the same magnitudes. Panels b of Tables 9-12 report for selected countries and macro regions the average absolute percentage deviation between model and data for selected years between 1820 and 2008, first for the case of (a, q) constant throughout the 1700-2008 period and then when they are subject to either one of the two shocks. The averages exclude the initial year, because by construction there is 100% fit in 1700, and the year 1950 to minimize the role of WWII in the comparison since the model *by design* has no feature capable of accommodating such disruption.

Table 11b shows that not only Japan but many other fast-growing Asian countries such as China, South Korea and Singapore likely benefited from reforms that improved corporate governance. In all cases, allowing for such change gets the model closer to the data. In contrast, when we allow for it in Western Europe as a macro region and in the USA the model does worse (see Table 9). Similarly, allowing for such change in the UK, Germany and France worsens the model's performance. Interestingly, we find some support for the hypothesis that improvements in corporate governance occurred in some northern European countries, most notably, Sweden, Norway, Finland, and in the Netherlands and Italy. Finally, the results in Table 8 say that neither in Latin America nor in Africa allowing for better post-war corporate governance improves significantly the model's fit of the data. Our reading of the vast literature on their development history is that in the case of Africa we need to identify and add to the model forces that delay even further the take-off. In the case of Latin America, instead, the 1950 shock occurs later than needed to improve the fit. This is in line with what history suggests: WWII was not a disruptive event for Latin America, surely not disruptive on a scale comparable to what occurred in Asia.

We conclude that explaining the dynamics of income of our macro regions and of leading economies like the USA, UK and Germany, does not require changes in fundamentals that result in better corporate governance. This conclusion is in agreement with arguments that attribute the contemporary income gaps of Latin American countries to the extractive-type of institutions that emerged in colonial times (Engerman and Sokoloff, 1997; Acemoglu and Robinson, 2012) and with the observation that modern economic institutions, including the basic elements of the modern corporation, developed in Europe centuries priors the onset of modern growth (Goetzmann, 2016, chapter 17; Le Bris et al., 2016). Our analysis provides some support to Fukuyama's interpretation (2014, chapter 23) of Asian rapid industrialization, namely, that the executive power of the government substituted for the lack of the rule of law that in Western countries provided the foundation for modern corporate governance. The confrontation with Western colonial powers disrupted then state institutions that were formed centuries prior to contact with the West.

8 Conclusion

Several recent studies emphasize the importance of corporate governance in explaining cross-country income differences. In this paper, we developed the long-run features and implications of this view by introducing in an innovation-led growth model within-firm principal-agent problems among shareholders, managers and directors (monitors). The model features a sequence of three phases, from a pre-industrial phase, through a takeoff phase, to the modern innovation economy phase. Our analysis shows that the severity of agency issues delays the economy's progress through the three phases. This result is in line with Figure 1, which documents a negative relation between the first growth acceleration and the rule of law score for a sample of 155 countries. Our analysis also shows that poor corporate governance can be a forbidding barrier that traps the economy in stagnation. Finally, conditional on takeoff, poor corporate governance weakens incentives to innovate and thus slows down the secular growth of productivity.

To assess how well corporate governance explains quantitatively the secular dynamics of relative incomes, we calibrated the model to the USA and conducted exercises that compare the income paths of economies that converge to a common growth rate but diverge in levels, allowing only corporate governance to differ across economies. We found that modest differences in corporate governance produce large differences in income. We calculated, for instance, that the cost of in-house investment in Latin America, which in 2008 had income a quarter of that of the USA and is predicted to decline to 16 percent in steady state, is only 32 percent more than in the USA. This divergence, moreover, depends on a delay in the first onset of industrialization, driven by entry of new firms with no in-house investment by incumbent firms yet, of only 14 years and a further delay in the onset of in-house innovation of 35 years. This finding is in contrast with previous studies that need much larger differences in the cost of capital to account for the observed income divergence over the transition to modern growth. The shape of the transition generated by the model drives our different estimate for the cost of investment. Specifically, in our framework the rates of entry and of in-house innovation pick up slowly. Consequently, a small delay in the onset of modern growth has large compounding effects on the income gap from early movers.

We have also conducted exercises to verify how well the agrees with the pattern produced by different metrics like the World Bank rule of law score, the take-off periods, and the income paths of individual countries. The model's endogenous variables that represent agency issues, a and q, are strongly correlated with the rule of law indicator. The model also fits the income data remarkably well. Our estimates of delayed industrialization are also highly correlated with the acceleration times observed in the data. The model, nevertheless, tends to underestimate the take-off time of countries that have experienced economic miracles in the post-WWII period.

We kept the institutional environment constant to isolate the role corporate governance and see how far it takes us without invoking changes in other fundamentals. We then allowed for a change in the model's micro parameters that results in better corporate governance in the post-WWII period. The level-change improves the model's fit of the data only for Asian countries and it actually worsens it for Western countries. This pattern is consistent with the idea that while in the West the fundamental features of the institutional environment developed prior to industrialization and remained largely stable, in other areas they changed drastically in the aftermath of WWII.

References

[1] Acemoglu, D. and J. A. Robinson (2012). Why Nations Fail: The Origins of Power, Prosperity and Poverty. New York: Crown.

[2] Aghion, P. J. Van Reenen and L. Zingales (2013). Innovation and Institutional Ownership, American Economic Review 13, 277–304.

[3] Aghion, P., P. Howitt and D. Mayer-Foulkes (2005). The Effect of Financial Development on Convergence: Theory and Evidence. Quarterly Journal of Economics 120, 173-222.

[4] Ang, J.B., and J.B. Madsen (2011). Can second-generation endogenous growth models explain the productivity trends in the Asian miracle economies?, Review of Economics and Statistics, 93 (4), 1360-1373.

[5] Balsmeier, B., L. Fleming, and G. Manso (2016). Independent Boards and Innovation. Journal of Financial Economics, 123 (3), 536–557.

[6] Baumol, W. J. (2002). The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism. Princeton University Press, Princeton, NJ.

[7] Celik, M. and X. Tian (2019). Agency Frictions, Managerial Compensation, and Disruptive Innovation. Available at SSRN: https://ssrn.com/abstract=3319148.

[8] Chu, A. C., Cozzi, G. Galli, S. (2014) Stage-dependent intellectual property rights, Journal of Development Economics, 116, 239-249.

[9] Chu, A. C., Kou, Z. and X. Wang (2019). Effects of Patents on the Transition from Stagnation to Growth. Journal of Population Economics, Forthcoming.

[10] Christopoulou, R and P. Vermeulen (2012). Markups in the Euro Area and the US over the Period 1981–2004: A Comparison of 50 sectors. Empirical Economics, 42 (1), 53-77.

[11] Coatsworth, J. H. (2005). Structures, Endowments, and Institutions in the Economic History of Latin America. Latin American Research Review, 40 (3), 126-145.

[12] Cooley, T. F. and V. Quadrini (2001). Financial Markets and Firm Dynamics. American Economic Review, 5, 1286-1310.

[13] Doidge C., Karolyi G.A., and R. M. Stulz (2007) Why do countries matter so much for corporate governance? Journal of Financial Economics 86, 1–39.

[14] Engerman, S. L. and K. L. Sokoloff (1997). Factor Endowments, Institutions, and Differential Paths of Growth Among New World Economies, in Stephen Haber, ed., How Latin America Fell Behind, Stanford, CA: Stanford University Press, 1997.

[15] Fukuyama, F. (2014). Political Order and Political Decay: From the Industrial Revolution to the Globalization of Democracy. London Profile Books.

[16] Fulghieri, P. and M. Suominen (2012). Corporate Governance, Finance, and the Real Sector. Journal of Financial and Quantitative Analysis 47, 1187–1214.

[17] Goetzmann, W. N. (2016). Money Changes Everything: How Finance Made Civilization Possible, Princeton University Press.

[18] Greif, A. (2006). Institutions and the Path to the Modern Economy: Lessons from Medieval Trade. Cambridge University Press.

[19] Hathaway, I. and R. E. Litan (2014), What's Driving the Decline in the Firm Formation Rate? A Partial Explanation, Economic Studies, at Brookings.

[20] Hausmann, R., Pritchett, L. and D. Rodrik (2005). Growth Accelerations. Journal of Economic Growth, 10(4), 303-329.

[21] Iacopetta, M., R. Minetti, and P. Peretto (2019). Financial Markets, Industry Dynamics, and Growth. Economic Journal, forthcoming.

[22] Kaufmann, D., Kraay A. and M. Mastruzzi (2010). The Worldwide Governance Indicators : A Summary of Methodology, Data and Analytical Issues. World Bank Policy Research Working Paper No. 5430.

[23] Le Bris, D., Goetzmann, W. N., and S. Pouget (2016). Testing Asset Pricing Theory on Six Hundred Years of Stock Returns: Prices and Dividends for the Bazacle Company from 1372 to 1946. Manuscript

[24] Lee, Y. and T. Mukoyama (2015). Entry and Exit of Manufacturing Plants over the Business Cycle. European Economic Review, 77, 20-27.

[25] Lins, K. V., H. Servaes, and A. Tamayo (2017). Social Capital, Trust, and Firm Performance: The Value of Corporate Social Responsibility during the Financial Crisis. Journal of Finance, 72(4), 1785-1824.

[26] Lopez, A. L. and X. Vives (2019). Overlapping Ownership, R&D Spillovers, and Antitrust Policy. Journal of Political Economy 127(5), 2394-2437.

[27] Lucas, R. E. (2000). Some Macroeconomics for the 21st Century. Journal of Economic Perspectives 14, 159-168.

[28] Maddison Database 2010. Available at https://www.rug.nl/ggdc/historicaldevelopment/maddison/rele
database-2010. Accessed on 23/10/2017.

[29] Madsen, J. B., Minniti, A., and F. Venturini (2019). Wealth inequality in the long run: A Schumpeterian growth perspective. Manuscript.

[30] Monthly Labor Review (2017). Estimating the U.S. labor share, February, Bureau of Economic Analysis. Available at https://www.bls.gov/opub/mlr/2017/article/estimating-the-us-labor-share.htm. Accessed on 29/04/2018.

[31] Morck, R., D. Wolfenzon and B. Yeung (2005). Corporate Governance, Economic Entrenchment, and Growth, Journal of Economic Literature 43, 655–720.

[32] Nikolov, B. and T. Whited (2014). Agency Conflicts and Cash: Estimates from a Dynamic Model. Journal of Finance, 69, 1883–1921.

[33] Peretto, P.F. (2015). From Smith to Schumpeter: A Theory of Take-off and Convergence to Sustained Growth. European Economic Review 78, 1-26.

[34] Shleifer, A., and D. Wolfenzon (2002). Investor Protection and Equity Markets. Journal of Financial Economics 66 (1): 3-27.

[35] Terry, J. S. (2017). The Macro Impact of Short-Termism. Available at http://people.bu.edu/stephent/files/MIFET_LATEST_DRAFT.pdf. Accessed 12/02/2019.

TABLES

Table 1: Parameters of Corporate Governance

	σ_1^F	σ_1^I	σ_2^F, σ_2^I	σ_3^F, σ_3^I	σ_4^F	σ_4^I	σ_5^F, σ_5^I	σ_6^F, σ_6^I	σ_7^F	σ_7^I
USA	1.274	1.365	1	1.5	1.1	1.0485	0	0.01	1.1	1.25
Latin America	1.274	1.365	1	1.5	1.2	1.1145	0	0.01	1.1	1.25

Table 2: Calibration USA

(a) Parameters

α	γ	θ	ϕ	β	ρ	λ
0.33	0.773	0.769	0.2675	3.2	0.03	0.0103

(b) Steady State Variables (%)

s	y, g, z	r	n	*labor share*
11.8	2.21	5.21	1.03	59

(c) Initial Conditions, Governance, Thresholds

Initial Conditions (year 1700)				Governance		Thresholds	
N_0	L_0	Ω	Z_0	a	q	T_N	T_Z
1	1	1291.1	5610.7	0.9	1.0720	100	112

Table 3: Latin America

(a) Income Ratio			**(b) Governance**		**(c) Thresholds**	
1700	2008	BGP	a	q	T_N	T_Z
1	0.24	0.16	0.68	1.39	114	147

Note: The technological, preference, and demographic parameters are the same as the USA's; see table 2.a.

Table 4: Corporate Governance and Industrialization Delays

(a) Europe

	(a.i) Common Ω and Z_0				*(a.ii) Common Ω, different Z_0*			
	a	q	T_N	T_Z	a	q	T_N	T_Z
Country								
Austria	0.83	1.14	104	119	0.73	1.28	110	135
Belgium	0.83	1.14	104	119	0.72	1.30	110	137
Denmark	0.85	1.12	102	117	0.74	1.26	109	133
Finland	0.82	1.15	104	121	0.79	1.19	106	125
France	0.83	1.14	104	119	0.74	1.26	109	133
Germany	0.82	1.15	104	121	0.73	1.28	110	135
Italy	0.81	1.16	105	122	0.71	1.32	111	139
Netherlands	0.84	1.13	103	118	0.65	1.47	116	156
Norway	0.87	1.10	102	115	0.81	1.16	105	122
Sweden	0.84	1.13	103	118	0.77	1.21	107	128
Switzerland	0.86	1.04	102	116	0.76	1.23	108	129
UK	0.83	1.14	104	119	0.70	1.34	112	141
Western Europe	0.83	1.14	104	119	0.72	1.30	110	137

(b) Regions

	(b.i) Common Ω and Z_0				*(a.ii) Common Ω, different Z_0*			
	a	q	T_N	T_Z	a	q	T_N	T_Z
Western Europe (12)	0.83	1.14	104	119	0.72	1.30	110	137
Western Offshoots (4)	0.89	1.16	101	113	0.92	1.05	99	111
Latin America (8)	0.68	1.39	114	147	0.68	1.39	114	147
East Asia (16)	0.63	1.53	118	164	0.62	1.57	119	169
Africa (Total)	0.55	1.94	128	125	0.57	1.81	125	203

- Note: The technological, preference, and demographic parameters are the same as the USA's; see table 2.a. The 12 Western European Countries are listed in table 5. Western Offshoots: Australia, Canada, New Zealand, and USA. The 8 Latin American countries: Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, and Venezuela; The 16 East Asian Countries: Bangladesh, Burma, China, Hong Kong, India, Indonesia (including Timor until 1999), Japan, Malaysia, Nepal, Pakistan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, and Thailand.

Table 5: Western Europe, common initial Z

	(a) p.c. GDP			**(b) Governance and delays** *(common Z_0, different Ω)*							
	Year			a	q	ΔT_N			ΔT_Z		
Country	1700	1820	2008			C. G.	I. C.	Total	C. G.	I. C.	Total
Austria	1.88	0.97	0.77	0.71	1.32	11	-26	-15	27	-26	1
Belgium	2.17	1.05	0.76	0.69	1.36	13	-34	-21	32	-34	-2
Denmark	1.97	1.01	0.79	0.72	1.30	10	-28	-18	25	-29	-4
Finland	1.21	0.62	0.78	0.79	1.19	6	-7	-1	13	-7	6
France	1.73	0.90	0.71	0.73	1.28	10	-22	-12	23	-22	1
Germany	1.72	0.86	0.67	0.72	1.30	10	-21	-11	25	-22	3
Italy	2.08	0.89	0.64	0.69	1.36	13	-32	–19	32	-31	1
Netherlands	4.04	1.46	0.79	0.61	1.61	20	-73	-53	62	-73	-11
Norway	1.37	0.64	0.91	0.80	1.17	5	-11	-6	11	-11	0
Sweden	1.42	0.65	0.78	0.77	1.22	7	-13	-6	16	-14	2
Switzerland	1.69	0.87	0.80	0.75	1.25	8	-20	-12	19	-21	-2
UK	2.37	1.36	0.76	0.68	1.39	14	-39	-25	35	-39	-4
W. Europe (12)	1.95	0.98	0.71	0.71	1.32	11	-28	-17	27	-28	-1

- Note: The technological, preference, and demographic parameters are the same as the USA's; see table 2.a. Δ indicates a country's or region's difference with respect to the USA estimated values.

Table 6: Latin America

	(a) p.c. GDP			(b) Governance and delays (common Z_0, different Ω)							
	Year			a	q	ΔT_N			ΔT_Z		
Country	1700	1820	2008			C. G.	I. C.	Total	C. G.	I. C.	Total
Argentina	1	0.57	0.35	0.71	1.31	11	0	11	27	0	27
Brazil	0.87	0.51	0.21	0.67	1.41	14	5	19	38	4	42
Chile	1	0.55	0.42	0.72	1.30	10	0	10	25	0	25
Colombia	1	0.57	0.20	0.66	1.41	15	0	15	41	0	41
Mexico	1.08	0.60	0.26	0.68	1.39	14	-3	11	35	-3	35
Peru	1	0.57	0.17	0.63	1.53	18	0	18	52	0	52
Uruguay	1	0.57	0.31	0.70	1.34	12	0	12	29	0	29
Venezuela	1	0.37	0.33	0.71	1.32	11	0	11	27	0	27
L. America (8)	1	0.57	0.24	0.68	1.39	14	0	14	35	0	35

- Note: The technological, preference, and demographic are the same as the USA's; see table 2.a. Δ indicates a country's or region's difference with respect to the USA estimated values. The ΔT_N and ΔT_Z are decomposed between the corporate governance (C. G.) and the initial condition (I.C.) effects.

Table 7: East Asia

	(a) p.c. GDP			(b) Governance and delays (common Z_0, different Ω)							
	Year			a	q	ΔT_N			ΔT_Z		
Country	1700	1820	2008			C. G.	I. C.	Total	C. G.	I. C.	Total
China	1.13	0.48	0.21	0.61	1.61	20	-4	16	62	-4	58
Japan	1.08	0.53	0.73	0.82	1.15	4	-3	1	9	-3	6
South Korea	1.12	0.48	0.63	0.74	1.26	9	-4	5	21	-4	17
Singapore	1.12	0.44	0.90	0.81	1.16	5	-4	1	10	-4	6
East Asia (16)	1.09	0.46	0.18	0.62	1.57	19	-3	16	57	-3	54

- Note: The technological, preference, and demographic parameters are the same as the USA's; see table 2.a. Δ indicates a country's or region's difference with respect to the USA estimated value. See note of table (4) for the complete list of the 16 East Asian countries.

Table 8: Macro-Regions

	(a) p.c. GDP			**(b) Governance and delays** *(common Z_0, different Ω)*							
	Year			a	q	ΔT_N			ΔT_Z		
Country	1700	1820	2008			C. G.	I. C.	Total	C. G.	I. C.	Total
W. Europe (12)	1.95	0.98	0.71	0.71	1.32	11	-28	-17	27	-28	-1
W. Offshoots (4)	0.90	0.95	0.97	0.92	1.06	-1	4	3	-1	3	2
Latin America (8)	1	0.57	0.24	0.68	1.39	14	0	14	35	0	35
East Asia (16)	1.09	0.46	0.18	0.62	1.57	19	-3	16	57	-3	54
Africa (Total)	0.80	0.33	0.06	0.56	1.87	26	7	33	101	6	107

– Note: The technological, preference, and demographic parameters are the same as the USA's; see table 2.a. Δ indicates the region's difference with respect to the USA estimated value. See note of table (4) for the complete list of countries for each of the five regions.

Table 9: Deviations from Data, Western Europe and USA

	(a) Prediction (%) (no shock)							**(b) Average Deviation (%)**		
				Year						
Country	1820	1870	1900	1950	1975	1990	2008	no shock	Δa (size shock)	
									0.05	*0.10*
Austria	120	116	112	199	100	92	93	10.52	5.82	10.25
Belgium	121	87	93	141	97	94	97	8.66	12.21	18.78
Denmark	120	117	119	122	100	100	107	10.87	7.79	12.73
Finland	150	157	168	164	100	93	94	31.58	28.09	24.50
France	123	112	111	146	94	93	106	11.12	10.18	15.91
Germany	129	110	102	181	94	95	104	9.70	11.85	15.93
Italy	139	149	183	208	106	93	108	32.37	25.14	22.56
Netherlands	135	126	139	153	100	99	94	18.08	11.70	11.25
Norway	157	151	177	157	115	105	100	34.61	27.96	21.32
Sweden	155	145	138	111	85	95	100	26.54	23.12	20.39
Switzerland	128	105	89	92	80	86	107	14.16	17.74	22.77
UK	99	79	81	116	107	102	100	8.40	13.80	17.64
W. Europe	121	108	109	154	101	98	106	8.14	8.93	15.69
USA	88	81	82	97	97	94	103	10.25	10.06	10.76

– Note. Panel (a): Percentage ratios between the model's prediction and the Maddison's data when Z_0 is fixed and Ω is country or region specific (see table 5). Panel (b) is the arithmentic average of the absolute deviations of the model relative to the data for the benchmark years in panel (a). It excludes the year 1950 to minimize the WWII noise on data, and the 1700 data point because, by construction, it is perfectly matched with data.

Table 10: Income Ratio Predicted by the Model, Latin American Countries

	(a) Prediction (%) (no shock)							**(b) Average Deviation (%)**		
				Year						
Country	1820	1870	1900	1950	1975	1990	2008	no shock	Δa (size shock)	
									0.05	*0.10*
Argentina	153	0.98	62	72	68	113	93	24.13	26.19	27.94
Brazil	161	155	200	146	85	92	96	40.85	37.77	36.84
Chile	157	101	82	104	140	123	85	25.84	25.14	24.47
Colombia	153	157	146	117	100	96	99	27.21	25.83	25.95
Mexico	148	186	118	131	90	99	104	28.11	26.71	27.86
Peru	153	151	187	88	64	113	83	24.12	39.95	38.38
Uruguay	153	57	75	72	94	103	95	22.55	24.91	27.86
Venezuela	237	225	210	48	53	88	97	72.47	67.40	64.95

– Note: The prediction refers to the estimates in table 6. See note of table (9) for further explanations.

Table 11: Income Ratio Predicted by the Model, East Asian Countries

Country	(a) Prediction (%) (no shock)							(b) Average Deviation (%)		
	Year									
	1820	1870	1900	1950	1975	1990	2008	no shock	Δa (size shock) *0.05*	*0.10*
China	191	220	236	426	288	162	58	106	98	88
Japan	168	238	238	375	106	88	106	61	54	49
South Korea	190	245	351	565	243	118	75	112	99	86
Singapore	207	259	460	321	184	114	85	123	109	97

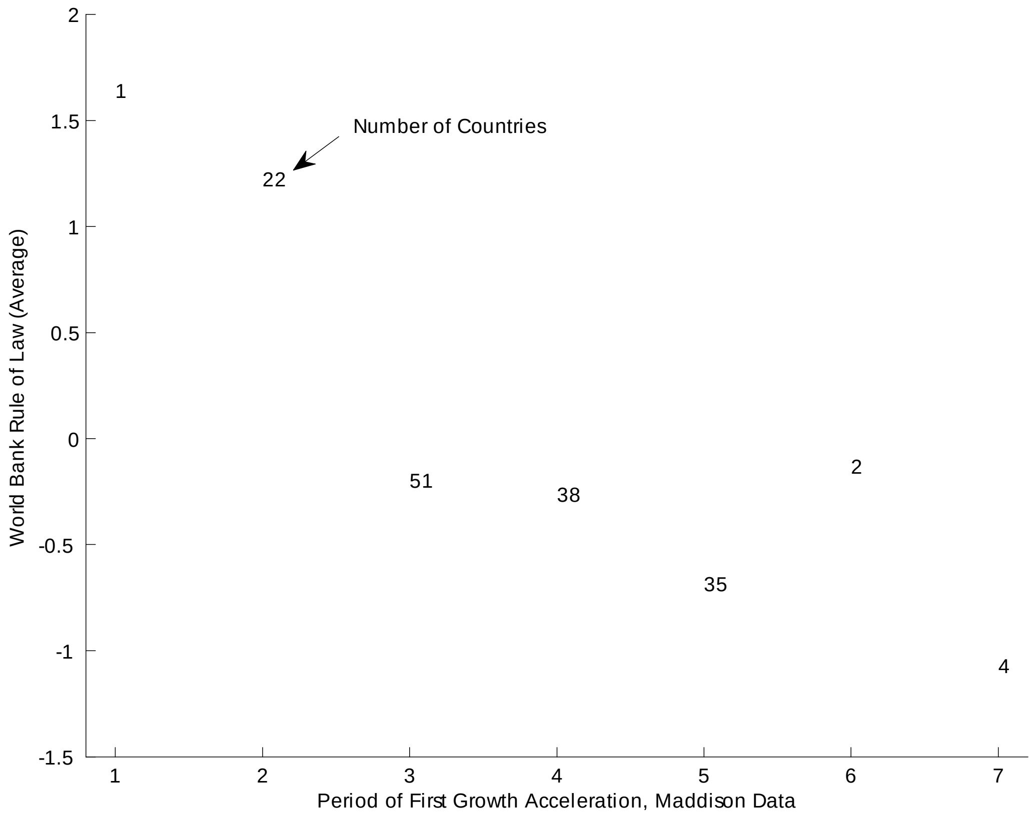
– Note: The prediction refers to the estimates in table 7. See note table (9) for further explanations.

Table 12: Income Ratio Predicted by the Model, Macro-Regions

Country	(a) Prediction (%) (no shock)							(b) Average Deviation (%)		
	Year									
	1820	1870	1900	1950	1975	1990	2008	no shock	Δa (size shock) *0.05*	*0.10*
Western Europe (12)	121	108	109	154	101	98	106	8.14	8.93	15.69
Western Offshoots (4)	89	78	80	96	96	95	103	11.06	13.88	17.75
Latin America (8)	153	162	128	108	86	102	102	27.21	25.01	24.55
East Asia (16)	194	210	213	297	167	120	74	72.09	65.09	59.19
Africa (Total)	242	206	171	127	92	98	90	56.51	58.08	57.13

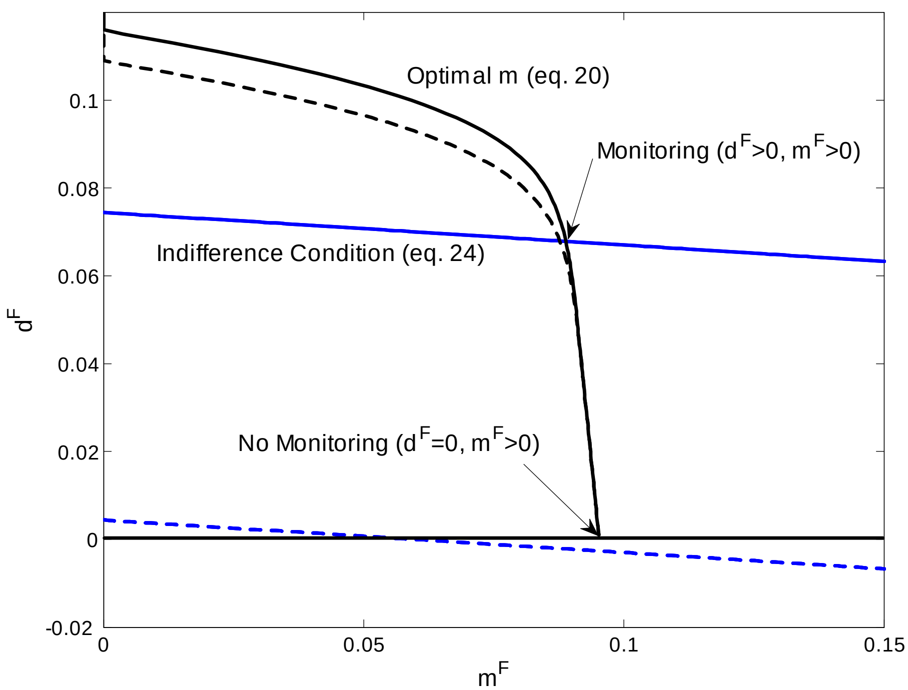
– Note: The prediction refers to the estimates in table 7. See note of table (9) for further explanations.

Figure 1: Governance and Delays in Industrialization



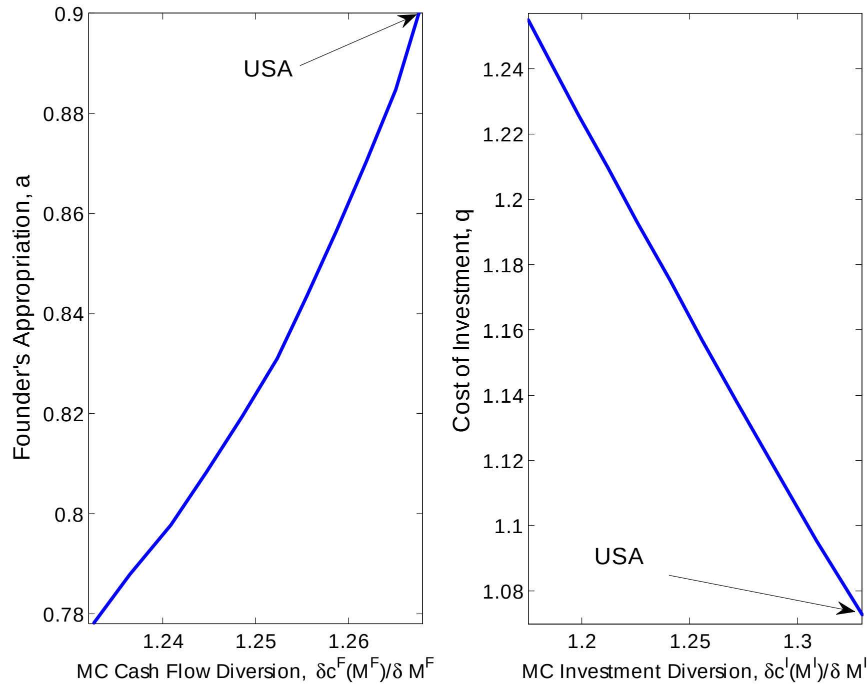
– Note: *Data source*: Maddison Database 2010 and Rule of Law, Estimate of Governance, 2017, World Bank (see Kaufman et al. 2010).
Period 1: 1770-1820; *Period 2*: 1820-1870; *Period 3*: 1870-1900; *Period 4*: 1900-1950; *Period 5:* 1950-1975; *Period 6*: 1975-1990; *Period 7*: 1990-2008;
Take-offs (countries ordered within each group according to per capita income in 2008). *Period 1*: USA; *Period 2*: Norway, Ireland, Australia, Canada, Switzerland, Netherlands, Denmark, Sweden, Finland, Austria, United Kingdom, Belgium, France, Germany, New Zealand, Chile, Argentina, Uruguay, Tunisia, Sri Lanka, South Africa, and Algeria. *Period 3*: Japan, Trinidad and Tobago, Estonia, Spain, Slovenia, Greece, Puerto Rico, Latvia, Portugal, Slovak Republic, Czech Republic, Belarus, Armenia, Kazakhstan, Venezuela, Poland, Hungary, Russian Feder., Croatia, Bulgaria, Azerbaijan, Costa Rica, Mexico, Bosnia and Herz., Panama, Colombia, Georgia, Uzbekistan, Ukraine, Romania, Dominican Repub., Guatemala, Turkmenistan, Albania, Macedonia, Ecuador, Cuba, Jamaica, Serbia, Moldova, Paraguay, Vietnam, Bolivia, El Salvador, Kyrgyz Republic, Honduras, Nicaragua, Ghana, Tajikistan, Nepal, and Haiti; *Period 4*: Hong Kong, Singapore, China, Taiwan, Italy, Israel, Qatar, United Arab Emirates, Mauritius, Kuwait, Malaysia, Saudi Arabia, Syria, Turkey, Bahrain, Iran, Brazil, Seychelles, Jordan, Peru, Namibia, Lebanon, Gabon, Egypt, Morocco, Philippines, Yemen, West Bank and Gaza, Mozambique, Rep. of Congo, Angola, Senegal, Benin, Djibouti, Côte d'Ivoire, Iraq, Somalia, Liberia, and Madagascar; *Period 5*: Equatorial Guinea, Thailand, Oman, China, Botswana, Indonesia, Swaziland, Libya, India, Cambodia, Pakistan, Lesotho, Laos, Nigeria, São Tomé and Principe, Mauritania, Cameroon, Mali, Kenya, Burkina Faso, The, Gambia, Rwanda, Mongolia, Eritrea, Zambia, Zimbabwe, Tanzania, Malawi, Sierra Leone, Guinea, Guinea-Bissau, Togo, Comoros, Burundi, Congo (Dem. Rep.); *Period 6*: Cape Verde and Bangladesh; *Period 7*: Sudan, Uganda, Afghanistan, and Chad; No take-off resulted for Niger and Central African Republic.

Figure 2: Governance Equilibrium

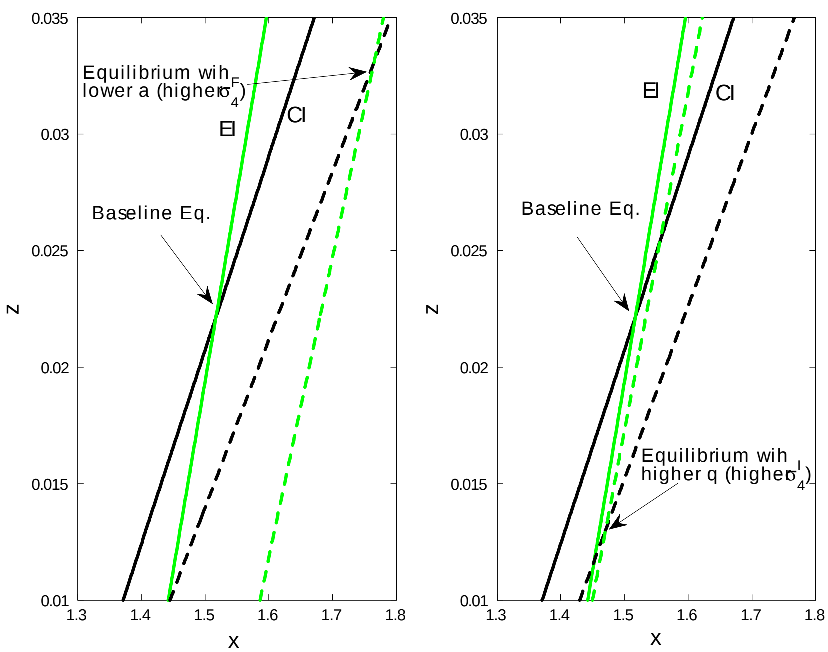


– Note: The steep descending line is the loci (m,d) that satisfies (20). The flatter line is the indifference condition (24). The description of the underlying diversion functions is in 29-30. A corner solution with $m^F > 0$ and $d^F = 0$ is obtained by augmenting the cost of monitoring. A similar figure can be obtained for investment diversion.

Figure 3: Diversion, Corporate Governance, and General Equilibrium
(a) Diversion and Corporate Governance

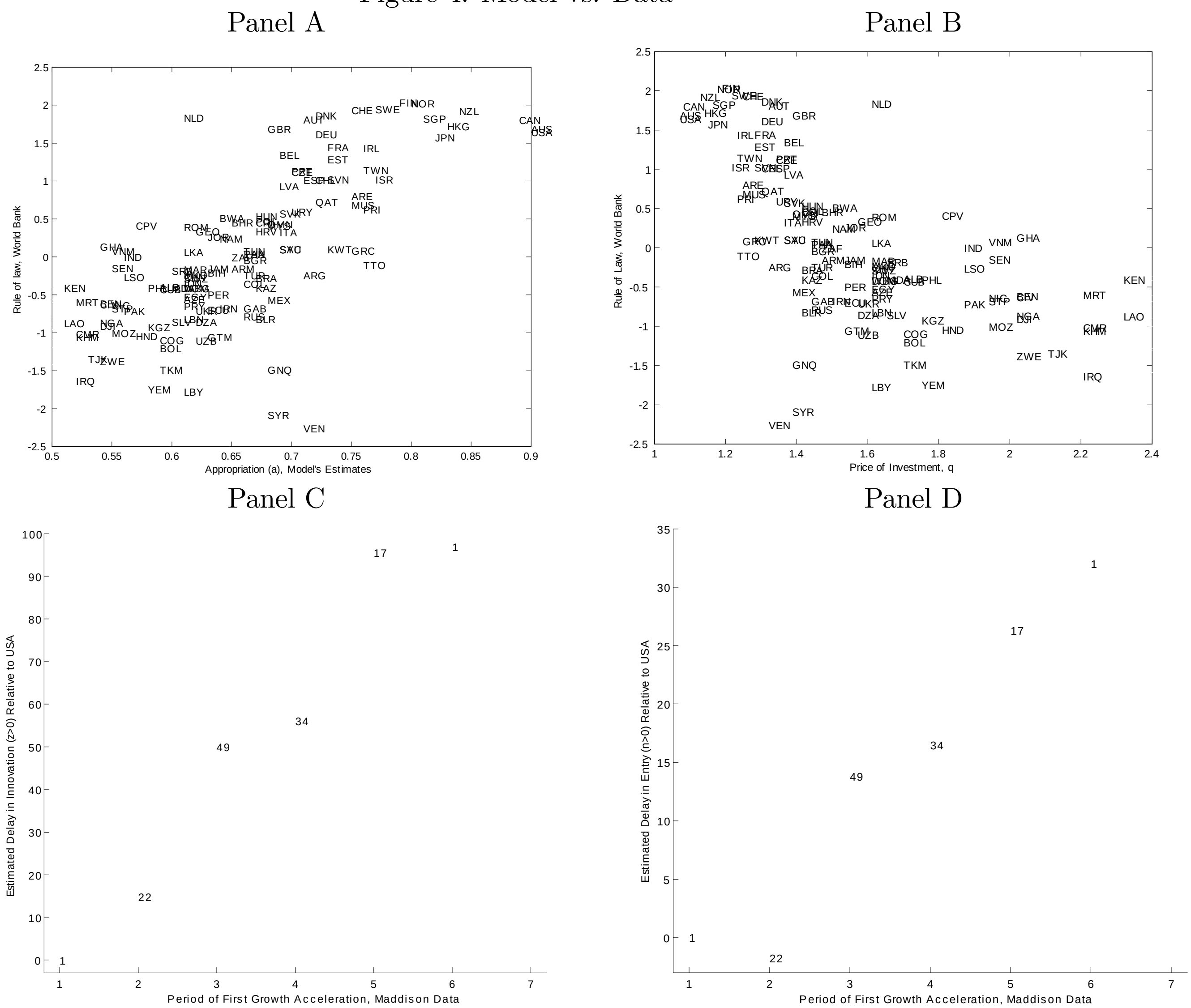


(b) General Equilibrium



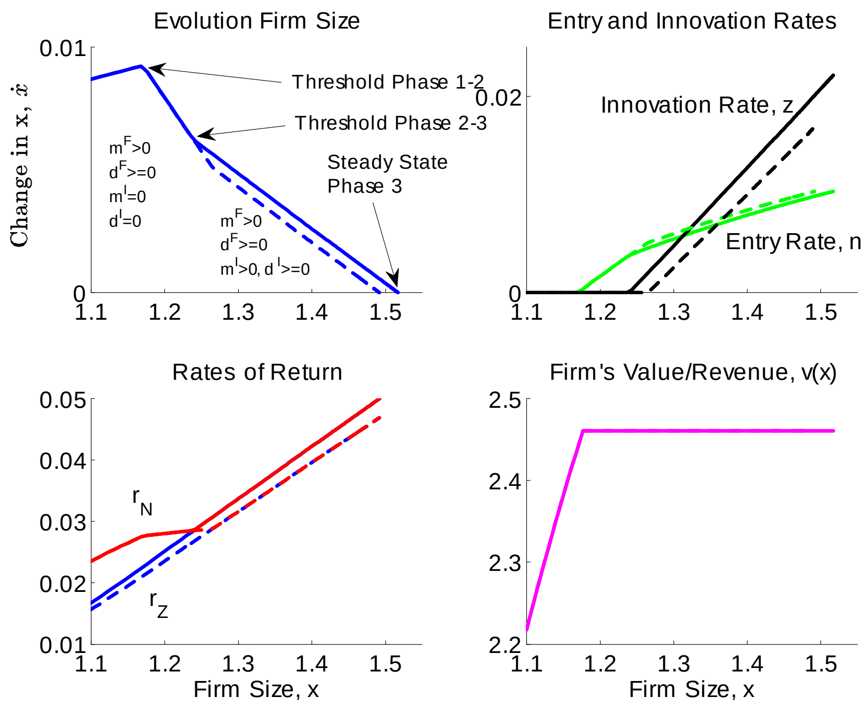
– Note: Parameters are in table 1, row USA. The lower bounds of the intervals for σ_4^F and σ_4^I in Panel A are also the USA baseline values.

Figure 4: Model vs. Data

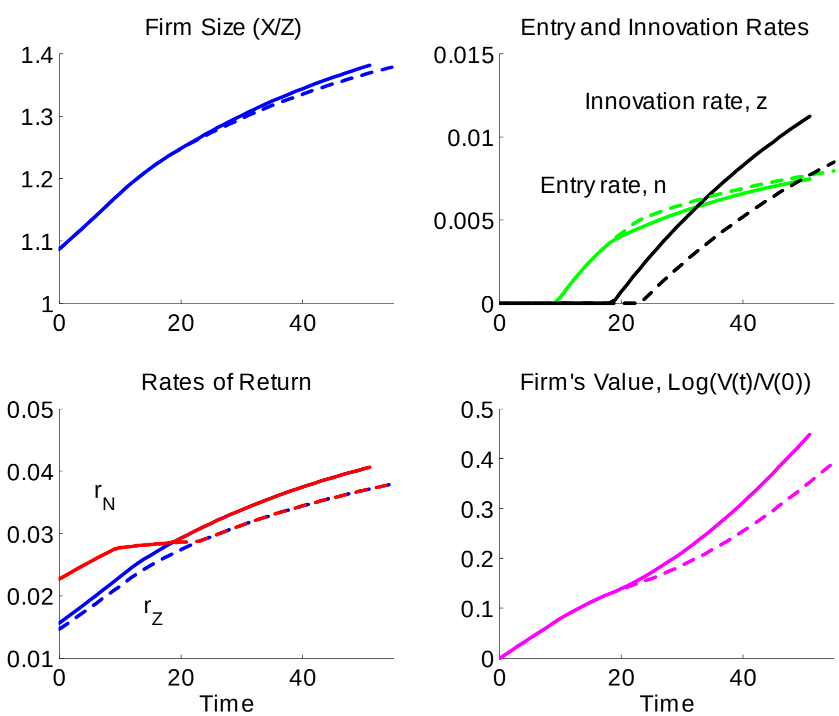


– Note. For list of countries see note of fig. 1. The digits inside the plots C and D indicate the number of countries. Countries that do not reach the third phase ($z = 0$) are excluded from the calculation. These are: Haiti and Nepal (period 3); Madagascar, Liberia, Somalia, and Angola (period 4); Rep. Dem. of Congo, Burundi, Comoros, Togo, Guinea-Bissau, Guinea, Sierra Leone, Malawi, Tanzania, Zambia, Eritrea, Mongolia, Rwanda, Gambia, Burkina Faso, Kenia, Mali, and Laos (period 5); Bangladesh (period 6); Chad, Afhanistan, Uganda, and Sudan (period 7).

Figure 5: Development Paths of Economies with Different Investment Cost, q
Panel A: Phase Diagrams



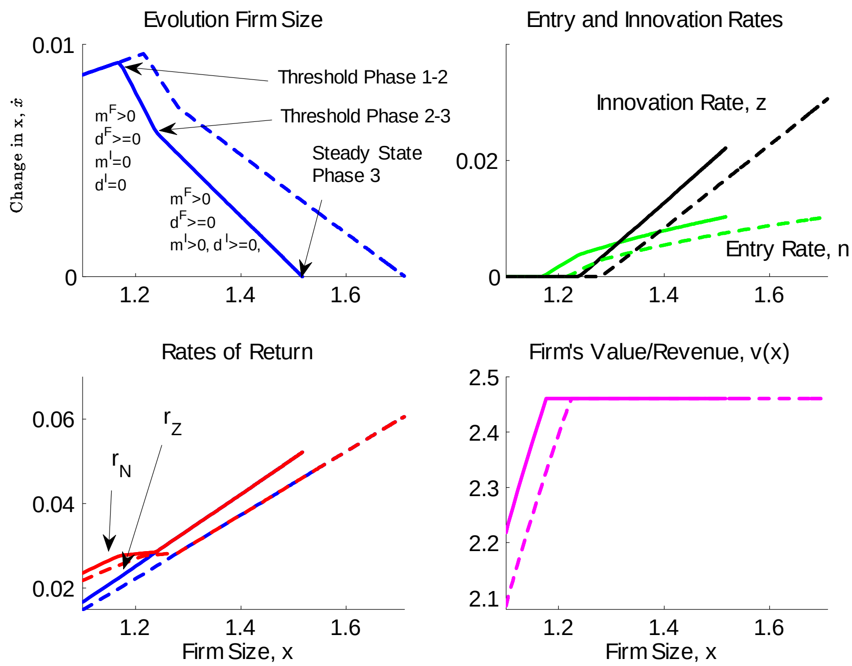
Panel B: Time Series



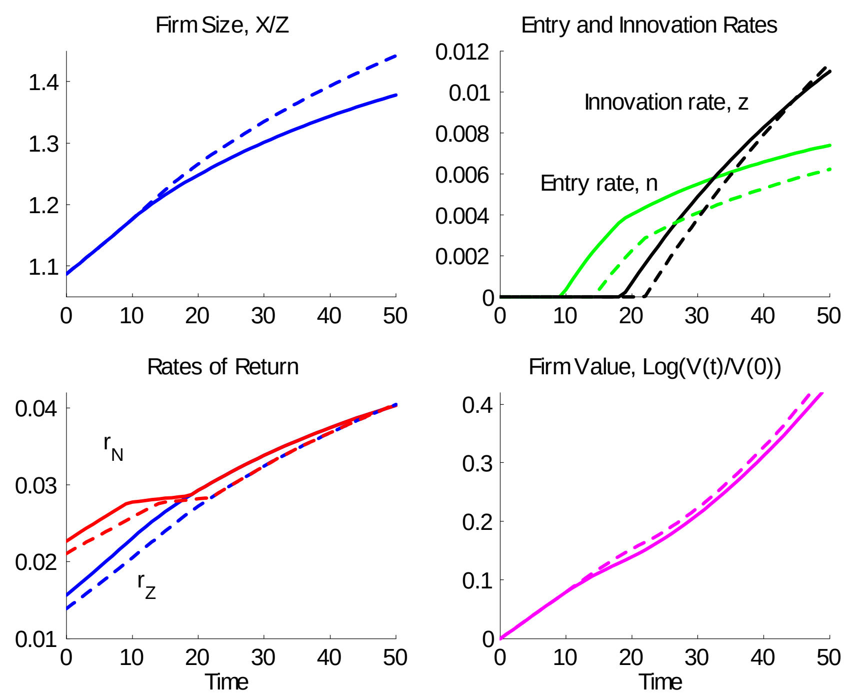
– Note. When the average firm size crosses the second thresholds, additional tasks for managers and directors emerge. The economy with dashed lines has a cost of capital $q = 1.114$ while that of the baseline economy (continuous lines) is 1.0720. In both economies $a = 0.9$, and $N(0) = Z(0) = 1$. The pair (a, q) of the baseline economy is computed with the governance parameters in table 1, row USA. For remaining parameters see table 2.

Figure 6: Development Paths of Economies with Different Appropriation Factor, a

Panel A: Phase Diagram



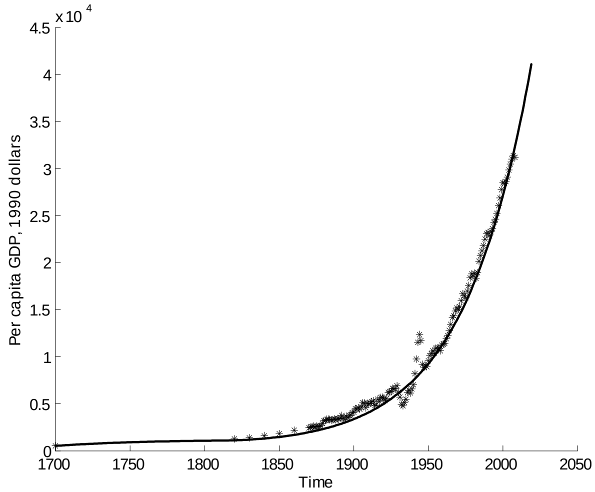
Panel B: Time Series



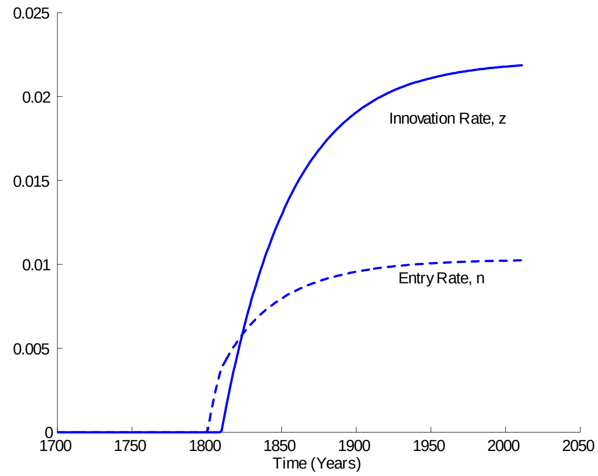
– Note. The economy with dashed lines has an appropriation factor 0.1 than the baseline economy's (continuous lines). In both economies $q = 1.072$, and $N(0) = Z(0) = 1$ (see table 2.a for other parameter values). When the average firm size crosses the second thresholds, additional tasks for managers and directors emerge.

Figure 7: Calibration USA

(a) Per capita GDP

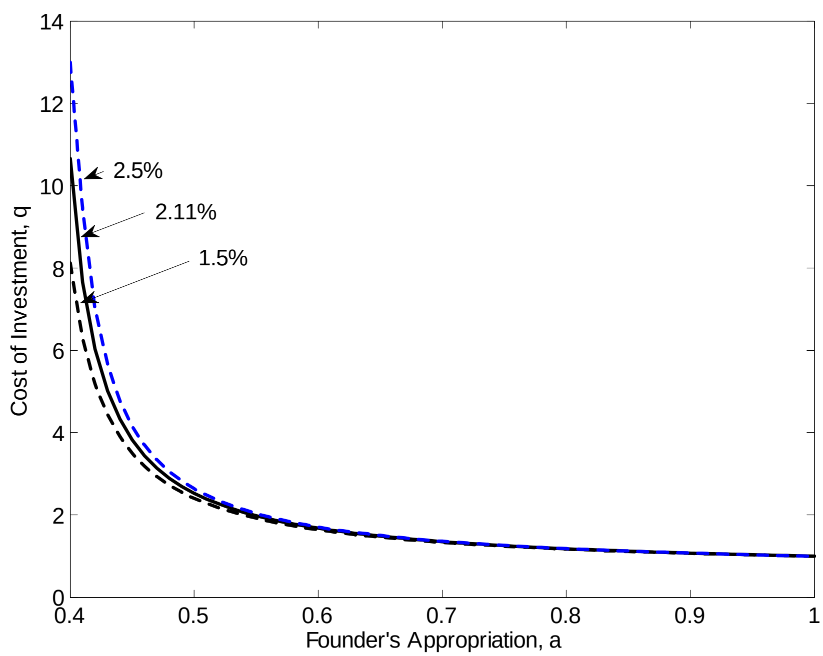


(b) Entry and Innovation



– Note. The values of a and q are 0.9 and 1.0720, respectively. The year 1700 is the first data point; ten–year frequency from 1820 to 1870; yearly frequency from 1870 to 2008. Parameters values are in table 2a.

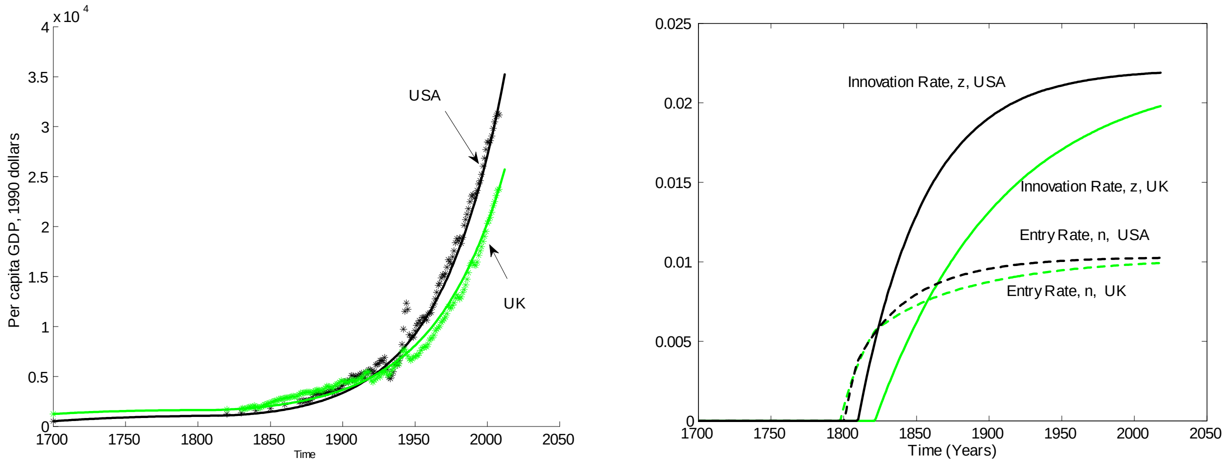
Figure 8: The Corporate Governance Loci



– Note: The corporate governance loci is based on eq. (60). Along the frontier the growth rate of per capita GDP is constant, g^*. In the interval [0.7, 1], the slope of any of the locus is approximately minus 1 – the slope is hardly sensitive to variations in the target rate g^*. For the 2.21% locus the macro parameters are 2.a and the macroeconomic steady state variables are 2.b. The parameters σ_4^F and σ_4^I are altered to generate the couple (a, q) that maintains a constant 2.21% GDP growth rate. See table 1 for the value of remaining governance parameters.

Figure 9: USA takes over UK

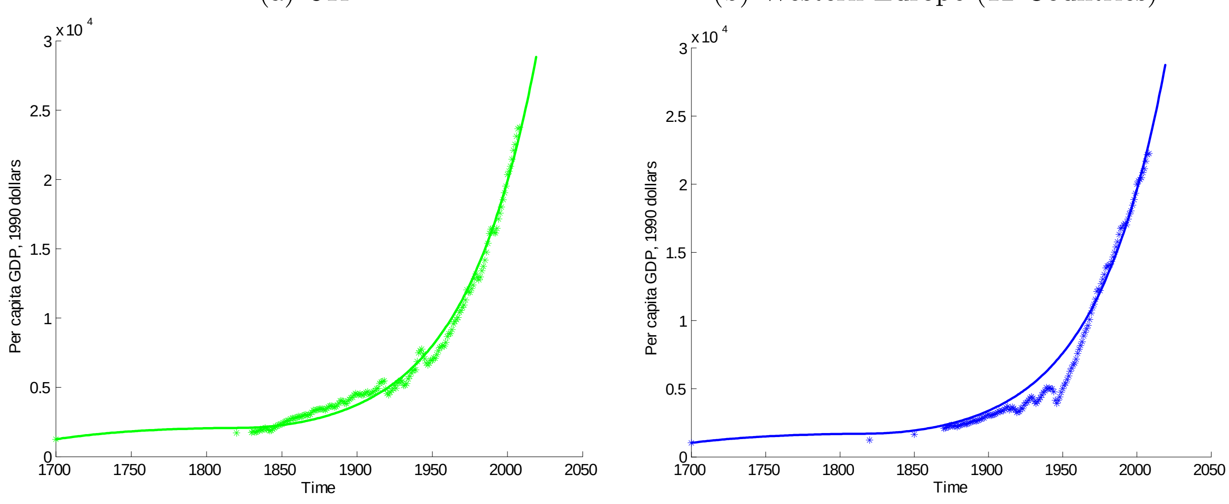
(a) Per capita GDP in USA and UK   Entry and in-house innovation



– Note. The values of $(a,\, q)$ are (0.9, 1.0702) and (0.7, 1.3420) for USA and UK, respectively (see tables 2.c and 4a.ii). For common parameters values see in table 2a.

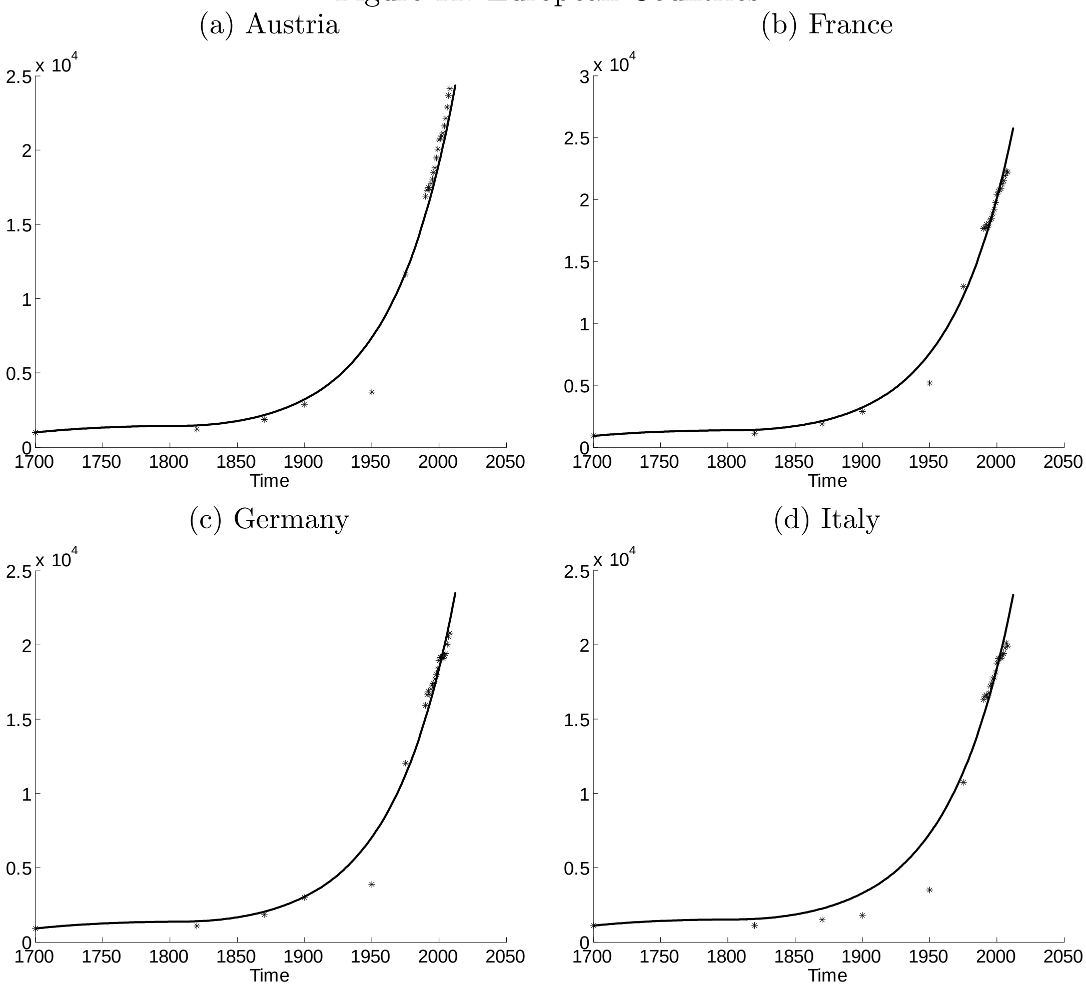
Figure 10: UK and Western Europe

(a) UK   (b) Western Europe (12 Countries)



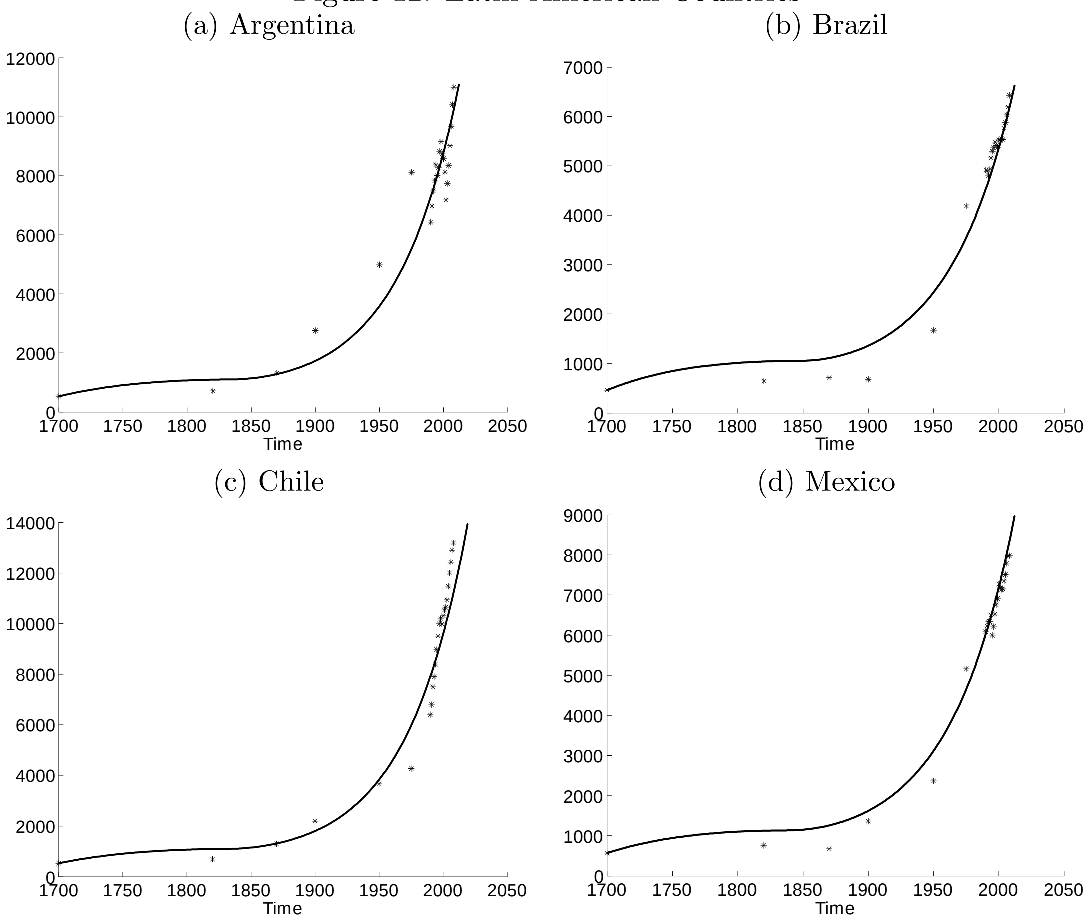
– Note. The values of a and q are for UK 0.7 and 1.3420 and for Western Europe 0.72 and 1.3010, respectively (see table 4a.ii). For common parameters values see tables 1 and 2a.

Figure 11: European Countries



– Note. Tables 5 and 9 reports the estimates of (a, q) of each of the four countries and the model's deviations from data (per capita GDP, 1990 dollars), respectively. For common parameters values see table 2a.

Figure 12: Latin American Countries

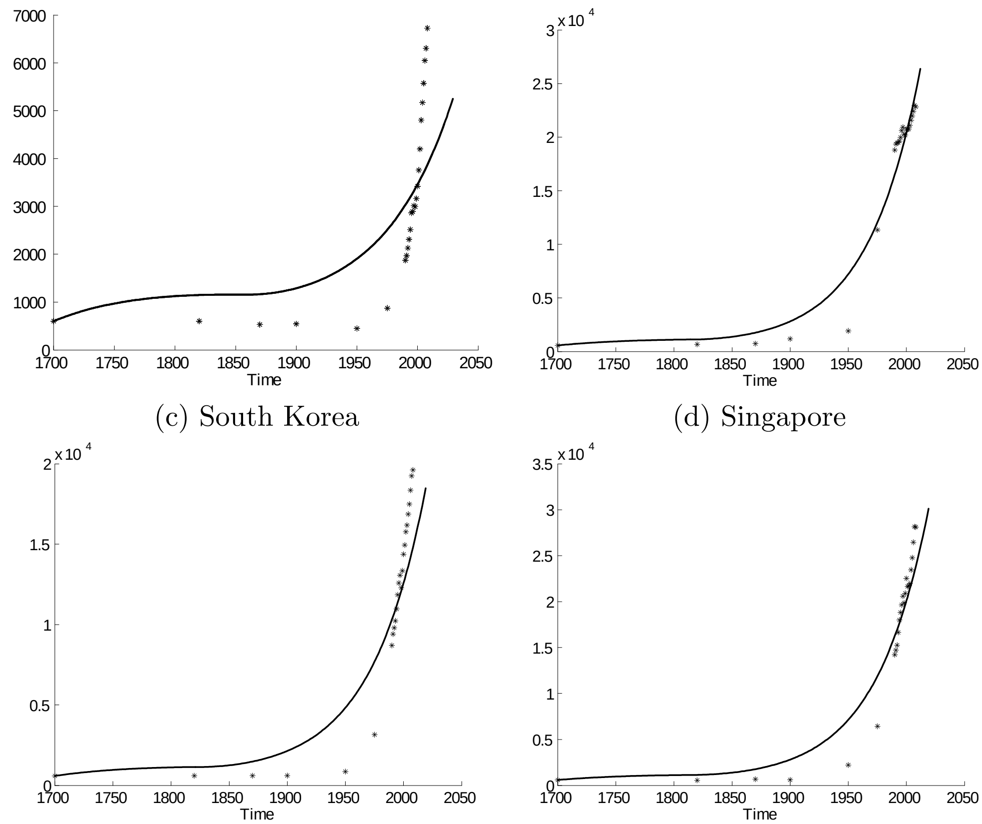


– Note. Tables 6 and 10 report, respectively, the estimates of (a, q) for the four countries and the model's deviations from data (per capita GDP, 1990 dollars). For common parameters values see table 2a.

Figure 13: Asian Countries

(a) China (b) Japan

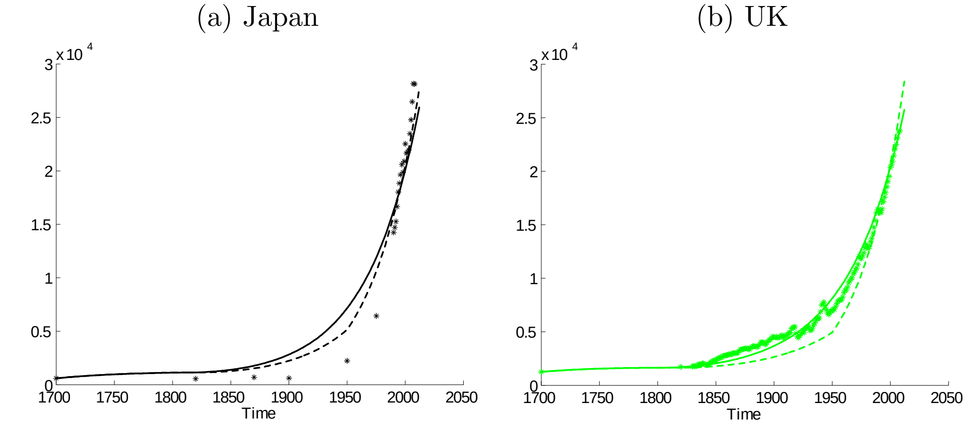
(c) South Korea (d) Singapore



– Note. Tables 7 and 11 report, respectively, the estimates of (a, q) for the four countries and the model's deviations from data. For common parameters values see table 2a.

Figure 14: Governance Shock in 1950

(a) Japan (b) UK



– Note. Continuous lines: constant governance. Dashed lines: in 1950 a increases by 0.1 and q adjusts to preserve the growth rate. The fit of the model improves in Japan but worsens in UK (see tables 9 and 11). For parameters values see table 2a. Data time series are per capita GDP, 1990 dollars.

ABOUT OFCE

The Paris-based Observatoire français des conjonctures économiques (OFCE), or French Economic Observatory is an independent and publicly-funded centre whose activities focus on economic research, forecasting and the evaluation of public policy.

Its 1981 founding charter established it as part of the French Fondation nationale des sciences politiques (Sciences Po), and gave it the mission is to "ensure that the fruits of scientific rigour and academic independence serve the public debate about the economy". The OFCE fulfils this mission by conducting theoretical and empirical studies, taking part in international scientific networks, and assuring a regular presence in the media through close cooperation with the French and European public authorities. The work of the OFCE covers most fields of economic analysis, from macroeconomics, growth, social welfare programmes, taxation and employment policy to sustainable development, competition, innovation and regulatory affairs.

ABOUT SCIENCES PO

Sciences Po is an institution of higher education and research in the humanities and social sciences. Its work in law, economics, history, political science and sociology is pursued through ten research units and several crosscutting programmes.
Its research community includes over two hundred twenty members and three hundred fifty PhD candidates. Recognized internationally, their work covers a wide range of topics including education, democracies, urban development, globalization and public health.
One of Sciences Po's key objectives is to make a significant contribution to methodological, epistemological and theoretical advances in the humanities and social sciences. Sciences Po's mission is also to share the results of its research with the international research community, students, and more broadly, society as a whole.

PARTNERSHIP