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Educational Content, Educational Institutions and Economic Development: Lessons from History

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Educational Content, Educational Institutions and Economic Development: Lessons from History

Davide Cantoni and Noam Yuchtman*

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Abstract

Individuals' choices of educational content are often shaped by the political economy of government policies that determine the incentives to acquire various skills. We first present a model to show how differences in educational content emerge as an equilibrium outcome of private decisions and government policy choices. We then illustrate these dynamics in two historical circumstances. In medieval Europe, states and the Church found individuals trained in Roman law valuable, and eventually supported investments in this new form of human capital. This had positive effects on Europe's commercial and institutional development. In late 19th-century China, elites were afraid of the introduction of Western science and engineering and continued to select civil servants—who enjoyed substantial rents—based on their knowledge of Confucian classics. As a result, China lacked skills useful in modern industry. Finally, we present a variety of other contemporary and historical applications of this theory.

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1 Introduction

Economists have long viewed education as an important determinant of economic development and growth.[1] Most analyses have focused on broad education quantities: years of schooling, enrollment rates, and school construction. Much less attention has been paid to the importance of different types of educational *content* to a country's economic development.[2]

Individuals investing in human capital often have a choice among several types of content; for example, at the tertiary level of education individuals can choose to study law, business, the humanities, the natural sciences, or engineering, among other subjects (subject to financial, and other, constraints). At the individual level, different types of educational content are associated with different skills acquired, different productivity levels across economic sectors, and different labor market outcomes. At more aggregate levels, different skills present in the population can make some sectors of the economy more successful than others, and can help determine a country's rate and direction of technical change, either through the adoption of existing technology or through innovation.

We go beyond previous work by considering the role that governments play in shaping incentives to acquire different forms of human capital. Governments (and elites more generally) have an interest in the content of schooling because it plays a role in determining the quality and stability of political institutions: government administrations rely, directly and indirectly (e.g., through the raising of revenues), on particular forms of human capital. Also, political participation of various sorts—including political protest—may depend on people's specific types of human capital: the content of people's education can support

[1] See Easterlin (1981); Mankiw et al. (1992); Benhabib and Spiegel (1994); Psacharopoulos and Patrinos (2004). Review articles by Krueger and Lindahl (2001) and Hanushek and Woessmann (2008) summarize the existing evidence on the effects of education on growth rates.

[2] Some examples of papers that widen the scope of analysis are Aghion et al. (2009), Jones (2011), and Algan et al. (2011).

seated governments, but also threaten them.[3]

In this work, we argue that individuals' investments in different forms of human capital are important to economic development, and that these investments are often shaped by the political economy of government policies that determine the incentives to acquire various skills. Just as the provision of schools and teachers is an outcome of political economic forces and affects development, so are the structure of educational institutions in a society and the costs and benefits of investing in particular forms of human capital.[4] On the one hand, private investment incentives may be sub-optimal, especially when a new form of human capital becomes available; in this case, governments might *subsidize* investment in new, productive skills, pushing investment toward the socially optimal level. On the other hand, governments or elites may choose to *discourage* investment in productive forms of human capital: new forms of human capital could empower new classes of individuals; lead to political pressure on the seated government; or, draw investment away from skills the government needs to function.[5]

Looking across countries today, there is enormous variation in the specific forms of human capital acquired.[6] UNESCO data show that the fraction of college and university students studying social science, business or law ranges from 14.4% in Saudi Arabia to 58.2% in Bahrain; the fraction studying engineering ranges from 1% in Congo to 31.9% in South Korea (see Figure 1 and Table 1).[7] Whether these differences arise because the most produc-

[3]Governments also have a stake in the content of education because education serves as a channel through which government can shape ideology. See Clots-Figueras and Masella (2009); Friedman et al. (2011).

[4]See, for example, Engerman et al. (1999); Acemoglu and Robinson (2008); Naidu (2010).

[5]Glaeser et al. (2004), among others, emphasize the role human capital plays in shaping political institutions.

[6]Our focus in on tertiary education here, though variation in content also exists at the secondary school level (e.g., education systems in many countries include academic and vocational tracks), and even earlier (e.g., religious versus secular education at the primary school level).

[7]The data from which these statistics are calculated are described in A. Even within OECD countries, these differences are sizeable: the share of enrollments in business or law varies between 48.8% (Turkey) and 21% (South Korea), whereas the share of enrollments in engineering is lowest in New Zealand (6.5%) and highest in South Korea (31.9%).

tive type of human capital is acquired in each country is not obvious *a priori*; this would be the case if engineers were very productive in countries where engineers are trained, while lawyers were especially productive in countries training many lawyers, and so on.

[Figure 1 about here]

[Table 1 about here]

The purpose of this paper is to show how differences in educational content emerge as an equilibrium outcome—possibly far from being socially optimal—of both private decisions to invest in different forms of human capital and government policy choices that affect the costs and benefits of acquiring different skills; we then link investments in different forms of human capital to historical and contemporary growth experiences.

This political economy nexus, we argue, remains relevant in understanding the current choices facing governments in developing countries. As an example, consider the shortage of (native-born) business managers in China since the economic reforms, and continuing into recent years, an issue discussed by Lane and Pollner (2008), among others. On the one hand, the Chinese government is clearly concerned about promoting economic growth, and so might wish to encourage training in business schools. On the other hand, the ruling Communist Party might wish to suppress modern business education: the Party could face ideological challenges from individuals trained in Western-style business courses that certainly do not tend to emphasize either communism or nationalism; in addition, the Chinese civil service must compete with private firms for top talent, and might prefer that the best students study fields more relevant to public administration. It appears that, in the eyes of the Chinese government, the benefits of allowing the study of Western management practices outweigh the potential threats to existing elites: the flourishing of modern business schools in Beijing, Shanghai, Shenzhen, and elsewhere in recent years is evidence of the

Party's stance on investments in this specific form of human capital today.

We follow other economists in pointing to government institutions and elites' incentives as important ultimate sources of variation in human capital.[8] However, we emphasize a particular policy channel that has not received a great deal of study: governments choose the structure of educational institutions and shape the content of education within those institutions. Importantly, the government's views on human capital acquisition will depend on the type of human capital being produced in a society's educational institutions, and on elites' expected payoffs from people's investments in various skills.

To clarify government's role in shaping the incentives to invest in different types of human capital, in Section 2 of this paper we present a simple model in which an individual chooses whether to invest in a new form of educational content, in an environment in which the government can subsidize or tax this investment.[9] Individuals face some private cost of acquiring a new form of human capital; an important component of the cost of, and expected return to, the individual's investment is government policy toward the new form of human capital. Governments might value investments in productive forms of human capital because they generate higher incomes, and so higher expected tax revenues; in addition, new human capital may affect the probability that the seated government remains in power, either negatively or positively.[10] In general, governments will trade off their desire to grow the economy against their potential loss of power in choosing an optimal tax or subsidy for the new educational content. The theoretical discussion suggests that, if governments are threatened by economic change, they will act to stifle investment in new skills, with adverse consequences for growth.

[8] See, for example, Engerman and Sokoloff (2005).

[9] The role of elites in the decision to provide education is discussed, among others, by Acemoglu and Robinson (2000), and Galor and Moav (2006).

[10] Novel forms of human capital may threaten existing elites' rents and thus be destabilizing. However, it is also conceivable that new forms of knowledge may serve to bolster existing regimes: they could improve the effectiveness of the military or the bureaucracy, or simply be ideologically effective.

We next illustrate these predictions through two historical case studies in Sections 3 and 4: medieval Europe, which witnessed the creation of the first modern universities, and late imperial China, where a "traditional" system of education was slowly replaced by a more modern curriculum that introduced the study of Western science and engineering. Both cases make clear the role—both promoting and retarding—played by governments in individuals' investments in new forms of human capital.

In medieval Europe, Roman law was studied in the world's first universities beginning in the 11th century, following the "rediscovery" of Justinian's Code. States (both secular and religious) found individuals who had studied law valuable, and generally supported investments in this new form of human capital, for example by granting privileges to universities and their students. Employment in secular and Church administrations increased the labor market returns to legal study. These implicit subsidies paid off: lawyers trained at universities reduced the uncertainty of, and obstacles to, trade across Europe's then highly-fragmented states.

In 19th century China, encounters with Western powers brought the study of Western science and engineering into some Chinese schools. For centuries, civil service exams based on the Confucian Classics had selected China's social and political elite; dismantling the traditional education system was perceived as a severe threat by those elites. Consequently, they preserved strong social and economic incentives to study traditional content. As a result, for much of the 19th century, the study of Western subjects was limited; China lacked skills useful in modern industry, and experienced limited economic development.

We bring the hypotheses resulting from our model to other cases in Section 5. First, we discuss a variety of historical and contemporary applications of our theory. These examples show how the political economy dimension of governments' policies toward different forms of educational content, either to promote growth, or to secure the positions of elites, is rele-

vant to many different places and time periods. Second, using correlational evidence from cross-country data over the last decade, we show that curricular choices are associated with different income growth rates, and that this relationship is mediated by a country's political institutions.[11] We interpret these findings in the light of our theory. In Section 6 we discuss our results, and offer concluding thoughts.

2 A Model of the Study of New Educational Content

2.1 Setup and Actors

Suppose that a representative individual can, at some cost, invest in a new form of human capital.[12] In expectation, the new human capital increases his income, but the actual realization of the productivity of the new skill is uncertain *ex ante*. He chooses his investment level to maximize expected after-tax income, less the cost of investing in human capital.

The other player in the model is "the state" (or "government"), which we assume to be a unitary actor representing a seated government elite. The goal of this elite is to maximize tax revenues, subject to the need to remain in power in order to enjoy those revenues. Individuals' investments in the new skill affect the state through two channels: first, because the state taxes income, greater private incomes will (*ceteris paribus*) increase state tax revenues. Second, greater quantities of the new skill affect the likelihood that the existing state retains

[11]The association between specific human capital content on growth was first examined by Murphy et al. (1991), who found that countries with more engineering students grew more quickly on average between 1970 and 1985, while countries with more students studying law grew more slowly. The investigation of "misallocations of talent"—this being the term coined by Murphy, Shleifer and Vishny—was readily picked up by the literature on endogenous growth theory (Jones, 1995; Romer, 2001). Krueger and Kumar (2004) and Vandenbussche et al. (2006) discuss the growth effects, depending on a country's distance to the technological frontier, of educational types favoring innovation or imitation.

[12]The model we present here can apply more generally to individuals' decisions of whether to increase their investments in an existing form of human capital, or to individuals' choices among different forms of human capital that already exist. Our discussion here focuses on new forms of human capital to match the circumstances of the historical cases we study below.

its power. More individuals studying the new educational content might support the existing state: these individuals could be productively employed in the bureaucracy, in the military, etc. On the other hand, individuals who study the new content might threaten the existing state, for example, because a new class of individuals gets money and influence, or because educated individuals might be more likely to revolt.[13]

To simplify the model, we assume that the tax rate on income is fixed, and that the state's only policy instrument is a "distortion" in the market for human capital. This distortion might come from regulations restricting (or encouraging) the teaching of new educational content, or from a state's choice to preferentially hire individuals without (or with) the new human capital.[14] States can thus raise or lower individuals' costs of acquiring the new form of human capital.[15] We assume that any distortion, whether promoting or retarding the study of the new content, has a direct cost to the state.

An individual's investment in a new form of human capital is the (subgame perfect) equilibrium outcome of a game between a representative individual and the state, the timing of which is as follows:

- The state acts first, choosing a distortion, δ^*, in the market for the new form of human capital, looking ahead toward the individual's optimal investment decision given the chosen distortion. The distortion may increase or decrease the individual's cost of acquiring a unit of the new form of human capital (positive values of δ indicate a subsidy).

[13] Another conceivable channel (not analyzed here) would link human capital to the likelihood that the elite maintains power through changes in income.

[14] In practice, governments act to distort the private costs and benefits of studying particular fields in many ways. They produce education and subsidize its production and consumption; they help coordinate investments in education; and, they affect the labor market returns to the study of various fields, either through direct hiring, or through various interventions in product and labor markets (e.g., "industrial policy").

[15] We load all of the state's distortions onto the cost term in the individual's objective function, though, of course, in reality both costs and expected benefits are affected by state policies.

- The individual then chooses his level of investment, h^*, in the new form of human capital to maximize his expected earnings, less costs. Greater levels of investment increase individual income, but come at a cost (which depends on the state's policy choice in the previous stage).

- Nature then determines the productivity of the new skill, and whether the existing government remains in power (the latter a function of the individual's investment in the new form of human capital).

The game is solved via backwards induction.

2.2 The Individual's Optimization Problem

The individual's problem is straightforward: taking the tax rate on income ($\tau \in [0,1]$) and the government's distortion of the cost of education ($\delta^* \in \left[-\overline{\delta}, \overline{\delta}\right]$) as given, the individual maximizes his expected income y, less the cost of the new form of human capital:

$$\max_h E[(1-\tau)y(h) - (1-\delta^*)c(h)] \tag{1}$$

subject to:

$$y(h) = Af(h),\ f_h > 0,\ f_{hh} < 0 \tag{2}$$

$$A \sim U[1-\epsilon_A, 1+\epsilon_A] \tag{3}$$

$$c_h > 0,\ c_{hh} > 0. \tag{4}$$

That is, the individual chooses h^* to maximize:

$$\int_{1-\epsilon_A}^{1+\epsilon_A} (1-\tau) A f(h) dA - (1-\delta^*) c(h). \tag{5}$$

The first order condition, which implicitly defines the individual's optimal choice, h^*, is:

$$f_h(h^*) = \frac{(1-\delta^*)}{(1-\tau)} c_h(h^*). \tag{6}$$

From the first order condition, one can easily see that higher tax rates and higher costs of investing in the human capital are associated with lower investment levels:

$$\frac{\partial h^*}{\partial c_h} < 0 \tag{7}$$

$$\frac{\partial h^*}{\partial \tau} < 0. \tag{8}$$

Most importantly for the game,

$$\frac{\partial h^*}{\partial \delta^*} > 0. \tag{9}$$

The individual's optimal level of investment in the new form of human capital is simply an increasing function of δ^*.[16]

It is of interest to consider the case when $\delta^* = 0$, that is, when there is no government distortion of the cost of studying the new educational content. In this case, given our assumption of expected income maximization by the individual, investment in the new form of human capital would be socially optimal. Of course, if the individual maximizes utility, and his utility function is a strictly concave function of income, it will *not* generally true that investment chosen by the representative individual will be the level chosen by a risk-neutral

[16]Our discussion here assumes well-behaved individual and state objective functions as well as interior values of the optimal human capital choice and optimal distortion. The various functional form assumptions made above (risk-neutrality, uniformly distributed productivity of human capital, etc.) are not necessary to derive our results; they are made for ease of exposition.

social planner.[17] Because of the uncertain realization of the actual productivity of the new form of human capital, risk-averse individuals will tend to under-invest in the new form of human capital. The more uncertain is the return to the new skill, the less the individual will invest, even if the expected return is very high. If the model included positive externalities from an individual's investment, or if there were strategic complementarities in individuals' investment decisions, there would be additional reason to think that the representative individual would under-invest in the new skill in the absence of government intervention.[18]

Private under-investment in human capital (relative to the social optimum) depends on the uncertainty of the returns to the new form of human capital; on the degree of complementarity among individuals' investments; and on the positive externalities (if any) arising from individuals' investments. Such under-investment implies a role for the state to play in encouraging investment in new forms of human capital. Of course, the mechanisms used to encourage investment can also be deployed to discourage it.

2.3 The Government's Problem

The government will choose an optimal distortion δ^* to maximize the expected revenues it will enjoy. Revenues are not certain because the existing government may be deposed; the government remains in power with probability $\pi(h^*) \in [0,1]$. Because we focus on subgame-perfect equilibria, we assume that the government (correctly) anticipates the optimal investment response h^* of the representative individual to any choice of δ.

Thus, plugging in the expected value of A in the production function, the government chooses δ^* to maximize the following:

[17] We assume that the social planner does not consider the state's objectives, but does take the tax rate on income as given.

[18] Although evidence in favor of large externalities to education is scarce (see Psacharopoulos and Patrinos, 2004, or Pritchett, 2001), education has been found to affect a wide range of social outcomes (for a review, see McMahon, 2004). Also see Jones (2011) on the importance of coordination in human capital investment choices and growth.

$$\max_{\delta} \ \pi(h^*(\delta)) \cdot \tau \cdot f(h^*(\delta)) + [1 - \pi(h^*(\delta))] \cdot 0 - d(\delta) \tag{10}$$

where $d(\delta)$ is the cost to the elite of implementing a distortion δ. We assume that the function $d(\delta)$ is continuously differentiable on the set $\left[-\overline{\delta}, \overline{\delta}\right]$ and has the following properties:

$$d(\delta) > 0, \tag{11}$$

$$d'(\delta) < 0 \text{ if } \ \delta < 0, d'(\delta) > 0 \text{ if } \ \delta > 0, \tag{12}$$

$$d(0) = 0. \tag{13}$$

The first order condition, which implicitly defines the optimal level δ^*, is as follows:

$$\tau \cdot \left[\pi(h^*(\delta^*)) \cdot \frac{\partial f}{\partial h^*} \cdot \frac{\partial h^*}{\partial \delta} + \cdot f(h^*(\delta^*)) \cdot \frac{\partial \pi}{\partial h^*} \cdot \frac{\partial h^*}{\partial \delta}\right] = \frac{\partial d}{\partial \delta}. \tag{14}$$

Suppose the government considers a small increase of δ^* from a value of zero, thus inducing a higher level of human capital investment by the individual. This will affect the government's payoffs through three channels. First, this increase in human capital will be reflected in expected income ($\frac{\partial f}{\partial h^*} \cdot \frac{\partial h^*}{\partial \delta} > 0$), and thus expected tax revenues raised. Second, the increased human capital affects the likelihood that the existing state remains in power by the time the higher revenues are collected ($\frac{\partial \pi}{\partial h^*} \cdot \frac{\partial h^*}{\partial \delta}$); in principle, higher levels of investment could either increase or decrease the probability that the existing government remains in power. Finally, the state weighs these two effects against the direct cost from its distortion of the market for human capital ($\frac{\partial d}{\partial \delta}$).

There are two cases to consider: first, suppose the new form of human capital *supports* the seated government: $\pi_h \equiv \frac{\partial \pi}{\partial h^*} \geq 0$. In this case, the state simply weighs the advantages of

a higher δ^*—greater revenue due to higher incomes and a higher probability of remaining in power to enjoy the revenue—against the direct cost of the distortion of the market for human capital. In this case, δ^* will be (weakly) positive, and individual investment will be (equal to or) greater than what it would have been without the government distortion. In a model in which individuals' private incentives are insufficient to generate socially optimal investment, the government's choice of subsidy in this case will move investment levels toward the social optimum.[19]

In the second case, the new form of human capital *threatens* the seated government: $\pi_h < 0$. In this case, it is ambiguous whether the government will subsidize or tax investment in the new form of human capital. It weighs the benefit of a positive δ^*—greater tax revenues received if the government remains in power—against the costs: now, both a decreased likelihood of remaining in power and a direct cost of distortion (see equation (14)). The greater is the threat—the more negative is π_h—the more likely is the state to choose a low, even negative, value for δ^*. Consequently, when the seated government is severely threatened by the accumulation of a new form of human capital, investments in the new skill, and income levels, will be lower than they would be in the absence of the government policy—perhaps far below the social optimum.

In the equilibrium of the game, the government chooses δ^* according to equation (14); the individual then chooses his best response, taken from equation (6).[20] Payoffs are finally determined by nature's draw of the productivity of human capital and whether the state remains in power.

[19] Of course, investment levels could be greater than would be socially optimal in this case, depending on the level of the subsidy chosen, and depending on externalities, among other issues.

[20] Assuming well-behaved, continuously differentiable functional forms, with closed, bounded domain and range, there will exist optimal strategies for the government and the individual.

3 Historical Case Study 1: Roman Law and Universities in Medieval Europe

The theoretical framework just outlined suggests that new forms of human capital may be acquired sub-optimally, and that government policy can play an important role determining how much of a new form of human capital will be acquired. In this and the following section we examine two historical instances in which new forms of human capital became available. In both cases, governments played critical roles in determining whether and how much of the new human capital would be accumulated, with important consequences for economic development.

3.1 Roman Law as New Educational Content

The high Middle Ages saw a resurgence of economic activity in Europe. New cities were founded, old cities grew, the volume and the scope of trade expanded and reached new heights, both at the local level and across the continent. Not only was the economy burgeoning, states also began to take on modern forms, by centralizing the monopoly of violence and clearly attributing elements of power and sovereignty to different layers and actors. Ultimately, this economic expansion and institutional transformation changed Europe from a rural backwater (relative to Asia and the Islamic world) into an urban and commercial continent, arguably setting the stage for the subsequent projection of European domination across the oceans, and the "Great Divergence" (Lopez, 1976; Postan, 1973; Britnell, 1993; Epstein, 2000; Buringh and van Zanden, 2009).

Around the same time, in the late 11th and 12th centuries, individuals came to Italy from across Europe to study the newly "rediscovered" Justinian Code of Roman law under

the tutelage of legal scholars in private schools.[21] Roman law was a distinct, qualitative improvement over the judicial systems in place up to that point.[22] Berman (1983, p. 50) writes:

> *[T]he legal rules and procedures which were applied in the various legal orders of the West in the period prior to the late eleventh and early twelfth centuries were largely undifferentiated from social custom and from political and religious institutions. No one had attempted to organize the prevailing laws and legal institutions into a distinct structure. Very little of the law was in writing. There was no professional judiciary, no professional class of lawyers, no professional legal literature. Law was not consciously systematized.*

Existing systems of law, such as the Germanic ones, thus had a series of drawbacks. First, they were very local; in a context of highly fragmented polities, this tended to discourage trade. Second, they were traditionally based on kinship, honor and superstition. As such, they were not ready to respond to the needs of expanding trade, as opposed to the developing body of Roman law. Finally, old systems of justice were informal—formal trials were seldom used; feuds between kin groups often functioned as trial substitutes, and oaths and trust within and across kin groups played an important role in preventing bloodshed. In an increasingly complex commercial and institutional environment, such community-based resolutions to legal disputes were bound to be more difficult to enforce and thus to implement.

Roman law, instead, was a complex and broad system of legal knowledge. It was a science "in which individual legal decisions, rules, and enactments were studied objectively and were explained in terms of general principles and truths basic to the system as a whole" (Berman, 1983, p. 120). It was flexible and it could look back on centuries of scholarly discussion, application, development and refinement. Savigny (1834, vol. 3, p. 86) argues that

[21] Other locations of scholarly rediscovery of Roman law were Provence, the Lombard cities and Ravenna (Vinogradoff, 1929, p. 33).

[22] We do not want to diminish the parallel importance of pre-Roman legal systems or alternative social and institutional arrangements, such as guilds or the Hanseatic league. We argue that a written, formal, and organized system of laws had a positive contribution to the outcomes studied here.

Roman law would have been much less attractive to the scholars and practical men of the Middle Ages if it had consisted only of Justinian's *Codex*. Rather, the *Corpus Iuris Civilis* also included the Digest (*Pandectae*), a rich collection of comments by Roman jurists on the topics of property rights, obligations, contracts, family and inheritance law, and on criminal law.

Most important, perhaps, was Roman law's suitability to the needs of an economically flourishing society.[23] Renewed trade and growing cities had created economic opportunities, and the citizens of Medieval Europe were looking for a legal system to match their needs. Savigny (1834, vol. 3, p. 84) writes that:

> *The first and foremost reason [for the reemergence of Roman law] were the needs of Lombard cities... These cities were now extremely rich, populated and active. Their brisk trade and commercial activities required a developed civil law; the Germanic systems of national laws were not adequate, and the poor knowledge of Roman law that had served its purpose up to then was now deemed insufficient. The well-preserved sources of this [Roman] law were alone entirely sufficient, and, used properly and in a scholarly way, they could deliver a body of law that matched these newly emerging needs. [own translation]*

More specifically, Berman (1983, p. 245) comments on the status of contract law in the Roman legal system:[24]

> *[T]he older Roman law (especially the ius gentium) had achieved a very high level of sophistication in the field of contracts, and much of its vocabulary in that field, as well as many of its solutions to individual questions, could be applied in the twelfth century to the newly burgeoning commercial life of western Europe.*

[23]Colliva (1977–1999) cites another factor that determined the demand for Roman law. As a consequence of the *constitutio de feudis* (an edict issued by the Holy Roman Emperor Conrad II in 1037), all fiefs, including those of minor nobility, became inheritable. This prompted an increased demand for more legal security, for more certain jurisdiction, and for a better system of inheritance law, as the minor nobility and gentry of northern Italy set off to defend their newly acquired privileges against their mostly clerical competitors, who could sustain their claims through their mastery of the sophisticated body of canon law.

[24]In the context of the Medieval systems of personal law, Canon law—applicable to clergymen and in transactions with 'moral' repercussions—also had a variety of economic applications. Berman (1983, p. 225) writes, "[T]here gradually developed... out of the church's jurisdiction over testaments, a body of law pertaining to inheritance; out of the church's jurisdiction over benefices, a body of law pertaining to property; out of the church's jurisdiction over oaths, a body of law pertaining to contracts; out of the church's jurisdiction over sins, a body of law pertaining to crimes and torts."

The complementary evolution to the rediscovery of Roman law and Roman legal thinking was the development of an educational institution that would teach and disseminate this body of knowledge. The university, as it emerged from the first societies of scholars and students in Bologna and other cities (cf. next section), was the result of this evolution. It represented a novel form of teaching, distinct from the cathedral schools and monastic schools. While many universities also taught canon law, and many of the students were clergymen or had at least received the minor orders, the university was a secular institution. Medicine and civil (Roman) law were the subjects that best embodied this change in the character of education, and which were from the beginning linked to the new institution.

The needs of a commercial society that had prompted the rediscovery of Roman law also characterized its teaching at universities. Students wished to study law not as a pastime, but for professional purposes: "Medieval legal education was not directed towards the training of law teachers but of professional legal practitioners" (Rüegg, 1992, p. 25). Scholarly activity was also concerned with practical aspects: "[T]he twelfth-century glossators of the Roman law were particularly sophisticated in their reconstruction and transformation of the older Roman law of contracts, in part just because of the demands placed upon them in that respect by the rapid economic changes of their time" (Berman, 1983, p. 245).

Training in the law, in Bologna and soon in other universities, attracted thousands of students each year. Universities quickly spread across Europe, with their charters granted by Kings, the Holy Roman Emperor and the Pope. Table 2 evidences this development: there were no universities in Europe in the 11th century; by the end of the 13th, there were more than a dozen; by the end of the 14th, the number had more than doubled again.

[Table 2 about here]

3.2 The Political Economy of University Establishment and of the Adoption of Roman Law

The law school in Bologna emerged as a "focal point" (Moraw, 1992, p. 247) for the education of jurists in the 10th century. Masters and their students formed corporations (*societates*) to institutionalize the teaching arrangement and defend their rights. However, it was far from obvious that these corporations would enjoy the support of the Kings, Popes, or even of the cities they resided in.

As long as the law schools were simply "private and unauthorised teachers" (Rashdall, 1895, vol. 1, p. 145), authorities such as Popes and Kings were not concerned with either hindering or supporting this new form of study. However, as the importance of the teaching of law grew and the number of students increased, different approaches became visible.

The Church initially looked at the new institution with suspicion. Universities were a competitor of cathedral schools and monastic schools—the traditional places where it had educated its elites up to then. Afraid of losing its monopoly of education, the Church imposed a ban on the study of medicine and civil law by monks and canons, particularly since the schools of medicine and civil law were led by laymen. This ban was issued in the in the Council of Clermont (1130), and reiterated in the Council of Reims (1131) and in the second Lateran council of 1139 (Verger, 1977–1999). Cities also had an ambivalent relationship to the new institution. The presence of a large number of (mainly wealthy) students and teachers was of course attractive; however, the unclear legal status of students was also a source of 'town and gown' conflicts.[25]

In contrast to this, Emperor Frederick I Barbarossa's approach to the students of law reflected his understanding of the usefulness of jurists. In 1155, he met the students of Bologna just outside the city walls and issued a bill of privileges, the *Authentica Habita*. With

[25] For example, a source of conflicts were merchants' attempts to seize some student's property to satisfy debts incurred by his compatriots.

this constitution, the Emperor granted professors and students freedom of movement for the purposes of their studies. He also forbade the right of reprisal against foreign scholars, and decreed that students summoned to court could choose to be tried by their own masters (teachers) or by the bishops' courts, rather than by the local courts (Nardi, 1992). To protect themselves further, early in the 13th century students in Bologna founded "universities" of students and gave themselves written statutes (Weimar, 1977–1999). These universities replaced the *societates* of students and teachers and were modeled after another self-governing, successful institution of the Middle Ages: the guild (Rashdall, 1895, vol. 1, p. 152).

The growing importance of jurists and of their specialized knowledge of Roman law in defining rulers' powers became clear at the Imperial Diet of Roncaglia (1158), a key moment in Frederick Barbarossa's attempts to restore the Imperial powers over Italy. The Emperor attended the diet accompanied by four legal counsellors from Bologna—Bulgarus, Martinus Gosia, Iacobus, and Hugo de Porta Ravennate—who provided expert legal advice (Georgi, 1977–1999); in exchange, he confirmed the privileges of *Authentica Habita*.

As in the case of Frederick Barbarossa, the authorities' suspicion of the new institution vanished with the realization of the usefulness of jurists, and of the role of universities as providers of highly educated graduates to staff the ranks in public and Church administration (Verger, 1977–1999). Popes, Emperors, and other lords (spiritual and temporal) found individuals trained in law at university to be extremely valuable: Moraw (1992, p. 247) writes that

> *[the universities] made possible the emergence of groups of persons who, as legal experts, occupied posts of growing importance for the life of society. The communities needed these specialists for their domestic administration and legal system, in the quest for increasing autonomy and in the competitive struggle with their neighbors.*

By the beginning of the 13th century jurists came to dominate the personnel of the chanceries of kingdoms such as France or England, as well as of the Church (Swanson,

1979, p. 15, Nardi, 1992, pp. 92–3).

In sum, the authorities of the epoch contributed to the success of the university, as a novel institution devoted to the teaching of Roman law in particular, in two ways. On one side, Popes, Kings, Holy Roman Emperors, and city governments issued privileges and granted various rights to universities and their students—as in the case of the *Authentica Habita*, or of the protection *tamquam filios speciales* ("like dearly beloved sons") explicitly accorded by Pope Honorius III to the students of Paris, who had been harassed by the local bishop (Nardi, 1992, p. 85).[26] The importance of having multiple sponsors for the ultimate success of a university is shown exemplarily in the cases of Piacenza and of the English universities: in the first case, Pope Innocent IV had founded a university, but the activities failed to take hold due to the lack of support of the city. In England, on the other hand, after 1231 King Henry III confirmed the privileges conceded by the Church to the universities of Oxford and Cambridge, thus contributing to their development (Nardi, 1992, p. 92).

On the other side, Kings, Emperors, and Popes increased the labor market returns to university study by hiring graduates of the universities to staff their chanceries and administrations. In doing this, they clearly signaled to potential students that the university study was not just an intellectual pastime, but that it taught skills that were valued and that could eventually be rewarded with prestigious and lucrative positions. As an illustration of the interest of rulers in universities, one should consider the efforts made by Emperor Frederick II to create a *studium* in Naples, both to give prestige to his throne and to train the ruling class of the kingdom of Sicily. His insistent attempts to poach teachers and students from

[26] There were, of course, limits to administrative elites' desire for expanded training at universities: the Church in the Middle Ages was concerned about heterodox teachings of theology, and at times resisted the chartering of new universities. This appears to have been one reason why the German lands of the Holy Roman Empire were without a single university until late in the 14th century. In 1378, a schism left the Church with two rivaling Popes, one in Rome and one in Avignon, resulting in the Roman Pope's loss of control over the flagship theological university at Paris. This led him to grant charters to new universities, among those the ones of Heidelberg, Cologne, and Erfurt (Nardi, 1992; Swanson, 1979).

Bologna were ultimately unsuccessful, and only confirmed the Popes' desire to support the other universities across Italy and the rest of Europe (Nardi, 1992, pp. 87f., Rashdall, 1895, vol. 2, pp. 22ff.).

Viewed through the framework of the model above, the historical evidence suggests that medieval rulers (in particular, the Church) initially perceived the introduction of the new legal knowledge as threatening ($\pi_h < 0$). In a later phase, they realized that their positions could be strengthened by encouraging the study of Roman law ($\pi_h > 0$). The consolidation of their power and the increased incomes that new human capital could generate led states (including the Church) to subsidize investment in the new human capital ($\delta^* > 0$). The rights and privileges granted to universities reduced the cost of acquiring education: more certainty about the legal value of the degrees attained and the elimination of the risk of being held at ransom by local authorities were factors that diminished the costs faced by students when choosing an educational path. The secure labor market returns from legal study by working in secular or Church administrations also increased students' expected returns from legal study.

Ultimately, the authorities' encouragement and support of the new institution, the university, and of the study of Roman law in particular, were effective: university training in the law was widespread in the Middle Ages, and the influence of trained jurists extended over various realms of public life, from academia to the commercial environment, and to the administration of Church and secular states.

3.3 The Effects of Legal Studies on Commercial Development

To understand the economic impact of legal studies in the context of the Middle Ages, two important aspects have to be taken into account. The first is the high number of different polities. After the collapse of the Carolingian empire, by some accounts the number of poli-

ties increased from 10 to more than 200 in the year 1300 (Tilly, 1990). Different polities had different jurisdictions, different customs, and different weights and measures; it was nearly impossible to prosecute, for example, an insolvent buyer across the borders of territories. These factors were a severe hindrance to trade, and reputational mechanisms or institutions such as merchant's guilds could only partly compensate for the absence of a unitary legal framework (Greif, 1989, 1993).

The second is the absence, compared to the modern world of nation-states with well-defined boundaries, of a clear demarcation of the different aspects of sovereignty between the political actors—Popes, Bishops, Kings or Emperors, local feudal lords, cities etc. In addition to the multiplication of the number of polities, local lords were trying to extend their control over the territories they held as fiefs (Bisson, 1994). Different layers of sovereignty, the competition between secular and Church powers (such as in the investiture conflict), and between different levels of each power (such as liege lords and vassals) led to a situation in which "no single power agency controlled a clear-cut territory or the people within it" (Mann, 1986, p. 386; cited in van Zanden, 2009).

In this context, the introduction of Roman legal knowledge was a useful innovation, contributing to the expansion of urbanization, long-distance trade and small-scale commerce that characterized—despite the obstacles described above—the high Middle Ages. Thanks to the sophistication of Roman law in the field of contracts, and the fact that a common legal language was now shared all over Europe (because of the similarity of curricula across universities), medieval jurists who worked as lawyers, judges, notaries, or procurators supported the unfolding of commercial activities. Berman (1983, p. 336) writes:

> *In fact, the new jurisprudence of the late eleventh and twelfth centuries provided a framework for institutionalizing and systematizing commercial relations in accordance with new concepts of order and justice. Without such new legal devices as negotiable bills of exchange and limited liability partnerships, without the reform of the antiquated commercial customs of the past, without mercantile courts and mercantile legislation, other social and economic pressures for change*

would have found no outlet. Thus the commercial revolution helped to produce commercial law, but commercial law also helped to produce the commercial revolution.

In addition to supporting commercial exchange, jurists played an important role in public administrations (Berman, 1983, p. 120). Here, again relying on the common, pan-European framework of Roman law, they could help solve the conflicts of rivaling sovereignties between Church and states, and between secular states. In fact, some of the most prestigious positions for jurists in the Middle Ages were those as counsellors, members of the chanceries, or envoys of Kings, Emperors, princes or cities. Even in the Church the highest-ranking appointments were reserved to jurists trained in Roman law, in addition to canon law (Moraw, 1992, p. 266). Other career paths in the public administration that were open to jurists trained in Roman law were: solicitors, town clerks, city chroniclers, or notaries—the latter two occupations could also be taken by students of law who had not completed their degrees (Wieacker, 1967, p. 159).

One of the earliest examples of jurists reconciling conflicts between polities dates from the Diet of Roncaglia (1158). Barbarossa's legal counsellors—together with experts representing the Lombard cities—drafted a document (*Regalia sunt hec*) which helped to define the rights and attributes of Emperors (*regalia*) as opposed to those of the cities of northern Italy, also spelling out under which conditions those rights could be devolved to other polities (Georgi, 1977–1999).

Roman law thus fulfilled the roles that have been identified by the literature (Greif, 2005, 2008a,b; Acemoglu and Johnson, 2005) as crucial to economic development: it placed constraints on rulers, thereby signaling that property rights were secure, provided mechanisms for contract enforcement, and facilitated coordination among powers.

The evidence on the careers of Medieval jurists is rich.[27] We analyzed the biographies

[27] Different attempts to reconstruct the careers of Medieval graduates of law have been published by Stelling-Michaud (1960), Martines (1968), and Kuhn (1971). A recent project is the "Repertorium Academicum Germanicum", available online at `http://www.rag-online.org/`. Cf. also the survey in Coing (1973), pp. 81ff.

of over 1,200 graduates of law from the university of Bologna, between its foundation and the early 17th century. These data, first collected by Alidosi (1623), give insights into the careers of graduates of the oldest and most distinguished law faculty in Europe.[28] In Table 3, the career choices of the Bolognese graduates are categorized into four broad areas: clerical positions in the Church, administrative positions in the Church, academia, and public administration. As the data include graduates of canon and Roman law together, the large number of careers in the Church is not surprising.[29] However, jurists' occupations in the Church were often related to administrative tasks. At the same time, almost a quarter of graduates went into explicitly secular administrative positions, such as governors or *podestà*—these were professional managers of cities, appointed for one year, taking the place of aristocratic administrators. They went from city to city together with a small group of judges, notaries, and secretaries (Moraw, 1992, p. 148; Greif, 1998).

[Table 3 about here]

In a recent working paper (Cantoni and Yuchtman, 2010), we go beyond the analysis of jurists' careers and try to investigate the potential aggregate economic effects of Roman law in Medieval Europe. To solve the endogeneity of the adoption of Roman law—arguably, Roman law re-emerged in the Middle Ages *because* of the needs of a commercializing society—we exploit the introduction of universities (and thus of Roman legal thinking) in the German lands of the Holy Roman Empire as a consequence of the Western Schism of 1378. Using data on the granting of market rights in 2,258 cities of the Empire as an indicator of economic activity, we find that the rates of market establishment experience a positive break after the foundation of the first universities in Heidelberg, Cologne and Erfurt. Moreover, the trend break is most pronounced in the regions that experienced the largest change in

[28] To our knowledge, this is the first quantitative examination of the work by Alidosi.

[29] Moreover, as many students of the Middle Ages had taken the minor orders, clerical activities often overlapped with secular ones (Moraw, 1992, p. 269).

distance to the closest university as a consequence of the foundation of the new schools. We interpret these findings as evidence in favor of a causal effect of university foundation (and of penetration of Roman legal knowledge) on economic development.

4 Historical Case Study 2: The Introduction of Western Education in Late Imperial and Republican China

4.1 Traditional Education in China and the Introduction of Western Science

For hundreds of years, the traditional Chinese education system, focused on the study of the Confucian classics, prepared students to take imperial exams with the goals of achieving gentry status and receiving a position in the imperial civil service. The traditional education system was, through its provision of human capital, its transmission of Confucian ideology, and its selection of social elites, a pillar of imperial China's social structure, government, and economy. "In China since medieval times, imperial dynasties, gentry-literati elites, and classical studies were tightly intertwined in the operation of the civil service examinations. All three were perpetuated during the late empire (1368–1911), and they stabilized for five hundred years because of their interdependence" (Elman, 2000, p. xvii).

Students began their studies as young children, typically in schools that were funded by their clans. After memorizing the thousands of characters comprising the Confucian classics (which might take over a decade), students would devote yet more time to practicing their composition skills—most importantly, the "eight-legged essays" on which they were evaluated in the examinations—and reading commentaries and histories that would be useful for their exams. Advanced study would take place in academies, generally organized and paid for privately, that prepared students to take civil service exams.

Traditional Chinese education had a remarkably narrow focus: mastery of the Confucian

classics and the ability to write the eight-legged essays were almost exclusively the skills that determined success on the imperial exams in the late Qing Dynasty (Elman, 2000). Students responded to the incentives offered by the examination system and typically did not seek broad educations that went beyond the material needed to succeed in the exams. One official, a holder of the highest, *jinshi*, degree in the examinations, "complained privately that the civil service lacked men with any practical talent because the selection process made little effort to stress administrative concerns" (Elman, 2000, p. 573). Another official stated that China's literati "study things they will never use and later use what they have never studied" (Elman, 2000, p. 589).

In Table 4, we present some data on the topics about which "policy questions" were asked in mid-19th century provincial-level exams (the Table is based on figures reported in Elman, 2000, p. 722). In both 1840 and 1849, topics in the humanities—the Classics, History, Poetry, and Philology—dominated the exams. In contrast, scientific questions nearly never appeared: no questions about nature were asked in 1840, across seven provinces' exams, and only one such question was asked, across 15 provinces' exams, in 1849. Even where questions on more applied topics were assigned, the style of writing, rather than the substance, was the most important metric by which an exam candidate was judged (Elman, 2000; Chang, 1955).

[Table 4 about here]

Prior to the 19th century, Chinese exposure to European science was extremely limited, and the gap between Chinese and Western science in the 19th century was massive. Elman (2006) writes:

> *By 1750, textbooks made the application of mechanical principles accessible to anyone literate in English or French, and artisans and engineers applied them. None were translated into Chinese, because the Jesuits [who controlled the transfer of Western science to China in the 18th*

century] never made the jump to the mathematicization of practical mechanics. ... By the late eighteenth century, experimental physics and mechanics had surpassed the use of geometry in Europe. Meanwhile, however, the Chinese were still using as a basis for mathematical learning the Ten Mathematical Classics.

In the 19th century, encounters with Western, imperialist powers introduced new fields of study to China—most notably, modern science, mathematics, and engineering. Missionary schools, some Jesuit and many Protestant, began to teach foreign languages and Western math, science, and engineering in the second half of the 19th century. Military (arsenal) schools, first established in the 1860s by the Qing government, provided applied training in Western science and engineering and produced Chinese-language translations of important books in the natural and applied sciences. A small modern educational hierarchy, including high schools and universities (privately funded, and often located in Western-controlled treaty ports), taught modern subjects as well. Finally, some Chinese students accessed Western knowledge through study abroad; Japan and the United States played important roles in training Chinese in modern subjects like medicine, engineering, and law.

4.2 The Political Economy of Education Reform in Late Imperial China

In the mid- to late-19th century, military defeats to Western countries in the Opium Wars and to Japan in the Sino-Japanese War indicated to many Chinese a need for modernization. Reformers urged military changes, political changes, and especially changes in the structure and content of education. One Qing dynasty official felt that "the military successes of Meiji Japan were a model for China and that emulating the Japanese would require expanded education in the sciences and industry" (Elman, 2006, p. 201). The importance of educational reform was even emphasized by the (Guangxu) Emperor: in 1898, he wrote, "Our scholars are now without solid and practical education; our artisans are without scientific instructors; when compared with other countries we soon see how weak we are" (Headland, n.d.,

p. 116). The narrow focus of the Imperial civil service exams was recognized by political reformers in the second half of the 19th century as being particularly problematic. In 1896, for example, Liang Qi-chao "pointed out the deleterious influence of the civil examinations on learning. Most candidates would master whatever curriculum was set on the examinations ... Hence, curricular reform was mandatory to change the learning habits of literati who sought public office" (Elman, 2000, p. 598).

Some efforts were made to increase the incentives to study modern educational content. First, the government enacted policies that reduced the cost of studying Western subjects: it established military arsenal schools, which provided training in science and engineering; opened some schools with training in foreign languages and Western subjects; and, supported the study of Western subjects by sending some students to study in Japan, Europe, and the United States. In addition, late in the 19th century, attempts were made to introduce Western subjects into the civil service exams, and so into the traditional schools' curriculum. In 1898, it seemed that radical educational reform would be implemented during the "100-days reform," but conservatives ultimately re-asserted themselves (Karl and Zarrow, 2002).

Throughout the second half of the 19th century, arguments for, and acts of, educational reform were met by powerful resistance from conservative officials. These officials argued that the investments in Western education ought to be sharply circumscribed: the goal was "Self-Strengthening," which meant preserving the core of Chinese learning and culture by studying Western subjects only to the extent necessary to prevent being militarily defeated by foreign powers. There were impassioned defenses of Chinese education. One individual argued that "For five thousand years the spirit of the sages has continued in China ... [we] absolutely must not do as the Japanese, who had dispensed with their own learning in favor of Western learning" (Weston, 2002, p. 108). Not only were cautious officials concerned

about the cultural losses stemming from educational reform, but they also saw a threat to the imperial government, and to their own positions, from the study of Western subjects. Zhang Zhidong, a government official, argued in the late 19th century that "if [one] want[s] to strengthen China and preserve Chinese learning, [one] must study Western learning. Yet, if someone [studies Western learning] without first firmly being rooted in Chinese learning to cultivate his character, he may become a rebel leader if he has a strong body and a slave [to the West] if he is weak. He will cause more harm [to society] than a person who knows nothing about Western learning" (Hon, 2002, p. 89).

Conservative Chinese officials for the most part succeeded in preserving the incentives to study the Classical curriculum in the traditional education system. Their motivations varied:

> *Some were antiquarians; others were by nature skeptical of change. But a large number were 'corrupt bureaucrats'* (suli*) who had a vested interest in preserving the political status quo. In other words, the conservatives were not as ignorant of China's problems as many people assumed; nonetheless, they would do what they could to protect their interests. (Hon, 2002, p. 96)*

Conservative bureaucrats' most effective policies were, first, preserving the material covered on the civil service exams; second, maintaining the links among the exams, "gentry" status, and economic rents; and third, limiting the application of Western learning in the labor force by restricting the activities of modern, Western firms.[30]

Chinese elites hoping to pass the civil service exams in the last decades of the 19th century continued to be evaluated as were their fathers and grandfathers. In practice, the limited introduction of Western science into the exams had little effect on Chinese elites' studies: questions about science were not of great consequence to a candidate's exam outcomes, and a successful answer did not depend on a mastery of scientific concepts. An 1889 exam asked examinees to explain the theories of Darwin and Spencer. Elman (2006, p. 150) writes that

[30] Of course, limitations on the activity of Western firms were also motivated by a variety of reasons other than the desire to reduce the returns to Western education.

"the essays on this topic reveal more ignorance than knowledge concerning Darwin's explanations about the evolution of life forms. Jiang Tongyin's prize essay, for example, simply bluffed its way through the issues—the judges, including [the scholar who wrote the question] apparently did not know the difference." The prize winner himself noted that he had never seen a translation into Chinese of Darwin's theories.

The continued emphasis in the exams on Classical learning and stylistic writing might have had less impact on human capital accumulation if the social and economic returns to mastering the exams had fallen. This was not the case: Chang (1955) describes the myriad benefits accruing to the "gentry" who were successful in the first set of (local) exams in the 19th century. First, they enjoyed high social status: "The gentry stood above the large mass of the commoners and the so-called 'mean people.' They dominated the social and economic life of Chinese communities" (Chang, 1955, p. xiii). They also filled local administrative positions that were not staffed by the imperial civil servants, and enjoyed exemption from taxes (in particular the tax on land holdings), and stipends in cash or rice in their years as students and exam candidates. Perhaps the greatest incentive to study the Classics was the possibility of a lucrative position in the civil service. Chang (1962) estimates that administrative secretaries (lower-level members of the gentry) earned good incomes of up to 1,500 *taels* per year. District level officials, who passed higher level exams, earned 30,000 *taels* per year; high-level officials earned 180,000 *taels* per year—truly massive incomes at the time—over 100 times the income of a well-off secretary. Gentry members who did not serve in the imperial civil service could also acquire great wealth by working in fields like tax collection and in the salt administration.

A final important source of distortions in the market for human capital was indirect: constraints on Western firms' activities in China sharply reduced the labor market opportunities available to Chinese who studied Western subjects. For example, the construction of

railroads, crucial for developing a modern Chinese economy in the first decades of the 20th century, was nearly never approved by the Qing government throughout the second half of the 19th century.[31] As a result, railroads were practically nonexistent: Ma (2008, p. 360) notes that there existed only 364 kilometers of railroads in all of China until 1894. Modern banks, too, were not developed prior to the 20th century, and industrial activity was concentrated in the Western-controlled treaty ports; both formal and informal institutions limited the productivity of modern, industrial firms across China. As such, it is less surprising that despite the scarcity of modern human capital, graduates of the arsenal schools in the second half of the 19th century were not especially successful in finding employment (Weston, 2002, p. 105).

On net, it is clear that the modern schools did not attract the very best away from the traditional system: Elman (2006, p. 158) writes that elites who studied Western subjects were "considered marginal because they usually had failed the more prestigious civil examinations." Chang (1955, p. 204) writes that until late in the 19th century, studying Western subjects was "shameful." In contrast, competition in the imperial exams was extremely intense in the second half of the 19th century: Elman (2000) presents evidence suggesting "graduation rates" of well below 10% at different examination levels; Chang (1955, p. 179) quotes Xue Fu-cheng as saying that in the late 1800s, the traditional education system "drove several hundred thousands to several millions of scholars to exhaust their physical and mental energy in the formalized writings."

The Qing government clearly viewed modern, Western subjects with some ambivalence. On the one hand, the study of modern science and engineering could support the state by improving military technology; indeed, it is clear that 19th-century Chinese reformers, in the notation of our model, expected $\pi_h > 0$. On the other hand, the study of the traditional

[31] Rawski (1989, p. 225) writes that "British observers recalled the 1920s as a period remarkable for 'the number of mills and factories of all kinds which were springing up all along the principal railway lines.'"

curriculum was linked to the selection of social elites and bureaucrats for centuries; questioning the curriculum implied questioning the qualifications of the social and political elite, as well as undermining the Confucian ideology that linked the Manchurian Qing dynasty to its Han subjects and legitimized the imperial bureaucracy. Conservative officials, and influential conservatives within the imperial household (notably, the Empress Dowager Cixi) felt that any investment in modern human capital beyond what was absolutely necessary to modernize the military was a grave threat to their positions of power ($\pi_h < 0$). Thus, although the government slightly reduced the direct cost of studying modern subjects (by establishing some modern schools), the opportunity cost of studying modern subjects was kept artificially high by reserving massive social and economic rents to those who studied the traditional curriculum. The expected returns to studying modern subjects were also made lower and more uncertain by Qing policies restricting the activities of firms that would find modern human capital most useful. As our model suggests, a government threatened by investment in a new form of human capital distorted the costs and benefits of that investment and effectively discouraged it ($\delta^* < 0$). The result, as one would expect, was limited acquisition of the new skills.

4.3 Modern Education and Growth: Evidence from Early 20th Century China

China's economic development in the second half of the 19th century was not impressive: outside the Western-controlled treaty ports, China did not modernize economically or institutionally; the Qing government continually faced conflicts, both internal and external, and pressure for institutional reform. In 1905, the system of imperial exams was abolished and a modern school system established; the decline of traditional institutions continued, and the last Qing emperor abdicated in 1912.

It is difficult to know whether different policy choices by the Qing government could

have encouraged greater investment in modern human capital in the second half of the 19th century, and even more difficult to know whether this might have had consequences for China's economic development.[32] We present evidence from the period immediately following the downfall of the Qing Empire that can provide some suggestive answers to these questions.

First, different government policies very likely would have encouraged greater investment in modern human capital. Yan (2007) finds that the number of advanced students enrolled in modern schools (high schools or universities) increased from under 150,000 in 1912 to well over 500,000 in 1930. The economic environment in Republican China was far from perfect—the 1910s and 1920s were times of internal conflict across China—but the Republican government encouraged modern industry and certainly did not promote a traditional education system. Eliminating the rents associated with traditional study and allowing the development of modern industry was enough to dramatically increase the number of individuals studying modern subjects.

There also exists evidence suggesting that investments in modern human capital could have promoted economic development in imperial China. Bai and Kung (2011) present evidence that Chinese counties with more Protestant missionaries were more urbanized (and thus plausibly more developed) than other counties in the early 20th century. Importantly, the channel through which missionaries affected urbanization seems to have been the transmission of Western knowledge: it was particularly the presence of missionaries from denominations involved in school and hospital construction that was associated with greater urbanization.

An early 20th century directory of individuals who had returned to China from study

[32] Lin (1995) and Huff (2003) argue that China's traditional education system was a hindrance to technological progress for centuries, as it diverted elites' attention away from scientific discovery. The question here is whether China would have more effectively adopted Western technology and modernized its economy, rather than indigenously innovated new technologies.

in America provides an indication of the usefulness to modern firms of the human capital provided by Western schools. The directory first notes (perhaps with some exaggeration) that "[I]t does not seem possible to give an adequate estimate of what the [returned] students as a whole have done for their country. But probably it is within the bounds of safety as well as propriety to say that it has been entirely due to their efforts and influence that the country is being modernized" (Tsinghua University, 1917). In Table 5, the sectors in which these individuals were employed in 1917 are summarized. It is clear that many of them were able to use their human capital in modern industries like the railroads and mining; in white collar positions, like banking; and in practicing medicine; many also found employment as officials in the Republican government.

[Table 5 about here]

Examining individual-level data, Yuchtman (2010) finds that in the 1920s, the Tianjin-Pukou Railroad paid extremely high wages to individuals who were trained at high levels in modern schools, especially those trained as engineers. Traditionally-educated workers earned wage premiums relative to unskilled workers, but significantly lower wages than the engineers. This suggests that individuals who studied modern subjects, especially engineering, were differentially productive in the railroads. Greater investment in modern human capital thus might have supported the establishment and growth of modern, industrial firms in 19th century China. In addition, had the Qing government not limited the development of Chinese railroads and other industries, there might have existed greater demand for individuals trained in modern schools, and thus greater investment in the new forms of human capital. Historical evidence thus suggests that a consequence of Qing policies incentivizing the study of traditional subjects was under-investment in productive, modern human capital, and consequently, delayed economic modernization.

5 Educational Content, Institutions, and Growth: Additional Applications of the Model

The two historical cases discussed above illustrate how our simple model can inform the study of investments in human capital and their relation to growth. We believe that these insights can be applied still more broadly to a variety of additional historical and present-day settings. Here we briefly discuss several of these, and then examine cross-country data on education and growth through the lens of our model.

5.1 Historical and Modern Cases

The rise and fall of Islamic science represented part of an epochal shift in the wealth and power of the civilizations of the West, and have received the attention of many scholars. Chaney (2008) presents an analysis along the lines suggested by our model: Islamic elites who controlled educational institutions in the Middle Ages initially promoted the study of logic and science, because the gains from spreading these skills (more converts to Islam) outweighed the drawbacks (potential criticism of the established religious elites). Using the language of our model, as Islam spread, elites perceived $\frac{\partial \pi}{\partial h} > 0$. This period of elite support for scientific study saw the flourishing of Islamic society. As Islam succeeded in conquering and converting the vast majority of the populations in the Middle East, the gains to elites from people's investments in the study of logic and science fell relative to the costs, and elites moved to prevent the further study of these subjects (over time, $\frac{\partial \pi}{\partial h}$ became negative). Unsurprisingly, with elites moving to prevent the study of science, Islam fell behind, ceding its scientific preeminence to Europe.

England around the time of the Industrial Revolution presents another fascinating case. At first glance, one might believe that this was a case of growth *without* proper educational

institutions or content. Smith (1776, book V, ch. 1) famously said of Oxford professors that "the greater part of [them] have, for these many years, given up altogether the pretence of teaching." University students in the 19th century focused their studies on the classics and history—much like the Chinese literati of the same period. On the other hand, educational institutions, broadly defined, were far more open in 18th and 19th century Britain than in China. Mitch (1999) and Mokyr (2005) provide many examples of sources of scientific knowledge that were available throughout Britain: from new ("Red Brick") universities established in the 19th century with a more applied slant than Oxbridge, to lectures, scientific society meetings, mechanics' institutes, and more. Viewed in light of our model, one can see that the British elite, for all of the distortions they imposed on a variety of sectors, did not prevent broad segments of the population from acquiring scientific knowledge, nor did they greatly distort the labor market returns to its acquisition. With a value of δ^* close to 0, individuals invested in acquiring scientific knowledge that drove the Industrial Revolution.

The emergence of the modern research university in the 19th century is another example that might fit well within our theoretical framework. With the changes inspired by the Humboldtian ideal of teaching and research, German universities were restructured in a manner complementary to the challenges of the rapid technological changes of the 19th century (Lenoir, 1998). Those changes in the structure of higher education were, in turn, the result of Prussia's critical reexamination of its institutions after its defeat at the hands of Napoleonic France: Prussia's reformers realized that $\frac{\partial \pi}{\partial h} > 0$. A similar, positive reaction in the structure of higher education can be observed in American universities, which were geared toward a stronger research focus in the early 20th century (Goldin and Katz, 1999; Goldin, 2001).

Moving forward in time, the 20th century is full of cases of governments implementing policies affecting educational content, driven by political economy concerns. One dramatic

instance was the passage of the National Defense Education Act in the United States in 1958. In this case, government support for scientific education was massively increased following the successful launch of the *Sputnik 1* satellite by the Soviet Union. Here, the government became aware that $\frac{\partial \pi}{\partial h} > 0$, where h in this case specifically represents scientific knowledge. The example reveals another angle of the political economy problem governments face: the U.S. elite was threatened by *Sputnik* both because the population of the U.S. evaluated the government according to its standing relative to the Soviet Union (hence, there existed some internal political incentives), and because there was a plausible *external* threat to the elites if Soviet technology became too advanced.

Today, one again sees a concerted effort made by governments to support the study of science and math. In his weekly address of February 19, 2011, Barack Obama proclaimed, "If we want to win the global competition for new jobs and industries, we've got to win the global competition to educate our people. We've got to have the best trained, best skilled workforce in the world. That's how we'll ensure that the next Intel, the next Google, or the next Microsoft is created in America, and hires American workers." To indicate the direction in which he thinks education should move, he continues: "[Intel] is providing training to help 100,000 math and science teachers improve their skills in the classroom. And today, I'm also meeting a few students from Oregon who impressed the judges in the high school science and engineering competitions that Intel sponsors across America."[33] The government of the United Kingdom, while cutting educational expenditures dramatically in 2010, did not cut spending in "STEM" subjects, i.e. science, technology, engineering, and maths (Morgan, 2010). In these cases, it appears that the purpose of efforts to promote specific fields of study is simply to increase individuals' incomes (and reduce unemployment rates)—which, of course, also typically leads to greater support for the existing elite in democratic societies.

[33]The full text of the address, titled "To Win the Future, America Must Win the Global Competition in Education," is available online at `http://www.whitehouse.gov/briefing-room/statements-and-releases`.

5.2 A Look at Contemporary Data

To illustrate how our theoretical framework can be applied to understand the political economy nexus between human capital investments and economic growth in the modern world, we turn to contemporary cross-country data. Guided by our model, we first try to identify whether, on average, particular types of educational content appear to be associated with more rapid economic growth in recent decades. Then, we explore whether the relationships between specific types of human capital and growth depend on a country's political institutions—which proxy for a government's incentives to distort the returns to human capital. This exercise will not allow us to identify causal relationships in the data, but will provide some indication of the importance of political institutions in mediating the relationship between particular types of human capital and growth.

As an indicator of differences across countries in the content of individuals' schooling, we use UNESCO data on tertiary education enrollments by field of study between 1998 and 2010.[34] We focus on the fraction of individuals enrolled in engineering programs and in social science, business and law programs (we shorten this to "business or law" hereafter, for brevity), both of which plausibly provide skills that are valuable in modern economies.

In the spirit of Murphy et al. (1991), we begin by regressing growth rates of GDP per capita over the 2000–2008 period on the average fraction of tertiary students enrolled in engineering programs and on the fraction of students enrolled in business or law, including standard controls for country characteristics used in cross-country analyses (see Table 6, col-

[34]Two caveats regarding these data should be mentioned. First, the enrollment data used are only from very recent years, while income growth will typically be determined by the existing stock of individuals' human capital, much of which was accumulated in prior years. We expect that current flows of human capital are a fair proxy for previous investments, but they are surely imperfect. Second, because data are typically not available for every country in every year, we construct a country's average share of tertiary-level students enrolled in different fields using the average values for all available years between 1998–2010, for countries with tertiary enrollments of 10,000 or more. These averages across several years are only noisy indicators of the human capital that individuals have acquired.

umn 1).[35] We find a positive and significant correlation between enrollment in engineering and GDP per capita growth rates; in contrast, the fraction of students enrolled in the fields of business or law has no effect.[36] The magnitude of the coefficient suggests that an increase of one standard deviation in the fraction of students enrolled in engineering is associated with an increase of average per capita GDP growth by $6.91 \cdot 0.101 = 0.698$ percentage points, slightly less than one third of a standard deviation.

[Table 6 about here]

We next examine whether our findings are similar even after controlling for the quality of political institutions. We choose the "Polity IV" score as our measure of institutions; higher levels correspond to higher degrees of democracy.[37] The results in column 2 are very similar to the ones in the previous regression setup, suggesting that the positive association of engineering training with growth was not simply due to a correlation between a country's institutions and students' enrollment choices.

Our model suggests that if a particular type of human capital content is unproductive, it still may be acquired in countries where educational investment decisions are distorted by government policies. Thus, estimating models in which the impact of enrollment shares on growth is restricted to be equal for countries with more and less distorted returns to human capital might cause us to miss the true effects of specific types of human capital. Here, we propose that a state's institutions (i.e., its Polity score) can be used as a proxy for governments' incentives to distort the costs and benefits of investing in specific educational content. We next examine the *interaction* between political institutions and human capital

[35] Summary statistics and details on sources of all variables are presented in A.

[36] All other categories of tertiary education listed in the UNESCO statistics also show no significant correlation with growth rates over 2000–2008, with the exception of enrollments in health sciences, which are negatively correlated.

[37] The Polity IV score is normalized between -10 (perfect autocracy) and 10 (perfect democracy).

investments, allowing the relationship between investments in human capital and growth to differ between more and less democratic countries.

Interestingly, we find that investment in business or law training seems to be positively associated with growth in countries with more democratic institutions: the interaction term between the share of enrollments in business or law studies and the Polity score is positive and marginally significant (column 3). In very democratic countries, more business or law training *is* associated with growth; the reverse is true in non-democracies. This suggests that individuals' investments in these skills are much more socially productive in societies in which government elites have less incentive to distort markets for human capital.

We finally examine whether enrollment shares in engineering and business or law are strongly associated with a country's political institutions. The results in columns 4 and 5 suggest that there is no clear relationship between the Polity score and the study of engineering or of business or law. This suggests that individuals in less democratic countries pursue social science, business, and law training despite relatively low social returns (i.e., growth): there seems to be a wedge between the private rate of return and the social rate of return to this particular form of human capital in these countries. A possible explanation for this finding is that more democratic states offer greater opportunities for entrepreneurial activity, and thus high private and social returns to studying in these fields, whereas less democratic societies offer more rent-seeking opportunities, and thus high private, but low social, returns to their study. Engineering training, on the other hand, is associated with growth across regimes; thus, it is not surprising that there is no significant difference in average enrollment rates depending on the Polity score—present-day data show little evidence in favor of distortion of the returns to engineering training across countries.

6 Conclusion

Development economists have long viewed variation in educational attainment across countries as an important factor determining the wealth of nations (e.g., Mankiw et al., 1992). There has been far less discussion among economists of the importance of differences in the content of education across countries. We argue that specific educational content can play an important role in economic development and that government policies play a crucial role in determining incentives to acquire different skills. Governments can play a salutary role, overcoming market failures that make individual investment levels sub-optimal, or they can play a damaging role, in pursuit of their own interest in maintaining power.

We have presented a simple model that makes clear how individual choices and governments' incentives interact in producing an equilibrium level of investment in a specific form of human capital. To illustrate the mechanisms of the model in historically important contexts, we have closely examined two cases to establish a tighter link among government policy, investments in particular types of human capital, and consequences for economic activity. These cases make clear that a new, productive form of human capital will only be invested in when governments do not discourage investment, and when governments act to reduce the uncertainty individuals face in choosing their fields of study. Indeed, government encouragement of investment (through institutional changes or through intervention in the labor market) can be crucial to ensuring that individuals choose to acquire new skills in a situation characterized by uncertain returns to the new technology.

We view our work on the content of education and the work in this volume on the *quality* of education as important complements to development research that has focused on quantities of human capital almost exclusively. Further study of educational content and institutions as crucial determinants of human capital in a society, and thus growth, appear to be an important, under-explored area of study. In addition, the content of education shapes

not only productive capacities, but also ideology, providing an additional political economy dimension to government policies toward human capital provision. We plan to pursue these areas of research in the future.

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Figures and Tables

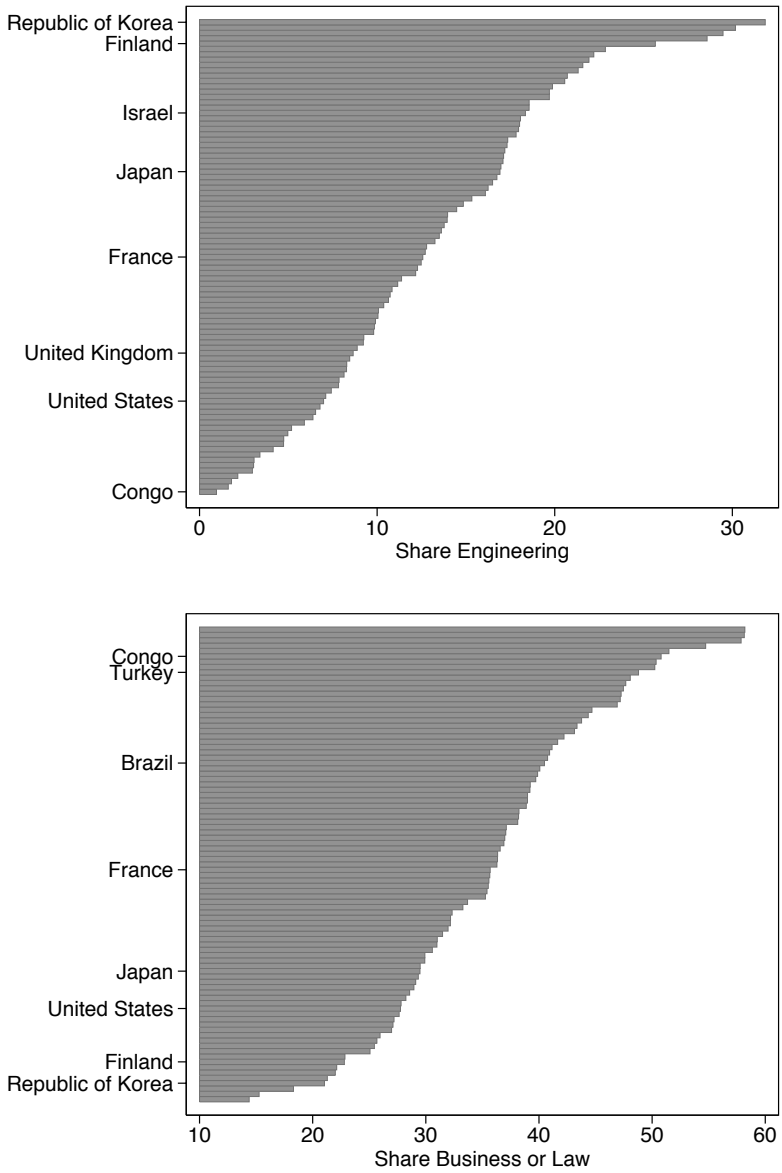

Figure 1: Educational Content Across Countries

Table 1: Educational Content Across Countries

	Country	Share Business or Law		Country	Share Engineering
1.	Bahrain	58.2	1.	Republic of Korea	31.9
2.	Mali	58.1	2.	Colombia	30.2
3.	Cameroon	57.9	3.	Singapore	29.5
4.	Cambodia	54.7	4.	Iran	28.6
5.	Latvia	51.4	5.	Finland	25.7
83.	Kenya	21.3	83.	Cambodia	3.0
84.	Republic of Korea	21.0	84.	Mali	2.2
85.	Libya	18.3	85.	Cuba	1.8
86.	Iraq	15.3	86.	Niger	1.6
87.	Saudi Arabia	14.4	87.	Congo	1.0

Note: Variable definitions and sources in A.

Table 2: Numbers of Universities

	Italy	France	British Isles	Iberia	H.R. Empire	Other Europe
1200	2	1	1	0	0	0
1250	7	2	2	2	0	0
1300	7	3	2	3	0	0
1350	10	8	2	5	0	0
1400	12	9	2	6	5	1
1450	14	14	3	6	8	2
1500	13	17	5	11	15	5

Numbers of universities active in each given year. Source: Rashdall (1895).

Table 3: Careers of Bologna Graduates in Law

Career	Number	% of sample
Church (clergy)	478	39.44
Among these: Canons (195), bishops (94), archdeacons (31), abbots (30), . . .		
Church Administration	381	31.44
Among these: officials of the Inquisition (86), Protonotaries Apostolic (84), auditors at the Rota (37), . . .		
Academia	91	7.51
Among these: lecturers (56), glossators (15), preceptors (10), . . .		
Public Administration	262	21.62
Among these: governors (91), podestà *(40), senators of the city of Bologna (36), . . .*		

Source: Own tabulations based on Alidosi (1623).

Table 4: Topics of Policy Questions in Qing Dynasty Provincial-level Exams

Topic	Fraction of Provinces Including Policy Question on Topic	
	1840	1849
Classical Studies	77.78	100.00
History	77.78	93.33
Learning/Selection	77.78	40.00
Literature/Poetry	55.56	26.67
Geography	55.56	53.33
Economy/Statecraft	44.44	73.33
Philology	44.44	40.00
Agriculture	22.22	6.67
World-ordering	11.11	6.67
Law	11.11	13.33
Military Matters	11.11	6.67
Pre-Han Masters	11.11	6.67
Nature	0.00	6.67
Local Governance	0.00	26.67

Notes: Table based on exam questions from 9 provincial exams in 1840 and 15 exams in 1849. Each provincial exam included 5 policy questions. Source: based on Table 8.8 in Elman (2000).

Table 5: Careers of Chinese Students Returned from Study in America

Career	Number	% of sample
Government officials	24	20.00
Academics	30	25.00
Among these: Faculty (14), Administrators (4), Librarian (1), . . .		
Engineering and Industry	40	33.33
Among these: Railroads (16), Mining (6), Iron and Steel Production (4), Petroleum (3), , . . .		
Medical Doctors	11	9.17
Banking and Law	8	6.67
Among these: Bankers (5), Lawyers (3).		
Other fields	7	5.83
Among these: Social work (3), Agriculture (1), . . .		

Source: Own tabulations based on Tsinghua University (1917).

Table 6: Educational Content and Growth

Dependent Variable	Average GDP p.c. Growth, 2000–2008			Share Engineering	Share Business or Law
	(1)	(2)	(3)	(4)	(5)
Share Engineering	0.101***	0.103***	0.110**		
	[0.034]	[0.033]	[0.047]		
Share Engineering · Polity IV			-0.002		
			[0.006]		
Share Business or Law	0.038	0.040	0.036		
	[0.030]	[0.031]	[0.030]		
Share Business or Law · Polity IV			0.006*		
			[0.003]		
Polity IV score		-0.018	-0.216	0.127	0.456
		[0.045]	[0.156]	[0.149]	[0.310]
Years of schooling	0.642***	0.654***	0.706***	-0.006	-0.807
	[0.137]	[0.140]	[0.144]	[0.395]	[0.486]
log(GDP p.c.)	-1.475***	-1.454***	-1.447***	1.408	-1.734
	[0.312]	[0.322]	[0.325]	[0.894]	[1.327]
Constant	8.477***	8.165**	7.745**	-0.549	55.229***
	[3.056]	[3.164]	[3.116]	[5.847]	[9.017]
Observations	87	87	87	87	87
Adjusted R-squared	0.287	0.279	0.296	0.083	0.110

Notes: *: Significant at 10%; **: 5%; ***: 1%. Robust standard errors in brackets. Years of Schooling, log(GDP p.c.) and the Polity IV score refer to the beginning of the time period considered. Variable definitions and sources in A.

A Data Description

A.1 Variables definitions and sources

Variable	Description
Avg. GDP p.c. Growth	Average (logarithmic) growth rate of PPP Converted GDP per capita (chain series), at 2005 constant prices (in %). Source: Penn World Table 7.0 (Heston et al., 2011).
Share Engineering	Tertiary education enrollment in engineering, manufacturing and construction programs, as a fraction of total tertiary education enrollment (in %). Average over all available years (maximum range: 1998–2010). Source: UNESCO Institute for Statistics.
Share Business or Law	Tertiary education enrollment in social sciences, business and law, as a fraction of total tertiary education enrollment (in %). Average over all available years (maximum range: 1998–2010). Source: UNESCO Institute for Statistics.
Years of schooling	Average years of schooling at the beginning of the period considered, from Barro and Lee (2010). Dataset available at `http://www.barrolee.com/`.
log(GDP p.c.)	Logarithm of PPP Converted GDP per capita (chain series), at 2005 constant prices, at the beginning of the period considered. Source: Penn World Table 7.0 (Heston et al., 2011).
Polity IV score	`polity2` score at the beginning of the period considered, from the Polity IV dataset, version 2010. Dataset available at `http://www.systemicpeace.org/polity/polity4.htm`.

A.2 Summary statistics

Variable	Obs.	Mean	Std.dev.	Min	Max
Average GDP p.c. Growth, 2000–2008	87	3.23	2.46	-3.52	10.07
Share Engineering	87	13.07	6.91	0.95	31.85
Share Business or Law	87	35.94	9.69	14.39	58.20
Polity IV score, 2000	87	5.32	5.73	-10	10
Years of Schooling, 2000	87	7.87	2.68	1.05	12.71
log(GDP p.c.), 2000	87	8.79	1.29	5.98	10.71