Essays on Institutions and Economic Development
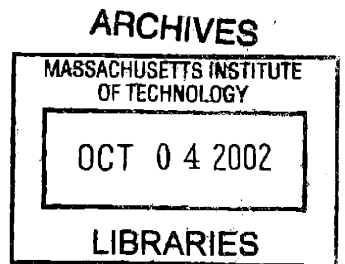
by

DO Quy Toan

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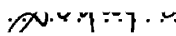in partial fulfillment of the requirements for the degree of

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Signature of Author ....
Department of Economics
15 August 2002

Certified by ....
Abhijit Banerjee
Professor of Economics
Thesis Supervisor

Certified by ....
Simon Johnson
Associate Professor of Entrepreneurship
Thesis Supervisor

Accepted by ....
Peter Temin
Elisha Gray II Professor of Economics

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Abstract

This thesis is the collection of three independent studies that analyze the interplay between institutions and economic development.

In Chapter 1, I examine the relationship between wealth inequality and institutions. I present a model of regulated entry where entrepreneurs form coalitions of potentially varying size to bribe the regulator. The prevalence of capture is thus determined by the distribution of wealth. In a dynamic framework and depending on initial conditions, the economy may be either on a path towards institutional change where inequality eventually vanishes; or, it may be on a path towards institutional sclerosis, which exhibits a polarization of society into two classes with a wealthy elite dominating the increasingly impoverished masses.

Chapter 2 investigates the relationship between trade and financial development. I thus present a simple model of trade in the presence of factor market imperfections. I consider an economy in which entrepreneurs undertake projects, and in doing so, contribute to the development of financial institutions. Such spillover fails to be internalized so that trade potentially induces externality losses that outweigh allocative gains. Financial markets in poorer countries deteriorate as a consequence of specialization. Static inefficiencies are exacerbated in a dynamic framework, leading poorer countries to fall into a liquidity trap. The predictions of the model suggest that trade and financial liberalization should be undertaken simultaneously and that temporary protectionist policies can be welfare improving.

Finally, Chapter 3 consists of a study I jointly did with Lakshmi Iyer, in which we look at the impact of land rights on economic outcomes. We examine the impact of a land reform in Viet Nam which gave households the power to exchange, transfer, lease, inherit and mortgage their land-use rights. We expect this change to increase incentives as well as ability to undertake long-term investments on the part of households. Our differences-in-differences estimation strategy takes advantage of the variation across provinces in the issuance of land-use certificates needed to enforce these rights. We find that the additional land rights led to significant increases in the share of total area devoted to multi-year crops, as well as some increase in irrigation investment.

Thesis Supervisor: Abhijit Banerjee
Title: Professor of Economics

Thesis Supervisor: Simon Johnson
Title: Associate Professor of Entrepreneurship

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J'ai l'honneur de dédier cette thèse à mes parents, mon frère et ma soeur.

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Contents

Chapter 1

Institutions, Institutional Change and the Distribution of Wealth

1.1 Introduction

What explains the persistence of institutions that are harmful to investment and growth? A major puzzle faced by economists is the observed differences in economic development between countries. These observed differences seem to be attributable to differences in institutions. While assessing the causality between institutional environments and economic performance, La Porta, Lopez-de-Silanes, Shleifer and Vishny [1998, 1999] and Acemoglu, Johnson and Robinson [2001] find that present institutions, largely inherited from the past, are significant determinants of current economic outcomes. Moreover, there is evidence that changes in institutions, once implemented, can have real effects on subsequent economic performance. Besley [1995], as well as Banerjee, Gertler and Ghatak [2002] find that improved land rights have a significant impact in Ghana and West Bengal, respectively, increasing agricultural productivity and investment.

This raises a key question: if some arrangements seem so detrimental to economic development, why don't governments implement institutions that foster investment and promote growth? This paper suggests one answer to this question. We analyze a political economy model where the distribution of wealth determines the quality of governance. Regulation introduces the possibility of imperfect competition in the product market, creating rents. Entrepreneurs may thus engage in rent-seeking activity, which in our model takes the form of restrictions

on entry. A coalition of entrepreneurs - the insiders - forms and offers bribes to a bureaucrat in order to limit entry from other entrepreneurs - the outsiders. Hence, insiders enjoy higher market power. The inefficiency of regulation is measured by the extent of underinvestment, and is determined by the distribution of wealth among entrepreneurs. A larger coalition of insiders is subject to more severe free-riding problems, while a smaller coalition lacks resources. When wealth is concentrated in the hands of few people, collusion is easier so that both the free-riding and budget constraints are less stringent; insiders form small coalitions, corruption is prevalent and entry is severely limited. Conversely, more equally distributed wealth inhibits such collusive behavior and thus, regulation is more efficient. In a dynamic framework, initial conditions determine the trajectory the economy follows. On a path towards positive institutional change, the wealth distribution becomes more equal and regulation improves over time. Conversely, institutional sclerosis is characterized by a widening gap between insiders and outsiders, and a society polarized around two classes: a rich and small entrepreneurial elite that dominates the increasingly impoverished masses.

This model offers one specific channel relating inequality and performance, contributing to a large literature on inequality and economic development. While Alesina and Rodrik [1994] and Persson and Tabellini [1994] examine mechanisms where inequality creates larger distortions through increased redistribution, another class of models explores the dynamics of wealth distribution and economic performance when credit markets are imperfect. In the presence of borrowing constraints, inequality maps into the extent of unfulfilled investment opportunities. Such economies exhibit either underinvestment in physical capital (Aghion and Bolton [1997]; Piketty [1997]) or human capital (Loury [1981]; Banerjee and Newman [1993]; Galor and Zeira [1993]). More recently, emphasis is put on the role of institutions and the interplay between inequality and the design of institutions. Engerman and Sokoloff [1997] adopt the view that exogenous factors such as geography determined initial differences in wealth distribution across countries. Unequal societies were then more likely to adopt inefficient institutions, as members of the elite opposed institutional change to protect their rents, leading to persistence. A subsequent literature illustrated by Acemoglu, Aghion and Zilibotti [2002] and Glaeser, Scheinkman and Shleifer [2002] also follows this approach by analyzing how inequality might be driving institutional choices. Within this framework, we present a model where the

interaction between inequality and institutions works through a mechanism of rent dissipation: competition among elites makes them less effective at extracting rents. In that respect, this paper relates to Krueger [1974] and Becker [1983]. While some previous works argue that persistence of institutional inefficiencies stems from the cost of changing institutions [North, 1990], the present analysis explains institutional sclerosis in a political economy model, emphasizing the commitment problem as in Fernandez and Rodrik [1991], or in Acemoglu and Robinson [2001] or more specifically the free-rider problem; it thus relates to Olson [1965].

The paper is organized as follows: the next section presents empirical motivation. Section 3 lays out the model in its simplest static form, without corruption: we refer to this situation as the benchmark case. In section 4 we relax the corruption-free assumption and analyze the economy when coalitions are exogenous. Section 5 characterizes the equilibrium of the endogenous coalition formation game. The dynamic analysis is presented in section 6 while section 7 relates the predictions of the model to empirical findings. Section 8 concludes.

1.2 Empirical Motivation

Large differences in levels of economic and institutional development can be observed throughout the world. Exogenous factors such as geographical conditions or ethnic composition of a population cannot alone explain such differences. Figure 1 − 1 below plots, for a sample of East-Asian countries, the level of economic development against an index of corruption.[1] Note that the same pattern is observed using other indexes of governance as well. This suggests a close relationship between economic development and institutional environments.

Figure 1 − 2 reports the findings of Claessens, Djankov and Lang [1998] for the same set of countries: concentration of family control, as percentage of total market capitalization owned by the top 15 families in a given country, is strongly and negatively correlated with the quality of governance.[2] The authors suggest that the "concentration of corporate control is a major deter-

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[1]Economic development is measured by the level of Gross Domestic Product (GDP) per capita in 1995, while the corruption index is the "assessment of the corruption in government. Lower scores indicate that 'high government officials are likely to demand special payments [and] illegal payments are generally expected throughout lower levels of government [in the form of] bribes connected with import and export licenses'[...]" [La Porta, Lopez-de-Silanes, Shleifer and Vishny, 1998, p. 1124].

[2]The authors find a Pearson correlation coefficient equal to −0.8.

minant in the evolution of the legal system, i.e. relationships exist between ownership structure of the whole corporate sector and the level of institutional development."[3] This statement suggests a theory of regulatory capture (cf. Stigler [1971]) supported by De Soto [1989] and later by Djankov, La Porta, Lopez-de-Silanes and Shleifer [2000]. These studies both claim that regulation benefits politicians, bureaucrats and incumbents more than economic development as a whole. Licensing policy in post-independence India illustrates the point. While licensing was in part aimed at breaking the domination of monopolies, Hazari [1967] noted in his *Final Report* to the Planning Commission: "[There is] the presumption that multiple applications for the same product and for a wide, very wide indeed variety of products are meant to foreclose lincensable (sic) capacity".[4]

History also provides many other examples of barriers to positive change. Parente and Prescott [2000] detail evidence of barriers to efficiency and argue that such barriers are the main determinants of cross-country differences in economic development. Looking at the textile industry across countries and through time, the authors conclude that vested interests played a significant role in cases of failure to adopt new technologies and new forms of organizations, which explains "the differences in the percentage increase in labor productivity in the cotton mills in India and Japan between 1920 and 1938. In this period, Japanese labor productivity increased by more than 120 percent, while Indian productivity increased by only 40 percent."[5] They argue further that barriers to technology adoption are key to understanding why England experienced modern economic growth before continental Europe, as well as why China did not exhibit sustained growth before 1950.

Similarly, Rajan and Zingales [2001] argue that the development of financial markets during the 20th century was partly driven by private interests. Incumbents opposed the development of financial institutions in order to prevent the emergence of competition and influenced the design of policies in the aftermath of the Great Depression. "Thus, Japan, for example, moved from an economy with a flourishing financial market, and a competitive banking system, to an economy with small financial markets and a concentrated banking system."[6]

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[3] [Claessens, Djankov and Lang, 1998, p.24]

[4] [Hazari, 1967, p. 7]

[5] [Parente and Prescott, 2000, p. 93]

[6] [Rajan and Zingales, 2001, p. 32]

The rise and fall of mercantilism in Western Europe provides an interesting illustration of the issue addressed in this paper. Ekelund and Tollison [1981] view "the historical record of the mercantilist era as an expression of individual rent-seeking behavior in a variety of institutional settings".[7] Competition among entrepreneurs to obtain monopoly rights from regulators and competition among political organizations (namely the Crown and the Parliament) for the authority to grant those rights is the main thread of the comparative analysis of mercantilism in England and France. Thus, the rise of the Parliament is associated with the fall of mercantilism in England while the strengthening central power in France in the same period is seen as a source of intensification of mercantilism under Colbert (1661 - 1683).

The evidence presented suggests that regulation is not necessarily driven by public interests but is often captured by a small elite at the expense of society as a whole. The rest of the paper describes a mechanism where the pursuit of monopoly rents governs the relationship between regulation and wealth distribution.

1.3   Static Model: The Benchmark Case

Consider a population of N individuals and one bureaucrat. There are two goods in the economy, a production good and a consumption good. We will call production goods *capital* and consumption goods *wealth*. Individuals are each endowed with an initial amount of wealth and one unit of labor. The time horizon consists of three dates. At time $T = 0$, individuals interact with a bureaucrat who issues licenses. At time $T = 1$, individuals choose their occupation: those receiving a license may undertake a project; the remaining are subsistence workers earning a fixed wage w. Licensed entrepreneurs compete in a Cournot game in which they choose the level of capital they supply. Finally at time $T = 2$, a production industry buys capital to produce wealth. Projects are then liquidated, profits are realized, consumption takes place and agents die. A storage technology is available to all entrepreneurs with no depreciation. The timing of the static economy is summarized in figure 1-3. We start with a crucial assumption to our model:

Assumption (A0)   There is no credit market.

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[7] [Ekelund and Tollison, 1981, p. 17]

1.3.1 Entrepreneurs

The set $\Im$ of entrepreneurs has size N.[8] Entrepreneurs are indexed by $i \in \Im$, and each of them is endowed with one unit of labor and an initial level of wealth a_i. The wealth distribution is characterized by a cumulative distribution function $F(.)$. As most results do not depend on N, we can normalize population size to 1.

Entrepreneurs are risk-neutral and maximize consumption at time $T = 2$.

1.3.2 Licensing, Cournot game and Production

- Licensing

  One bureaucrat issues licenses at time $T = 0$. Licenses are necessary for entrepreneurs who want to undertake a project. Licensing will be discussed in detail below.

- Cournot game

  At time $T = 1$, licensed entrepreneurs have access to a continuous investment technology. Entrepreneurs non-cooperatively choose the level V of capital they wish to supply. V is produced at no cost but is bounded above by some $\bar{V}$.[9] Capital is then sold to the production sector at uniform price r, wealth being the numeraire.

- Production

  Entrepreneurs at time $T = 1$ face a demand for capital from an industry which operates at time $T = 2$. This industry buys the total amount of capital K supplied by entrepreneurs at price r and produces $\pi(K)$ units of wealth. $\pi(.)$ is assumed to have the standard regularity properties.[10]

1.3.3 Equilibrium Outcome

In order to provide a benchmark for the rest of the analysis, we solve for the equilibrium of the economy in this simple framework. A natural equilibrium concept to adopt is Subgame

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[8] The assumption that the set of entrepreneurs is finite is crucial here. A finite population size ensures that the free-rider problem at the Cournot stage is bounded.

[9] The capacity constraint merely simplifies algebra and interpretation. Though relaxing this assumption complicates the interpretation of the results, the same conclusions nevertheless hold.

[10] The regularity properties are formally stated in the Appendix.

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Perfection. We therefore solve the model by backward induction.

Time $T = 2$: Final Production

Facing a rental price r, producers choose a demand level to equalize price and marginal product of capital. This defines the demand function faced by entrepreneurs at the end of Time $T = 1$: $\forall K \geq 0$,

$$r = \pi'(K).$$

Time $T = 1$: Cournot game and supply decision

Entrepreneurs in subgames starting at date $T = 1$ are characterized by whether they were issued a license at the end of time $T = 0$ or not. We will denote $\Gamma \in P(\Im)$, the set of licensees.[11]

In this game, licensed entrepreneurs compete à la Cournot. They non-cooperatively set levels of supply. Non-cooperative behavior is assumed and can be justified by transaction costs or inability to make binding commitments. To simplify notations, let's denote $V_{-i} \equiv \sum_{j \in \Gamma \setminus \{i\}} V_j$. Each insider $i \in \Gamma$ solves the following program:

$$V_i = \arg \max_{v \leq \bar{V}} \pi'(V_{-i} + v) v.$$

Entrepreneurs' supply choices equalize the marginal benefit of an additional unit of capital produced and the marginal cost due to a decrease in price. When project capacities are small, entrepreneurs will be "at the corner" and produce at full capacity.

Lemma 1 *For low capacities $\bar{V}$, all entrepreneurs who undertake a project choose to supply $\bar{V}$ units of capital.*[12]

Henceforth, to simplify notation we will normalize the investment cap to 1.

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[11] $P(\Im)$ is the set of all subsets of $\Im$.

[12] *The result of this lemma is standard and the proof is omitted here. As individual supply is decreasing in the number of suppliers (under some implicitly assumed regularity assumptions about $\pi(.)$), setting $\bar{V}$ below the individual production when all N entrepreneurs enter the market is sufficient to induce capacity constraints to always bind. For more details, see e.g. Tirole [1995]*

Assumption (A1)   Investment cap normalization:

$$\bar{V} \equiv 1.$$

When the subsistence wage level is low, all licensed entrepreneurs prefer to undertake a project rather than work.

Assumption (A2)   Alternative occupation condition:

$$w < \pi'(1).$$

Corollary 2 *Under assumptions (A0) to (A2), all licensed entrepreneurs undertake a project and choose to supply $\bar{V} = 1$ unit of capital.*

Time $T = 0$: Licensing

Under these conditions, a licensed entrepreneur undertakes a project and produces at full capacity. We describe as the benchmark case, an economy in which the bureaucrat issues a license at not cost to anyone who requests one. This implies that every entrepreneur asks for a license and supplies 1 unit of capital.

Lemma 3 *In the benchmark case, and under assumptions (A1) and (A2), every entrepreneur is granted a license and supplies 1 unit of capital, so that the equilibrium price of capital is given by*

$$r = \pi'(1),$$

and aggregate output achieves the highest possible level equal to

$$\pi(1).$$

When transfers between entrepreneurs and the bureaucrat are possible, a coalition of entrepreneurs may form and bribe the bureaucrat to limit the total number of licenses issued. This

results in a higher price of capital for insiders, at the expense of outsiders who are barred from entry. We now turn to an economy where regulatory capture is possible.

1.4 The Bribing Game: A First Example

To focus on the value of license restrictions and the free-rider problem, we begin by assuming that entrepreneurs are *exogenously* divided into two groups: insiders (or incumbents) and outsiders (or entrants). We analyze the behavior of each of the parties vis-à-vis the bureaucrat, when incumbents face threats of entry.

1.4.1 Outline of the game

The bureaucrat may now enter into contracts with entrepreneurs. We assume that the bureaucrat has developed a reputation for honoring agreements made with entrepreneurs. Bribes are paid at the end of time $T = 0$.

Incumbents are members of $\Gamma \in P(\Im)$, while entrants belong to the complementary set, $E \equiv \Im \setminus \Gamma$. Γ is exogenously given.

1. Entrepreneurs offer $(s_i)_{i \in \Im}$ to the bureaucrat: incumbents bid to prevent entry, while entrants bid for entry.

2. The bureaucrat decides whether to grant a license to all or no entrants. Payments are made accordingly.

3. Players move to time $T = 1$ subgame: licensees choose a level of supply, and then move to time $T = 2$ subgames.

Figure 1-4 illustrates the timing of the game.

Strategies

Entrepreneurs' strategies are denoted $(s_i)_{i \in \Im}$. Without credit markets, no coalition of entrepreneurs (either incumbents or entrants) can offer more than its aggregate wealth as a bribe to the bureaucrat. Agents are however allowed to pool resources, so wealth constraints may

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potentially bind at the aggregate rather than individual level. In this specific setting, the game is equivalent to a first-price auction with two bidders: the coalition of incumbents versus the coalition of entrants.

Payoffs

We first introduce a convenient notation.

Notation 4 *For any subset $J \in P(\Im)$,*

$$\eta^J \equiv \sum_{i \in \Im} 1_{i \in J},$$

where 1_X is the indicator function which takes value 1 if X is true and 0 otherwise, so that η^J is the size of coalition J measured by the fraction of the population present in J.

Whereas entrants bid to have access to the productive investment technology, incumbents bid to bar entry and enjoy more market power. Entry depreciates the price of capital by increasing supply. Thus, for any incumbent $i \in \Gamma$ who bids s_i,

$$U_i(s_i) = \begin{cases} \pi'(1) + a_i & \text{if entry occurs} \\ \pi'\left(\eta^\Gamma\right) + a_i - s_i & \text{otherwise} \end{cases}.$$

Conversely, entrants enjoy the benefits of the project if and only if they are granted entry. We thus have for any entrant $i \in E$ who bids s_i,

$$U_i(s_i) = \begin{cases} \pi'(1) + a_i - s_i & \text{if entry occurs} \\ a_i + w & \text{otherwise} \end{cases}.$$

1.4.2 Equilibrium Outcome

Offers and Payments

Players' willingness to pay is the amount that makes them indifferent between the two alternatives: entry or no entry. Thus, incumbent $i's$ willingness to pay is given by

$$v_i = \pi'\left(\eta^\Gamma\right) - \pi'(1), \tag{1.1}$$

while entrant $i's$ willingness to pay is equal to

$$v_i = \pi'(1) - w. \tag{1.2}$$

In this setting, the coalitions of incumbents and entrants behave like two buyers in an auction of licenses. The valuation of a given coalition is the sum of members' valuations while the budget limit is the aggregate wealth of each coalition. Hence entry is precluded if and only if incumbents value eviction more than entrants value entry, provided that wealth constraints do not bind; the result is summarized in inequality (1.3) :

$$\min\left[\eta^\Gamma\left[\pi'\left(\eta^\Gamma\right) - \pi'(1)\right], \sum_{i\in\Gamma} a_i\right] \geq \min\left[\eta^E\left[\pi'(1) - w\right], \sum_{i\in E} a_i\right]. \tag{1.3}$$

Group size and the free-rider problem

Equations (1.1) and (1.3) determine the impact of group size on the outcome of the game. When the size of the group of entrants is small, a Taylor approximation of (1.1) gives: $\forall i \in \Gamma$,

$$v_i \approx -\pi''\left(\eta^\Gamma\right) \times \eta^E. \tag{1.4}$$

Equation (1.4) deserves particular attention as it synthesizes the underlying forces of the model. The first term, $-\pi''\left(\eta^\Gamma\right)$, is the marginal increase in price when aggregate output falls by one unit; the second term of the equality, η^E, is the shortfall in investment following the eviction of all entrants. The product $-\pi''\left(\eta^\Gamma\right) \times \eta^E$ is then the total price increase when entrants are deterred from entry, which is also the marginal benefit for entrant i as she supplies

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1 unit of capital.

Thus the coalition will be willing to bid in order to deter entry if and only if

$$-\pi''\left(\eta^{\Gamma}\right) \times \eta^{E} \geq \frac{1}{\eta^{\Gamma}} \min\left[\sum_{i \in E} a_i, \eta^{E}\left[\pi'(1) - w\right]\right]. \qquad (1.5)$$

Each incumbent trades-off the benefit from entry deterrence, $-\pi''\left(\eta^{\Gamma}\right) \times \eta^{E}$, and the per incumbent cost of eviction, $\frac{1}{\eta^{\Gamma}} \min\left[\eta^{E}\left[\pi'\left(\eta^{\Gamma} + \eta^{E}\right) - w\right], \sum_{i \in E} a_i\right]$.

The outcome of the bribing game is driven by the free-rider problem that characterizes Cournot competition. Free-riding at the Cournot stage, by increasing the ex-post level of capital supply, mechanically decreases incumbents' gains from eviction at the corruption stage. In other words, *ex-post competition undermines ex-ante incentives for entry deterrence.*

While aggregate willingness to bribe decreases with group size, the aggregate budget constraint is loosened as the group becomes larger; incumbents face the well-known group size paradox. Figure $1-6$ illustrates the different outcomes of the game. When entrants' bids are low, entry is deterred (bottom quadrant of figure $1-6$). For higher bids, entry occurs either because a small coalition faces cash constraints (left quadrant) or because a large coalition suffers from free-riding (right quadrant), or both (top quadrant).

1.5   Coalition Formation : The General Case

In the previous example, we studied the impact of group size on incumbents' incentives to deter entry. However, we assumed that incumbents were chosen exogenously. In this section, we relax this assumption and study how, given an initial population of entrepreneurs, a coalition will form in order to preclude its complementary set from entering. We no longer refer to incumbents and entrants, as entrepreneurs are not characterized by any time precedence; we instead refer to insiders and outsiders.

A complete analysis of such coalition formation game is somewhat involved as precise notation is cumbersome. We will therefore, in this section, describe briefly the game and present the major results without proof. A formal analysis is provided in the appendix.

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1.5.1 Outline

Entrepreneurs play a bribing game at time $T = 0$. There is a set $\mathfrak{S}$ of players and one auctioneer, the bureaucrat. Individuals interact in a multi-stage game, with the following timing also depicted in figure 1-5:

- Stage 1: Coalition announcements

  Entrepreneurs sequentially announce a coalition to which they want to belong. The order of announcements is determined randomly. A coalition emerges when all players named in a given coalition agree: this procedure therefore follows a uninamity rule.

- Stage 2: Bureaucrat's choice

  Among all coalitions formed, the bureaucrat chooses one. Members of this coalition are called insiders while outsiders are members of the complementary set.

- Stage 3: Bargaining over contributions and Licensing

  Insiders and outsiders play two distinct multilateral bargaining games where they determine contribution levels. The bargaining game is structured such that all players in a given coalition contribute the same amount. If insiders provide a higher aggregate contribution, then licenses are not given to outsiders. Otherwise outsiders receive licenses. Losers contributions are refunded.

1.5.2 Properties of the equilibrium outcome

We now describe some properties of the equilibrium outcome, again adopting a subgame-perfection solution concept.

Stage 3: Bargaining over Contributions and Licensing

Insiders bid against outsiders. In each coalition, a multilateral bargaining game is played within each coalition. In equilibrium, contributions are efficient (the coalition with highest aggregate willingness/ability to pay wins the auction) and members of each coalition contribute the same amount. We can then state the *feasibility condition*, identical to condition (1.3):

Claim 5 (feasibility) *For any subset $\varphi \in P(\mathfrak{I})$ chosen by the bureaucrat to be the coalition of insiders, eviction takes place if and only if*

$$\min\left[\sum_{i \in \varphi} a_i; \eta^{\varphi}\left[\pi'\left(\eta^{\varphi}\right) - \pi'(1)\right]\right] \geq \min\left[\sum_{i \notin \varphi} a_i; \left(1 - \eta^{\varphi}\right)\left[\pi'(1) - w\right]\right].$$

Stage 2: Bureaucrat's choice

At this stage, the bureaucrat picks the coalition that offers the highest bribe. If insiders outbid outsiders, then outsiders are barred from entry. Otherwise, entry is allowed. Under weak restrictions on feasible coalitions, the winning coalition is uniquely determined by the distribution of wealth and the shape of the profits function. We call this the *uniqueness property*:

Proposition 6 (uniqueness) *Assuming that agents do not announce losing coalitions in Stage 1, any coalition structure that forms in equilibrium contains one and only one winning coalition.*

Stage 1: Coalition formation

When players are restricted to feasible coalition announcements, players face a trade-off: the gain from a high price when the group of outsiders barred from entry is large, but so is the per-capita cost of the bribe as it is bourne by fewer people. Besides any winning coalition will always be made of richest entrepreneurs: a richer insider contributes more, while a richer outsider makes the cost of bribe higher. The game is thus a game in which the richest entrepreneur chooses the members of the winning coalition, trading off ex-post market power gains and ex-ante contribution levels. This leads to the central result of the paper:

Theorem 7 *The equilibrium coalition chosen by the bureaucrat in stage 2 has the form:*

$$\varphi^* = \left\{i \in \mathfrak{I}, a_i \geq a^*\right\},$$

so that the coalition size is

$$\eta^{\varphi^*} = 1 - F\left(a^*\right),$$

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where a^* is the solution to

$$a^* \in \arg\max_{a} \left\{ \pi' \left[1 - F\left(a\right) \right] - \frac{1}{1 - F\left(a\right)} \min \left[\int_0^a \tilde{a} dF\left(\tilde{a}\right), F\left(a\right) \left[\pi'\left(1\right) - w \right] \right] \right\}, \qquad (1.6)$$

subject to the feasibility condition:

$$\min \left[\int_0^a \tilde{a} dF\left(\tilde{a}\right), F\left(a\right) \left[\pi'\left(1\right) - w \right] \right] \leq \min \left[\int_a^{+\infty} \tilde{a} dF\left(\tilde{a}\right), \left[1 - F\left(a\right) \right] \left[\pi'\left[1 - F\left(a\right)\right] - \pi'\left(1\right) \right] \right].^{13}$$

The result is fairly intuitive. The "strongest" coalition maximizes its constituents' payoffs $\pi' \left[1 - F\left(a\right) \right]$, net of corruption costs given by $\min \left[\int_0^a \tilde{a} dF\left(\tilde{a}\right), F\left(a\right) \left[\pi'\left(1\right) - w \right] \right]$, which is equal to the outsiders bid. Such costs are split equally among members of the coalition of size $1 - F\left(a\right)$. Such optimization is subject to the feasibility condition. The winning coalition is "connected" and the economy is partitioned into richer insiders (whose wealth is above a^*) and poorer outsiders (whose wealth is below a^*).

1.5.3 Comparative Statics

To understand the determinants of the equilibrium coalition, it is necessary to look at the first-order condition implied by program (1.6).

Lemma 8 (first-order conditions) *Let $\lambda \geq 0$ be the Lagrange multiplier of the feasibility constraint in program (1.6). When aggregate budget constraints are binding around a^*, a^* satisfies*

$$-\pi'' \left\{ \left[1 - F\left(a^*\right) \right] \right\} = \frac{1}{1 - F\left(a^*\right)} \left[a^* + \frac{1}{1 - F\left(a^*\right)} \int_0^{a^*} a dF\left(a\right) + 2\lambda a^* \right]. \qquad (1.7)$$

Equation (1.7) summarizes the trade-off faced by insiders. As in the exogenous coalition case, the left-hand side of the equality is a single insider's marginal benefit when one additional entrepreneur is evicted, which consists of the marginal price increase. The right-hand side

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[13] *To account for the discreteness of the population while maintaining consistent notations, let the integral $\int_0^a dF\left(a'\right)$ be a sum in which the upper bound a is not included, while $\int_a^{+\infty} dF\left(a'\right)$ does include a.*

of (1.7) is the per insider marginal cost of evicting an additional entrepreneur. The term $\frac{1}{1-F(a^*)}$ divides total cost between all members of the coalition. This total cost is the sum of three elements. The first term is the additional amount to pay to exclude the marginal entrepreneur. Since the budget constraint is assumed to be binding, the cost is the marginal outsider's wealth. Up to this point, the analysis is identical to the case in which the coalition was exogenously determined.[14] When coalitions are formed endogenously, an additional factor comes into play: the opportunity cost of evicting an additional insider. Such cost is twofold: first, insiders lose $\frac{1}{1-F(a^*)} \int_0^{a^*} a \, dF(a)$, which is the contribution of the marginal outsider, were she to be admitted into the coalition; second, when the aggregate budget constraint is binding, the Lagrange multiplier λ is positive and therefore evicting an additional entrepreneur has a double effect as it decreases the ability to pay and increases the cost of eviction by the same amount. This last statement explains why equilibrium coalitions are connected with respect to wealth; richer entrepreneurs have higher shadow values so that coalitions made of richest entrepreneurs prevail.

We now investigate the importance of these effects. Looking at the components of equation (1.7), one sees that the equilibrium outcome is essentially determined by the characteristics of the distribution function $F(.)$.

Wealth concentration: The central prediction of our model relates to the comparative statics arising from changes in the distribution of wealth. When wealth is concentrated in the hands of a small elite, both budget and free-riding constraints are looser. This allows small coalitions to capture regulation and deter entry. When wealth is more evenly distributed, large coalitions are necessary to satisfy the feasibility condition. But the free-rider problem will make such coalitions unstable or ineffective. One straightforward corollary of the previous statement is the impact of a redistribution of wealth on the extent of regulatory capture.

Any exogenous shock that changes the distribution of wealth is likely to have an impact on the subsequent regulatory environment. Consider redistributions that are a progressive transfer from wealthy to poor individuals, which preserves the mean wealth of the economy as well

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[14]See equation (1.5).

as the ranking of individuals.[15] As insiders happen to be the wealthiest class in the economy, redistribution weakens insiders while it strengthens outsiders. This implies that the equilibrium coalition needs to be larger after redistribution.

Openess to Trade: Although the model describes a closed economy, we can tackle the issue of trade along two different angles. Considering openess to trade to be *exogenously* given, trade creates an increased competition for each entrepreneur in the domestic market. Each foreign competitor is a distinct player who bids for entry. This is then equivalent to bringing additional entrepreneurs (foreign entrepreneurs) to the game. Then, by increasing ex-post competition, trade openness decreases the ex-ante incentives to create barriers to entry. Our model therefore predicts that the functioning of national institutions is therefore improved when the country is widely open to trade.

However, as analyzed theoretically by Grossman and Helpman [1994] and tested by Goldberg and Maggi [1999], the decision to open to trade is likely to be itself *endogenous* as policy makers are subject to capture as well. By considering foreign entrepreneurs as potential entrants, the model presented so far accomodates a theory of trade policy capture. While Grossman and Helpman [1994] take the coalition structure as given, they predict that the better-organized coalition will capture regulation, our model makes endogenous the composition of each coalition, relying on the assumption that credit markets are imperfect.

1.6 Dynamics

The previous sections were devoted to understanding one channel through which the distribution of wealth affects the efficiency of regulation. However, institutions also have a direct impact on investment and wealth as they are aimed at raising investment capacities. Hence, differential

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[15]Formally, we define a redistribution as follows: $\rho(.)$ is a redistribution function of the economy, if $\rho(.)$ is a decreasing function such that

$$\sum_{i \in \Im} \rho(a_i) = 0$$

and $\forall i, j \in \Im$,

$$a_i \leq a_j \quad \Rightarrow \quad a_i + \rho(a_i) \leq a_j + \rho(a_j)$$

access to government services has direct consequences on inequality of wealth throughout the economy in the subsequent period.

1.6.1 Dynamic Setting

We now extend the model to analyze the behavior of the economy in a dynamic framework. Each generation $t = 1, \ldots$ plays the static game studied in the previous sections. Each memer of generation t has one offspring to whom she leaves a bequest. The distribution of wealth at $t = 1$ is given exogenously.

For simplicity, assume each entrepreneur has a Cobb-Douglass utility function: $\forall i \in \Im$,

$$U_i\left(c_i, b_i\right) = c_i^{1-\beta} b_i^{\beta},$$

where c_i is individual $i's$ consumption at period $T = 2$, and b_i is the bequest individual i leaves her offspring at the end of period $T = 2$, before she retires and dies. A straightforward implication of this specification is that each individual will, within each generation, maximize period $T = 2$ wealth and then consume exactly a fraction $(1 - \beta)$ of that final wealth, passing on the remainder. Thus, the static results derived in the previous sections remain unchanged. Under this specification, the wealth distribution follows a Markov process.

For any lineage $i \in \Im$, indexing by t variables on the equilibrium path for generation t, the transition is given by :

$$a_i^{t+1} = \begin{cases} \beta\left[\pi'\left(\eta^{\Gamma^t}\right) + a_i^t - s_i^t\right] & if\ i \in \Gamma^t \\ \beta\left[a_i^t + w\right] & otherwise \end{cases},$$

where Γ^t is the (unique) equilibrium winning coalition formed at date t, and s_i^t the corresponding bribe level.

Generically, the process is not stationary as the transition is itself endogenous, since it is determined by the entire distribution of wealth through Γ^t.

1.6.2 Convergence

Convergence without corruption

When no transfers are allowed, every entrepreneur receives a license at no cost. All entrepreneurs invest and for any $t \geq 1$:

$$\Gamma^t = \Im \; and \; r^t = \pi' \left(1 \right).$$

And wealth follows a Markov process with stationary transitions: $\forall t \geq 1$,

$$a_i^{t+1} = \beta \left[\pi' \left(1 \right) + a_i^t \right].$$

In the limit, all entrepreneurs end up with the same level of wealth equal to

$$a^\infty \left(1 \right) = \frac{\beta}{1 - \beta} \pi' \left(1 \right),$$

where we define

$$a^\infty \left(\eta \right) \equiv \frac{\beta}{1 - \beta} \left[\pi' \left(\eta \right) - \frac{1 - \eta}{\eta} \frac{\beta}{1 - \beta} w \right].$$

The dynamics of the wealth distribution is described in figure $1 - 7$.

Steady state: general case

In the general case, there exist steady states where licenses become hereditary. A dynasty which starts as an outsider remains so in all subsequent periods, for a small enough β (proofs are provided in appendix).

(A4)   We suppose that the saving rate β is such that:

$$\beta \leq \frac{1}{2}.$$

Proposition 9 (steady states) *When the outside opportunity pays a low wage w, there exists two threshold values η^* and η^{**} such that*

$$0 \leq \eta^* < \eta^{**} \leq 1$$

and any feasible value

$$\eta \in [0, \eta^*] \cup [\eta^{**}, 1],$$

defines a steady state with a population divided into two classes.[16]

1. An elite of size η with wealth

$$a^\infty(\eta) = \frac{\beta}{1-\beta} \left[\pi'(\eta) - \frac{1-\eta}{\eta} \frac{\beta}{1-\beta} w \right].$$

2. A wage labor class of size $(1 - \eta)$ with wealth

$$a^\infty = \frac{\beta}{1-\beta} w.$$

For low values of η, $\eta \leq \eta^*$, the economy is said to be in an oligopolistic steady state. We will refer to cases of higher values of η, $\eta \geq \eta^{**}$, as competitive steady states.

Each steady state is determined by two forces: free-riding and eviction costs. In the oligopolistic steady state, insiders' wealth is high, thus further evictions are too costly to undertake and the economy is stable. In competitive steady states, the number of wealthy individuals is large, so that small coalitions cannot form and the free-rider problem is exacerbated; this ensures stability. Similarly, when the outside opportunity pays high wages, only large coalitions can potentially win. However, this induces the free-rider problem to undermine the incentives to bribe, making oligopolistic distributions unstable.

Corollary 10 *For large values of w, the only steady states are competitive.*

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[16]η *is said to be feasible if and only if ηN is an integer smaller than N.*

Local Convergence and Stability

Though we can characterize the set of steady states, little can be said about convergence. We can nevertheless provide two properties of convergence and local stability.

Proposition 11 (basin of attraction) *Consider the threshold $\hat{\eta}$ defined by*

$$\pi'(\hat{\eta}) = \frac{1}{1-\beta}\pi'(1).$$

For low values of w, any equilibrium coalition with a size smaller or equal to $\hat{\eta}$ shrinks over time and the economy converges to an oligopolistic steady state.

Symmetrically, when the economy is in the domain of competitive outcomes, we can derive some stability properties. The grand coalition, i.e. the coalition including all entrepreneurs, is dynamically stable. Once the economy has reached the efficient outcome in some generation $t \geq 1$, it will converge to the efficient limiting distribution of wealth described by $(1-7)$.

Proposition 12 (dynamic stability) *The grand coalition $\mathfrak{S}$ is dynamically stable.*

Convergence results cannot be derived explicitly as we are dealing with non-linear Markov processes.[17] We thus rely on a numerical analysis to have a sense of the dynamic behavior of the economy.

Convergence: Simulation

We consider four cases with identical parameter values but varying levels of initial inequality. The distribution of wealth is generated as follows. Each individual in the population can initially be either poor or rich. A poor individual starts with wealth a^L while a rich individual starts with wealth a^H, with $a^H > a^L$. The four economies we consider differ by the proportion of poor people in the population: the two extreme cases exhibit either very high or very low levels of inequality, while the two other cases are intermediate. The results of the simulation

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[17]For examples of non-linear Markov processes in similar situations, see Banerjee and Newman [1991], Aghion and Bolton [1997] or Piketty [1997].

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are shown in figure $1 - 8$:[18] while the horizontal axis measures generations, the vertical axis measures the size of the winning coalition, denoted earlier Γ^t. Thus, 100 percent entry means that the grand coalition is the unique equilibrium coalition, while 1 percent is the case in which one lone monopolist blocks all other entry. We next comment on the dynamics of the wealth distribution.

The dynamics of the wealth distribution: a theory of class formation

In a given generation, we define the middle-class as the group of entrepreneurs who are either richest among outsiders or poorest among insiders. The middle-class is pivotal to the trajectory followed by the economy: when a small and relatively poor middle-class is evicted, the economy converges to an oligopolistic steady state. On the contrary, a large and relatively wealthy middle-class can resist eviction from the upper-class while undermining incentives for corruption by increasing the free-rider problem. The economy is then potentially able to converge to a competitive steady state, in which the poorest individuals have access to profitable opportunities. Wealth differences eventually vanish.

On the path towards institutional sclerosis, the gap between insiders and outsiders widens. As the lower-class (poorest entrepreneurs) grows poorer, the cost of eviction becomes smaller. Thus, it decreases the strength of the middle-class: members of the middle-class are now threatened with eviction (medium-low and medium-high-initial-inequality curve in figure $1 - 8$). The phenomenon accelerates as both cash constraints and free-riding are less and less severe for an upper-class that ends up dominating the economy in an oligopolistic steady state: access to profitable opportunities is restricted to a minority (high-initial-inequality curve in figure $1 - 8$).

In the opposite case, an economy characterized by positive institutional change, the size

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[18] We use a sample of 100 individuals divided into two groups: poor individuals have wealth a_L, while rich individuals have wealth a_H. The "low initial inequality" curve is generated from an economy in which 5 percent of the population are initially poor, while the three other curves have respectively 10, 15 and 40 percent poor entrepreneurs.

The demand function is specified according to:

$$\pi\left(K\right) = A\left(1 - \frac{1}{K^{\alpha}}\right)$$

and parameter values are $a_L = .5$, $a_H = 10$, $\bar{V} = .5$, $A = 1000$, $\alpha = .3$, $\beta = .4$, $w = .2$.

The scale (above 10 percent) has been modified to emphasize the behavior of the economy around the threshold 10 percent.

and wealth of the middle-class increases continuously. The bargaining power of the upper-class diminishes as wealth levels equalize. The equilibrium coalition must therefore be larger and the free-riding problem is exacerbated. Eventually, the equilibrium coalition is the grand coalition. The economy converges towards a competitive steady state: all individuals can access the profitable investment opportunity and inequality vanishes (low-initial-inequality curve in figure $1 - 8$).

Figure $1 - 9$ summarizes the dynamics of the wealth distribution: on a path toward institutional change (left arrow), barriers to entry fall so more entrepreneurs may access productive occupations. Aggregate output mechanically increases and the wealth distribution converges to the degenerate case of strict equality. On the other hand, on a path toward institutional sclerosis (right arrow), barriers to entry increase so that the circle of privileged entrepreneurs shrinks. Inequality becomes more severe and output drops. In the limit, a small elite owns the means of production while a large mass works in the subsistence sector.

1.7 More Empirical Evidence

1.7.1 From Political Institutions to Licenses

The model we have presented and analyzed encompasses a large number of institutional environments. Licensing is a convenient formalization, but the model provides insights into the mechanics of other phenomena. Just as entrepreneurs compete for licenses, so may bureaucrats compete for the right to issue licenses. We have until now taken the bureaucratic structure as given. However, political struggles were major determinants of the institutional environments in many countries. The next example illustrates this point.

The comparative development of Mexico versus Brazil, and Japan versus China.

The comparative development of the financial sectors of Mexico and Brazil provide an interesting illustration of the mechanism we describe. The overthrow of the Brazilian monarchy in 1889 provides an example of an exogenous redistribution of political power, while the persistence of the *Díaz* dictatorship (1877-1911) in Mexico constitutes a convenient control to assess the impact of redistribution on subsequent economic outcomes. Haber [1991] argues that Mexico

and Brazil were characterized by the same level of financial underdevelopment at the end of the 19th century. Important among the causes of such backwardness, was the perverse regulatory environment preventing the development of banks: the Mexican government privileged the nation's largest bank by granting the institution special rights and simultaneously creating barriers to entry for competitors. While the author acknowledges this protection provided a needed stable source of financing, there is no denying that executives of the Banco Naciónal de México were close to the Díaz regime and used their political advantage to restrict market entry. While a similar situation prevailed in Brazil, the First Republic proclaimed in 1889 resulted in a deregulation of the financial sector. With access to a competitive credit market, Brazilian entrepreneurs were able to enter into a thriving textile industry. In Mexico on the other hand, the textile industry languished.

A similar story accounts for the comparative development of China and Japan at the end of the 19th century. As Olson [1982] suggested, when Japan underwent the Meiji restoration (1867), guilds lost their influence, while their counterparts in China maintained strict control of the economy. One cause of this decline, although not the only one, may have been the forced openness to trade of the Japanese economy under Western pressure. Olson also argues that the persistence of guilds and their preserved influence on the regulatory environment constituted a major obstacle to Chinese industrialization at the end of the 19th century.

Those two stories illustrate the impact of a redistribution of political power. In a world where wealth is power, the histories of Brazil and Japan are consistent with the prediction of our model when wealth redistribution or opening to trade are undertaken.

The deregulation of the banking industry in the United States in the 1970s

Krozner and Strahan [1999] look at the elimination of restrictions on bank branching since the 1970s in the United States. Their main finding supports a theory of interest-group regulation as developed in this paper. Observing that deregulation of restrictions on geographical expansions in the banking industry did not take effect the same year across states, Krozner and Strahan look for determinants of such difference. Looking at the strength of small banks, they find that "[a] one-standard-deviation increase in the small bank share results in a 30 percent increase

in the time until deregulation, or about 4.7 years".[19] Taking the channel described in the present paper seriously, small banks and larger banks can be seen as respectively, insiders and outsiders. When insiders are strong enough to preclude entry, deregulation occurs later, while with weaker small banks, coalitions are unstable, leading to earlier deregulation. The mechanics of deregulation are thus well described by figure $1 - 6$. Indeed, as the value of local banking declined over time, entry of larger banks could not be prevented, given the increasing demand for finance. Consistent also with the theory developed so far, there is support for the view that the timing of deregulation, which started in the early 1970s, corresponds to shocks to the balance of power between insiders and outsiders. "[T]echnological, economic, and legal shocks generated conditions that changed the long-standing balance favoring the antibranching forces. The marginal value of lobbying to repeal branching restrictions increased just as the relative value to the small banks of maintaining branching restrictions was declining".[20] This story is consistent with the dynamics of our model.

1.7.2 Initial Conditions and Persistence

The dynamic analysis provides an explanation for the persistence of intense regulatory capture. Countries may fall into an institutional trap, in which the elite does not face any opposition from the rest of the population, and can maintain a regime, which protects its members' personal interests. Initial conditions or historical shocks matter in determining the subsequent growth paths countries follow.

"How Latin America fell behind?"

Engerman and Sokoloff [1997] argue that geographical conditions largely determined initial levels of inequality and the corresponding institutional environment in the early history of colonization. The countries of Latin America "possessed climates and soils that were well-suited for the production of sugar and other highly valued crops characterized by extensive scale economies associated with the use of slaves", whereas North American colonies "were not endowed with substantial populations of natives able to provide labor, nor with climates and soils that gave

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[19][Krozner and Strahan, 1999, p. 1453]
[20][Ibid, p. 1462]

them comparative advantage in the production of crops characterized by major economies in using slave labor."[21]

The extent of initial inequality then determined the level of investment in schooling and the pattern of diffusion of universal male suffrage across New World countries. In unequal societies, elites seek to restrict access to political rights and schooling to protect their privileges, hence impeding long-term growth. Such a conjecture is consistent with the predictions delivered by our model.

On legal origins

To conclude this section, we compare our analysis to Glaeser and Shleifer [2001, 2002] and argue that the two descriptions of institutional environment are complementary. Glaeser and Shleifer explain how the choice of the legal structure (civil versus common law) or the regulatory environment (regulation versus litigation) was governed by the trade-off between distortion and subversion. Just as a common law system is considered to be more efficient than a civil law system, litigation is less distortionary than regulation. However, when bureaucratic capture is a potential threat to the well-functioning of institutions, Glaeser and Shleifer argue that civil law was adopted in France because it was less subject to capture. Whereas in England juries could be protected against bribery and violence by a strong central power, the French king found it preferable to hire and protect judges. Similarly, under the influence of the Progressive movement at the beginning of the 20th century, regulation was preferred to litigation because it was less prone to subversion. Their analysis relies on the claim that "Courts are more vulnerable to subversion than regulators, especially in an environment of significant inequality of wealth and political power."[22]. Evidence supporting this theory is provided by Djankov, La Porta, Lopez-de-Silanes, and Shleifer [2002]. In recent work, Glaeser, Scheinkman and Shleifer [2002] go one step further and relate the choice of institutions to an exogenous distribution of political power. The model presented in this paper provides a rationale for a difference of vulnerability to subversion across societies and time, and points out to a mechanism that relates economic and political power.

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[21] Engerman, Haber and Sokoloff (2000), p.117-8
[22] [Glaeser and Shleifer, 2001]

1.8 Conclusion

This paper has described and analyzed a model of institutional choice and dynamics in which the distribution of wealth is the key variable. The contribution of this paper is twofold: (1) it provides a theoretical framework to evaluate the impact of inequality on the design of institutions, and on the persistence of inefficiencies in the long-run; (2) it highlights a mechanism which helps understand why countries experience such different growth paths.

We emphasized that free-riding and credit constraints are the main forces underlying our results. When coalitions form to extract rents, inequality determines the optimal coalition size; the more unequal a society, the smaller the equilibrium coalition, and the more regulation is captured. Inefficient institutions create a feedback effect whereby unequal access to investment opportunities exacerbates inequality.

The model provides a view on political transitions complementary to Acemoglu and Robinson [2000]. While Acemoglu and Robinson build their theory on the threat of revolution coming from the masses, emphasis is put on the balance of power between the classes and especially the pivotal role of the middle-class. The paper thus parallels the view of Engels and Marx [1848] in which class relationships were the key determinant of the shape of societies in the modern world.

While we present historical evidence that is consistent with our analysis, a rigorous empirical test of the model is warranted.

1.9 Appendix 1

1.9.1 Proof or Proposition 9 (steady states)

To prove the proposition, we specify regularity assumptions so far implicitly assumed.

(AA1) $\pi\left(.\right)$ is increasing concave and $\pi'\left(K\right) = O\left(K\right)$.

(AA2) $\varepsilon\left(K\right) = -K\frac{\pi''(K)}{\pi'(K)}$ is decreasing for all $K \geq 0$.

For a given value of η, insiders pay a price of zero for corruption. Their wealth thus remains equal to $a^{\infty}\left(\eta\right)$. However, the stability of the coalition requires that no sub-coalition has an incentive to evict any member. The feasibility condition for the whole coalition is always

satisfied as outsiders have little wealth (w is small). The optimization program then yields the following solution:

$$1 = \arg \max_{\lambda} V(\lambda) \equiv \pi'(\lambda\eta) - \frac{1}{\lambda\eta} \left\{ (1-\lambda)\eta \min\left[a^{\infty}(\eta), \pi'(1) - w\right] + (1-\eta)\frac{\beta}{1-\beta}w \right\}, \quad (1.8)$$

subject to the feasibility condition:

$$(1-\lambda)\eta \min\left[a^{\infty}(\eta), \pi'(1) - w\right] + (1-\eta)\frac{\beta}{1-\beta}w \leq \lambda\eta \min\left[a^{\infty}(\eta), \pi'(\lambda\eta) - \pi'(1)\right].$$

For large values of λ, the feasibility condition always holds and the unconstrained first-order derivative is:

$$V'(\lambda) = \eta\pi''(\lambda\eta) + \frac{1}{\lambda^2}\left\{\min\left[a^{\infty}(\eta), \pi'(1) - w\right] + \frac{1-\eta}{\eta}\frac{\beta}{1-\beta}w\right\}.$$

Under assumptions (AA1) and (AA2), for $\lambda = 1$ to be the solution to program (1.8), a necessary and sufficient condition is

$$V'(1) \geq 0,$$

which translates into:

$$-\eta\pi''(\eta) - \frac{1-\eta}{\eta}\frac{\beta}{1-\beta}w \leq \min\left[a^{\infty}(\eta), \pi'(1) - w\right]. \qquad (1.9)$$

We can first assume that the constraint is not binding ($\pi'(1)$ is high enough) so that the condition becomes

$$-\frac{1-\beta}{\beta}\eta\pi''(\eta) - \frac{1-\eta}{\eta}\frac{1-2\beta}{1-\beta}w \leq \pi'(\eta). \qquad (1.10)$$

Let's denote $R(\eta)$ and $L(\eta)$ the right-hand side and left-hand side of (1.10) respectively. While $R(\eta)$ is always decreasing, $L(\eta)$ is increasing for low values of η and decreasing for large values of η. As β may be thought of as a scaling factor, the graphs drawn in figure 1-10 illustrate possible values of $R(\eta)$ and $L(\eta)$.

Relaxing the assumption that $\pi'(1)$ is large does not qualitatively change the results. We

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now define

$$\Theta \equiv \left\{ \eta \in [0,1] \ / \ -\eta\pi''(\eta) - \frac{1-\eta}{\eta}\frac{\beta}{1-\beta}w \leq \min\left[a^{\infty}(\eta), \pi'(1) - w\right] \right\}.$$

For low values of β, every coalition size can be sustained in a steady state (provided that the feasibility constraint holds); for high values of β, only small coalitions will be observed in the long run, and for intermediate values of β, the set of steady states has the form:

$$\Theta = [0, \eta^*] \cup [\eta^{**}, 1].$$

Q.E.D.

1.9.2 Proof of Proposition 11 (basin of attraction)

In period t, the equilibrium coalition Γ^t is a solution to program (1.6) under the feasibility constraint. Suppose that $\eta^{\Gamma^t} \leq \hat{\eta}$ and consider the transition function:

$$a_i^{t+1} = \begin{cases} \beta\left[\pi'\left(\eta^{\Gamma^t}\right) + a_i^t - s_i^t\right] & \text{if } i \in \Gamma^t \\ \beta\left[a_i^t + w\right] & \text{otherwise} \end{cases}.$$

This implies the following dynamics, for low enough values of w :

$$\begin{aligned}
\min\left[\sum_{i \notin \Gamma^t} a_i^{t+1}, \sum_{i \notin \Gamma^t} \pi'(1) - w\right] &\leq \min\left[\sum_{i \notin \Gamma^t} a_i^t, \sum_{i \notin \Gamma^t} \pi'(1) - w\right], \\
\min\left[\sum_{i \in \Gamma^t} a_i^{t+1}, \sum_{i \in \Gamma^t} \pi'\left(\eta^{\Gamma^t}\right) - \pi'(1)\right] &\geq \min\left[\sum_{i \in \Gamma^t} a_i^t, \sum_{i \in \Gamma^t} \pi'\left(\eta^{\Gamma^t}\right) - \pi'(1)\right].
\end{aligned}$$

Hence, in period $t+1$, the feasibility constraint is looser and the cost of eviction is lower and thus

$$\eta^{\Gamma^t} \geq \eta^{\Gamma^{t+1}}.$$

The sequence $\left(\eta^{\Gamma^t}\right)_{t \geq 1}$ is non-increasing and bounded below: it thus converges to a parameter η^{∞}. Stability then implies that $\eta^{\infty} \leq \eta^*$

Q.E.D.

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1.9.3 Proof of Proposition 12 (dynamic stability)

Suppose that for some time $T \geq 0$, the grand coalition is the equilibrium outcome of the static game. For values of $\pi'(1)$ large enough, such that an entrepreneur who undertakes a project bequeaths to her offspring more than what she started with, the transition function implies that if

$$\Im = \arg\max_{\gamma} \pi'(\eta^{\gamma}) - \min\left[\sum_{i \notin \gamma} a_i^t, \sum_{i \notin \gamma} \pi'(1) - w\right],$$

subject to the feasibility condition, then in the following period, the feasibility condition is stricter and the cost function is uniformly steeper. For any $\gamma \in P(\Im)$

$$\pi'(\eta^{\gamma}) - \min\left[\sum_{i \notin \gamma} a_i^t, \sum_{i \notin \gamma} \pi'(1) - w\right] \leq \pi'(\eta^{\gamma}) - \min\left[\sum_{i \notin \gamma} a_i^{t+1}, \sum_{i \notin \gamma} \pi'(1) - w\right],$$

with strict inequality if $\gamma \neq \emptyset$. The same property holds for the feasibility constraint:

$$\min\left[\sum_{i \in \gamma} a_i^{t+1}, \sum_{i \in \gamma} \pi'(\eta^{\gamma}) - \pi'(1)\right] - \min\left[\sum_{i \notin \gamma} a_i^{t+1}, \sum_{i \notin \gamma} \pi'(1) - w\right],$$

$$\leq \min\left[\sum_{i \in \gamma} a_i^t, \sum_{i \in \gamma} \pi'(\eta^{\gamma}) - \pi'(1)\right] \min\left[\sum_{i \notin \gamma} a_i^t, \sum_{i \notin \gamma} \pi'(1) - w\right].$$

The set of feasible coalitions shrinks so that the optimal solution at date $t + 1$ is still the grand coalition:

$$\Im = \arg\max_{\gamma} \pi'(\eta^{\gamma}) - \min\left[\sum_{i \notin \gamma} a_i^{t+1}, \sum_{i \notin \gamma} \pi'(1) - w\right],$$

subject to

$$\min\left[\sum_{i \in \gamma} a_i^{t+1}, \sum_{i \in \gamma} \pi'(\eta^{\gamma}) - \pi'(1)\right] \geq \min\left[\sum_{i \notin \gamma} a_i^{t+1}, \sum_{i \notin \gamma} \pi'(1) - w\right].$$

Q.E.D.

1.10 Appendix 2: Coalition Formation Game

In this section, we formally describe and solve the game described in the paper. In order to make this section self-contained, some notation be redundant. The set of players consists of the population $\Im$ of entrepreneurs of size N and the bureaucrat. Entrepreneurs have an initial endowment of wealth $(a_i)_{i \in \Im}$

We first introduce (or recall) the following notations:

- Complementary set: $\forall \varphi \in P(\Im)$,

$$\bar{\varphi} \equiv \Im \setminus \varphi,$$

  so that we may equivalently write $i \in \bar{\varphi}$ or $i \notin \varphi$

- Cardinality of a set: $\forall \varphi \in P(\Im)$,

$$\eta^{\varphi} \equiv \sum_{i \in \Im} 1_{i \in \varphi}.$$

Entrepreneurs and the bureaucrat interact in a multi-stage game with observed actions. The game consists of three stages:

- **Stage 1: Coalition announcements**

  Entrepreneurs sequentially announce a coalition to which they want to belong. The order of announcements is determined randomly. A coalition structure emerges.

- **Stage 2: Bureaucrat's choice**

  Among all the coalitions that were formed, the bureaucrat chooses one. Members become insiders while outsiders are members of the complementary set.

- **Stage 3: Bargaining over contributions and Licensing**

  Insiders and outsiders play two distinct multilateral bargaining games where contributions are determined. If insiders provide a higher aggregate contribution, then licenses are not given to outsiders and insiders pay their contribution to the bureaucrat. Otherwise, outsiders receive licenses and pay their contribution to the bureaucrat.

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1.10.1 Timing, action spaces and payoffs

Stage 1: Coalition announcements

Nature moves and picks p among all permutations of the set $\mathfrak{S}$. Each entrepreneur $i \in \mathfrak{S}$ receives an order number $p(i)$. The set of all permutations of $\mathfrak{S}$ is denoted $p(\mathfrak{S})$.

For $k = 1$ to $k = N$, individual i such that $p(i) = k$, observes previous moves and makes an announcement γ_i which consists of a list of entrepreneurs in $\mathfrak{S}$.

Definition 13 *An **announcement** for individual i is a subset $\gamma_i \in P(\mathfrak{S})$ such that $i \in \gamma_i$*

The outcome of the announcement game is a coalition structure; entrepreneurs are divided into coalitions according to the *unanimity rule*:

Definition 14 *A coalition $\varphi \in P(\mathfrak{S})$ **forms subsequently to the announcement profile** $(\gamma_i)_{i \in \mathfrak{S}}$, if $\forall i \in \varphi$,*

$$\varphi = \{i\}$$

or

$$\gamma_i = \varphi.$$

In other words, subsequent to announcements made during stage 1, entrepreneurs are divided into coalitions. An entrepreneur is either alone (the coalition is a singleton) or is in a coalition with other entrepreneurs. In order for a coalition to form, all members must agree to be in that same coalition, which implies that they must have made the same announcement in stage 1. For example, if entrepreneur i announces γ_i and one individual in γ_i does not announce that same coalition, then i ends up being alone in $\{i\}$. Note that at the end of stage 1, the announcement profile $(\gamma_i)_{i \in \mathfrak{S}}$ defines a partition of $\mathfrak{S}$.

Stage 2: Bureaucrat's choice

The bureaucrat's action consists of the choice of a coalition to be considered the coalition of insiders, the complementary set being the set of outsiders.

Definition 15 *The bureaucrat's **decision** is a subset of $\varphi \in P(\mathfrak{S})$.*

Stage 3: Bargaining over contributions

At this stage, and for a given decision $\varphi \in P(\mathfrak{I})$ made by the bureaucrat in stage 2, entrepreneurs submit bids to the bureaucrat. Insiders are individuals listed in φ while outsiders are in $\bar{\varphi}$. Insiders bid for eviction of outsiders, while outsiders bid for entry.

Each group of entrepreneurs plays a two-stage bargaining game. Denote Φ the set that can either be φ or $\bar{\varphi}$.

Stage 3.1: First offer

Nature determines randomly a permutation $p_1 \in p(\Phi)$. Player i such that $p_1(i) = 1$ makes an offer. An offer consists of a contribution profile $\sigma_i^1 = (s_j)_{j \in \Phi}$. Following the order defined by p_1, other members of Φ either accept (A) or reject (R) the offer made by i. The game ends if and only if no member plays R and the aggregate contribution is then given by $\sum_{j \in \Phi} s_j$. Otherwise the game moves to Stage 3.2

Stage 3.2: Final offer

Nature determines randomly a permutation $p_2 \in p(\Phi)$. Player i such that $p_2(i) = 1$ makes an offer. An offer consists of a contribution profile $\sigma_i^2 = (s_j)_{j \in \Phi}$. Following the order defined by p_2, other members of Φ either accept (A) or reject (R) the offer made by i. If no member plays R then the aggregate contribution is given by $\sum_{j \in \Phi} s_j$. Otherwise the aggregate contribution is given by 0.

In case of delay (games where nodes corresponding to Stage 3.2 are reached), all members of Φ incur a cost of delay in the form of a discount $\delta < 1$ on their final wealth level.

Actions relevant to stage 3 consist of moves of nature, p_1 and p_2 in $p(\Phi)$ and offers and responses made by players:

$$\sigma_i^k \in \begin{cases} R^\Phi & if \ p_k(i) = 1 \\ \{A, R\} & otherwise \end{cases} \quad for \ k = 1, 2.$$

Payoffs

In the game we began describing above, the set of players is a set

$$\Omega = \Im \cup \{bureaucrat\} \cup \{Nature\}.$$

The description of the timing and the action spaces determines a set H of sequences (of histories) and a mapping h that assigns to each non-terminal history a player in Ω. For simplicity, we will omit explicitly definition of the set H and the function h.

We now define the finite extensive form game that we are analyzing by:

$$G = \left\{ \Omega, H, h, U_b, (U_i)_{i \in \Im} \right\},$$

where U_b and $(U_i)_{i \in \Im}$ are payoffs of players at the end of the game and are defined below.

To determine terminal histories, let us denote by $\gamma^* = (\gamma_i^*)_{i \in \Im}$ announcements made in stage 1 by entrepreneurs, by φ^*, the bureaucrat's decision made in stage 2, and $s^* = (s_i^*)_{i \in \Im}$ the contribution profile obtained at the end of stage 3. Finally, for the bargaining game played between players in φ^* (respectively $\bar{\varphi}^*$), we will write $t^* = 1$ (respectively $\bar{t}^* = 1$) when the node corresponding to Step 3.2 of the negotiation is reached and $t^* = 0$ (respectively $\bar{t}^* = 0$) otherwise . In the latter case, we will say that agreement has been reached with no delay.

Bureaucrat'a payoff:

The bureaucrat chooses a coalition φ^* to be insiders, and his payoffs are given by:

$$U_b\left(\varphi^*, \gamma^*, s^*, t^*, \bar{t}^*\right) = \begin{cases} \max\left\{\sum_{i \in \varphi} s_i^*, \sum_{i \in \bar{\varphi}} s_i^*\right\} & \text{if } \varphi^* \text{ formed subsequently to } \gamma^* \\ 0 & \text{otherwise} \end{cases}.$$

The bureaucrat derives utility from bribes only if he picks a subset in the coalition structure which emerged from the announcements made in stage 1.

Entrepreneurs' payoffs

Entrepreneurs have access to supply of capital when they are granted a license. Using standard

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notation, we can write their payoffs as:

If φ^* is realized subsequently to γ^*, then|

$\forall i \in \varphi^*$,

$$U_i\left(\varphi^*, \gamma^*, s^*, t^*, \bar{t}^*\right) = \begin{cases} \delta^{t^*}\left[\pi'\left(\eta^{\varphi^*}\right) - s_i^* + a_i\right] & \text{if } \sum_{j \in \varphi} s_j^* \geq \sum_{j \in \bar{\varphi}} s_j^* \\ \delta^{t^*}\left[\pi'\left(1\right) + a_i\right] & \text{otherwise} \end{cases},$$

and $\forall i \in \bar{\varphi}^*$,

$$U_i\left(\varphi^*, \gamma^*, s^*, t^*, \bar{t}^*\right) = \begin{cases} \delta^{\bar{t}^*}\left[a_i + w\right] & \text{if } \sum_{j \in \varphi} s_j^* \geq \sum_{j \in \bar{\varphi}} s_j^* \\ \delta^{\bar{t}^*}\left[\pi'\left(1\right) - s_i^* + a_i\right] & \text{otherwise} \end{cases}.$$

Otherwise, if φ^* is not realized subsequently to the announcement profile γ^*, $\forall i \in \mathfrak{S}$,

$$U_i\left(\varphi^*, \gamma^*, s^*, t^*, \bar{t}^*\right) = \pi'\left(1\right) + a_i.$$

1.10.2 Equilibrium Outcome

In this multi-stage game with observed actions, strategies are simply defined. A strategy for player i when it is her turn to play is a mapping from the set of possible histories to the set of actions available to i. Abusing notation, we will assimilate strategies and actions, and will omit references to histories when no ambiguity is possible.

A natural equilibrium concept is Subgame Perfection. We thus solve the equilibrium outcome of the game G using a backward induction argument.

Stage 3: Bargaining over Contributions

In this paragraph, we take as given the bureaucrat's decision φ^* that we suppose realized subsequently to the announcement profile γ^* (if φ^* is not realized subsequently to the announcement profile γ^*, actions are payoff-irrelevant).

To start with, we are making an assumption on the set of possible strategies at this stage.

(AB1)   Members of the same coalition can borrow from one another at an interest rate

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of 1.

Lemma 16 *For any subset* $\varphi \in P(\mathfrak{S})$, *individuals' willingness to pay is given by:*

$$\mu_i^\varphi = \begin{cases} \pi'(\eta^\varphi) - \pi'(1) & if \ i \in \varphi \\ \pi'(1) - w & otherwise \end{cases}.$$

Proof. *Omitted.* ∎

Notation 17 *For any subset* $\varphi \in P(\mathfrak{S})$, *we denote by* Δ^φ *the aggregate surplus of insiders in the auction they play against outsiders:*

$$\Delta_{ins}^\varphi \equiv \min\left[\sum_{i \in \varphi} \mu_i^\varphi ; \sum_{i \in \varphi} a_i\right],$$

$$\Delta_{out}^\varphi \equiv \min\left[\sum_{i \in \bar{\varphi}} \mu_i^\varphi ; \sum_{i \in \bar{\varphi}} a_i\right],$$

$$\Delta^\varphi \equiv \Delta_{ins}^\varphi - \Delta_{out}^\varphi.$$

The structure of the game delivers the following outcome: insiders win if and only if $\Delta^\varphi \geq 0$. If $\Delta^\varphi \geq 0$, then each member of winning coalition contribute the same amount equal to $\Delta_{out}^\varphi/\eta^\varphi$. The following claim formalizes this point without a proof.

Claim 18 *Insiders win the auction if and only if*

$$\Delta^\varphi \geq 0. \tag{1.11}$$

If (1.11) *holds then* $\forall i \in \varphi$,

$$s_i = \frac{\Delta_{out}^\varphi}{\eta^\varphi},$$

so that

$$\sum_{i \in \varphi} s_i = \Delta_{out}^\varphi.$$

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Stage 2: Bureaucrat's decision

In stage 2, the bureaucrat maximizes the sum of transfers made to him at the end of stage 3. In case of indifference, we assume that the bureaucrat picks a coalition, realized subsequently to the announcement profile γ^*. Thus as transfers are nonnegative, the bureaucrat always picks a coalition φ^*, realized subsequently to γ^*.

Notice that the set of realized coalitions defines a partition of $\mathfrak{S}$. We first put some restrictions on parameters of the model:

(AB2)

$$\pi'(0) - \pi'(1) \leq \pi'(1) - w.$$

Lemma 19 *Under assumption (AB2), and for any announcement profile γ^*, there exists at most one coalition realized subsequently to γ^*, where insiders bid more than outsiders do.*

Proof. *Suppose there exists one such coalition φ^* realized subsequently to γ^*. The result presented in the previous paragraph implies that $\Delta^{\varphi^*} \geq 0$. As the set of realized coalitions defines a partition of $\mathfrak{S}$, any other coalition different from φ^* is included in $\bar{\varphi}^*$. Assumption (AB1) induces the following implication: $\forall \varphi \in P(\mathfrak{S})$*

$$\Delta^{\varphi} \geq 0 \Rightarrow \Delta^{\bar{\varphi}} < 0. \tag{1.12}$$

Furthermore, the operator Δ is characterized by the following property: $\forall \varphi, \varphi' \in P(\mathfrak{S})$,

$$\varphi \subseteq \varphi' \Rightarrow \Delta^{\varphi} \leq \Delta^{\varphi'}. \tag{1.13}$$

Implications (1.12) and (1.13) imply that there does not exist two disjoint winning coalitions.

∎

Stage 1: Coalition Announcements

We start this section by assuming the following restriction on feasible announcements:

(AB3) $\forall i \in \mathfrak{S},$

$$\Delta^{\gamma_i} \geq 0.$$

Assumption (AB3) deletes weakly dominated strategies. Insiders in a losing coalition do not benefit nor lose from the auction as losing bids are refunded. Thus, we assume that entrepreneurs prefer to name the grand coalition $\Im$ rather than a coalition which does not have the ability to outbid outsiders.

In this section, we will determine necessary and sufficient conditions for existence and uniqueness of an equilibrium of game G. The proof is organized as follows: we will first summarize the results proved so far in order to define a reduced-form game played in stage 1. We will then determine the outcome of the game G. Finally, we will prove that the equilibrium outcome is characterized by Theorem 7.

Summary of results

Consider the choice γ_i of entrepreneur $i \in \Im$. Suppose that the bureaucrat's decision φ^* is such that $\Delta^{\varphi^*} \geq 0$. Then we have the following:

$$U_i\left(\gamma_i\right) = \begin{cases} \pi'\left(\eta^{\gamma_i}\right) + a_i - \mu_i^{\gamma_i} + \frac{1}{\eta^{\gamma_i}}\Delta^{\gamma_i} & if \ \varphi^* = \gamma_i \\ a_i + w & otherwise \end{cases}.$$

Individual optimal coalition

We first characterize the optimal coalition for each entrepreneur $i \in \Im$.

Each entrepreneur's "preferred coalition" is given by:

$$\gamma_i^m = \arg\max_\gamma \left[\pi'\left(\eta^\gamma\right) - \mu_i^\gamma + \frac{1}{\eta^\gamma}\Delta^\gamma\right],$$

subject to

$$\begin{cases} i \in \gamma \\ \Delta^\gamma \geq 0 \end{cases}.$$

Lemma 20 (Convexity) *For all* $i \in \Im$, γ_i^m *can be written*

$$\gamma_i^m = \{i\} \cup \Gamma_i^m$$

where $\forall j, k \in \mathfrak{S}$

$$[j \in \Gamma_i^m \text{ and } a_j < a_k < \pi'(1) - w] \Rightarrow [k \in \Gamma_i^m] \tag{1.14}$$

Proof. *Suppose that* $\exists i, j, k \in \mathfrak{S}$

$$j \in \Gamma_i^m \text{and } a_j < a_k < \pi'(1) - w \text{ and } k \notin \Gamma_i^m.$$

Then consider the coalition

$$\hat{\gamma}_i^m = \gamma_i^m \cup \{k\} \setminus \{j\}.$$

We thus have

$$
\begin{aligned}
i &\in \hat{\gamma}_i^m, \\
\Delta^{\hat{\gamma}_i^m} &> \Delta^{\gamma_i^m}.
\end{aligned}
$$

As

$$\eta^{\hat{\gamma}_i^m} = \eta^{\gamma_i^m},$$

we have

$$\mu_i^{\gamma_i^m} = \mu_i^{\hat{\gamma}_i^m}.$$

And thus

$$\pi'\left(\eta^{\gamma_i^m}\right) + a_i - \mu_i^{\gamma_i^m} + \frac{1}{\eta^{\gamma_i^m}}\Delta^{\gamma_i^m} < \pi'\left(\eta^{\hat{\gamma}_i^m}\right) + a_i - \mu_i^{\hat{\gamma}_i^m} + \frac{1}{\eta^{\hat{\gamma}_i^m}}\Delta^{\hat{\gamma}_i^m},$$

which contradicts the optimality condition for γ_i^m. ■

Equilibrium Outcome

Let's index by $i = 1$ the richest individual in the economy. Consider the following assumption on the price elasticity (previously made in AA1):

(AA1) The function $\pi'(.)$ is concave

Proposition 21 *Under assumption (AA1), the unique equilibrium coalition is given by* γ_1^m

$$\gamma_1^m = \arg\max_{\gamma}\left[\pi'\left(\eta^{\gamma}\right) - \mu_1^{\gamma} + \frac{1}{\eta^{\gamma}}\Delta^{\gamma}\right],$$

subject to

$$\Delta^\gamma \geq 0.$$

Proof. *Consider a draw of nature and members of γ_1^m. All members of γ_1^m also have γ_1^m as their preferred coalition. Consider the subgame with the following characteristics:*

- *The last member of γ_1^m, i say, is making an announcement*

- *All previous members of γ_1^m have announced γ_1^m*

Then as

$$\gamma_1^m = \arg \max_\gamma \left[\pi'\left(\eta^\gamma\right) - \mu_i^\gamma + \frac{1}{\eta^\gamma} \Delta^\gamma \right],$$

subject to

$$\Delta^\gamma \geq 0.$$

and under assumption (AA1), the optimum is unique. Then individual i is announcing:

$$\gamma_i = \gamma_i^m = \gamma_1^m.$$

A backward induction argument proves that all members of γ_1^m are announcing γ_1^m as well so that γ_1^m is formed subsequently to the equilibrium announcement profile $(\gamma_i^*)_{i \in \mathfrak{S}}$. Under assumption (AB2), the bureaucrat's equilibrium choice is uniquely given by γ_1^m. ■

We have proved that the optimal coalition for the richest entrepreneur is always chosen in equilibrium, regardless of the order of moves in the first stage. This result is equivalent to a Coalition-Proofness property developed by Bernheim, Peleg and Whinston [1987].

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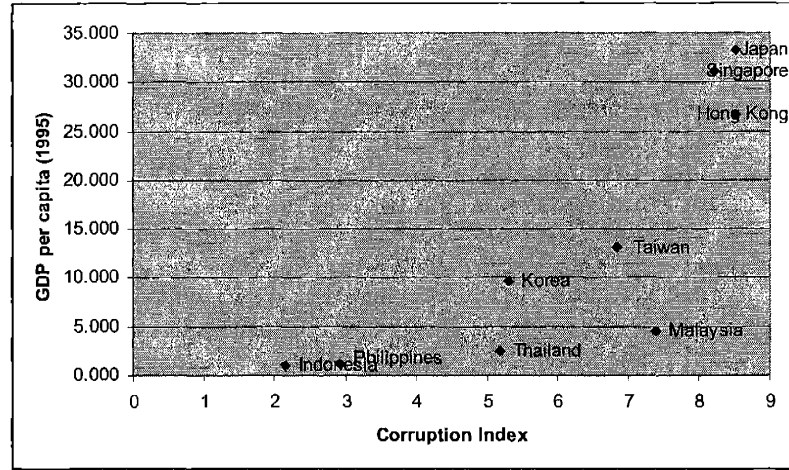
Figure 1-1: Corruption Index and GDP
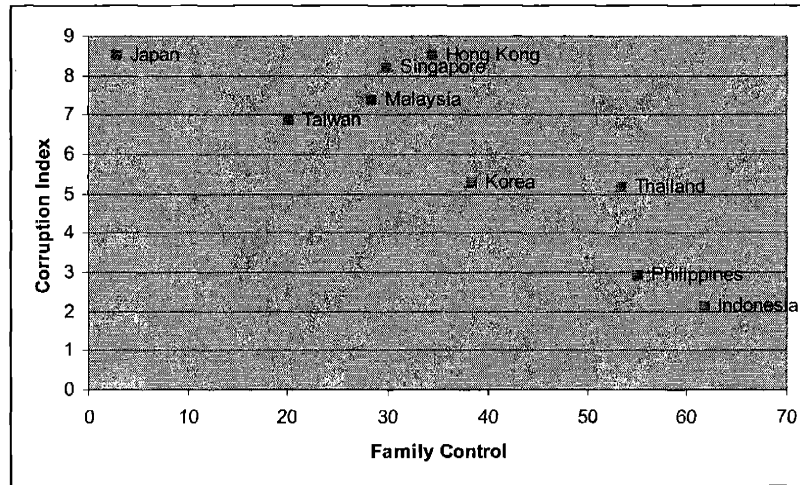
Figure 1-2: Wealth Concentration and Corruption Index

T = 0   T = 1   T = 2

Licensing   Cournot Competition   Final Production
                         Supply Choice   Consumption
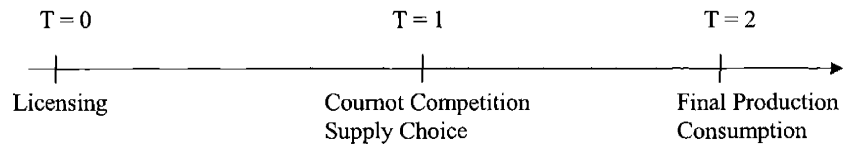
Figure 1-3: Timeline Benchmark Case

T = 0   T = 1   T = 2

Licensing   Cournot Competition   Production
                                   Supply Choice   Consumption

Bribing Game
  - Step 1: Offers
  - Step 2: Licensing decision

Figure 1-4: Timeline Bribing Game

T = 0   T = 1   T = 2

Licensing   Cournot Competition   Production
Coalition Formation   Supply Choice   Consumption
    - Step 1: Announcements
    - Step 2: Bureaucrat's choice
Bribing Game
    - Step 1: Contribution decision
    - Step 2: Licensing decision

Figure 1-5: Timeline Coalition Formation Game

Figure 1-6: Ex-ante wealth constraints versus ex-post competition.

Figure 1-7: Dynamics - Benchmark case
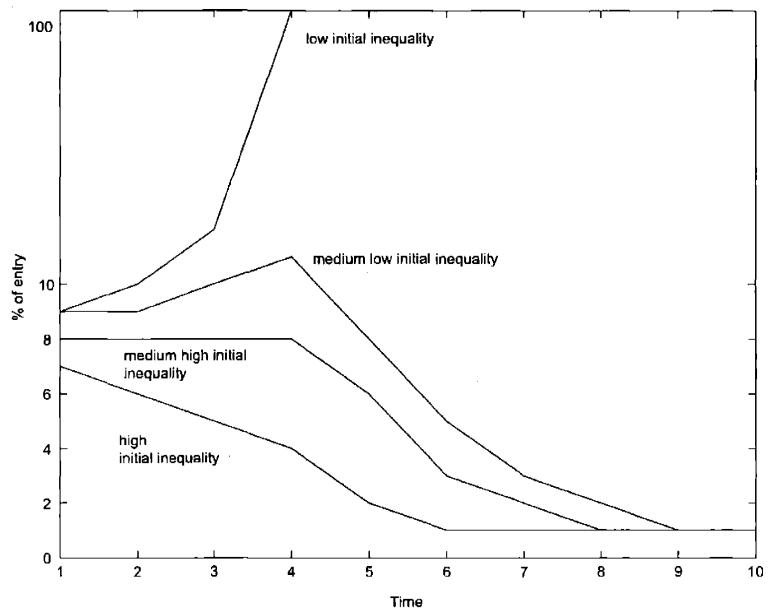
Figure 1-8: Dynamics - Simulation

60
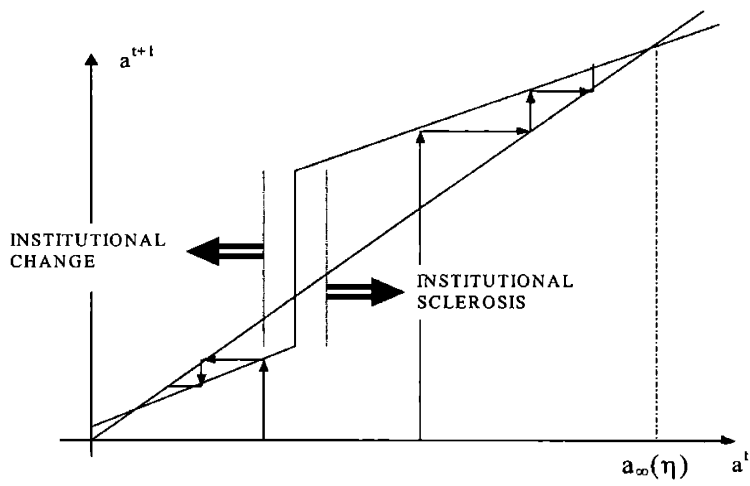
Figure 1-9: Institutional Change and Institutional Sclerosis
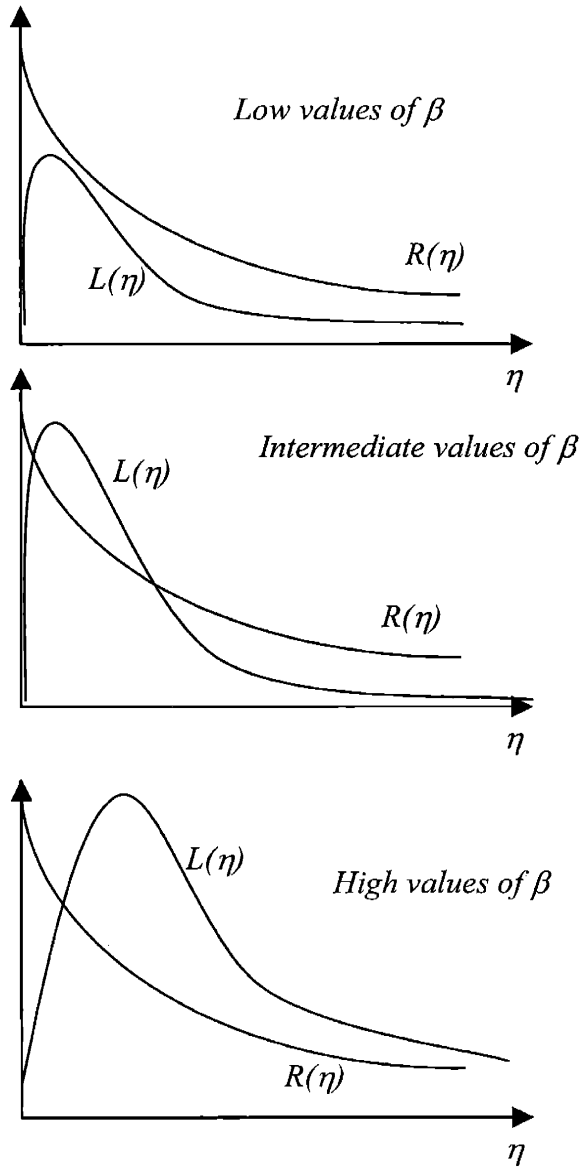
Figure 1-10: Steady States Analysis

Chapter 2

Trade and Financial Development

2.1 Introduction

Browsing the World Trade Organization (WTO) website, one can read the following lines: "Trade allows a division of labor between countries. It allows resources to be used more appropriately and efficiently for production." This statement reflects a well-accepted premise that free trade brings large benefits while protectionism is harmful to economic development (see e.g. Corden [1984]). However, as emphasized by Bhagwati [1994], the case for free trade is undermined by the existence of market imperfections. The present paper investigates the implications of a specific source of factor market failure, namely the existence of positive externalities.

We analyze an economy in which entrepreneurs can choose to run projects that are subject to uncorrelated liquidity shocks. In case of distress, firms may only call on fellow companies with excess cash to get refinancing. Through this implicit insurance mechanism, each entrepreneur with excess cash is a valuable source of liquidity to colleagues in distress. This positive externality is indeed the source of market failure: if prices reflect firms' ability to get additional resources in case of adverse liquidity shocks, they ignore firms contribution to a larger hence more liquid financial market. In autarky, this leads the decentralized equilibrium to be suboptimal because too few entrepreneurs undertake such projects. Besides, inefficiencies are potentially exacerbated when allowing for trade. Capital-intensive countries will specialize in projects that rely more on external finance. Thus, the market forces induce poorer countries to move away from risky technologies, and in doing so, increase the volatility of remaining

projects. Richer countries, by specializing, benefit from a more liquid financial market at home. However, the concave nature of the externality makes liquidity losses incured by poor countriers larger than gains brought to richer ones. Consequently, trade among partners characterized by large wealth gaps leads to excess specialization so that overall liquidity losses outweigh allocative gains. In these circumstances, free trade brings allocative benefits to the richer country, at the expense of its poorer counterparts. In a dynamic setting, static inefficiencies are exacerbated through time. When the terms of trade are unbalanced, the wealth gap between the two partners worsens, further damaging the terms of trade, and so on. In the long-run, three forces are driving the steady-state terms of trade: (i) a "specialization effect" tends to increase the comparative advantage of the richer country then endowed with a more developed financial market, inducing further specialization, (ii) a "decreasing-returns effect" makes poorer countries more productive, and finally (iii) a "trade effect" values scarce resources, so that poorer countries tend to catch up. The balance between these three forces then determines whether the world economy reaches a second-best level, characterized by similar countries enjoying the benefits of a better allocation of resources at no extra cost, or whether countries are locked in a "specialization" trap, in which a significant wealth gap between trade partners makes excess specialization patterns sustainable in the long-run. The world is then divided into two: rich countries with high levels of financial development specializing in volatile technologies and poor countries characterized by poorly performing financial institutions, therefore undertaking safer but less rewarding projects. In our model, trade always benefits richer countries at the expense of their poorer partners. From a normative point of view, rich countries may thus prefer to trade with poor counterparts while poorer countries are better-off trading between themselves. Furthermore, this paper provides a rationale for temporary protectionist policy. In autarky, countries further away from their steady-state level grow faster, catching-up with their richer counterparts. Then, when countries characteristics become similar enough, free trade allows both partners to realize the gains from a better allocation of resources, without paying the costs of excess specialization. Furthermore, as inefficiencies stem from the inability of countries to pool their liquidity risks because capital cannot flow between countries, our model suggests that financial liberalization and trade liberalization should go together.

The mechanism analyzed in this paper relies heavily on the structure of the externality and

its impact on the terms of trade. When projects are subject to uncorrelated liquidity shocks, the role of financial markets is to move resources from firms with excess cash to firms with liquidity needs. When the distribution of shocks is symmetric, the law of large numbers implies that larger economies experience a negative aggregate shock with a lower probability. At the firm level, this just means that a firm in distress will get refinanced with probability converging to one as the total number of firms grows to infinity. Thus, defining financial development as the ability to diversify out idiosyncratic risk, countries with larger economies are more financially developed. Each entrepreneur then makes it easier for other entrepreneurs to refinance their projects in case of distress, reinforcing the interplay between wealth and financial development. In an open-economy framework, this feature translates into a comparative advantage for rich countries in financially dependent industries. Trade can therefore be detrimental to poorer countries, inasmuch as financial markets deteriorate in less capital-intensive countries following specialization. The dynamic implication of such pattern follows naturally: specialization exacerbates differences between countries, increasing the scope for further specialization. Trade is then unbalanced as poorer countries bear the costs, while richer countries benefit from it. In extreme cases, a "no trade" economy even Pareto dominates the open economy.

Empirically, there is evidence that financial development creates a comparative advantage in financially-dependent industries. Beck [2002] finds that countries with better-developed financial systems specialize in industries that rely heavily on external finance. Although our model predicts a feedback effect of trade into financial development, the author's results, though weakened when considering such possibility, still suggest that financial development directly induces specialization in financially-dependent industries. Furthermore, Rajan and Zingales [2001] describe the dynamics of trade, cross-border capital flows and financial development throughout the twentieth century and find that (i) when the world is open to cross-border capital flows, trade and financial development are positively correlated, while (ii) when worldwide cross-border capital flows are low, such correlation is weaker. Although the authors invoke a political economy channel to explain these stylized facts, our model is also consistent with such a pattern. Indeed, in our model, cross-border capital flows allow countries to pool liquidity risks: the world becomes a large integrated economy and financial markets are thus more developed. Conversely, our model predicts an asymmetric impact of trade on patterns of financial development in case

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of low cross-border capital flows.

The main feature of our model is the effect of market size on financial market efficiency. We have focused on the ability of entrepreneurs to add liquidity to the market. In that respect, the structure of the externality we use is close to Acemoglu and Zilibotti [1997] where entrepreneurs play a role of risk-diversification instead of liquidity-provision. The focus of Acemoglu and Zilibotti [1997] is different as they analyze the interaction between volatility and growth in a closed-economy framework. Along the same lines, Acemoglu and Zilibotti [1999] are putting emphasis on a different spillover mechanism. In an asymmetric information framework, entrepreneurs are adding information to a market in which contracts are based on relative performance monitoring. All these models rely on the law of large numbers, which makes larger countries less volatile than smaller ones. However little attention is given to the interaction between such externality and trade. Yet, Young [1991] and Krugman [1987] are analyzing the implications of similar spillover on the patterns of trade. When the externality consists of agents learning by doing, specialization subsequent to trade inhibits learning-by-doing and therefore growth of knowledge in poorer countries. The mechanics of such phenomenon are similar to the model we present here although Young [1991] focuses on the dynamic inefficiencies induced by trade, whereas we argue that trade yields inefficient outcomes in both static and dynamic settings.

The rest of the paper is organized as follows: section 2.2 lays out the static model. Section 2.3 solves the equilibrium in a closed-economy framework, while section 2.4 analyzes the case with trade. The dynamic version of the model is left to section 2.5. Section 2.6 concludes.

2.2 The Model

Consider two countries $j = 1, 2$ each populated with a number N of entrepreneurs. Each entrepreneur is endowed with a level of wealth w and one unit of labor. The distribution of wealth in country j is given by a function $G^j(.)$. There are three goods in the economy. Wealth is the numeraire and is used for consumption and production of two inputs: intermediate good 1 and intermediate good 2. Intermediary goods are tradeable. In each country, the time horizon consists of an interval $[0, 1]$. At time $t = 0$, entrepreneurs make their occupation choices. They

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either decide to undertake the production of intermediate goods of type 1 or they choose to produce intermediate good 2. The production of intermediate goods is a continuous process, which takes place between time $t = 0$ and $t = 1$. At time $t = 1$, one final industry in each country buys intermediate goods on the international market and produces wealth according to a production function

$$\pi\left(K_{11}, K_{12}, K_2\right) = A\left[K_{11}^\rho + K_{12}^\rho\right]^{\alpha/\rho} K_2^{1-\alpha}, \tag{2.1}$$

where K_{11} and K_{12} are aggregate amounts of intermediate goods 1 produced in country 1 and 2 respectively and K_2 is the world aggregate amount of intermediate good of type 2. We will also assume that

$$0 < \alpha < \rho \leq 1.$$

Payments are made, projects are liquidated, consumption takes place and the game ends.

2.2.1 Technology

Each country is characterized by the production of two tradeable goods and a final industry.

Intermediate good 1: the Risky Project.

In both countries, intermediate good 1 requires a fixed start-up cost C in order to be produced. Each entrepreneur then manages a flow of projects between dates $t = 0$ and $t = 1$. Between time t and $t + dt$, entrepreneurs face a liquidity shock $\tilde{L}^t dt$. At each date, we assume that $L^t = -L$ with probability $\frac{1}{2}$ and $L^t = L$ with probability $\frac{1}{2}$. Shocks are assumed to be identically and independently distributed. If the liquidity need is fulfilled, then the project yields a flow of returns R; otherwise it returns 0 (see figure $2-1$). Writing R_i^t the realized flow of returns at date t for entrepreneur i, the total output produced by entrepreneur i is then given by

$$R_i^1 = \int_0^1 R_i^t dt$$

Intermediate good 2: the Riskless Project.

Intermediate good 2 does not require a start-up cost to be implemented. Each entrepreneur

produces a constant flow of return R, so that total output produced by entrepreneur i is simply

$$R_i^2 = R.$$

Final Industry.

A final industry, identical in both countries, combines inputs and produces wealth. Intermediate goods of type 1 are imperfect substitutes with constant elasticity of substitution, while intermediate goods of type 2 produced in each country are assumed to be perfect substitutes. Denoting K_{11}, K_{12} and K_2 the aggregate capital levels of good 1 and 2 respectively used by the final industry, the final industry output in wealth units is given by (2.1).

2.2.2 Preferences

There are three types of agents in the economy: entrepreneurs borrow capital from lenders and sell their output to final producers.

Entrepreneurs.

Each country $j = 1, 2$ is characterized by a large population of N with a wealth cumulative distribution function $G^j(.)$. We normalize population size in both countries to 1. We will denote

$$W_j \equiv \int_0^{+\infty} w \, dG^j(w).$$

Entrepreneurs are risk-neutral so that they maximize final period wealth levels. At date $t = 0$, entrepreneurs choose their occupation: they invest capital and labor either in a risky project or in a riskless project.

Lenders.

Entrepreneurs are lenders as well. There is no saving instrument in the economy; wealth, which is not invested depreciates at rate 1. Let's denote r_t the gross interest rate which prevails at time t; a debt contracted at time t is a claim on time $t = 1$ returns and as individuals can always store their wealth, so that the gross interest rate cannot be negative: $\forall t \in [0, 1]$, $r_t \geq 0$.

Producers.

Final-industry producers maximize profits and behave competitively.

The timing of the game is summarized in figure $2-2$.

2.3 Closed-Economy Equilibrium

In this section, inputs are assumed to be non tradeable. The analysis of autarky equilibria is symmetric in both countries so country indexes are dropped. As only home production of inputs of type 1 can be used for production purpose, we will simplify notation and denote K_1 the country aggregate level of capital of type 1 at price p_1. The aggregate production of inputs 1 and the final production function can then be written

$$\pi\left(K_1, K_2\right) = A K_1^{\alpha} K_2^{1-\alpha}.$$

A natural equilibrium concept to be adopted is the Walrasian concept: agents take prices as given before taking their investment decisions, and prices clear product markets. However, because investment decisions may be subject to coordination problems as in Murphy, Shleifer and Vishny [1986], agents are implicitly assumed to choose their occupation sequentially. We now solve the game backward. All proofs are left to the appendix.

2.3.1 Final Production

At prices p_1 and p_2, equilibrium demand for intermediate goods is denoted $\left(K_1^d, K_2^d\right)$ and given by

$$
\begin{cases}
p_1 = \alpha A \left[\dfrac{K_2^d}{K_1^d}\right]^{1-\alpha} \\
p_2 = (1-\alpha) A \left[\dfrac{K_1^d}{K_2^d}\right]^{\alpha}
\end{cases} .
\tag{2.2}
$$

Equations (2.2) define the demand functions that entrepreneurs face at date $t = 1$.

2.3.2 Equilibrium Project Choices

Let's denote η, the number of entrepreneurs who invest in the risky project. Then, by normalizing population size to 1, $(1 - \eta)$ represents the number (or fraction) of entrepreneurs

undertaking the riskless project.

Riskless projects.

Riskless projects provide a deterministic flow of returns so that aggregate supply of intermediate goods of type 2 is equal to

$$K_2^s = (1 - \eta) R.$$

Risky projects.

At each time t, we denote

$$\Lambda^t = \sum_{i \in \Gamma_1} L_i^t.$$

Without savings, entrepreneurs with excess liquidity lend to entrepreneurs with liquidity shortages at the instantaneous interest rate r_t. In case of a positive aggregate liquidity shock $(\Lambda^t \geq 0)$, interest rate drops to zero and all projects yield a flow R. If a negative aggregate shock hits the economy at time t, then a fraction γ^t of projects are liquidated and interest rates rise so that lenders appropriate all surplus. The aggregate production flow is thus given by

$$K_1^t = \eta R \left(1 - \gamma^t\right),$$

and the total supply of input 1 is equal to

$$K_1^s = \eta R \left[1 - \int_0^1 \gamma^t dt\right].$$

Lemma 1: The structure of liquidity externalities

Aggregate supply of intermediate good 1 is given by

$$K_1^s = \eta R \left[1 - \gamma(\eta)\right]$$

where $\eta \gamma(\eta)$ is a decreasing and convex function of η such that $\lim_{\eta \to 0} \gamma(\eta) = \frac{1}{2}$ and $\lim_{\eta \to \infty} \gamma(\eta) = 0$.

At each date $t \in (0, 1)$, either $\Lambda^t \geq 0$, and all projects are refunded at rate $r^t = 0$, or $\Lambda^t < 0$ and $(1 - \gamma^t)$ projects are funded and net lenders capture the whole benefit of continuation so that $r^t L = p_1 R$. Thus, denoting the time 0 interest rate as r, the value of a project of type 1 is given by

$$V_1(\eta) = p_1 R [1 - \gamma(\eta)] - rC. \tag{2.3}$$

Similarly, a project of type 2 has value

$$V_2(\eta) = p_2 R. \tag{2.4}$$

Proposition 1 : Equilibrium in a closed-economy

The equilibrium of the economy is characterized by a vector of prices (p_1, p_2, r) and a fraction η of entrepreneurs of type 1, such that the following conditions hold:

1. Intermediate good market clearing conditions:

$$p_1 = \alpha A \left[\frac{1 - \eta}{\eta [1 - \gamma(\eta)]} \right]^{1-\alpha}, \tag{2.5}$$

$$p_2 = (1 - \alpha) A \left[\frac{\eta [1 - \gamma(\eta)]}{1 - \eta} \right]^{\alpha}. \tag{2.6}$$

2. Time $t = 0$ credit market clearing conditions:

$$\eta C \leq W,$$

and

$$\eta C < W \Rightarrow r = 0.$$

3. Project choice arbitrage condition:

$$p_1 R \left[1 - \gamma \left(\eta\right)\right] - rC = p_2 R.$$ (2.7)

Corollary 1: In autarky, the following implication holds:

$$r = 0 \Rightarrow \eta = \alpha.$$

We can then determine the equilibrium industrial structure of the country, which fully characterizes the economy:

Corollary 2: In a closed economy, the equilibrium number of entrepreneurs who undertake the risky project is given by

$$\eta = \min \left[\alpha, \frac{W}{C}\right].$$ (2.8)

Definition 1: Country 1 is said to be rich relative to country 2, if

$$W_1 \geq W_2.$$

Furthermore, country j is said to be rich in absolute terms, if

$$W_j \geq \alpha C.$$

2.3.3 The Social Planner Solution

The main thread of the paper is the implicit insurance mechanism between entrepreneurs that fails to be internalized in a decentralized equilibrium. To have a sense of the inefficiency induced by the market, let us look at the Pareto optimal allocation of tasks.

The social planner solution:

A social planner would maximize aggregate output. He would choose the number of entrepreneurs η^{SP} to work in projects 1 to maximize:

$$\eta^{SP} = \arg \max_{\eta \in (0,1)} \pi \left[K_1 \left(\eta \right), K_2 \left(1 - \eta \right) \right],$$

subject to

$$\eta C \leq W.$$

This would imply the following program:

$$\eta^{SP} = \arg \max_{\eta \in (0,1)} AR \left\{ \eta \left[1 - \gamma \left(\eta \right) \right] \right\}^{\alpha} \left(1 - \eta \right)^{1-\alpha},$$

subject to

$$\eta C \leq W.$$

When the aggregate budget constraint does not bind, the first-order condition can be written as

$$\frac{\alpha}{\eta^{SP}} - \alpha \frac{\gamma' \left(\eta^{SP} \right)}{1 - \gamma \left(\eta^{SP} \right)} = \frac{1 - \alpha}{1 - \eta^{SP}}. \tag{2.9}$$

The first term in equation (2.9) is the allocative gain from moving one entrepreneur initially in sector 2 into sector 1, while the right-hand side is the allocative loss of such transfer. However, equation (2.9) has an additional term, $-\alpha \frac{\gamma'(\eta^{SP})}{1-\gamma(\eta^{SP})} > 0$, which can be interpreted as the marginal liquidity gain as an additional entrepreneur undertakes project 1. Thus, the social value of an entrepreneur undertaking a risky project is equal to the associated allocative gains augmented by the liquidity benefits of a larger risk-pooling market. We next analyze the failure of the decentralized equilibrium to internalize such spillover.

A suboptimal decentralized equilibrium:

The decentralized equilibrium is the solution to a different program. Indeed, the liquidity effect is not internalized so that in a decentralized economy, the equilibrium allocation of tasks η^{DC}

is given by:

$$\eta^{DC} = \arg \max_{\eta \in (0,1)} AR \left\{ \eta \left[1 - \gamma \left(\bar{\eta} \right) \right] \right\}^{\alpha} \left(1 - \eta \right)^{1-\alpha} - \eta rC,$$

subject to

$$\eta C \leq W,$$

and

$$\bar{\eta} = \eta^{DC}.$$

Similarly to the social planner analysis, if we assume that the budget constraint does not bind, the equilibrium outcome is determined by:

$$\eta^{DC} = \arg \max_{\eta \in (0,1)} AR \left\{ \eta \left[1 - \gamma \left(\eta^{DC} \right) \right] \right\}^{\alpha} \left(1 - \eta \right)^{1-\alpha}.$$

An interior solution is thus characterized by

$$\frac{\alpha}{\eta^{DC}} = \frac{1-\alpha}{1-\eta^{DC}},$$

so that the decentralized equilibrium fails to internalize the positive impact that each risky project brings to the financial market. Equation (2.3) embodies the tension of the paper: the value of projects 1 depends on the number of entrepreneurs that actually undertake the production of input 1. However the value of projects 1 does not internalize the liquidity effect: the social value of a project of type 1 exceeds its market value. The response of the market can actually be seen through price equation (2.5) : rewriting p_1 after a Taylor expansion, we have

$$p_1 = \alpha A \left[\frac{1-\eta}{\eta} \right]^{1-\alpha} \left[1 + (1-\alpha) \gamma \left(\eta \right) \right]. \tag{2.10}$$

Equation (2.10) indeed shows that the market rewards entrepreneurs who invest in projects 1 by paying a premium $(1-\alpha) \gamma \left(\eta \right)$ for the risk undertaken, but fails to compensate entrepreneurs for the liquidity they bring to one another. The decentralized equilibrium therefore exhibits underinvestment in projects of type 1 compared to a social planner solution given by (2.9).

Some rudimentary comparative statics:

In order to investigate the extent of inefficiencies, we compare two countries differing only by their levels of initial aggregate wealth. Thus, to make the comparison relevant, we suppose that aggregate budget constraints bind (at least for the poorer country). In such a situation, an additional dollar given to the economy has a marginal impact on occupation choices equal to:

$$d\eta = \frac{1}{C}dw.$$

Then, the welfare impact of an extra dollar can be measured by:

$$\frac{d\ln\pi}{dw}(\eta) = \frac{1}{C}\left[\frac{\alpha}{\eta} - \frac{1-\alpha}{1-\eta} - \alpha\frac{\gamma'(\eta)}{1-\gamma(\eta)}\right],$$

which can be decomposed into an allocative effect, $\frac{1}{C}\left(\frac{\alpha}{\eta} - \frac{1-\alpha}{1-\eta}\right)$, and a liquidity effect $\frac{\alpha}{C}\frac{-\gamma'(\eta)}{1-\gamma(\eta)}$. A poor country is not only subject to misallocation of tasks because when credit constrained, it cannot implement the optimal number of projects of type 1, but is also subject to larger aggregate liquidity shocks that undermines the expected return of each risky project undertaken. Looking at the structure of the liquidity component, we can already emphasize an asymmetry between wealthy and poor countries: marginal liquidity losses are larger when the economy is smaller.

2.4 Open-Economy Equilibrium

Consider now two economies with wealth distribution $G^j(.)$, $j = 1, 2$, and identical otherwise. As we saw in the previous section, decentralized equilibria are inefficient. The presence of national spillover as we just described can induce trade to be suboptimal as allocative gains can be largely offset by losses due to the destruction of externalities subsequent to specialization. This result, similar to Young [1991], suggests that opening to trade can be harmful to growth, especially when the wealth difference between the two countries is large.

2.4.1 Equilibrium in an Integrated Economy

In an integrated economy, cross-country capital flows take place. The equilibrium conditions derived in Proposition 2 still hold and are summarized in the following proposition:

Proposition 2: Equilibrium in an integrated economy

The equilibrium of the integrated economy is characterized by a vector of prices (p_{11}, p_{12}, p_2, r) and fractions η^1 and η^2 of entrepreneurs investing in the risky project in countries 1 and 2 respectively such that inputs of type 1 are produced in same quantities

$$\eta \equiv \eta^1 = \eta^2$$

and therefore have same price

$$p_1 \equiv p_{11} = p_{12}$$

and the following relations are satisfied:

1. Intermediate good markets clear:

$$
\begin{aligned}
p_1 &= \alpha 2^{\alpha\left(\frac{1}{\rho}-1\right)} A \left[\frac{1-\eta}{\eta\left[1-\gamma\left(2\eta\right)\right]}\right]^{1-\alpha}, \\
p_2 &= (1-\alpha) 2^{\alpha\left(\frac{1}{\rho}-1\right)} A \left[\frac{\eta\left[1-\gamma\left(2\eta\right)\right]}{1-\eta}\right]^{\alpha}.
\end{aligned}
$$

2. Time $t = 0$ credit market clears:

$$\eta C \leq \frac{1}{2}\left(W_1 + W_2\right),$$

and

$$\eta C < \frac{1}{2}\left(W_1 + W_2\right) \Rightarrow r = 0.$$

3. Riskless and risky projects have same ex-ante value:

$$p_1 R\left[1 - \gamma\left(2\eta\right)\right] - rC = p_2 R.$$

If the integrated economy equilibrium is still suboptimal, it is nevertheless worth noticing through equation (2.9) that the market failure, measured by the term $-\alpha\frac{\gamma'(2\eta)}{1-\gamma(2\eta)}$ is smaller as

η gets larger. When wealth can move costlessly between the two countries, liquidity shocks that hit entrepreneurs are averaged out at the world level, which decreases the likelihood of a negative aggregate shock occuring.

The economy described above realizes allocative gains by producing the same amount of capital goods of type 1 and minimizes the number of liquidations, now brought down to $\gamma(2\eta)$. Indeed, allowing externalities to cross borders, financial market performance is improved in both countries. Trade associated with free flows of capital increases efficiency gains in both countries by inducing better allocation of resources and by aggregating liquidity externalities.

2.4.2 Equilibrium with Trade

Opening economies to free trade implies that prices of intermediate goods are equal in both countries. For notational purpose, a superscript $j = 1, 2$ is reintroduced to index state variables in country $j = 1, 2$. The equilibrium is described in the following proposition.

Proposition 3: Equilibrium with Trade

In presence of free trade of intermediate goods and without wealth mobility, the equilibrium with trade is a vector of prices $(p_{11}, p_{12}, p_2, r^1, r^2)$ where (r^1, r^2) is the vector of time $t = 0$ interest rates in countries 1 and 2, and (η^1, η^2) is the number of entrepreneurs undertaking risky projects in each country, respectively. The equilibrium verifies the following conditions:

1. Equilibrium prices and quantities:

$$\frac{K_{11}}{K_{12}} = \left(\frac{p_{12}}{p_{11}}\right)^{\frac{1}{1-\rho}}, \tag{2.11}$$

$$p_{11}K_{11} + p_{12}K_{12} = \alpha A \left[K_{11}^\rho + K_{12}^\rho\right]^{\alpha/\rho} K_2^{1-\alpha}, \tag{2.12}$$

$$p_2 K_2 = (1-\alpha) A \left[K_{11}^\rho + K_{12}^\rho\right]^{\alpha/\rho} K_2^{1-\alpha}, \tag{2.13}$$

where, for $j = 1, 2$,

$$K_{1j} = \eta^j \left[1 - \gamma\left(\eta^j\right)\right] R,$$

and

$$K_2 = \left(2 - \eta^1 - \eta^2\right) R.$$

2. *Time $t = 0$ credit markets clear: for $j = 1, 2$,*

$$\eta^j C \leq W_j, \tag{2.14}$$

and

$$\eta^j C < W^j \Rightarrow r^j = 0. \tag{2.15}$$

3. *Project choice arbitrage condition: for $j = 1, 2$,*

$$p_{1j} R \left[1 - \gamma \left(\eta^j \right) \right] - r^j C = p_2 R, \tag{2.16}$$

Equations (2.11), (2.12), and (2.13) are standard results associated to constant-elasticity-of-substitution and Cobb-Douglas functions, whereas the other relations are derived similarly to previous results. While the equilibrium with trade is stricly dominated (in the Pareto sense) by the integrated equilibrium, it is more relevant to address the question whether trade is preferable to autarky. If trade permits allocative gains by allowing exchange of inputs, it however damages the efficiency of financial markets as fewer entrepreneurs end up producing in the poorer country compared to the autarkic level. The balance between allocative gains and liquidity losses is determined by both the relative characteristics of the two countries and the overall world wealth.

Trade between two poor countries

Consider two countries 1 and 2 such that $W_j < \alpha C$ for both $j = 1, 2$. In a closed-economy framework, both countries will produce at full capacity, i.e. W_j / C risky projects will be undertaken. When opening to trade, there is no specialization pattern as both countries will keep investing in the risky project as much as they can afford to. Thus trade between two poor countries brings allocative efficiency gains. The next proposition formalizes this point. We denote K_i^j, the level of demand of capital good i by country j.

Proposition 4: Equilibrium with trade between two poor countries

Suppose that countries 1 and 2 are such that

$$W_2 \leq W_1 \leq \alpha C.$$

Then, for high enough values of α, the equilibrium with trade is characterized by full-capacity production:

$$\eta^j = \frac{1}{C} W_j,$$

for $j = 1, 2$, and imports and exports patterns are given by equations (2.11), (2.12), and (2.13).

When final production is intensive in capital goods of type 1, or equivalently when countries are wealth-constraint, prices for inputs 1 increase enough, so that entrepreneurs in both countries have an incentive to undertake risky projects as long as resources are abundant enough. Therefore trade under these conditions allows both countries to realize allocative gains. The optimal allocation of inputs is then such that both countries use both intermediate goods 1 in identical proportions determined by (2.11).

Trade between two rich countries

Suppose that country 1 is richer than country 2, but both countries are rich. In autarky, each country will have α entrepreneurs undertaking risky projects.

Proposition 5: Equilibrium with trade between two rich countries

Suppose that

$$W_j \geq \alpha C,$$

for $j = 1, 2$. For large values of α, the unique equilibrium with trade is characterized by second-best production:

$$\eta^j = \alpha,$$

for $j = 1, 2$. Prices of inputs of type 1 are equal and the terms of trade are such that world production is equally split between the two countries.

The equilibrium with trade between two similar countries is characterized by the same occupation structure as in the closed-economy equilibrium. However, the ability to trade induces countries to realize allocative gains by exchanging (at a one-for-one rate) home for foreign type-1 inputs. Notice that, in this specific setting, there is no trade of capital goods of type 2.

Trade between rich and poor countries.

In the two previous cases, no specialization was really taking place because the differences in factor endowments were not large enough to create significant comparative advantage for either country. Thus, trade brought the advantage of better allocation of resources across countries ex-post. In this paragraph, we analyze cases where there is scope for specialization and then investigate the welfare implications of trade. In propositions 4 and 5, we have seen that when prices can increase enough in order to provide incentives to entrepreneurs to undertake risky projects, occupations are characterized by full-capacity production (Proposition 4) or second-best production (Proposition 5).

In order to have a clear idea of the mechanics of the model, suppose that country 1 is rich (i.e. $W_1 > \alpha C$) and country 2 is poor (i.e. $W_2 < \alpha C$). Such considerations are not necessary but convenient for the analysis. In autarky, country 1 industry composition consists of α entrepreneurs of type 1 with a zero interest rate, while only $\frac{1}{C} W_2$ projects are funded in country 2. Allowing for trade between the two countries enlarges the market that entrepreneurs in country 1 enjoy so that the equilibrium with trade in country 1 may exhibit a positive interest rate:

$$r^1 > 0$$

and

$$\eta^1 = \frac{1}{C} W_1 > \alpha.$$

Conversely for country 2, while the scarcity of resources was compensated by high prices for input 1 in a closed-economy framework, trade implies that the price mechanism may now be unable to provide enough incentives to entrepreneurs to undertake risky projects even when interest rates drop to zero:

$$r^2 = 0$$

with

$$\eta^2 < \frac{1}{C}W_2.$$

The intuition of such result can be easily understood through the occupation-choice arbitrage equation: for $j = 1, 2$

$$p_{1j}R\left[1 - \gamma\left(\eta^j\right)\right] - r^jC = p_2R. \tag{2.17}$$

Two forces are driving equation (2.17). *First*, a price effect drives p_{1j} down as more entrepreneurs undertake risky projects, and doing so, it undermines incentives to invest. *Second* a liquidity effect which increases the net present value of each project as it reduces the number of liquidations. In the case described in Proposition 4, the number of projects is small so that the first effect dominates: prices p_{1j} are always high enough so that entry is profitable: countries are always producing at full capacity. The case of Proposition 5, in the contrary, is such that the potential number of entrants is high enough so that every single project has a high net present value $\left[1 - \gamma\left(\eta^j\right)\right]R$, despite low prices. In this paragraph, we therefore explore the intermediate case, in which specialization takes place.

Lemma 2: Patterns of specialization.

There exists threshold values W_1^*, and W_2^* and W_2^{**} such that for any countries 1 and 2 such that $W_1 \geq W_1^*$, and $W_2^* \leq W_2 \leq W_2^{**}$, country 2 produces less while country 1 produces more than they would do under "no trade":

$$\eta^1 > \alpha,$$

and

$$\eta^2 < \frac{1}{C}W_2.$$

2.4.3 The Welfare Consequences of Trade

While specialization reflects comparative advantage, failure to internalize liquidity spillovers induces the decentralized equilibrium to be suboptimal; the decrease in the number of entrepreneurs producing inputs of type 1 in country 2 decreases also the liquidity of the financial market at home, harming even further the incentives to invest in risky projects. By the same token, the increased number of risky projects in country 1 fosters the development of national

financial institutions, encouraging more entry and thus, further specialization. The overall impact is potentially negative, offsetting the gains from ex-post trade. Whether the costs of excess specialization outweigh the benefits from allocation benefits is an issue we now address. It is first necessary to define a welfare criterion.

Definition 2: Welfare functions

In autarky, when $\bar{\eta}^j$ risky projects are undertaken in country j, national welfare is defined by:

$$\Omega_{aut}^j \left(\bar{\eta}^j\right) = p_{1j}\bar{\eta}^j \left[1 - \gamma\left(\bar{\eta}^j\right)\right] R + p_2 \left(1 - \bar{\eta}^j\right) R, \tag{2.18}$$

where $\bar{\eta}^j$ is given by equation (2.8). At the world level, we thus define

$$\Omega_{aut} \left(\bar{\eta}^1, \bar{\eta}^2\right) = \Omega_{aut}^1 \left(\bar{\eta}^1\right) + \Omega_{aut}^2 \left(\bar{\eta}^2\right).$$

With trade, when the vector of occupation choices is given by $\left(\eta^1, \eta^2\right)$, national welfare is the sum of payments to entrepreneurs:

$$\Omega_{trade}^j \left(\eta^1, \eta^2\right) = p_{1j}\eta^j \left[1 - \gamma\left(\eta^j\right)\right] R + p_2 \left(1 - \eta^j\right) R. \tag{2.19}$$

and similarly,

$$\Omega_{trade} \left(\eta^1, \eta^2\right) = \Omega_{trade}^1 \left(\eta^1, \eta^2\right) + \Omega_{trade}^2 \left(\eta^1, \eta^2\right)$$

In order to make the analysis interesting, we will consider the case of two countries such that

$$W_2 \leq \alpha C \leq W_1. \tag{2.20}$$

Consequently, in autarky, country 2 would produce $\bar{\eta}^2 = \frac{1}{C}W_2$, while country 1 is undertaking $\bar{\eta}^1 = \alpha$ risky projects.

When trade is a win-win situation.

When trade allows inputs of type 1 to be traded between countries, allocative gains are realized; trade becomes a win-win situation. A simple way to illustrate the case where trade brings

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allocative benefits to both participants consists of considering two countries with same wealth levels. Then, we are in situations described either by Proposition 4 or by Proposition 5. In this specific setting, allocative gains due to trade of inputs of type 1 benefit both trade partners equivalently. Such gains amount to

$$\Omega_{trade}\left(\eta,\eta\right) - \Omega_{aut}\left(\eta,\eta\right) = \left[2^{\alpha\left(\frac{1}{\rho}-1\right)} - 1\right]\Omega_{aut}\left(\eta,\eta\right),$$

where η is given by (2.8). As expected, the world as a whole gains more from trade when the two inputs have a lower elasticity of substitution.

When trade decreases aggregate production.

The opposite situation to the case described before is when trade decreases world production. Because type 1 inputs produced by the two countries are substitutes, prices in the poor country are prevented from raising in order to provide incentives to entrepreneurs to undertake projects in a poorly performing financial environment. To see this, consider the extreme case where inputs of type 1 are perfect substitutes so that $\rho = 1$. Let's rewrite the occupation choice arbitrage equation for country 2:

$$p_{12}\left[1 - \gamma\left(\eta^2\right)\right] \geq p_2. \tag{2.21}$$

With perfect substituability, inequality (2.21) becomes

$$\left[2 - \alpha\eta^1 - (1-\alpha)\eta^2\right]\left[1 - \gamma\left(\eta^2\right)\right] \geq (1-\alpha)\eta^1\left[1 - \gamma\left(\eta^1\right)\right].$$

Let's denote W_2^{**} the wealth level for which (2.21) holds with equality when $\eta^1 = \alpha$ and $\eta^2 = W_2^{**}/C$ and (2.21) fails to hold for any $\eta^2 < W_2^{**}/C$. W_2^{**} exists for α large enough. Thus, choosing an aggregate level of wealth W_2 for country 2 such that $W_2 < W_2^{**}$, and a wealth level for country 1 equal to W_1, the autarkic provision of inputs of type 1 is given by

$$\bar{\eta}^1\left[1 - \gamma\left(\bar{\eta}^1\right)\right] + \bar{\eta}^2\left[1 - \gamma\left(\bar{\eta}^2\right)\right] = \alpha\left[1 - \gamma\left(\alpha\right)\right] + \frac{W_2^{**}}{C}\left[1 - \gamma\left(\frac{W_2^{**}}{C}\right)\right],$$

while trade implies that

$$\eta^1 \left[1 - \gamma \left(\eta^1 \right) \right] + \eta^2 \left[1 - \gamma \left(\eta^2 \right) \right] \le \frac{W_1}{C} \times \left[1 - \gamma \left(\frac{W_1}{C} \right) \right].$$

For large values of α, post-trade provision of inputs of type 1 is lower than it is in autarky. As capital goods 1 produced by each country are perfect substitutes, such conclusion translates into a decrease of aggregate welfare subsequent to trade. While entrepreneurs in the poorer country are all strictly worse-off than in autarky, individuals in the richer country are better-off as they enjoy higher prices for type 1 inputs.

Towards a general analysis.

The two previous examples isolated the two opposite forces that determine the welfare consequences of trade. The latter case underlines the allocative gains generated by trade. As production is concave in each of its inputs, the ability to trade optimizes the allocation of each of the inputs across countries. At the other end, the former case minimizes the allocative gains of trade by assuming perfect substituability of the two type 1 inputs and emphasizes the liquidity externality: trade induces rich countries to specialize in the production of financially-dependent inputs. In the presence of spillover, financial markets deteriorate in poor countries, while those in rich countries improve, but to a lesser extent. The magnitude of excess specialization is driven by the wealth gap between the two trade partners. The following analysis addresses this issue.

Consider two economies such that (2.20) holds. Then, suppose that country 1 receives an exogenous income shock $\delta w > 0$. What is the impact of such change on the patterns of trade? To answer the question, we assume that the two countries have the characteristics described in Lemma 2. Thus, the new equilibrium will exhibit some specialization such that the following conditions prevail:

$$\begin{aligned} \delta \eta^1 &= \frac{1}{C} \delta w \\ \delta \eta^2 &= -\kappa \delta \eta^1, \end{aligned}$$

where $\kappa > 0$. We indeed consider the case where the income shock is entirely invested in

country 1, and depreciates prices of type 1 inputs so that country 2 loses $\kappa \delta \eta^1$ risky projects. The impact on welfare for country 2, $\delta \Omega^2_{trade}$, is such that

$$
\begin{aligned}
\delta \Omega^2_{trade} = {} & \left\{ \eta^2 \left[1 - \gamma \left(\eta^2 \right) \right] \left[\frac{\partial p_{12}}{\partial \eta^1} - \kappa \frac{\partial p_{12}}{\partial \eta^2} \right] + \left(1 - \eta^2 \right) \left[\frac{\partial p_2}{\partial \eta^1} - \kappa \frac{\partial p_2}{\partial \eta^2} \right] \right\} \frac{1}{C} \delta w \\
& + \left\{ \eta^2 \gamma' \left(\eta^2 \right) p_{12} \right\} \kappa \frac{1}{C} \delta w.
\end{aligned}
\tag{2.22}
$$

The first determinant on welfare of country j is the "allocation effect": by allowing country 1 to specialize in inputs of type 1, allocative gains are realized and prices reflect such changes (first term of equation (2.22)). Such gains can be mitigated or even offset by a "liquidity effect": a decrease in the number of risky projects undertaken in country 2 induces an increase in the rate of liquidation, which hurts entrepreneurs (second term of equation (2.22)). Looking at the world level, it is easy to see that allocative gains are aggregated across countries. Adding up liquidity effects for country 1 and 2, we have

$$
\Delta \equiv \left[\eta^2 \gamma' \left(\eta^2 \right) p_{12} \kappa - \eta^1 \gamma' \left(\eta^1 \right) p_{11} \right] \frac{1}{C} \delta w.
\tag{2.23}
$$

Equation (2.23) illustrates the intuition developped throughout this paper: the characteristics of the liquidation rate function $\gamma (.)$ is such that a loss of projects in country 2 has a negative effect which largely outweighs the gains of having more efficient financial markets in country 1. Thus, world aggregate liquidity decreases as a result of specialization.

Lemma 3: Liquidity loss

Consider Δ, as defined in (2.23). Under conditions described in Lemma 2, we have

$$
\Delta < 0.
$$

Equations (2.22) and (2.23) summarize the tension driving the welfare consequences of trade. The failure to internalize liquidity spillovers induces equilibria with trade to exhibit excess specialization. Poor countries lose entrepreneurs who are able to undertake risky projects, while rich countries gain from trade as they benefit from specialization and allocative gains without bearing any cost. Trade is therefore beneficial when the two partners are similar so

that scope for specialization is reduced. This is true when goods are imperfect substitutes (ρ small), or countries have comparable wealth levels.

2.5 Dynamics

In previous sections, a static analysis of trade in presence of country-level externalities revealed cases of excess specialization. Under some circumstances, trade hurts the poor country as liquidity losses outweigh allocative gains. In this section, we explore the dynamic implications of such inefficiency. In order to accomodate a dynamic analysis, some modifications of the static model are necessary. A dynastic structure is considered where agents, at the end of their lives consume and leave bequests to one offspring, so generation $T + 1$ initial distribution of wealth is determined by wealth bequeathed at the end of generation T. We moreover assume agents to have the following utility function:

$$u_i\left(c_T, b_T\right) = c_T^{1-\beta} b_T^{\beta},$$

where $\beta \in (0, 1)$, and (c_T, b_T) is the vector of consumption and bequests, respectively, that are chosen in equilibrium by generation T. It is then easy to see that wealth will follow a Markov process where generation $T + 1$ initial wealth is equal to a fraction β of generation T final wealth. In the rest of the section, subscript T will refer to generation T variables.

2.5.1 Autarkies and Integrated Economies

In autarky, equilibrium occupation choices are determined by equation (2.8). Thus the transition function that governs the sequence $(W_T)_{T \geq 0}$ of aggregate wealth is given by

$$W_{T+1} = \begin{cases} \beta A \left\{ \frac{W_T}{C} \left[1 - \gamma\left(\frac{W_T}{C}\right)\right] \right\}^{\alpha} \left\{1 - \frac{W_T}{C}\right\}^{1-\alpha} R & \text{if } \frac{W_T}{C} < \alpha \\ \beta A \left\{\alpha \left[1 - \gamma\left(\alpha\right)\right]\right\}^{\alpha} \left\{1 - \alpha\right\}^{1-\alpha} R & \text{otherwise} \end{cases}.$$

Besides, we assume that β and C are such that

$$\beta A \left\{\alpha \left[1 - \gamma\left(\alpha\right)\right]\right\}^{\alpha} \left\{1 - \alpha\right\}^{1-\alpha} R \geq \alpha C, \tag{2.24}$$

Inequality (2.24) implies that, if $W_0 < \alpha C$, then $(W_T)_{T \geq 0}$ is a non decreasing sequence and converges to the autarky long-run wealth level equal to

$$W_\infty^{aut} = \beta A \left\{ \alpha \left[1 - \gamma(\alpha) \right] \right\}^\alpha \left\{ 1 - \alpha \right\}^{1-\alpha} R. \tag{2.25}$$

By the same token, the long-run national level of wealth in an integrated economy is given by

$$W_\infty^{int} = \beta A 2^{\alpha(1/\rho-1)} \left\{ \alpha \left[1 - \gamma(2\alpha) \right] \right\}^\alpha \left\{ 1 - \alpha \right\}^{1-\alpha} R. \tag{2.26}$$

Both equilibria are characterized by wealth equality across individuals and countries in the long run. Note that we have

$$\frac{W_\infty^{int}}{W_\infty^{aut}} = 2^{\alpha(1/\rho-1)} \left[\frac{1 - \gamma(2\alpha)}{1 - \gamma(\alpha)} \right]^\alpha. \tag{2.27}$$

An integrated economy realizes allocative gains and also aggregates liquidity externalities. Figure $2 - 3$ compares the two trajectories followed.

2.5.2 Trade and the Dynamics of Financial Development

When countries are allowed to trade inputs, the dynamic behavior of trade and financial development is as diverse as in the static case. Indeed, two general patterns emerge: when trade brings positive benefits to both countries, they eventually realize all possible allocative gains in the long-run; conversely, when trade takes place between two very unequal partners, wealth differences increase through time, exacerbating excess specialization, leading to opposite development paths.

The wealth transition process is non-stationary and is given by

$$W_{T+1}^j = \beta \left\{ p_{1j} \left(\eta_T^1, \eta_T^2 \right) \eta_T^j \left[1 - \gamma \left(\eta_T^j \right) \right] + p_2 \left(\eta_T^1, \eta_T^2 \right) \left[1 - \eta_T^j \right] \right\}, \tag{2.28}$$

where (η_T^1, η_T^2) is the vector of equilibrium occupation choices in generation T. The next proposition lays long-run properties of the economy.

Proposition 6: Long-run development levels

Suppose that country 1 and country 2 are characterized by (2.20). The process $(W_T^1, W_T^2)_{t \geq 0}$

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with transition given by (2.28), is a Markov process. Let's define the vectors $\left(W_\infty^{trade}, W_\infty^{trade}\right)$ and $\left(W_\infty^1, W_\infty^2\right)$, where

$$W_\infty^{trade} = \beta A 2^{\alpha(1/\rho-1)} \left\{\alpha\left[1-\gamma\left(\alpha\right)\right]\right\}^\alpha \left\{1-\alpha\right\}^{1-\alpha} R, \qquad (2.29)$$

and, considering η^2 such that

$$\eta^2 = \inf\left\{\eta \in (0,1) \ / \ \frac{\alpha}{1-\alpha}\frac{1-\eta}{\eta} - \left[\frac{\eta\left[1-\gamma\left(\eta\right)\right]}{1-\gamma\left(1\right)}\right]^\rho = 1\right\},$$

we define

$$\begin{cases} W_\infty^1 = \beta\alpha A\left[1-\gamma\left(1\right)\right]^\alpha \left[1-\eta^2\right]^{1-\alpha}\left\{1 + \frac{\alpha}{1-\alpha}\frac{1-\eta^2}{\eta^2}\right\}^{\alpha/\rho-1} R \\ W_\infty^2 = \beta\left(1-\alpha\right)A\left[1-\gamma\left(1\right)\right]^\alpha\left[1-\eta^2\right]^{1-\alpha}\left\{1 + \frac{\alpha}{1-\alpha}\frac{1-\eta^2}{\eta^2}\right\}^{\alpha/\rho} R \end{cases} \qquad (2.30)$$

Then the sets $\left\{\left(W_\infty^{trade}, W_\infty^{trade}\right)\right\}$ and $\left\{\left(W_\infty^1, W_\infty^2\right)\right\}$ are ergodic.

If the two countries involved in trade are similar enough, allocative gains will induce both countries to grow faster than in the case of autarky. Then, both countries will reach a long-run wealth level given by (2.29). Comparing to W_∞^{aut}, the ratio of long-run wealth is equal to

$$\frac{W_\infty^{trade}}{W_\infty^{aut}} = 2^{\alpha\left(\frac{1}{\rho}-1\right)}.$$

Although, in an equilibrium with trade, countries do not share liquidity shocks, allocative gains drive the ratio of long-run wealth levels and are all the more important than the type 1 inputs produced by each country are imperfect substitute. In case of perfect substituability ($\rho = 1$), trade has no long-run effect compared to the no-trade case. Conversely, when trade involves two countries with a large wealth difference, the poorer country experiences a deteriorating financial environment. Then, the wealth gap is increasing until the economies converge to long-run wealth levels as characterized in Proposition 6. Figure 2-4 describes possible dynamics that countries may follow. While country 1 is strictly better off than in autarky, the long-run wealth of country 2 is below its closed-economy level. To see this, we can just notice that if p_2^∞ is the long run price of type 2 inputs, we have

$$W_\infty^2 = \beta p_2^\infty.$$

Thus, as the number of entrepreneurs in country 2 who undertake riskless projects exceeds $1 - \alpha$, their rewards are lower than in the autarky case:

$$p_2^\infty < \beta (1 - \alpha) A \left[\frac{\alpha [1 - \gamma(\alpha)]}{1 - \alpha} \right]^\alpha .$$

To sum up, trade will induce parallel economic and financial development when economic partners present similar characteristics ("EQUAL TRADE" curve), while when wealth gaps are large, excess specialization will induce two opposite trends: an impoverishing country losing competence ("UNEQUAL TRADE: COUNTRY 2" curve) and a fast developing country specializing in the capital intensive technology ("UNEQUAL TRADE: COUNTRY 1" curve).

2.6 Concluding Remarks

Against a well-accepted fact that trade is beneficial to both partners, we presented a simple model, in which country-level externalities could induce excess specialization when countries differ significantly. Such market failure could then potentially offset the allocative benefits associated to trade.

The positive externality assumed in the model yields a technology with increasing returns. Thus, our model has the same implication as Acemoglu and Ventura [2002]: economies may converge to a steady-state world income distribution with a rich North and a poor South. The presence of trade and specialization is such that there is no unconditional convergence, while in autarky, countries further away from the steady state grow faster, thus catching up with richer countries. This suggests that a temporary protectionist policy may induce some degree of convergence before trade realizes allocative benefits. The same conclusion holds in Krugman [1987], in which the externality is instead driven by learning-by-doing rather than financial development.

One important feature in the model is the absence of savings instruments so that liquidity shocks cannot be smoothed over time. Relaxing this assumption and allowing governments to issue bonds (see Holmström and Tirole [1998]), would not qualitatively change our results, provided that governments do not have free access to a world financial market. Indeed, smaller economies are still hit with larger aggregate shocks, inducing poorer economic performance. A

second extension which is worth considering is the definition of financial development. So far, financial development is entirely driven by the size of the economy, as we have been dealing with a simplified framework: financial resources move at no cost between firms within a given country but no capital flows take place between countries. To reconcile our model with the existence of cross-country capital flows and the variety in the levels of financial development across countries (see e.g. La Porta et al. [1998]), some exogenous determinants of financial development need to be brought into the picture. Although such extension deserves a deeper analysis, the results derived in this paper are likely to persist if not exacerbated.

The model we presented predicted that trade induces countries with poor financial development to specialize in industries with low financial needs. While this prediction finds empirical support (see Beck [2002]), little has been observed concerning the welfare implications of such a specialization pattern. An empirical investigation of the interplay between trade and financial development therefore remains on the research agenda.

2.7 Appendix

Proof of Lemma 1:

γ^t is a random variable with the following probability distribution:

$$\gamma^t = \begin{cases} 0 & \text{with probability } \frac{1}{2} \\ 1 - \frac{2k}{\eta} & \text{with probability } \frac{1}{2^\eta}\binom{\eta}{k} \text{ for } 0 < k < \frac{\eta+1}{2} \end{cases},$$

and this implies that

$$E\left(\gamma^t\right) = \frac{1}{2^\eta}\begin{pmatrix} \eta - 1 \\ Int\left(\eta/2\right) \end{pmatrix} \equiv \gamma\left(\eta\right)$$

and it is easy to check that $\gamma\left(1\right) = 1/2$ and $\lim_{\eta \to \infty} \gamma\left(\eta\right) = 0$. Furthermore the sequences $\left\{2\eta\left[\gamma\left(2\eta\right) - \gamma\left(2\eta + 2\right)\right]\right\}_{\eta \geq 1}$ and $\left\{\left(2\eta - 1\right)\left[\gamma\left(2\eta - 1\right) - \gamma\left(2\eta + 1\right)\right]\right\}_{\eta \geq 1}$ are positive and decreasing. In the rest of the paper, the notation $\gamma'\left(\eta\right)$ will refer to $\frac{1}{2}\left[\gamma\left(2k + 2\right) - \gamma\left(2k\right)\right]$ if η is of the form $\eta = 2k$ for some $k \geq 1$ and $\frac{1}{2}\left[\gamma\left(2k + 1\right) - \gamma\left(2k - 1\right)\right]$ if η is of the form $\eta = 2k - 1$ for some $k \geq 1$.

Q.E.D.

Proof of Proposition 1: omitted.

Proof of Corollary 1:

Rewriting the arbitrage condition (2.7) in terms of η, the expression becomes:

$$\alpha A \left[\frac{1 - \eta}{\eta \left[1 - \gamma \left(\eta \right) \right]} \right]^{1-\alpha} R \left[1 - \gamma \left(\eta \right) \right] - rC = \left(1 - \alpha \right) A \left[\frac{\eta \left[1 - \gamma \left(\eta \right) \right]}{1 - \eta} \right]^{\alpha} R,$$

which can be simplified to

$$\alpha AR \left(\frac{1 - \eta}{\eta} \right)^{1-\alpha} - \frac{r}{\left[1 - \gamma \left(\eta \right) \right]^{\alpha}} C = \left(1 - \alpha \right) AR \left(\frac{\eta}{1 - \eta} \right)^{\alpha}.$$

When interest rates drop to zero, the arbitrage condition becomes

$$\alpha AR \left(\frac{1 - \eta}{\eta} \right)^{1-\alpha} = \left(1 - \alpha \right) AR \left(\frac{\eta}{1 - \eta} \right)^{\alpha},$$

which implies that

$$\eta = \alpha.$$

Q.E.D.

Proof of Corollary 2: omitted.

Proof of Proposition 2: omitted.

Proof of Proposition 3: omitted.

Proof of Proposition 4:

In order to produce risky inputs at full capacity, it must be the case that in both countries, interest rates r^j are strictly positive, which implies $\forall j = 1, 2$

$$\frac{p_{1j}}{p_2} \left[1 - \gamma \left(\eta^j \right) \right] > 1. \tag{2.31}$$

and after substitution,

$$\frac{\alpha}{1 - \alpha} \frac{2 - \eta^j - \eta^{3-j}}{\eta^j} - \left[\frac{\eta^{3-j} \left[1 - \gamma \left(\eta^{3-j} \right) \right]}{\eta^j \left[1 - \gamma \left(\eta^j \right) \right]} \right]^{\rho} > 1. \tag{2.32}$$

Thus, there exists $\bar{\alpha}^j \in (0,1)$, such that for any $\alpha \geq \bar{\alpha}^j$ and for any $\eta^{3-j} \leq \int_0^{+\infty} w dG^{3-j}(w)$, equation (2.32) holds for $\eta^j = \int_0^{+\infty} w dG^{3-j}(w)$.

Finally, by choosing $\bar{\alpha} = \max(\bar{\alpha}^1, \bar{\alpha}^2)$, any equilibrium with trade verifies inequality (2.31) for $j = 1, 2$.

Q.E.D.

Proof of Proposition 5 (sketch):

The proof is similar to the proof of Proposition 4. As inequality (2.32) must hold for $\eta^j = \alpha$, it is sufficient to assume that α is large enough so that (2.32) holds for $\eta^j = \alpha$, when η^{3-j} can take any value in $(0, 1]$. Denoting $\bar{\alpha}^j$ such value, Proposition 5 holds when choosing $\bar{\alpha} = \max(\bar{\alpha}^1, \bar{\alpha}^2)$.

Q.E.D.

Proof of Lemma 2:

Consider the two arbitrage conditions faced by entrepreneurs in country 1 and 2 respectively; equation (2.32) must hold:

$$\frac{\alpha}{1-\alpha} \frac{2 - \eta^j - \eta^{3-j}}{\eta^j} - \left[\frac{\eta^{3-j} \left[1 - \gamma(\eta^{3-j}) \right]}{\eta^j \left[1 - \gamma(\eta^j) \right]} \right]^{\rho} \geq 1.$$

Let's set a wealth level $W_1 > C$, and define the following thresholds:

1- W_2^1 is the highest possible wealth level such that country 1 undertakes a number of risky projects equal to 1, when country 2 undertakes W_2^1/C projects:

$$W_2^1(\alpha) = \sup \left\{ W \in [0, 1/C] \, / \, \frac{\alpha}{1-\alpha}(1 - W/C) - \left[\frac{W/C \left[1 - \gamma(W/C) \right]}{1 - \gamma(1)} \right]^{\rho} > 1 \right\}.$$

It is straightforward to see that such $W_2^1(\alpha)$ always exists. Furthermore, $W_2^1(\alpha)$ is an increasing function of α.

2- W_2^2 is the lowest wealth level such that any country 2 with wealth $W_2 \leq W_2^2$, always invest at full capacity when country 1 is undertaking a measure 1 of risky projects:

$$W_2^2(\alpha) = \inf \left\{ W \in [0, 1/C] \, / \, \frac{\alpha}{1-\alpha} \frac{1 - W/C}{W/C} - \left[\frac{1 - \gamma(1)}{W/C \left[1 - \gamma(W/C) \right]} \right]^{\rho} < 1 \right\}.$$

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Such threshold exists. Furthermore, we notice that W_2^2 is decreasing in ρ, and increases with α.

3- W_2^3 is the lowest wealth level above W_2^2 such that countries with wealth equal to W_2^2 can invest at full capacity:

$$W_2^3(\alpha) = \inf\left\{ W \in \left(W_2^2, 1/C \right] / \frac{\alpha}{1-\alpha} \frac{1 - W/C}{W/C} - \left[\frac{1 - \gamma(1)}{W/C\left[1 - \gamma(W/C)\right]} \right]^\rho = 1 \right\}.$$

As we saw in proposition 5, for high enough values of α, such threshold exists.

Finally, as ρ gets closer to 1, W_2^2 tends to zero, so that we can set

$$W_1^* = C$$

$$W_2^* = W_2^2$$

and

$$W_2^{**} = \min\left[W_2^1, W_2^3\right],$$

so that we have

$$W_2^* < W_2^{**}.$$

By construction, for country 2 such that $W_2 \in (W_2^*, W_2^{**})$ and country 1 such that $W_1 \geq C$, allowing for trade will induce country 2 to undertake W_2^*/C risky projects and country 1 will undertake a measure 1 of projects.

Q.E.D.

Proof of Lemma 3:

The situation we consider is the following:

- before income shock, country 2 is characterized by

$$p_{12}\left(1 - \gamma\left(\eta^2\right)\right) > p_2,$$

so that all resources are used to fund risky projects.

- after income shock, we have

$$p_{12}\left(1 - \gamma\left(\eta^2\right)\right) = p_2.$$

Now, if we define

$$f\left(\eta^1, \eta^2\right) = p_{12}\left(1 - \gamma\left(\eta^2\right)\right) - p_2,$$

then we have the following property:

$$\kappa > \left|\frac{\frac{\partial f}{\partial \eta^1}\left(\eta^1, \eta^2\right)}{\frac{\partial f}{\partial \eta^2}\left(\eta^1, \eta^2\right)}\right|,$$

which translates into:

$$\kappa > \left|\frac{\frac{\partial p_2}{\partial \eta^1} - \frac{\partial p_{12}}{\partial \eta^1}\left(1 - \gamma\left(\eta^2\right)\right)}{\frac{\partial p_2}{\partial \eta^2} - \frac{\partial p_{12}}{\partial \eta^2}\left(1 - \gamma\left(\eta^2\right)\right) + \gamma'\left(\eta^2\right)p_{12}}\right|.$$

The following relations also hold:

$$\frac{\partial p_2}{\partial \eta^1} = \frac{\partial p_2}{\partial \eta^2}$$

$$-\frac{\partial p_{12}}{\partial \eta^1} \leq -\frac{\partial p_{12}}{\partial \eta^2}$$

$$\gamma'\left(\eta^2\right)p_{12} < 0$$

so that

$$\kappa > 1.$$

The properties of $\gamma\left(.\right)$ and as $p_{12} > p_{11}$, we thus have

$$\left|\eta^2\gamma'\left(\eta^2\right)p_{12}\kappa\right| > \left|\eta^1\gamma'\left(\eta^1\right)p_{11}\right|.$$

Q.E.D.

Proof of Proposition 6:

The steady state defined by (2.29) is obtained when the two countries, for example, start with equal wealth levels. We therefore focus on states defined by (2.30). The situation refered to in this case occurs when country 2 is severely cash constrained so that it cannot achieve high

levels of investment. Such situation is depicted in Lemma 2. High liquidation rates then induce underinvestment, so that the occupation choice equation for country 2 at time t is given by

$$p_{12}\left(1,\eta^2\right)\left[1-\gamma\left(\eta^2\right)\right]=p_2\left(1,\eta^2\right),$$

or after substitution

$$\frac{\alpha}{1-\alpha}\frac{1-\eta^2}{\eta^2}-\left[\frac{\eta^2\left[1-\gamma\left(\eta^2\right)\right]}{1-\gamma\left(1\right)}\right]^\rho=1,$$

while for country 1,

$$\eta^1=1.$$

The corresponding wealth dynamics is then governed by

$$W_{t+1}^1=\beta\alpha A\left[1-\gamma\left(1\right)\right]^\alpha\left[1-\eta^2\right]^{1-\alpha}\left\{1+\frac{\alpha}{1-\alpha}\frac{1-\eta^2}{\eta^2}\right\}^{\alpha/\rho-1}R,$$

while

$$W_{t+1}^2=\beta\left(1-\alpha\right)A\left[1-\gamma\left(1\right)\right]^\alpha\left[1-\eta^2\right]^{1-\alpha}\left\{1+\frac{\alpha}{1-\alpha}\frac{1-\eta^2}{\eta^2}\right\}^{\alpha/\rho}R.$$

To verify that $\left(1,\eta^2\right)$ is a long-run equilibrium, we argue that there exists β^1,β^2 and β^3 such that we have

$$
\begin{aligned}
W_{t+1}^1 &\geq W_T \text{ for } \beta\geq\beta^1\\
W_{t+1}^2 &\geq W_T \text{ for } \beta\geq\beta^2
\end{aligned}
$$

and, when $\beta\leq\beta^3$, for any $w\in\left(\eta^2C,W_{t+1}^2\right)$,

$$\frac{\alpha}{1-\alpha}\frac{1-w/C}{w/C}-\left[\frac{w/C\left[1-\gamma\left(w/C\right)\right]}{1-\gamma\left(1\right)}\right]^\rho<1.$$

As we can find $\beta^1\leq\beta^2$ and by construction $\beta^3\geq\beta^2$, it is then sufficient to choose any $\beta\in\left[\beta^2,\beta^3\right]$ to insure that the equilibrium occupation choices $\left(1,\eta^2\right)$ are dynamically stable. Q.E.D.

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t *Liquidity shock: L_t* $t+dt$

Refunded $R_t = R$

Liquidated $R_t = 0$
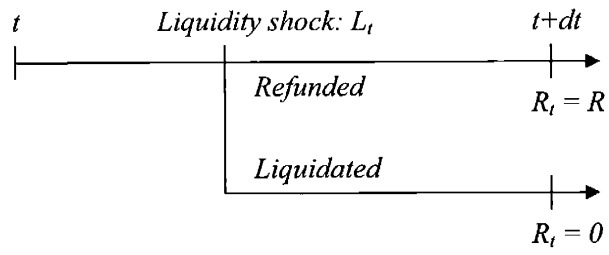
Figure 2-1: Timing of the risky project

$t = 0$ $t = 1$
occupation choice   *Intermediate goods production*   *final production*

Risky Project

Risk-free Project
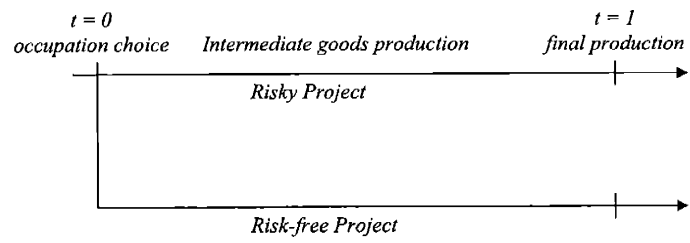
Figure 2-2: Timing of the static economy
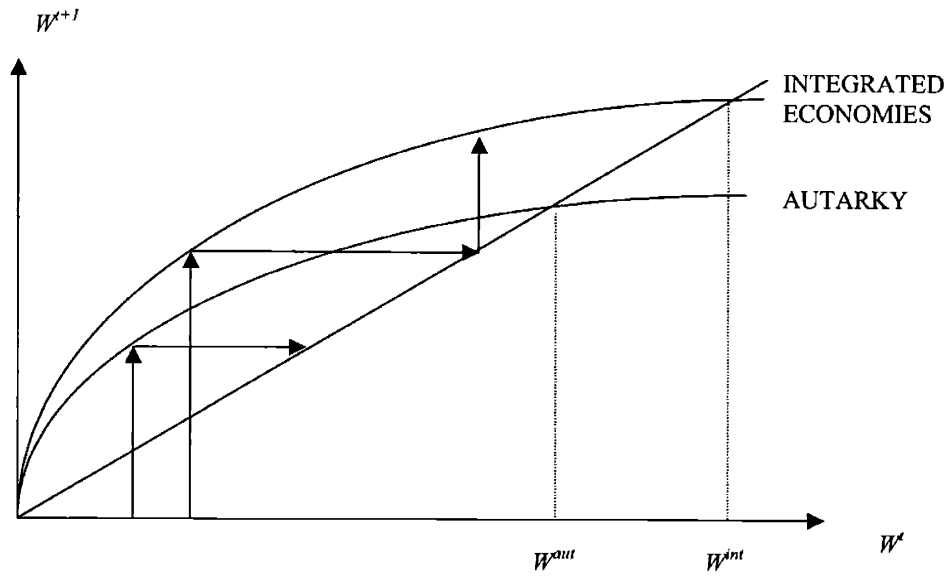
Figure 2-3: The dynamics of financial development - autarkies and integrated economies
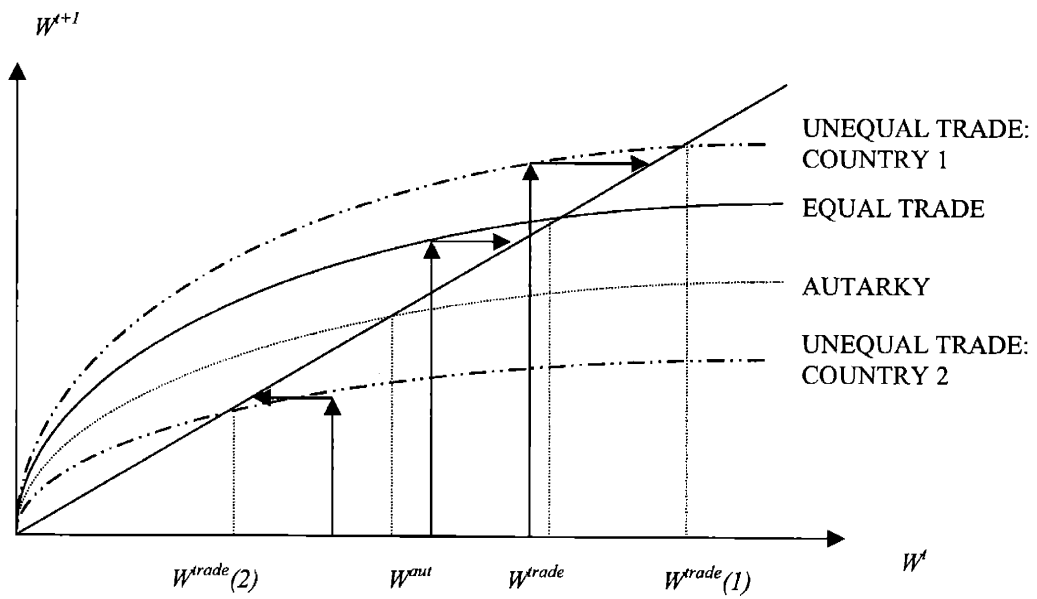
Figure 2-4: The dynamics of trade and financial development

Chapter 3

Land Rights and Economic Development: The Case of Vietnam

3.1 Introduction

Land rights are an important issue in developing countries where land is a major asset for most people and the product of agriculture accounts for a large share of national income. There is a certain amount of consensus among economists that better land rights lead to better outcomes. However, the empirical evidence is not conclusive on which dimensions of land rights are crucial. We do not have complete answers to several questions: is ownership of land the most important, or is it the ability to transform land into working capital that matters? Is government legislation effective in providing better land rights, or is everything determined by local conditions? For instance, Besley [1995] shows, for the particular case of Ghana, that a greater degree of land rights leads to more investment on the land; however, in the specific setting he is focusing on, such institutions are determined by social custom rather than conferred by the State. Similarly, Banerjee, Gertler and Ghatak [2001] argue that increasing tenants' bargaining power increases agricultural productivity, but it is not clear whether changing other features of the structure of land rights would have the same impact. This paper therefore investigates the impact of a specific legal change to land rights in Viet Nam on agricultural investments and productivity.

Since 1986 and the "Doi Moi" policy, Viet Nam progressively moved towards a market economy. As far as land rights are concerned, the regulatory environment witnessed two major

changes. In 1988, the collective system was abandoned in favor of private ownership. While land still remains the property of the State (Land Law 1993, Article 1), rights to use the land were assigned to individuals over a period of up to fifteen years. However, such rights were not tradeable. In 1993, a new land law was enacted and in addition to an increased lease term, land-use rights could now be inherited, transfered, exchanged, leased and mortgaged. The law of 1993 is therefore seen as setting the foundations of a formal market for land. This paper investigates the incremental impact of the 1993 land reform on economic outcomes. Since the law was implemented through the issuance of Land Use Certificates (LUCs), and as the issuance of LUCs was not uniform across the country, our empirical strategy relies on such heterogeneity to identify the effect of formal land rights on economic decisions and outcomes.

Although an entire section of this paper provides a deeper theoretical analysis, we briefly outline how the 1993 land law might have a positive impact on efficiency. *First*, an increased lease term together with the right to bequeath LUCs makes farmers even less liable to expropriation from the State, than they were after 1988. More generally, the 1993 land law is perceived as an additional signal from a government, that wants to commit to secure property rights. Households are therefore expected to achieve greater efficiency in their investment decisions. *Second*, the right to mortgage land rights can be expected to make access to credit easier, especially from formal sources such as State-owned banks. The impact is then twofold: on the one hand, the ability to borrow ex-ante induces agents to invest more efficiently; on the other hand, the ability to borrow ex-post allows individuals to smooth consumption, and hence avoid costly income smoothing. *Third*, the dispositions of the law that make LUCs tradeable are likely to translate into allocative efficiency gains. This is even more relevant to the case of Viet Nam: as initial allocation was made on a fairness basis, farmers happened to receive up to twenty small plots each, often far from one another. We then expect to observe land consolidation aimed at realizing economies of scale. These three channels suggest that land rights should increase economic efficiency.

In order to assess the impact of the 1993 land law, we use pre-reform and post-reform household-level data. Although we do not have individual-level information on LUC issuance, provincial-level status of registration are available. Hence, individuals will be assigned the percentage of LUCs granted in the province they live in, thus interpreted as the likelihood they

benefited from the reform. Although the differences in registration levels can be induced by factors that also affect our variables of interest, we argue that between-province heterogeneity is due to bureaucratic performance and other exogenous reasons, that are unlikely to simultaneously influence the outcomes we are interested in. A differences-in-differences estimation strategy then allows us to observe whether households more exposed to the reform are more willing and able to undertake long-term investments. We find that farmers in highly-registered provinces implement larger changes in their portfolio of activities: they invest relatively more in multi-year crops and devote more resources to irrigation. These results are consistent with our hypothesis that land-rights increase the ability and willingness to take long-term investments. However, we do not observe any significant impact of the reform on measures of agricultural productivity.

The paper is structured as follows: sections 3.2 describe the process of reform and land policies in Viet Nam, section 3.3 discusses the possible impacts of the land law and section 3.4 describe our data and empirical strategy. Our main results are discussed in section 3.5 and some further remarks are given in section 3.6. Section 2.6 concludes.

3.2 Land Rights in Viet Nam

The history of Viet Nam in the second half of the twentieth century is punctuated by three key dates: 1954 marked the independence of the country from the French and its division into two parts, North and South; in 1975, the so-called "Viet Nam war" ended with the reunification of North and South Viet Nam, and 1986 corresponds to the implementation of sweeping economic reforms (the "Doi Moi" policy) and a move towards a market-oriented economy, which continues to the present day.[1]

3.2.1 The institutional framework until 1988

Before the Geneva Accord of 1954, Viet Nam was under French control. During the Colonial period, most farmland in Viet Nam was owned either by French plantation owners or by large

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[1] This material in this section is largerly based on Boothroyd and Pham [2000], Pingali and Vo-Tong [1992], and Wiegersma [1988]

Vietnamese landlords: 52 percent of the land was owned by only 3 percent of the indigenous population and more than 60 percent of farmers across the country were landless in the mid-1940s.

After independence in the North, a major land reform was carried out. As a reward for their war efforts, land and ownership rights were distributed to farmers and a rapid increase in agricultural output and productivity followed. However, the policy was reversed and land began to be collectivized in the late 1950s, as Communist ideology gained strength. As a result, 86 percent of all peasant households and 68 percent of total farmland, were brought into cooperatives by 1960. Despite significant declines in output, the collectivization process continued so that 90 percent of all peasant households in the North were working in cooperatives by the mid-1960s. An illuminating stylized fact illustrates the impact of such an incentive system: while individual rural households were privately allocated 5 percent of farmland, they derived 60 to 70 percent of their earnings from this small plot.

Land institutions in the South during that same period were driven by political conflicts. At times where the government sought support from the local elites, pro-landowner policies were adopted. When the war against North Viet Nam began, the government tried to gain popular support by adopting the Land-to-the-Tiller law in 1970. Tillers of the soil were to enjoy all the benefits of their work, and this would be accomplished by providing ownership rights to cultivators and putting a retention limit on landlords as low as 20 hectares. However, the law found opposition from landlords and the lack of independence of the bureaucracy made enforcement uneven throughout South Viet Nam. Of the 1 million hectares initially aimed at being redistributed, more than 700 000 hectares were exempted from expropriation!

In 1975, when the war ended and the country was reunified, land collectivization started in the South but was implemented with little success: as late as 1986, only 5.9 percent of farmers in the Mekong Delta and 20 percent in the Southeastern region were part of cooperatives, while this figure amounted to 85 percent in the Central Lowlands region. Under the collective system, all households were paid a share of output according to their recorded labor hours on the communal land. In 1981, the first changes were made to these arrangements: workers were now allowed to keep all of the surplus they produced over a contracted output. However, this policy was later modified and quotas were constantly renegotiated, resulting in a decline of

public confidence. Agricultural yields were extremely low in this period and even as late as 1985, Viet Nam was a net importer of rice.

Faced with a worsening economic crisis, the government announced the program of "Doi Moi" (literally "change and newness") in 1986 and began a gradual movement towards a market economy. As part of a major structural adjustment program, production and consumption subsidies were eliminated from the State budget, government spending was reduced to 6 percent of Gross Domestic Product (GDP), the government work force was reduced by 15 percent, 500 000 soldiers were demobilized, interest rates on loans to State-owned firms were raised and central bank credit was no longer used to finance the budget deficit. The economy started opening up to trade, and the central bank undertook a massive devaluation of the currency to the prevailing black market rate bringing inflation rates from 400 percent in 1986-87 down to 10 percent in 1993. Financial markets were partly deregulated, foreign banks are now allowed to operate in Viet Nam and a stock exchange was opened in 2000. In the agricultural sector, Resolution 10 of 1988 granted land-use rights to individual households, while the land law of 1993 made these rights pledgeable and tradeable. These two changes are described in detail in following sections.

These reforms have had a dramatic impact on the economy. Government revenue and spending began increasing after 1991. Agricultural production increased rapidly after 1988, and Viet Nam is currently a major exporter of rice, as well as cash crops like coffee, pepper and cashew. Exports accounted for 79 percent of GDP by 1995, and the economy has experienced a growth rate of above 8 percent in the 1990's. Agriculture now accounts for only 25 percent of GDP, down from 40 percent in 1989. The benefits from growth have been fairly widespread: poverty rates are estimated to have declined from 75 percent in 1984 to 55 percent in 1993.[2]

3.2.2 The 1988 Land Law - Resolution 10

A reform undertaken in 1981 allowed households to keep any surplus above a quota level. Such reform was a failure partly because the government did not manage to commit not to raise quotas, always extracting more surplus from farmers. The lack of commitment from the authorities eventually destroyed individual incentives. Then came Resolution 10 of the 1988

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[2]See Dollar and Litvack [1998]

land law, aimed at recovering credibility by further liberalizing the agricultural sector in Viet Nam. The reform consisted of transfering control and cash-flow rights from the cooperative to the individual household. Land was allocated to households with a fifteen-year security of tenure and tacit renewal, output markets were privatized and investment decisions were decentralized and left to households. Private property was virtually instituted. However, as land-use rights were given to families without the possibility to trade such rights, a proper land market did not develop despite some informal transactions.

Land allocation to individual households was conducted by the commune authorities, and encountered some difficulties across the country. In the North and in some regions of the South, land was distributed on a *fairness* basis, taking into account soil and socio-demographic characteristics of the region. Hayami [1993] reports that "a farmer (...) in Hai Hung Province complained that he received too small a land allocation because his eldest son was in military service and his other children were so young that they received only one-third of an adult's allocation at a time. Thus, he expects that his unfavorable allocation will be corrected at the end of the ten-year tenure period" (p. 13). Such statement confirms the presumption that land allocation sometimes relies on arbitrary considerations, leading to favoritism and disputes. The situation in the South is by no means simpler. As we described previously, the land redistribution program undertaken in the South in the early 1970s was far from being completed in 1975. Resolution 10 furthermore stipulated that farmers should be assigned the land they owned prior to 1975 and this generated disagreement between farmers and former landlords, although a 1989 ordinance gave rights to farmers. The allocation was thus not immune to controversy and disputes were still being settled in July 2001, as land allocation was being brought to completion in rural areas.

To many Vietnamese, Resolution 10 is perceived as the major land reform undertaken since 1975 and some scholars attributed Viet Nam's agricultural output growth to such liberalization (see e.g. Pingali and Vo-Tong [1992]). There is no denying that newly assigned property rights must have unleashed farmers' incentives to invest and put effort, but much remained to be done to achieve further economic efficiency. The 1993 land law is an additional step towards this end.

3.2.3 The 1993 Land Law and the Issuance of Land Use Certificates

The main focus of this paper is the 1993 land law. The spirit of the law is in continuation of the reforms undertaken by the government since 1988. Despite the allocation of land and its corresponding use-rights, no transaction could yet be made officially. The 1993 land law made up for this deficiency. It granted five rights to the household: the right to transfer, exchange, inherit, rent and mortgage.[3] The implementation of the land law consisted of provision of LUCs. As the actual procedure has some interest for our empirical strategy, it is worth going into some details.

The issuance of LUCs is done as follows: individuals have first to apply for a Land Use Certificate (alternatively known as Land Tenure Certificate or the Red Book) through the commune-level People's Committee. The district Bureau of Land Administration then does the groundwork, which includes making a list of all land users, training the staff, purchasing materials, checking and updating the documents related to land such as cadastral maps, land survey records etc. In the meantime, a Land Registration Committee is set up, which includes members from the District Bureau of Land Administration, as well as officials from the commune-level, district-level and sometimes province-level People's Committees. This process takes about four or five weeks. Application forms for land registration are then given out to all the land-users in the commune, who are asked to list all the plots of land owned or allocated to them. This form has finally to be signed, not only by the land user himself, but also by all neighboring households in order to certify the absence of dispute regarding claims on the land.

The Land Registration Committee scrutinizes all these forms and then decides whether a given land-user is eligible or not. Land-users are classified as ineligible if (i) they obtain the land through an illegal land transfer i.e. without registering the transaction, without paying transfer taxes, or without a legal contract, (ii) they inherit the land from parents without a formal inheritance letter, so that old documents are still in the parents' names, (iii) they have no legal documents to prove their claim to the land, (iv) they are illegally occupying unallocated land, (v) they have not paid all their land taxes in the past, or (vi) there are disputes regarding their

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[3] There were further modifications to the land law in 1998 and recently in July 2001. The 1998 revisions granted further rights by making it possible to sub-lease land and they moreover allowed Vietnamese entrepreneurs to use such rights as contribution in a joint venture with a foreign company. The 2001 additions simplified procedures in urban areas.

ownership or the boundaries of the land they claim. Within 10 days of sending these application forms, a public meeting is held where information regarding eligibility is made public. At this time, the land administration also tries to resolve these disputes. The list of land users who are eligible for receiving the LUC is then sent to the distict-level People's Committee. Unresolved disputes are referred to a special working group within the Department of Land Administration. After approval at the district-level, work begins on making the actual LUC for the land-user. This stage is estimated to take about 1500-2000 mandays per commune in urban areas, and this figure is unlikely to be much different in rural areas.

Similarly to previous land reforms, the 1993 land law was unevenly implemented throughout the country. Because province-level differences in the level of registration, i.e. the percentage of households registered, is the keystone of our empirical strategy, we investigate the sources of such heterogeneity. According to Vo [1997], district Bureaus of Land Administration have on average five members and most communes have only one land officer, which makes registration a lengthy process. Haque and Montesi [1996] also report the major reasons for this slow progress to be "a lack of adequate finances, a lack of trained cadres, a lack of interest and enthusiasm on the part of officials, a lack of proper direction and supervision and disputes among the cadres", which is consistent with the information given to us by the General Department of Land Adminstration, henceforth GDLA. As we mentioned earlier, a phenomenon which is likely to slow down the process is the number of disputes that can emerge in villages. The way allocation was made, the existence of pre-existing property rights, the personality of the head of the village are as many determinants that can cause one region to achieve faster registration than another one. An additional reason for delay may also be due to the fees related to registration and the backlog of taxes that some households may be required to pay to become eligible. However fees are not very high, below VND 20 000 (less than USD 1.50) in most areas. Besides, in an effort to increase land registration rates, the government has even made it free for people residing in remote and mountainous areas, and the payment of overdue taxes was no longer a prerequisite for the issuance of LUCs.

By the end of 1994, about 24 percent of households in a province had been issued land-use certificates on average. In 1997, 44 percent of land users had been granted certificates, but the figure was only 3 percent in urban areas (Vo [1997]). In an interview in July 2001, the Deputy

Director General of the GDLA further reports that in the first three years after the law was passed, over 40,000 cases were discovered where the law was being violated, and he concludes that "the work of land management was still being relaxed and the land law was not regularly publicized by local authorities." By 1998, certificates had been issued to 71 percent of rural households.[4] At the end of 2000, 90 percent of land users in rural areas had been granted land use certificates, and the process is expected to have been completed at the end of 2001. However, in urban areas, only 16 percent of land users have been issued certificates, and the process is not expected to be completed before 2005. Meanwhile, entrepreneurs are now allowed to use their land for collateral without a LUC, provided they have papers certifying land allocation or land rent receipts.[5]

The map in figure 1 shows the geographical distribution of registration levels in 1994 and 1998. Each province is categorized as low, middle-low, middle-high or high depending on the quartile it belongs to, quartiles being obtained from the distribution of registration levels across provinces. A quick glance at the maps does not reveal any obvious North-South pattern, in spite of the North's longer history of collectivization.[6]

3.3   What does the theory tell us?

What is likely to be the impact of the land law and more specifically the issuance of LUCs? Rights to transfer, exchange, lease, inherit, and mortgage LUCs are expected to improve economic efficiency through different channels. This section reviews briefly the potential impacts of each of the rights, borrowing intuition and exhaustiveness from Besley [1995].

Tradeable Land-Use Certificates: The rights to transfer, exchange, lease, and then sublease LUCs creates a formal market for land. Land transactions are now possible at a larger scale. We then expect a better allocation of land and the realization of economies of scale, which translate into higher yields. Indeed, a market for land should induce consolidation of highly fragmented

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[4] Figures from GDLA registration data.

[5] Joint circular of the State Bank, the Ministry of Justice, the Land Adminstration and the Ministry of Finance dated November 21, 2000.

[6] In 1994, provinces in the North had on average 24 percent of households registered, while provinces in the South had a registration level of 23 percent. The corresponding figures for 1998 were 74 percent and 69 percent.

ownership of land, as we saw earlier on, as well as transfers of land from less productive to more productive farmers.

Secure Land-Use Certificates: The longer lease term and the right to inherit (and thus bequeath) that came with LUCs have the impact to decrease the likelihood that an individual and her offspring will be expropriated by the State. However, with Resolution 10, though tenure was given for 10 years, tacit renewal and transfer within the family were the rule. In that respect, the 1993 Land Law is an incremental improvement of ownership security vis-à-vis Resolution 10, as it makes such provision formal and constitutes an additional signal sent by a government which seeks to build a reputation of enforcing private ownership. Thus, we expect the land law of 1993 to increase farmers' willingness to undertake long-term investments. Furthermore, it is worth noticing that if we only look at the potential impact of the reform on, say, annual crop yields, the effect of secure land rights on the intensive margin is ambiguous as it depends on the consequences on the extensive margin: land rights give farmers the incentive to undertake long-term investments, therefore focusing on perennial crops at the expense of annual crops.

Pledgeable Land-Use Certificates: In a world with imperfect credit markets, property rights are, as stated by De Soto [2000], a way to transform illiquid assets into money. Without collateral, no individual would be able to run a profitable project when some fixed cost exceeds their net worth. Thus, a certificate that can be pledged against a loan gives access to profitable investments. We thus expect LUC holders to be able to access credit at lower costs, using formal channels such as banks. While security of tenure increases the willingness to invest, pledgeable rights boost the ability to do so. The credit channel has moreover a second dimension. LUCs can be pledged as collateral ex-post, i.e. to smooth consumption in case of a bad shock. Individuals are now able to smooth consumption directly and hence avoid costly income smoothing strategies. Depending on risk-aversion, wealth levels and local credit market conditions, the ability to pledge rights may decrease or increase the extent to which individuals are diversifying their activities. More diversification would suggest that farmers have a higher ability to self-insure, while less diversification suggests that the ability to smooth consumption ex-post allows agents to specialize in the more productive technology available to them. The

overall observed impact of pledgeable land-rights becomes an empirical issue.

3.4 Data and Empirical Strategy

3.4.1 Data

Our major source of data are the two rounds of the Viet Nam Living Standards Survey (VNLSS), conducted by the General Statistical Office (GSO) of the Government of Viet Nam and funded by the United Nations Development Program (UNDP) and the World Bank under the Living Standards Measurement Study (LSMS). The surveys follow established LSMS practices and is considered a high-quality data set. They contain detailed information on household size and composition, educational attainment, health, employment, fertility, migration, household expenditures, agricultural activities, non-farm economic activities and borrowing and lending activities. The first round of the survey was conducted in 1992-93 (henceforth VNLSS-93) and the second round was conducted in 1997-98 (henceforth VNLSS-98). We take the former as our pre-reform baseline data and the latter as our post-reform outcomes. The surveys have a panel dimension in the sense that 4285 of the 4800 households interviewed in 1993 were re-interviewed in 1998. However, in most of our regressions, we will treat the two surveys as repeated cross-sections. There is also some attrition between the two surveys, which is around 7% in rural areas.

We have data on land registration (percentage of households who have been issued with a land-use certificate) at the province-level for 1994, 1998 and 2000. These data come from the records of the General Department of Land Administration (GDLA) in Hanoi. We also have data on province-level population, agricultural yields, local government investments etc. from the annual Statistical Yearbooks published by the General Statistical Office (GSO). We use some data from the 1994 Agricultural and Rural Census conducted by the Ministry of Agriculture and Rural Development (MARD), which has detailed information on the infrastructure facilities in rural areas in 1994.

3.4.2 Empirical Strategy

Ideally we would like to compare investment and productivity across two identical households who differ only in the quality of land rights possessed by them. In our setting, we take the possession of a land-use certificate as an indicator of having good land rights. However we do not have household level data on land registration, since the VNLSS does not ask this question. We therefore use province-level registration rates as a measure of the probability that a given household would have a LUC. We will thus be using the differences in the rate of issuing land use certificates across provinces to identify the impact of the Land Law.

Our major focus will be on measures of long-term agricultural investment. We will use the farmers' decision to switch crops away from food crops to more valuable cash crops to measure longer-term investments, since many of these crops (coffee, pepper, fruit trees etc.) require large initial investments and a longer time before returns are realized. We will also look at measures of irrigation (which could be either long-term or short-term investment), as well as short-term investments like fertilizer and pesticide use. We will also look at households' labor input into agriculture. However, as discussed in the theory section, the impact of the land reform on this is a little ambiguous: while greater security of tenure could lead to increased labor input into agriculture, the ability to lease out or mortgage land could lead to decreased labor hours in agriculture with a corresponding shift to other activities.

We will estimate the impact of the land reform using a differences-in-differences strategy, basically by comparing the difference between 1993 and 1998 (before and after reform) for the highly registered provinces as compared to the low-registered provinces. The regression equation we use is:

$$y_{ijt} = \beta_0 + \beta_1 T_t + \beta_2 R_{j,98} + \beta_3 (T_t \times R_{j,98}) + X_{it}\gamma + \epsilon_{it} \tag{3.1}$$

where y_{ijt} represents the outcome of household i of province j at time t (1993 or 1998), T_t represents the time dummy (equal to 0 for 1993, and 1 for 1998), $R_{j,98}$ is the proportion of households registered (registration level) in province j in 1998 and X_{it} are other household characterisitics. The coefficient β_1 represents the change between 1993 and 1998 for a province which had zero registration, while β_2 represents the difference between highly registered and

low-registered provinces in 1993 (pre-existing difference). Our coefficient of interest is β_3, which tells us how much the high-registration provinces have increased investment, compared to the low-registration provinces over the period 1993-1998. We will be controlling for household characteristics like age, gender and education of the household head, total household size and ethnicity. All our regressions are for households in rural areas only, since our registration figures are for rural households. Since our main explanatory variable, the registration level, is measured at the province level, we will also cluster all our standard errors at the province level.[7]

3.4.3 Endogeneity

Our strategy is likely to give biased results if the province-level registration levels are correlated with other unobserved variables, which also affect our dependent variables. This could be due to both "supply" and "demand" factors for land registration. For instance, more productive farmers may be registering their land earlier (demand side effect), or a higher registration level might be indicative of a more efficient local bureaucracy, which might have a direct effect on any outcomes we examine, irrespective of the impact of the Land Law itself. As discussed in section 3.2, the major reasons for delays in registration were stated to be low levels of manpower in the hands of the land department and high numbers of disputes over land in certain areas. These could be correlated with both supply-side and demand-side factors.

As Figure 1 shows, there does not appear to be any obvious regional pattern in registration levels. Figure 2 graphs the province registration level against several other province characteristics. Again there is no apparent pattern and all the correlations are below 0.17 in absolute value. Table 1 formalizes this by presenting multivariate regressions of the province registration rate on several province characteristics, where we see that none of the coefficients is significant, except for per capita household expenditure which is significant in one of the specifications (at 10% level of significance). This supports the hypothesis that the variation in registration levels is mainly driven by bureaucratic factors and unpredictable incidence of disputes in different areas. This is a preliminary, though certainly not conclusive, check on the exogeneity of our main explanatory variable.

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[7]Bertrand et. al. [2001] suggest clustering as one way to obtain correct standard errors in a difference-in-differences framework.

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For the time being therefore, we take the registration levels in a province to be exogenously determined. We do however run specifications where we control explicitly for province-level mean per capita household expenditure (since this was the only variable which was even marginally related to registration levels). This makes no change to any of our regression coefficients. We could also construct instrumental variables using the exogenous component of registration rates, perhaps by using data on bureaucratic manpower or some information on disputes. However, we do not have such data currently.

3.5 Impact of land reform on agriculture

3.5.1 Crop choice

As discussed earlier, the additional land rights conferred by the 1993 law might induce households to undertake more long-term investments on their land. One way of measuring this is by looking at the allocatin of land between annual crops and multi-year industrial or fruit crops, which typically require large investments up-front and yield returns only after a few years. Table 2 shows that the land reform led to a large and statistically significant increase in the proportion of total cultivated area devoted to multi-year crops: a household who received a LUC would increase this proportion by 7.5 percentage points over the period 1993-98, compared to an unregistered household. This is quite large given that multi-year crops accounted for only 9 percent of total cultivated area in 1993. This increase comes at the expense of annual crops, which show a decrease of 6.5 percentage points in their share of total cultivated area. We control for household characteristics like age, education, gender, household size and ethnicity while obtaining these estimates. The coefficients are robust to the addition of region fixed effects, to adding the household controls interacted with the time dummy, and to adding province-level mean per-capita income as an additional regressor (last two specifications not shown in the table).

When we divide our sample according to whether or not the province was highly registered in 1994 itself,[8] we find that the results are much stronger for areas which were highly registered

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[8] We define areas with registration levels above the median as "High 94" and those below the median as "Low 94". The median registration level in 1994 was 19%.

early on.[9] This is consistent with the idea that the additional rights encourage long-term investment, so that areas which got these rights earlier would be expected to show a greater response to the land reform.

3.5.2 Agricultural inputs

Table 3 shows that households in highly registered provinces increase their proportion of irrigated area by about 20 percentage points as compared to those in low-registered areas. While this figure is not statistically significant, we should note that it is not small: the mean level of registration in 1998 was 0.71, so registration accounts for an increase of $0.71 \times 20 = 14.2$ percentage points in irrigated proportion, which is about 35 percent of the total increase in irrigated proportion (from 0.17 in 1993 to 0.61 in 1998). Again, we note that the increase in irrigation is much larger for areas which were highly registered in 1994 itself. Further, Table 4 shows that the increase in the proportion of annual crop land which is irrigated is much smaller than the increase in the proportion of *total* area which is irrigated. This seems to indicate that more of the increase in irrigation is coming from area devoted to multi-year crops,[10] again consistent with the idea of households being more motivated in taking up long-term investments.

We also observe that there is no significant difference between highly registered and low registered areas with respect to the total amount of fertilizer used or in total agricultural expenses, both normalized by the total area cultivated (Table 5); in fact highly registered areas show a slight decrease compared to low-registered areas. However, most of these data pertain to annual expenses of agriculture and may not capture the high initial startup costs of switching to perennial crops. Turning to labor input, we find that the average number of weeks spent on agriculture per working member has increased by about 4.5 weeks. This figure is not statistically significant, but is quite large compared to the mean of 32 weeks worked in 1993.[11]

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[9] Provinces which are highly registered in 1994 continue to be highly registered in 1998, which is not surprising since registration levels do not decrease over time; however a number of provinces which had very low registration in 1994 achieve high registration in 1998. The correlation between 1994 and 1998 registration levels is 0.37.

[10] We cannot get this directly, since the survey only asks about total irrigated area and irrigated annual crop area.

[11] We are unable to say whether total weeks of work by households has gone up overall, because of a reporting problem: several households report far greater than 52 weeks of work for each household member, this is probably due to non-exclusivity of replies i.e. weeks which were spent partly as wage labor and partly on own farm were probably counted twice in both categories. Data on hours worked is missing for too many households to make this a reliable figure.

3.5.3   Output and productivity

We consider two measures of agricultural productivity: the first is simply the yield of rice, and the second is the total value of agricultural output divided by the total cultivated area, which takes into account all the different crops grown by the household. Table 6 shows that while there has been considerable productivity growth between 1993 and 1998 on the whole, areas with high registration levels do not have any significant advantage in this regard. As discussed before, the impact on rice yield on the intensive margin is *a priori* ambiguous, while it could also be that the total gains from investing more in long-term crops is yet to materialize by the end of our sample period.

3.5.4   Further robustness checks

Our results on long-term investments could perhaps be driven by direct government incentives for investing in such crops rather than by the land reform itself. Or it could also be that local governments which do more to implement the land law also do more to help farmers in general. We perform a preliminary check for this by considering the proportion of fertilizer and pesticide expenditures which goes towards buying from government sources. This is a crude measure of how important the government sources are for agricultural inputs in general. Table 7 shows no significant difference in these measures across areas with different registration levels. It is however interesting to note that the importance of the government has declined a little over the period 1993-98 (which is consistent with the general trend towards a market economy), and that the government is relatively more important in the North (which is probably because of the longer history of Communist rule and collectivized agriculture here).

3.6   Impact on credit and land markets

In this section, we check whether our results on long-term investments arise because of the impact of the land law on credit markets. We consider two measures of households' borrowing behaviour which might be affected by having greater land rights: the proportion of borrowing which comes from formal sources (like banks and credit cooperatives) and the proportion of borrowing with collateral (since the land law allows land to be mortgaged). Table 8 however

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does not reveal any significant differences by registration levels on these measures, though the point estimates are all positive. We should however keep in mind that the decision to borrow may depend on various characteristics of the household and on the policy environment; here we are looking at the composition of the borrowing, taking the decision to borrow and the amount borrowed as given.

We would also like to investigate whether the land law facilitated land transfers, thereby making the land market more efficient. Unfortunately, evidence on land market transactions is hard to come by because of substantial underreporting by respondents. This is mainly because of the high tax imposed on land transactions. Nevertheless, there seems to be an increase in land market transactions between 1993 and 1998: the proportion of households who report receiving land increases ten-fold from 2.5 percent in 1993 to 25 percent in 1998, a similar ten-fold increase is seen for households reporting sales of land (from 1 percent to 10 percent). This could however simply reflect less under-reporting after the law was passed. The increase does not seem to be very different across highly registered vs. low registered provinces (regressions not shown).

3.7 Conclusion and further research

We show that a land reform which makes land rights pledgeable and tradeable has a noticeable impact on the decisions of households to undertake long-term investments. However, we do not find any significant impact on the intensive margin on measures of agricultural productivity. We should note that these results are subject to caveats about possible endogeneity of our main explanatory variable, though we do not find any robust evidence of such endogeneity.

In further research, we would like to explore these outcomes in greater detail, possibly with the help of an instrumental variables strategy as well. Further, the response of households to take advantage of the rights conferred by the law are likely to depend on their access to sources of credit and other institutional factors. We would thus like to examine whether the impact of the law differs across areas with different institutional characteristics.

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TABLE 1: WHAT DETERMINES REGISTRATION LEVELS ?

Sample: Provinces
Dependent variable: proportion of rural households holding Land Use Certificate in 1998

	Province chars. (1)	Income, yield (2)	Household chars (3)	Infrastructure (4)	All (5)
Population density	-0.027				-0.041
	(0.020)				(0.029)
Total area of province ('000 sq km)	-0.093	0.044			0.062
	(0.128)	(0.090)			(0.105)
Proportion urban	0.516				0.516
	(0.330)				(0.373)
Proportion of agricultural land	0.232	-0.170			0.391
	(0.215)	(0.155)			(0.338)
Proportion sown with rice	0.159	0.078			0.276
	(0.195)	(0.203)			(0.235)
Dummy for North	0.048	0.015	0.061	0.010	0.126
	(0.085)	(0.093)	(0.123)	(0.073)	(0.169)
Per capita HH expenditure (log)		0.246	0.318*		0.207
		(0.154)	(0.172)		(0.208)
Rice yield 1993 (log)		0.192	0.100		
		(0.148)	(0.124)		
Proportion of majority ethnic group			-0.104		-0.188
			(0.108)		(0.167)
Mean years of education			-0.005		0.219
			(0.026)		(0.235)
Prop. Communes having market				0.200	0.143
				(0.198)	(0.256)
Prop. Communes having highway				-0.174	0.211
				(0.143)	(0.428)
Prop. Communes having clinic				0.329	0.023
				(0.376)	(0.041)
Observations	59	56	56	59	56
R-squared	0.09	0.12	0.11	0.08	0.16

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions are at province level. Rice yield and population density are very highly correlated
(correlation =0.83) hence are not put together into any regressions.
All regressions exclude Hanoi and Ho Chi Minh City, which are clear outliers in terms of population
density and urbanization rates.

TABLE 2 : IMPACT OF LAND REFORM ON CROP CHOICE

Sample: Rural households

Dependent variable	Proportion of total cultivated area devoted to									
	Perennial industrial crops + fruit crops					All annual crops				
Mean (s.d.) in 1993	0.0938 (0.2049)					0.8846 (0.2238)				
Mean (s.d.) in 1998	0.1185 (0.2565)					0.8508 (0.2752)				
	No controls	HH chars.	Region FE	High 94	Low 94	No controls	HH chars.	Region FE	High 94	Low 94
Registration rate 1998*Year=1998	0.080***	0.076***	0.075***	0.114***	0.028	-0.073***	-0.068***	-0.065**	-0.089**	-0.025
	(0.025)	(0.024)	(0.025)	(0.037)	(0.027)	(0.026)	(0.025)	(0.026)	(0.043)	(0.031)
Year=1998	-0.033	-0.033*	-0.032*	-0.050*	-0.008	0.018	0.023	0.022	0.025	0.004
	(0.020)	(0.017)	(0.017)	(0.026)	(0.015)	(0.020)	(0.018)	(0.018)	(0.034)	(0.019)
Registration 1998	0.038	-0.012	-0.011	-0.023	0.003	-0.011	0.027	0.032	0.044	0.018
	(0.047)	(0.038)	(0.027)	(0.050)	(0.024)	(0.053)	(0.042)	(0.032)	(0.059)	(0.028)
Age of household head		0.001***	0.002***	0.002***	0.001**		-0.002***	-0.002***	-0.002***	-0.001***
		(0.000)	(0.000)	(0.001)	(0.000)		(0.000)	(0.000)	(0.001)	(0.000)
Male household head		-0.019*	-0.020**	-0.029	-0.007		0.022*	0.022**	0.028	0.013
		(0.011)	(0.010)	(0.018)	(0.009)		(0.011)	(0.010)	(0.018)	(0.010)
Years of education of head		0.008***	0.008***	0.009***	0.006***		-0.009***	-0.010***	-0.010***	-0.007***
		(0.002)	(0.002)	(0.003)	(0.002)		(0.002)	(0.002)	(0.003)	(0.002)
Household size		-0.001	-0.003	-0.002	-0.004		0.002	0.004	0.004	0.006*
		(0.003)	(0.002)	(0.003)	(0.004)		(0.003)	(0.003)	(0.003)	(0.003)
Majority ethnic group dummy		-0.007	0.002	0.033	-0.035		0.052	0.035	-0.005	0.078*
		(0.029)	(0.030)	(0.027)	(0.037)		(0.032)	(0.032)	(0.031)	(0.038)
Dummy for north		-0.194***	-0.242***	-0.268***	-0.105***		0.177***	0.191**	0.266***	0.081***
		(0.039)	(0.080)	(0.040)	(0.016)		(0.041)	(0.086)	(0.033)	(0.022)
Total area cultivated (*10^-5)		-0.151	-0.210**	-0.331***	0.002		0.010	0.080	0.219	-0.000
		(0.093)	(0.094)	(0.103)	(0.099)		(0.111)	(0.110)	(0.132)	(0.118)
Region fixed effects	no	no	yes	yes	yes	no	no	yes	yes	yes
No. of observations	7469	7469	7469	7469	7469	7469	7469	7469	7469	7469
No. of provinces	59	59	59	59	59	59	59	59	59	59
R-squared	0.01	0.15	0.22	0.20	0.35	0.01	0.12	0.18	0.13	0.33

Standard errors in parentheses, corrected for province-level clustering. * significant at 10%; ** significant at 5%; *** significant at 1%

All regressions weighted by sampling weights

Regressions with controls interacted with time were tried: the interactions were not jointly significant, hence these are not reported

High 94 refers to areas where registration levels were higher than the median (0.19) in 1994.

TABLE 3 : IMPACT OF LAND REFORM ON PROPORTION OF TOTAL LAND IRRIGATED

Sample: Rural households in 1993 and 1998
Dependent variable= Proportion of total land irrigated; Mean (s.d.) = 0.170 (0.314) in 1993; = 0.606 (0.383) in 1998

	No controls	HH characteristics	Controls interacted with time[a]	Weather controls	Region fixed effects	High 94	Low 94
Registration 1998*Year=1998	0.200	0.194	0.161	0.218	0.218	0.496***	0.120
	(0.184)	(0.180)	(0.159)	(0.172)	(0.172)	(0.147)	(0.222)
Year=1998	0.292**	0.305**	0.235	0.283*	0.283*	0.101	0.398**
	(0.142)	(0.139)	(0.152)	(0.143)	(0.143)	(0.119)	(0.171)
Registration 1998	0.072	0.018	0.034	-0.006	-0.006	-0.068	-0.035
	(0.088)	(0.083)	(0.081)	(0.092)	(0.092)	(0.094)	(0.108)
Age of household head		-0.001	0.000	0.000	0.000	0.001	0.000
		(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
Male household head		0.023	0.041*	0.022	0.022	0.023**	0.006
		(0.014)	(0.020)	(0.013)	(0.013)	(0.010)	(0.013)
Years of education of head		-0.006***	-0.006**	-0.003*	-0.003*	0.001	-0.001
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Household size		0.001	0.003	0.003	0.003	-0.001	0.006*
		(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)
Majority ethnic group dummy		0.176***	0.042	0.118***	0.118***	0.032	0.117*
		(0.040)	(0.044)	(0.037)	(0.037)	(0.029)	(0.067)
Dummy for north		-0.128**	-0.156***	-0.349***	-0.349***	-0.145	0.102
		(0.049)	(0.058)	(0.084)	(0.084)	(0.091)	(0.113)
Rainfall				-0.022	-0.022	-0.033	-0.043
				(0.027)	(0.027)	(0.031)	(0.055)
Sunshine hours				-0.222*	-0.222*	-0.021	-0.203
				(0.115)	(0.115)	(0.114)	(0.192)
% annual crop land				0.399***	0.399***	0.497***	0.405***
				(0.046)	(0.046)	(0.047)	(0.051)
Region dummies	no	no	no	no	yes	yes	yes
No. of observations	7438	7438	7438	7438	7438	3606	3832
No.of provinces	59	59	59	59	59	59	59
R-squared	0.30	0.35	0.37	0.46	0.53	0.58	0.53

Standard errors in parentheses, corrected for province-level clustering. All regressions weighted by sampling weights.
* significant at 10%; ** significant at 5%; *** significant at 1%
High 94 refers to areas where registration levels were higher than the median (0.19) in 1994.
[a]Coefficients on household characteristics and time dummy interactions not shown due to lack of space.

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TABLE 4 : IMPACT OF LAND REFORM ON PROPORTION OF ANNUAL LAND IRRIGATED

Sample: Rural households
Dependent variable= Proportion of annual land irrigated; Mean (s.d.) = 0.255 (0.397) in 1993; = 0.683 (0.416) in 1998

	No controls	HH characteristics	HH chars interacted with time[a]	Weather controls	Region fixed effects	High 94	Low 94
Registration 1998*Year=1998	0.124	0.121	0.180	0.107	0.123	0.445	0.027
	(0.223)	(0.220)	(0.174)	(0.223)	(0.215)	(0.291)	(0.257)
Year=1998	0.339**	0.349**	0.058	0.273	0.318*	-0.019	0.491**
	(0.168)	(0.165)	(0.184)	(0.172)	(0.167)	(0.227)	(0.181)
Registration 1998	0.058	0.009	-0.017	0.012	0.001	-0.037	-0.058
	(0.131)	(0.112)	(0.112)	(0.113)	(0.105)	(0.129)	(0.132)
Age of household head		-0.000	0.001	-0.000	0.000	-0.000	0.001
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Male household head		0.025	0.026	0.028	0.023	0.032*	0.003
		(0.018)	(0.025)	(0.017)	(0.014)	(0.017)	(0.017)
Years of education of head		-0.005*	-0.004	-0.006**	-0.004	-0.005	0.001
		(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Household size		0.006*	0.009*	0.007**	0.008***	0.006**	0.009**
		(0.003)	(0.005)	(0.003)	(0.002)	(0.003)	(0.004)
Majority ethnic group dummy		0.144**	0.041	0.145***	0.117**	0.072	0.101
		(0.055)	(0.062)	(0.051)	(0.053)	(0.055)	(0.089)
Dummy for north		-0.120**	-0.319***	-0.336***	-0.063	-0.130	0.251**
		(0.049)	(0.074)	(0.091)	(0.151)	(0.138)	(0.112)
Rainfall				-0.006	-0.033	-0.021	0.030
				(0.027)	(0.029)	(0.039)	(0.056)
Sunshine hours				-0.325***	-0.167	-0.171	0.048
				(0.121)	(0.109)	(0.136)	(0.138)
Region fixed effects	no	no	no	no	yes	yes	yes
No. of observations	7438	7438	7438	7438	7438	3606	3832
No. of provinces							
R-squared	0.22	0.26	0.31	0.27	0.35	0.34	0.41

Standard errors in parentheses, corrected for province-level clustering. * significant at 10%; ** significant at 5%; *** significant at 1%.
All regressions weighted by sampling weights
High 94 refers to areas where registration levels were higher than the median (0.19) in 1994.
[a]Coefficients on household characteristics and time dummy interactions not shown due to lack of space.

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TABLE 5 : LAND REFORM AND AGRICULTURAL INPUTS

Sample: Rural households

Dependent variable	Fertilizer usage (kg used/ sq m cultivated)				Labor input (weeks)			
	No controls HH chars.	HH chars. interacted with time[a]	Region fixed effects		No controls	HH chars.	HH chars. interacted with time[a]	Region fixed effects
Mean (s.d.) in 1993	0.033 (0.026)				31.58 (12.53)			
Mean (s.d.) in 1998	0.048 (0.033)				37.46 (11.89)			
Registration rate 1998*Year=1998	-0.003 (0.005) / -0.004 (0.006)	-0.002 (0.006)	-0.003 (0.006)		4.638 (3.025)	4.736 (3.023)	3.696 (3.039)	4.578 (2.969)
Year=1998	0.017*** (0.004) / 0.018*** (0.004)	0.011** (0.005)	0.018*** (0.005)		2.549 (2.312)	2.477 (2.336)	1.860 (2.742)	2.434 (2.287)
Registration 1998	0.009 (0.007) / 0.006 (0.005)	0.005 (0.005)	0.011*** (0.004)		-3.940 (4.004)	-1.543 (3.777)	-1.054 (3.717)	-2.107 (2.640)
Age of household head	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)			-0.046*** (0.016)	-0.049** (0.022)	-0.047*** (0.016)
Male household head	0.001 (0.001)	0.000 (0.001)	0.001 (0.001)			1.408** (0.613)	1.935** (0.750)	1.457*** (0.536)
Years of education of head/10	0.004** (0.002)	0.004** (0.002)	0.004** (0.001)			-0.960 (0.770)	-2.07** (0.890)	-1.18 (0.710)
Household size	-0.001*** (0.000)	-0.001* (0.000)	-0.000** (0.000)			-0.232 (0.147)	-0.024 (0.177)	-0.332*** (0.121)
Majority ethnic group dummy	0.021*** (0.003)	0.021*** (0.003)	0.019*** (0.002)			-4.949*** (1.303)	-6.968*** (1.593)	-2.831** (1.199)
Dummy for north	0.006** (0.003)	0.001 (0.003)	0.008 (0.008)			5.535*** (1.378)	5.463*** (1.608)	3.216 (2.175)
Region fixed effects	no / no	no	yes		no	no	no	yes
No. of observations	6568 / 6568	6568	6568		7350	7350	7350	7350
No. of provinces	59 / 59	59	59		59	59	59	59
R-squared	0.07 / 0.18	0.19	0.23		0.06	0.13	0.14	0.19

Standard errors in parentheses, corrected for province-level clustering. All regressions weighted by sampling weights.

* significant at 10%; ** significant at 5%; *** significant at 1%

Fertilizer usage is obtained as the amount of fertilizer (kg) by a household divided by total cultivated area.

Labor input is the weeks worked in agriculture in the preceding year by the whole household divided by the number of working members.

[a] Coefficients on household characteristics and time dummy interactions not shown due to lack of space.

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TABLE 6 : LAND REFORM AND AGRICULTURAL OUTPUT

Sample: Rural households

Dependent variable	Log rice yields				Log (Value of agr output / cultivated area)			
	No controls	HH chars.	HH chars inter-acted with time[a]	Region fixed effects	No controls	HH chars.	HH chars inter-acted with time[a]	Region fixed effects
Mean (s.d.) in 1993	3.35 (0.505)				-0.599 (0.701)			
Mean (s.d.) in 1998	3.56 (0.411)				-0.262 (1.095)			
Registration rate 1998*Year=1998	-0.019	-0.028	-0.014	0.002	-0.070	-0.048	-0.019	-0.022
	(0.103)	(0.102)	(0.088)	(0.096)	(0.143)	(0.128)	(0.113)	(0.147)
Year=1998	0.229***	0.233***	0.445***	0.218***	0.387***	0.380***	0.627***	0.368***
	(0.084)	(0.084)	(0.128)	(0.079)	(0.107)	(0.098)	(0.218)	(0.113)
Registration 1998	0.221	0.167	0.160	0.264**	0.289	0.198	0.182	0.284***
	(0.192)	(0.146)	(0.140)	(0.130)	(0.221)	(0.133)	(0.127)	(0.082)
Age of household head		0.001	0.001	0.001		0.006***	0.006***	0.006***
		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Male household head		-0.014	-0.026	-0.009		0.003	-0.018	0.002
		(0.016)	(0.022)	(0.012)		(0.031)	(0.028)	(0.029)
Years of education of head		0.015***	0.018***	0.013***		0.028***	0.029***	0.029***
		(0.004)	(0.006)	(0.003)		(0.004)	(0.006)	(0.004)
Household size		-0.002	0.002	0.006		0.014*	0.021***	0.018***
		(0.006)	(0.006)	(0.005)		(0.008)	(0.008)	(0.006)
Majority ethnic group dummy		0.322***	0.370***	0.275***		0.395***	0.467***	0.393***
		(0.068)	(0.079)	(0.058)		(0.071)	(0.086)	(0.061)
Dummy for north		0.074	0.096	-0.025		0.167**	0.173**	0.087
		(0.051)	(0.060)	(0.271)		(0.079)	(0.079)	(0.085)
Total area cultivated (*10^-5)		-0.150	-0.191	-0.140		-1.71***	-1.67***	-1.80***
		(0.130)	(0.179)	(0.117)		(0.273)	(0.396)	(0.201)
Region fixed effects	no	no	no	yes	no	no	no	yes
No. of observations	6547	6547	6547	6547	7443	7443	7443	7443
No. of provinces	59	59	59	59	59	59	59	59
R-squared	0.06	0.17	0.17	0.24	0.04	0.16	0.16	0.18

Standard errors in parentheses, corrected for village-year clustering. All regressions weighted by sampling weights.
* significant at 10%; ** significant at 5%; *** significant at 1%

[a]Coefficients on household characteristics and time dummy interactions not shown due to lack of space.

TABLE 7 : DO GOVERNMENTS HELP AGRICULTURE DIRECTLY?

Sample: Rural households

Dependent variable	Proportion of fertilizer obtained from govt. sources				Proportion of pesticide obtained from govt. sources			
	No controls	HH chars.	HH chars inter-acted with time[a]	Region fixed effects	No controls	HH chars.	HH chars inter-acted with time[a]	Region fixed effects
Mean (s.d.) in 1993			0.069 (0.251)				0.139 (0.345)	
Mean (s.d.) in 1998			0.066 (0.247)				0.092 (0.288)	
Registration rate 1998*Year=1998	0.031	0.043	0.065	0.042	0.008	0.013	0.030	-0.001
	(0.063)	(0.062)	(0.063)	(0.064)	(0.129)	(0.127)	(0.125)	(0.125)
Year=1998	-0.027	-0.038	0.043	-0.038	-0.053	-0.068	0.171	-0.066
	(0.053)	(0.051)	(0.067)	(0.052)	(0.097)	(0.094)	(0.115)	(0.094)
Registration 1998	-0.120	-0.085	-0.094	-0.096	-0.076	-0.029	-0.036	-0.067
	(0.094)	(0.087)	(0.089)	(0.084)	(0.127)	(0.119)	(0.122)	(0.110)
Age of household head		-0.000	-0.000	-0.000		0.000	0.001	0.000
		(0.001)	(0.001)	(0.001)		(0.000)	(0.001)	(0.000)
Male household head		-0.007	-0.008	-0.007		0.001	-0.009	0.001
		(0.014)	(0.016)	(0.014)		(0.010)	(0.018)	(0.010)
Years of education of head		-0.002	-0.002	-0.002		0.001	0.002	0.001
		(0.004)	(0.004)	(0.004)		(0.003)	(0.003)	(0.002)
Household size		0.003	0.002	0.002		0.004	0.006	0.000
		(0.002)	(0.003)	(0.002)		(0.003)	(0.004)	(0.003)
Majority ethnic group dummy		-0.144**	-0.086	-0.130**		-0.098*	0.012	-0.075*
		(0.060)	(0.065)	(0.052)		(0.055)	(0.063)	(0.044)
Dummy for north		0.074***	0.065**	0.067		0.140***	0.170***	0.215***
		(0.022)	(0.025)	(0.131)		(0.024)	(0.039)	(0.034)
Region fixed effects	no	no	no	yes	no	no	no	yes
No. of observations	6347	6347	6347	6347	5601	5601	5601	5601
No. of provinces	59	59	59	59	59	59	59	59
R-squared	0.01	0.08	0.09	0.09	0.01	0.07	0.08	0.09

Standard errors in parentheses, corrected for province-level clustering. All regressions weighted by sampling weights.

* significant at 10%; ** significant at 5%; *** significant at 1%

[a]Coefficients on household characteristics and time dummy interactions not shown due to lack of space.

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TABLE 8 : IMPACT OF LAND REFORM ON NATURE OF CREDIT

Sample: Rural households

Dependent variable	Proportion of credit obtained from formal sources				Proportion of credit taken with collateral			
	No controls	HH chars.	HH chars interacted with time[a]	Region fixed effects	No controls	HH chars.	HH chars interacted with time[a]	Region fixed effects
Mean (s.d.) in 1993		0.3175 (0.4295)				0.1326 (0.3154)		
Mean (s.d.) in 1998		0.5867 (0.4528)				0.3759 (0.4562)		
Registration rate 1998*Year=1998	0.060	0.066	0.050	0.062	0.103	0.107	0.085	0.107
	(0.089)	(0.089)	(0.083)	(0.089)	(0.088)	(0.085)	(0.086)	(0.086)
Year=1998	0.226***	0.213***	0.430***	0.210***	0.169***	0.162**	0.077	0.153**
	(0.065)	(0.065)	(0.117)	(0.065)	(0.064)	(0.061)	(0.106)	(0.061)
Registration 1998	-0.052	-0.072	-0.058	-0.122**	-0.050	-0.089**	-0.077*	-0.108**
	(0.073)	(0.074)	(0.073)	(0.057)	(0.046)	(0.042)	(0.040)	(0.041)
Age of household head		0.002***	0.002***	0.002***		0.001**	0.001	0.001**
		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Male household head		0.024	0.038	0.017		0.044**	0.063***	0.037**
		(0.019)	(0.024)	(0.019)		(0.017)	(0.017)	(0.017)
Years of education of head		0.008**	0.007*	0.009***		0.009***	0.007**	0.011***
		(0.003)	(0.004)	(0.003)		(0.003)	(0.003)	(0.002)
Household size		0.008**	0.005	0.005		0.014***	0.008**	0.011***
		(0.004)	(0.004)	(0.004)		(0.003)	(0.003)	(0.003)
Majority ethnic group dummy		-0.019	0.082	0.014		0.025	0.019	0.047
		(0.049)	(0.050)	(0.047)		(0.036)	(0.028)	(0.042)
Dummy for north		-0.054**	0.021	0.169**		-0.118***	-0.084***	0.161
		(0.026)	(0.034)	(0.067)		(0.029)	(0.027)	(0.138)
Region fixed effects	no	no	no	yes	no	no	no	yes
No. of observations	4319	4319	4319	4319	4319	4319	4319	4319
No. of provinces	59	59	59	59	59	59	59	59
R-squared	0.09	0.10	0.11	0.11	0.09	0.12	0.12	0.14

Standard errors in parentheses, corrected for province-level clustering. All regressions weighted by sampling weights.

* significant at 10%; ** significant at 5%; *** significant at 1%

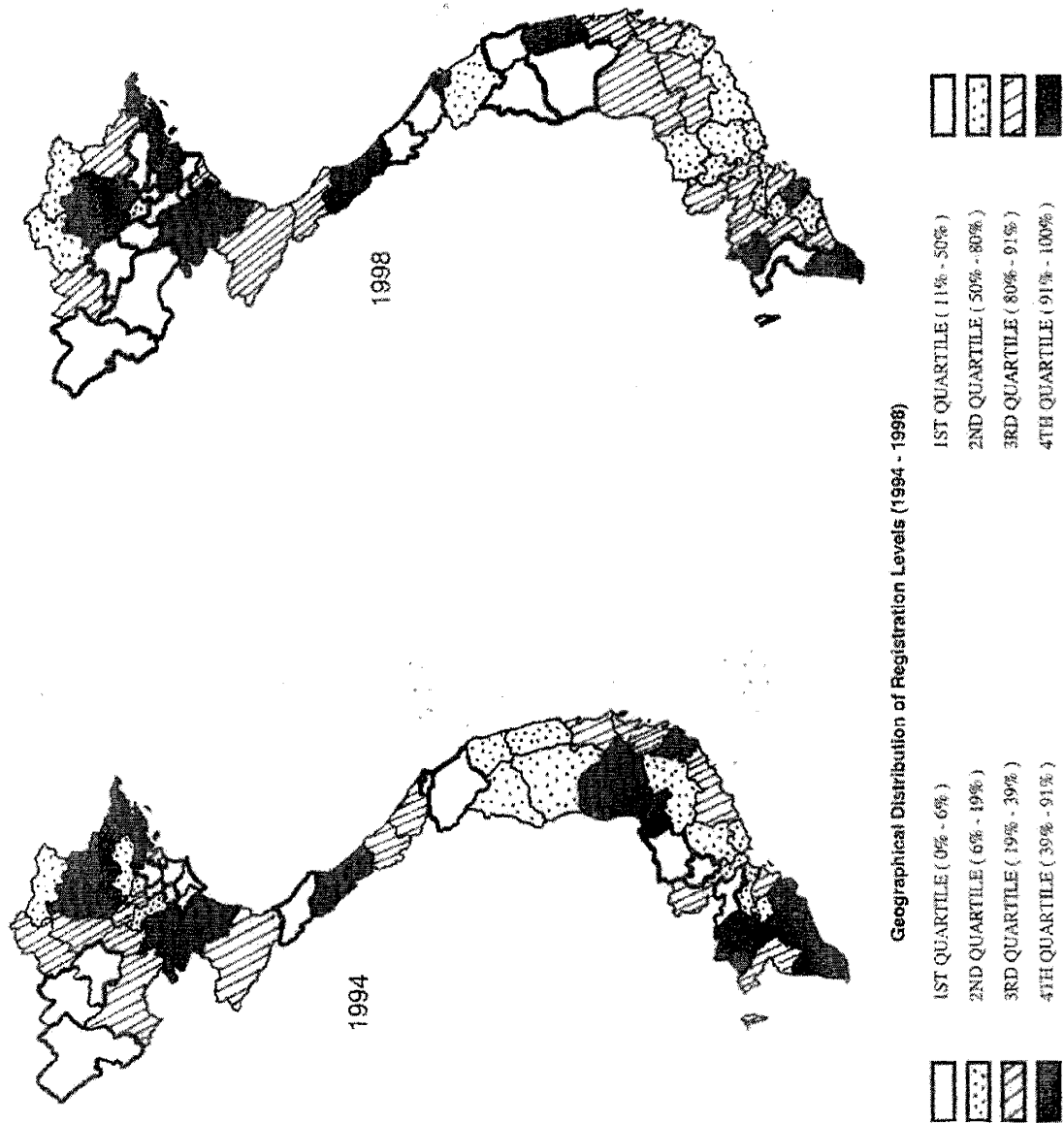[a]Coefficients on household characteristics and time dummy interactions not shown due to lack of space.
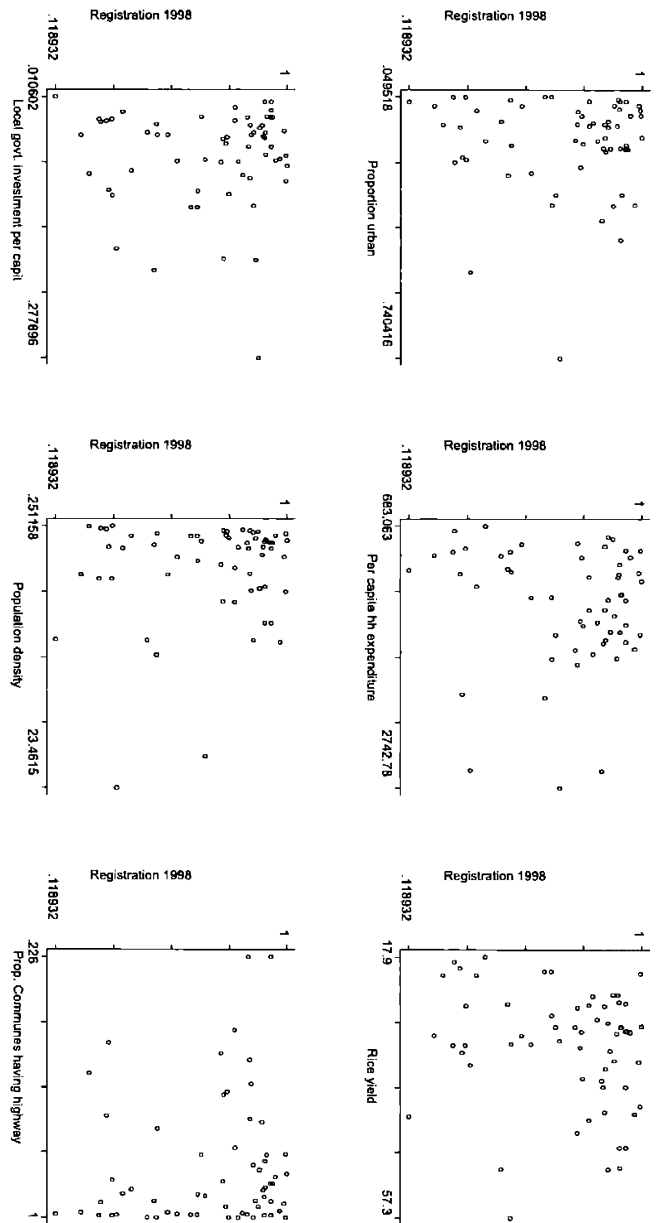
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Figure 3-1:

Registration 1998

Figure 3-2:

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