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WHEN IS QUALITY OF FINANCIAL SYSTEM A SOURCE OF COMPARATIVE
ADVANTAGE?

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ABSTRACT

Does finance follow the real economy, or the other way around? This paper unites the two competing schools of thought in a general equilibrium framework. Our key result is that there are threshold effects defined by a set of deep institutional parameters (cost of financial intermediation, quality of corporate governance, and level of property rights protection) which can be used to separate economies of high-quality institutions from those of low-quality institutions. On one hand, for economies with high-quality institutions, the view that finance follows the real economy is essentially correct. Equilibrium output and prices are determined by factor endowment. Further improvement in the institutions does not affect patterns of output. On the other hand, for economies with low-quality institutions, the view that finance is a key driver of the real economy is essentially correct. Not only is finance a source of comparative advantage, but an increase in capital endowment has no effect on outputs and prices. Our model extends a standard one-sector, partial equilibrium model of corporate finance to a multi-sector, general equilibrium analysis. Surprisingly, but consistent with data, we show that the size of financial markets (relative to GDP) does not change monotonically with either the quality of institutions or with the factor endowment. Free trade may reduce the aggregate income of an economy with low-quality institutions. Financial capital tends to flow from economies with low-quality institutions to those with high-quality institutions.

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1 Introduction

Dominant theories of international trade tend to ignore the role of finance as a source of comparative advantage. For example, finance is absent in leading graduate level textbooks by Dixit and Norman (1980), Bhagwati, Panagariya, and Srinivasan (1998) and Feenstra (2004), in the recently revived Ricardian model of Eaton and Kortum (2002) and Alvarez and Lucas (2005), and in a recent resurgence of empirical papers on determinants of trade structure by Trefler (1993 and 1995), Harrigan (1997), Davis and Weinstein (2001 and 2003), and Romalis (2004). The absence of a role for finance in trade theories is in line with an influential view in economics generally that financial development merely follows on the development of the real economy. In other words, the observed level of financial development is an endogenous consequence of a country's factor endowment. This view is shared by Robinson (1952) and Lucas (1988), among others.

On the other hand, an equally influential view regards financial development as an independent source of comparative advantage and economic growth. This second view is promoted by Schumpeter (1912), Goldsmith (1969), and Miller (1998). A vast empirical literature, mostly in the field of finance, has sought to discover the role of finance in determining production structure. Pioneered by Rajan and Zingales (1998) and followed by Beck and Levine (2002), Carlin and Mayer (2003), Claessens and Laeven (2003), and Fisman and Love (2004) among others, this body of work demonstrates that, in countries with developed financial systems, those industries reliant more on external finance are likely to grow faster relative to other industries. An economy's level of financial development is typically measured in the empirical literature by the size of its financial market (the ratio of domestic credit to GDP, or the ratio of stock market capitalization to GDP). Perhaps it is not surprising that financial development should similarly reveal itself in trade patterns. Beck (2002 and 2003), Svaleryd and Vlachos (2005), and Manova (2008) report evidence that

countries with a higher level of financial development have a higher export share in industries that use more external finance. Manova (2007) further investigates the effects of credit constraints on the observed zeros in a bilateral trade matrix, the varieties of exports, and turnover in the product mix of exports over time.

Do and Levchenko (2007) cast doubt on the notion that financial development is a genuinely independent source of comparative advantage, and present a model that argues for reverse causality: the size of financial markets, an empirical measure of financial development, is itself influenced by comparative advantage and international trade. Suppose, for reasons unrelated to financial development, country A has a comparative advantage in a sector that uses more external finance than country B. As both countries move from autarky towards free trade, country A's financial market (and the sector that uses more external finance) should expand while that of country B shrinks. This will generate the pattern identified by Rajan and Zingales (1998), but the direction of causality goes from endowment, to the pattern of growth, and to the size of financial markets (relative to GDP). In order to support this competing interpretation, Do and Levchenko report evidence taken from a sample of 96 countries between 1977 and 1999.

In this paper, we develop a general equilibrium theory to unify the two competing schools of thought. We consider each view only partially correct, not just because both finance and the real economy affect each other. Our key result is that there are threshold effects defined by a set of deep institutional parameters (cost of financial intermediation, quality of corporate governance, and level of property rights protection). On one hand, for economies with high-quality institutions, the view that finance follows the real economy is essentially correct. Equilibrium output and prices are determined by initial endowments, and finance is not a source of comparative advantage. That is, an improvement in the quality of the financial system in such an economy would not alter patterns of production and trade, contrary to the arguments of Rajan and Zingales (1998). Because of these properties, such

economies can also be called endowment binding. On the other hand, for economies with low-quality institutions, the view that finance is a key driver of the real economy is essentially correct. Finance is a source of comparative advantage, and factor endowments may fail to determine equilibrium outputs or prices at the margin. That is, an infusion of capital into such an economy, holding institutional parameters constant, would not change equilibrium output and trade patterns. Such economies may be called institutionally binding. The Rajan-Zingales (1998) interpretation of the finance-growth connection works in such economies.

In order to have a meaningful discussion of comparative advantage, we must consider at least two sectors (something theoretical models in the finance literature, do not commonly do with regards to this topic). In order to introduce the relevant institutional parameters, we incorporate the financial contract model of Holmstrom and Tirole (1997) into the standard Heckscher-Ohlin-Samuelson (HOS) framework. Both production structure and the size of a financial market are endogenously determined by deep institutional parameters and by factor endowment. The precise definition of high and low-quality institutions, and the exact threshold that separates the two types of economy, will be derived and made explicit later in this paper.

Our model implies two wedges between expected marginal returns to capital and the financial interest rates received by financial investors: the first is the cost of financial intermediation, and the second is agency cost. This suggests that, due to inefficient financial intermediation or to poor corporate governance, the financial interest rate on savings could be low even if an economy were to have a low capital-to-labor ratio. Indeed, if the quality of these institutions lies below a certain threshold, the financial interest rate will remain at zero, and a portion of the economy's capital endowment will be unemployed in equilibrium. Therefore, in this case, it is the quality of the financial system, rather than the capital endowment, that determines equilibrium prices and output.

Economies with low-quality institutions have a few noteworthy features. First,

their comparative advantage is determined by institutions, rather than by factor endowment. An improvement in financial intermediation or corporate governance increases total capital usage in the country, thereby increasing the output of capital intensive goods while reducing the output of labor intensive goods. This further raises the total amount of external finance in the economy. Second, consider an economy with a lower capital-to-labor ratio than the world average. Going from autarky to free trade, such an economy exports labor intensive goods and imports capital intensive goods. As a result, more capital is left unemployed, so that trade openness reduces aggregate income. Going from financial autarky to financial openness, this economy generates capital flows from South to North in a pattern known as the Lucas paradox.

An economy with high-quality institutions behaves as a textbook Heckscher-Ohlin economy. In particular, standard results such as the Stolper-Samuelson theorem and the Rybczynski theorem all hold. We provide additional comparative statics by varying deep institutional parameters. For example, we show that a reduction in the cost of financial intermediation would not affect production and trade patterns.

Our paper makes another contribution to the literature. We distinguish the deep institutional parameters (i.e. cost of financial intermediation, quality of corporate governance, and protection of property rights) that are important to determine the relative size of a financial market, from the relative size of the financial market itself. We derive the latter to be a function of the former, and show that the two do not always have a monotonic relationship, but instead depend crucially on the quality of economic institutions. Rajan and Zingales (1998) popularized the notion of intrinsic demands, by sector, for external finance. In this model, we derive the demand for external finance as a function of deep institutional parameters. Across sectors, differences in the use of external finance come primarily from differences in the fixed costs a capitalist must pay to become an entrepreneur. Across countries, differences in the use of external finance even in the same sector depend most heavily

on the quality of corporate governance.

For economies with high-quality institutions, we show that improved financial systems increase the relative size of financial markets, while increased capital endowments reduce financial interest rates, depress the incentive for capitalists to become financial investors, and thereby reduce the relative size of financial markets. We also show that the effect of an improvement in the quality of financial systems on the relative size of financial markets may not be monotonic. For economies with high-quality institutions, improvements in the quality of financial systems increase the total amount of external finance more than they increase GDP. Therefore, such improvements raise the relative size of the financial market. For economies with low-quality financial institutions, however, the same improvements lead to smaller increases in total amounts of external finance as a fraction of GDP. Such improvements therefore reduce the relative size of financial markets in economies with low-quality financial institutions. Our theory provides an explanation for the empirical finding reported by Rajan and Zingales (2003), that financial markets did not grow in step with income in many countries, but instead experienced what they call “great reversals” over the past century. Our theoretical results are consistent with the empirical finding of La Porta et al. (1997 and 1998) that investor protection is important for determining the relative size of financial markets.

Our paper is related to a small but growing theoretical literature that models the role of financial systems in determining patterns of production and trade. Kletzer and Bardhan (1987), Baldwin (1989), Beck (2002), Matsuyama (2005), and Wynne (2005) show that countries with a relatively well-developed financial systems have a comparative advantage in industries that are reliant on external finance. Two recent papers are particularly interesting to us. While our model discusses the role of the financial system in an otherwise classical HOS form, Antras and Caballero (2007) study the effect of credit constraints on international trade and capital flows using a specific-factor model form, and show that in less financially developed economies,

trade and capital mobility are complements. Manova (2007) introduces credit constraints to a monopolistic competition model with heterogeneous firms. None of these papers studies threshold effects in economies with high-quality institutions versus low-quality institutions. Ju and Wei (2005) provide the first paper to discuss threshold effects in financial development. Except for that of Do and Levchenko (2007), all these papers treat financial development as exogenous. Our paper is also related to a body of literature on international trade and institutional quality. See Levchenko (2007), and Costinot (2005) for applications of a transaction cost approach, and Antras (2003), Antras and Helpman (2004), and Nunn (2007) for applications of a property rights approach.

The rest of this paper is organized as follows: Section 2 describes the setup of our model and discusses the microfoundation of internal and external finance. Section 3 studies equilibrium properties, with attention to differences between economies with high-quality institutions or low-quality institutions. Section 4 discusses the endogenous determination of both firm-level demand for external finance and country-level size of financial market. Section 5 studies the consequences of free trade and capital flows. Section 6 concludes. An Appendix collects formal proofs of various propositions introduced in the text.

2 The Model

In an otherwise standard HOS framework of two goods, two factors, and two countries, we introduce a financial contract between entrepreneur and investors. There is a large literature on agency models in corporate finance in which a contracting problem is solved to implement a firm's second-best demand for external finance (see Diamond 1991, Berglof and von Thadden 1994, Hart and Moore 1998, and Holmstrom and Tirole 1997). We modify the setup in Holmstrom and Tirole (1997) from a one-good, one-factor model to a two-goods, two-factors model.

2.1 Basic Setup

We start with a closed economy with two factors, labor and capital, and two sectors $i = 1, 2$. The production function for firms in industry i has constant return to scale and is denoted by $y_i = F_i(l_i, k_i)$. The labor-capital ratio, l_i/k_i , is assumed to be fixed and denoted by a_i . The real wage rate and the real financial interest rate are represented by w and r , respectively. Let p_i be the price of good i . Good 2 is taken as the numeraire whose price is normalized to be 1. Without loss of generality, we assume that good 1 is labor intensive, and good 2 is capital intensive.

The model features financial investors, entrepreneurs and (passive) financial intermediation. The timing of events is described in Figure 1. K denotes both the number of capitalists and the amount of capital in the economy. Each capitalist is assumed to be born with 1 unit of capital and faces an endogenous choice, at the beginning of the first period, of becoming either an entrepreneur or a financial investor. If she chooses to be an entrepreneur, she would manage a project, investing her 1 unit of capital (labeled as internal capital) and raising k_i^X amount of external capital from financial investors through the financial system. The total investment in the firm is the sum of internal and external capital, or $k_i = 1 + k_i^X$. Correspondingly, $a_i k_i$ amount of labor is hired.¹

After the investment decision is made in the first period, production and consumption take place in the second period. The return to one unit of capital if the project succeeds, R_i , is defined by the firm's zero profit condition

$$p_i y_i - w l_i = [p_i F_i(a_i, 1) - w a_i] k_i = R_i k_i \quad (1)$$

We use a framework of moral hazard that is derived and simplified from Holmstrom and Tirole (HT for short, 1997) to parameterize the quality of corporate governance.

¹Each variable in principle should have separate firm and sector subscripts. Since all firms within a sector are identical, we abuse the notation a bit by using a single subscript to denote a typical firm in sector i .

More precisely, entrepreneurs, whose own capital endowment is insufficient for the firm's financial needs, obtain external financing from financial investors. We extend the HT (1997) setup in two ways. First, the marginal return to capital, R_i , is endogenously determined (whereas it is exogenous in the HT setup). Second, capitalists make an endogenous career choice between being financial investors or entrepreneurs (whereas this choice is also exogenous in HT (1997)).

For a representative firm, the final output depends in part on the entrepreneur's level of effort, which can be low or high, but is not observable by the financial investors or by the financial institution. The entrepreneur can choose among two versions of the project. The "Good" version has a high probability of success, λ^H , while offering no private benefit. The "Bad" version has a low probability of project success, λ^L , but offering a private benefit per unit of capital managed, b , to the entrepreneur. We further assume that only the "Good" version is economically viable. That is, $(1 + \lambda^H R_i) - (1 + r) > 0 > (1 + \lambda^L R_i) - (1 + r) + b$, so that only the "Good" version is implemented. For simplicity, the probability of success and private benefit are assumed to be identical across all entrepreneurs. In subsequent discussions, we normalize $\lambda^L = 0$ and let $\lambda^H = \lambda$. The total expected return per unit of capital in this two-period model is equal to

$$1 + \lambda R_i = 1 + \lambda [p_i F_i(a_i, 1) - w a_i] \quad (2)$$

The quality of a financial system, depicted in Figure 2, is summarized by two parameters: the cost of financial intermediation, c , and the agency cost (private benefit), b . Investors collectively put k_i^X amount of external capital into a firm through financial intermediation. In equilibrium, while the total return per unit of capital is $1 + \lambda R_i$, an entrepreneur receives a payment of λR_i^E per unit of capital managed. The entrepreneur then pays $1 + \lambda R_i - \lambda R_i^E$ per unit of capital to the financial intermediaries, who retain c as the cost of intermediation, and pass on

$1 + \lambda R_i - \lambda R_i^E - c$ per unit of capital to the financial investors.

The equilibrium internal and external finance in the economy is determined by two parts: (a) a representative entrepreneur's optimization problem, and (b) a free entry condition that governs the division of the capitalists into the entrepreneurs' and financial investors' groups. We discuss the two parts sequentially.

2.2 Entrepreneur's Optimization Problem

The entrepreneur chooses the amount of external capital k_i^X , her own capital contribution to the project k_i^N , the total investment in the project k_i , and the marginal payment to the entrepreneur's effort R_i^E to solve the following program:

$$\max_{k_i^X, k_i^N, k_i, R_i^E} U_i = k_i \lambda R_i^E + (1 + r) (1 - k_i^N) \quad (3)$$

subject to

$$k_i^N \leq 1 \quad (4)$$

$$k_i \leq k_i^N + k_i^X \quad (5)$$

$$[1 + \lambda R_i - \lambda R_i^E - c] k_i \geq (1 + r) k_i^X \quad (6)$$

$$\lambda R_i^E \geq b \quad (7)$$

The objective function (3) represents the entrepreneur's expected income. The first term represents the entrepreneur's share in total capital revenue. The second term is the gross return from investing her own $1 - k_i^N$ capital in the market. Turning to the constraints, inequality (4) specifies that entrepreneur's internal capital is less than or equal to her capital endowment. Inequality (5) requires that total investment does not exceed the sum of internal and external capital. Inequality (6) is the participation constraint for outside financial investors, while inequality (7) is the entrepreneur's incentive compatibility constraint.

It is straightforward to show that all constraints must be binding in equilibrium. The entrepreneur will invest all her endowment $k_i^N = 1$ in the firm. The total investment k_i equals the sum of internal and external capital, $k_i^X + 1$. The incentive compatibility constraint (7) must be binding, which gives

$$R_i^E = \frac{b}{\lambda} \quad (8)$$

The investors' participation constraint (6) is binding. Substituting (8) into (6) gives the firm's optimal investment²

$$k_i = \frac{1+r}{(r+c)+b-\lambda R_i} \quad (9)$$

Therefore, the firm's dependence on external finance, measured by the ratio of external to total capital, is equal to

$$\phi_i = \frac{k_i - 1}{k_i} = \frac{1 + \lambda R_i - c - b}{1 + r} \quad (10)$$

Substituting (8) and (9) into (3), the entrepreneur's expected income becomes

$$U_i = k_i b = \frac{(1+r)b}{(r+c)+b-\lambda R_i} \quad (11)$$

2.3 Free Entry Condition

We assume that a capitalist (a potential entrepreneur) needs to pay a fixed entry cost of f_i in units of numeraire goods to become an entrepreneur in sector i .³ With free entry and exit, a capitalist is indifferent between becoming an entrepreneur or

²Following Holmstrom and Tirole (1997), we rule out the case that $(1+r+c)+b_i-\lambda R_i < 0$ in which the firm would want to invest without limit.

³For expositional convenience, we assume that neither the entry cost for becoming an entrepreneur, nor the cost of financial intermediation, reduces the amount of capital that can be employed in the first period. Both costs have to be paid up in the second period, but their present values in the first period are f_i and c , respectively. For example, the entrepreneur's entry cost specifies that the payment in the second period is equal to $\frac{f_i(1+r)}{\lambda}$ if the project succeeds and zero otherwise, so that the expected present value in the first period is exactly f_i .

a financial investor in equilibrium. A financial investor's expected return per unit of capital is $1 + r$. Thus, an entrepreneur's expected income net of the entry cost, $U_i - (1 + r)f_i$, should be equal to $(1 + r)$. That is,

$$U_i - (1 + r)f_i = 1 + r \quad (12)$$

Using (11), the free entry condition (12) implies that

$$1 + \lambda R_i = (1 + r) + c + \frac{f_i b}{1 + f_i} \quad (13)$$

By combining equations (11) and (12), the last term in (13), $\frac{f_i b}{1 + f_i}$, can be easily shown to be equal to $[U_i - (1 + r)] / k_i = f_i(1 + r) / k_i$, or the entrepreneur's expected return net of the opportunity cost of her own endowment per unit of capital invested. We therefore refer to the last term as the average net pay to the entrepreneur, denoted by b_i^{avg} . That is,

$$b_i^{avg} = \frac{f_i b}{1 + f_i}, \quad (14)$$

Equation (13) is an important relationship and will be referred to later as a *capital revenue sharing rule (CRSR)*. It states that the expected marginal product of physical capital is the sum of three terms: the financial interest rate paid to the financial investors, $(1 + r)$, the cost of financial intermediation, c , and the average net pay to the entrepreneur, b_i^{avg} . Following the literature, we assume that the fixed entry cost in the capital intensive sector is larger than that in the labor intensive sector⁴. With $f_2 > f_1$, it follows that $b_2^{avg} > b_1^{avg}$.

When $c = b = 0$, the marginal return to physical capital and the financial interest rate coincide. On the other hand, inefficiencies in the financial system due to either a high cost of financial intermediation, or a high level of corporate agency cost, drive a wedge between the two. The poorer the quality of corporate

⁴Antras and Caballero (2007) make a similar assumption. Manova (2006) reports a positive cross-sectoral correlation between capital intensity and the dependence on external finance.

governance (represented by a higher value of b), or the lower the efficiency of financial intermediation (represented by a higher value of c), the lower the financial interest rate for a given level of marginal return to physical capital.

3 Institutional Quality and Equilibrium Conditions

We now examine how the nature of the economic equilibrium depends on the three deep institutional parameters, c , b , and λ , and factor endowment. We start with an economy with high-quality institutions. That is, relative to factor endowment, the cost of intermediation, c , and the agency cost, b , are sufficiently low, and the level of property rights protection, λ , is sufficiently high. While many standard results such as the Stolper-Samuelson theorem and the Rybczynski theorem hold, we emphasize some comparative statics results involving the deep institutional parameters that have not been explored in the literature.

The second part of the section will then discuss equilibrium properties of an economy with low-quality institutions, that is, when c or b is high, or λ is low, relative to factor endowment. Standard results such as the Rybczynski theorem no longer hold. A change in endowment does not affect the equilibrium output. Indeed, it is possible for some of the capital endowment to be unemployed in equilibrium.

3.1 Equilibrium Properties with High-quality Institutions

We start with the case of an economy with high-quality institutions. The exact thresholds on c , b , and λ will be made precise in the next subsection. The first set of equilibrium conditions are free entry conditions. Using (2) and rewriting *CRSR* (13) in two sectors, we have:

$$g + \lambda a_1 w = \lambda p F_1(a_1, 1) - b_1^{avg} \quad (15)$$

$$g + \lambda a_2 w = \lambda F_2(a_2, 1) - b_2^{avg} \quad (16)$$

where $g = r + c$ is the gross interest rate. Equations (15) and (16) resemble the zero profit conditions in a Heckscher-Ohlin model. For given institutional variables λ and b_i^{avg} , it is immediately seen that factor prices (w, g) are uniquely determined by product prices $(p, 1)$. The standard Stolper-Samuelson theorem holds here. That is, an increase in the price of a good will increase the return to the factor used more intensively in producing that good, and reduce the return to the other factor.

Let L and K be the country's labor and capital endowments, respectively. Let the number of firms in sector i be N_i . The expected output in sector i ,

$$Y_i = N_i y_i = \lambda F_i(a_i, 1) K_i,$$

where $K_i = N_i k_i$ is the amount of capital used in sector i . Let $z_i = Y_i/L$, and $\kappa = K/L$ be the output and capital endowment per capita, respectively. The factor endowment constraints can therefore be written as

$$a_{1L} z_1 + a_{2L} z_2 = 1 \tag{17}$$

$$a_{1K} z_1 + a_{2K} z_2 = \kappa \tag{18}$$

where

$$a_{iL} = \frac{a_i}{\lambda F_i(a_i, 1)} \text{ and } a_{iK} = \frac{1}{\lambda F_i(a_i, 1)} \tag{19}$$

are labor and capital usages to produce one unit of output in sector i .

The labor constraint (17) and the capital constraint (18) jointly determine the equilibrium output per capita (z_1, z_2) . As can be verified, an increase in the capital-labor ratio would increase the output of the capital intensive sector, but would decrease the output of the labor intensive sector. This is a result familiar to trade economists, known as the Rybczynski Theorem.

The third equilibrium condition requires that the product market clears. We assume that the representative consumer's preference is homothetic. The ratio of

the quantities consumed, $D(p)$, depends only upon the relative product price. To clear the product market, the relative supply equals the relative demand.

$$\frac{z_1}{z_2} = D(p) \tag{20}$$

The five endogenous variables, w , r , z_1 , z_2 , and p are determined by five equations, (15), (16), (17), (18) and (20). As in a standard HOS model, under an assumption of a fixed labor-capital ratio, a_i , the equilibrium conditions are simplified into a block-recursive system. Outputs per capita (z_1, z_2) are determined by endowment ($1, \kappa$) through equations (17) and (18). The relative price p is then determined by (z_1, z_2) through (20). Given p , factor prices (w, g) can be solved by equations (15) and (16). Because the labor-capital ratio a_i is assumed fixed, this analysis produces *direct effects*.⁵ By combining the Rybczynski and the Stolper-Samuelson theorems, we can easily show that r declines as κ increases.

We now study the consequences of an improvement in the quality of financial institutions on the equilibrium output and prices. Because the equilibrium conditions have a block-recursive structure, such an improvement (a reduction in c , or a reduction in b) affects only factor prices through (15) and (16), but not the equilibrium output and product prices. There is some small difference between a reduction in c and a reduction in b . Since the gross interest rate g is determined by equations (15) and (16) and c appears only through g , a decrease in c must increase the financial interest rate by the same amount ($dr = -dc$), but has no effect on the wage rate. On the other hand, a reduction in b increases g (therefore r) but decreases w .

Strengthening *property rights protection* (an increase in λ) changes both factor prices and outputs. By inspecting equations (17) and (18), we see that a larger λ raises output in both sectors (y_1, y_2) proportionally, while maintaining the relative

⁵If a_i is recognized to depend on factor prices, there are additional *feedback effects*. However, as it has been proven by Jones (1965), as long as some stability conditions hold, there would be no qualitative difference in the comparative statics if the *feedback effects* are ignored.

price p unchanged. Using equations (15) and (16) again, we can show that an increase in λ reduces the wage rate w , but raises the financial interest rate r . Note that similar to Stolper-Samuelson theorem, a reduction in b , or an increase in λ results in a conflict of interests between capital owners and labor owners. We summarize the discussion by the following proposition and relegate a formal proof to the Appendix.

Proposition 1 *With high-quality institutions, the following comparative statics hold.*

(1) Both the Stolper-Samuelson theorem and the Rybczynski theorem hold. (2) An improvement in the efficiency of financial intermediation (a lower c), quality of corporate governance (a lower b), or property rights protection (a higher λ) would raise the equilibrium level of financial interest rate. (3) While an improvement in the efficiency of financial intermediation has no effect on the wage rate, an improvement in either corporate governance or property rights protection would reduce the wage rate. (4) An improvement in any of three institutional parameters has no effect on the equilibrium relative output and relative prices.

In other words, with high-quality institutions, the comparative advantage of an economy is fully determined by its factor endowment. An increase in capital endowment increases the output of the capital intensive good, but decreases the output of the labor intensive good. In comparison, an improvement in the efficiency of financial intermediation or corporate governance, while raising the financial interest rate, has no effect on the production pattern. Because of these features, an economy with high-quality institutions is also referred to as an endowment-binding economy.

3.2 What Defines High-quality Institutions?

We now come to the task of defining the threshold values of the institutions that separate high-quality institutions from low-quality institutions. Holding factor endowment constant, since the level of the financial interest rate is affected by the three institutional

parameters, c , b , and λ , the maximum amount of capital employed in an economy is determined by them as well.

Using equilibrium conditions (17), (18), and (20), we solve for the relative price

$$p = D^{-1} \left(\frac{a_{2K} - \kappa a_{2L}}{\kappa a_{1L} - a_{1K}} \right) \quad (21)$$

where $D^{-1}(\cdot)$ is the inverse function of demand. Applying (21) into equations (15) and (16), and solving for g , we obtain

$$g = \frac{\lambda}{(a_1 - a_2)} \left[a_1 F_2(a_2, 1) - a_2 D^{-1} \left(\frac{a_{2K} - \kappa a_{2L}}{\kappa a_{1L} - a_{1K}} \right) F_1(a_1, 1) \right] + \frac{b}{(a_1 - a_2)} \left(\frac{a_2 f_1}{1 + f_1} - \frac{a_1 f_2}{1 + f_2} \right) \quad (22)$$

$g = c + r$ is a decreasing function of capital per capita, κ , the agency cost b and the level of property rights protection λ . We denote it as $g = I(\kappa, b, \lambda)$. Its inverse, $\kappa(g) = I^{-1}(g, b, \lambda)$, gives the maximum amount of capital per capita that an economy employs at any given level of gross interest rate g .

The gross interest rate cannot be lower than the cost of intermediation c , since otherwise the financial interest rate r would have to be negative.⁶ Letting $g = c$ and rewriting expression (22), we have

$$\frac{a_{2K} - \kappa^{\max} a_{2L}}{\kappa^{\max} a_{1L} - a_{1K}} = D \left(\frac{a_1 F_2(\cdot)}{a_2 F_1(\cdot)} - \frac{(a_1 - a_2)c + b \left(\frac{a_1 f_2}{1 + f_2} - \frac{a_2 f_1}{1 + f_1} \right)}{a_2 F_1(\cdot) \lambda} \right) \quad (23)$$

Equation (23) gives the maximum amount of capital employed per capita, κ^{\max} , as a function of c , b , and λ . Since demand $D(\cdot)$ decreases in its variable, we immediately see that $\frac{d\kappa^{\max}(c, b, \lambda)}{dc} < 0$, $\frac{d\kappa^{\max}(c, b, \lambda)}{db} < 0$, and $\frac{d\kappa^{\max}(c, b, \lambda)}{d\lambda} > 0$. That is, a reduction in the cost of intermediation, a reduction in the agency cost, or a strengthening of

⁶The real (financial) interest rate could be negative in the real world due to inflation. However, there is still a minimum real interest rate (a floor) below which households would not want to put their savings in the formal financial system. As long as this is the case, the qualitative results of our discussion carry through.

property rights protection increases the employment of capital in the economy.

If $\kappa > \kappa^{\max}(c, b, \lambda)$, $(\kappa - \kappa^{\max}(c, b, \lambda))L$ number of investors exit from the financial system. Financial investors are indifferent between investing and not investing. Given any two parameters among c, b , and λ , equation (23) defines a threshold curve to determine whether an economy has high-quality institutions (*endowment-binding*) or low-quality institutions (*institutionally binding*). For example, given $b = b^0$ and $\lambda = \lambda^0$, equation (23) defines a threshold curve in (κ, c) space, depicted in Figure 3 as $c\kappa$ curve. The capital endowment per capita κ and intermediation cost c are represented in horizontal and vertical axes, respectively. For all points to the left side of the curve, all capital endowment is in full usage, and all values of c (relative to a particular κ) correspond to high-quality institutions. For example, at point $D = (\kappa', c)$ where $\kappa' < \kappa^{\max}(c, b^0, \lambda^0)$, the gross interest rate $g' = I(\kappa') > c$ so that all capital in the country is employed. The points to the right side of $c\kappa$ curve, however, define low-quality institutions. At point $B = (\kappa'', c)$ where $\kappa'' > \kappa^{\max}(c, b^0, \lambda^0)$, the gross interest rate is stuck at c and the financial interest rate $r = 0$. Since $(\kappa'' - \kappa^{\max}(c, b^0, \lambda^0))L$ amount of capital is unemployed, the capital endowment is no longer binding. Instead, the *cost of financial intermediation*, c , now determines the equilibrium output and prices. Relative to a particular value of κ , these values of c 's are too high.

Of course, we can also hold c and λ constant, and vary b , or hold c and b constant, and vary λ . In general, a four-dimensional space of thresholds, $(\kappa^{\max}, c, b, \lambda)$, given by equation (23), separates high-quality from low-quality institutions.

3.3 Equilibrium Properties with Low-quality Institutions

For an economy with low-quality institutions, the *capital revenue sharing rule* in two sectors (15) and (16) can be written as

$$c + \lambda a_1 w = \lambda p F_1(a_1, 1) - \frac{f_1 b}{1 + f_1} \quad (24)$$

$$c + \lambda a_2 w = \lambda F_2(a_2, 1) - \frac{f_2 b}{1 + f_2} \quad (25)$$

Two striking results in such an economy are that prices are stuck and that there is unemployed capital. Given that the gross interest rate $g = c$, the *capital revenue sharing rule* for good 2, equation (25), solves for the wage rate w . Given the gross interest rate c and the wage rate w , the *capital revenue sharing rule* for good 1, equation (24), solves for the product price p .

As long as the institutional parameters (c, b, λ) do not change, both factor and product prices are stuck. Changes in market demand and supply do not affect product prices; instead, the reverse is true. Institutional parameters determine product price p ; product market clearing condition (20) then solves for relative output z_1/z_2 . Given z_1/z_2 , factor market clearing conditions (17) and (18) determine the amount of employed capital in the economy, $K^{\max}(c, b, \lambda) = \kappa^{\max}(c, b, \lambda)L$.

To summarize, a country's use of capital is bound by $\kappa^{\max}(c, b, \lambda)$. When the capital-labor ratio is less than $\kappa^{\max}(c, b, \lambda)$, the country behaves as a textbook version of a neoclassical economy. When capital endowment is abundant in the sense that $\kappa > \kappa^{\max}(c, b, \lambda)$, however, the capital usage is stuck at $\kappa^{\max}(c, b, \lambda)$. Beyond that level, the financial interest rate becomes zero, and investors lose incentives to supply capital. Any infusion of additional capital from abroad, for example, through the World Bank, the IMF, or rich country governments, is not productive in such an economy. An improvement in financial system, however, can alter equilibrium output and prices.

To see the comparative statics, let us focus on cases in which the economy is

still *institutionally binding* after the changes. It is easy to see that an increase in c has no effect on net interest rate r since $r = g - c = 0$. Using (25), an increase in c reduces the wage rate w . Substituting (25) into (24), we can show that the relative price of labor intensive good p decreases, which raises the labor intensive output z_1 but reduces the capital intensive output z_2 . Total investment in the economy, $\kappa^{\max}(c, b, \lambda)$, decreases as c increases. An increase in b has the same effect as an increase in c .

The effect of a deterioration in the *property rights protection* (a decrease in λ) reduces the wage rate. Its effect on output is more complicated. Through factor constraints (17) and (18), it reduces the expected output in the two sectors proportionally. On the other hand, it also reduces the relative price p through equations (24) and (25), which increases z_1 , but reduces z_2 . Thus, the overall effect of a worsening of the *property rights protection* is to reduce the capital intensive output, while the effect on the labor intensive output is ambiguous. We summarize these results below and relegate a formal proof to the Appendix.

Proposition 2 *In an economy with low-quality of institutions, the comparative advantage is determined by the three institutional parameters, rather than by the factor endowment. An increase in capital endowment has no effect on the economy. A reduction in the cost of financial intermediation or the agency cost, on the other hand, increases the wage rate and total capital usage in the country, thereby increasing the output of capital intensive good but reducing the output of labor intensive good.*

4 Dependence on External Finance and Financial Development

The empirical literature reports that the level of dependence on external finance varies dramatically across different industries. Rajan and Zingales (1998) define external finance as the amount of desired investment that cannot be financed through internal cash flows generated by the same business. Using data from the United

States, they measure a firm's dependence on external finance by capital expenditures minus cash flow from operations divided by capital expenditures. An economy's financial development, on the other hand, is commonly measured by the size of financial market (the ratio of domestic bank credit to GDP, or that plus the ratio of stock market capitalization to GDP) in the empirical literature. To evaluate the appropriateness of these measures, we now derive their counterparts in our model.

4.1 Firm-level Dependence on External Finance

Since allowing $b_1 \neq b_2$ does not change any results in Section 2, we therefore let private benefits differ across sectors in this subsection. Substituting *CRSR* (13) into (10) gives the firm's dependence on external finance

$$\phi_i(r, b_i, f_i) = 1 - \frac{b_i}{(1+r)(1+f_i)} \quad (26)$$

Expression (26) gives the equilibrium level of a firm's use of external finance, which increases in r and f_i but decreases in b_i . Here we offer some intuition. First, when the financial interest rate r increases, more capitalists choose to become financial investors. The economy-wide ratio of external capital (from financial investors) to internal capital (from entrepreneurs) increases, and the external dependence ϕ_i increases in every sector. Second, when the fixed cost in sector i , f_i , increases, fewer entrepreneurs enter sector i so that fewer firms are producing. The product price and therefore the expected marginal value product of capital in sector i , λR_i , increase. As a result, firms in sector i can raise more funding from outside investors. Lastly, the marginal pay to the entrepreneur is equal to the private benefit in equilibrium. If it is lower, the pay to outside investors in sector i , $\lambda R_i - b_i$, is higher, which results in more external investment in the project and therefore higher usage of external finance. Summarizing we have:

Proposition 3 *An industry is more dependent on external finance if the entrepreneur's*

entry cost is higher, or if the entrepreneur's private benefit per unit of capital managed is lower.

A key assumption in Rajan and Zingales (1998) is that the external dependence in sector i , $\phi_i(r, b_i, f_i)$, is the same across countries (measured by U.S. data). This assumption can be examined here. The functional form of $\phi_i(r, b_i, f_i)$ is indeed the same across countries. However, in order for the value of $\phi_i(r, b_i, f_i)$ to be the same, one must assume that the financial interest rate r , the private benefit b_i and the entry cost f_i are the same across countries. Within a country, the difference in entry cost across sectors generates differences in actual use of external finance. Across countries, the difference in the quality of corporate governance generates differences in actual use of external finance even for the same sector. Of course, with cross-country variations in b_i , f_i , and r , the realized dependence on external finance in sector i , $\phi_i(r, b_i, f_i)$, is country-specific in general.

4.2 The Relative Size of Financial Markets - A Common Measure of Financial Development

In the empirical literature, a country's financial development is often represented by the size of a financial market (e.g., Rajan and Zingales 1998, La Porta et al. 1997 and 1998). Theoretical studies on the determinants of the size of financial markets are limited. Shleifer and Wolfenzon (2002) show that as investor protection becomes stronger, the financial markets becomes larger. Rajan and Zingales (2003) propose an interest group theory to explain the evolution of financial market.

In our model, the size of a financial market (the ratio of total external finance to GDP) is determined by intermediation cost c , agency cost b , level of property rights protection λ , and capital-labor ratio κ . We can show that with high-quality institutions, an improvement in the quality of financial system increases total external finance, but leaves GDP unchanged, thereby increasing the relative size of the financial market. However, an increase in capital-labor ratio κ reduces the financial

interest rate and depresses the incentive for capitalists to supply external finance, thereby reducing the relative size of the financial market. In an economy with low-quality institutions, on the other hand, an improvement in the quality of financial system increases total external finance, but not by as much as it increases GDP, thereby resulting in a smaller relative size of the financial market. These opposite effects provide a possibly non-monotonic relationship between income level and the relative size of the financial markets, which is consistent with the evidence presented by Rajan and Zingales (2003), without appealing to a political economy story. We now move to a formal analysis.

As each capitalist owns one unit of capital, the total external finance in the economy is equal to the number of active financial investors. Recall that N_i is the number of entrepreneurs in sectors i . The capital endowment constraint (18) can be rewritten as

$$(a_{1K}Y_1 - N_1) + (a_{2K}Y_2 - N_2) = K^{\max} - N_1 - N_2 \Leftrightarrow \quad (27)$$

$$\phi_1 a_{1K} Y_1 + \phi_2 a_{2K} Y_2 = K^X \quad (28)$$

The right hand side of (28), $K^X = K^{\max} - N_1 - N_2$, is the total supply of external finance, while each component of the left hand side, $a_{iK}Y_i - N_i = (k_i - 1)N_i = \phi_i K_i = \phi_i a_{iK} Y_i$, represents the demand for external fund in sector i .

Equation (28) highlights two channels in determining *total external finance*: an *interest rate channel* and a *relative output channel*. First, a change in $\phi_i(r, b, f_i)$ affects K^X . When the financial interest rate is higher, more capitalists choose to become financial investors rather than entrepreneurs. Therefore, $\phi_i(r, b, f_i)$ is higher as indicated by equation (26) so that K^X becomes larger. That is denoted as the *interest rate channel*. A reduction in either intermediation cost c or agency cost b , or a strengthening of property rights protection (i.e. a rise in) would raise the financial interest rate r . As a result, realized external finance $\phi_i(r, b, f_i)$ rises in

every sector and therefore total external finance K^X also rises.

Second, a change in output (Y_1, Y_2) affects K^X . Recall that k_i^X and l_i are external finance and labor employed by the firm in sector i , respectively. We define sector i to be more external finance intensive if

$$\frac{k_i^X}{l_i} = \frac{\phi_i}{a_i} > \frac{k_j^X}{l_j} = \frac{\phi_j}{a_j} (i, j = 1, 2). \quad (29)$$

Since $\phi_2 > \phi_1$ and $a_1 > a_2$, it must be the case that $\phi_2/a_2 > \phi_1/a_1$. That is, the capital intensive sector is more external finance intensive. It is easy to show that an increase in relative output $\frac{Y_1}{Y_2}$ raises total external finance K^X . That is referred to as the *relative output channel*.

The size of a financial market is represented by

$$\Omega = \frac{K^X}{Y} = \frac{\phi_1 a_{1K} Y_1 + \phi_2 a_{2K} Y_2}{pY_1 + Y_2} = \frac{\phi_1 a_{1K} z_1 + \phi_2 a_{2K} z_2}{pz_1 + z_2} \quad (30)$$

where Y denotes GDP. As we will show next, the comparative statics involving Ω differs between the case of high-quality institutions and that of the low-quality institutions, sometimes with opposite signs.

4.2.1 The Size of Financial Market with High-quality Institutions

We first consider the comparative statics with high-quality institutions. Proposition 1 shows that a reduction in c increases the financial interest rate, and therefore increases K^X , but leaves Y unaffected. This results in a higher Ω . A reduction in b raises $\phi_i(r, b_i, f_i)$ by equation (26). It also increases the financial interest rate, and again increases $\phi_i(r, b_i, f_i)$. Since a reduction in b unambiguously raises K^X , while leaves Y unaffected, it also results in a higher Ω . The effect of an increase in λ is somewhat different. First, through the *relative output channel*, it increases K^X and Y proportionally, which has no effect on Ω . Second, through the *interest rate channel*, it increases the financial interest rate and therefore increase K^X , while

leaves Y unaffected. The net effect is a higher Ω . To summarize, an improvement in any of the three institutional parameters would lead to a bigger financial market relative to GDP (i.e., a higher Ω).

We now consider the effect of an increase in capital to labor ratio, κ . By the *Rybczynski Theorem*, this increases the output of the good that uses more external finance, Y_2 , but reduces the output of the other good, Y_1 . By a change in the composition of the output (the *relative output channel*), this raises K^X . On the other hand, an increase in κ (or an increase in K while holding L fixed) raises GDP Y , too. At the same time, however, the increase in κ reduces the financial interest rate r . Through the *interest rate channel*, it reduces K^X . In general, the effect of an increase in κ on Ω is ambiguous. We formally prove in the Appendix that as long as the relative demand for the good less intensive in external finance, $D(p)$, is inelastic, an increase in κ reduces Ω . From equation (30), we can see that a change in the relative price p affects Y but not K^X . When $D(p)$ is inelastic, the decline in relative output Y_1/Y_2 raises p significantly. Thus, an increase in κ increases Y more than K^X . Note that the assumption that $D(p)$ is inelastic is plausible if the good less intensive in external finance is a composite of necessary goods.

4.2.2 The Size of Financial Market with Low-quality Institutions

In an economy with low-quality institutions, an increase in κ has no effect on either K^X , Y (Proposition 2), or Ω . When the quality of institution improves, on the other hand, both K^X and Y change. First, through the *interest rate channel*, a reduction in the agency cost raises $\phi_i(0, b, f_i)$ and therefore increases K^X . A reduction in the cost of financial intermediation or an improvement in property rights protection has no effect on $\phi_i(0, b, f_i)$. Second, an improvement in any institutional parameter increases the maximum amount of capital employed in the economy, $\kappa^{\max}(c, b, \lambda)$, which in turn increases both K^X through the *relative output channel* and GDP Y as well. The effect on Ω thus is ambiguous. We prove in the Appendix that if the

relative demand, $D(p)$, is inelastic, an improvement in any institutional parameter increases Y more than it does K^X , thereby reducing Ω . This discussion can be summarized by the following proposition:

Proposition 4 *Suppose that the relative demand for the good less intensive in external finance is inelastic. a) An improvement in the quality of institutions increases the size of the financial market in an economy with high-quality institutions, but reduces it in an economy with low-quality institutions. b) An increase in capital endowment, on the other hand, reduces the size of the financial market in an economy with high-quality institutions, but has no effect with low-quality institutions. c) An improvement in the quality of institutions has no effect on GDP in an economy with high-quality institutions, but increases GDP with low-quality institutions. d) On the other hand, an increase in the capital endowment increases GDP in an economy with high-quality institutions, but has no effect on the GDP with low-quality institutions.*

A visual representation of the comparative statics is described in Figure 4, where vertical axis represents the size of the financial market Ω , and the horizontal axis represents the quality of financial intermediation $1/c$, respectively. Given $b = b^0$ and $\lambda = \lambda^0$, \bar{c} represents the threshold that separates economies with high-quality institutions ($1/c > 1/\bar{c}$) from the ones with low-quality institutions ($1/c \leq 1/\bar{c}$). When $1/c \leq 1/\bar{c}$, the economy is in the range of low-quality institutions. For comparison, the effect on Y is also depicted. Figure 5 depicts the effect of an increase in capital-labor ratio κ , with the horizontal axis representing κ . When $\kappa < \kappa^{\max}$, the economy is in the range of high-quality institutions; an increase in κ reduces Ω . When $\kappa \geq \kappa^{\max}$, an increase in κ has no effect on Ω .

Rajan and Zingales (2003) report an intriguing (and somewhat surprising) pattern in the data: the relative size of financial markets in the United States and most other countries was lower in 1980 than in 1913, and only in more recent years does it tend to surpass the 1913 value. The apparent non-monotonic relationship between

income (or institutional development) and the relative size of financial markets can be rationalized by our model. The relative size of financial market is a function of the capital-labor ratio and of institutional parameters. That is,

$$\begin{aligned}\Omega &= \Omega(\kappa, 1/c, 1/b, \lambda) \Leftrightarrow \\ d\Omega &= \frac{\partial\Omega}{\partial\kappa}d\kappa + \left[\frac{\partial\Omega}{\partial(1/c)}d(1/c) + \frac{\partial\Omega}{\partial(1/b)}d(1/b) + \frac{\partial\Omega}{\partial\lambda}d\lambda \right]\end{aligned}\quad (31)$$

Take the United States as an example of an economy with high-quality institutions. Over the last century both its capital-labor ratio, κ , and its quality of institutions $(1/c, 1/b, \lambda)$ have been improving. Using Proposition 4, the first term (the endowment effect) in the right hand side of (31) is negative, while the second term (the institutional effect) is positive. If from 1913 to 1980, the endowment effect dominated the institutional effect, then it would not be surprising, according to our model, that the relative size of the financial market in the U.S. actually declined. This is plausible if regulatory measures such as the Glass-Steagall Act (restricting cross-state banking and universal banking) and Regulation Q (imposing a ceiling on bank interest rates) may have increased the cost of financial intermediation. If, since the 1980s, the institutional effect began to dominate the endowment effect, perhaps through financial deregulation, then the relative size of the financial market may exhibit a revival. Of course, our model is only suggestive. To truly explain the evolution of financial development over a century, we need to extend this static model to a dynamic one, which is left for future research.

4.2.3 The Size of Financial Market and Production Structure

With low-quality institutions, Proposition 2 points out that the country with a better financial system (a lower c or b) produces more goods in the external finance intensive sector (sector 2). The most common proxy for financial development in the empirical literature—the ratio of total external finance to GDP, Ω ,—may be

misleading. As indicated by Figure 4 and Proposition 4, when financial intermediation improves, Ω declines even though the country produces more of the external finance intensive good. Thus, the ratio of total external finance to GDP and the relative output of external finance intensive good could be negatively correlated.

For an economy with high-quality institutions, Proposition 1 shows a lack of monotonic mapping between the quality of financial systems and production structure. However, as the capital to labor ratio increases, the relative size of a financial market can also be negatively correlated with the relative output of the external finance intensive good.

In summary, we recognize the endogenous nature of the relative size of financial markets, and show that its relationship with deep parameters representing the cost of financial intermediation or the quality of corporate governance is not monotonic. The common empirical measure that uses the relative size of financial markets as a proxy for the level of financial development may be unreliable.

5 Free Trade and Capital Flows

Using the comparative statics derived above, we are now ready to study the consequences of free trade in goods and of international capital flows. Consider two countries with identical and homothetic tastes and identical technologies, but with different endowments and different financial systems. To simplify the analysis, we assume that the extent of property rights protection, λ , and entrepreneurs' entry costs f_i , are the same in the two countries. Labor is immobile across countries by assumption. To organize our discussion, we start with the case of free trade in goods without international capital flows. We then discuss the case with international capital flows.

5.1 Free Trade

Let two countries, “South” and “North”, be open to free trade. In the case when both South and North have high-quality institutions, the trade pattern and welfare effect of moving from autarky to free trade are identical to the Heckscher-Ohlin case: the country will export the good using its abundant factor intensively and import the other good; free trade enhances welfare for both countries. We therefore choose to focus on a more interesting (and less familiar) case in which South has low-quality institutions and North has high-quality institutions.

5.1.1 Trade Pattern and Relative Size of Financial Market

We use superscripts (S, N) to denote countries, and a and f to denote autarky and free trade, respectively. Let p^{Sa} and p^{Na} be relative prices of good 1 in South and North under autarky, respectively. The pattern of trade is determined by comparing p^{Sa} and p^{Na} . We assume that South is both poorer in capital endowment (i.e. $\kappa^S < \kappa^N$) and inferior in financial system (i.e. $(c^S, b^S) > (c^N, b^N)$). The factor endowment constraints in South in autarky are:

$$a_{1L}z_1^S + a_{2L}z_2^S = 1 \quad (32)$$

$$a_{1K}z_1^S + a_{2K}z_2^S = \kappa^{\max}(c^S, b^S) \quad (33)$$

where $\kappa^{\max}(c^S, b^S)$ is the maximum amount of capital employed per capita in South and is less than the capital endowment per capita, $\kappa^S = \frac{K^S}{L^S}$, since South is *institutionally binding*. Thus, $\kappa^{\max}(c^S, b^S) \leq \kappa^S < \kappa^N$. Comparing equations (32) and (33) in South and (17) and (18) in North and using the Rybczynski theorem, we immediately see that in autarky $z_1^{Sa}/z_2^{Sa} > z_1^{Na}/z_2^{Na}$ so that $p^{Sa} < p^{Na}$.

Let p^f be the price after free trade. It must be the case that $p^{Sa} \leq p^f \leq p^{Na}$. Compared with autarky, therefore, South produces more of the labor intensive good and exports it, and imports the capital intensive good. Since free trade raises

the relative price of the labor intensive good in South, by the Stolper-Samuelson theorem, the gross interest rate in South would decline. Therefore, the financial interest rate in South is still stuck at zero, and South must remain *institutionally binding* after free trade. On the other hand, free trade raises North's gross interest rate so it remains *endowment-binding*. The factor endowment constraints in North, (17) and (18), do not change, which implies that the equilibrium output remains the same as that in autarky. That is, $z_i^{Nf} = z_i^{Na}$.

The free trade price p^f must be equal to the autarky price in South, p^{Sa} , if South is diversified. To see this, note that since the gross interest rate is stuck at c , as equation (25) indicates, the wage rate in South under free trade remains unchanged. If $p^f > p^{Sa}$, the profit in sector 1 would be positive and factors would flow from sector 2 to 1, so p^f would decline. Therefore in free trade equilibrium we must have $p^f = p^{Sa}$ as long as South is diversified. In that case, the world market clearing condition is

$$\frac{z_1^{Sf} + z_1^{Nf}}{z_2^{Sf} + z_2^{Nf}} = \frac{z_1^{Sf} + z_1^{Na}}{z_2^{Sf} + z_2^{Na}} = D(p^{Sa}) \quad (34)$$

The labor endowment constraint in South is the same as before:

$$a_{1L}z_1^{Sf} + a_{2L}z_2^{Sf} = 1 \quad (35)$$

Equations (34) and (35) solve for the output in South under free trade, (z_1^{Sf}, z_2^{Sf}) . Given output (z_1^{Sf}, z_2^{Sf}) , the amount of capital usage per capita is determined by the following equation:

$$a_{1K}z_1^{Sf} + a_{2K}z_2^{Sf} = \kappa^{Sf} \quad (36)$$

It is straightforward to show that the South produces more of the labor intensive good and less of the capital intensive good in free trade than in autarky; hence, $z_1^{Sf} > z_1^{Sa}$ but $z_2^{Sf} < z_2^{Sa}$. It is then easy to show that $\kappa^{Sf} < \kappa^{\max}(c^S, b^S)$. That is, South uses less capital in free trade than in autarky. The boundary condition for

South to be diversified is

$$\frac{\bar{z}_1 + z_1^{Na}}{z_2^{Na}} = D(p^{Sa}) \quad (37)$$

where $\bar{z}_1 = L^S/a_{1L}$ is the maximum amount of good 1 that South could produce. Note that the output in North is a function of its labor endowment and the capital-labor ratio. That is, $z_i^{Na} = z_i^{Na}(L^N, \kappa^N)$. So equation (37) defines the boundary conditions in North, (L^{*N}, κ^{*N}) , by which South remains diversified in free trade. If $L^N > L^{*N}$, or $\kappa^N > \kappa^{*N}$, South must completely specialize in producing good 1. In that case, the total amount of capital employed in South is fixed at $\kappa^{Sf} = L^S/a_1$.

Suppose that South remains diversified. Free trade increases the relative size of the financial market in North. To see this, note that $p^f = p^{Sa} < p^{Na}$ and $z_i^{Nf} = z_i^{Na}$ so the GDP (in units of good 2) in North declines, while its financial interest rate and therefore the amount of its total external finance increase. With these two effects, the ratio of total external finance to GDP in North must increase. The effect on South is mixed. On one hand, as South produces less of the good that is relatively intensive in external finance (the capital intensive good) after free trade, its total external finance declines. On the other hand, as will be shown below, its GDP also declines. As a result, the ratio of the two may either increase or decrease.

5.1.2 Aggregate Income

Assume that total cost of financial intermediation, cK^{\max} , and all entry costs paid by entrepreneurs, $(1+r)(f_1N_1 + f_2N_2)$, are distributed to labor. The aggregate income, W , is the sum of expected labor income, entrepreneurs' net income, and investors' net income. Note that the income for a typical entrepreneur (net of entry cost), and that for a typical active financial investor are both equal to $1+r$. $K - K^{\max}$ of capitalists do not invest (and eat their capital at the end of period 2). The total

investment, $K^{\max} = K_1 + K_2$. Combining these results, we have:

$$\begin{aligned} W &= [\lambda wL + cK^{\max} + (1+r)f_1N_1 + (1+r)f_2N_2] + (1+r)K^{\max} + (K - K^{\max}) \\ &= K + \lambda wL + \sum_{i=1}^2 \left[r + c + \frac{(1+r)f_i}{k_i} \right] K_i \end{aligned} \quad (38)$$

Using (11) and (13), we have $U_i = (1+r)(1+f_i) = bk_i$, which implies that $\frac{(1+r)f_i}{k_i} = \frac{f_i b}{1+f_i} = b_i^{avg}$. Using this result, expression (38) can be written as

$$W = K + \lambda wL + (r+c)K^{\max} + b_1^{avg}K^{\max} + (b_2^{avg} - b_1^{avg})K_2 \quad (39)$$

Since South is *institutionally binding*, its aggregate income is

$$W^{St} = K^S + \lambda w^{St}L^S + cK^{St} + b_1^{avg}K^{St} + (b_2^{avg} - b_1^{avg})K_2^{St} \quad (40)$$

for $t = a$ in autarky and f in free trade, respectively. Expression (40) highlights a possible income loss in South due to free trade. As discussed earlier, $w^{Sa} = w^{Sf}$ as long as South remains diversified. $K^{Sa} = K^{\max} > K^{Sf}$ since the South produces more of the labor intensive good under free trade and therefore uses less capital. The last term, $(b_2^{avg} - b_1^{avg})K_2^{St}$, also becomes smaller since $b_2^{avg} > b_1^{avg}$ and the capital usage in sector 2 is smaller under free trade than in autarky. Free trade, by reducing both the total capital usage and the pay to entrepreneurs, without changing the wage rate, must reduce the aggregate income in South. If South completely specializes in producing good 1 under free trade, the wage rate may go up, and hence make up for some of the lost capital income.

5.1.3 Welfare

Using (13), the aggregate income (38) can also be written as the sum of the capital endowment and GDP

$$W = K + \lambda [pF_1(L_1, K_1) + F_2(L_2, K_2)] \quad (41)$$

As capital endowment K is exogenous, the decrease in aggregate income W implies a decrease in GDP. Let the utility function for a representative consumer be $u(c_1, c_2)$. The indirect utility function becomes

$$V(p, L, K) = \max_{c_1, c_2} \{u(c_1, c_2) : pc_1 + c_2 \leq W\} \quad (42)$$

Note that $K_1 + K_2 = K^{\max}$. Differentiating $V(p, L, K)$ with respect to p and using the envelope theorem,⁷ we obtain

$$\frac{\partial V(p, L, K)}{\partial p} = \mu(Y_1 - c_1) + \mu \frac{\partial F_2}{\partial K_2} \frac{\partial K^{\max}}{\partial p} \quad (43)$$

where μ is the marginal utility of income.

p increases and $Y_1^{Sf} - c_1^{Sf} > 0$ in South since it exports good 1. Thus the first term captures the traditional gain from trade. The second term, however, represents a negative effect due to a loss of capital income. On the other hand, p decreases and $Y_1^{Sf} - c_1^{Sf} < 0$ in North and the second term vanishes since $K^{\max} = K^N$, which implies that North always gains from free trade. Summarizing we have:

Proposition 5 (1) *South (with low-quality institutions) exports a labor intensive good and imports a capital intensive good. (2) If South remains diversified, free trade increases North's size of the financial market. (3) While North always gains from free trade, South exhibits a decline in aggregate income (and potentially welfare)*

⁷We allow labor-capital ratio a_i to vary now, and use firms' first order conditions $\frac{p\partial F_1}{\partial L_1} = \frac{\partial F_2}{\partial L_2}$ and $\frac{p\partial F_1}{\partial K_1} = \frac{\partial F_2}{\partial K_2}$.

if it remains diversified.

5.2 Capital Flows

We consider two types of international capital flows. Financial capital is assumed to go where the financial interest rate is the highest; it occurs when a financial investor decides to take her endowment out of the country and places it in a foreign financial system. Foreign direct investment (FDI) is assumed to go where the expected return to physical capital is the highest; it takes place when an entrepreneur decides to take her project to a foreign country and combine the capital under her management with foreign labor in the production. We first study financial capital movement by assuming FDI is disallowed. We then go on to allow both types of capital flows.

5.2.1 Financial Capital Flow

Suppose South is diversified after free trade. The gross interest rate in South is equal to its cost of financial intermediation, $g^S = c^S$, while the gross interest rate in North, $g^N = r^N + c^N$, is determined by equations (15) and (16). Since $r^S = 0 < r^N$, financial capital must flow from South to North. As long as South is diversified, the financial interest rate in South remains at zero. This means financial capital will keep leaving South until it becomes completely specialized in producing the labor intensive good. If capital continues to flow from South to North after that, South produces less of the labor intensive good; North produces more of the capital intensive good and less labor intensive good. So the world relative price of good 1, p , increases, reducing r^N in North in accord with the Stolper-Samuelson theorem. The financial interest rate in South r^S , however, increases as p increases, and is determined by equation (24) which we rewrite as follows:

$$(c^S + r^S) + \lambda^S a_1 w^S = \lambda p^f F_1(a_1, 1) - \frac{f_1 b^S}{1 + f_1} \quad (44)$$

In equilibrium we must have $r^S = r^N$. Equation (44) then solves for the wage rate w^S . The following proposition summarizes our discussion:

Proposition 6 *Allowing financial capital flow (but disallowing FDI), financial capital tends to flow from South to North. As a result, South must completely specialize in producing the labor intensive good.*

5.2.2 Two-Way Capital Flows and the Bypass Effect

We now allow for both types of capital flow. We assume that the entrepreneur who takes her project to a foreign country still uses her home financial system to obtain external finance. In other words, if a U.S. multinational firm operates in India, the firm still uses a US bank or stock market for its financing needs. Note that South specializes in producing good 1 due to financial capital flow, so FDI takes place in sector 1 initially. When a Northern entrepreneur in sector 1 directly engages in FDI in South, using (11), her expected income becomes

$$U_1^{Nd} = \frac{(1 + r^N) b^N}{(r^N + c^N) + b^N - \lambda^S R_1^S} \quad (45)$$

The entrepreneur engages in FDI in South if and only if $U_1^{Nd} > U_1^N$, which holds in turn if and only if $\lambda^S R_1^S > \lambda^N R_1^N$.

Rewriting condition (13) in both countries, we have:

$$\lambda^S R_1^S = (r^S + c^S) + b_1^{avg,S} = r^S + \rho_1^S \quad (46)$$

$$\lambda^N R_1^N = (r^N + c^N) + b_1^{avg,N} = r^N + \rho_1^N \quad (47)$$

Since $(c^S, b^S) > (c^N, b^N)$ by assumption, $\rho_1^S = c^S + b_1^{avg,S} > \rho_1^N = c^N + b_1^{avg,N}$ where $\rho_i^j (i = 1, 2; j = S, N)$ is the sum of the financial intermediation cost and the average net pay to an entrepreneur in sector i . Since $r^S = r^N$ due to financial capital flow, we must have $\lambda^S R_1^S > \lambda^N R_1^N$. Therefore, FDI flows from North to South.

South sends out financial capital to escape the low financial interest rate at home, and at the same time, receives inward FDI due to higher domestic return to physical capital. As financial capital flows from South to North, South produces less of the labor intensive good and North produces more of the capital intensive good. So p increases, which reduces r^N in North by the Stolper-Samuelson theorem and increases r^S because of a complete specialization in South. As a result, $\lambda^N R_1^N$ decreases but $\lambda^S R_1^S$ increases, driving more FDI flowing from North into South. On the other hand, as FDI flows into South, North produces less of the capital intensive good and South produces more of the labor intensive good. So p decreases, which increases r^N and reduces r^S , which in turn drives more financial capital to flow from South to North. In summary, financial capital and FDI tend to move in the opposite directions and reinforce each other. So in equilibrium all financial capital owned by South leaves the country in the form of financial capital outflow, and reenters in the form of *FDI*. The equilibrium can be summarized by the following proposition:

Proposition 7 *Allowing both for FDI and financial capital flow, the unique equilibrium features a complete bypass: all capital endowment in South leaves the country in the form of financial capital outflow, and all physical investment in South takes place through FDI; the low quality financial institutions in South are completely bypassed.*

The above proposition is a two-sector generalization of Ju and Wei (2007). Welfare effects of capital flows in South are mixed. First, the world output of capital intensive good increases when financial capital flows from South to North, which improves terms of trade in South. Second, investors in South earn higher interest rate. Both effects benefit South. On the other hand, the bypassing of the inefficient financial system transfers the revenue of South's financial intermediation and management from South to North. The welfare impact on South, therefore, is determined by a trade-off between an efficiency gain from capital mobility and a revenue loss in financial intermediation and entrepreneurial pay.

6 Conclusion

While dominant trade theories and leading textbooks on trade ignore the role of finance in determining production and trade patterns, recent empirical literature based in financial economics (pioneered by Rajan and Zingales, 1998) has recognized a possibly prominent role for financial development in determining patterns of trade. However, whether the role of finance is a reflection of underlying factor endowment or an independent source of comparative advantage has not been clearly worked out in theory. This paper provides a unified general equilibrium model in which both the quality of a financial system and the underlying factor endowment jointly determine patterns of production and trade.

Our model does more than merely suggest that finance and the real economy affect each other; it yields dichotomous economic equilibria. On one hand, for economies with low-quality institutions (relative to endowment) the quality of financial systems plays a decisive role, and an increase in factor endowment does not alter output or trade patterns. On the other hand, for economies with high-quality institutions, factor endowment plays the customary role in determining output and trade patterns, just as in a textbook version of the HOS model; additionally, a further reduction in the cost of financial intermediation does not alter output and trade patterns (although it raises financial return to financial investors).

In terms of modeling innovations, we adapt a standard partial equilibrium corporate finance model from Holmstrom and Tirole (1997) to a multi-sector, general equilibrium model. This framework allows us to endogenize both firm-level dependence on external finance, and a measure of economy-wide financial development (the size of a financial market relative to GDP). An interesting implication of our formulation is that the deep parameters of a country's financial system efficiency or corporate governance do not have a simple, monotonic relationship with the conventional measure of a country's level of financial development or income level. Indeed, it

is possible for an economy's financial development to experience a "great reversal" (Rajan and Zingales, 2003) as it gets richer or as its institutions improve.

This is a static model in the tradition of the classic Heckscher-Ohlin-Samuelson theory. This analysis could be enriched considerably if recast into a dynamic setting. For example, unemployed capital in an economy with low-quality institutions may manifest itself in discouraged savings (in a closed economy) or in capital flight (in a financially open economy). The cost of a dynamic setting is that some simple and intuitive results from the HOS setup could become substantially more complicated. We leave this extension for future research.

References

- [1] Alvarez, Fernando and Robert Lucas (2005) "General Equilibrium Analysis of the Eaton-Kortum Model of International Trade," *NBER Working Paper*, No. 11764.
- [2] Antras, Pol (2003), "Firms, Contracts, and Trade Structure," *Quarterly Journal of Economics*, 118(4), 1374-1418.
- [3] Antras, Pol and Ricardo J. Caballero (2007), "Trade and Capital Flows: A Financial Frictions Perspective," *Working Paper*.
- [4] Antras, Pol and Elhanan Helpman (2004), "Global Sourcing," *Journal of Political Economy*, 112, 552-580.
- [5] Baldwin, Richard (1989), "Exporting the Capital Markets: Comparative Advantage and Capital Market Imperfections," In *The Convergence of International and Domestic Markets*, edited by Audretsch, D., L. Sleuwaegen, and H. Yamawaki, North-Holland, Amsterdam.
- [6] Beck, Thorsten (2002), "Financial Development and International Trade: Is There a Link?" *Journal of International Economics*, 57, 107-31.
- [7] Beck, Thorsten (2003), "Financial Dependence and International Trade," *Review of International Economics* 11, 296-316.
- [8] Beck, Thorsten and Ross Levine (2002), "Industry Growth and Capital Allocation: Does Having a Market- or Bank-based System Matter?" *Journal of Financial Economics*, 64, 147-180.
- [9] Berglof, Erik, and E. von Thadden (1994), "Short-Term versus Long-Term Interests: Capital Structure with Multiple Investors," *Quarterly Journal of Economics*, 109, 1055-84.
- [10] Bhagwati, Jagdish, Arvind Panagariya and T.N. Srinivasan (1998), *Lectures on International Trade*, The MIT Press.

- [11] Carlin, Wendy and Colin Mayer (2003), “Finance, Investment, and Growth,” *Journal of Financial Economics*, 69, 191-226.
- [12] Claessens, S. and L. Laeven (2003), “Financial Development, Property Rights, and Growth,” *Journal of Finance*, 58: 2401-36.
- [13] Costinot, Arnaud (2007), “Contract Enforcement, Division of Labor, and the Pattern of Trade,” *Quarterly Journal of Economics*, 122 (2), 569-600.
- [14] Davis, D. and David Weinstein (2001), “An Account of Global Factor Trade,” *American Economic Review*, 91(5), 1423-1453.
- [15] Davis, D. and David Weinstein (2003), “The Factor Content of Trade,” in Kwan Choi and James Harrigan, eds., *Handbook of International Trade*, Basil Blackwell.
- [16] Diamond, Douglas (1991), “Debt Maturity Structure and Liquidity Risk,” *Quarterly Journal of Economics*, 106, 709-37.
- [17] Do, Quy-Toan and Andrei Levchenko (2007), “Comparative Advantage, Demand for External Finance, and Financial Development,” *Journal of Financial Economics*, 86:3, 796–834.
- [18] Dixit, A.K. and V. Norman (1980), *Theory of International Trade*, Cambridge University Press.
- [19] Eaton, Jonathan and Samuel Kortum (2002), “Technology, Geography, and Trade,” *Econometrica*, 70(5), 1741-1779.
- [20] Feenstra, Robert (2004), *Advanced International Trade*, Princeton University Press.
- [21] Fisman, Raymond and Inessa Love (2004), “Financial Development and Growth in the Short and Long Run,” *NBER Working Paper* 10236.
- [22] Goldsmith, R. W. (1969), *Financial Structure and Development*, New Haven, CT: Yale University Press.
- [23] Hart, Oliver and John Moore (1998), “Default and Renegotiation: A Dynamic Model of Debt,” *Quarterly Journal of Economics*, 113(1), 1-41.
- [24] Holmstrom, Bengt and Jean Tirole (1997), “Financial Intermediation, Loanable Funds, and the Real Sector,” *Quarterly Journal of Economics*, 112(3), 663–691.
- [25] Harrigan, James (1997), “Technology, Factor Supplies, and International Specialization: Estimating the Neoclassical Model,” *American Economic Review*, 87, 475-94.
- [26] Jones, Ronald (1965), “The Structure of Simple General Equilibrium Models,” *Journal of Political Economy*, 73(6), 557-72.
- [27] Ju, Jiandong and Shang-Jin Wei (2005), “Endowment versus Finance: A Wooden Barrel Theory of International Trade,” *CEPR Discussion Paper* 5109.

- [28] Ju, Jiandong and Shang-Jin Wei (2007), "Domestic Institutions and the Bypass Effect of Financial Globalization," *NBER working paper 13148*.
- [29] Kletzer, Kenneth and Pranab Bardhan (1987), "Credit Market and Patterns of International Trade," *Journal of Development Economics*, 27, 57-70.
- [30] La Porta, Rafael, Florencio Lopez-de-Silanes, Andrei Shleifer and Robert Vishny (1997), "Legal Determinants of External Finance," *Journal of Finance*, 52(3), 1131-50.
- [31] La Porta, Rafael, Florencio Lopez-de-Silanes, Andrei Shleifer and Robert Vishny (1998), "Law and Finance," *Journal of Political Economy*, 106(6), 1113-55.
- [32] Levchenko, Andrei (2007), "Institutional Quality and International Trade," *Review of Economic Studies*, 74:3, 791-819.
- [33] Levine, Ross (2005), "Finance and Growth: Theory and Evidence," in Philippe Aghion and Steven Durlauf, eds. *Handbook of Economic Growth*, The Netherlands: Elsevier Science.
- [34] Lucas, R. E. (1988), "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22: 3-42.
- [35] Manova, Kalina (2007), "Credit Constraints, Heterogeneous Firms, and International Trade," *Working Paper*.
- [36] Manova, Kalina (2008), "Credit Constraints, Equity Market Liberalizations and International Trade," *Working Paper*.
- [37] Matsuyama, Kiminori (2005), "Credit Market Imperfection and Patterns of International Trade and Capital Flows", *Journal of the European Economic Association*, 3: 714-23.
- [38] Miller, M. H. (1998), "Financial Markets and Economic Growth," *Journal of Applied Corporate Finance*, 11: 8-14.
- [39] Nunn, Nathan (2005), "Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade," *mimeo*.
- [40] Rajan, Raghuram and Luigi Zingales (1998), "Financial Development and Growth," *American Economic Review*, 88(3), 559-586.
- [41] Rajan, Raghuram and Luigi Zingales (2003), "The Great Reversals: The Politics of Financial Development in the Twentieth Century," *Journal of Financial Economics*, 69, 5-50.
- [42] Robinson, J. (1952), "The Generalization of the General Theory," In: *the Rate of Interest and Other Essays*, London: MacMillan.
- [43] Romalis, John (2004), "Factor Proportions and the Structure of Commodity Trade," *American Economic Review*, 94(1), 67-97.
- [44] Schumpeter, J. A. (1912), *The Theory of Economic Development*, translated by R. Opie, Cambridge, MA: Harvard University Press, 1934.

- [45] Shleifer, Andrei, and D. Wolfenzon (2002), “Investor Protection and Equity Markets,” *Journal of Financial Economics* 66, 3-27.
- [46] Svaleryd, H. and J. Vlachos (2005), “Financial Markets, the Pattern of Industrial Specialization and Comparative Advantage: Evidence from OECD Countries,” *European Economic Review* 49, 113-44.
- [47] Trefler, Daniel (1993), “International Factor Price Differences: Leontief was Right!” *Journal of Political Economy*, 101(6), 961-987.
- [48] Trefler, Daniel (1995), “The Case of the Missing Trade and Other Mysteries,” *American Economic Review*, 85(5),1029-1046
- [49] Wynne, J. (2005), “Wealth As a Determinant of Comparative Advantage,” *American Economic Review* 95(1), 226-54.

7 Appendix

1. Proof of Proposition 1:

By differentiating equations (15), (16), (17), and (18), it is straightforward to prove the Stolper-Samuelson theorem and the Rybczynski theorem. We therefore show only the effects of a change in the institutional parameters. Solving equations (15) and (16), we obtain:

$$w = \frac{1}{(a_1 - a_2)} \left[pF_1(a_1, 1) - F_2(a_2, 1) + \left(\frac{f_2}{1 + f_2} - \frac{f_1}{1 + f_1} \right) \frac{b}{\lambda} \right] \quad (48)$$

$$g = \frac{1}{(a_1 - a_2)} \left[\lambda [a_1 F_2(a_2, 1) - a_2 p F_1(a_1, 1)] + b \left(\frac{a_2 f_1}{1 + f_1} - \frac{a_1 f_2}{1 + f_2} \right) \right] \quad (49)$$

Note that

$$R_1 = pF_1(\cdot) - wa_1 > 0 \quad (50)$$

Substituting (48) into (50), we have

$$R_1 > 0 \Rightarrow a_1 F_2(\cdot) - a_2 p F_1(\cdot) > 0 \quad (51)$$

Noting that $f_2 > f_1$, $a_1 > a_2$, and that increasing λ does not change p , we have $\frac{dw}{db} > 0$, $\frac{dw}{d\lambda} < 0$, $\frac{dg}{db} < 0$, and $\frac{dg}{d\lambda} > 0$. This proves Proposition 1.

2. Proof of Proposition 2:

We first derive the effects of a change in c , b , or λ on p . Total differentiating (24), we have:

$$dw = -\frac{dc}{\lambda a_2} - \frac{f_2}{(1 + f_2)\lambda a_2} db + \frac{(F_2(\cdot) - a_2 w)}{\lambda a_2} d\lambda \quad (52)$$

Total differentiating (24) and using (52), we obtain:

$$\lambda F_1(\cdot) dp = \left(1 - \frac{a_1}{a_2}\right) dc + \left(\frac{f_1}{1+f_1} - \frac{a_1 f_2}{a_2(1+f_2)}\right) db + \frac{[a_1 F_2(\cdot) - a_2 p F_1(\cdot)]}{a_2} d\lambda \quad (53)$$

Applying (51) to (53), we obtain that $\frac{dw}{dc} < 0$, $\frac{dw}{db} < 0$, and $\frac{dw}{d\lambda} > 0$, while $\frac{dp}{dc} < 0$, $\frac{dp}{db} < 0$, and $\frac{dp}{d\lambda} > 0$.

To study the effect of a change in p on z_1 and z_2 , we differentiate (17) and (20),

$$\left(\frac{1}{z_1} + \frac{a_1 F_2(\cdot)}{a_2 F_1(\cdot) z_2}\right) dz_1 = \frac{D'(p)}{D(p)} dp \quad (54)$$

$$dz_2 = -\frac{a_1 F_2(\cdot)}{a_2 F_1(\cdot)} dz_1 \quad (55)$$

Therefore, $\frac{dz_1}{dp} < 0$ and $\frac{dz_2}{dp} > 0$. A reduction in c or b , or an increase in λ , all raises p , which in turn reduces z_1 but increases z_2 .

Finally let us consider the effect on $\kappa^{\max}(c, b, \lambda)$. Given z_1 and z_2 , $\kappa^{\max}(c, b, \lambda)$ is determined by equation (18). Using (55) and differentiating (18), we obtain

$$d\kappa^{\max} = \frac{1}{\lambda F_1(\cdot)} \left(1 - \frac{a_1}{a_2}\right) dz_1 \quad (56)$$

Thus, $d\kappa^{\max} > 0$ since $dz_1 < 0$.

3. Proof of Proposition 4:

We first consider an *institutionally binding economy*. Using (30) and noting that $r = 0$, we have

$$(pz_1 + z_2)^2 \frac{d\Omega}{dc} = (\phi_1 a_{1K} - p\phi_2 a_{2K}) \left(z_2 \frac{dz_1}{dc} - z_1 \frac{dz_2}{dc}\right) - [\phi_1 a_{1K} z_1^2 + \phi_2 a_{2K} z_1 z_2] \frac{dp}{dc} \quad (57)$$

Since $\frac{dz_1}{dc} > 0$, $\frac{dz_2}{dc} < 0$, and $\frac{dp}{dc} < 0$ as we have proved in Proposition 2, $\frac{d\Omega}{dc} > 0$ if $\phi_1 a_{1K} - p\phi_2 a_{2K} = \phi_2 a_{2K} \left(\frac{\phi_1 F_2}{\phi_2 F_1} - p\right) \geq 0$. If $\frac{\phi_1 F_2}{\phi_2 F_1} - p < 0$, with a little bit of algebra, we have

$$\frac{d\Omega}{dc} = \frac{\left(z_2 + \frac{\phi_1 F_2 z_1}{\phi_2 F_1}\right) \frac{z_1 \phi_2}{F_2} \frac{dp}{dc}}{(pz_1 + z_2)^2} \left[-1 + \frac{\left(\frac{\phi_1 F_2}{\phi_2 F_1} - p\right) \frac{D'(p)P}{D(p)}}{p \left(1 + \frac{\phi_1 F_2 z_1}{\phi_2 F_1 z_2}\right)}\right]$$

Note that $\frac{dp}{dc} < 0$ and the elasticity of relative demand, $\frac{D'(p)P}{D(p)}$, is negative. Thus, $\frac{d\Omega}{dc} > 0$ if $\frac{D'(p)P}{D(p)} > -1$. Similarly we can show that $\frac{d\Omega}{db} > 0$ and $\frac{d\Omega}{d\lambda} > 0$.

Turning to the effect on GDP, we have

$$\frac{dY}{Ldc} = \frac{z_1 dp}{dc} \left[1 + \frac{\left(p - \frac{a_1 F_2}{a_2 F_1} \right) \frac{D'(p)P}{D(p)}}{p \left(1 + \frac{a_1 F_2 z_1}{a_2 F_1 z_2} \right)} \right]$$

So $\frac{dY}{dc} < 0$ if $\frac{D'(p)P}{D(p)} > -1$.

We now consider an *endowment-binding economy*.

$$\begin{aligned} (pz_1 + z_2)^2 \frac{d\Omega}{d\kappa} &= \left(a_{1K} z_1 \frac{d\phi_1}{d\kappa} + a_{2K} z_2 \frac{d\phi_2}{d\kappa} \right) (pz_1 + z_2) \\ &\quad + (\phi_1 a_{1K} - p \phi_2 a_{2K}) \left(z_2 \frac{dz_1}{d\kappa} - z_1 \frac{dz_2}{d\kappa} \right) \\ &\quad - [\phi_1 a_{1K} z_1^2 + \phi_2 a_{2K} z_1 z_2] \frac{dp}{d\kappa} \end{aligned}$$

Similar to the case for an *institutionally binding economy*, we have, after a bit of algebra,

$$\begin{aligned} \frac{d\Omega}{d\kappa} &= \frac{\left(a_{1K} z_1 \frac{d\phi_1}{d\kappa} + a_{2K} z_2 \frac{d\phi_2}{d\kappa} \right)}{(pz_1 + z_2)} \\ &\quad + \frac{\left(z_2 + \frac{\phi_1 F_2 z_1}{\phi_2 F_1} \right) \frac{\phi_2}{F_2} \frac{D(p)}{D'(p)} \left(1 + \frac{a_1 F_2 z_1}{a_2 F_1 z_2} \right) \frac{dz_1}{d\kappa}}{(pz_1 + z_2)^2} \left[-1 + \frac{\left(\frac{\phi_1 F_2}{\phi_2 F_1} - p \right) \frac{D'(p)P}{D(p)}}{p \left(1 + \frac{\phi_1 F_2 z_1}{\phi_2 F_1 z_2} \right)} \right] \end{aligned}$$

Since $\frac{dz_1}{d\kappa} < 0$, so $\frac{d\Omega}{d\kappa} < 0$ if $\frac{D'(p)P}{D(p)} > -1$. Finally,

$$\frac{dY}{Ld\kappa} = \frac{z_1 dp}{d\kappa} \left[1 + \frac{\left(p - \frac{a_1 F_2}{a_2 F_1} \right) \frac{D'(p)P}{D(p)}}{p \left(1 + \frac{a_1 F_2 z_1}{a_2 F_1 z_2} \right)} \right]$$

So $\frac{dY}{d\kappa} > 0$ if $\frac{D'(p)P}{D(p)} > -1$.

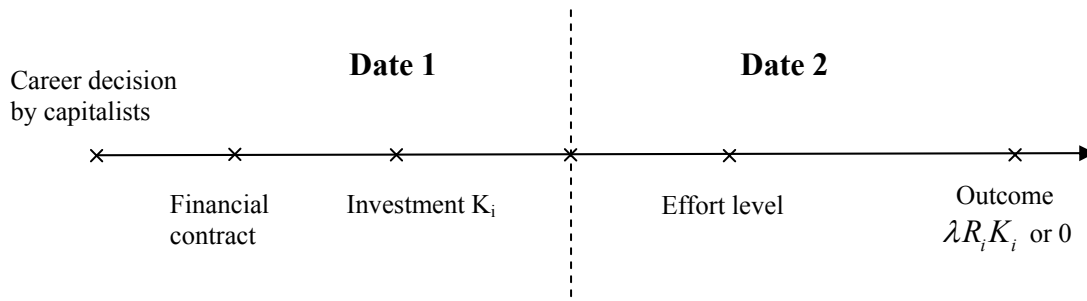


Figure 1

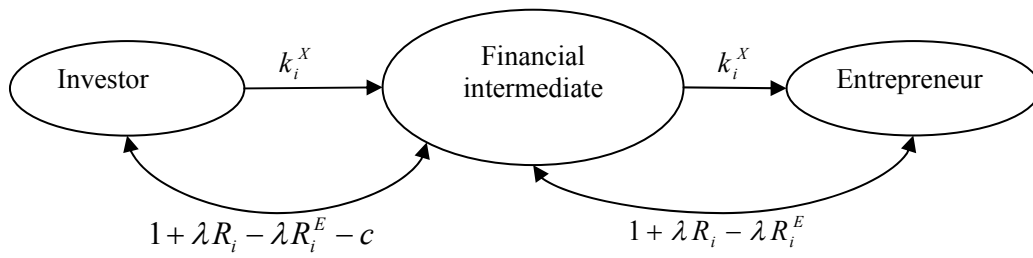


Figure 2

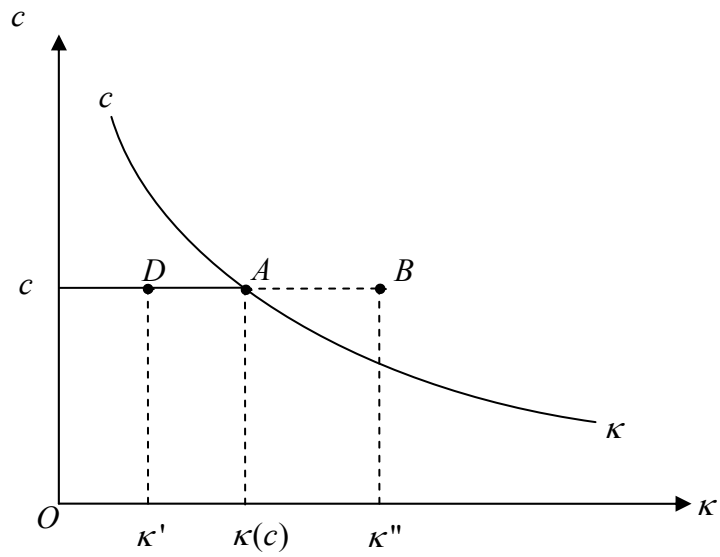


Figure 3

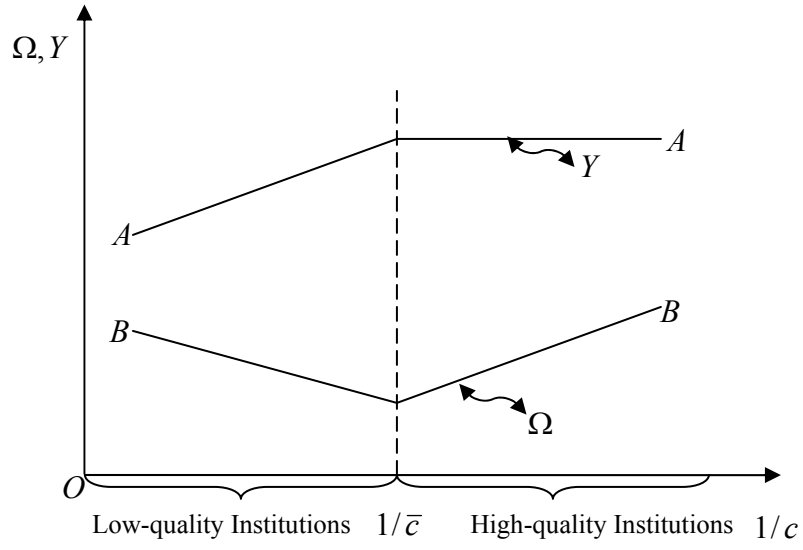


Figure 4

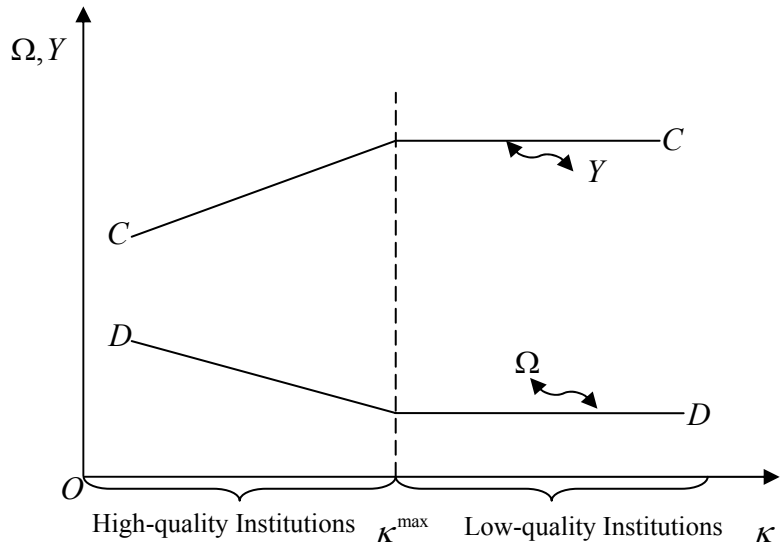


Figure 5