UNIVERSITÀ DEGLI STUDI DI NAPOLI
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BANKRUPTCY COSTS, DILUTION COSTS AND STOCK MARKET DEVELOPMENT

Salvatore Capasso*

This paper presents a dynamic general equilibrium analysis of stock market development, providing a theoretical support for the empirical positive correlation between equity markets development and economic growth. If potential investors are unable to distinguish between good (high productivity) and bad (low productivity) firms, then problems of adverse selection may arise, leading to a low price of equities as bad firms are attracted to the market and good firms are driven from the market – the dilution cost of asymmetric information (Bolton and Freixas. 2000). As a consequence, average productivity will be depressed and the economy will evolve along a relatively low growth path. The greater is the degree of asymmetric information, the greater will be the severity of the problem due to a greater (lower) number of bad (good) firms exploiting investment opportunities. Problems of asymmetric information are likely to become less acute as an economy develops and more resources become available for allowing investors to identify good firms and for allowing good firms to signal their own identity. Under such circumstances, the price of equities rise, attracting an increasing number of good firms to the equity market which, in turn, has a positive feedback effect on capital accumulation and growth.

JEL Classification: O16, O40, G10

Keywords: asymmetry of information, economic growth, financial markets, stock markets development

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Contents

1. Introduction

By simply observing the composition of the financial systems in different countries, one cannot help but notice that the size of the stock market relative to the size of the total financial sector is much larger in more advanced economies than in poorer ones. In addition, the expansion of stock markets is characterised not only by an increase in the total number of firms listed, but also by an increase in the level of market capitalisation. These observations, documented by Atje and Jovanovich (1993), Demirgüç-Kunt and Levine (1996a,b), Korajczyk (1996), Levine and Zervos (1996) (1998), point to the existence of a strong positive correlation between stock market development and economic growth. At present, there are very few theoretical studies that seek to explain this correlation. Moreover, those that do tend to focus on only one direction of causality in the relationship – either from stock markets to growth or vice versa. Yet, there is a strong presumption that causality runs both ways – that changes in the structure of the financial system both determine, and are determined by, changes in the level of real activity. This paper presents a dynamic general equilibrium analysis of stock market development, providing rigorous support for this presumption.

According to Levine (1991), the existence of liquidity costs is the fundamental reason for why equity market activity can affect the real allocation of resources. Agents might not be willing to tie-up their resources in long term investments even though the returns on these investments may be high compared to others. By offering the opportunity to trade ownership of projects without disrupting the productive process, equities help to channel resources towards these investments and, thus, spur economic growth. In a similar vein, Bencivenga, Smith and Starr (1996) show that, by reducing transaction costs, the development of equity markets can increase the amount of investment in projects with longer maturity periods and thereby, exert a positive effect on capital accumulation. From the opposite perspective, Boyd and Smith (1998) analyse the way in which capital accumulation and growth might stimulate the development of stock markets. In a "costly state verification" framework, where agents have access to two technologies, it is shown that, when growth occurs, agents are driven by lower expected verification costs to use more intensively an observable technology financed by equity and less intensively an unobservable technology financed by debt.

In extending the above literature to the case in which stock market development and real economic activity are determined jointly, we build upon the microeconomic framework of Bolton and Frexias (2000), who study the optimal choice of financial contract in an environment of asymmetric information. When firms have superior information about the returns on their investments, the costs associated with the optimal security used to finance those investments depend on the degree of informational asymmetry. This is simply because lenders, who cannot *a priori* observe project returns, average among all possible outcomes. As in a typical lemons' market, owners of projects with high returns will be penalised since their projects will be valued at the lower average price. This is referred to as the dilution cost of asymmetric information. Under such circumstances, Bolton and Frexias (2000) show that firms' optimal capital structure consists essentially of two forms of securities: equity and/or debt. Whichever type of security is issued depends on the level of dilution costs, together with the level of bankruptcy costs associated with the loss of future income following the borrower's inability to repay debt.

An important feature of the above framework is that the degree of informational asymmetry, or dilution, is treated as exogenous. In the analysis that follows, this is no longer true. Assume that different types of firm have access to different sets of projects with different expected returns. Assume, also, that the return on all, or some, of these projects depend on specific market conditions. If lenders know which firms prefer to operate which project, then the set of projects undertaken will signal precisely the nature and the types of firms in the market. If, on the other hand, some firms have access to common projects, then the types of firms in the market can be inferred only probabilistically by observing the projects. The higher is the number of firms accessing the same sets of projects, the lower will be the probability of correctly inferring a firms' type. Now, if the set of "common projects" undertaken becomes smaller for some reason (e.g. because some of these projects become economically inefficient), then the signal from the market becomes stronger and the possibility of inferring a firm's type becomes easier. This is the mechanism by which the degree of informational asymmetry is endogenised in the model. The link with growth arises from the fact that capital accumulation reduces the incentive of low productivity firms to operate projects that are typical of high productivity firms. Thus, capital accumulation leads to an improvement in the "visibility" of more efficient firms.

The market value of a project reflects the level of information available in the market. Under the assumption that the same project yields different returns to different firms (e.g. because some firms are more efficient than others), the value attached by the market to a project will depend on which types of firms find it optimal to operate that project. If a project is run only by high productivity firms, then the market value will be high. On the other hand, if the project is run by some less efficient firms, then its value will be lower, or "diluted". This dilution cost is one of the factors that determines the optimal choice of one form of security over another. The other factor is a bankruptcy cost. Given that dilution costs are mainly associated with equity, while bankruptcy costs are wholly relevant to debt, changes in the relative levels of these costs induce changes in the optimal choice of security. In particular, the reduction of dilution costs along the path of capital accumulation can spur the development of equity markets. This appears to come close to what actually happens in many economies. Even if it is very difficult to measure the degree of information asymmetry or the level of information dilution, it is undeniable that information travels faster and is more easily diffused in relatively advanced economies, where stock market are more developed.

As already indicated, the model also contains a feed back effect from stock market development to growth. This follows from the fact that the incentive of firms to access a specified set of projects depends on the financial contracting regime. Accordingly, the model provides an account of the joint determination of the degree of informational asymmetry, the structure of the financial system and the level of real economic activity.

The paper is organised as follows. In Section 2, we describe the physical set up of the economy in terms of agents' preferences, technologies and endowments. In Section 3, we study the functioning of the capital market under the assumptions of asymmetric information between borrowers and lenders. In Section 4, we analyse the optimal choice between debt and equity contracts. In Section 5, we characterise the general equilibrium of the economy and identify the feed back effects between stock market development and growth. In section 6, we offer some concluding remarks.

2. The Environment

We consider an overlapping generations economy in which there is a constant population (normalised to 3) of two-period lived, non altruistic agents. Each generation is divided at birth into a unit mass of households (workers or lenders), a unit mass of firms producing capital (investors or borrowers) and a unit mass of firms producing final output (manufacturers of goods). All agents are risk neutral and derive utility only from old-age consumption. Young households are endowed with one unit of labour which is supplied inelastically to old output producers of the previous generation in return for the wage w_t (measured in units of consumption goods). This income can be stored or lent out to young capital producers. The storage technology of households converts one unit of output at time t into one unit of output at time t+1. Capital is produced by young borrowers through the operation of risky projects financed by loans from young households. Output is produced by old entrepreneurs by employing the labour of young households and capital produced from risky projects in the previous period.

A risky project requires a fixed amount of output, a, at time t, to produce a stochastic amount of output at time t+1, according to a linear probability distribution which depends on a borrower's type. A skilled type of borrower obtains κ_1 units of capital with probability p, and zero units of capital with probability $1-p$. An unskilled type of borrower obtains $\kappa_2<\kappa_1$ units of capital with probability p, and zero units of capital with probability $1-p$. We assume that $r_{t+1}p\kappa_1 > a > r_{t+1}p\kappa_2$, where r_{t+1} is the price of capital next period, which implies that only skilled borrowers are creditworthy since only these borrowers receive a positive net expected return from project investment. The fraction of skilled (unskilled) borrowers in the total borrower population is $\eta \in (0,1)$ $(1-\eta)$. In addition to being more efficient in capital production, skilled borrowers who run risky projects are also able to acquire entrepreneurial (or managerial) expertise which they can supply to final output producers in the second period of their lives.[1] While unskilled borrowers cannot acquire such expertise, they are able to make use of a storage technology which converts one unit of output at time t into $\rho \geq 1$ units of output at time t+1.

Final output in period t+1, y_{t+1}, is produced by old manufacturers according to

$$y_{t+1} = \Theta k_{t+1}^{\theta}(l_{t+1}K_{t+1})^{1-\theta} + \Phi h_{t+1}^{\alpha}; \; \Theta, \Phi > 0; \; \theta, \alpha \in (0,1), \tag{1}$$

where k_{t+1} denotes capital (obtained from firms of the same generation that run projects in period t), l_{t+1} denotes labour (hired from households of the next generation), K_{t+1} denotes aggregate capital and h_{t+1} denotes the amount of managerial expertise supplied by skilled capital producers of the same generation. The production function in (1) displays increasing social returns to scale and learning by doing externality effects. Perfectly competitive markets ensure that all factors of production are paid according to their marginal products. Thus, $(1-\theta)\Theta k_{t+1}^{\theta} l_{t+1}^{-\theta} K_{t+1}^{1-\theta} = w_{t+1}$, $\theta\Theta k_{t+1}^{\theta-1} l_{t+1}^{1-\theta} K_{t+1}^{1-\theta} = r_{t+1}$ and $\alpha\Phi h_{t+1}^{\alpha-1} = \omega_{t+1}$, where w_{t+1}, r_{t+1}, and ω_{t+1} are the prices of labour, capital and managerial expertise, respectively. The first two expressions can be further simplified by recalling that there is a unit mass of firms producing

[1] This assumption captures the idea that very good entrepreneurs and managers, recognised as such by the market, are employed as consultants by other firms even when they are retired from their main activity.

output and a unit mass of households supplying labour. In equilibrium, therefore, $K_{t+1} = k_{t+1}$ and $l_{t+1} = 1$. It follows that

$$\theta\Theta = r_{t+1} = r\,, \tag{2}$$

$$(1-\theta)\Theta k_{t+1} = (1-\theta)\Theta K_{t+1} = w_{t+1}\,. \tag{3}$$

As usual, the wage rate is an increasing function of capital, $w_{t+1} = W(K_{t+1})$, with $W'(\cdot) > 0$. Since the production function in (1) is not homogeneous of degree one, total output will not be exhausted by the factors of production, implying that manufacturing firms will make a positive level of profit. This profit is given by:

$$\pi_{t+1} = (1-\alpha)\Phi h_{t+1}^{\alpha}\,. \tag{4}$$

3. The Credit Market

At the beginning of each period a newly born borrower approaches a newly born lender with request for a loan to finance a risky project. Following others (e.g. Bencivenga and Smith, 1993; Bose and Cothren 1996, 1997) we simplify the analysis by assuming that borrowers and lenders are coupled together in randomly matched pairs.[2] A loan contract can involve the issue of debt – which requires a fixed lump-sum repayment, $d_{t+1}>0$, independent of the project's outcome – and/or the issue of equity – which specifies a repayment as a share, $s_{t+1}\in(0,1)$, of the project's net profit. Only a debt contract implies the possibility of bankruptcy, which occurs when the realised return on the risky technology is lower than the required contractual repayment. Note that a lender's participation constraint in the case of debt is given by $prd_{t+1}=a$, where r is given by (2); that is, a lender expects to receive pd_{t+1} units of capital from a risky project, which can be rented out to final goods producers to earn an expected income of prd_{t+1} units of output; this expected income must be no less than the income earned from storage, a, and must be equal to that income, given competition among lenders. It follows from the previous restrictions on project returns, $rp\kappa_1 > a > rp\kappa_2$, that $\kappa_1 > d_{t+1} > \kappa_2$, so that only skilled borrowers who succeed in the risky projects are able to repay their debts and avoid bankruptcy. The repayment of a firm that goes bankrupt is simply the capital that has been produced, which is zero units of capital for all types of firm if the project fails and κ_2 units of capital for unskilled firms if the project succeeds. It also follows that no

[2] Hence, it must be the case that $w_t > a$.

lender will, knowingly, make any type of loan – debt or equity – to unskilled firms. Under either type of security, the maximum amount of income that a lender would expect to earn is $rp\kappa_2$, which is less than the income that could be earned from storage, a. Thus, the only way that unskilled firms can secure loans is to disguise themselves as skilled firms. As such, the optimal financial contract will be designed exclusively by the latter.

The major consequence of bankruptcy for a skilled borrower is the possibility of losing all, or part, of his future income from the supply of his managerial expertise to final output producers when old. Assuming that the borrower acquires one unit of expertise, then his income is ω_{t+1}. If a lender could lay his hands on this income, then the borrower would need to pay rd_{t+1} units of output to substitute for the debt payment, leaving an income of $\omega_{t+1} - rd_{t+1}$ units of output. We assume that the borrower can seek to avoid this by severing ties with the lender and relocating elsewhere at a cost of $\varepsilon \in (0,1)$ units of the borrower's time. If so, then the borrower's net income will be $(1-\varepsilon)\omega_{t+1}$. In what follows, we impose the condition $rd_{t+1} > \varepsilon\omega_{t+1}$, which implies that it is always optimal for a borrower to relocate.[3]

Since unskilled borrowers do not acquire any managerial expertise, and since they always go bankrupt if they finance their risky projects by issuing debt, their payoff from running such projects is always zero. By contrast, they are able to obtain a positive profit by revealing their type and asking for funds to invest in their alternative storage technology. It follows that unskilled borrowers will never issue debt to run risky projects. Moreover, since the storage technology of unskilled borrowers dominates the storage technology of lenders, a lender will find it optimal to lend his entire wage in return for a debt payment that satisfies $\tilde{d}_{t+1} = w_{t+1}$. Under such circumstances, the borrower will obtain a net income of $\rho w_{t+1} - \tilde{d}_{t+1} = (\rho-1)w_{t+1}$, where $\rho \geq 1$ is recalled to be the return on the borrower's storage technology.

In the case of equity, an unskilled borrower does not end up with a zero payoff if he runs a risky project. In the event of success he retains $(1-s_{t+1})\kappa_2$ units of capital as profit. His profit from running the storage technology, financed by equity, would be $\rho w_t(1-\tilde{s}_{t+1})$, where $\rho w_t \tilde{s}_{t+1} = w_t$ in accordance with the lender's participation constraint for this technology. As above, therefore, the borrower's net income from this technology is $(\rho - 1)w_t$. It follows that, in the case of equity, an unskilled borrower faces a trade-off between revealing his type (and

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[3] Making use of some results derived later, it ca be shown that this condition is satisfied by imposing the parameter restriction $a > p\varepsilon\alpha\Phi[p + (1-p)(1-\varepsilon)]^{\alpha-1}\eta^{\alpha-1}$.

running the storage technology), or concealing his type (and running the risky technology). He will be indifferent between these courses of action if

$$(\rho-1)w_t=(1-s_{t+1})p\kappa_2 r\,, \tag{5}$$

When, (5) holds, an unskilled borrower randomises between risky and storage technologies. In what follows, we denote by λ_t the fraction of unskilled borrowers running risky capital projects (financed by equity) and by $1-\lambda_t$ the fraction of borrowers operating the storage technology.

4. The Optimal Financial Contract

It has been established that, when seeking a loan to finance a risky project, an unskilled borrower will never issue debt, but may issue equity. Thus, while the issue of debt immediately reveals a borrower to be skilled, the issue of equity provides an imprecise signal about the borrower's type. Only in the case of equity, therefore, do problems of asymmetric information arise. Our next objective is to determine the degree of informational asymmetry, and the effect of this on firms' optimal capital structure and allocation of resources between the different investment technologies.

Let γ_t denote the fraction of skilled borrowers participating in the equity market. The fraction of unskilled borrowers participating in this market was defined above as λ_t. Since the total population of skilled (unskilled) borrowers is η $(1-\eta)$, then the probability that a lender faces an issuer of equities who is skilled is given by:

$$z_t=\frac{\gamma_t\eta}{(1-\eta)\lambda_t+\gamma_t\eta}\quad . \tag{6}$$

The variable z_t can be interpreted as a measure of the degree of information dilution in the economy. It may be written as the function $z_t = Z(\gamma_t, \lambda_t) \in (0,1)$, where $Z_\gamma > 0$ and $Z_\lambda < 0$. Thus, if the fraction of skilled borrowers issuing equities in the total population of firms issuing equities increases (i.e. if γ_t increases and/or λ_t decreases), then the degree of information dilution decreases as the "visibility" of skilled firms in the market improves. In the limiting case of $\lambda_t = 0$, $z_t = 1$ since only skilled firms issue equity in this instance.

As one might expect, the value that the market attaches to a risky project will be a function of the degree of information dilution. Each lender takes account of the fact that an issuer of equity might be either a skilled or an unskilled capital producer. A project will be valued, therefore, as a weighted average of the possible returns, $z_t p\kappa_1 + (1-z_t)p\kappa_2$. Given this, together with a lender's binding participation (or zero profit) constraint under competition, $a = rs_{t+1}[z_t p\kappa_1 + (1-z_t)p\kappa_2]$, it is straightforward to determine the amount of equity that a skilled borrower must issue in order to take on a risky project; that is,

$$s_{t+1} = \frac{a}{r[z_t p\kappa_1 + (1-z_t)p\kappa_2]}. \tag{7}$$

Thus, the required amount of equity is a decreasing function of the degree of information dilution, $s_{t+1} = S(z_t)$, where $S_z(\cdot) < 0$. Intuitively, an increase in z_t (i.e. a decrease in information dilution) causes the market value of projects to increase (as skilled entrepreneurs become more "visible"), thereby reducing the amount of equity needed to be raised to cover the fixed initial outlay, *a*. The expected payoff to a skilled entrepreneur issuing equity is given by $V_{t+1}^E = r(1-s_{t+1})p\kappa_1 + \alpha\Phi h_{t+1}^{\alpha-1}$ (where it is recalled that $\alpha\Phi h_{t+1}^{\alpha-1} = \omega_{t+1}$, the price of managerial skills, of which the entrepreneur has one unit, which is supplied to final goods producers). Using (7) the expected payoff may be written as

$$V_{t+1}^E = \left\{\frac{r[z_t p\kappa_1 + (1-z_t)p\kappa_2] - a}{z_t p\kappa_1 + (1-z_t)p\kappa_2}\right\} p\kappa_1 + \alpha\Phi h_{t+1}^{\alpha-1}. \tag{8}$$

In contrast to the above, debt contracts do not involve any information dilution costs since they are issued only by skilled borrowers. In this case, a lender's participation constraint is simply $prd_{t+1}=a$, implying that a skilled borrower needs to issue an amount of debt equal to

$$d_{t+1} = \frac{a}{pr}. \tag{9}$$

Debt contracts involve bankruptcy costs, however. These costs are incurred by a skilled borrower when the project fails and the borrower is unable to make the debt repayment. Under such circumstances, the borrower defaults by moving location, but sacrifices a fraction, ε, of his managerial income. Given this, then the expected payoff to a skilled borrower issuing debt is $V_{t+1}^D = rp(\kappa_1 - d_{t+1}) + [p + (1-p)(1-\varepsilon)]\alpha\Phi h_{t+1}^{\alpha-1}$. Together with (9), this yields:

$$V_{t+1}^D = rp\kappa_1 - a + [p + (1-p)(1-\varepsilon)]\alpha\Phi h_{t+1}^{\alpha-1}. \tag{10}$$

The expressions in (8) and (10) contain the variable h_{t+1} which is the total amount of managerial expertise supplied by skilled producers of capital. A producer who issues equity supplies one unit of expertise with certainty, while a producer who issues debt supplies one unit with probability *p* (when the project succeed) and $1-\varepsilon$ units with probability $1-p$ (when the project fails). Since the total population of skilled producers issuing equity (debt) is $\gamma_t\eta$ ($(1-\gamma_t)\eta$), it follows that $h_{t+1} = \{\gamma_t + (1-\gamma_t)[p + (1-p)(1-\varepsilon)]\}\eta$. Substitution into (8) and (10) gives

$$V_{t+1}^E = \left\{ \frac{r[z_t p\kappa_1 + (1-z_t)p\kappa_2] - a}{z_t p\kappa_1 + (1-z_t)p\kappa_2} \right\} p\kappa_1 +$$

$$+\alpha\Phi\{\gamma_t + (1-\gamma_t)[p + (1-p)(1-\varepsilon)]\}^{\alpha-1}\eta^{\alpha-1}, \tag{11}$$

$$V_{t+1}^D = rp\kappa_1 - a +$$

$$+[p + (1-p)(1-\varepsilon)]\alpha\Phi\{\gamma_t + (1-\gamma_t)[p + (1-p)(1-\varepsilon)]\}^{\alpha-1}\eta^{\alpha-1}. \tag{12}$$

Hence, $V_{t+1}^E = V^E(z_t, \gamma_t)$ and $V_{t+1}^D = V^D(\gamma_t)$, where $V_z^E(\cdot) > 0$ and $V_\gamma^D(\cdot) < 0$.

Evidently, a skilled borrower will find it optimal to issue only equity (debt) if $V_{t+1}^E - V_{t+1}^D > 0$ ($V_{t+1}^E - V_{t+1}^D < 0$). For both types of security to co-exist, borrowers must be indifferent between them, implying $V_{t+1}^E - V_{t+1}^D = 0$. From (11) and (12), this condition can be expressed as

$$\Phi\alpha[1-(1-p)(1-\gamma_t)\varepsilon]^{\alpha-1}\eta^{\alpha-1}(1-p)\varepsilon = \left[\frac{p\kappa_1}{z_t p\kappa_1 + (1-z_t)p\kappa_2} - 1 \right] a. \tag{13}$$

Since $z_t = Z(\gamma_t, \lambda_t)$ by virtue of (6), then (13) implicitly defines a relationship between γ_t and λ_t for which skilled borrowers are indifferent between debt and equity. Under such circumstances, these borrowers randomise between the two contracts, issuing equity with probability $\gamma_t \in (0,1)$ and debt with probability $1-\gamma_t$, for a given value of λ_t. Another relationship between γ_t and λ_t is obtained from (5) which, in conjunction with (7), may be written as

$$\lambda_t = \frac{\eta}{1-\eta} \frac{\kappa_1[rp\kappa_2 - w_t(\rho-1)] - a\kappa_2}{\kappa_2[a + w_t(\rho-1) - rp\kappa_2]}\gamma_t. \tag{14}$$

This is a relationship between γ_t and λ_t for which unskilled borrowers are indifferent between running risky projects (financed through equity) by disguising themselves as skilled borrowers, and running the storage technology. Under such circumstances, these borrowers randomise between the two technologies, adopting the former with probability λ_t and the latter with probability $1-\lambda_t$.

The expressions in (13) and (14) determine, jointly, the equilibrium values of γ_t and λ_t for a given wage rate, w_t. A detailed analysis of these expressions is contained in the Appendix and summarised in Figure 1. The curve $f(\gamma_t)$ is obtained from (13) which, under appropriate parameter restrictions, gives λ_t as an increasing and concave function of γ_t. The curve $g(\gamma_t)$ is derived from (14) which defines λ_t as a linear function of γ_t.

The intersection of these curves determines the equilibrium pair ($\hat{\gamma}_t, \hat{\lambda}_t$), explicit solutions for which can be obtained as

$$\hat{\gamma}_t = \Gamma(w_t) = \frac{\left[\dfrac{(1-p)\varepsilon\Phi\alpha\kappa_2}{\eta^{1-\alpha}\{\kappa_1[rp\kappa_2 - w_t(\rho-1)] - a\kappa_2\}}\right]^{1/(1-\alpha)} + (1-p)\varepsilon - 1}{(1-p)\varepsilon}, \qquad (15)$$

$$\hat{\lambda}_t = \Lambda(w_t) = \frac{\eta}{1-\eta}\frac{\kappa_1[rp\kappa_2 - w_t(\rho-1)] - a\kappa_2}{\kappa_2[rp\kappa_2 - w_t(\rho-1)]}\hat{\gamma}_t. \qquad (16)$$

The intersection of these curves determines the equilibrium pair ($\hat{\gamma}_t, \hat{\lambda}_t$), explicit solutions for which can be obtained as

$$\hat{\gamma}_t = \Gamma(w_t) = \frac{\left[\dfrac{(1-p)\varepsilon\Phi\alpha\kappa_2}{\eta^{1-\alpha}\{\kappa_1[rp\kappa_2 - w_t(\rho-1)] - a\kappa_2\}}\right]^{1/(1-\alpha)} + (1-p)\varepsilon - 1}{(1-p)\varepsilon}, \qquad (17)$$

$$\hat{\lambda}_t = \Lambda(w_t) = \frac{\eta}{1-\eta}\frac{\kappa_1[rp\kappa_2 - w_t(\rho-1)] - a\kappa_2}{\kappa_2[rp\kappa_2 - w_t(\rho-1)]}\hat{\gamma}_t. \qquad (18)$$

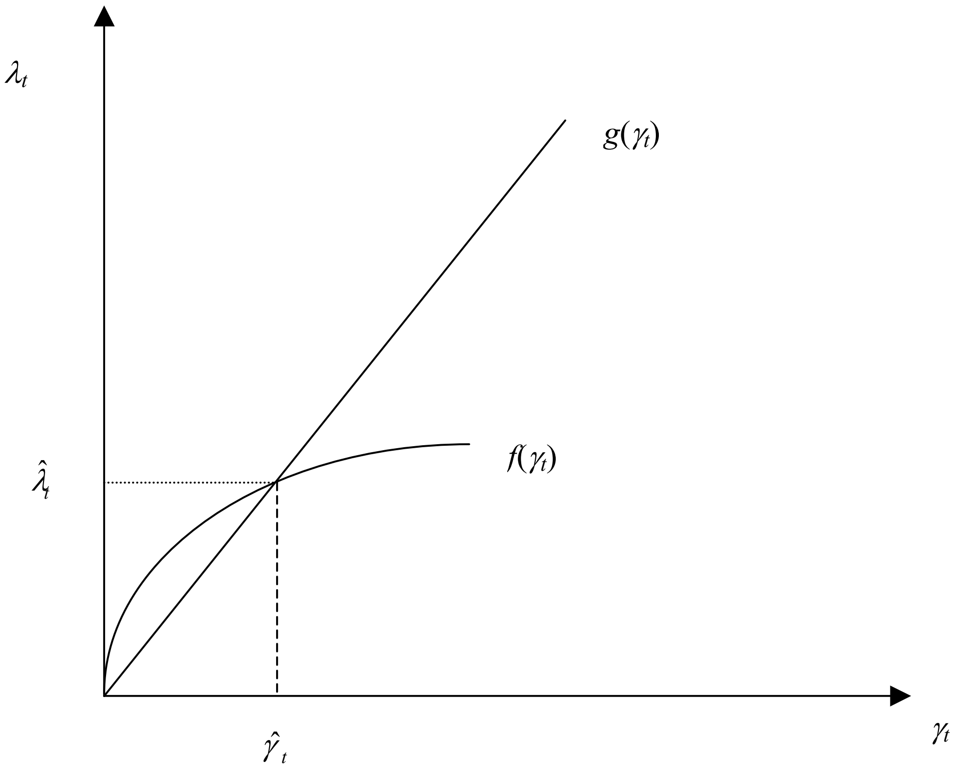

Fig. 1

Given the above, it is possible to see how changes in real economic activity can affect the structure of the financial system. The slope of the $g(\cdot)$ curve, and hence the intersection of this curve with the $f(\cdot)$ schedule, depends on the wage, w_t. By virtue of (3), the wage is a function of the capital stock, k_t. Consequently, changes in the level of capital will cause changes in $\hat{\gamma}_t$ and $\hat{\lambda}_t$, the equilibrium fractions of skilled firms issuing equity, and the equilibrium fraction of unskilled firms participating in the equity market to run risky projects. More precisely, an increase in k_t causes an increase in w_t which induces a downward rotation of the $g(\cdot)$ schedule. This produces both a higher value of $\hat{\gamma}_t$ and a higher value of $\hat{\lambda}_t$, as illustrated in Figure 2 and confirmed by (17) and (18). Thus, capital accumulation leads to an increase in the fractions of unskilled firms issuing equities. The reason is that an increase in the wage rate augments the return on the storage technology. Consequently, the return on the risky technology financed with equity must also increase in order to keep unskilled borrowers indifferent between the two types of investment. This causes, in turn, a rise in the fraction of skilled borrowers issuing equities. The increase in the expected return on equity is such that it more than compensates the initial increase in the return on storage, with the result that the fraction of unskilled borrowers issuing equity also increases.

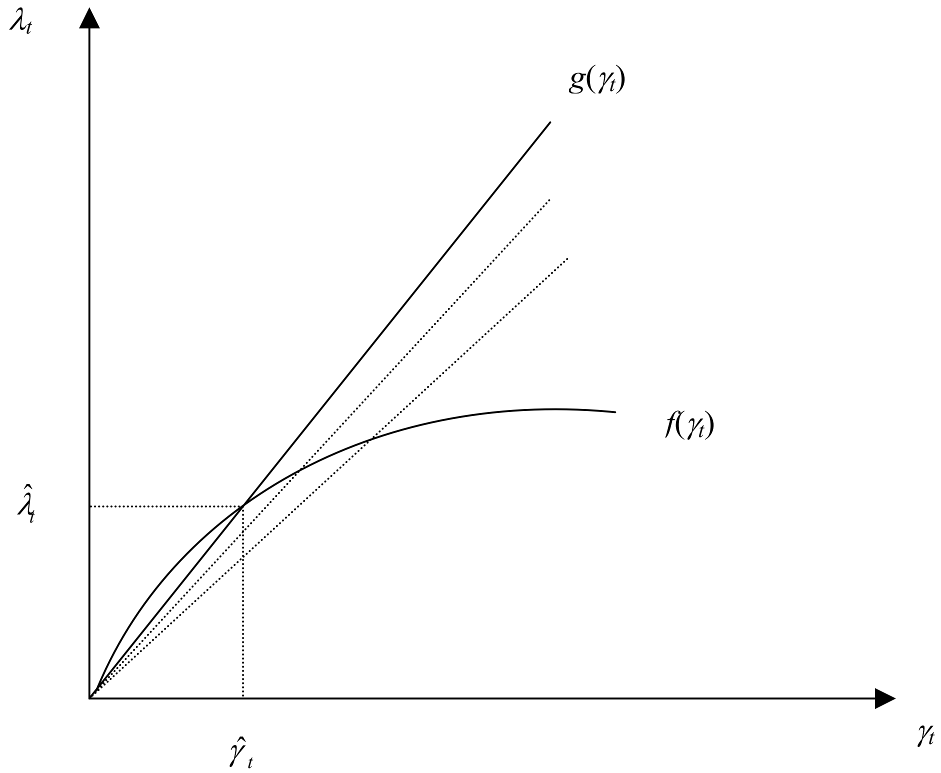

Fig. 2

Although γ_t and λ_t have opposite effects on z_t (see (6)), it is possible to deduce that, as the equilibrium values of these variables increase with capital accumulation, the equilibrium degree of information dilution unambiguously falls (i.e. $\hat{z}_t = Z(\hat{\gamma}_t, \hat{\lambda}_t)$ increases). According to (5), an increase in the wage, w_t, must be associated with a reduction in the issue of equity, s_{t+1}, if unskilled borrowers are to remain indifferent between risky and storage technologies. By virtue of (7), this means that z_t must rise, which is equivalent to implying that the degree of information dilution must fall. In terms of Figure 2, a rotation of the $g(\cdot)$ schedule causes $\hat{\lambda}_t$ to increase less proportionally than $\hat{\gamma}_t$. This follows immediately from the shapes of the $g(\cdot)$ and $f(\cdot)$ curves.

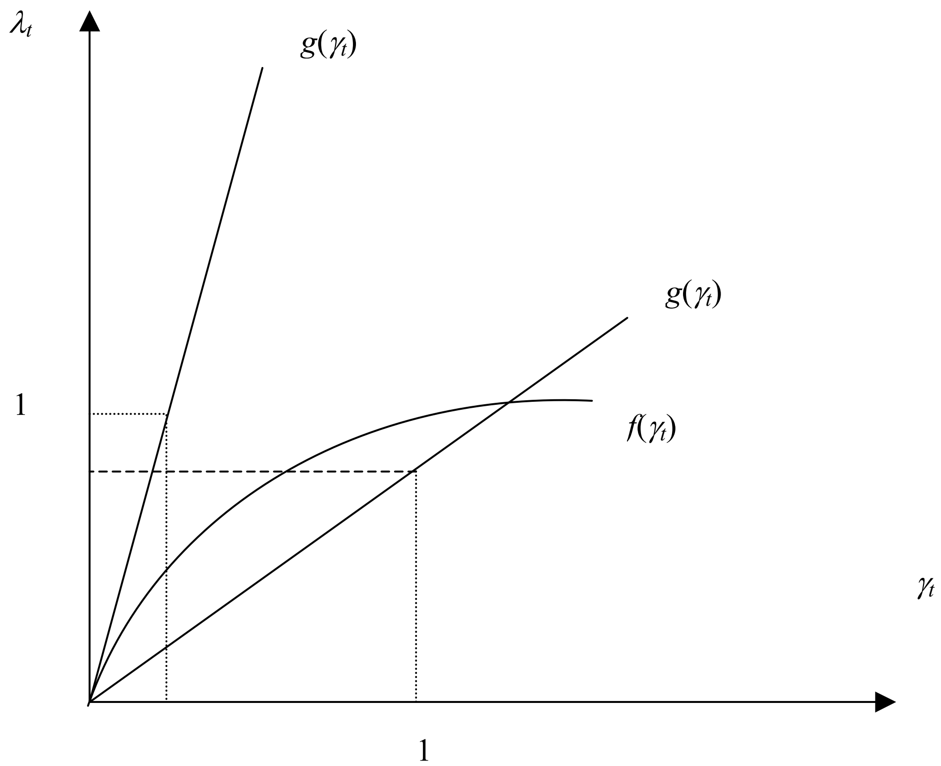

Fig. 3

The foregoing analysis has focused on the case in which the model generates interior solutions, $\hat{\gamma}_t \in (0,1)$ and $\hat{\lambda}_t \in (0,1)$. Yet it is also possible for corner solutions to arise, as illustrated in Figure 3. For example, at very low levels of capital (and therefore very low levels of wages) a market for equity may not exist because unskilled borrowers have no incentive to run the storage technology, preferring instead to operate projects by pretending to be skilled borrowers and applying for equity finance. This is the case in which the $g(\cdot)$ schedule is so steep as to never intersect the $f(\cdot)$ schedule (except at $\gamma_t = \lambda_t = 0$). At the opposite extreme, sufficiently high levels of capital may imply the non-existence of a debt market as all skilled borrowers prefer to issue equity. This is the case in which the $g(\cdot)$ schedule intersects the $f(\cdot)$ schedule at $\gamma_t > 1$ which is not feasible (so that $\gamma_t = 1$ and λ_t is then determined by (14)).

5. Capital accumulation

In contrast to existing models, the present framework admits the prospect of two-way causality in the relationship between stock market development and economic growth. That is, capital accumulation both influences, and is influenced by, the financial contracting regime. This may be established as follows.

Capital is produced by both skilled and unskilled borrowers from the operation of risky projects. All skilled borrowers run these projects, producing a total of κ_1 units of capital with probability p and zero units of capital with probability $1-p$. Within the population of unskilled borrowers, only the fraction $\hat{\lambda}_t$ run risky projects, producing a total of $(1-\eta)\kappa_2$ units of capital with probability p, and zero units of capital with probability $1-p$. Applying the law of large number, it is possible to deduce the aggregate stock of capital at time t+1 as

$$K_{t+1} = p\kappa_1\eta + p\kappa_2(1-\eta)\hat{\lambda}_t \tag{19}$$

This expression shows that the path of capital accumulation depends on the fraction of unskilled borrowers issuing equities to run risky projects. By virtue of (18) this fraction is an increasing function of the wage rate ($\Lambda'(w_t) > 0$), which, in turn, is an increasing function of capital from (3). Hence, the capital stock at time t+1 is unambiguously an increasing function of the capital stock at time t. The precise shape of this capital accumulation path depends on the properties of $\Lambda(w_t)$.

The mutual interaction between real and financial activity is now evident from (19) and the preceding analysis of the determination of $\hat{\gamma}_t$ and $\hat{\lambda}_t$. At the beginning of each period skilled borrowers decide whether to finance their risky projects through the issue of debt or equity. The return on each financial contract depends on the level of asymmetric information which influences both the level of dilution costs (relevant to equity) and expected bankruptcy cost (relevant to debt). Unskilled borrowers deciding to run risky projects issue only equity and disguise themselves as skilled borrowers. The fraction of skilled and unskilled borrowers issuing equities determine the equilibrium degree of informational asymmetry at which skilled borrowers are indifferent between equity and debt, and unskilled borrowers are indifferent between running their storage technology and running risky projects. This is the only level of informational asymmetry compatible with an equilibrium in which equity and debt co-exist. A different value would make one financial contract dominate the other and would cause all borrowers to opt for one technology or the other. As the wage rate increases because of capital accumulation, the return on the storage increases and this modifies the incentive of unskilled borrowers to access the equity market. The return on the risky technology for these borrowers must increase in order to keep them indifferent between the two alternative technologies. This requires a reduction in dilution costs and, therefore, a decrease in the degree of information asymmetry. As a consequence, the equilibrium fractions of both skilled and unskilled borrowers issuing equities increases.

As indicated earlier, it is possible to obtain an equilibrium in which only one type of loan market – equity or debt – is active. At sufficiently low levels of capital, only a debt market may exist in which case $\hat{\lambda}_t = 0$ and the economy may be trapped in a state of low financial and low real development. This outcome occurs if the steady state level of capital when $\hat{\lambda}_t = 0$ (given by $p\kappa_1\eta/\delta$ from (19)) is lower than the level of capital needed to support equity market. At sufficiently high level of capital, the opposite may occur and only an equity market may exist, implying a relatively advanced state of real and financial development.

6. Final Considerations

A large body of empirical evidence has shown the existence of a clear pattern in the evolution of financial markets in many economies. One aspect of this pattern is the development of financial intermediation and the substitution of indirect lending for direct lending. Another feature is the development of stock markets and the increasing use of equity as an alternative to debt in financing investments. Only recently, have economists begun to model this latter phenomenon using insights of modern finance theory and techniques of modern dynamic general equilibrium analysis. The purpose of this paper has been to extend the existing literature by developing a framework that admits two-way causality in the relationship between stock markets and growth, and which, therefore, provides a theory of the co-evolution of real and financial sector activity.

One of the prerequisites for the Modigliani-Miller theorem is the assumption of fully informed agents. In the presence of asymmetric information, the theorem fails to hold and a firm's capital structure is no longer independent of its productivity and efficiency. As a consequence, the financial contract, through which firms obtain loans to finance their investments, is intimately linked with the returns on these investment. In other words, asymmetric information implies that different financial contracts involve different costs. Given this, then one of the major problems facing firms is the determination of their optimal capital structures and the minimisation of the associated costs.

When firms have different levels of efficiency and private information about the expected return on their investments, the optimal security to issue is either debt or equity. Each of these securities involves a different type of cost: a bankruptcy cost in the case of debt, and a dilution cost in the case of equity. Dilution costs arise because of the typical "lemons' market" problem. Relatively efficient firms see the market value of their projects diluted because of the presence of relatively inefficient firms. The higher is the proportion of inefficient firms, the lower is the visibility of efficient ones and the higher is the degree of information asymmetry.

The model presented in this paper has the distinction of endogenising the degree of asymmetric information. The presence of less efficient firms in the equity market is driven by the incentive of these firms to invest in alternative projects. With capital accumulation, these incentives change and so does the fraction of such firms accessing the equity market. Even if this fraction increases, however, the degree of informational asymmetry falls. This is because the fraction of efficient firms accessing the equity market increases more than proportionally. The final effect of capital accumulation is an overall increase in the number of firms issuing equities to finance their investment. This has a feedback effect on capital accumulation itself, so that the real and financial sectors of the economy evolve together.

Appendix

The following analysis is concerned with the properties of (13) and (14) in (γ_t,λ_t) space. Time subscripts are omitted for simplicity.

Substituting (6) into (13) gives:

$$T[\gamma\eta\kappa_1 + \lambda(1-\eta)\kappa_2] - \lambda(1-\eta)a(\kappa_1 - \kappa_2) = 0 \qquad \text{(A.1)}$$

where $T = (1-p)\varepsilon\alpha\Phi[1-(1-p)\varepsilon(1-\gamma)]^{\alpha-1}\eta^{\alpha-1}$. Equation (A.1) gives $\lambda = f(\gamma)$. Provided that $(1-\eta)[a(\kappa_1-\kappa_2)-T\kappa_2] > 0$, then $\lambda > 0$. Given this, then implicit differentiation of (A.1) reveals that

$$f'(\gamma) > 0 <=> \eta\kappa_1[1-(1-p)\varepsilon(1-\gamma)] > \lambda(1-\eta)\kappa_2(1-p)\varepsilon(1-\alpha) \qquad \text{(A.2)}$$

We assume that this condition is always satisfied (a sufficient condition for which is that it is satisfied at $\gamma = 0$ and $\lambda = 1$). The same parameter restrictions ensure that $f''(\gamma) < 0$, in which case $f(\gamma)$ is increasing and concave function.

Equation (14) gives $\lambda = g(\gamma)$, where $g'(\gamma) > 0$ and $g''(\gamma) = 0$, so that $g(\cdot)$ is a linear function of γ. Provided that $w < \frac{\kappa_1 rp\kappa_2 - a\kappa_2}{\kappa_1(\rho-1)}$, then $\lambda > 0$.

From (17) and (18), interior solutions, or $\hat{\gamma} \in (0,1)$ and $\hat{\lambda} \in (0,1)$, are obtained if

$$\frac{[1-(1-p)\varepsilon]^{1-\alpha}[\kappa_1 rp\kappa_2 - a\kappa_2] - (1-p)\varepsilon\Phi\alpha\kappa_2\eta^{\alpha-1}}{[1-(1-p)\varepsilon]^{1-\alpha}\kappa_1(\rho-1)} < w < \frac{\kappa_1 rp\kappa_2 - a\kappa_2 - (1-p)\varepsilon\Phi\alpha\kappa_2\eta^{\alpha-1}}{\kappa_1(\rho-1)}$$

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