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DIPARTIMENTO DI ECONOMIA POLITICA

ANTONIO NICITA
UGO PAGANO

Finance and Technology: A Comparative Institutional Analysis of the Firm

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by

ANTONIO NICITA[*] and UGO PAGANO[°]

ABSTRACT

In this paper we investigate a rationale for co-evolution of financial and technological structures in modern firms according to the Comparative Institutional Analysis Approach (CIA). Starting from the 'Transaction Costs Approach' (TCE) to the analysis of the relationship between corporate governance and corporate finance (Williamson, 1988) we show, by a very simple model, the emergence of financial and technological equilibria in a given institutional context. While the TCE's Approach describes a direction of causality moving from asset specificity to the financial structure of the firm, and thus to its governance structure, we observe that an opposite direction of causality may also hold: financiers, seeking appropriate safeguards for financial investments within the firm, could influence the emergence of generic (re-deployable) or specific assets according to their preferences on expected residual income and/or to the legal bankruptcy system enforced by judicial authorities. However, if both the direction of causality hold some self-enforcing equilibrium could prevail in an incomplete contract framework. We explicitly consider the ways in which alternative forms of finance can influence and be influenced by technology and the cases in which equity-capital is likely to prevail over debt-capital. It is then suggested that the emergence of the diversity of corporate governance models may be explained in terms of the historical conditions governing the path dependency and the institutional complementarities between 'Technology' and 'Finance'.

Keywords: transaction costs, property rights, financing policy, capital and ownership structure, dequity, institutional complementarity, comparative institutional analysis

JEL: D23, G32, G33, L22, L23

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[*] Dept. of Economics, University of Siena

[°] Dept. of Economics, University of Siena, and Central European University, Budapest.

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1. Introduction

In recent years, an extensive body of studies have dealt with the problem of convergence *versus* diversity in corporation's ownership and control systems. Most of these works have compared corporate governance models under the lens of the New Institutional Economics (NIE) theory of the firm, stressing the role of the legal nature of corporations beside the traditional agency costs theories. This theoretical interest started in the 1980s following the huge changes observed in corporate ownership and control occurred in North America and in United Kingdom and has been thus renewed by the institutional changes which very rapidly invested emerging and transition economies.

The main question addressed recently by a wide scholarly literature is whether one or another national corporate governance system possesses some relative competitive advantage in the global market so as to overcome any national diversity towards a global model of governance which shapes markets and firms[1]. According to this literature two main systems of corporate governance might be distinguished[2]: a *market system* characterised by dispersed shareholding and thick, liquid trading markets, and a *hierarchical control system* characterised by a hard control exerted over the management by a principal or a coalition of principals (banks, families, etc.) and thin trading and non-controlling stakes. While the former system may be found in Usa and UK, the latter has been experienced, with many differences, in Germany, in Italy and in Japan, among other countries. Some of these systems, as the German and the Japanese systems are now subject to economic and institutional crises, whereas the US corporate system seems having absorbed some Japanese and German features into its original structure. This leaves unsolved the problem of convergence *versus* diversity.

It has been widely known that corporate governance changes are not merely financial matters, since they occur in a given institutional framework, in which economic, legal and organisational issues are bundled in a complex institutional order, shaping all the relevant agents and their actions.

Recent works by Oliver Williamson (1988), Aghion and Bolton (1992) and Oliver Hart (1995) have emphasised the relationship between corporate governance and corporate finance, stressing the role of incomplete contracting in shaping governance and financial structures of the firm, as well as the rationale and the role of some institutional rule, as the

[1] See W. W. Bratton and J.A. McCahery (1999) "Comparative Corporate Governance and the Theory of the Firm: The Case against Global Cross Reference", *Columbia Journal of Transnational Law* 38, 213-297.
[2] See W. W. Bratton and J.A. McCahery (1999).

bankruptcy procedure, in aligning managers, financiers and shareholders incentives. Starting from the traditional problem of hold-up in incomplete contracts characterised by assets' specificity and opportunistic agents, these authors have investigated the agency problems rising when the investor is wealth-constrained and cannot buy the asset, having to raise funds from an outside investor.

All these contributions however neglect the persistent diversity observed in many corporate governance systems and fail to provide an explanation of the (non)emergence of a global model of corporate governance. Diversity of governance systems calls indeed for an explanation of path-dependency phenomena in governance as in financial structures which shapes, at the same time, firms and markets, sheltering national systems from external competition.

In this paper we extend the contribution provided by Williamson (1988) in order to point out the emergence of path-dependency between 'governance' and 'finance' in corporate systems, and the structuring of multiple *organisational equilibria* between the degree of assets specificity in the firm (i.e. its technological structure) and the its financial structure.

The traditional NIE's approach to the analysis of corporate governance was mainly aimed at investigating the relationship occurring between the nature of the financial structure of the firm and the incentives carried on by managers in the selection of efficient investments. The analysis provided by Williamson (the so-called 'Transaction Costs Economics', or TCE Approach) describes a direction of causality which moves from asset specificity to the financial structure of the firm, and thus to its governance structure. According to the TCE's framework, projects for which physical asset specificity is low are easy to finance with debt and ought to be financed by debt, whereas as asset specificity increases equity should be the preferred financial instrument. This is due to the fact that, as the degree of assets specificity increases, their re-deployability in alternative uses (or their 'liquidity') is fairly limited. As a consequence, pre-emptive claims of the bondholders against the investments afford limited protection, in the case of bankruptcy[3]. In order to finance projects characterised by high levels of specificity the board of directors should thus switch to the selective intervention allowed by equity finance. Since holders of common stocks are the firm's ultimate residual claimants, entitled to get what is left after everyone else is paid in the event of bankruptcy, they have a very limited interest in the degree of assets specificity to be financed. The main result of the transaction-cost approach is that, as

[3] This is another explanation of the extent of pre-emptive claims, beside that base don debt capacity constraints. See Hart and Moore (1994).

the transactions costs become relevant in the analysis of corporate finance, a new governance structure, called de-quity, might be implemented. This governance structure combines the best properties of debt and equity and allows some form of selective intervention which in turn enables the firm to select the appropriate combination of debt and equity which provides the appropriate degree of assets specificity.

This consequence leads us to pose the following questions: why don't we observe, in a world of growing interdependence and globalisation, a convergence towards a unique model of 'dequity'? Why, instead of observing such a convergence process we still face persistent diversity of corporations' ownership and control systems?

One possible answer is that the transaction-cost approach assumes the existence of a infinite elasticity of substitution between debt and equity financing, depending on the nature of the assets to be produced by the investments financed. However, financial markets may differ from one country to another and access to financial market might be inhibited. This means that the initial conditions of financial markets may strictly affect firms' technical choice and might favour specific forms of institutional complementarities between Finance and Technology in firms. In order to illustrate this straightforward point we apply the notion of institutional complementarity and the Comparative Institutional Analysis (CIA) Approach on the study of corporate governance and finance[4]. We first show that, with reference to the TCE's approach, the opposite direction of causality may also hold, i.e. that the nature of financial market affects assets' specificity degree, and thus we infer that in the absence of perfect competition in financial markets, firms specialise in selecting those investments types (generic or specific) which maximise the expected utility stream of financiers[5].

More specifically, financiers, seeking appropriate safeguards for financial investments within the firm, may influence the emergence of generic (re-deployable) or specific assets and/or organisational setting according to their preferences on expected residual income and/or to the legal bankruptcy system enforced by judicial authorities[6].

[4] On the concept of Institutional Complementarity, that is one of the central concepts of comparative institutional analysis, see Milgrom and Roberts (1990) and Aoki (2001). According to Aoki (2001, p.396) "[a]lso Pagano (1993) and Pagano and Rowthorn (1994) are two of the earliest analytical contributions to institutional complementarity".

[5] This explanation is based on the degree of competition occurring in financial markets. However, also the degree of competition in the goods markets – which may differ among countries – might well be much more important. See Allen and Gale (2000).

[6] We refer to assets specificity but the argument can go further regarding also the organisational structure on the firm. In other terms we can have two firms producing the same goods by assembling the same assets while employing organisational structures which are characterised by a different degree of specificity.

However, if both the directions of causality (finance-technology and vice versa) hold, some self-enforcing equilibrium could prevail in an incomplete contract framework, and generate path-dependency between financial and technological structures and a diversity pattern in a given corporate system. Economic agents acting in the financial markets domain and those acting in the production technology domain may make un-coordinated self-reinforcing choices generating arrangements in the two domains that are institutional complements generating multiple organizational equilibria[7].

It is then suggested that the emergence of the diversity in corporate governance models as well as in the rate of innovation in different countries may be explained in terms of the historical conditions governing the path dependency between 'Technology' and 'Finance'.

The paper proceeds as follows. In section two we introduce corporate finance issues in traditional corporate governance theories, summarising the main results pointed out by Williamson (1988). In section three we thus extend the TCE's approach to the notions of organisational equilibria and institutional complementarity in order to take into account the emergence of multiple self-enforcing equilibria between 'technology' and 'finance'. In section four we try to explain how the emergence of path-dependency between 'technology' and 'finance' might help in explaining the persistence of diversity observed in many corporate governance systems.

2. Corporate finance and corporate governance: the TCE Approach

The TCE's approach to corporate finance is mainly based on the extensions of the transactions cost minimizing paradigm to the analysis of the financial attributes of different transactions. The Williamson's starting point[8] is to move from standard studies based on a composite-capital set-up towards a study of the investment attributes of alternative corporate projects so as to regard debt and equity as governance structures rather than as merely financial instruments. The intuition behind this, is trying to evaluate the emergence of alternative financial instruments in terms of their compared transaction costs, rather than on the basis of their composite-capital characteristics. The main result is that two apparently disparate phenomena such as those of debt-based and equity-based financing – beside

[7] On the concept of Strategic and Institutional Complementarity see Milgrom and Roberts (1990) and Aoki (2001). Pagano (1993) and Pagano and Rowthorn (1994) introduce the concept of Organizational Equilibria. According to Aoki (2001, p.396) the two concepts share many similarities.

internally raised funds - might be analysed under the very same transaction costs economizing scheme. According to Williamson, what distinguishes debt and equity – considered as polar financial devises - is the asset specificity characteristics of investment projects.

Let us assume that in a given corporation there is only one form of financing, debt, and that the management has to choose among several alternative projects, within the investment set $J= (j^1, j^2, ..., j^n)$**,** ordered in terms of their degree of asset specificity, so that the costs H to be sustained in order to redeploy the project in alternative uses increases as assets involved in the project become more specific with $\Delta H(j^n)=[H(j^n)- H(j^{n-1})]>0$ being an indicator of the degree of specificity or irreversibility of the investment j^n with respect to the investment j^{n-1}. Suppose further that the investment set is given by $J=(j^1, j^2)$ with $\Delta H=[H(j^2)- H(j^1)]>0$, i.e. with j^1 being a general-purpose investment and j^2 being a specific investment. Thus suppose that our management has to finance the project j^1. In the simplest case debt financing might be defined as a financial claim which imposes on the firm an obligation to pay a specific amount (by stipulated interest payments to be transferred at regular intervals) either the firm will be forced into bankruptcy. In the event of bankruptcy, scheduled payments result in debt-reorganisation or in liquidation. In this last case, firm's assets are liquidated, their liquidation degree depending on their re-deployability in alternative uses.

As a consequence the nature of physical assets plays a very important role in the event of bankruptcy: "since the value of a pre-emptive claim declines as the degree of assets specificity deepens, the terms of debt financing will be adjusted adversely". Under this framework the cost of debt financing increases, not only as long as 'bet capacity' declines, but also as assets re-deployability decreases (or assets specificity increases). If the only possibility for a firm to finance its projects is given by debt financing, the more specialised investments will require growing costs and the firm might be forced to some *investment rationing*, in favour of greater assets' re-deployability.

Thus, according to a given budget constraint[9], the firm will be induced to select greater redeployable assets as long as the costs of debt financing increase.

As a consequence, for a given financial constraint of the firm, the higher is the costs of debt, the greater is the probability of selecting a project characterised by a very low degree of

[8] See O. Williamson (1988) "Corporate Finance and Corporate Governance" (1988), *Journal of Finance*, 43

[9] In Williamsons' analysis budget constraint is assumed to be exogenously determined, before investment decision are taken.

assets' specificity (a general-purpose project). In any case, regardless of any consideration about the costs of debt financing, this form of financing truncates the set of possible investments to be financed due to the budget constraint if the firm (in the most favourable case the most specific project to be financed by debt is a project like *D*).

Now let us assume that another financial instrument, equity, is available and that firm could also recur to this form of financing in order to realise a given project. The main difference with debt financing, in the simplest form, is that equity does not have to be repaid and it is junior to debt, given that holders of common stock are the firm's ultimate residual claimants. According to Williamson (1988) the Board of Directors, elected by the pro-rata votes of those who hold tradable shares, "evolves as a way by which to reduce the costs of capital for projects that involved limited redeployability". The Board of directors indeed has the power to replace management and to monitor operating investment and the way in which the firm is managed[10]. In a sense, while debt financing is more market-like kind, equity implies some form of (vertical) integration and the shareholders are more interested in investments that are characterised by higher returns in no-bankruptcy event, rather than in higher liquidity in the bankruptcy event.

According to Williamson, for any given set *J* of investment projects, we can define as $D(\Delta H)$ and $E(\Delta H)$, respectively, the costs of debt and equity financing, with $D(0)<E(0)$ and $D'(\Delta H)>E'(\Delta H)$ (Williamson, 1988).

The expressions above mean that, when assets are highly re-deployable, equity is more costly than debt, since it involves higher transaction costs (implementing a rule for governance). By contrasts, when assets become more specific, debt financing is more costly, since it induces the firm to face its budget constraint and to truncate the range of potential projects to be financed and realised. Now, let ΔH^* be the value for which $D(\Delta H)=E(\Delta H)$, thus the optimal financial choice for a given project *J* is to use debt finance for all projects for which $\Delta H<\Delta H^*$, and to use equity financing for those projects for which $\Delta H>\Delta H^*$. This leads us to the formulation of a new financial instrument or governance structure called de-quity. Under 'dequity', the best properties of debt and equity are combined. According to the degree of assets specificity the firm can use discretionally alternative financial instruments so as to minimise the transaction costs involved in the realisation of a give project.

[10] Williamson's analysis neglects in this formulation the role played by minority shareholders as the possibility of having a complex system of control over the management.

In the Williamsonian approach, the technological structure of the firm endogenously selects the most efficient financial structure, financiers are able to 'control' ex-ante the nature of the assets to be realised by the investments financed. In this case a sort of pre-commitment effect between technology and finance decreases the problem of managers' moral hazard, which represents a central issue in traditional agency costs analyses of the financial structure of the firm.

However, the TCE's approach leads us to pose the following questions: why don't we observe, in a world of growing interdependence and globalisation, a convergence towards a unique model of 'dequity'? Why, instead of observing such a convergence process we still face persistent diversity of corporations' ownership and control systems?

One possible answer is that the transaction-cost approach assumes the existence of a infinite elasticity of substitution between debt and equity financing, depending on the nature of the assets to be produced by the investments financed. However, financial markets may differ form one country to another and access to financial market might be inhibited. This means that the initial conditions of financial markets may strictly affect firms' technical choice. In the next section we extend thus the TCE's approach to the notion of organisational equilibria in order to take into account the emergence of multiple self-enforcing equilibria between 'technology' and 'finance'.

3. A Comparative Institutional Analysis of 'Technology' and 'Finance'

The TCE approach recalled above constitutes an original way to show the underlying relationship between the degree of asset specificity within the firm and the Debt/Equity ratio characterising its financial structure. However the notion of 'de-quity' introduced by Williamson and the associated 'manager's discretion' craft a general static case in which past investments and financing decisions have negligible effects on future manager's choices.

The analysis provided by Williamson describes a direction of causality moving from asset specificity to the financial structure of the firm, and thus to its governance structure. However, the opposite direction of causality may also hold: financiers, seeking appropriate safeguards for financial investments within the firm, could influence the emergence of generic (re-deployable) or specific assets according to their preferences on expected residual income and/or to the legal bankruptcy system enforced by judicial authorities.

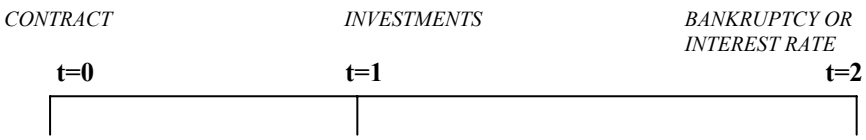
Inside the Williamsonian notion of 'dequity', specific investments characterised by low 'liquidity' but high expected quasi-rents, are always financed by the appropriate 'type' of financier they require in order to be started-up. However, unless one assumes perfect credit markets, financiers decisions matter and affect investments decision within the firm. Assume, for instance, that the 'type' of financier selected is willing to finance a low risk investment. By consequence, he will finance an investment characterised by a positive rate of liquidity in the case of bankruptcy, showing direction of causality which moves from technology to finance. However, as it happens, this means also that the degree of asset specificity will be determined by the 'type' of financier selected, suggesting an opposite direction of causality respect to the one suggested by Williamson, for which 'finance' affects 'technology'. However, if both the direction of causality hold, it means that some self-enforcing equilibrium could prevail in an incomplete contract framework. In this case, the explanatory power of the notion of "dequity" and the associated "powerful discretionality" of the governance structure suggested by Williamson are inevitably destined to fall, and some path dependent equilibrium could prevail.

One possible way to extend the approach provided by Williamson is thus to apply a earlier schematisation (Williamson, 1985) to the relationship occurring between the financial structure (*F*) and technological structure of the firm (*T*). In this a setting the contracting scheme suggested by the NIE shows that in the case of the adoption of a specific technology, in order to protect investors in assets specificity, managers will develop appropriate legal and economic safeguards. Alternatively, when these safeguards are not enforced, specific investments will not be selected, since investors in specific assets will be exposed to post-contractual opportunism. In the traditional NIE's contracting scheme, specific investments provide a higher ex-post value in respect to the ex-ante parties' outside options only if the underlying transaction takes place. Once made, a specific investment will lock-in the investors into the contractual relationship by raising their ex-post exit costs: outside the transaction, the ex-post value of specific assets or investments will thus be lower than their best ex-ante outside options. Agents who make specific investments are then vulnerable to counterpart's post-contractual opportunism and in order to be induced to invest they might require appropriate safeguards, in terms of property rights on assets and/or breach penalties. Thus, in order to align parties' incentives to maximise their expected joint rent, economic agents have to design optimal endogenous enforcement devices ("private orderings").

However, in the traditional analysis of the hold-up problem, it is assumed that agents have not to recur to external financing in order to make the investment. The removal of this assumption implies thus the emergence of another incomplete contract: that occurring between the financier and the manager[11]. In its simplest form, this incomplete contract between financier and manager will depend on the realisation of two variables: the degree of asset specificity and the expected return of the investment.

3.1 Financiers-Managers' incomplete contract

Let us assume that the incomplete contract between financiers and investors lasts two periods and is characterised by the following scheme:



At *t=0* the contract starts, parties sign the reciprocal obligations in terms of the amount of the external financing provided and in terms of the structure and the timing of the reimbursement of the capital borrowed. Once the contract is signed, the manager makes his investment choices at *t=1*. We assume here the simplest contract form according to which, in the case of "no bankruptcy", the financier will receive the rate of return on the investment negotiated at *t=0* by the parties (we assume that only this promise is verifiable and enforceable), while in the case of "bankruptcy" he will receive property rights on the assets purchased with the financing he provided. The ex-post value of the assets will depend on their expected degree of "liquidity".

Suppose now that – within the Williamsonian framework – we can distinguish two domains of choice respectively, for production managers and for financiers:

(i) the technology domain;

(ii) the financial rights domain.

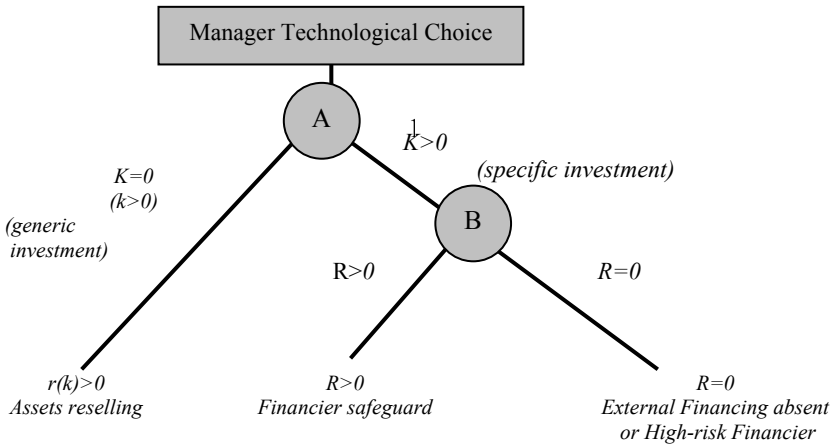
In the *technology domain*, production managers will choose that technology that maximizes profits given the financial structure of the firm, whereas in the *financial rights domain* financiers have to determine the financial structure of the projects undertaken by the firm given their technological structure.

[11] See Dalmazzo (2000).

The technological choices domain

In the technology domain, the choice of the production manager is about two different technologies (or investments): a general-purpose investment, denoted by $k>0$ and a *specific* investment, denoted by $K>0$ ($k=1-K$, *with* $k, K \in (0,1)$). If the technology adopted by the manager, in node *A* in the following figure, is the general–purpose technology *k*, then financiers, in our simple contractual scheme, do not need any particular safeguard other than receiving the property rights on the assets of the firm in the case of bankruptcy. In such a case, financiers will possess a set of generic (re-deployable or "liquid") assets for which there is a market opportunity outside the firm. The resulting contractual scheme for the financier is given by the right branch in the following figure where $R=r(k)>0$ is the value associated to the sale of generic assets in the event of bankruptcy.

Fig.1 – Choices in the Technology domain (*T*) -



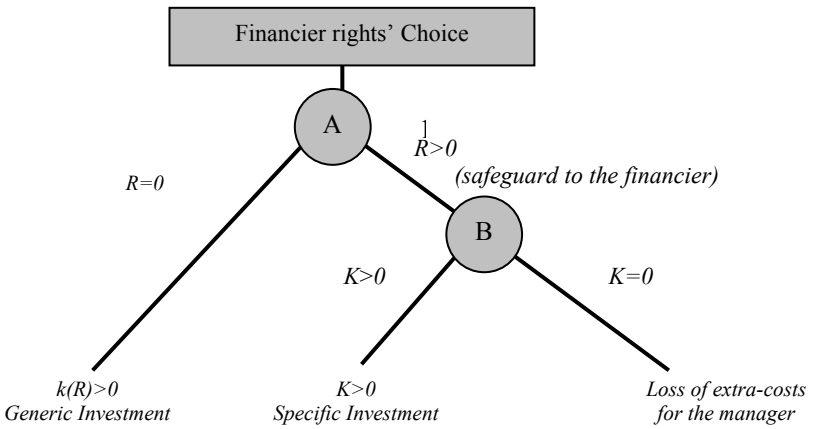
Suppose now that a specific investment is selected in node *A*, with $K>0$. Thus, as the share of assets specificity increases, it is also increases the share of firm deployable assets, which have no "full" market opportunities outside the firm. Given the specific investment choice by the manager, the financier would be discouraged to finance the firm investment in the absence of any post-contractual safeguard in the case of bankruptcy, as a monetary compensation for the loss of re-deployability of the assets the financier will receive in the bankruptcy event. According to Williamson (1985) one can imagine financiers requiring some ex-post monetary compensation, as $R>0$, in figure 1, to be induced to finance the

investment[12]. This means, however, that a configuration characterised by specific investments and no safeguard (*K>0*; *R=0*) for the manager will be very difficult to sustain in our setting (obviously one can thing to public financing as an investment of this type). The main consequence of figure 1 is that when managers need to recur to external financing, the nature of the investments to be financed will select an appropriate financial structure of the firm. However, given the contractual scheme in fig.1, in order to show how the opposite direction of causality may also hold, such a scheme could also be inverted, as in fig. 2 which represents the financial domain.

The financial rights domain

In the financial rights domain, as in fig. 2, financiers have to determine the financial structure of the projects undertaken by the firm given their technological structure. The initial node in fig. 2, shows thus the alternative choices available to the firm in order to adopt a financial contracting scheme. Once is given to the financier some positive level of safeguard (*R>0*), there is the opportunity to increase the share of specific (deployable) assets *K>0,* until the point which equalises, ' at the margin', *R* and *K,* for any given probability of bankruptcy, (1- *p*)[13]. In such a context, the choice of a generic investment, once the financier has received some positive financial safeguards as *R*, will be an inefficient outcome. The efficient equilibria in fig. 2 are thus given by the choices [(*R=0*, *K=0*); (*R>0*, *K>0*)] where, for a given financial structure there is an efficient technological choice.

Fig.3 – Choices in the Financial rights domain (*F*) -



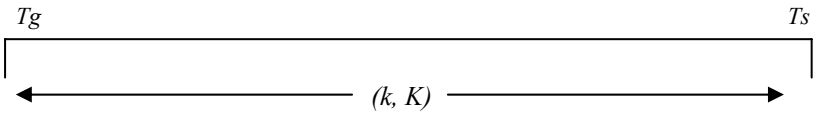
[12] This is a very simple assumption. Here R is exogenously determined, but one can thing to R as determined by a zero-profit condition on the financial market.

[13] The probability of success is given by $p \in (0,1)$, while the probability of bankruptcy is denoted by (1-*p*).

Comparing fig.1 and fig.2 with the notion of organisational equilibrium recalled in section 2, we can thus show that some self-enforcing equilibrium could prevail between 'technology and 'finance'. The model below clarifies the conditions for such an outcome to occur.

3.2 A model of self enforcing equilibria between technology and finance

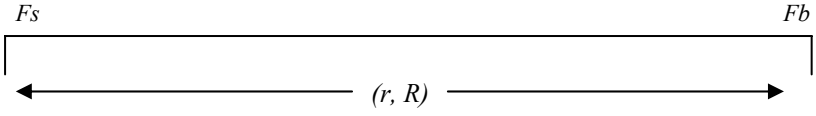
Assume that, in the above contractual scheme, at $t=0$ the technological structure of the firm is given by the ratio k/K (with $k=1-K$, *with* $k, K \in (0,1)$), where, as above, K indicates the stock of specific assets, whereas k denotes of general-purpose assets. The technological choice domain is thus given by the values of k/K which fall on a range that goes from a very general purpose technology (*Tg*) to a specific one (*Ts*).



Technological structure in the technology domain

Assume also that financiers may select a financial rights' scheme that belong to a range of values that fall between a shareholder financial scheme (*Fs*) and a bondholder financial scheme (*Fb*), where *S* represent the shareholders of the firm and *B* its the bondholders. Let r be the economic return generated by general-purpose assets, while R is the economic return of specific assets[14] (with $R \neq 0$, $r \neq 0$). Suppose also that R is the no-bankruptcy extra-return received by agent *S* for financing the project *j(K),* while z^L, with $L=(S,B)$ is the return-share received by each agent in the event of Bankruptcy with $0 \leq z^S < z^B \leq r$[15].

This means that financiers have to choose an appropriate value of safeguards (r, R) which belong to the range of values falling between the shareholders contractual scheme and the bondholders contractual scheme.



Financial rights choice in the financial domain

[14] All these variables are expressed in monetary units.

[15] We assume that in the case of bankruptcy bondholders have a seniority debt with respect to shareholders' rights scheme.

We assume, for simplicity, that when $R>0$, z^S approaches to zero, and vice versa, and that the cost of employing one unit of specific or general-purpose assets is given by C and c, respectively. From the assumptions made above it turns out that when financiers select a financial scheme like *Fs* rather than *Fb* they reveal alternative preferences over the ratio *k/K* expressing the intensity of specific investments: agents *S* (shareholders) receive a fixed or "bounded return" z^S in the bankruptcy event, denoted by the probability (1-*p*), due to the fact that shareholders have bounded (eventually zero) financial claims on firm's assets,; at the same time agents S receive an extra-return or an "unbounded return", $R>0$ in the no-bankruptcy event, *p*[16]; by contrast, agents *B* (bondholders) obtains an "unbounded return"[17] z^S in the bankruptcy event, receiving however a fixed or "bounded" return (extra-return is approximately zero, $R\approx 0$), in the no-bankruptcy event.

Denote now by P_S and P_B the profits respectively of shareholders and bond holders[18]:

$$(1) \quad P_S = \left\{ p\,(rk + RK) + (1\text{-}p)\, z^S k - [c(k) + C(K)] \right\}$$

$$(2) \quad P_B = \left\{ pr\,(k + K) + (1\text{-}p)\, z^B k - [c(k) + C(K)] \right\}$$

In order to show the strongest result in the simplest extreme case, we assume, without loss of generality, that $z^S = 0$ and $z^B = r$ or, in other words, that shareholders perceive no returns in the case of bankruptcy and that bond holders perceive the same "bounded" return r independently of the nature of the investments.

Given the technology (*K,k*), financiers will choose the best financial structure. This must be such that shareholders rights F_S will prevail when their benefit $U(F_S)$ is greater than the benefit $U(F_B)$ of bond holders rights. This occurs when

$$P_S \geq P_B$$

that is

$$(3) \quad p(R\text{-}r)K \geq (1-p)rk$$

[16] See above.
[17] We assume however that this value cannot exceed the return associate with general purpose assets.
[18] We define here, in fact, the profits that the firm will gain according to 'type' of financier selected. We refer to shareholder and bondholder only as stylised agent in order to outline the simplest context.

or:

$$(3') \quad \frac{p(R-r)}{(1-p)r} \geq \frac{k}{K}$$

Vice-versa, financiers will arrange transactions such that debt-holders rights F_B will prevail when their benefit U(R_B) is greater than the benefit U(F_S) of bond holders rights. This occurs when: when:

$$P_B \geq P_S$$

that is

$$(4) \quad (1\text{-}p)rk \geq p(R\text{-}r)K$$

or:

$$(4') \quad \frac{k}{K} \geq \frac{p(R-r)}{(1-p)r}$$

Define now any two technologies, as T_g and $T_{s,}$ such that the asset specificity ratio, k/K, is greater under T_g than under T_s (in Williamson's terminology T_g is the *general purpose technology* and T_s is the *specific technology*). Denote, as above, by *F the financial rights domain* where the choice between the rights F_S and F_B is made by the financiers and by *T* the *technology domain* where the choice between T_s and T_g is made by production managers.

From (4) we get immediately the following proposition:

Proposition 1. In the domain R the benefit of shareholders rights F_S over debt holder rights F_B increases when a more specific technology T_s (instead of a more general purpose one T_g) is chosen in the domain *T*. That is:

$$U(F_S,T_s) - U(F_B,T_s) \geq U(F_S,T_g) - U(F_B,T_g)$$

Proposition 1 tell us what happens to different financial rights (F_S, F_B) for given alternative technologies (T_s, T_g). We would like now to investigate what happens to different technologies for given alternative systems of rights.

Given the 'financial rights' (F_S, F_B), technology will be chosen maximising:

A) under *shareholders rights* F_S:

$$Max \quad P_S = \left\{ p\,(rk + RK) + (1\text{-}p)\, z^S k - [c(k) + C(K)] \right\}$$

that implies:

$$(5) \quad \frac{\partial P_S}{\partial K} = pR - C'(K) = 0$$

$$(6) \quad \frac{\partial \mathrm{P_S}}{\partial \mathrm{k}} = pr - c'(k) = 0$$

B) under *debt holder rights* F_B:

$$Max \quad P_B = \left\{ pr\,(k + K) + (1\text{-}p)\, z^B k - [c(k) + C(K)] \right\}$$

that implies[19]:

$$(7) \quad \frac{\partial P_B}{\partial K} = pr - C'(K) = 0$$

$$(8) \quad \frac{\partial P_B}{\partial k} = pr + (1-p)r - c'(k) = 0$$

[19] Under the assumption that $z^S = r$

Now, define by K_S and k_S the arguments that maximize P_S and by K_B and k_B the arguments that maximize P_B. Comparing (5) and (7) we have that[20]:

(9) $K_S \geq K_B$

and comparing (6) and (8) we have that[21]:

(10) $k_B \geq k_S$

It follows, thus, from (9) and (10) that:

(11) $$\frac{k_B}{K_B} \geq \frac{k_S}{K_S}$$

Recall now that T_g and T_s are any two technologies such that the asset specificity ratio k/K is greater under T_g than under T_s (in Williamson's terminology T_g is the *general purpose technology* and T_s is the *specific technology*). Thus (11) implies the following proposition.

Proposition 2. In the domain T the benefit of a more general purpose technology T_g over a more specific technology T_s increases when bondholder rights F_B (instead of shareholders rights F_S) are chosen in the domain F. That is:

$$U(T_g, F_B) - U(T_s, F_B,) \geq U(T_g, F_S) - U(T_s, F_S)$$

Observe that proposition 1 and 2 imply that the choices made in the financial rights and the technology domains satisfy the standard super-modularity conditions[22]. This implies that multiple financial equilibria(F_S ,T_s) and (F_B, T_g) are possible where (F_S ,T_s) is characterised by the *complementarity* of share holders rights and specific technology and

[20] Since $R \geq r$.
[21] Since $(1-p)r \geq 0$.
[22] Milgrom P. Roberts J. (1990), Aoki M. (2001).

(F_B, T_g) is characterised by the *complementarity* of bond holder rights and general purpose technology. We are now going to investigate more precisely under which conditions these multiplicity of financial equilibria occurs.

A *shareholder financial equilibrium* (F_S ,T_s) is defined by the set of values for which shareholders rights F_S bring about the highest value of the firm given a technology T_s and, in turn, a technology T_s maximizes profits under the shareholders rights F_S . This occurs when the values of the arguments (k_S,K_S), that maximise (1), satisfy also (3') that is

$$(12) \qquad \frac{p(R-r)}{(1-p)r} \geq \frac{k_S}{K_S}$$

A *debt holder financial equilibrium* (F_B T_g) is defined by the set of values for which shareholders rights F_B bring about the highest value of the firm given a technology T_g and, in turn, a technology T_g maximizes profits under the shareholders rights F_B This occurs when the values of the arguments (k_B,K_B) that maximise (2) and satisfy (4') that is:

$$(13) \qquad \frac{k_B}{K_B} \geq \frac{p(R-r)}{(1-p)r}$$

Denote now:

$$\mathrm{ER}_{GS} = \frac{p(R-r)}{(1-p)r}$$

ER_{GS} expresses the ratio between the expected extra-return from specific investment K and the return from general purpose investments k. The ratio k_S/K_S represent the relative values of k and K associated to the more specific technology T_s operated by shareholders and k_B/K_B are the relative values of k and K associated to the more general purpose technology T_g that is operated by the debt holders. Because of (11), ER_{GS} must either fall within the interval defined by k_S/K_S and k_B/K_B or in the interval defined by 0 and k_S/K_S or in that

defined by k_B/K_B and infinity. Thus we have the following proposition on the existence of multiple financial-technological equilibria.

Proposition 3. Multiple financial-technological equilibria (F_S , T_s) and (F_B , T_g) exist when ER_{GS} falls between the values k_S/K_S and k_B/K_B . A unique bond holder (F_B , T_g) equilibrium exists when ER_{GS} is smaller than k_S/K_S while a unique shareholder (F_S , T_s) equilibrium exists when ER_{GS} is greater than k_B/K_B .

Proof.

Proposition 3 follows from the fact that when:

$$(14) \qquad \frac{k_S}{K_S} \leq \frac{p(R-r)}{(1-p)r} \leq \frac{k_B}{K_B}$$

both (12) and (13) are satisfied whereas when:

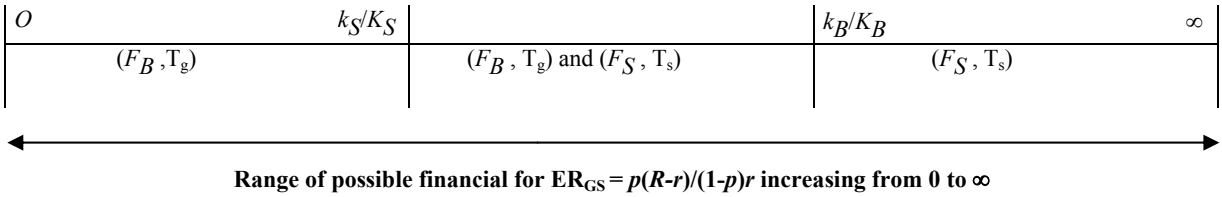
$$(15) \qquad \frac{k_S}{K_S} \leq \frac{k_B}{K_B} \leq \frac{p(R-r)}{(1-p)r}$$

then (12) is satisfied but (13) is not satisfied and when:

$$(16) \qquad \frac{p(R-r)}{(1-p)r} \leq \frac{k_S}{K_S} \leq \frac{k_B}{K_B}$$

(12) is not satisfied while (13) is satisfied.

Proposition 3 can be visualised thus by the following scheme:



Range of possible financial for $ER_{GS} = p(R-r)/(1-p)r$ increasing from 0 to ∞

The results coming form the above proposition have an interesting meaning in our setting. The expression in (16) means that *when the probability of success for the project is low and the ratio between the return of specific and general capital is also low, then only debt-holders financial equilibria are possible*.
By contrast, *when the probability of success is high and the ratio between the return of specific and general capital is also high, then only share-holders financial equilibria are possible*.

Out of these assumptions, initial conditions on financial markets and on the technological structure of the firm shape thus future financiers-managers decisions, as long as financial structure in $t=0$ affects technological structure in $t=1$ and viceversa[23].

The emergence of path-dependency between "finance" (F) and "technology" (T) has thus several consequences: "dequity" is not a transaction costs minimising governance structure, since it applies in a world of perfect financial and technological markets; the stylised fact that we do not observe any convergence toward a global model of 'dequity' governance is manly due to the fact that initial conditions matter and affect future evolution of firms and markets; the emergence of self-enforcing equilibria between (F) and (T) puts together a transaction costs economics explanations with the observations of diversity in corporate governance patterns and gives an explanation of the fact that independently of their historical origins (which may be different in different countries) corporate governance models persist in their diversity over time.

4. Conclusions and Extensions

In the last section, following the CIA approach, we have shown how introducing in the traditional Williamsonian setting agency problems rising when wealth-constrained investors cannot buy assets and have to raise funds from an outside investor, the co-structuring financial and technological equilibria becomes a central issue in the analysis of corporate governance. Starting from the results of 'Transaction Costs Approach' (TCE) to

[23] In this simple setting we neglect internal funds raised by cash flows self-financing as a third way of financing investments, beside debt and equity. Worthington (1995) compares the trade-off between debt and cash flows financing instead of debt and equity.

the analysis of the relationship occurring between corporate governance and corporate finance, we have show, by a very simple model, the emergence of financial and technological equilibria in a given institutional context. However, while the TCE's Approach describes a direction of causality which moves from asset specificity to the financial structure of the firm, and thus to its governance structure, the CIA's Approach points out that an opposite direction of causality may also hold: financiers, seeking appropriate safeguards for financial investments within the firm, could influence the emergence of generic (re-deployable) or specific assets according to their preferences on expected residual income and/or to the legal bankruptcy system enforced by judicial authorities. However, if both the direction of causality hold some self-enforcing equilibrium between 'Technology' and 'Finance' could prevail in an incomplete contract framework. In our simple framework, the CIA Approach obtained this result by introducing the simplest polarized structure of financial and technological choice inside the firm. Our aim is to focus on possible tendencies that may hold in corporate governance models' evolution. We are aware of the fact that by doing so we explicitly neglected further complications which however might be taken into account in order o explain specific evolution patterns in alternative models of corporate governance. In the above framework we have, for instance, explicitly excluded self-financing by internally raised funds as an alternative way to structure investment decisions. As Allen and Gale (2000) show, self- financing is one of the most diffused way of investment financing among firms through different corporate governance systems. In our framework, self-financing could however be introduced as a particular case of equity financing. In this case, internally raised funds can be treated as a particular form of equity which gives no claims in the case of bankruptcy and which is selected when the degree of asset re-deployability prevents any debt contract. According to this assumption, thus, the result outlined above still apply to self-financing.

The results shown above may suggest that the observed diversity in corporate governance models might thus be explained in terms of the historical conditions governing the path dependency between 'Technology' and 'Finance'. Under the CIA approach followed here, the financial policies reproduce themselves *via* technology and the technology reproduces itself *via* the particular financial policy which has originated that technology and so on.

According to the way in which we assume that the initial conditions of the system were given, a corporate equilibrium, in terms of the particular combination of (F) and (T) can be interpreted as a "financial equilibrium" or as a "technological equilibrium". If we

assume that the initial conditions of the system were given in terms of a "strong" financial markets shock, then an corporate structure can be interpreted as a "financial equilibrium" where the initial condition in financial markets reproduced themselves via technology. By contrast, assume that a technological innovation or a change in the structure of demand has changed the technological characteristics of the resources to be employed. In this case the initial conditions have occurred in terms of a strong technological shock and the structure of the firm, both financial and technological, can be interpreted as a technological equilibrium where the initial technological shock has reproduced itself via an appropriate financial policy. In this respect, independently of their historical origins (which may be different in different countries) the opposite structuring of corporate governance models, such as the American corporate governance system, the German system and the Japanese firm, might be viewed as alternative finance-technology equilibria which endure over time. These explanations of alternative governance systems, based on the notion of institutional complementarities between finance and technology in firms, might so-far introduce further insights in valuing the question of convergence *versus* diversity in corporation's ownership and control systems[24].

[24] A possible extension of the model here proposed could thus regard an econometric investigation on the evolution of alternative corporate governance models according to specific proxies for asset specificity ratio as for the ratio between the expected extra-return from specific investment and the return from general purpose investments. We have now several investigation which might be successfully used as a possible framework for econometric investigation. Zeckhauser and Pound (1990) estimated the value of assets specificity in some US industries, showing how assets specificity implies a higher difficulty in monitoring management with respect to general purpose investments. Worthington (1995) found that the effect of cash flow on investments is larger in industries whose capital expenditure are likely to be "highly sunk" than in low capital industries. Worthington interpreted this finding as evidence that external financing of capital investment is more difficult when the assets being financed have low recovery (resale) values or are sunk (specific). Vilasuso and Minkler (2001) develop a dynamic model that incorporates the insights of both the agency cost and asset specificity literature about corporate finance. In general, they find that neither can be ignored, and that the optimal capital structure minimizes agency cost and asset specificity considerations. A key finding in their work is that the conditions most favorable for reducing transaction costs due to asset specificity are the same as those for reducing the agency costs of debt. Empirically, they find that agency costs and asset specificity are significant determinants of a firm's capital structure in the transportation equipment and the printing and publishing industries.

References

Allen F., Gale, D. (2000), *Comparing Financial Systems*, MIT Press

Aghion, P., Bolton, P., (1992), "An Incomplete Contracts Approach to Financial Contracting", *Review of Economic Studies*, 59: 473-94

Alchian, A. and Demsetz, H., (1972), "Production, information costs and economic organization", *American Economic Review*, 62, pp. 777-95.

Aoki M. (2001) *Towards a Comparative Institutional Analysis*. MIT Press, Cambridge.

Bratton W. and McCahery J. (1999) "Comparative Corporate Governance and the Theory of the Firm: The Case against Global Cross Reference", *Columbia Journal of Transnational Law* 38, 213-297.

Coase R. H. (1937) " The Nature of the Firm" *Economica* pp. 386-405. Reprinted in R. H. Coase (1988) *The Firm, the Market and the Law*. University of Chicago Press, Chicago pp.-57.

Dalmazzo A., (2000) "Strategic debt with multi-task technologies", *Canadian Journal of Economics*, February 2002

Hart O. (1995) *Firms, Contracts and Financial Structure.* Oxford University Press, Oxford.

Hart O. and J. Moore, (1994) "A Theory of Debt Based on the Inalienability of Human Capital", *Quarterly Journal of Economics* 109:841-79

Hart O. and J. Moore, (1995) "Debt and Seniority: An Analysis of the Role of Hard Claims in Constraining Management", *American Economic Review* 85(3):567-85

Milgrom P. Roberts J. (1990) "Rationalizability, Learning and Equilibrium Games with Strategic Complementarities", *Econometrica* v. 59 pp. 511-528.

Pagano U. (1993) "Organisational Equilibria and Institutional Stability" in Bowles S., Gintis H. , Gustafson B. eds. *Markets and Democracy*. Cambridge University Press, Cambridge

Pagano U. and Rowthorn R. (1994) "Ownership, technology and Institutional Stability" Structural Change and Economic Dynamics. Vol.5 No 2 pp. 221-243.

Pagano U. and Rowthorn R. (1996) "The Competitive Selection of Democratic Firms" in Pagano U. and Rowthorn R. (eds) *Democracy and Efficiency in the Economic Enterprise*, Routledge

Shleifer A. and Vishny R. (1992) "Liquidation Values and Debt Capacity: A Market Equilibrium Approach", *Journal of Finance* 47(4), pp. 1343-1366

Vilasuso J., Minkler A. (2001), "Agency costs, asset specificity, and the capital structure of the firm", *Journal of Economic Behavior and Organization* Vol. 44 (1) pp. 55-69

Williamson O. (1988) "Corporate Finance and Corporate Governance" (1988), *Journal of Finance*, 43

Williamson O. E. (1985) *The Economic Institutions of Capitalism*. The Free Press

Worthington P. (1995) "Investment, Cash Flows and Sunk Costs", *The Journal of Industrial Economics*, Vol. XLIII, No.1, p 49-61

Zeckhauser R J. and Pound J. (1990) “Are Large Shareholders Effective Monitors?” in Hubbard, R. Glenn (Eds), *Asymmetric Information, Corporate Finance and Investment*, University of Chicago Press.