Chapter 2

Collateral Composition, Diversification Risk, and Systemically Important Merchant Banks

by Alexis DERVIZ
Czech National Bank, Czech republic
Institute of Information Theory and Automation, Czech republic
alexis.derviz@cnb.cz

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Alexis Derviz [16]
Czech National Bank, Czech republic
Institute of Information Theory and Automation, Czech republic
alexis.derviz@cnb.cz

Abstract

We study the impact of collateral diversification by non-financial firms on systemic risk in a general equilibrium model with standard production functions and mixed debt-equity financing. Systemic risk comes about as soon as firms diversify their collateral by holding claims on a big wholesale (merchant) bank whose asset side includes claims on the same producer set. The merchant bank sector proves to be fragile (has a short distance to default) regardless of competition. In this setting, the policy response consisting in official guarantees for the merchant bank liabilities entails considerable government loss risk. An alternative without the need of public sector involvement is to encourage systemically important merchant banks to introduce a simple bail-in mechanism by restricting their liabilities to contingent convertible bonds. This direction of regulatory policies can be particularly relevant for containment of systemic events in globally leveraged economies serviced by big international banks outside the host country regulatory control.

Keywords: collateral, diversification, default systemic risk, merchant bank, CoCos

2.1 Introduction

Financial instability and crises are inseparably tied to the phenomenon of default. A crisis can start with mass defaults on micro level, as in the U.S. subprime mortgage market breakdown case of 2007. It often results in default, including one of financial intermediaries, as in most manifestations of the latest financial crisis in the U.S. and Europe following summer months of 2008. At its worse, there is a vicious circle of defaults involving banks, non-banking private sector and the government, so that funds borrowed to prevent insolvency in one sector push towards insolvency the one who went to rescue, as in the current EU periphery sovereign debt impasse. This makes default a natural candidate for the role of absolute economic evil and the main adversary of prudential policy.

However, as if totally unaware of this dismal record, the available economic theories of default offer a much less dramatic picture. Agents enter into debt contracts conscious of the possibility that the payment obligation will not be honored, and there is a whole spectrum of methods, from elementary to highly sophisticated, describing how the non-payment contingency can be reflected in the price of a debt claim. In popular terms, forewarned should be forearmed, so, where are the arms of rational creditors? If default is so universally bad, why are there perfectly sensible theories telling us how the debtor chooses to default optimally, or how the creditor optimally calls an insolvency procedure in advance of a credit event? Unfortunately, economics has not yet developed a

[16] Alexis Derviz, Principal Economist at Czech National Bank, Monetary and Statistics Department, Na Příkopě 28 115 03 Praha 1, Czech republic
Research Fellow at Institute of Information Theory and Automation, Department of Econometrics, Czech republic

comprehensive picture of default costs, their genesis, structure or ways of containment. These matters are mainly explored by practitioners. From the point of view of the latter, including policymakers, the disastrous effect of default on economic activity and welfare comes from two sources: legal complexity of debt workout procedures and destruction of value, such as human capital and other assets, as a result of forced changes of ownership and control. Neither of the named areas is sufficiently investigated by mainstream financial economics whose language is usually employed to formulate policy. Therefore, there is not much more than a general understanding that both private and social default costs are significant enough to be acted against. This understanding has a very long tradition and may have been the principal force behind the custom, existing since ancient times, of equipping loan agreements that showed a material default probability, with the provision of recourse to collateral. Accordingly, without dwelling excessively on the question why, economics of debt and investment includes collateral as a standard element of its models. As an unintended consequence, since financial crises same as their spillovers to the real economy are crises of risky debt and the latter has collateral attached to it (with the objective to reduce risk), what we face are, essentially, crises of collateral markets. This observation has been gradually finding its way into formal theory in works of Morris and Shin (2004), Brunnermeier and Pedersen (2009) and Geanakoplos (2010), among others.

No matter how much an in-depth theory of default involving collateral processing would be welcome, our objective here is more modest and goes in a somewhat different direction. Taking as given the lesson that factors relevant for collateral price movements matter substantially for the economy as whole, we would like to examine in what ways the heterogeneous collateral and the origin of its different subspecies, can generate sources of systemic risk. This is a question earlier models did not cover sufficiently. For an answer, we will employ a formal approach much more explicit than the extant macroeconomic models (mainly DSGE) have been used to.

The rest of the chapter is organized as follows. In Section 2.2, we give a formal outline of the problem, our solution approach and put both in the context of existing literature. Section 2.3 describes the model. Section 4 reports results of numerical experiments of different merchant bank liability regimes. Section 5 discusses implications of these simulation results in more detail and concludes.

2.2. Methodological Background

What we work with is, essentially, a model of production financing in which the Modigliani-Miller law does not hold for capital scarcity reasons. Those who have the knowledge and authority to invest (firm shareholders) do not have own funds whereas those who can bring investors and production opportunities together (merchant banks) first need to convince at least some of the potential investors to become depositors as well, since there is no one else to turn to. However, no one can deposit enough without borrowing from some other party (commercial banks) first, and such loans are risky. This economy can only operate with leverage, and with leverage comes a systemic risk threat.

It turns out that, in a fairly standard model of debt-financed producer choices under uncertainty, the threat of a systemic collateralization breakdown is not just conceptually, but also quantitatively, significant. To see this, one only needs to recognize and implement in the model a few notoriously salient stylized facts.

First, firms and their managers do not normally engage in outside equity investment of their own. Particularly, when they decide to purchase liquid collateral other than a sight deposit, they have no other choice than to become clients of the investment banking industry. Second, investment banking tends to be oligopolistic with marked economies of scale. This property is usually explained, among other things, by diversification benefits positively related to size, soft "closed club" human expertise of investment monitoring and information processing, or high fixed costs involved, sometimes also by political clout going hand in hand with network externalities. In any case, and despite turbulent structural overhauls they regularly go through, mature financial centers catering to corporate clients are invariably dominated by a few big companies, for which we will employ the term merchant bank.[17] Third, no matter how much the merchant bank would like to fund its liabilities by a well-diversified asset portfolio, in a globalized (i.e. essentially closed) economy it cannot avoid buying liabilities connected to, ultimately, the same universe of firms whose deposit money it accepts. The chain from some firm's excess cash invested in a merchant bank CD to a private equity fund holding shares of that very firm may have multiple links, but it can be invariably traced down. Accordingly, by aggregating the merchant bank sector into one entity and inspecting that entity's balance sheet, we feel it justifiable to stylize the analysis, initially, to the case of just a few firms (we will have two in the quantitative examples of this chapter) holding claims on one merchant bank who, in its turn, holds a tangible portion of equity of those same firms.

Not surprisingly, in such an environment, the aggregate productivity threshold below which there comes default of the merchant bank is much higher than the same threshold for an individual producer. The merchant bank has to pay sufficiently high deposit rates to its investors to be attractive as a collateral provider. Therefore, there is a clear bound to the merchant bank profit regardless of competition in the industry. The situation of a commercial bank lending to the same producers is qualitatively different, as its market power depends mainly on informational exclusivity in relation to the client and is only limited by the productivity characteristics of the latter.

The merchant bank can offer claims on itself as diversified collateral to the firms only as long as it is solvent, but the solvency buffer size, i.e. the merchant bank profit, is limited by the need to make collateral worthy. Consequently, diversified collateral in the form of deposits (or bonds) is much more susceptible to systemic impairment than liabilities of standalone producers. Under this structure of financial services, the more one tries to diversify the more fragile leverage one creates, and the harsher are the aggregate consequences.

Can there be a remedy, particularly assisted by an appropriate policy? The most immediate one (also tried many times) would be an official guarantee of the merchant bank liabilities. However, the fiscal costs may be untenable, as the Irish and Spanish examples of these days make clear. Naturally, going back to default treatment in the earlier mainstream microeconomics, a merchant bank default would be no problem at all if its pecuniary implications were transferred one-to-one to the

[17] Our use of the term is motivated by its inclusiveness in the sense that features like catering to the corporate sector instead of retail clients, cross-border operations, involvement in private equity investment and substantial market power are, or were in the past, all typical for this financial institution variety. A historical overview of the subject can be found in, e.g. Craig (2002).

ultimate creditors and did not receive an institutional spin in the form of value-destroying bankruptcy procedure. In a frictionless world, this could be achieved if the merchant bank were mandated to issue only equity as liabilities. Still, merchant bank equity may be unsellable to firms for reasons already explained in Townsend's (1979) costly state verification (CSV) model: impossibility for a small shareholder to establish the appropriate value of the dividend that a big and complex merchant bank owes him. Therefore, we suggest an alternative, equally inspired by Townsend (1979) as well as the Black-Scholes (1973) and Merton (1974) treatment of risky company debt. Recall that under the Black-Scholes-Merton approach the company assets in default are transferred one to one to the creditor. The same thing happens under the debt contract considered in Townsend (1979). This is tantamount to the creditor becoming a shareholder. The resulting liability is a fixed-income debt instrument in good times and equity in bad times, i.e., essentially, a convertible bond. An important formal difference with the classical understanding of the latter is that its covenant makes conversion the decision of the holder. In our setting, the conversion trigger is exogenously tied to the merchant bank solvency (the current model is sufficiently simple in this respect, so that one can assume automatic conversion whenever the bank is unable to pay the original deposit rate, without further procedural details). This means that our construction is, essentially, a variety of the so-called contingent convertible (CoCo) bond. In our view, the most important advantage of this bond covenant is that a shareholder of a living company has a much stronger legal standing in what concerns state verification than a creditor of a defaulting company. So, the key statement we want to exemplify with our formal exercise is that an insolvent merchant bank should not be sent into bankruptcy but rather, exchange its fixed income liabilities for shares and then distribute whatever (little) it actually earned among the old and new shareholders. In this way, consequences of an adverse aggregate productivity shock will not be avoided. They will still be borne. However, in our model of merchant bank bond conversion they only have a one-to-one impact on firm owners whereas in a pure deposit-taking merchant bank facing insolvency they are expanded. Additional losses emerge either because of a system-wide shock due to debt workout delays and destruction of value (if the merchant bank is allowed to fail) or in view of a heavy fiscal burden (if official deposit guarantees are given). Accordingly, risks will be diversified as long as they are really diversifiable and not just be different labels of an aggregate risk common to everybody (as in a systemic shock case), whereas the costs of the latter will be distributed predictably among firm owners without a legal breakdown.

Firms that hold liquid assets in parallel with using bank loans are a well known phenomenon. It was studied theoretically in the context of credit constrained neoclassical economy by Woodford (1990), and there has been substantial theoretical and empirical literature in the same vein since then (see, e.g., Bacchetta and Benhima, 2010, for further references). Diversification leading to the opposite of its initial goal, i.e. risk concentration, has been quantitatively examined by, e.g., Ibragimov et al. (2011) and a host of earlier papers cited therein. However, these models are almost purely probabilistic and have but a rudimentary economic structure (i.e. no distinction between agent roles or between equity and debt, etc.). In our approach, diversification curse is accommodated in a standard choice-theoretic environment of a production economy.

2.3. Model

2.3.1 The Economy

Agents of this economy include firm shareholders, firm managers, workers, commercial banks and merchant banks. In the baseline setup, there will be two firms with one shareholder, one manager and one worker in each, two commercial banks and one merchant bank. Investment opportunities include firm stock (available to the merchant bank), bank loans (available to the commercial banks) and claims on the merchant bank in deposit form (available to the two firms' shareholders).

A household sells one unit of labor to his firm. A shareholder owns an exogenous endowment of stock in his firm, measured in the same units as physical capital and transferrable between the latter and deposits in the merchant bank, at no cost. Firm managers hire labor, borrow from commercial banks and split the loan proceeds between wage expenditure and purchase of physical capital in access of the quantity provided by the shareholder. The merchant bank purchases private equity partnerships in both firms with funds raised as deposits; it can also invest in the world market (outside the examined economy) at a fixed positive rate.

There are two periods. In the first, labor hiring and pre-paying, borrowing and investment decisions are made, in the second, the production output is sold and the revenue distributed between the borrowers and the lenders, and other investment returns paid out.

The producer has a Cobb-Douglas production function

$$Af(k,m) = ALk^{\alpha}m^{1-\alpha}\,, \tag{2.1}$$

in which *k* is physical capital, *m* is labor, *L* is a private total factor productivity (TFP) component, and *A* is an aggregate TFP component. We think of the situations in which *A* is a random variable with known distribution, whereas *L* is either a simple scaling constant (benchmark case) or a firm-specific parameter with each of a large set of small firms identified by their individual *L*-values.

Capital is released after the end of the production cycle, but its transformation from producer-specific to generally usable state is costly. For each quantity *k* leaving the production facility one gets (1-*t*(*k*))*k* marketable units for further use. The structure of capital transformation function *t* is as follows:

$$t(k) = \delta + \tau(k)\,, \tag{2.2}$$

where positive constant δ is the conventional depreciation rate and a strictly increasing function τ ($\tau(0)=0,\ \tau(k)>0$ for all $k>0$) stands for increasing "capital dismantling" costs. That is, τ can be considered a reverse of the traditional capital installation cost function. If the firm defaults (see later), (1-*t*(*k*))*k* is added to the collateral seized by the lender, if it survives, this term is a part of the shareholder revenue ("EBIT"). Thus, EBIT comprises

$$Af(k,m) + \left(1 - t(k)\right)k\,,$$

and one other term to be described below.

We assume a competitive labor market with labor force supply normalized to unity for each firm (if there are many firms, one has to assume some form of firm-specific skills; in that case, m becomes more a variety of human capital than classic unskilled labor). Labor market competitiveness means that workers are paid the marginal product of labor as wage, and the wage expenditure is subtracted from the firm revenue. To avoid dealing with wage settlements in a defaulting firm, we assume that the whole wage bill is paid in advance in period 1, for which purpose the firm borrows the whole amount b^m from its "house" bank (working capital loan).

The labor market does not play any significant conceptual role in this model, but it is necessary for calibration purposes. With a single-input production function, one would have obtained unrealistically high marginal products of capital as well as interest rate levels, and also have had difficulties generating reasonable default rates.

Remark The present version is in two periods. In a multi-period variant, interpretation of m as skilled labor (firm-specific human capital) could be used to augment default costs in welfare terms with the corresponding loss of accumulated human capital. This feature might add rationale to policy trying to reduce default frequency.

2.3.2 Borrowing, Collateral, and Default

Physical capital is financed by both equity and bank debt. If q is the amount available as equity (the equity market shall be defined separately), then

$$k = q - v + b^k \tag{2.3}$$

Here, b^k is the amount borrowed to co-finance physical capital purchase. We have already introduced another component of bank debt, b^m, needed to pay labor force wages. Thus, the total loan size is $b=b^k+b^m$.

The remaining term on the right hand side of (2.3), v, is the amount set aside by the controlling shareholder as a source of additional collateral in excess of $(1-t(k))k$. This quantity (we call it diversified collateral) is invested outside the firm to generate a buffer formally unrelated to the company's own production. (Note that "unrelated to" does not always mean "independent of", since, under systemic events, as we shall see, the dependence comes about.) When v=0, the only collateral the firm has comes from its own output and (dismantled) physical capital. When v>0, the collateral is augmented by $(1+i^o)v$, where i^o is the rate of return that can be earned on v in financial markets through the merchant bank. In a surviving firm, $(1+i^o)v$ is a part of its revenue. We set the maximal allowed value of v equal to q in order to exclude cases of unlimited leverage out of bank-lent funds. When v=q, the firm only finances physical capital out of its bank loan while spending the totality of its equity capital on collateral diversification. Such a behavior, if shared by all producers, generates the maximum admissible degree of leverage in the economy.

The firm pays the shareholders dividends defined as

$$y(A) = \max\left\{Af(k,m) + \left(1-t(k)\right)k + (1+i^o)v - (1+r)(b^k+b^m), 0\right\}, \tag{2.4}$$

under constraint $b^k=k-q+v$. In a defaulting firm, $Af(k,m)+(1-t(k))k+(1+i^o)v$ is treated as collateral seized by the bank. This definition of collateral is a synthesis of the Classical Black-Scholes-Merton one (Black and Scholes, 1973, Merton, 1974), later taken over by Bernanke, Gertler and Gilchrist (1999) and supported by Townsend's (1979) CSV analysis, and the Kiyotaki-Moore (1997) concept, also widely used in models created by Geanakoplos (cf. Geanakoplos, 2010, and references to his earlier papers therein). The "Merton part" is formed by the output plus released physical capital, $Af(k,m)+k$. We have added the $-kt(k)$ term to account for the difference between firm-specific and general collateral, important both conceptually and quantitatively. The term $(1+i^o)v$ is the "Geanakoplos part", potentially liquid but subject to random swings in value. In a multi-period model, this part would be the source of collateral cycle and, given a systemic event, the debt deflation effect.

The firm either survives or defaults depending on the realized total factor productivity A. Survival is equivalent to the firm's EBIT exceeding its debt service:

$$Af(k,m)+\left(1-t(k)\right)k+(1+i^o)v \geq (1+r)\left(b^k+b^m\right). \tag{2.5}$$

This happens if and only if the realized A exceeds the threshold value

$$A^d=\frac{(1+r)\left(b^k+b^m\right)-\left(1-t(k)\right)k-(1+i^o)v}{Lk^{\alpha}m^{1-\alpha}}. \tag{2.6}$$

If the realized A is below A^d, the firm defaults and the bank seizes EBIT, whereas the firm shareholders get nothing. There are situations in which A^d is negative (typically, this means very strongly capitalized firms in an environment of low lending rates), in which case survival is a certainty.

2.3.3 Investment and Labor Hiring Decisions

Let us denote the p.d.f. of aggregate TFP factor A by [illegible] and introduce the notation

$$\Phi^+(A)=\int_A^{+\infty}\varphi(S)dS\ ,\quad \Psi^+(A)=\int_A^{+\infty}S\varphi(S)dS\ , \text{ for } A\geq 0.$$

That is, $\Phi^+(A^d)$ is the survival probability of the firm and $\Psi^+(A^d)$ is the expected TFP of surviving firms. Another piece of notation to be used in the sequel is

$$\theta(A)=\frac{\Psi^+(A)}{\Phi^+(A)}\ \text{-}$$

the average TFP-value of a firm conditioned on it exceeding A.

For future use, we also introduce the notation Φ for the cumulative distribution of A (i.e. $\Phi^+(A)=1-\Phi(A)$) and Ψ^- - for the expected TFP of defaulting firms (i.e. $\Psi^-(A)=\overline{A}-\Psi^+(A)$, $\overline{A}$ being the unconditional mean of A).

We assume a hired manager remunerated in proportion with the firm's dividend (i.e. the manager receives 0 if the firm defaults). This assumption is made to avoid complications with agency problems between the shareholder and the manager. Also for the sake of simplification, we assume manager risk-neutrality.

The manager takes the level of equity *q*, the diversified collateral *v*, the lending rate *r* and the wage level as given and decides upon labor hiring and investment in physical capital *k* (which, for him, becomes equivalent to setting the size of the bank loan). Due to risk-neutrality, the chosen *k*- and *m*-levels must satisfy the first order conditions

$$\Psi^{+}\left(A^{d}\right) f_{k}(k,m)=\Phi^{+}\left(A^{d}\right)\left[r+t(k)+kt'(k)\right], \qquad (2.7a)$$

$$\Psi^{+}\left(A^{d}\right) f_{m}(k,m)=\Phi^{+}\left(A^{d}\right)(1+r)w, \qquad (2.7b)$$

where *w* is wage, paid, as was agreed, out of the bank loan in advance of production (that is why (2.7b) contains the lending rate factor 1+*r*). Accordingly, $b^m=wm$ and

$$\theta\left(A^{d}\right) f_{m}(k,m)m=(1+r)b^{m}.$$

In the case of Cobb-Douglas production, this fact allows one to eliminate the labor market variables from further calculations completely. Recall that we normalize the labor input to unity, therewith pinning the wage level down.

2.3.4 Bank Loans

Jointly, production decisions (2.7) determine the demand *B*(*r*) for loans (parameters on which *B* depends beside *r* are omitted for simplicity). On the credit supply side, a commercial bank is assumed to enjoy market power over borrower (e.g. due to a borrower hold-up problem of the Diamond-Rajan type, cf. Diamond and Rajan, 2000, as the firm cannot credibly communicate its productivity type to outsiders). The base funding cost for the bank is denoted by *i*. To endow credit supply side with some realistic elasticity, we assume that there is also a non-linear component of the funding cost, e.g. quadratic of the form

$$\frac{a}{2}\left(\frac{B(r)-v-y_{0}}{q}\right)^{2}, \qquad (2.8)$$

which is added to the linear component (1+*i*)*B*(*r*) and puts an additional brake on borrower leverage expansion in excess of some exogenous reference level. Here, we have set the driving variable of this brake as the ratio of the debt in excess of the diversified part of the collateral plus a reference output, y_0, over the equity value. The exogenous parameters appearing in (2.8), namely, y_0 and a positive constant *a*, originate in macroprudential regulation.

We will denote by hats the variables (such as physical capital and production level) chosen optimally by the borrowing firm. A risk-neutral bank announces *r* taking into account the loan demand, its funding costs, and the equity value of the loan applicant. Altogether, the bank maximizes the expected profit from the loan given by

$$\Psi^{-}\left(\hat{A}^{d}\right)\hat{f}+\Phi\left(\hat{A}^{d}\right)\left[\left(1-t\left(\hat{k}\right)\right)\hat{k}+\left(1+i^{o}\right)n\right]+\Phi^{+}\left(\hat{A}^{d}\right)(1+r)B(r)-(1+i)B(r)-\frac{a}{2}\left(\frac{B(r)-n-y_{0}}{q}\right)^{2}$$

2.3.5 Choice of Collateral Diversification

We assume that the shareholder sets aside the preferred quantity of diversified collateral, *v*, in advance of all other decisions in the first period. Generically, varying *v* from zero to *q*, one obtains increasing total output, but decreasing expected dividend. The former property is the consequence of higher debt levels under higher *v*, cf. (2.3): whereas physical capital *k* is determined "technologically" by the hired manager according to (2.7a), there is less equity to finance it if *q* is diverted towards *v*. Consequently, the firm must borrow more and the debt service component of output goes up. Declining dividends are a consequence of higher debt service. As a result, the firm manager and the shareholders would prefer no collateral diversification at all (at least as long as they do not internalize the effect of their financial decisions on the lending rate). On the contrary, both banks and the GDP-valuing social planner would prefer maximal diversification. However, if the social planner overlooks the systemic consequences of collateral funds being invested in the same type of assets (firm equity directly or through further intermediaries such as the merchant bank in our case), she runs the risk of magnifying a systemic crisis which might emanate from, e.g., an adverse shock to aggregate TFP. Actually, a regulatory omission is easy since, whilst collateral in the form of the firm's physical assets is generally regarded as highly illiquid, window-dressing *v* can create a powerful illusion of collateral liquidity.

Since firms are unable to engage in equity trade of their own, they need expert intermediaries. Intermediaries accumulate assets which, as they may erroneously believe, play the role of risk diversifiers.

Having both equity and debt investment financing is important while we want to consider a case of limited (or, at least, highly elastic) supply of equity capital. That this intention has good grounds can be validated ex post in our setting if one considers a standard stock market populated by traditional small moderately risk-averse equity investors. Then it turns out that in many situations such a market, acting on the usual limited information about the producer technology, is only able to provide for a portion of the needed capital, the rest being necessary to have available as either an exogenous foundation stock, private partnership or bank loan. In other words, quite often, there does not exist an equilibrium based predominantly on publicly traded stock able to complement a small level of private equity participation. These are the cases when a merchant bank can fill the gap.

2.3.6 Merchant Banks, Equity Partnerships

The basic arrangement to be considered here for the merchant bank is to take deposits from both firms. These deposits constitute its liability side. On the asset side, the merchant bank acquires shares of the same two firms in the form of a partnership or private equity participation. One should remember that the abstract merchant bank construction here impersonates the whole global investment banking sector. Inside this aggregate construction with its consolidated balance sheet, individual institutions hold claims on others from the same set, so that the balance sheets of constituent parts are strongly interconnected. Shin and Shin (2011) argue that growth of these non-core bank liabilities (they also include foreign liabilities in the same non-core group) indicate a nascent credit bubble. This view can be made consistent with our own if we agree that a high weight of non-core bank liabilities is just the reverse side of concentrating non-financial corporate sector non-core (outside collateral in our terms) assets within one highly specialized branch of the financial industry, which is represented by the merchant bank in the model.

Being a big company, the merchant bank acquires a stock sufficient to influence the marginal product of capital in any firm it buys itself into. For simplicity, we assume a risk-neutral merchant bank, as would be natural to expect from a manager of a large enterprise. In any case, risk attitudes of merchant banks are not our prime concern here.

The firm is controlled by two agents: the holder of the foundation stock, which we consider an exogenous initial endowment, and the merchant bank purchasing a partnership. One can think of many variants as to how the stock is split between the two, e.g. depending on the relative negotiation power. Namely, the optimal size of private partnership from the viewpoint of the foundation stock holder is normally smaller than the optimal size from the merchant bank (incoming partner) perspective. In order not to complicate matters with the issue of bargaining between shareholder incumbents and newcomers, we assume throughout that the two are always able to agree on the partnership size that maximizes the producer’s expected output when the amount and cost of credit (commercial bank loan size and the lending rate) are given. This is what would happen if the representative shareholder played a symmetric information simultaneous-move game with the firm manager (recall that the latter, in his turn, is assumed to take the equity capital size as given).

We assume that the merchant bank has just one other investment opportunity beside equity partnerships in the two firms. This outside investment has the form of a homogeneous asset paying net return i^0 on a unit of investment. Since, in order not to complicate matters with the merchant bank risk management decisions, we will deal with risk-neutral merchant banks in this chapter, it is irrelevant whether i^0 is deterministic or stochastic. So, we take it to be a mean net return. Recall that the merchant bank and the incumbent shareholder take the borrowing decision of the manager as given. The initial stock q^h given exogenously, and taking into account the first order conditions (2.7) of the production input optimization, they should jointly optimize the size of merchant bank’s private partnership, q^p, to satisfy the following simple first order condition:

$$\Phi^+\left(A^d(q^h+q^p)\right)(1+r)=1+i^0\,. \qquad (2.9)$$

Here, the default threshold A^d defined in (6) is considered a function of total equity capital $q^h+q^p=q$ (recall that physical capital is given by $k=b^k+q-v$, v has been pre-defined by the shareholder, cf. 2.5, $b=b^m+b^k$ is chosen by the manager and b^m is pinned down by (2.7b)).

When there are just two ex-ante identical firms, the v value of one becomes the q^p-value of the other, and vice versa. In this chapter, we restrict attention to this symmetric case.

2.4 Calculated Equilibria

Let us start with the case in which the merchant bank pays the agreed deposit rate regardless of the performance of its equity portfolio. For instance, this behavior can be rationally expected from it by the firm shareholders (who decide about the deposit amounts) if the government provides full guarantee. That is, we examine, so to say, an “Irish” type of policy.

Given the outside return rate i^0 and the commercial bank cost of funds, i, simple symmetric (i.e. with two identical firms and TFP A being the common aggregate productivity shock) equilibria of our model are pairs of lending rate r and merchant bank partnership size q^p variables jointly satisfying equations (2.7a) and (2.9). The economy is then characterized by fundamentals collected in the last column of Table 2.1 (all values are for one of the two identical representative firms). For comparison, in two additional columns we also show values of economic fundamentals in the cases when collateral diversification is restricted downwards away from the decentralized equilibrium: one with no collateral diversification (v=0) and another with low collateral diversification (v=0.1).

Apparently, total output is not particularly affected by the diversified funds approaching the optimal size. On the other hand, the survival probability increases and the TFP default threshold decreases. This can be attractive from the viewpoint of risk managers within firms, and provide strong support to the use of diversifying financial intermediary services.

An important thing to observe about the results shown in Table 2.1 is the merchant bank performance. Whereas individual firm default probabilities are less than 2% (a little higher if collateral diversification size is restricted) even when their TFP shocks are perfectly correlated, as we assume in this example, the merchant bank makes a negative profit even under a small deviation from the average TFP of unity. This fragility can be somewhat reduced when it is allowed to raise the size of its partnership to the optimal level, but still remains incomparable with those of its client firms: the latter safely survive when their common TFP falls to the level of 0.5, whereas the merchant bank becomes insolvent.

Insolvency of the merchant bank means that the loss must be taken by the government who provided the deposit guarantee. The expected size of official loss conditioned on the aggregate TFP falling below the merchant bank survival threshold, is shown in the last column of Table 2.1. Although it starts at a low level when collateral diversification and the implied leverage are low themselves (because the merchant bank balance sheet size is proportional to leverage), it reaches levels comparable to the economy’s aggregate output as soon as collateral diversification moves towards the decentralized equilibrium of the last column. If guarantees must be funded by additional tax revenue, the private sector’s net loss from collateral diversification behavior would likely exceed its benefits from optimal capital structure.

If collateral diversification entails such big tail risks to the public sector, can the firms do without it, given that the government may take steps to ban outside collateral altogether? The model suggests that attractions of collateral diversification behavior can be quite strong. One reason is the already mentioned reduction of default frequency in sectors that diversify. Another is even more fundamental and has to do with scarce equity capital.

Our next example concerns a pair of cases in which the foundation equity is lower compared to the q^h=2.7 value considered earlier. Let us allow for the existence of a standard market with the firm's shares, in which traders are small, risk-averse with negative exponential utility of final wealth, and have alternative investment opportunities beside the discussed firm stock, with an imperfect correlation of returns. The important thing is that these investors do not know the firm production function, just the statistics of its TFP, average revenue and costs, i.e. see the dividend defined in (2.4) as an affine function $Af+g$ truncated at zero due to limited liability at default, with no introspect into the structure of f and g. Being small, they do not internalize the effect of their investment on the firm's earnings (as opposed to the merchant bank with its private equity position). As a first step, we would like to know what amount of equity capital is this set of traders able to provide in equilibrium.

The results for the case of two identical firms in a symmetric equilibrium (i.e. $v=q^p$) are shown in the first column of Table 2.2. We see that the firm cannot be completely financed in the secondary stock market, i.e. there is a minimal positive value of foundation capital q^h for which both equity and credit markets clear. This is a variation of the classical CSV theme: investors without inside knowledge of the firm can provide only so much equity. The needed minimal q^h for the chosen stock market parameters is provided in the column head. As soon as the available foundation stock is lower, public traders are not enough, one needs additional private equity to get the firm operating, and the merchant bank becomes indispensible. In circumstances of scarce private equity, leverage through collateral diversification becomes attractive from the private sector perspective no matter what the public authority knows or thinks about the attached risks.

The first column of Table 2.2 was calculated under the natural assumption that there are no private equity partnerships beside the foundation stock (i.e. v=0). We call this case of stock market financing complete. If the number of publicly traded shares is normalized to unity (number in the last line), the penultimate two (equal) numbers of the same column give the total stock market financing and the share price. Next, let us allow for a non-zero participation of the merchant bank (positive v) in the presence of the same stock market. Since, from the stock market trader perspective there is no difference between equity provided in the form of foundation stock and private equity partnership (due to the assumed joint optimality behavior of inside shareholders, expressed by (2.9), only the sum $q=q^h+q^p$ matters), we fix the value $q^h=2$ for definiteness. Then, one can raise the value of v from zero to some level at which the outside stock market becomes redundant, i.e. the optimal level of equity capital $q^*=q^h+v^*$. The 2nd and 3rd columns of Table 2.2 describe the corresponding equilibria for the intermediate case of v=1 and the maximal v-level compatible with secondary stock trading (the exact number shown in the column heading).

Actually, the firm can now choose between raising private and public equity capital. In the lower part of Table 2.2 we show two corner alternatives: all-public (denoted *complete* stock market financing) and residual (denoted *incomplete*) public stock trading. Both alternatives are non-trivial only in intermediate cases (since $x^e=0$ when $q^p=q^*-q^h$ same as it was $x^e=1$ when $q^p=0$). We see that for v=1, publicly trading stock comprises less than 50 % of shares in the ***Complete*** case and less than 2.5% in the ***Incomplete*** case. For obvious reasons, residual public trading results in a higher stock price than the all-public trading.

Naturally, the size of possible partnership is not limited to the value q^*-q^h. It can grow further, as we agreed in Section 2.3.2, up to the total equity level, which becomes an endogenously determined quantity. This is the case of the entire foundation capital spent on diversified collateral, whereas own production is funded by commercial bank loans. In fact, the amount of deposits amassed by the merchant bank is now much bigger than required for optimal equity participations. Therefore, we assume for simplicity that the merchant bank invests excess funds outside the economy at the same rate as the one it pays to the firms, i.e. it makes no profit on this part of its portfolio. All profits it can make in expectation come from private equity partnerships. However, with growing deposit size servicing this liability becomes increasingly expensive, so that expected profits fall whereas the merchant bank default threshold in terms of aggregate TFP becomes precariously close to the average TFP value (of unity in our examples). That is, the resulting “crazy” leverage serviced by the merchant bank comes along with an extreme fragility of the latter, which the regulator should by all means prevent.

We go over to the third example which concerns a change in the definition of the merchant bank claims. As mentioned in the introduction, it may be infeasible, even though desirable in principle, to restrict merchant bank liabilities to common equity. So, we try out a hybrid solution that mandates conversion into equity only when the merchant bank becomes insolvent. In this CoCo liability regime, the firms do not have to solve the CSV problem in a high-earning merchant bank. On the other hand, they participate in the debt workout as bona fide shareholders when the merchant bank is in distress, meaning that, in bad times, they simply receive what little the economy (including the firm itself) in aggregate was able to earn, without additional losses associated with the merchant bank dissolution under a standard bankruptcy procedure.

When we say “bad times”, this means an intermediate outcome between the failure of the merchant bank and that of the firms. (When aggregate TFP falls below the corporate default threshold A^d, as defined by (2.6), everybody’s earnings are zero except for the commercial banks.) As could be seen in the last column of Table 2.1, reproduced as the first column in Table 2.3, the TFP default threshold of the merchant bank is much higher, so there is a whole range of TFP-realizations under which the firms can operate, i.e. repay their loans, even if the merchant bank cannot honor its deposit rate payments.

Complete quantitative results are shown in Table 2.3. Beside the 1st column carried over from Table 2.1, we show a hypothetical case of the merchant bank issuing liabilities in the form of equity only, in the 2nd column. Apparently, the change of legal status of the merchant bank liabilities has a very modest impact on major fundamentals (interest rate, credit, investment, and average output), at the same time as it eliminates, by construction, the huge conditional liability of the government associated with the merchant bank deposit guarantee. However, as mentioned earlier, if pure equity funding of the merchant banking sector is infeasible (e.g. for CSV and other asymmetric information-related reasons), the 3rd column shows a compromise with deposits transformed into equity only when the merchant bank does not earn enough to pay the deposits out in full. Also under this contractual change, most economic fundamentals move only slightly. There is marginally less investment, lower expected output and the lending rate going up by a couple of basis points. The survival probability of both firms same as the TFP default threshold imperceptibly increase. A somewhat more tangible change is visible in the quantity of diversified collateral (it is roughly 30 per cent higher under convertible than under guaranteed deposits), as well as in the default threshold of the merchant bank (it is about 14 per cent lower). Actually, when deposits are convertible, the default as such is not required, so that it is better to talk about the liability transformation threshold. The expected profit of the merchant bank is also higher in the conversion case than under official guarantees (note that profit is zero by construction in an equity-funded merchant bank). Most importantly, the merchant bank LGD, comparable to the size of economy-wide physical capital aggregate, now disappears, same as the associated contingent claim on the official bailout fund.

2.5 Discussion and Conclusion

We have defined a production economy in which attempts to diversify productivity risk on producer (micro) level result in elevated systemic (macro) risk due to the mechanism through which collateral is being transformed into private equity partnerships and concentrated in one sector of the financial industry (merchant banks) with a highly fragile balance sheet.

Merchant banks do not have to be fully competitive. They may pay fixed interest allowing for an economic profit, but still be fragile because what they pay is tied to what their depositors receive as prudential buffers. So, higher/lower buffers mean safer/riskier equity participations in the merchant bank portfolio, but have to be provided by the merchant bank itself in the form of interest payments to the same set of agents. The systemic merchant bank in this setting is not just a gainful enterprise but also a device holding together the equilibrium in the credit market. As such, it cannot make full use of, let alone abuse, its market power. An additional problem of interest in its own right would be of choosing an optimal deposit rate for the merchant bank who internalizes the impact of paid interest on the earnings of firms in its equity portfolio. We postpone this problem for future research but note that even the set of feasible deposit rates in such a problem would be relatively narrow. That is, the merchant bank is constrained in the ability to pay low rate for its funds to such a degree that it turns out to be very moderately profitable and is forced to operate quite close to the default boundary. Its high default probability becomes a natural concern of macroprudential regulation.

Leverage stemming from collateral diversification will hardly be voluntarily reduced to zero by the non-financial private sector since under scarce equity, its presence both provides better managerial incentives in firms and improves welfare. In certain cases, it can even be the only way to allow production financing as standard secondary stock market participation is limited by information barriers on the side of small shareholders.

However, what appears optimal from the micro perspective of a single enterprise can generate poorly sustainable leverage in aggregate. In principle, any amount of leverage reduces distance to default as long as one counts on the possibility of sudden deleveraging based on self-fulfilling collateral reappraisal. Such a reappraisal, in its turn, entails a very probable solvency crisis in the merchant bank sector since, as our examples have demonstrated, default thresholds of the latter are much easier to attain than in a standard non-financial firm. The destiny of investment banks in the U.S. in 2008-9 provides a good example of this.

Policy we know from the latest crisis would, in our environment, roughly correspond to merchant bank bailouts by government funds in order to prevent collateral destruction. This policy entails considerable fiscal costs and soon reaches its limit, as the current sovereign solvency problem in Europe has clearly demonstrated. Accordingly, one should look for alternatives, preferably such that, instead of a futile attempt to transfer losses from sector to sector as a hot potato, would return them to their originators. This is the mechanism of collateral back-conversion into the merchant bank equity, with which we formally experiment in this chapter. The results suggest that the formal effect of a simple legal status adjustment from plain deposits to CoCo deposits on aggregate economic indicators is likely to be of the second order compared to the quantitative benefit of eliminating the contingent public sector exposure one creates by an across-the-board deposit guarantee.

Convertible bonds instead of government-insured deposits reduce fragility and public loss risk, but preserve both the welfare level and Townsend's (1979) CSV regularity. Quantitatively, in our model firms holding merchant bank CoCos invest and produce almost identically with the earlier government guarantee case (this is, of course, a huge simplification due to our manager risk-neutrality assumption and the primitive merchant bank balance sheet structure), but expected fiscal costs are now zero as opposed to near half-GDP under guarantees.

In a small open economy, the adverse effect of international financial intermediary insolvency can be exacerbated if the real sector is the source of domestic GDP, whereas banks and their regulators are predominantly foreign, implying that they mostly care about gross investment and expected bank earnings on a consolidated basis. For this reason, macroprudential policies targeting a particular pattern of collateral diversification (in the notation of our model this is the ratio of v to q and the structure of the portfolio in which v is invested) can be important for systemic event propagation. In practice, explicit regulation of balance sheet composition of global systemically important financial institutions (SIFIs) is extremely cumbersome and costly for everyone, if possible at all. Therefore, the arrangement based on conversion into common stock can be an enormous simplification for small companies unable to bear legal representation costs in a multinational merchant bank resolution process. An international guarantee of their shareholder rights in the case of a SIFI insolvency is much easier, same as delegation of shareholder rights on a national principle to an official fiduciary agent. That is, instead of a long and uncertain search for a satisfactory international systemic risk containment mechanism, as one can currently observe, e.g. on the G20 level, a stepwise international harmonization based on support of shareholder rights seems a lot more feasible.

2.6 References

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2.7 Appendix

v:	0	0.1	0.404991
Lending rate	0.0757712	0.0732556	0.069355
Physical capital	13.6654	13.7408	13.656000
Total equity capital	2.7	2.8	3.104991
Average gross output	17.1668	17.2473	17.156800
Working capital loans	2.55836	2.51444	2.408040
Total loans	13.5394	13.5711	13.379800
Debt service	14.56529659	14.5652591	14.30776
Survival probability, firm	0.901305	0.928249	0.981900
Default threshold, firm	0.319907	0.272727	0.143834
Expected dividend	2.64068	2.81098	3.277320
Expected merchant bank profit	0	-0.00921571	0.00445542
Default threshold, merchant bank	0.98492915	0.98295585	0.623454
LGD of merchant bank	0	5.00129	27.3482

Table 2.1 Economic Fundamentals in a Asymmetric Equilibrium with Fully Guaranteed Deposits in the Merchant Bank

Notes: the foundation equity capital of each of the two identical firms is q^h=2.7. Outside investment rate of return is equal to 5 per cent, same as the merchant bank own deposit rate. The commercial bank cost of funds is 4 per cent. Data are shown for one of the two identical firms. LGD=Loss Given Default. The last column shows optimal private equity participation size.

q^h:	1.0286351	2		2		2
v:	0	1		1.06316		3.06023
	Minimal q^h for which equity finance suffices			*$v=q^p$, i.e. no outside equity needed*		*$v=q$, max allowed*
Lending rate	0.0675991	0.0683201		0.0683651		0.069773404
Physical capital	13.7016000	13.551		13.5417		13.2554
Total equity capital	3.0679157	3.06337		3.06316		3.06023
Average gross output	17.2055000	17.0446		17.0347		16.7286
Working capital loans	2.3910200	2.38065		2.38001		2.36008
Total loans	13.0247000	13.8683		13.9217		15.6155
Debt service	13.9051580	14.8157836		14.873458		16.705047
Survival probability, firm	0.9835150	0.982852		0.98281		0.981516
Default threshold, firm	0.1379920	0.140426		0.140576		0.145183
Expected dividend	3.3029400	3.28166		3.28035		3.23994
Merchant bank profit		0.04251625		0.04444839		0.01849962
Secondary equity market financing	*Complete*	*Complete*	*Incomplete (q^p-v)*	*Complete*	*Incomplete (q^p-v)*	
q^o	2.0392800	1.06337	0.0633700	1.06316	0	
p	2.0392800	2.33000	2.63417	2.32895	2.65199	
x^e	1	0.456384	0.0240583	0.456497	0	

Table 2.2 Economic Fundamentals in the Presence of Secondary Equity Market

Notes: the foundation equity capital of each of the two identical firms is q^h=2.7. The outside investment rate of return is equal to 5 per cent, same as the merchant bank own deposit rate. The commercial bank cost of funds is 4 per cent. Data are shown for one of the two identical firms. q^0 is the secondary stock market capitalization, x^e is the number of shares sold in the secondary market, p is the share price.

q^h=2.7	*Merchant bank deposits officially guaranteed*	*Merchant bank liabilities in equity form only*	*Merchant bank deposits converted into equity when insolvent*
v:	0.404991	0.402676	0.598661
Lending rate	0.069355	*0.069351*	0.0697665
Physical capital	13.656000	*13.6569*	13.5779
Total equity capital	3.104991	*3.102676*	3.298661
Average gross output	17.156800	*17.1577*	17.0733
Working capital loans	2.408040	*2.40809*	2.40342
Total loans	13.379800	*13.3807*	13.2969
Debt service	14.30776	*14.308665*	14.224578
Survival probability, firm	0.981900	*0.981904*	0.981523
Default threshold, firm	0.143834	*0.14382*	0.145161
Expected dividend	3.277320	*3.27744*	3.26608
Expected merchant bank profit	0.00445542	*0*	0.117892
Merchant bank profit under unit TFP	0.00366253	*0*	0.00498064
Default threshold, merchant bank	0.623454	*0*	0.546639
Expected revenue on diversified collateral	0.42746826	*0.425357475*	0.414181
LGD of the merchant bank	27.3482	*0*	0

Table 2.3 Economic Fundamentals when Merchant Bank Debt is Convertible into Equity

Notes: the foundation equity capital of each of the two identical firms is q^h=2.7. Outside investment rate of return is equal to 5 per cent, same as the merchant bank own deposit rate. The outside investment rate of return is equal to 5 per cent, same as the merchant bank own deposit rate. The commercial bank cost of funds is 4 per cent. Data are shown for one of the two identical firms. LGD=Loss Given Default.