Stress Testing and Corporate Finance *

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Abstract

The paper contributes to the literature on financial fragility, studying how macroeconomic shocks affect supply and demand in the corporate debt market. We take into account the effect of the competitive environment, as well as the risk level, measured by companies' default rate. The model is estimated using data from the Harmonised BACH database of corporate accounts for large euro area countries on the 1993-2005 period, in order to carry out an illustrative stress testing exercise. We measure the impact of large macroeconomic shocks (a severe recession and a sharp increase in oil prices) on the equilibrium in the debt market.

Key words : corporate finance, debt, financial fragility, stress tests, panel data
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In the last few years, "stress tests" have been applied to an increasing number of countries in order to assess the resilience of the financial system to large macroeconomic shocks (see Jones, Hilbers and Slack, 2004). The spirit of the exercise is to consider shocks that have a low -but non zero- probability of occurence, typically a large increase in interest rates, a severe recession hitting the economy, a large oil price shock or a significant foreign exchange shock, etc. One drawback of these tests is that they are rather mechanistic and do not take into account of feedback effects from financial institutions to the real economy.

In the paper, we propose a way to improve upon the way stress tests are usually carried out, concentrating on the corporate segment of the debt market in the euro area. Such a market is important in itself since loans by euro area financial institutions to non financial corporations amounted to 43% of euro area GDP in 2005. The innovation of the paper is to distinguish explicitly between the demand for debt by corporate firms, and the supply of debt, notably by financial institutions. Of course, such an analysis is useful to study the transmission mechanism of monetary policy to the corporate sector, through the effect on its financial structure. However, its relevance is more direct in the context of "stress tests". Indeed, the debt market is the major channel of transmission of macroeconomic shocks to the financial sector. We follow the "balance sheet approach" (Sorge and Virolainen, 2006), but this is an "extended portfolio approach" since we assume that risk is time-varying, even if it remains exogenous. However, by carefully distinguishing between supply and demand for debt, the analysis allows to improve significantly upon the usual practice for stress tests, where only demand factors are taken into account and the counter reaction of the financial sector to the real economy is not considered.

In the paper we derive the equilibrium in the corporate debt market in terms of the interest rate and the volume of debt by non financial corporations, estimating jointly a supply and a demand schedule for debt. While demand determinants (interest rates and activity variables) are rather standard, the modelling approach devotes significant attention to the supply side, with emphasis on the competitive conditions as well as on the risks faced by fund providers. Shocks to credit risks, by affecting the profitability of financial institutions may, as a consequence, also endanger financial stability (Davis and Stone, 2004, Ivaschenko, 2003).

To study the debt market, we rely on the EU Commission's Harmonised BACH database which provides detailed balance sheet and profit&loss accounts by sectors and size classes for several countries. Due to data availability, we concentrate on France, Germany, Italy and Spain on the 1993-2005 period.

The structure of the paper is the following. In section 1, we sketch the theoretical model and its testable implications, deriving the supply and the demand for debt by corporate firms. The data are presented in section 2. Section 3 discusses the empirical results. Section 4 illustrates how the model can be used for stress testing by considering the effect of a severe recession and an oil price shock.

1 Basic model

In this section we describe the supply and demand for debt, as well as the estimation of the equilibrium debt and interest rate. While the demand for debt is rather standard, we derive more precisely the supply of debt.

1.1 Demand for debt by corporate firms

Firms rely on various sources of funds to finance their activities and investment: own funds, equities, bonds and bank loans, and even commercial loans among companies. Here, the analysis concentrates on aggregate financial debt, which is the sum of bonds and bank loans, but we also take into account the existence of alternative sources of funds.

The economy is made of firms of different types $i = 1, ...I$. Demand for debt from a representative firm of type i results from cost minimisation among a variety of financial sources. Let firm of type i decide to finance an investment. For that purpose, it will rely on its net funds, complemented with debt. Net profits generate internal cash flow, hence reduce the demand for debt. In addition, according to Myers and Majluf (1984), if managers have information that external finance suppliers do not have, external finance signal bad information on the firm's prospects, so that firms are charged a premium. Firms are therefore induced to rely on external capital if they do not have internal resources ("pecking order theory"). The amount to finance is therefore Y_i = Investment minus own funds, which is produced as a combination of debt D and equity financing E, such that $Y_i = D_i^{\alpha} E_i^{1-\alpha}$ under the constraint of minimizing the cost of financial resources $r_i^D D_i + r_i^E E_i \leq R_i$ (r_i^D is the cost of debt and r_i^E is the cost of equity). This yields the demand for debt:

$$D_i = (\frac{r_i^E}{r_i^D})^{\alpha_0} Y_i,$$

or, in logarithms:

$$Log(D_i) = \alpha_0 Log(\frac{r_i^E}{r_i^D}) + Log(Y_i),$$

where $\alpha_0 = 1 - \alpha$. This is the so-called log-log specification.

An alternative specification, often encountered in the demand for money literature is the semi-log specification which is written as:

$$Log(D_i) = \alpha_1(\frac{r_i^E}{r_i^D}) + Log(Y_i). \quad (1)$$

Demand for debt is decreasing with r_i^D, but increasing in r_i^E and Y_i, the volume to finance. In what follows, we retain the latter specification.

Now, we focus on the supply of credit from banks.

1.2 Supply of debt

Regarding the supply of debt, one should, in principle, distinguish between bank loans and bonds. While the bond market is likely to be quite competitive, there is substantial evidence that bank credit markets are characterised by imperfect competition, where banks compete in Cournot fashion (see Monti Klein, 1971, Freixas and Rochet, 1995, Neven and Röller, 1999, Corvoisier and Gropp, 2002). However, it is also clear that, depending on their size, corporate firms face different financial constraints. While small firms do not have access to the bond market, the competitive conditions are likely to be identical in the bond market and in the large company segment of the credit market. We assume therefore that the supply for debt differs across company size segments, i. e. that small and large firms do not experience similar competitive conditions.

Each firm of type i faces a supply schedule $L_i(r_i^L)$, which is derived from profit maximisation by the monopolist bank in the credit market for small and medium size firms that do not have access to the bond markets (r_i^L is the cost of credit). Note that for large companies, there exists also a $L_i(r_i^L)$ schedule. However, our assumption that bond and credit market face similar competitive conditions, implies that $L_i(r_i^L) = D_i(r_i^D)$. Nevertheless, we keep the distinction between loan L and debt D at this stage.

One single bank can serve different types of firms, but we assume separability of costs between the different segments. Let $\mathbb{P}_i(L_i)$ be the expected profit of the bank serving segment i of the market, which is associated with the loan L_i:

$$\mathbb{P}_i(L_i) = r_i^L(1 - \pi_i^{fail})L_i - r^R L_i - C_i(L_i),$$

where r^R and $MC(L^i)$ are the short term refinancing cost for banks (the short term interest rate) and the marginal cost, respectively. The probability of default is noted π_i^{fail}, so that $1 - \pi_i^{fail}$ is the probability of success (the time index is omitted but all variables are time-varying). The optimality condition holds as:

$$\frac{\partial \mathbb{P}_i}{\partial L_i} = 0 \Longleftrightarrow r_i^L(1 - \pi_i^{fail}) + \frac{\partial r_i^L}{\partial L_i} L_i(1 - \pi_i^{fail}) - r^R - MC_i(L_i) = 0, \tag{1}$$

Banks are supposed to be symmetric, so that they have identical marginal cost schedules across markets they serve. Under the standard increasing and convex costs assumption, the first and second derivatives, respectively MC_L and MC_{LL} , are both positive.

One assumes that each bank faces a continuum of identical firms of a given type i, so that one can just consider the average loan L_i to firms of type i (nevertheless banks may have different supply schedule to different types of firms and discriminate between firms of different types), so that, for type i firms, the previous equation can be rewritten as:

$$r_i^L = -\frac{\partial r_i^L}{\partial L_i} L_i + \frac{r^R + MC_i(L_i)}{(1 - \pi_i^{fail})}$$

and using the approximation $(1 - \pi_i^{fail})^{-1} = (1 + \pi_i^{fail})$ for π_i^{fail} small, one gets:

$$r_i^L = -c_{isl} + (1 + \pi_i^{fail})(r^R + MC_i(L_i)), \tag{2}$$

where c_{isl} is equal to $\frac{\partial r_i^L}{\partial L_i} L_i = \frac{\partial r_i^L}{\partial Log L_i} < 0$ which is constant in the semi-log specification.

1.3 Estimating the supply and demand equilibrium

We describe now the regression to be implemented and give some details on the estimation methods.

1.3.1 Supply and demand regressions

Using the arbitrage condition in the segment of debt to large companies, the demand for debt is estimated as (notice that in principle, all the coefficients may be individual specific, although depending on the empirical method used, one needs to put more constraints on the coefficients) :

$$Log(D_{it}/P_t) = \gamma_{10i} + \gamma_{11} Log(Turn_{it}) + \gamma_{12} Inv_{it} - \gamma_{13} Roa_{it} + \gamma_{14} r_{it}^D + \epsilon_{it}^d, \qquad (3)$$

with $Turn_{it}$ and Roa_{it} are companies' sales growth and net profits, respectively. Net profits have a negative effect on borrowing. Higher sales growth are also likely to require more debt to finance the expanded activity level. We also introduce a indicator of investment structure, namely the investment ratio. (investment/sales) Inv_{it} : a higher investment ratio is more likely to raise the demand for debt.

Concerning supply, we need to assume a parametric form for $MC_i(D_{it}) = \alpha + \beta Log(D_{it}/P_t)$, the form of which is indifferent as long as it is an increasing function of D_{it}.

Moreover, as indicated below, for lack of data we need to assume that the default probability does not depend on individual i; it only depends on time (and the country) : π_t^{fail}.

The supply function is thererefore specified with the following structural form:

$$r_{it}^D = \gamma_{20i} + \gamma_{21}(1 + \pi_t^{fail}) r_t^R + \gamma_{22}(1 + \pi_t^{fail}) + \gamma_{23}(1 + \pi_t^{fail}) Log(D_{it}/P_t) + \epsilon_{it}^s. \qquad (4)$$

$\gamma_{20i} = -c_{isl}$ is the interest margin, which is expected to be positive if r_{it}^D is correctly measured. More importantly, the interest margin is also expected to be decreasing with the size of the company, due to higher competition in the larger company segment of the debt market. Several functional form are possible to model the dependence of the margin on the size of the company. We assume a linear relationship as $\gamma_{20i} = \mu_i + \gamma Size_{it}$ and introduce directly the $Size$ variable in the supply equation. The coefficients γ_{22} and γ_{23} are also positive because of the properties of the cost function. Moreover, one expects the coefficient γ_{21} to be close to 1.

Notice that, in a simultaneous equation system, one should also impose the cross-equation constraint:

$$\frac{\partial r_{it}^D}{\partial Log D_{it}} = (\gamma_{14})^{-1} = c_{sl} = -\gamma_{20} < 0.$$

At this stage, the constraint has not been imposed and this is reserved for future work.

Note that the interest rate at which banks are willing to supply loans is an increasing function of the reference rate r_t^R. It is also increasing in the debt volume D_{it}, the default probability π_t^{fail}.

1.3.2 Estimation methods

Regarding estimation, our approach is static and neglects at this stage the existence of possible serial correlations. However, we face two more crucial econometric problems: (i) the existence of simultaneity in a supply/demand system and (ii) the need to take into account of heterogeneity in a panel context.

Regarding the issue of simultaneity, the estimation of a joint supply/demand system raise the classical problem of endogeneity. If endogenous variable are used as regressors, they are, in general, not independent of the error terms, so that OLS is biased. To avoid this problem, we use an instrumental variable method, where the estimates of the parameters are Two Stage Least Square (2SLS) estimates, obtained as follows:

- in a first step, one regresses the endogenous variables on all exogenous variables by OLS;
- in a second step, one estimates by a Least Square method the parameters of the regression after replacing the RHS endogenous variable by its estimate from the first step.

It is well known that 2SLS estimates are the best way to deal with the endogeneity problem when the system is just identified or over identified. Notice that in our case, the system is overidentified. In addition, to recover the structural parameters, we proceed with two types of specification:

- a non-structural one, where demand and supply are explained by the relevant fondamentals, the list of which is selected according to regression (3) and (4), respectively for demand and supply;
- a structural one, where regressions (3) and regression (4) are implemented directly and explicitly. In the latter case, the supply regression (4) is derived from the structural equation (2).

Regarding the use of panel data, we consider both fixed effects and random effects models. More precisely, for the fixed effects specification, we implement the Within-2SLS method (hereafter noted as W2SLS), while, for the random effects models, we computed the EC2SLS (Error Component 2SLS) and the G2SLS (Generalized 2SLS) estimates of the parameters.

The EC2SLS estimates are obtained as a weighted average of the "Within-2SLS" and the "Between-2SLS" estimates, with weights depending on the respective variance-covariance matrices of both estimates (Baltagi, 2001). The G2SLS estimates (Balestra and Varadharajan-Krishakumar, 1987) involve instrument variables optimally transformed according to the variance matrix of the residuals of the estimated equation. It differs from the EC2SLS by the choice of instrumental variables that are used, but both have the same asymptotic Variance-Covariance matrix.

The classical Hausman (1978) test allows to distinguish between fixed or random effects models. Baltagi (2006) suggests a generalisation of such a test in the presence of endogeneity (FE2SLS *vs* RE2SLS, or in our case W2SLS *vs* EC2SLS).

2 Data

The analysis of the euro area corporate debt market is based on the EU Commission's Harmonised BACH database, which provides harmonised balance sheet and profit and loss accounts for different countries. The data are annual and available according to a breakdown by industrial sectors and three size classes (small/medium/large[1]). Due to data availability, only corporate firms in France, Germany, Italy and Spain are used on the 1993-2005 period. In the empirical analysis, each class i is therefore a country-sector-size triplet. The 12 sectors that are selected are manufacturing (excluding energy), construction, wholesale and retail trade.[2] It is important to note that the database does not provide individual data but aggregates, i.e. sums over the companies belonging the class. Indicators in level are therefore expressed in terms of averages over the number of companies belonging to the class, while indicators in ratios are computed with aggregate items, which are the only information available (hence they are ratios of averages and not average ratios). While this may be seen as a drawback, it is actually one of the strengths of the BACH database, since entry/exit of individual companies are taken care of, through the availability of overlapping samples. Indicators in growth rates are therefore computed on samples that are constant over two successive years. All in all, the analysis is based on a sample of 144 triplets (i.e. $12 \times 3 \times 4$) observed over 12 years (we lose a year when computing growth rates), hence a total of 1728 observations. The following indicators are computed:

- **Det**, total financial debt (in logarithms, average value, divided by the GDP deflator);
- **Int**, interest burden in % of total financial debt (r^D in section 1);
- **Turn**, year-on-year growth of sales;
- **Inv**, investment ratio, measured as financial debt divided by total assets;
- **Roa**, measured as net profits divided by total assets.

In addition, with respect to the model presented in equation (4), we include two other variables:

[1]Small firms have an anual sales below 7 Million euros, medium firms are between 7 and 40 Million euros of annual sales, and large firms have sales above 40 Million euros.

[2]Manufacture of food products, beverages and tobacco, manufacture of wood and wood products, manufacture of pulp, paper and paper products, manufacture of chemicals, chemical products and man-made fibres, manufacture of rubber and plastic products, manufacture of other non metallic products, manufacture of basic metals and fabricated metal products, manufacture of machinery and equipment n.e.c., manufacture of elecrical and optical equipment, manufacture of transport equipment,manufacturing n.e.c., construction, wholesale and retail trade..

- **Gar(i),** indicator assessing the amount of collateral available to the company, measured by the ratio of "Tangible fixed assets+stocks" to "total assets". This is a further risk factor that is often found in the empirical finance literature (see Kremp and Sauve, 1999): the amount of collateral, i. e. the garantees pledged by the borrower provide to the lender, is likely to have a positive effect on debt, or, equivalently, a negative effect on the interest charges. Such a variable is more likely to affect small and medium sized firms and the variable is interacted with a size dummy for small companies ($Gar1$) or medium-sized companies ($Gar2$).[3] It is expected that the constraint on collateral effect is larger for small than for medium sized companies, so that the coefficient on $Gar1$ is negative and larger in absolute value than for $Gar2$.
- **Size,** measured by average total assets (in logarithms). Here, the variable is designed to measure the impact of competition on the banks' margin -which should be decreasing with the size the borrower. If the market is more competitive for larger companies, the margin of debt suppliers should be smaller- we introduce the total size of the balance sheet as indicator of size. The coefficient associated with $Size$ is expected to be negative.

For lack of detailed data at the sector-size level on the corporate default rates π_{it}^{fail} for all countries over the whole sample,[4] we use aggregate data by country. For France, we rely on data from Insee, while data for the other countries are provided by a rating agency (see Euler-Hermes, 2006). The number of bankruptcies is divided by the number of companies as published by Eurostat. We also introduce the three month interest rate, in annual average, to measure the refinancing cost for banks (r^R in the previous section).

3 Empirical results

We now proceed with the estimation of the model. We first consider the non structural model where all the relevant variables enter in each of the two equations derived in section 1. We then discuss the results from estimating the structural model derived in that section 1. In each case, we consider different estimation methods: W2SLS, EC2SLS and G2SLS.[5]

Several specification tests are carried out. First, we run Hausman tests to assess whether the heterogeneity across groups (i. e. our country-sector-size triplets of companies) rather comes from differences in average values (for which the fixed effect would be more appropriate) or from differences in the coefficients (hence leading to the choice of a random effect estimator).[6] In addition, for the fixed effect model, we test whether the different intercepts are significantly different from zero.

[3] See above for the definition of the size classes.

[4] See Nahmias (2005) for data with a sector-size breakdown for France over the last part of the sample. The paper also deals with the delicate issue of computing default rates, ie due the difficulty of to find consistent data of number of bankruptcies and companies, due to the tendency of companies that are experiencing difficulties to stop reporting information.

[5] Results were obtained with the help of STATA 9.1.

[6] The statistic of the Hausman test is distributed as $\chi^2(k)$ with k the number of variables, so that fixed effect is accepted when it is larger than the threshold value.

The results are the following:

- Hausman tests cannot distinguish between the fixed effect and the random effect model for the demand equation, while fixed effects are strongly accepted for the supply equation.
- Consistently across specifications and estimation methods, the empirical fit of the supply equation appears to be better than that of the demand equation.
- Demand equations are consistent with the structural model described in section 1. Structural supply equations estimated by W2SLS exhibit coefficients of the correct sign and order of magnitude.
- Fixed effects in the supply equation, which measure the interest margin of fund suppliers, notably financial institutions, indicate that the degree of competition is higher for large than for small companies.

We now go through the results in greater detail.

3.1 Non Structural model

Regarding the non structural model, we discuss two models which are rather similar, the only difference is the presence of interactions with the amount of collateral ($Gar1$ and $Gar2$). These models provide a first run at the data without identification constraints on the coefficients.

With respect to the model discussed in section 1 and 2, equations are correctly specified, in the sense that the coefficients of both demand and supply equations exhibit the expected sign, but only in the W2SLS and G2SLS cases. The demand equation is usually adequately specified but in the EC2SLS case, with or without $Gar1/Gar2$, the model fails to identify a proper supply equation, in particular a significantly positive effect of the Det variable, which measures the upward sloping Marginal Cost Function. Otherwise, sales growth and the investment ratio have a positive effect on demand and the profit rate a negative effect. The refinancing rate r^R and the default rate π_t^{fail} have a positive effect on the interest rate charged on debt.

Table 1: Non structural Model[a]

	Fixed effects model		Random effects model			
	W2SLS		EC2SLS		G2SLS	
	Det	r^D	*Det*	r^D	*Det*	r^D
r^D	-2.771^{***} (0.544)	—	-2.857^{***} (0.509)	—	-2.798^{***} (0.511)	—
Det	—	0.012^{**} (0.005)	—	-0.018^{***} (0.003)	—	0.004 (0.004)
Turn	0.464^{***} (0.107)	—	0.472^{***} (0.093)	—	0.470^{***} (0.094)	—
Inv	2.049^{***} (0.437)	—	2.030^{***} (0.263)	—	2.038^{***} (0.263)	—
Roa	-4.219^{***} (0.402)	—	-4.211^{***} (0.278)	—	-4.210^{***} (0.278)	—
r^R	—	0.817^{***} (0.03)	—	1.016^{***} (0.018)	—	0.958^{***} (0.021)
π^{fail}	—	0.916^{***} (0.098)	—	0.575^{***} (0.054)	—	0.497^{***} (0.056)
Size	—	-0.029^{***} (0.006)	—	0.015^{***} (0.003)	—	0.002 (0.004)
Const.	15.874^{***} (0.054)	0.321^{***} (0.041)	15.882^{***} (0.145)	0.041^{***} (0.007)	15.877^{***} (0.143)	0.052^{***} (0.007)
R^2	0.259	0.764	0.259	0.773	0.259	0.770
$H_{\chi^2(k)}$	—	—	0.000	97.43^{***}	0.000	101.06^{***}
$F_{(k-1,n-k)}$	1038^{***}	9.28^{***}	—	—	—	—

Notes :***indicates significance at 1% level; ** at 5% and * at 10%;
[a] Firm and time effects are not reported here;
Numbers in brackets denote standards errors (White's robust std err. for W2SLS);
W2SLS: within two-stage least squares method; EC2SLS:error-component two-stage least squares method; G2SLS: generalized two-stage least squares method;
$H_{\chi^2(k)}$ denotes the Hausman test fixed effects (W2SLS) *vs* Random effects (EC2SLS or G2SLS);
$F_{(k-1,n-k)}$ denotes the Fisher test that all fixed effects are equal to 0.

As indicated in Table 1, the demand equation adequately exhibits in all cases a negative and significant coefficient on the regression of *Det* on interest rate r^D. The coefficient associated with r^D in the demand equation is around -2.8 (-2.771 for W2SLS, -2.857 for EC2SLS, -2.798 for G2SLS), so that an increase in the cost of debt by 100 basis points (bp) triggers decrease in real debt by 2.8 %. All estimation methods find very similar estimates for the parameters of the demand equation. However, the EC2SLS model fails to exhibit a proper supply/demand system, since the coefficient associated with *Det* in the supply equation is negative instead of the expected positive sign. The coefficient associated with the short term nominal interest rate r^R is close to one in the random effect models, while it is around 0.8 for the W2SLS, and, in the latter case, the equality of the coefficient to 1 is rejected given the low standard errors. Nevertheless, the interpretation of the supply equation in terms of interest margin behavior, i.e $r^D - r^R$, implies that the margin is a decreasing function of the level of r^R, indicating that competition is more acute with higher nominal interest rates r^R. One observes rather similar coefficients in the supply equation except concerning the coefficients of π_t^{fail} which ranges from 0.916 (W2SLS), 0.575 (EC2SLS) and 0.497 (G2SLS), and also for the coefficient of the *Size* variable, which is only negative for the W2SLS model. The fixed effect model appears therefore as the only one to be well specified.

Table 2 : Non structural Model with collateral variables[a]

	Fixed effects model		*Random effects model*			
	W2SLS		*EC2SLS*		*G2SLS*	
	Det	r^D	*Det*	r^D	*Det*	r^D
r^D	-2.802^{***} (0.544)	—	-2.890^{***} (0.508)	—	-2.865^{***} (0.510)	—
Det	—	0.016^{***} (0.005)	—	-0.005 (0.004)	—	0.015^{***} (0.005)
Turn	0.465^{***} (0.107)	—	0.474^{***} (0.093)	—	0.473^{***} (0.093)	—
Inv	2.046^{***} (0.436)	—	2.026^{***} (0.263)	—	2.029^{***} (0.263)	—
Roa	-4.220^{***} (0.402)	—	-4.211^{***} (0.278)	—	-4.210^{***} (0.278)	—
r^R	—	0.805^{***} (0.030)	—	0.960^{***} (0.022)	—	0.869^{***} (0.028)
π^{fail}	—	0.934^{***} (0.062)	—	0.450^{***} (0.060)	—	0.284^{***} (0.069)
Size	—	-0.033^{***} (0.006)	—	-0.001 (0.005)	—	-0.024^{***} (0.006)
Gar1	—	-0.066^{***} (0.021)	—	-0.038^{***} (0.010)	—	-0.075^{***} (0.012)
Gar2	—	-0.044^{*} (0.026)	—	-0.034^{***} (0.007)	—	-0.059^{***} (0.009)
Const.	15.877^{***} (0.054)	0.340^{***} (0.042)	15.886^{***} (0.144)	0.128^{***} (0.023)	15.883^{***} (0.143)	0.218^{***} (0.028)
R^2	0.259	0.759	0.259	0.773	0.259	0.751
$H_{\chi^2(k)}$	—	—	0.000	91.19^{***}	0.000	1433^{***}
$F_{(k-1,n-k)}$	1038^{***}	8.72^{***}	—	—	—	—

Notes :***indicates significance at 1% level; ** at 5% and * at 10%;
[a] Firm and time effects are not reported here.
Numbers in brackets denote standards errors (White's robust std err. for W2SLS).
W2SLS: within two-stage least squares method; EC2SLS:error-component two-stage least squares method; G2SLS: generalized two-stage least squares method.
$H_{\chi^2(k)}$ denotes the Hausman test fixed effects (W2SLS) *vs* Random effects (EC2SLS or G2SLS);
$F_{(k-1,n-k)}$ denotes the Fisher test that all fixed effects are equal to 0.

When the collateral variables Gar1 and Gar2 are introduced (see Table 2), all estimation methods still find very similar estimates for the parameters of the demand equation. For the supply equation, the W2SLS and G2SLS methods identify a well specified positively sloped Marginal Cost function, with a positive coefficient associated with *Det*. However, this coefficient is not significantly different from zero in the EC2SLS case. One also continues to observe the same similarity of coefficients across methods for the supply equation except concerning the coefficients of π_t^{fail}, which varies from 0.934 (W2SLS), 0.450 (EC2SLS) and 0.284 (G2SLS). The $Size$ variable in the supply equation has now the appropriate negative sign for all three models, providing evidence in favour of greater competition in the larger company segment of the debt market.

The Gar1 and Gar2 variables, introduced as a additional measure of risk in the supply equation, have the correct sign and order of magnitude (respectively -0.066 and -0.044 for W2SLS, -0.038 and -0.034 for EC2SLS, -0.075 and -0.059 for G2SLS), since the collateral requirement is expected to be more severe for small than for medium sized firms.

All in all, these results could indicate that the condition of independence of the unobserved individual effects and the exogenous variables is not satisfied in all cases. Thus the Random effect estimates could be inconsistent. However, the "within" transformation leaves the W2SLS estimate consistent and unbiased so that we only retain the W2SLS estimation for the supply/demand system. Notice that in Table 1 and 2, the coefficient of the $Size$ variable in the supply equation is negative with the W2SLS method, providing evidence that the degree of competition in the debt market is higher for large company than for small companies.

3.2 Structural model

In order to estimate the structural model, as given in equation (7), we need to introduce additional variables, namely: $(1+\pi_t^{fail})r_t^R$, $(1+\pi_t^{fail})$ and $(1+\pi_t^{fail})Log(D_{it}/P_t)$. Such a non linear model is non standard, since there is not perfect symmetry in the supply/demand system, as estimated in the previous subsection (in that subsection, Det_{it} and r_{it}^D appeared directly in the supply and demand equations, while $(1+\pi_t^{fail})Det_{it}$ now appears on the LHS of the structural supply equation). This is, however, feasible for the W2SLS model as well as for the random effect specifications. It implies nevertheless that the reduced form model derived from the structural model would be non linear, since the elasticity of the endogenous to the exogenous variables would depend on π_t^{fail}. On the basis of our theoretical model (equation (4)) which is more consistent with a fixed effect specification, and on the basis of our previous results providing evidence that the W2SLS is consistently well specified and accepted by the Hausman test, we decide therefore to concentrate on that model. We provide in annex A1 the results on the same model estimated with EC2SLS and G2SLS.

Table 3 : Fixed effects estimation of structural Models $(W2SLS)^a$

	without collateral variables		*with collateral variables*	
	Det	r^D	Det	r^D
r^D	-2.805^{***} (0.545)	—	-2.838^{***} (0.545)	—
$\widetilde{Det}$	—	0.012^{**} (0.005)	—	0.016^{***} (0.005)
$Turn$	0.466^{***} (0.106)	—	0.467^{***} (0.107)	—
Inv	2.045^{***} (0.437)	—	2.041^{***} (0.436)	—
Roa	-4.220^{***} (0.402)	—	-4.221^{***} (0.402)	—
$\widetilde{r}^R$	—	0.811^{***} (0.030)	—	0.800^{***} (0.030)
$\widetilde{\pi}^{fail}$	—	0.70^{**} (0.144)	—	0.655^{***} (0.143)
$Size$	—	-0.028^{***} (0.006)	—	-0.033^{***} (0.006)
$Gar1$	—	—	—	-0.065^{***} (0.021)
$Gar2$	—	—	—	-0.044^{*} (0.026)
$Const.$	15.878^{***} (0.054)	-0.371^{**} (0.156)	15.881^{***} (0.054)	-0.308^{*} (0.159)
R^2	0.259	0.763	0.259	0.758
$F_{(k-1,n-k)}$	1038^{***}	9.20^{***}	1038^{***}	8.67^{***}

Notes : ***indicates significance at 1% level; ** at 5% and * at 10%;
Numbers in brackets denote White's robust standards errors.
^{a} Firm and time effects are not reported here.
W2SLS: within two-stage least squares method.
$F_{(k-1,n-k)}$ denotes the Fisher test that all fixed effects are equal to 0.
$\widetilde{Det} = (1+\pi^{fail})Det$; $\widetilde{r}^R = (1+\pi^{fail})\times r^R$ and $\widetilde{\pi}^{fail} = (1+\pi^{fail})$.

Looking more in detail at the results of Table 3, the two models estimated by W2SLS -with or without collateral ($Gar1/Gar2$)- provide a well specified demand/supply system, with all coefficients of the expected sign. In particular, the coefficient associated with $(1+\pi_t^{fail})r_t^R$ -which measures the margin over the refinancing rate- as well as $(1+\pi_t^{fail})$ and $(1+\pi_t^{fail})Det_{it}$ -which measure the Marginal Cost- are all positive. The value of the coefficient associated with $(1+\pi_t^{fail})r_t^R$ provides information on the negative effect of the level of refinancing rate on the expected margin defined as $\left[r^D-(1+\pi^{fail})r^R\right] \approx (1+\pi^{fail})\left[(1-\pi^{fail})r^D-r^R\right]$ for $\pi^{fail}\simeq 0$. It appears that the effect is close to 0.8-1=-0.2. Here again, higher interest rates imply a lower margin, which may be associated with higher competive pressures. Both Gar1 and Gar2 variables are significant.

The Tables A1 and A2 in the Annex indicate that the results are rather similar across models, whatever the estimation method, confirming the robustness of our results One should note, however, the negative sign on $(1+\pi_t^{fail})Det_{it}$ when $Gar1/Gar2$ are excluded for the random effect models. With the $Gar1/Gar2$ variables $(1+\pi_t^{fail})Det_{it}$ is significant with the correct sign for the G2SLS model.

We now discuss more in details, the negative effect of the $Size$ variable in Table 3. As indicated before, the interest margin that can be derived from the supply side equation is decreasing with the size of the company, since competition is more acute for large companies than for small companies. To verify that it is indeed the case for our sample, we provide in Table 4 statistics on the distribution of the fixed effect by groups of companies. The μ_i coefficient is the fixed effect from the model estimated in Table 3 and we take averages across the three size classes (i. e. small/medium/large). As can be verified, the overall average across the three class sizes is exactly equal to zero.[7] Given the large standard errors, it appears that the size class averages of the μ_i coefficients are not significantly different from zero and from each other. More importantly, it should be remembered that this fixed effect is computed from a model where we include the Size variable on the RHS, so that it does not provide the value of the interest margin γ_{20i} as defined in equation (4). Under the assumption that the $Size$ variable is uncorrelated with the other exogenous variables, one can compute the implied γ_{20i} coefficients as $\gamma_{20i} = \mu_i + \widehat{\gamma} Size_{i.}$, where $\widehat{\gamma}$ is the coefficient associated with $Size$ in Table 3 and $Size_{i.}$ is the average of the $Size$ variable for the companies of type i (i.e. the triplet i).[8] The mean and distribution of the γ_{20i}'s is provided in the bottom row of Table 4. It is clear from the bottom row that the interest margin is decreasing with the size class. Indeed the class average for small companies is -0.50 while it is -0.60 for large firms, when the collateral variable is included. Even taking into account the size of the standard deviations, the difference is statistically significant (this is only true at the 10% level, when the collateral variable is excluded). This provides evidence that the market for corporate debt is more competitive for the large companies.

Table 4 : Distribution of fixed effects (Supply function)

	model without collateral			*model with collateral*		
Size category	*Small*	*Medium*	*Large*	*Small*	*Medium*	*Large*
μ_i	-0.0290 (0.0211)	-0.0070 (0.0157)	0.0360 (0.0205)	-0.0155 (0.0201)	-0.0040 (0.0148)	0.0195 (0.0215)
γ_{20i}	-0.4593 (0.0160)	-0.4859 (0.0134)	-0.5138 (0.0187)	-0.5044 (0.0144)	-0.5481 (0.0124)	-0.6051 (0.0205)

Numbers in brackets denote standards deviations.

γ_{20i} are fixed effects defined in (4) with $\gamma_{20i} = \mu_i + \gamma Size_{i.}$.

4 Stress testing exercice

In order to illustrate how the model can be used for stress testing, we derive the equilibrium in the debt market and consider two "stress scenarios" that are used to shock the exogenous

[7] The μ_i coefficients are the difference with respect to the overall average, which appears as "Const" in Table 3. The fact that the intercept is negative may be due to measurement errors on r^D(if Int from BACH under-estimates the true value of the interest charges)..

[8] See Annex A3 for details.

variables. The scenarios are calibrated on the basis the Banque de France MASCOTTE macroeconometric model (see Baghli et al., 2004, as well as Fagan and Morgan, 2006) and the NIESR's Nigem model. Based on the responses of the macroeconomic variables (real GDP and its deflator, companies investment/value added, growth of value added in nominal terms, gross operating surplus/capital stock) to the initial shocks, we use bridge equations to shock the exogenous variable of the reduced form of our structural model.[9]

The two scenarios considered are as follows (see de Bandt and Oung, 2004, for details):

- a significant reduction in world demand (originating in the US), leading to a recession in the euro area;
- an increase in oil prices (+70%) with monetary a policy reaction to counteract secound round effects on inflation.

Technically, the exogenous variables are shocked from the level of the last observation available, namely the year 2007, assuming the shock is persistent and takes place at the beginning of the year (in the first quarter, since MASCOTTE and NIGEM are quarterly models).[10] The impact is measured in percentage change for Det (since it is expressed in logarithms) and basis point of Int. The impact elasticities are given by the coefficients of the reduced form model as indicated in table 5 and 6. These coefficients are non linear functions of the structural parameters of the supply and demand equations (they are also a non linear function of $(1+\pi^{fail})$ for the reduced form derived from the model in table 3). Standard errors on the impact can be computed with the "Delta method", using the variance-covariance of the residuals in each structural equation.[11]

4.1 Non structural model

We use the structural model with collateral to compute the multipliers.

Table 5 : Coefficients of the reduced form of non structural model

	$Turn$	Inv	Roa	r^R	π^{fail}	$Size$	$Const.$
Det	0.449	1.983	-4.083	-2.191	-2.456	7.78×10^{-2}	14.503
r^D	5.39×10^{-3}	2.38×10^{-2}	-4.90×10^{-2}	0.791	0.886	-2.81×10^{-2}	0.495

[9] The bridge equations, not reported here but available upon request, link Inv to the ratio of companies investment/value added; Turn to the growth of nominal value added, Roa to the ratio Gross Operating Surplus/Capital stock, and π^{fail} to (inverted) real GDP growth.

[10] The shock is considered as deviation from a macroeconomic baseline scenario for projections made for 2007.

[11] The 95% confidence bound is only computed in the case of the structural model (see section 4.2). This implies computing the reduced form coefficients r of the structural model. Since the reduced form coefficients (or the elasticity of debt and interest rate to the exogenous variables) are non linear functions of the structural coefficients s, the standard errors are computed as $C\Sigma C'$ with C the matrix $\partial r(s)/\partial s'$ and Σ is the covariance matrix of the structural coefficients, as available in Table 3. We only assume that the structural coefficients are uncorrelated between the supply and the demand equation, so that Σ is actually a block-diagonal matrix.

Applying these multipliers to the historical value of the exogenous variables (this constitutes the reference scenario), one can derive stressed values of the exogenous variables, hence the new equilibrium values for Det and r^D. Table 6 provides the new values of the exogenous variables in response to the stress (see line "scenario 1-stressed values" and "scenario 2-stressed values"). Summing up the contribution of the different exogenous variables one can determine the new equilibrium values. Note that the $Size$ and Gar variables are unchanged and do not appear in the table for the non structural model.

Table 6: Non structural model - impact of the stress scenarios on equilibrium Det and r^D

	$Turn$	Inv	Roa	π^{fail}	r^R	Det	r^D
Value in 2005	0.040	0.030	0.045	0.012	0.022	16.96	0.050
Scenario 1: stressed values	-0.031	0.031	0.041	0.019	–	–	
Impact on Det (in % points)	-3.206	0.033	1.734	-1.744		**-3.183**	
Impact on r^D (in basis points)	-3.847	0.040	2.081	62.942			**61.216**
Scenario 2: stressed values	0.042	0.031	0.046	0.012	0.030		
Impact on Det (in % points)	0.058	0.067	0	-0.077	-1.753	**-1.701**	
Impact on r^D (in basis points)	0.070	0.080	0	2.659	63.26		**66.066**

From Table 6, it appears that the scenario 1 of recession implies an increase of borrowing requirements due to lower Roa, which is more than offset by a lower turnover and higher risk for banks (with higher default rate), which decrease supply. The final effect is that real debt decreases by 3.2%, while the debt burden (r^D) increases by 61 basis points (bp). In the second scenario, the oil price shocks is associated with an increase in the short term interest rate r^R by the Central Bank (by 70 bp) in order to offset the second round effects on inflation which triggers, according to MASCOTTE and NIGEM a decrease in GDP growth by 0.15%. It leads to a slightly higher default rate, but the main negative effect on Det (-1.7%) comes through the increase in r^R. It induces an increase in the interest burden r^D by 66 bp.

4.2 Structural model

It is also possible to compute the reduced form from the structural model of Table 3 (we choose the one without Gar1/Gar2 variables), which gives results that are qualitatively similar. It should be mentioned that solving such a model yields a reduced form model, which has a non linear structure. In particular, as indicated in Annex A2, all elasticities are functions of $(1+\pi^{fail})$. It implies that they are not constant, even if $(1+\pi^{fail}) \simeq 1$ for $\pi^{fail} \simeq 0$. In that case, the Size variable as well as the intercept, which now has a non linear multiplier, matter. But as indicated below, they incorporate the effect of the default rate π^{fail}. When running the stress testing exercise, we assume that the structural model estimated on the 1993-2005 period is stable, hence still valid for 2007. In addition, in our baseline scenario, $\pi^{fail}(2007) = \pi^{fail}(2005)$ is assumed to hold, although we could also make forecasts for $\pi^{fail}(2007)$.

Table 7a : Structural model - impact of the stress scenarios on exogenous variables

	$Turn$	Inv	Roa	π^{fail}	r^R	$Size$	$Cst.$
Value in 2005	0.040	0.030	0.045	0.012	0.022	16.96	1
Scenario 1: stressed values	-0.031	0.037	0.041	0.019	0.022	16.96	1
Impact on Det (in % points)	-3.217	0.032	1.736	-1.303	-0.033	-0.029	-0.378
Impact on r^D (in basis points)	-3.918	0.090	1.964	0.829	1.176	1.061	59.12
Scenario 2: stressed values	0.042	0.031	0.046	0.0121	0.0298	16.96	1
Impact on Det (in % points)	0.0585	0.066	0.000	-0.055	-1.783	-0.001	-0.016
Impact on r^D (in basis points)	0.072	0.083	-0.006	0.035	63.55	0.045	2.498

Table 7a below provides the impact of our two "stressed scenarios" on the different exogenous variables. This is equivalent to the five first columns of Table 6. Table 7b is equivalent to the last two columns of Table 6 and provides the final impact on Det and r^D but includes also the upper bound and the lower band of the 95% confidence interval on the final final on these variables. Table 7b indicates that scenario 1 yields a decrease in debt by 3.2% which only differs from the non structural model at the second decimal point; in addition, interest rates increase by 60.3 bp, against 61.2 bp previously. For scenario 2, the results are even closer: a decrease in debt by 1.73% (1.70% previously), and an increase in interest rates by 66,3 bp (66,1 bp previously). In the latter case, the largest contribution to the changes comes from the increase in the Central Bank's refinancing rate. The 95% confidence interval is rather large, but confirms the hypothesis that both scenarios lead to an economically and statistically significant reduction in debt. The decrease in debt is between -4.16% and -2,16% in scenario 1 and between -2.51% and -0.95% in scenario 2.

Table 7b : Structural model - total impact of stress scenarios on Det and r^D

	Impact on Det (in % points)	Impact on r^D (in basis points)
Scenario 1:	**-3.160**	**60.320**
Confidence Intervals[(1)]		
Lower bounds	-4.160	29.269
Upper bounds	-2.160	91.375
Scenario 2:	**-1.730**	**66.277**
Confidence Intervals[(1)]		
Lower bounds	-2.510	60.747
Upper bounds	-0.949	71.736

[(1)] Confidence Intervals was constructed using the DELTA Method.

Looking more in detail into the contributions of the different exogenous variables, the large contribution of π^{fail} to r^D in the non structural model is consistent with the large role of the intercept in the structural model, which implies also a significant impact of π^{fail}. The elasticity to the intercept actually depends on π^{fail} since it is $((1+\pi^{fail})^{-1}+0.03366)^{-1}$ so that an increase of the default rate by 1 percentage point, from 1,20% to 2.20%, implies an increase in r^D by almost 1%. In the demand scenario, the default rate increases from 1.20% to 1.92%, explaining a significant impact of the increase in the default rate on r^D.

5 Conclusion

In the paper we model the impact of macroeconomic shocks on the equilibrium in the corporate debt market, introducing the effect of competitive conditions (we provide evidence of a stronger competitive environment in the segment for large than small companies) as well as credit risk. Although risk is exogenous in our analysis, we explicitly measure how the equilibrium depends on time-varying risk in the economy. This provides a richer analysis of the debt market, as well as a way to measure the second round effect of stress tests. By measuring supply effects, one comes closer to an assessment of feedback effects from the financial sector to the real sector from shocks initiating in the real sector. The results from the illustrative stress tests that we run in the last section, indicate that the equilibrium depends on the change in the default rate. In particular, in the first scenario of recession, the suppliers of capital, and financial institutions among them, raise interest rates in order to take into account the increase in the default rate. Such an effect is both statistically and economically significant.

However, as already mentioned, the risk factor remains exogenous to the financial sector, while it may, to some extent, depend on credit distribution (an increase in debt is likely to bring a more than proportional increase in risk). Further work should therefore attempt to determine jointly the evolution of debt and risk.

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A Annex

A.1 Variants on the structural model

Table A1 : Structural Model without collateral variables[a]

	Fixed effects model		Random effects model			
	W2SLS		EC2SLS		G2SLS	
	Det	r^D	*Det*	r^D	*Det*	r^D
r^D	-2.805^{***} (0.545)	—	-2.892^{***} (0.510)	—	-2.833^{***} (0.512)	—
$\widetilde{Det}$	—	0.012^{**} (0.005)	—	-0.018^{***} (0.003)	—	-0.004 (0.004)
Turn	0.466^{***} (0.106)	—	0.474^{***} (0.093)	—	0.471^{***} (0.094)	—
Inv	2.045^{***} (0.437)	—	2.026^{***} (0.263)	—	2.033^{***} (0.263)	—
Roa	-4.220^{***} (0.402)	—	-4.211^{***} (0.277)	—	-4.210^{***} (0.278)	—
$\widetilde{r}^R$	—	0.811^{***} (0.030)	—	1.01^{***} (0.018)	—	0.952^{***} (0.021)
$\widetilde{\pi}^{fail}$	—	0.70^{***} (0.144)	—	0.805^{***} (0.078)	—	0.524^{***} (0.093)
Size	—	-0.028^{***} (0.006)	—	0.015^{***} (0.003)	—	0.002 (0.004)
Const.	15.878^{***} (0.054)	-0.371^{**} (0.156)	15.886^{***} (0.145)	-0.767^{***} (0.082)	15.880^{***} (0.143)	-0.472^{***} (0.097)
R^2	0.259	0.763	0.259	0.772	0.259	0.769
$H_{\chi^2(k)}$	—	—	0.000	97.89^{***}	0.000	101.42^{***}
$F_{(k-1,n-k)}$	1038^{***}	9.20^{***}	—	—	—	—

Notes : ***indicates significance at 1% level; ** at 5% and * at 10%;

[a] Firm and time effects are not reported here.

Numbers in brackets denote standards errors (White's robust std err. for W2SLS).

W2SLS: within two-stage least squares method; EC2SLS:error-component two-stage least squares method; G2SLS: generalized two-stage least squares method.

$H_{\chi^2(k)}$ denotes the Hausman test fixed effects (W2SLS) *vs* Random effects (EC2SLS or G2SLS);

$F_{(k-1,n-k)}$ denotes the Fisher test that all fixed effects are equal to 0.

$\widetilde{Det} = (1+\pi^{fail})Det$; $\widetilde{r}^R = (1+\pi^{fail}) \times r^R$ and $\widetilde{\pi}^{fail} = (1+\pi^{fail})$.

Table A2 : Structural Model with collateral variables[a]

	Fixed effects model		*Random effects model*			
	W2SLS		*EC2SLS*		*G2SLS*	
	Det	r^D	*Det*	r^D	*Det*	r^D
r^D	-2.838^{***} (0.545)	—	-2.926^{***} (0.510)	—	-2.900^{***} (0.511)	—
$\widetilde{Det}$	—	0.016^{***} (0.005)	—	-0.005 (0.004)	—	0.015^{***} (0.005)
$Turn$	0.467^{***} (0.107)	—	0.475^{***} (0.094)	—	0.474^{***} (0.093)	—
Inv	2.041^{***} (0.436)	—	2.021^{***} (0.263)	—	2.024^{***} (0.263)	—
Roa	-4.221^{***} (0.402)	—	-4.212^{***} (0.278)	—	-4.211^{***} (0.278)	—
$\widetilde{r}^R$	—	0.800^{***} (0.030)	—	0.954^{***} (0.022)	—	0.862^{***} (0.028)
$\widetilde{\pi}^{fail}$	—	0.655^{***} (0.143)	—	0.496^{***} (0.104)	—	0.021 (0.133)
$Size$	—	-0.033^{***} (0.006)	—	-0.005 (0.004)	—	-0.024^{***} (0.006)
$Gar1$	—	-0.065^{***} (0.021)	—	-0.038^{***} (0.010)	—	-0.075^{***} (0.012)
$Gar2$	—	-0.044^{*} (0.026)	—	-0.033^{***} (0.007)	—	-0.060^{***} (0.009)
$Const.$	15.881^{***} (0.054)	-0.308^{*} (0.159)	15.889^{***} (0.144)	-0.037^{***} (0.123)	15.887^{***} (0.143)	0.204 (0.160)
R^2	0.259	0.758	0.259	0.773	0.259	0.750
$H_{\chi^2(k)}$	—	—	0.000	90.87^{***}	0.000	2324^{***}
$F_{(k-1,n-k)}$	1038^{***}	8.67^{***}	—	—	—	—

Notes :***indicates significance at 1% level; ** at 5% and * at 10%;

[a] Firm and time effects are not reported here.

Numbers in brackets denote standards errors (White's robust std err. for W2SLS).

W2SLS: within two-stage least squares method; EC2SLS:error-component two-stage least squares method; G2SLS: generalized two-stage least squares method.

$H_{\chi^2(k)}$ denotes the Hausman test fixed effects (W2SLS) *vs* Random effects (EC2SLS or G2SLS);

$F_{(k-1,n-k)}$ denotes the Fisher test that all fixed effects are equal to 0.

$\widetilde{Det} = (1+\pi^{fail})Det$; $\widetilde{r}^R = (1+\pi^{fail}) \times r^R$ and $\widetilde{\pi}^{fail} = (1+\pi^{fail})$.

A.2 Deriving the reduced form model

From table 3, the demand/supply system can be written as:

$$\begin{cases} Det = 15.878 - 2.805 r^D + 0.466 Turn + 2.045 Inv - 4.220 Roa \\ r^D = -0.371 + 0.012(1+\pi^{fail}) Det + 0.811 \times (1+\pi^{fail}) r^R + 0.70(1+\pi^{fail}) - 0.028 Size \end{cases}$$

Starting from the demand equation, and substituting r from the supply equation, one gets:

$$Det = \frac{1}{(1+0.03366(1+\pi^{fail}))} \times (0.0785\, Size - 4.22 Roa + 0.466 Turn - 2.275(1+\pi^{fail}) r^R - 1.963(1+\pi^{fail}) + 2.045 Inv + 16.919)$$

Similarly, starting from the supply equation and substituting Det from the demand equation:

$$r^D = \frac{1}{(1+0.03366(1+\pi^{fail}))} \times (0.890(1+\pi^{fail}) - 0.028 Size + 2.45 \times 10^{-2}(1+\pi^{fail}) Inv - 5.06 \times 10^{-2}(1+\pi^{fail}) Roa + 0.811(1+\pi^{fail}) r^R + 5.59 \times 10^{-3}(1+\pi^{fail}) Turn - 0.371)$$

$(1+\pi)$ appears in almost all multipliers, but one should keep in mind that $1+\pi \simeq 1$, for $\pi \simeq 0$. One can also factor this expression as :

$$r^D = \frac{(1+\pi^{fail})}{(1+0.03366(1+\pi^{fail}))} \times (0.890 - 0.028 \frac{Size}{1+\pi^{fail}} + 2.45 \times 10^{-2} Inv - 5.06 \times 10^{-2} Roa + 0.811 r^R + 5.59 \times 10^{-3} Turn - 0.371 \frac{1}{1+\pi^{fail}})$$

Table A3 : Coefficients of the reduced form model for $\pi^{fail} = \pi^{fail}_{2005}$

	$Turn$	Inv	Roa	r^R	$Size$	$Const.$
Det	0.451	1.978	-4.081	-2.226	7.59×10^{-2}	14.44
r^D	5.47×10^{-3}	2.40×10^{-2}	-4.95×10^{-2}	0.793	-2.71×10^{-2}	0.512

In Table 7, we provide the results of stresses on the equilibrium value of Det, r^D which are computed as:

$$Det(stressed) - Det(2005) = G((\pi^{fail}(stressed),\ Z(stressed)) - G(\pi^{fail}(2005),\ Z(2005))$$
$$r^D(stressed) - r^D(2005) = F((\pi^{fail}(stressed),\ Z(stressed)) - F(\pi^{fail}(2005),\ Z(2005))$$

where Z are the exogenous variables and $F(.)$ and $G(.)$ are non linear functions of the estimated coefficients of the structural model, as well as π^{fail}.

A.3 Appendix 1: the fixed effects in the model and the size effect

In the structural model, there is no size variable, while we have introduced one in the regression. The point is to link the structural parameter γ_{20i} to the estimates obtained from the regression.

Let us assume that, in the regression, we have a X_1 variable (for sake of simplicity, we suppose that it is unique) and a size variable X_2.

The Within estimates satisfy:

$$\widehat{\beta_{0i}} = \overline{y_i} - \widehat{\beta_1}\overline{x_{1i}} - \widehat{\beta_2}\overline{x_{2i}} \tag{A1}$$

where $\overline{z_i}$ denotes the average value: $\overline{z_i} = \frac{1}{T}\sum_t z_{it}$.

If variable X_2 were omitted in the regression, one would get:

$$\widehat{\alpha_{0i}} = \overline{y_i} - \widehat{\alpha_1}\overline{x_{1i}} \tag{A2}$$

so that the fixed effect $\widehat{\alpha_{0i}}$ in the simple model should obey:

$$\widehat{\alpha_{0i}} = \widehat{\beta_{0i}} + (\widehat{\beta_1} - \widehat{\alpha_1})\overline{x_{1i}} + \widehat{\beta_2}\overline{x_{2i}} \tag{A3}$$

Averaging the previous equations over the individuals gives:

$$\widehat{\alpha_0} = \widehat{\beta_0} + (\widehat{\beta_1} - \widehat{\alpha_1})\overline{\overline{x_1}} + \widehat{\beta_2}\overline{\overline{x_2}} \tag{A4}$$

where $\overline{\overline{x_1}} = \frac{1}{N}\sum_i \overline{x_{1i}}$

Accordingly, one can write that the structural parameter γ_{20i} should be estimated with $\widehat{\alpha_{0i}}$. Substracting A4 from A3:

$$\widehat{\gamma_{20i}} = \widehat{\alpha_{0i}} = \widehat{\alpha_0} + \widehat{\mu_i} + (\widehat{\beta_1} - \widehat{\alpha_1})(\overline{x_{1i}} - \overline{\overline{x_1}}) + \widehat{\beta_2}(\overline{x_{2i}} - \overline{\overline{x_2}}) \tag{A5}$$

with $\widehat{\mu_i} = \widehat{\beta_{0i}} - \widehat{\beta_0}$

If one can neglect the term $(\widehat{\beta_1} - \widehat{\alpha_1})(\overline{x_{1i}} - \overline{\overline{x_1}})$, if the regression is unaffected by the introduction of the X_2 variable, one can compute $\widehat{\gamma_{20i}} \simeq \widehat{\mu_i} + \widehat{\beta_2}(\overline{x_{2i}} - \overline{\overline{x_2}})$.

One finds $\widehat{\beta_0} = -0.371$. Moreover, averaging the previous equations inside three classes (corresponding to small, medium and large sizes) gives:

$$\widehat{\mu}^{(1)} = -0.0290, \widehat{\mu_2}^{(2)} = -0.0070, \widehat{\mu_2}^{(3)} = 0.0360$$

so that the $\widehat{\mu}^{(j)}, 1 \leq j \leq 3$, are not significantly different from 0.

One has $(\overline{x_2^{(1)}} - \overline{\overline{x_2}}) < 0$ and $(\overline{x_2^{(3)}} - \overline{\overline{x_2}}) > 0$.(since average size is, respectively, bigger (resp. smaller) than average for the larger (resp. smaller) firms. Moreover, one obtains a negative $\widehat{\beta_2}$.

Accordingly, $\gamma_{20}^{(1)}$ is expected to be greater (resp. $\gamma_{20}^{(3)}$ to be smaller) than its overall mean α_0. As a consequence, the interest margin γ_{20i} appears to be a decreasing function of the size.