Review of Economics & Finance
Submitted on 12/05/2015
Article ID: 1923-7529-2015-04-60-18
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The Role of Banks as Producers of Information: Can It Survive Competition and Cross-Selling Incentives?

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Abstract: This paper studies the impact of competition on lending behaviour and cross-selling incentives of banks in a spatial competition model of the banking sector where positively evaluated loan applicants are more likely to buy other services from their lending bank. Overall our model suggests that the more competition increases in the loan market, the more the banking system is encouraged to move towards non-traditional activities and the less credit is information-based. This undesired effect of competition in the loan market may have contributed in the past to the excessive risk-taking behaviour of European banks and could hamper the stability of the financial system in the future.

Keywords: Bank-firm relationships, Screening, Cross-selling, Spatial competition

JEL Classifications: D43, D82, G21, L15

1. Introduction

The European banking system has deeply changed since the Nineties. The diffusion of Information and Communication Technologies (ICTs) has been accompanied by a process of deregulation taking place both in Europe and in United States and by a process of harmonisation and internationalisation across European Union (EU). The use of ICTs in the banking sector has facilitated the internationalisation of banks' activity while also affecting the distribution strategies of banks. Deregulation has favoured the entrance of new actors challenging banks in their intermediation activity and intensifying the competitive pressure. Banks have been losing their relative share of financial intermediation to institutional investors (investment funds, insurance companies and pension funds).

These important technological and institutional changes in the banking environment have been accompanied by a significant process of concentration, by decreasing interest margins and by a significant increase in banks' non-interest incomes[1].

Several empirical studies have investigated the consequences of banks' diversification on risk, using different methodologies. Contrary to conventional wisdom most of them find a positive significant relationship between diversification and some indicators of banks' risk (DeYoung and Roland 2001; Stiroh 2004; Lepetit, et al. 2008a; Cosci, et al. 2009). Moreover, the financial crisis showed that many banks do not perform effectively their traditional role of producers of imperfect information about borrowers through their screening activity.

While there is empirical evidence of increasing competition, increasing diversification and increasing risk in the banking sector, we are not aware of any theoretical model assessing whether and how these aspects interrelate. Are more competitive lending markets leading banks to diversify towards non-traditional cross-selling activities? What are the consequences of cross-selling on banks' incentives to screen loan applicants accurately?

The aim of this paper is to study the impact of competition in the lending market on cross-selling and of the latter on banks' screening incentives. Other studies have investigated the impact of more competition in the lending market on banks' incentives to produce imperfect information about their borrowers[2]. Example are given by Caminal and Matutes (2002) and Freixas (2005) showing that more competition in the banking industry reduces banks' monitoring effort and Manove, et al. (2001), Cetorelli and Peretto (2000) and Hauswald and Marquez (2006) showing that more competition weakens banks' incentives to screen borrowers. On the opposite Boot and Thakor (2000) and Yafeh and Yosha (2001) prove that, when competition grows, the profitability of market finance falls more than that of relationship loans, leading the bank to raise relationship lending at the expense of transaction lending. Villas-Boas and Schmidt-Mohr (1999) show that with less competition banks may screen credit applicants less intensively. From an ex ante perspective Gehrig (1998) shows that the relationship between the degree of competition and the screening effort is ambiguous, depending on the decision of banks to detect good and bad investment projects.

We suggest a possible indirect effect of competition on screening incentives, via the increase in the profitability of services. In a recent paper, Cosci, et al. (2009) show that, in a duopoly model of the banking sector with asymmetric information where banks provide loans and sell services to borrowers, an increase in cross-selling reduces banks' optimal screening effort. We extend that model to allow for spatial competition in order to investigate the effect of competition on the expected profitability of cross-selling and the effect of cross-selling on banks' incentives to produce information about borrowers[3]. We define cross-selling as a bundling strategy based on the assumption that, once a loan applicant gets a loan, she becomes a warm customer, i.e. it is easier to

[1] According to some studies banks have responded to the increased potential competition by consolidating in the attempt to reap efficiency gains (see, e.g., Berger, et al. 2004). At the same time, according to some authors (Allen and Santomero 2001; DeYoung and Rice 2004), many banks have reacted to higher competition in the lending market by widening the range of products they offer. Williams and Rajaguru (2013) find empirical evidence of a stable relationship between Australian banks' fee-income and margin income, indicating that increases in fee-income are being used to supplement declines in margins.

[2] Also see Carletti and Hartmann (2003) for a survey on the literature on financial stability and competition.

[3] We build on Cosci, et al. (2012) that use the same spatial competition model in order to take into account possible complementarities between screening and cross-selling activities.

sell her other services different from loans. All the loans are packaged with other services that will be bought by the customer with a positive probability so that the relationship with a borrower has a marketing value for the bank and the bank must consider the cost of rejecting loan applicants when choosing the optimal screening effort.

Under these assumptions the profitability of services increases with the number of positively evaluated loan applicants (borrowers) per bank. Therefore the impact of competition on the profitability of cross-selling depends on how competition affects the equilibrium number of banks in the market and the number of positively evaluated loan applicants. In our setting, by reducing expected profits from lending, more competition in the lending market among existing banks leads to a more concentrated banking system, as in standard Salop competition models, and affects the number of positively evaluated borrowers in a way that depends on the composition and heterogeneity of the projects pool. Overall we show that increasing competition in the lending market may affect positively the banks' expected profitability of selling services, so that cross-selling may be an optimal response to a more competitive lending market. Furthermore cross-selling has, also in this context, a negative impact on the optimal screening effort.

The paper is organised as follows. Section 2 describes the recent trends in the European banking system. Section 3 presents the basic set-up of the model and in Section 4 equilibrium results are determined. Section 5 analyses the effect of competition in the lending market on the profitability of cross-selling. Finally Section 6 draws the main conclusions of the paper.

2. Transformation of the European Banking System: Some Evidence

During the last two decades the European banking system has gone through a deep transformation characterised by the following main facts:

i) The information revolution changed the distribution strategies of banks making geographical distances less important and the environment more competitive. The use of ICTs in the banking sector has facilitated the internationalisation of banks' activity while also affecting the distribution strategies of banks. European Central Bank (2008) identifies three main developments in the distribution strategies of banks favoured by the adoption of the new technologies. First, branches have been redesigned in terms of location and services offered to clients in order to make them more cost-efficient and more integrated with the new distribution channels used by banks. Second, electronic channels, used not only for providing information and transaction services, but also for the promotion and sale of banking products, have grown rapidly. Third, banks have gradually increased their cooperation with third parties, such as retailers, financial companies and financial services groups.

ii) During the last decade European banks have experienced a significant process of consolidation[4], as indicated by a substantial decrease in their number and by the increase in both the share of total assets of the five largest credit institutions and the Herfindahl index for credit institutions' total assets. This process, documented by data reported in table 1, has been accompanied by a decrease in net interest margin in most European countries[5].

[4] Berger (2003) argues that this process has been fostered by the adoption of ICTs.

[5] Claessens and Laeven (2004) find that lower entry barriers, greater deregulation, the presence of foreign banks and a greater market concentration are associated with higher competition. Amel, et al. (2004) and Sapienza (2002) find that banks' mergers increased concentration but also increased the degree of competition.

iii) The weight of non-interest income on banks' total income has increased significantly. Revenue from non-interest income activities in the main European countries[6] was 20% in 1987 but 44% by 2006 (Bolt and Humphrey 2008). Data reported in table 1 show that also after the financial crisis the weight of non-interest income on total income in Continental Europe's main countries remains high.

iv) An interesting evidence emerging in the economic literature is that the increases in fee-income have been accompanied in Europe by increased variability in profits and worsening in bank risk-return trade-off. Schmid and Walter (2009) find that bank income diversification is value-reducing. Baele, et al. (2007) find that over-exposure to fees increases European bank risk. Lepetit, et al. (2008a, 2008b) find evidence of a negative correlation between interest margin and non-interest income for 602 European banks during the period 1996-2002. The authors assume that banks use loans as a loss leader to expand their non-interest income via cross-selling. They document that European banks accept lower loan portfolio returns and higher loan risk to obtain higher commission and fee-income. Cosci, et al. (2009) show, using banks' balance sheet data for a sample of six European countries over the period 2001-2006, that the higher is the banks' share of commission income (a proxy for banks' diversification into non-interest income, and in particular services' income) the lower is the quality of banks' loans.

Table 1. Banking structure indicators

Indicators	Italy	Germany	France	Spain	Belgium	In Year
Number of Credit Institutions (CIs) *	909	3,420	1,258	416	131	1997
	801	2,225	939	348	108	2003
	611	1,734	579	204	39	2013
Share of total assets of the five largest CIs (%) *	25	17	40	32	54	1997
	27	22	47	44	83	2003
	40	31	46	56	64	2013
Herfindahl index for CIs' total assets (ranging from 0 to 10,000) *	201	114	449	285	699	1997
	240	173	597	521	2,065	2003
	406	266	551	757	979	2013
Net interest margin (%) **	2.27	1.34	1.17	1.90	1.23	1998
	1.70	0.98	1.07	2.31	1.73	2003
	1.37	0.77	0.90	1.62	1.35	2011
Bank's non-interest income/total income (%) **	32	35	46	34	33	1997
	50	54	52	32	25	2003
	45	47	41	27	24	2010

Source: *ECB Banking Structures Report (2004) and (2014); **World Bank, retrieved from FRED, Federal Reserve Bank of St. Louis, https://research.stlouisfed.org/fred2/series/, March 11, 2015.

Summarising, during the last 25 years the ICT revolution has changed the distribution strategies of banks making geographical distances less important and the environment more competitive. European banks have experienced a significant process of consolidation while interest margins have decreased. The weight of non-interest income on banks' total income has risen significantly but this seems to have increased loan risk. In order to explain these stylised facts we develop a theoretical model of banks' lending behaviour where banks offer loans and also other services different from loans to their borrowers. We argue that banks have moved towards non-

[6] Spain, UK, Italy, Germany, France, Netherlands, Sweden, Norway, Belgium, Finland and Denmark.

traditional cross-selling activities as an optimal response to increased competition in the lending market, while weakening banks' screening incentives and worsening the quality of their portfolios of loans.

In order to capture the role of the information revolution in the transformation of European banking system we model the lending market as a Salop spatial competition where transportation costs are the source of banks' market power. A decrease in transportation costs make geographical distances less important and the market more competitive. Another appealing feature of standard Salop competition models is that lower transportation costs (lower market power) lead to more concentrated markets. In this set-up we investigate the effect of increased competition (lower transportation costs) on lending interest rates and on the profitability of cross-selling activity.

3. The Set-up of the Model

We build on the model of Cosci, et al. (2012), where in a Salop model of spatial competition a continuum of borrowers (firms) is located uniformly (with density 1) and n banks are located symmetrically around a unit circle. All the agents are risk-neutral. Each borrower has to finance an investment project with one unit of loanable funds. Since firms have no private funds, they borrow from a bank. Travelling to banks is costly for borrowers, which is the source of the banks' market power. In particular, each firm, when granted a loan, incurs a transportation cost $\gamma > 0$ for unit of length.

Firms' projects generate a random return $y(z)$ characterised by a random binary variable $y(z) \in \{0, z\}$. Projects can be either good (G) or bad (B), where the probability of yielding the positive return z of good projects is p_G and the probability of success of bad projects is $p_B < p_G$. Firms are informed about the quality of their projects but banks are uninformed, and the return z cannot be observed on the basis of ex ante screening[7].

The proportion of good projects (for which $p_G z > r_f$, where r_f is the risk-free interest rate) in the population is $\theta \in [0,1]$ and is common knowledge. Bad projects are dominated by the safe capital market investment so that $p_B z < r_f$ and are observationally indistinguishable from good ones without some screening activity.

Since firms are protected by limited liability, demand for credit occurs if the net expected outcome from borrowing and investing is non-negative[8] and a firm j ($j = G, B$) located at distance $x \in [0, 1/n]$ from a typical bank i will apply to bank i if its net expected outcome from borrowing from bank i is not less than that from borrowing from bank i+1 (or i-1):

$$p_j (z - r_i) - \gamma x \geq p_j (z - r_0) - \gamma \left(\frac{1}{n} - x \right) \tag{1}$$

where r_i denotes the interest rate offered to borrowers by bank i[9] and r_0 denotes the interest rate offered by bank i's neighbour competitors (banks i+1 and i-1).

[7] This assumption prevents banks from offering loan interest rates that induce borrowers self-selection.

[8] Borrower j's participation constraint $p_j(z-r_i)-\gamma x \geq 0$ always holds for sufficiently high levels of z. We assume that the return z is 'large enough' so that both good and bad borrowers will always apply for loans at the prevailing interest rate.

[9] Banks cannot determine the location of the loan applicants and therefore no location-based price-discrimination is feasible.

Condition (1) with equality gives firm *j*'s indifference condition between bank *i* and bank *i*+1 (or *i*-1):

$$p_j(z-r_i)-\gamma x = p_j(z-r_0)-\gamma\left(\frac{1}{n}-x\right) \tag{2}$$

Since in the population there are θ good firms and 1-θ bad firms, each bank's demand for loans (2*x*) is given by:

$$L_i=\frac{1}{n}-\frac{p}{\gamma}(r_i-r_0) \tag{3}$$

where $p\equiv\theta p_G+(1-\theta)p_B$ is the average success probability in the population. The demand function (3) states that the lower the transportation cost for unit of length γ and the higher the average success probability p, the higher is the sensitivity of loans demand to interest rate differentials. Note that for $r_i=r_0$ we have $L_i=1/n$.

Banks have access to competitive capital markets, where they issue bonds at the risk-free interest rate r_f. Each bank has a fixed cost of installation K. Market power derives from transportation costs: as it is usual in spatial model of imperfect competition, transportation costs can be used as proxy for the degree of competition in the credit market.

Banks face an informational problem in their lending decision as they do not know the exact type of their potential borrowers. They have access to an imperfect screening technology to detect good and bad projects. In particular, the screening of loan applicants yields an imperfect signal $s\in\{b,g\}$ about borrower type and we assume that banks accept borrowers when they observe a good signal and reject borrowers when they observe a bad signal[10]. Denoting by $e\in[0,1]$ the bank's effort in the screening activity, we define $\alpha(e)=\text{Prob}(g|G,e)$ as the acceptance probability for truly good borrowers (i.e. the probability of correctly observing a good signal) and $\beta(e)=\text{Prob}(g|B,e)$ as the acceptance probability for truly bad borrowers (i.e. the probability of erroneously observing a good signal). Accordingly, imperfect screening generates a type-I error with probability $1-\alpha(e)$ and a type-II error with probability$\beta(e)$. The higher is the bank's effort in screening e, the higher is the ability of the bank to recognise good projects with $\alpha'(e)>0$, $\alpha''(e)\leq 0$, and bad projects with $\beta'(e)<0$, $\beta''(e)\geq 0$. If banks do not screen, they do not get any information beyond the known distribution of population so that $\alpha(0)=\theta$ and $\beta(0)=1-\theta$, while at intensity 1 the screening technology is completely informative so that $\alpha(1)=1$ and $\beta(1)=0$. Finally screening is a costly activity with total cost $C(e)$ and marginal cost $C'(e)$. We assume that total cost of screening is strictly convex, with $C'(e)>0$, $C''(e)>0$, $C(0)=0$, and $\lim_{e\to 1} C'(e)=\infty$[11].

We denote by $A(e)\equiv\alpha(e)\theta+\beta(e)(1-\theta)$ the selection ratio, measuring the percentage of loan applicants that are positively evaluated by banks, and thus become borrowers, and by $B(e)\equiv\alpha(e)\theta p_G+\beta(e)(1-\theta)p_B$ the expected ratio of successful borrowers, measuring the percentage of loan applicants that become borrowers and are successful. Screening can either increase or decrease the selection ratio and the expected ratio of successful borrowers depending on the distribution of borrower types in the population and on the characteristics of the screening technology. The share of successful borrowers over all borrowers $Q(e)\equiv B(e)/A(e)$ is a measure of the quality of the bank's loans and results to be increasing in the screening effort.

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[10] Screening of loan applicants typically takes the form of creditworthiness tests, that we model here as in Gehrig (1998).

[11] The latter assumption implies that *e*=1 will never be optimal for the bank.

Each bank is a multiproduct firm selling loans and also a given number S of other services. For each service other than loan the bank pays fixed and variable costs. We assume that the variable cost is negligible so that we can consider only the fixed cost that is included in the installation cost K[12]. Firms that are not financed by banks buy services from other suppliers. Since there are many specialised institutions selling services, we assume that the bank is price-taker in the service market, where it sells the given number S of services at the given price v[13]. We denote by $\sigma \equiv vS$ the (given) income from services. We also assume that the probability q to sell a service to a borrower is larger than the probability of selling a service to a non-customer which, for simplicity, we normalise to zero. Since we are interested in studying the interaction between screening and cross-selling, we assume that the expected revenue from services ($q\sigma$) is small enough that banks will never be willing to finance bad projects: $p_B z + q\sigma < r_f$. There are no information synergies between screening and cross-selling activities. Finally we assume that borrowers pay for services also in case of default out of the loan[14].

The structure of the game is as follows. In the first stage banks simultaneously set the equilibrium screening effort and interest rate so as to maximise expected profits, and firms apply for loans. In the second stage banks screen loan applicants and extend credit at the announced rate to positively evaluated loan applicants (borrowers). In the third stage banks offer services at the given price v and sell them to borrowers with probability q. Services, if bought, are paid at this stage. Finally borrowers run their projects, returns are realised, and, in case of success, the loan is paid off, otherwise the loan is defaulted and the bank will receive nothing.

4. Equilibrium Results

We focus on symmetric equilibria in which all the banks choose the same screening effort and interest rate[15]. Each bank i sets the screening effort and the lending interest rate so as to maximise expected profits:

$$\pi_i^e = L_i\left[\alpha(e_i)\eta_G(r_i) + \beta(e_i)\eta_B(r_i) - C(e_i)\right] - K \qquad (4)$$

where L_i is the demand function (3) and $\eta_G(r_i)$ and $\eta_B(r_i)$ denote the unconditional expected profitabilities, including the cross-selling activity, from lending, respectively, to good and bad firms:

$$\begin{aligned} \eta_G(r_i) &\equiv \theta(p_G r_i - r_f + q\sigma) > 0 \\ \eta_B(r_i) &\equiv (1-\theta)(p_B r_i - r_f + q\sigma) < 0 \end{aligned} \qquad (5)$$

[12] In this model services are exogenous. We can, therefore, imagine that the bank chooses ex ante the number of services to sell and incurs the fixed costs of organising the service activity.

[13] Since the model is aimed at studying how competition affects banks' lending behaviour through its impact on banks' incentives to cross-sell services, we are not concerned with modelling the price of services nor determining the optimal number of services. In this set-up the banks' price-taking assumption, although unrealistic, does not change the results of the model.

[14] We are aware that some financial services like, for example, underwriting activity are state-contingent but this is not the case for many other services.

[15] See Appendix A for derivation and properties of the equilibrium results.

Proposition 1. *In the symmetric equilibrium the optimal level of screening effort e^* satisfies:*

$$\frac{1}{n}[\alpha'(e^*)\eta_G(r^*)+\beta'(e^*)\eta_B(r^*)-C'(e^*)]=0 \tag{6}$$

In equation (6) the sum of the first two terms in the square brackets is the marginal benefit of screening: given the unconditional expected profitability from lending to good and bad firms (i.e. given the interest rate), screening increases the proportion of accepted good firms (i.e. screening reduces type-I error) and it increases the proportion of rejected bad firms (i.e. screening reduces type-II error). In equilibrium the marginal benefit of screening is equal to its marginal cost.

Therefore, from equation (6), the optimal screening effort depends on the unconditional expected profitabilities of the good and the bad borrowers and on the interest rate. Given the interest rate, screening incentives increase as good borrowers become more profitable and bad borrowers become less profitable. The relationship with the lending rate is, on the contrary, ambiguous because, as the interest rate increases, both good and bad borrowers become more profitable. If, as the interest rate increases, the marginal benefit of screening from accepting more good borrowers is greater than the marginal benefit from rejecting more bad borrowers[16] - i.e. if $\alpha'(e)\theta p_G > -\beta'(e)(1-\theta)p_B$ implying $B'(e)>0$ - the optimal screening effort is increasing in the lending interest rate.

Proposition 2. *In the symmetric equilibrium the optimal lending interest rate r^* satisfies:*

$$-\frac{p}{\gamma}\left[\alpha(e^*)\eta_G(r^*)+\beta(e^*)\eta_B(r^*)-C(e^*)\right]+\frac{1}{n}B(e^*)=0 \tag{7}$$

In equation (7), given the screening effort, an increased interest rate reduces expected profits since the demand for loans decreases, while it increases expected profits by the number of successful borrowers (i.e. the borrowers who repay the loan). In equilibrium the overall effect on expected profit is zero.

From equation (7) the optimal interest rate is given by:

$$r^*=\frac{\gamma}{pn}+\frac{A(e^*)}{B(e^*)}(r_f-q\sigma)+\frac{C(e^*)}{B(e^*)} \tag{8}$$

Therefore the optimal lending rate increases with total transportation costs γ/n (i.e. the higher the bank's market power the higher the interest rate the bank sets), with the cost of funds for successful borrower $A(e)r_f/B(e)$ and the cost of screening for successful borrower $C(e)/B(e)$, and it decreases with the average success probability p (i.e. the less risky the borrowers' population the smaller the interest rate the bank sets) and with the expected income from services for successful borrower $A(e)q\sigma/B(e)$.

In this framework cross-selling affects screening incentives (it affects the marginal benefit of screening) and thus the quality of banks' loans. Cosci, et al. (2012) demonstrate that, when there are no information synergies between screening and cross-selling activities, cross-selling reduces the optimal screening effort, because it makes good borrowers less profitable and bad borrowers more profitable[17], and thereby it reduces the quality of the loans as measured by the share of successful

[16] This case implies that the expected ratio of successful borrowers increases with the screening effort.

[17] As the expected income from cross-selling increases, for given screening effort, the lending interest rate decreases so that the unconditional expected profitability of borrowers may either increase or decrease. Cosci, et al. (2012) demonstrate that the latter effect on interest rate prevails for good borrowers, while the increase in the expected income from cross-selling is dominant for bad

borrowers over all borrowers $Q(e)$. This result is consistent with the evidence reported in Cosci, et al. (2009) that banks characterised by a higher proportion of non-interest income (a proxy for the bank's cross-selling activity) are also characterised by a larger proportion of impaired loans (a proxy for the quality of the financed projects' pool).

The equilibrium results as stated in Propositions 1 and 2 assume that the number of banks is given (i.e. they hold in the short-run). In the long-run the number of banks is endogenous. By substituting the optimal screening effort and interest rate into expected profits and equating to zero, we determine the equilibrium number of banks in the market[18].

Proposition 3. *In the long-run the equilibrium number of banks is given by:*

$$n^* = \frac{1}{K}\left[\alpha(e^*_{LR})\eta_G(r^*_{LR}) + \beta(e^*_{LR})\eta_B(r^*_{LR}) - C(e^*_{LR})\right] \tag{9}$$

where e^*_{LR} and r^*_{LR} denote the long-run equilibrium levels of screening and interest rate:

$$\frac{1}{n^*}\left[\alpha'(e^*_{LR})\eta_G(r^*_{LR}) + \beta'(e^*_{LR})\eta_B(r^*_{LR}) - C'(e^*_{LR})\right] = 0 \tag{10}$$

$$r^*_{LR} = \left[\frac{\gamma K}{B(e^*_{LR})p}\right]^{1/2} + \frac{A(e^*_{LR})}{B(e^*_{LR})}(r_f - q\sigma) + \frac{C(e^*_{LR})}{B(e^*_{LR})} \tag{11}$$

Equation (9) states that entry in the market is induced by an increase in profits. From equations (9) and (11), the equilibrium number of banks can be written as:

$$n^* = \left[\frac{\gamma B(e^*_{LR})}{pK}\right]^{1/2} \tag{12}$$

Therefore the equilibrium number of banks increases with transportation costs γ and the equilibrium expected ratio of successful borrowers $B(e^*_{LR})$ and it decreases with the average success probability p and installation costs K.

5. The Impact of Competition in the Lending Market on the Profitability of Cross-selling

Capital market liberalisation and the diffusion of ICTs in the banking sector in advanced industrial countries have led to an increase in competition in the lending market. We ask whether cross-selling can partly be a response to this increase in competition. Since in the present framework the source of banks' market power is transportation costs, we model more competition in the lending market as a decrease in transportation costs γ and we study its effect on the optimal interest rate, on the equilibrium number of banks and finally on the profitability of cross-selling[19].

From equation (11) the effect of competition (as measured inversely by γ) on the optimal interest rate is given by:

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borrowers. As a result the unconditional expected profitability of good borrowers η_G decreases, while that of bad borrowers η_B increases. See Appendix B for an analytical derivation of this effect.

[18] See Appendix A.

[19] See Appendix C for the derivation of the results.

$$\frac{dr^*_{RL}}{d\gamma} = \frac{\gamma_0}{pn^*(2\gamma_0 - \gamma)} > 0 \tag{13}$$

i.e. increasing competition in the lending market (decreasing transportation costs γ) reduces the equilibrium interest rate.

From equation (9) the effect of competition on the equilibrium number of banks is given by:

$$\frac{dn^*}{d\gamma} = \frac{n^*}{\gamma}\frac{\gamma_0}{2\gamma_0 - \gamma} > 0 \tag{14}$$

i.e. increasing competition (decreasing transportation costs γ) reduces the equilibrium number of banks in the lending market. As shown in Appendix C, this effect follows from the decrease in the interest rate, induced by more competition, which reduces profits for existing banks in the market, thus lowering entry. Therefore increasing competition in the lending market always induces less entry, via a reduction in the interest rate, making the lending market more concentrated.

The expected profitability of services in the symmetric equilibrium is given by:

$$\pi^e_S = \frac{A(e^*_{LR})}{n^*} q\sigma - K \tag{15}$$

where n^* is given by equation (12). Equation (15) shows that, given the expected revenue from services ($q\sigma$), the profitability of services depends on the number of borrowers per bank $A(e^*_{LR})/n^*$, since the bank has a positive probability of selling services to its borrowers, and on installation costs K (fixed). In particular the lower is the equilibrium number of banks n^* and the higher the selection ratio $A(e^*_{LR})$ the higher is the expected profitability of cross-selling. Hence the effect of an increase in competition in the lending market on the expected profitability of services depends on its effect on the equilibrium number of banks and on the selection ratio.

From equation (15) the overall impact of competition on the expected profitability of services can be studied looking at the sign of the following derivative:

$$\frac{d(A(e^*_{RL})/n^*)}{d\gamma} = \frac{1}{n^*}\left[\frac{dA(e^*_{RL})}{d\gamma} - \frac{A(e^*_{RL})}{n^*}\frac{dn^*}{d\gamma}\right] \tag{16}$$

where $dn^*/d\gamma$ is given by equation (14) and $dA(e^*_{LR})/d\gamma$ is given by:

$$\frac{dA(e^*_{RL})}{d\gamma} = \frac{A'(e^*_{RL})B'(e^*_{RL})}{pn^*\,|SOC|}\frac{\gamma_0}{2\gamma_0 - \gamma} \tag{17}$$

Whether the selection ratio decreases or increases with competition depends on the specific properties of the screening technology, which determines also the sign of the relationship between the optimal screening effort and the optimal interest rate.

Since increasing competition reduces the optimal interest rate, when the optimal screening effort is increasing in the lending rate ($B'(e^*_{LR})>0$), the reduction in screening incentives either increases the selection ratio (when $A'(e^*_{LR})<0$) or reduces it (when $A'(e^*_{LR})>0$). In the latter case, as demonstrated in Appendix C, the reduction in the equilibrium number of banks in the market always prevails on the reduction in the selection ratio, so that more competition leads to a higher number of borrowers per bank, thus increasing the expected profitability of services. When the optimal screening effort is decreasing in the lending rate ($B'(e^*_{LR})<0$), the increase in bank's screening incentives induced by the lower interest rate always reduces the selection ratio ($A'(e^*_{LR})<0$), but, again, the reduction in the equilibrium number of banks results to prevail on the reduction in the selection ratio for sufficiently low levels of transportation costs.

Corollary *When the optimal screening effort is increasing in the lending rate ($B'(e^*)>0$) an increase in competition in the lending market (a decrease in transportation costs γ) increases the expected profitability of services. When the optimal screening effort is decreasing in the lending rate ($B'(e^*)<0$) an increase in competition increases the expected profitability of services for sufficiently low levels of transportation costs.*

Proof. See Appendix C.

In this model more competition in the lending market among existing banks, by reducing expected profits from lending, leads to a more concentrated banking system. Competition also affects lending (the number of positively evaluated borrowers) in a way that depends on the composition and heterogeneity of the projects' pool. However, for sufficiently low levels of transportation costs, an increase in competition leads to a higher number of each bank's borrowers, thus increasing the expected profitability of services.

This result suggests that the transition to a marketing-orientation in banking documented in the literature is, at least in part, a response to increasing competition in the lending market. The model also suggests that the shift in banks' activity towards non-traditional cross-selling activities is responsible for the increase in loan risk since, as in Cosci, et al. (2009) and (2012), cross-selling weakens banks' screening incentives, thus reducing the quality of their portfolios of loans.

In conclusion, our results show that market structure affects banks' lending behaviour and banks' incentives to invest in gathering information. In particular a competitive banking sector provides cheaper credit to potential borrowers by setting lower lending rates, which reduces the number of banks and may increase the number of borrowers per bank. By dealing with a larger number of borrowers, banks may be willing to enhance their (more profitable) cross-selling activity and invest less in screening technology.

6. Conclusions

In this paper we find that, for sufficiently low levels of transportation costs, an increase in competition leads to a more concentrated banking sector and to an increase in banks' expected profitability from offering services other than loans. This result could help explaining the transformation of the European banking system of the last 25 years since the increase in the degree of competition brought by ICT (which caused a fall in transportation costs) has been followed by an increase in both banking concentration and banks' non-interest income.

The positive relationship between competition and cross-selling incentives may raise some concern when we consider the negative effect of cross-selling on banks' optimal screening effort. In fact our model also shows that the higher is the income from cross-selling the lower is the screening effort and the lower is the quality of the financed projects' pool, i.e. the shift in banks' activity towards the provision of services different from loans reduces the traditional role of banks as providers of information about borrowers. This is consistent with the empirical evidence in Cosci, et al. 2009 showing that the higher is the share of banks' commission income (a proxy for cross-selling activities) the higher is the ratio of impaired loans over total loans (a proxy for low quality of banks' loans).

Overall our model suggests that the more competition increases in the loan market, the more the banking system is encouraged to move towards non-traditional activities and the less credit is information-based. This undesired effect of competition in the loan market may have contributed in the past to the excessive risk-taking behaviour of European banks and could hamper the stability of the financial system in the future.

In the context of our model the existence of some elements of interdependence between cross-selling and screening effort can make the trade-off between them less likely, as demonstrated by Cosci, et al. 2012. By offering a broader set of financial products, a cross-selling bank can develop a "wider" relationship with a firm that may be a source of relevant information scope economies: on the one side, the bank learns more about the firm by observing its behaviour with respect to a larger number of financial instruments, on the other side, the bank has the opportunity to use the information it collects through screening in other businesses rather than just in lending decision (see Santos 1998). Overall, in the financial sector having customer-information available for multiple uses may significantly reduce average costs (see Herring and Santomero, 1990) and increase revenues.

Banks play a crucial Schumpeterian role in fostering economic development as they produce information about borrowers. However, it seems currently that banks are progressively losing this role. Our model suggests that this may be caused also by the negative effect of cross-selling on screening incentives. Investigating both theoretically and empirically the elements of inter-dependence between competition and cross-selling, and between cross-selling and screening effort, will remain an important area of research and policy focus**.**

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Appendix A. Derivation and properties of equilibrium results

The first-order conditions for the maximisation problem of bank i are:

$$\begin{aligned}&\left[\frac{1}{n}-\frac{p}{\gamma}(r_i-r_0)\right][\alpha'(e_i)\eta_G(r_i)+\beta'(e_i)\eta_B(r_i)-C'(e_i)]=0\\&-\frac{p}{\gamma}[\alpha(e_i)\eta_G(r_i)+\beta(e_i)\eta_B(r_i)-C(e_i)]+\left[\frac{1}{n}-\frac{p}{\gamma}(r_i-r_0)\right]\left[\alpha(e_i)\theta p_G+\beta(e_i)(1-\theta)p_B\right]=0\end{aligned}\qquad\text{(A1)}$$

The second-order conditions are:

$\left[\frac{1}{n}-\frac{p}{\gamma}(r_i-r_0)\right][\alpha''(e_i)\eta_G(r_i)+\beta''(e_i)\eta_B(r_i)-C''(e_i)]<0$ under our assumptions $\alpha''(e)\leq 0$, $\eta_G(r)>0$, $\beta''(e)\geq 0$, $\eta_B(r)<0$, $C''(e)>0$, and

$$-\frac{[\alpha''(e_i)\eta_G(r_i)+\beta''(e_i)\eta_B(r_i)-C''(e_i)][\alpha(e_i)\theta p_G+\beta(e_i)(1-\theta)p_B]p}{n\gamma}-\frac{[\alpha'(e_i)\theta p_G+\beta'(e_i)(1-\theta)p_B]^2}{n^2}>0$$

for sufficiently low levels of transportation costs:

$$\gamma<\frac{-pn[\alpha''(e_i)\eta_G(r_i)+\beta''(e_i)\eta_B(r_i)-C''(e_i)][\alpha(e_i)\theta p_G+\beta(e_i)(1-\theta)p_B]}{[\alpha'(e_i)\theta p_G+\beta'(e_i)(1-\theta)p_B]^2}\qquad\text{(A2)}$$

The solution of system (A1) in the symmetric equilibrium gives the optimal screening effort as a function of the optimal lending rate $e^*=e^*(r^*)$ satisfying equation (6) in the text, and the optimal lending rate as a function of the optimal screening effort $r^*=r^*(e^*)$ satisfying equation (7) in the text where $B(e^*)\equiv\alpha(e^*)\theta p_G+\beta(e^*)(1-\theta)p_B$.

In order to simplify the notation define:

$$SOC\equiv\alpha''(e^*)\eta_G(r^*)+\beta''(e^*)\eta_B(r^*)-C''(e^*)<0$$

and
$$\gamma_0\equiv\frac{pn\,|SOC|\,B(e^*)}{[B'(e^*)]^2}$$

All the equilibrium results hold for $\gamma<\gamma_0$, that is inequality (A2) in the symmetric equilibrium.

In order to study the relationship between the optimal screening effort and the unconditional expected profitabilities of the good borrowers and the bad borrowers, by totally differentiating equation (6) in the text, we get:

$$\frac{de^*}{d\eta_G}=\frac{\alpha'(e^*)}{|SOC|}>0\qquad\text{(A3)}$$

i.e. the optimal screening effort increases with the unconditional expected profitability of good borrowers, and

$$\frac{de^*}{d\eta_B} = \frac{\beta'(e^*)}{|SOC|} < 0 \qquad \text{(A4)}$$

i.e. the optimal screening effort decreases with the unconditional expected profitability of bad borrowers.

In order to study the relationship between the optimal screening effort and interest rate, by totally differentiating equation (6) in the text, we get:

$$\frac{de^*}{dr^*} = \frac{B'(e^*)}{|SOC|} \qquad \text{(A5)}$$

Whether the optimal screening effort increases or decreases with the interest rate depends on the sign of $B'(e^*) \equiv \alpha'(e^*)\theta p_G + \beta'(e^*)(1-\theta)p_B$. If the benefits from accepting good borrowers $\alpha'(e^*)\theta p_G$ are greater than the benefits from rejecting bad borrowers $-\beta'(e^*)(1-\theta)p_B$, implying $B'(e^*)>0$, the optimal screening effort is increasing in the interest rate.

In the equilibrium (maximum) expected profits are:

$$\pi^e(e^*, r^*) = \frac{1}{n}[\alpha(e^*)\eta_G(r^*) + \beta(e^*)\eta_B(r^*) - C(e^*)] - K \qquad \text{(A6)}$$

Equating (A6) to zero and solving by n gives the equilibrium number of banks in the market as in equation (9) in the text.

Long-run equilibrium levels of screening effort and interest rate are defined, respectively, as:

$$\frac{1}{n^*}[\alpha'(e^*_{RL})\eta_G(r^*_{RL}) + \beta'(e^*_{RL})\eta_B(r^*_{RL}) - C'(e^*_{RL})] = 0 \qquad \text{(A7)}$$

$$-\frac{p}{\gamma}[\alpha(e^*_{RL})\eta_G(r^*_{RL}) + \beta(e^*_{RL})\eta_B(r^*_{RL}) - C(e^*_{RL})] + \frac{1}{n^*}\left[\alpha(e^*_{RL})\theta p_G + \beta(e^*_{RL})(1-\theta)p_B\right] = 0 \qquad \text{(A8)}$$

Solving (A8) for r^*_{RL} gives equation (11) in the text.

Appendix B. The effect of cross-selling on screening incentives

Equation (6) in the text implicitly defines e^* as a function of σ:

$$\frac{1}{n}[\alpha'(e^*)\eta_G(e^*, \sigma) + \beta'(e^*)\eta_B(e^*, \sigma) - C'(e^*)] = 0 \qquad \text{(B1)}$$

where:

$$\eta_G(e^*, \sigma) = \theta[p_G r(e^*, \sigma) - r_f + q\sigma]$$

$$\eta_B(e^*, \sigma) = (1-\theta)[p_B r(e^*, \sigma) - r_f + q\sigma]$$

$$r(e^*, \sigma) = \frac{\gamma}{pn} + \frac{A(e^*)}{B(e^*)}(r_f - q\sigma) + \frac{C(e^*)}{B(e^*)}$$

Totally differentiating (B1) yields:

$$\frac{de^*}{d\sigma} = \frac{\left[\alpha'(e^*)\dfrac{\partial \eta_G}{\partial \sigma} + \beta'(e^*)\dfrac{\partial \eta_B}{\partial \sigma}\right]}{|SOC| - B'(e^*)\dfrac{\partial r^*}{\partial e^*}} \tag{B2}$$

where:

$$\frac{\partial \eta_G}{\partial \sigma} = \theta q + \theta p_G \frac{\partial r^*}{\partial \sigma} \tag{B3}$$

$$\frac{\partial \eta_B}{\partial \sigma} = (1-\theta)q + (1-\theta)\, p_B \frac{\partial r^*}{\partial \sigma} \tag{B4}$$

$$\frac{\partial r^*}{\partial \sigma} = -\frac{A(e^*)}{B(e^*)} q < 0 \text{ , and } \quad \frac{\partial r^*}{\partial e^*} = \frac{B'(e^*)}{B(e^*)} \frac{\gamma}{pn}$$

In (B2) the denominator is positive, since $\gamma < \gamma_0$:

$$|SOC| - B'(e^*)\frac{\partial r^*}{\partial e^*} = \frac{\left[B'(e^*)\right]^2}{B(e^*)} \frac{\gamma_0 - \gamma}{pn} > 0 \tag{B5}$$

In order to study the sign of the numerator, note that, from (B3) and (B4), cross-selling affects the unconditional expected profitabilities of (good and bad) borrowers through a direct effect (the expected income from selling services increases) and an indirect effect (the interest rate decreases). For good borrowers the indirect effect (via the interest rate) is stronger than the direct effect so that cross-selling makes good borrowers less profitable:

$$\frac{\partial \eta_G}{\partial \sigma} = \theta q - \theta p_G \frac{A(e^*)}{B(e^*)} q = \theta q \left[1 - p_G \frac{A(e^*)}{B(e^*)}\right] < 0 \tag{B6}$$

since $p_G A(e^*)/B(e^*)>1$. For bad borrowers the direct effect is stronger than the indirect effect so that cross-selling makes bad borrowers more profitable:

$$\frac{\partial \eta_B}{\partial \sigma} = (1-\theta)q - (1-\theta)\, p_B \frac{A(e^*)}{B(e^*)} q = (1-\theta) q \left[1 - p_B \frac{A(e^*)}{B(e^*)}\right] > 0 \tag{B7}$$

since $p_B A(e^*)/B(e^*)<1$.

By substituting (B5), (B6) and (B7) in (B2) $de^*/d\sigma$ results to be negative under the assumptions of the model $\alpha'(e)>0$, $\beta'(e)<0$ and $\gamma < \gamma_0$, i.e. cross-selling always weakens screening incentives because it reduces the expected profitability of good borrowers and increases that of bad borrowers. Since the quality of loans as measured by the ratio of successful borrowers over all borrowers $Q(e)\equiv B(e)/A(e)$ is increasing in the screening effort, cross-selling, by reducing screening incentives, worsens the quality of the loan portfolio:

$\frac{dQ(e^*)}{d\sigma}=\frac{[\alpha'(e^*)\beta(e^*)-\alpha(e^*)\beta'(e^*)]\theta(1-\theta)(p_G-p_B)}{\left[A(e^*)\right]^2}\frac{de^*}{d\sigma}<0$ under the assumptions of the model $\alpha'(e)>0$, $\beta'(e)<0$ and $p_G>p_B$ and the above result $de^*/d\sigma<0$.

Appendix C. The effect of competition on the profitability of cross-selling

In order to study the effect of competition on the optimal interest rate, note that equation (11) in the text expresses the optimal interest rate as a function of transportation costs and the optimal screening effort, which is, in turn, a function of r^*_{LR}: $r^*_{LR}=r^*_{LR}[\gamma,e^*_{LR}(r^*_{LR})]$. Thus the effect of competition (as measured by the parameter γ) can be computed as:

$$\frac{dr^*_{RL}}{d\gamma}=\frac{\frac{\partial r^*_{RL}}{\partial\gamma}}{1-\frac{\partial r^*_{RL}}{\partial e^*_{RL}}\frac{\partial e^*_{RL}}{\partial r^*_{RL}}} \tag{C1}$$

where the direct effect of γ on r^*_{LR} and the effect of e^*_{LR} on r^*_{LR}, from equations (11) and (12) in the text, are given, respectively, by:

$$\frac{\partial r^*_{LR}}{\partial\gamma}=\frac{1}{2pn^*} \tag{C2}$$

and

$$\frac{\partial r^*_{LR}}{\partial e^*_{LR}}=\frac{\gamma}{2pn^*}\frac{B'(e^*_{LR})}{B(e^*_{LR})} \tag{C3}$$

and the effect of r^*_{LR} on e^*_{LR} is given as in (A5):

$$\frac{\partial e^*_{LR}}{\partial r^*_{LR}}=\frac{B'(e^*_{LR})}{|SOC|} \tag{C4}$$

Substituting (C2), (C3) and (C4) in (C1) and rearranging gives equation (13) in the text, which is positive since $\gamma<\gamma_0$.

In order to study the effect of competition on the equilibrium number of banks, note that equation (9) in the text expresses the equilibrium number of banks as a function of the optimal lending rate and the optimal screening effort: $n^*=n^*(r^*_{LR},e^*_{LR})$. Thus the effect of γ on n^* can be computed as:

$$\frac{dn^*}{d\gamma}=\frac{\partial n^*}{\partial r^*_{LR}}\frac{dr^*_{LR}}{d\gamma}+\frac{\partial n^*}{\partial e^*_{LR}}\frac{de^*_{LR}}{d\gamma} \tag{C5}$$

where the partial effect of r^*_{LR} on n^* is given by:

$$\frac{\partial n^*}{\partial r^*_{LR}}=\frac{B(e^*_{LR})}{K} \tag{C6}$$

Since the partial effect of e^*_{LR} on n^* is null, the second term in (C5) is zero, i.e. the effect of competition on the equilibrium number of banks goes through only the effect on the interest rate.

Substituting equations (13) in the text and (C6) in (C5) gives equation (14) in the text, which is positive since $\gamma<\gamma_0$.

In order to study the overall impact of competition on the expected profitability of services we look at the effect of a decrease in transportation costs on the number of borrowers per bank, computed as in equation (16) in the text, where $dn^*/d\gamma$ is given by equation (14) in the text and $dA(e^*_{LR})/d\gamma$ is:

$$\frac{dA(e^*_{RL})}{d\gamma} = A'(e^*_{RL})\frac{de^*_{RL}}{d\gamma} \tag{C7}$$

In (C7), since the effect of the number of banks on the optimal screening effort is null, $dA(e^*_{LR})/d\gamma$ is given by:

$$\frac{dA(e^*_{RL})}{d\gamma} = \frac{\partial e^*_{RL}}{\partial r^*_{RL}}\frac{dr^*_{RL}}{d\gamma} \tag{C8}$$

where $\partial e^*_{LR}/\partial r^*_{LR}$ is given by (C4) and $dr^*_{LR}/d\gamma$ is given by equation (13) in the text. Substituting in (C7) gives equation (17) in the text.

Substituting equations (14) and (17) in equation (16) in the text yields:

$$\frac{d(A(e^*_{LR})/n^*)}{d\gamma} = \frac{B(e^*_{LR})}{n^*(2\gamma_0-\gamma)[B'(e^*_{LR})]^2}\left[A'(e^*_{LR})B'(e^*_{LR}) - \frac{pn^*|SOC|A(e^*_{LR})}{\gamma}\right] \tag{C9}$$

which is negative (i.e. an increase in competition in the lending market increases the number of borrowers per bank, thereby increasing the profitability of cross-selling) when the term in the squared brackets is negative. This is always the case when $A'(e^*_{LR})$ and $B'(e^*_{LR})$ have opposite sign. When $A'(e^*_{LR})$ and $B'(e^*_{LR})$ have the same sign (both positive or negative), it is still negative when:

$$\gamma < \frac{pn^*|SOC|A(e^*_{LR})}{A'(e^*_{LR})B'(e^*_{LR})} \equiv \gamma_{CR} \tag{C10}$$

Condition (C10) is satisfied when the optimal screening effort is increasing in the lending rate ($B'(e^*_{LR})>0$) and the selection ratio is increasing in the screening effort ($A'(e^*_{LR})> 0$), since $\gamma<\gamma_0<\gamma_{CR}$, but, when the optimal screening effort is decreasing in the lending rate ($B'(e^*_{LR})<0$) and the selection ratio is decreasing in the screening effort ($A'(e^*_{LR})<0$), $\gamma_{CR}<\gamma_0$ implies that there is a range of levels of transportation costs $\gamma_{CR}<\gamma<\gamma_0$ for which as γ decreases (competition increases) $A(e^*_{LR})/n^*$ decreases. However, as transportation costs continue to decrease ($\gamma<\gamma_{CR}$), $A(e^*_{LR})/n^*$ increases again.