Université de Limoges (France)
Ecole Doctorale SHS
LAPE – EA 1088

University of Birmingham (U.K.)
Economics Department

European Doctorate
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SERVICE PROVISION AND BANK INTEREST MARGINS : AN ADVERSE SELECTION APPROACH AND RISK IMPLICATIONS FOR E.U. BANKS

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Emmanuelle NYS

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Supervisors / Directeurs

Mr. Andrew MULLINEUX, *Professor at the University of Birmingham (U.K.)*

Mr. Alain SAUVIAT, *Professeur à l'Université de Limoges (France)*

Mr. Amine TARAZI, *Professeur à l'Université de Limoges (France)*

Reviewed by / Rapporteurs

Mr. David DICKINSON, *Senior Lecturer at the University of Birmingham (U.K.)*

Mr. Dominique LACOUE-LABARTHE, *Professeur à l'Université Montesquieu-Bordeaux IV (France)*

Mr. Clas WIHLBORG, *Professor at the Copenhagen Business School (Denmark)*

JURY

Mr. Christian BORDES, *Professeur à l'Université de Paris I Panthéon-Sorbonne (France)*

Mr. David DICKINSON, *Senior Lecturer at the University of Birmingham (U.K.)*

Mr. Dominique LACOUE-LABARTHE, *Professeur à l'Université Montesquieu-Bordeaux IV (France)*

Mr. Alain SAUVIAT, *Professeur à l'Université de Limoges (France)*

Mr. Amine TARAZI, *Professeur à l'Université de Limoges (France)*

SYNOPSIS

The deregulation of the banking system initiated in the 70's in the USA, and during the 80's in Europe, has prompted competition and therefore wide changes in the activities of banks. Indeed, as revenue from the intermediation activity of banks has decreased since this period, banks have broadened the range of products they offer to their clients, and which generate revenue other than interest income.

Given the increasing share of non-interest income, the motivation behind this thesis is to understand how the major changes that took place in the banking industry may have affected banks' traditional activity, that is intermediation. To investigate this issue, the thesis is divided into four chapters.

Chapter 1 reviews the theoretical literature on the price setting of intermediation activities. This survey underlines the major role of risk, whilst considering the intermediation activity of banks, and it will be therefore considered all along this thesis. We also study the effects on prices that may occur when banks offer more than one product. To further investigate our interrogation, we undertake in chapter 2 a review of the empirical literature on bank interest margins, in order then to carry out our own study on a set of twelve European countries. To the standard determinants of the interest margin, we add also commission and fee revenue. We then show that this variable has an impact on bank margins. This result leads us in chapter 3 to theoretically investigate this link. The role of banks in reducing asymmetric information between lenders and borrowers is modelled in a principal-agent framework, in which the bank sells loans and services. We underline two major results : on the one hand banks subsidise their lending rate as they desire to increase their sale of services, on the other hand a strategy to further increase service revenue decreases their incentives to screen firms' project, taking on higher credit risk. The objective of chapter 4 is then to assess our theoretical findings on the twelve European countries previously considered in chapter 2.

RÉSUMÉ

La déréglementation bancaire initiée dans les années soixante-dix aux USA, et qui a eu lieu dans les années quatre-vingt en Europe, a profondément modifié l'activité des banques. On a effectivement assisté, d'une part, à une concurrence accrue entre les banques et le marché financier et, d'autre part, à une désintermédiation suscitant la montée alternative de nouvelles activités, générant des revenus autres que ceux d'intérêt.

Etant donnée cette montée en puissance de l'activité de services des banques, l'objectif de cette thèse est de mettre en évidence les effets possibles de la vente de services par les banques sur leur activité d'intermédiation. Pour cela, ce travail est divisé en quatre chapitres.

Dans un premier chapitre, nous nous attachons à étudier la formation des prix de l'activité d'intermédiation dans la littérature bancaire. Il apparaît alors que le rôle du risque dans l'activité d'intermédiation est fondamental, ce qui nous amènera à le considérer tout au long de cette thèse. Nous mettons aussi en évidence les interactions qui peuvent exister dans cette formation des prix si nous considérons les différents produits de la banque. Le second chapitre consiste à étayer notre interrogation sur le lien activités de services et d'intermédiation. Pour cela, nous considérons, dans un premier temps, différentes études économétriques de la marge d'intérêt. Puis, dans notre propre analyse empirique des déterminants traditionnels de la marge appliquée au cas de l'Europe, nous ajoutons également les commissions et les frais provenant des services. Nous mettons alors en évidence un effet des services sur la marge. Ce résultat nous conduit dans le chapitre 3 à modéliser l'activité d'intermédiation, dans le cadre d'un modèle principal-agent qui tient compte du rôle de la banque dans la réduction de l'asymétrie d'information entre prêteurs et emprunteurs, et nous introduisons l'activité de services des banques. Ce modèle met en évidence deux résultats : d'une part, les banques qui se font concurrence sur le marché du crédit diminuent leur taux débiteur pour attirer de nouveaux clients, d'autre part, elles sont enclines également à prendre plus de risque en acceptant des projets qu'elles auraient auparavant refusés. Nous complétons notre analyse des systèmes bancaires européens dans un quatrième chapitre, en étudiant plus précisément l'effet des revenus de services sur le taux débiteur, et également sur le risque de crédit pris par les banques.

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CONTENTS IN BRIEF

GENERAL INTRODUCTION

As a result of the deregulation process, the banking industry in Europe has experienced major changes over the last two decades. Banks have faced increasing competition both within the industry and from financial markets. This in turn had an impact on banking market structure and on banking behaviour. This reform of the banking system was initiated first in the USA, before it took place in Europe.

In the sixties, in the USA, banks found themselves increasingly compressed by deposit rate regulations and restrictions on activities that hindered their pursuit of profitable opportunities. Their response was to seek ways to circumvent the regulatory obstacles. Then, regulators tried to adjust the law every time that banks discovered a shortage in the regulation (the well-known regulatory dialectic, Kane, 1981, 1986). In the seventies, deregulation arose in the USA, when regulators began to accommodate change rather than to resist it (Silber, 1983, Kaufman, Mote, Rosenblum, 1984). State and federal regulators authorized, for instance, the issue by thrift institutions of NOW[1] accounts (interest bearing checking accounts) in 1972, and the issue of NOW accounts by all banks and thrift institutions in New England in 1974. The payment of market related interest rates on so-called money market deposits were authorized in 1977, and the automatic transfer of funds from savings to checking accounts in 1979 (Norton *et al.*, 1992, Kaufman, 1994). In 1980, the Depository Institutions Deregulation and Monetary Control Act strengthened the deregulation process started before. This directive had two goals : the first one was to improve the effectiveness of monetary policy, and the second one was to provide a level playing field among financial institutions, which, subject to uniform reserve requirements, would be placed on a more equal footing and, given a new regulatory environment, would be able to offer similar

[1] Negotiable Order of Withdrawal.

services to their customers. Moreover, major changes took place in the American capital and money markets in the seventies[2].

As in the USA, the deregulation process took also place in the European Union. Actually, since the 1957 Treaty of Rome, the European Commission has been taking steps towards regulatory reforms and harmonisation in the supply of financial services in the European Community. In the period 1957-1973, the European Community focused on the deregulation of entry into domestic markets for financial institutions from other member states. In the period 1973-1985, the efforts of the European Community concentrated on the harmonisation of financial regulation. In 1977, the First Banking Directive established the principle of home country control : credit institutions operating in foreign markets within the European Community are to be under the supervision of the monetary authorities of their home country rather than the host country. In practice, member countries had more stringent regulations than those in the First Banking Directive, and thus the harmonisation process was difficult to achieve. At the beginning of the 1980s the banking sector of many European countries was still rather fragmented, very much repressed with a large set of regulations (table I.1) constraining their activities. Exceptions included Germany, Luxembourg, the Netherlands and the United Kingdom.

Table I.1. Banking regulation in 1980

	Control of interest rate	Capital controls	Stock exchange member-ship	Branch restrict-tions	Foreign bank entry	Credit ceilings	MIR (*)	Restric-tion on insurance	Leasing
Belgium	✓	✓							
Denmark	✓	✓	✓			✓		✓	
France	✓	✓	✓	✓		✓	✓	✓	
Germany	✓							✓	
Greece	✓	✓			✓	✓	✓	✓	✓
Ireland	✓	✓							
Italy	✓	✓	✓	✓	✓	✓			
Luxembourg	✓								
Netherlands							✓	✓	
Portugal	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spain	✓	✓	✓		✓	✓	✓	✓	✓
United Kingdom			✓						

(*) Mandatory Investment Requirement
Source: Dermine (2003)

[2] In the USA, the first Certificate of Deposits was issued in 1961 (Lewis and Pescetto, 1996).

In the pursuit of a full financial integration in the Community, the European Commission has had as its main objective the promotion of a fair competition. The Second Banking Directive 1989 (table I.2.), is based on three general principles : minimal harmonisation of regulations, mutual recognition of rules and regulations, and home country control. The first principle requires that only several fundamental banking regulations and procedures can be secured by Community legislation. The second and essential principle of mutual recognition provides that each member state basically accepts as applicable within its own boundaries the regulation established in other member states. This provides free access to domestic markets for all Community members, even if some of the specified list of activities are prohibited to domestically established financial institutions. And thirdly, banks operating in other European Economic Community member countries are to be subject to the control and supervision of their home countries.

Table I.2. Scope of the EC Second Banking Directive

1. Deposit-taking and other forms of borrowing
2. Lending (consumer credit, mortgages, factoring, trade finance)
3. Financial leasing
4. Money transmission services
5. Issuing and administering means of payments (credit cards, travellers' cheques and bankers' drafts)
6. Guarantees and commitments
7. Trading for own account or for the account of the customers in:
   - (i) Money market instruments (cheques, bills, CDs, etc.)
   - (ii) Foreign exchange
   - (iii) Financial futures and options
   - (iv) Exchange and interest rate instruments
   - (v) Securities
8. Participation in share issues and the provision of services related to such issues
9. Money broking
10. Portfolio management and advice
11. Safekeeping of securities
12. Credit reference services
13. Safe custody

Source: Lewis and Pescetto (1996)

While banking deregulation was taking place, major changes appeared in financial instruments and markets, increasing competition faced by banks. Except the United Kingdom, all the other countries had under developed securities and money markets. As table I.3. shows, the creation of the Certificate of Deposits and Commercial Paper market took place in the 1980s, enhancing competition with banking.

Table I.3. Introduction of negotiable money market instruments in selected countries, 1981-1987

Country	Instruments (1)
France	CD, CP, TB
Greece	TB
Italy	CD
Netherlands	CD, CP
Portugal	TB, CD
Spain	TB, CP

(1)Certificate of Deposits (CD), Commercial Paper (CP), Treasury Bill (TB)

Source: Dermine (2003)

The regulatory reforms that took place in the 1970s and in the 1980s did not mean that the process involved the complete abandonment of all regulation (Kane, 1984). The supervision of banks is needed, while liberalising financial markets, in order : (*i*) to assure efficiency and create stability avoiding the negative consequences of panics ; and (*ii*) to protect depositors and investors. To be more precise, a solvency ratio is needed in order to lessen the moral hazard behaviour that banks may adopt, i.e. banks may take greater risk, due to the existence of a deposit insurance scheme which reduces the "bank run" risk, and thereby increase systemic risk. When such a regulatory framework is missing, bank failures arise as the ones that took place in the USA, during the Saving and Loans crisis in the 1980s, or in the Nordic countries. The 1988 Basel Accord promoted the international harmonisation of prudential regulation through the generalised adoption of a common measure of solvency, the Cooke ratio. This accord, which considers credit risk, requires international banks to hold a minimum level of total capital equal to eight percent of risk-adjusted assets. To account for financial innovations and some risks that were not considered initially, operational and market risks, the Cooke ratio was amended. To achieve less distortions, these measures are going to be redefined in the New Basel Capital Accord (Mc Donough ratio).

In this context of deregulation and reregulation, banking systems faced major changes in the form of increased competition, concentration and restructuring. These changes were triggered by a number of factors including technological change, financial liberalisation and globalisation. Two major phenomena have to be underlined. The first one, securitisation, has expanded greatly, that is equities and bonds have been increasingly used as an alternative source for funds, and loans have become more and

more tradable[3]. The second one, banking disintermediation, lies in the arrival of new market participants. Banking systems have been losing their relative share of financial intermediation to institutional investors (investment funds, insurance companies and pension funds)[4]. Competition with institutional investors has been the most pronounced in the collection of savings. Comparatively, the asset side of banks' balance sheet has been less affected, until the 1990s. Additionally, the new entrants (table I.4.) into banking have substantially intensified the competitive environment. The existing players have been forced to compete harder on price terms.

Table I.4. Major entries into banking in the late 1990s

	Mortgages	**Personal sector Consumer credit**	**deposits**	**Corporate loans**
Belgium		Car companies		
Denmark	Internet banks			Foreign banks
Greece	Co-operative banks and niche credit institution			
Germany	Direct banks (telephone and internet banking operation)			
Spain			Foreign banks New domestic institutions	
France	Direct banks (internet banking operation)			
Ireland	Foreign banks		Foreign banks	
Italy	Foreign banks			
Luxembourg	No significant recent entries			
Netherlands	No significant recent entries			
Austria	No significant recent entries			
Portugal	Foreign and domestic credit institutions			
Finland	Foreign banks			Foreign banks
Sweden	Domestic mortgage institution	Domestic and foreign banks	Domestic banks, retail and insurance companies	Domestic banks
United Kingdom	Insurance companies (direct banking operation) Supermarket banks Internet banks Foreign banks			Foreign banks

Source: Banking Supervision Committee (ECB, 2000b)

However, a progressive reduction in importance of the banking sector was not to be anticipated. Indeed, banks have reacted to the new environment by adopting a proactive strategy. Banks have widened the range of products they offer to their clients, sometimes entering new markets. For example, on the liabilities side of banks' balance

[3] Securitisation encompasses two different processes. One refers to the replacement of non-marketable loans provided by financial intermediaries with negotiable securities issued in the public capital markets. The other one is the process of pooling various types of debt, mortgages, car loans, or credit card debt …, and packaging that debt as bonds which are then sold to investors, i.e. the process that converts bank loans and other non tradeable financial transactions into tradeable securities.

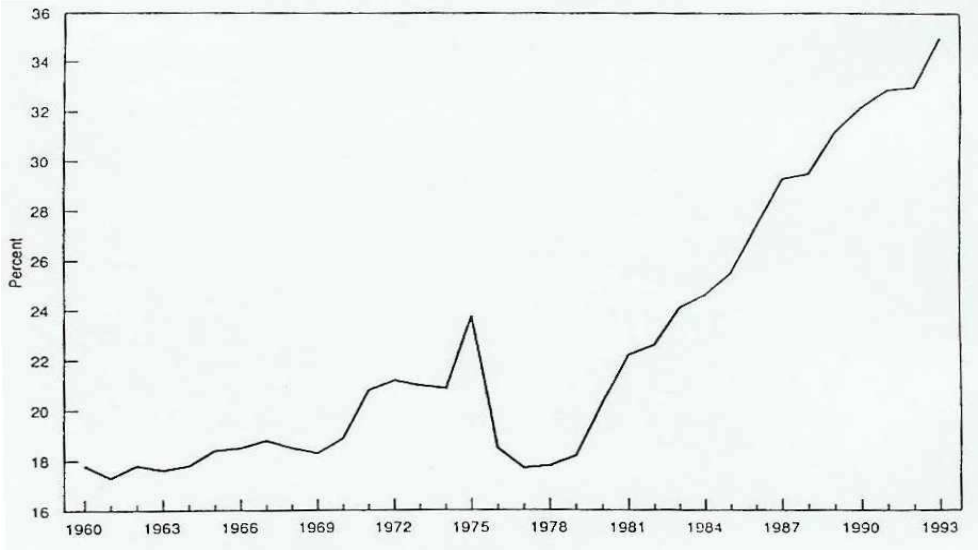
[4] This phenomenon has been observed both in the European Union and in the United States.

sheet, the banking sector can offer to their clients traditional deposits, investment funds and pension funds as alternatives, depending on specific, market, legal and fiscal situations. On the assets side of banks' balance sheet, banks complement their traditional activity of lending, by offering services such as backup lines of credit, underwriting facilities and treasury management or by developing trading activities and securitisation operations which relate to the transformation of pooled banking assets into securities.

The effects of these changes are mainly reflected in changes in the structure of banks' income statement and, in particular, in the increasing share of non-interest revenue. It is also reflected in the increasing size of off-balance-sheet items in banks' financial accounts. If banking activity has long consisted in granting loans and managing demand deposits, the so-called "non-traditional" activity which generates non-interest income is becoming an important source of revenue for banks. As a consequence, the definition of banking activity now encompasses a much wider range of activities. The competition from non-bank financial institutions has resulted in pressure on intermediation margins. In the mean time, banks have developed other sources of income.

Banking sectors around the world, and especially in Western countries, were affected by these transformations. In the 1980s, US commercial banks derived an increasing share of their profit from non-interest income (figure I.1.), such as fee and trading income, which averaged 19 percent of total income in the 1960 to 1980 period. By 1993, this source of income had grown to 35 percent of total bank income, and in 2001, non-interest income accounted for 43 percent of total income (Stiroh, 2002a).

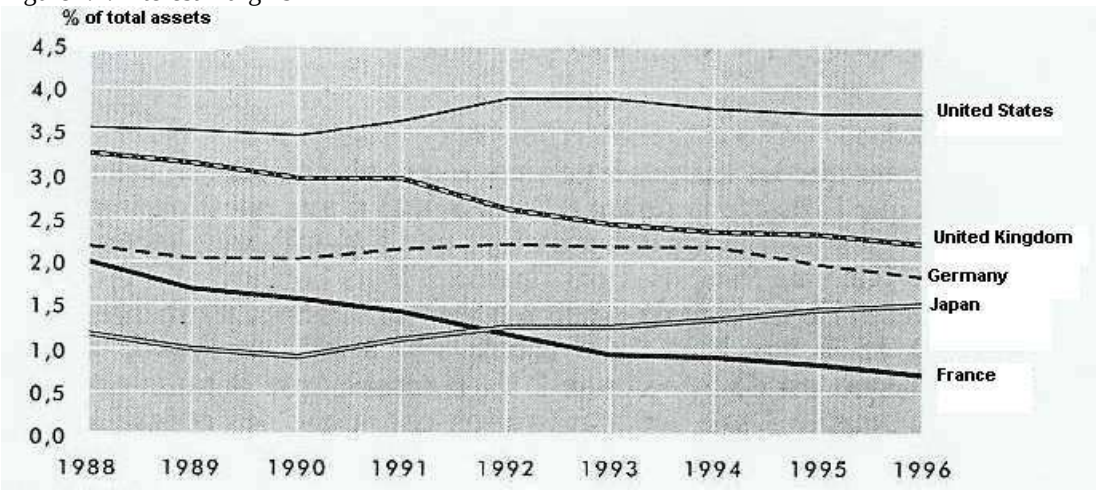
Figure I.1. Share of non-interest income in total income, for USA commercial banks, 1960-1993



Source : Edwards and Mishkin (1995)

Financial innovation and regulatory reforms have created alternatives for both depositors and borrowers. Consequently, the profitability of banks' traditional businesses, i.e. loans and deposits, has gradually declined (Edwards and Mishkin, 1995, Lewis and Pescetto, 1996, Plihon, 1998, Rogers and Sinkey, 1999).

Figure I.2. Interest margins



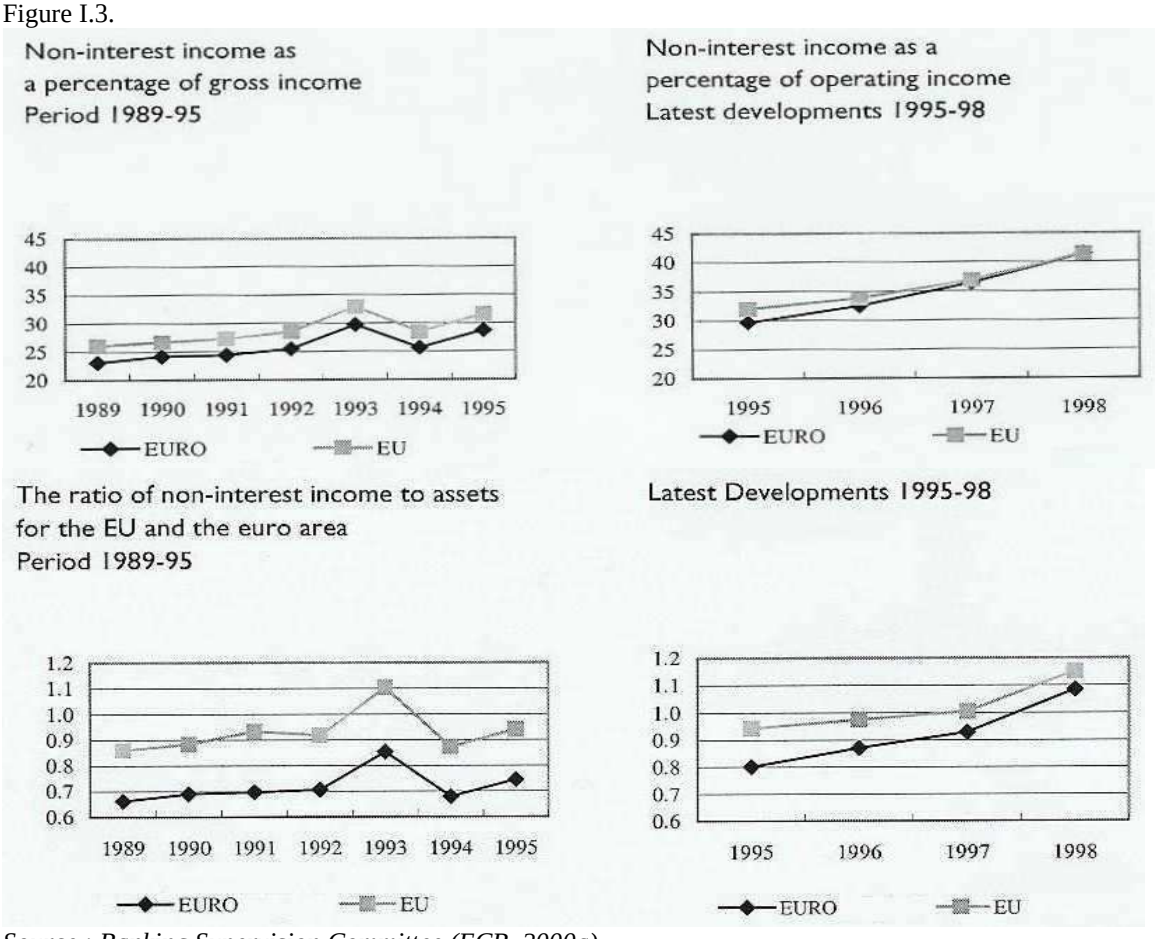
Source : Plihon, 1998

In the USA, banks appear to have maintained their interest margins (the ratio of interest revenue minus interest expense to total assets) (figure I.2.) even if the profitability of intermediation products has decreased. Indeed, Edwards and Mishkin (1995) argue that, to do so, banks took greater risk. In the presence of a federal deposit insurance scheme and a "too-big-to-fail" policy, and without capital regulation, banks

may adopt a moral hazard attitude towards the deposit insurance system, which means that they have the incentive to take greater risk in a deregulated environment (Keeley, 1990). Therefore, one of the consequences of the deregulation process was to strengthen financial fragility. Indeed, in the 1960 to 1980 period, bank failures in the USA averaged less than ten per year, but soared during the 1980s, rising to over two hundreds a year in the late 1980s (Kane, 1989, Edwards and Mishkin, 1995).

The report "European Union banks' income structure", prepared by the Banking Supervision Committee (2000a), mentioned that the non-interest income share of banks' revenue has increased from 26 percent to 41 percent between 1989 and 1998 in EU countries[5], (figure I.3.), while revenue from the intermediation activity was decreasing (figure I.4.).

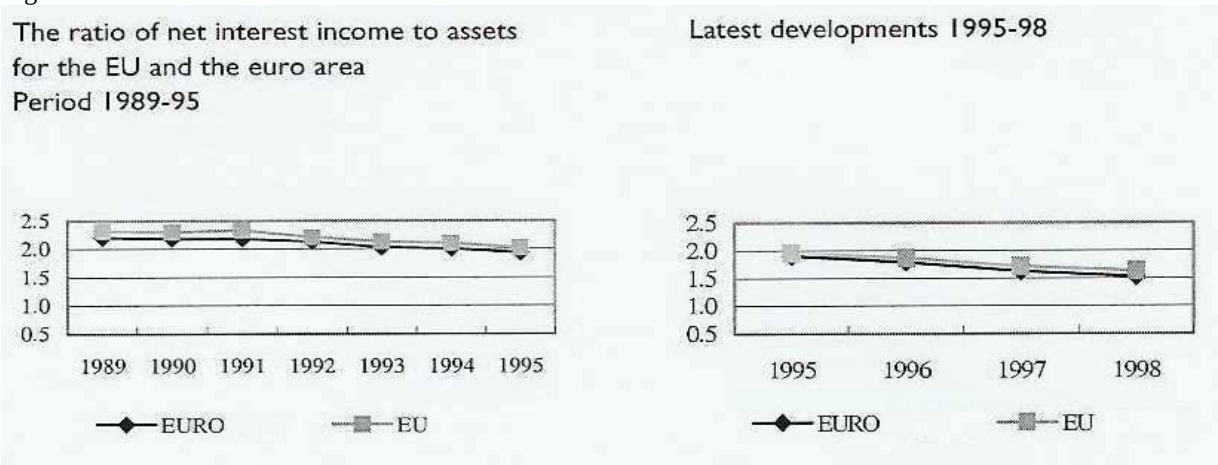
Figure I.3.



Source : Banking Supervision Committee (ECB, 2000a)

[5] The European Union is composed of the following countries : Austria, Belgium, Denmark, Finland, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden, United Kingdom. The EURO area includes the following countries : Austria, Belgium, France, Germany, Finland, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain.

Figure I.4.



Source : Banking Supervision Committee (ECB, 2000a)

We can observe that bank margins on lending have significantly fallen since the mid-1990s (figure I.4.). The Banking Supervision Committee (ECB, 2000b) argues that the narrowing of bank lending margins is mainly attributable to the tightening of pricing competition owing to competition amongst banks.

The composition of non-interest income is rather heterogeneous. It can be divided in four main components (ECB, 2000a) : income from fees and commissions, net profit (loss) on financial operations, income from securities, and other operating income[6]. Fees and commissions represent the most important component, accounting in average for 54 percent of non-interest income of EU banks in 1998. However, this activity has recorded a downward trend over the period 1994-1998 (from 68 percent to 54 percent). Commissions and fees represent the most important part of non-interest income in the United Kingdom and Ireland (72 percent and 68 percent, respectively), and the smallest levels are observed in Portugal and Sweden (35 percent for both countries).

As in the USA, European banking systems experienced increased risk-taking by banks (Bonin, 1997, Lambert, Le Cacheux, and Mahuet, 1997, Plihon, 1998, Lacoue-Labarthe, 2001). For example, banks in Nordic countries responded to deregulation by dramatically increasing their real estate lending, which was followed by a boom and

[6] ECB (2000a) gives the following typology of non-interest income activities : (*i*) fee-based activities include underwriting, securitisation, consulting (advisory activities), treasury management, private banking, information and data processing, real estate and housing transactions, correspondent banking, credit cards, provision of guarantees, payment transactions, account administration, foreign exchange transactions ; (*ii*) financial operations comprise proprietary trading in security, proprietary trading in foreign exchange, and proprietary trading in derivatives ; and (*iii*) income from securities includes income from shares and other variable yield securities and income from participating interests and shares in affiliated undertakings.

bust in real estate sectors that resulted in the insolvency of many large institutions. French and British banks also suffered from the worldwide collapse of real estate prices and from major failures of risky real estate projects funded by banks. Some German and Spanish banks (as Bank füer Gemeinwesen, Banco Español de Credito) have run into trouble due to huge losses in the early 1990s. Thus, the deregulation process and the resulting tougher competition have created incentives for banks to take on additional risks.

Disintermediation and financial liberalisation impacted strongly on bank margins, but also implied a problem of "excess capacity" in the banking industry (De Bandt and Davis, 1999). Banks responded partly by reducing excess capacity by mergers and branch closure. An overall reduction in the number of credit institutions can be observed in Europe, especially due to mergers and acquisitions, since 1996. In the European Union, the number of credit institutions fell from 12 256 in 1985 to 9 285 in 1997[7] (ECB, 1999, Dermine, 2003). Domestic mergers, which represent more than half of mergers and acquisition in European countries, have led to a massive consolidation process. A series of specific cross-border transactions have involved the acquisition of merchant banks to access expertise in corporate finance and asset management. In the countries under study, the five largest commercial banks comprised, in 1998, between 26 percent to 90 percent in aggregate assets (table I.5.).

Table I.5. Concentration Ratios *

	CR(5) index	CR(2) index		CR(5) index	CR(2) index
Belgium	0.90	0.52	Italy	0.41	0.24
Denmark	0.80	0.52	Luxembourg	0.26	0.12
France	0.57	0.32	Netherlands	0.64	0.51
Germany	0.40	0.20	Portugal	0.79	0.48
Greece	0.82	0.53	Spain	0.70	0.54
Ireland	0.70	0.51	UK	0.47	0.25

* The five-bank (respectively two-bank) concentration ratio, CR(5) (respectively CR(2)), is defined as the sum of the market share of the five (respectively two) largest banks in terms of total assets within the domestic market.
Sources : Belaisch et al. (2001), Bikker and Haaf (2002)

[7] The phenomenon started first in the USA, the number of commercial banks fell from around 15 000 to 9200 institutions between 1980 and 1997. The decreasing number of credit institutions, in the USA, in the 1980s, is also due to large wave of banks' failure (this episode is referred to the Saving and Loans crisis).

The European banking sectors under study are characterised by relatively few large banks, some of which are considered as having an international standing, and an array of medium-sized and small institutions (Belaisch *et al.* (2001)). The degree of concentration is particularly strong in the smaller European countries reported here (table I.5.). In almost all of the smallest countries, the top five banks account for more than 50 percent of the banking system. In Belgium, Denmark, Greece, Ireland and the Netherlands, the concentration is even more pronounced since in these countries the two largest banks hold more than half of banking sector assets. The five biggest countries (France, Germany, Italy, Spain and the U.K.) have less concentrated banking markets. Spain and France remain relatively more concentrated, and Germany has the lowest level of concentration. Commercial banks are still major competitors on the loan market in the industry. Table I.6. displays the share of commercial banks in the number of institutions in the banking industry[8], in Europe.

Table I.6. Commercial banks as a percentage of the banking industry, 1998

Belgium	75 %	Italy	33 %
Denmark	*NA*	Luxembourg	71 %
France	31 %	Netherlands	16 %
Germany	11 %	Portugal	21 %
Greece	*NA*	Spain	38 %
Ireland	88 %	U.K.	84 %

NA = not available
Source : Belaisch et al. (2001)

The market shares of commercial banks in percentage of total industry loans, which are shown in table I.7., may give a more precise picture of the lending activity of commercial banks. The market share is defined as the ratio of loans made by commercial banks to total loans in the banking industry for France, Germany, Italy and Spain in 1998. For the other countries, only the share of loans made by the five biggest commercial banks in percent of total industry loans, in 1997, is available.

[8] We include in the banking industry, as Plihon (1998) and Belaisch *et al.* (2001), commercial banks, savings banks, cooperative banks, post offices and investment companies.

Table I.7. Market shares of commercial banks in percent of total loans

Belgium	66 %	Italy	83 %
France	48 %	Luxembourg	29 %
Germany	47 %	Netherlands	81 %
Denmark	75 %	Portugal	75 %
Greece	77 %	Spain	53 %
Ireland	47 %	U.K.	44 %

France, Germany, Italy and Spain : ratio of loans made by commercial banks to total loans in the banking industry
Belgium, Denmark, Greece, Ireland, Luxembourg, the Netherlands, Portugal and the U.K. : share of loans made by the five biggest commercial banks in percent of total industry loans
Source : Banking Supervision Committee (ECB, 1999), Dermine (2003)

The two previous tables show that commercial banks' loans constitute a large share of loans made. These types of banks which are heavily represented in the banking industry are also the ones that experienced an important shift towards financial innovation and non-interest generating activities.

To summarise, we observed in the 1980s a large wave of regulatory reforms in the European banking markets. This prompted increased competition in the lending market between banks and financial markets, and within the banking industry. As a consequence, bank interest margins decreased. In the mean time, banks had to seek new sources of revenue. They increased their sale of services, and sought commission and fee income bringing about a change in banks' revenue structure.

The picture depicted here of the environment in which banks compete shows deep modifications of the activities and behaviours that banks have adopted since deregulation. We have shown, in particular, that service revenue became a major component of banks' income statement. The development of services has been undertaken by banks as an alternative source of revenue, to offset the decrease of traditional intermediation revenue due to increased competition in the banking industry. The disintermediation process means that banks can no longer be defined only as "institutions whose current operations consist in granting loans and receiving deposits

from the public"[9]. In addition to many payments services, they increasingly offer other services such as consulting activities, asset management, brokerage and underwriting services…

Therefore, the rise of commission and fee-based activities is often explained by deregulation and its consequences in terms of competition. One may question, however, whether this evolution of banks' activities is thoroughly explained when considered as a consequence of disintermediation. We could alternatively expect that the rise of the sale of services affects banks' incentives with regard to their intermediation activity. In other words, in the current literature it is supposed that modifications to traditional intermediation activities induced a rise of services. However, a point that remains unexplored is whether this increase of service provision leads to alterations of banks' traditional activity.

We can find in the banking literature some reasons to suspect that this may be the case. Indeed the link between services and the pricing of intermediation has been identified. For example, Barro and Santomero (1972), Mitchell (1979, 1988), Walsh (1983), and Whiteshell (1988, 1992) suggest that service supply may have been used to over-rule regulation and to offer implicit interest to interest rate regulated deposits by supplying services free of charge. This literature shows the existence of an influence of service supply on intermediation products. However, in that case, the supply of services remains an instrument to circumvent the regulation of intermediation activity. Nevertheless, Cukierman (1978) argues that clients with a larger propensity to buy services could be offered more credit (i.e. less credit rationed). This means that banks could be tempted to modify their behaviour with regard to traditional activities in order to sell more services. Under such an approach intermediation products, used as loss leaders, can be seen as a mean to improve profit on service activity.

This causality suggested by Cukierman (1978) naturally raises the issue of whether services could induce modifications of banking behaviour with regard to their lending activity. To our knowledge this question has never been formally discussed in the existing banking literature. From our point of view this is a major issue which enables to take into account the incentives of banks with regard to pricing and risk, the latter being an inherent consequence of the intermediation activity. Precisely, the question raised is how the sale of services impacts on banks' behaviour : do banks modify their

[9] Definition given by Freixas and Rochet (1997), *p.1*.

price setting and the risk they take on the lending market ? Do banks cross-sell service products ?

To answer these questions, our approach is in line with the modern theory of banking. Our objective is to consider the possible effects of new products (or recently charged products) on banks' incentives. This thesis will address this issue both theoretically and empirically.

Chapter 1 reviews the literature which is relevant in explaining how banks set their price with regard to their deposit and loan activities. We first survey the literature that stresses the usual determinants of bank margins. However, the reviewed frameworks do not model risk, i.e. risk is at most taken as given, even though it is an inherent consequence of banking activities. Therefore, the asymmetric information paradigm is considered in order to analyse more precisely price setting and banks' incentives whilst modelling risk. Finally, we survey the banking literature with regard to cross-subsidisation whilst considering banks from a multi-product firm point of view. This literature lacks any relevant framework which fits our issue. We therefore need a specific approach combining cross-subsidisation and asymmetric information in an integrated model of loan price determination.

We assess, in chapter 2, the relevance of our questioning. To do so, we survey the empirical literature, which complies with the theoretical review on bank interest margins. The aim of this review is to emphasise the appropriate determinants of bank margins, before investigating our issue. The relevant factors being chosen, we can include commission and fee revenue in our own study. The empirical estimations undertaken attempt to explain bank interest margins in the context of European countries in the 1990's. This study aims to provide a preliminary analysis of banks' behaviour in terms of pricing strategy within traditional theoretical frameworks of bank margins.

Our theoretical and empirical review of the literature prompts us, in chapter 3, to build a model in the steps of the microeconomic theory of banking. We aim to show theoretically that the sale of services may induce an evolution in banks' incentives

towards pricing and risk. For that purpose, we use a principal-agent framework in order to emphasise banks' incentives, and in which the bank must cope with adverse selection problems. The bank cannot observe the level of risk of the project undertaken by the firm without screening. We also consider the bank as a multi-product firm, which therefore sells not only loans but services as well. Our objective is then to analyse the possible interactions between these two activities, and the consequences on the intermediation activity of banks.

Finally, in chapter 4, the theoretical results highlighted in the previous chapter are empirically investigated. Using panel regressions, we conduct an analysis for each of the twelve European countries considered in chapter 2, covering the period 1989-1999. Two empirical specifications derived from the theoretical model developed in chapter 3 are defined for each countries. Their purpose is to assess the effect of the modification of banks' incentives due to the sale of services, firstly on the lending rate, and secondly on credit risk.

CHAPTER 1.

LOAN PRICING AND MARGIN SETTING IN SINGLE AND MULTI-PRODUCT BANK FIRMS : A REVIEW OF THE LITERATURE

1.1. Introduction

As seen in the general introduction, banks' income structure is characterised since the 1980s by the decrease of net interest margins and the increase of commission and fee revenue (Boyd and Gertler, 1994, Edwards and Mishkin, 1995, ECB, 2000a). Competitive pressure prompted by deregulation and disintermediation is the standard explanation of such an evolution. According to this argument, banks have been led to decrease their margin to face new competitors on their traditional activities, i.e. loans and deposits (Plihon, 1998, Scialom, 1999, Daley, 2001). Thereby they had to find other sources of revenue, within which fee and commission activities. The supply of different products may induce other effects than the substitution of one source of profit to another. We are therefore concerned by possible links between standard intermediation, as the provision of loans, and non-bank specific activities that could influence banks' incentives. Loans and deposits have sometimes been considered as loss leaders (Cukierman, 1978, Chiappori *et al.*, 1995), and we wonder how banks' behaviour is affected by the sale of services. In other words, our concern is the impact of the sale of services on banks' incentives, with regard to their traditional lending activity.

We are aiming in this chapter to over-view the literature dealing with loan price setting, with the issue of margin setting. Indeed, as we have already said, we may suspect that the traditional explanation of the link "decreasing margins-rise of service revenue" is only partial. We may wonder if this phenomenon does not conceal a new kind of competition between banks. To address this point we first need to have a clear understanding of banks' incentives and the inter-relation which can exist between credits and services. Indeed, we need a theoretical background to support potential alternative effects of services. This implies to understand clearly what are the determinants of banks' behaviour on their traditional activities, and among them to stress the role of risk. Once this preliminary work done, the next step consists in trying to understand how other activities could interact with the behaviour previously exposed.

In a second section, our objective is to focus on the traditional margin explanation. We therefore first study the modelling of banks' revenue in a perfect information market setting. The theoretical literature (Klein, 1971, Monti, 1972, Ho and Saunders, 1981, Zarruk, 1989) has focused on the intermediation activity of banks, that is the determination of loan and deposit interest rates. We present models of the banking firm, in which both loan and deposit rates are determined. Nevertheless, in that field, we observe that the effect on risk has not been completely taken into account.

In order to redress this shortcoming, we briefly review, in a third section, the incompleteness of the lending market. Indeed asymmetric information makes the credit risk exposure the result of banks' choice. Therefore we are not only able to complete our analysis of the link between price and risk but also to study the endogenous determinants of the former. This point is not only crucial to understand banks pricing, but it could also impact on banks' behaviour once dealing with activities other than traditional intermediation.

As a matter of fact, in the models considered in sections 1.2. and 1.3., no products other than loans and deposits are taken into consideration. That may be a shortcoming with regard to our analysis as we suspect the existence of other activities to profoundly modify banks' behaviour on their traditional activities. We thus survey, in a fourth section, the bank as a multi-product firm. More precisely, we review the existing literature on the possible cross-subsidisation between bank products.

1.2. Return and price setting with perfect information

The determination and the explanation of prices in the banking sector have long been studied. What make the contributions of Monti (1972) and Klein (1971) original is that they intend to explain it modelling both sides of the balance sheet. More precisely, they build a complete model of the banking firm in which deposit and loan activities are thoroughly explained.

To determine prices in the banking market, we first present a so called "complete model"[1] of the banking firm that does not only explain banks' asset and liability choices and their interactions (if any), but also the determination of the total size of the firm.

The seminal works of Monti (1972) and Klein (1971), which explain not only firm scale, portfolio structure, but also asset and liability prices, rely on several assumptions. First, the presence of monopoly power is perceived as something characteristic of banking market. Secondly the models disregard the explicit introduction of risk, and when introduced in Monti-Klein extensions the bank is still assumed risk neutral.

In the following subsections, we intend to review the literature which explains the setting of bank prices. Whilst surveying this issue, we aim to underline the changes induced by the introduction of risk and risk aversion.

1.2.1. Bank interest margins in the Monti-Klein approach

Monti (1972) and Klein (1971) are among the first to offer a modelling of the banking firm. They propose a simple microeconomic model of the banking firm in which the equilibrium scale of the bank, the composition of asset portfolios, as well as the bank's liability structure and the level of interest rate are endogenously determined.

[1] In contrast with partial models which explain only one side of the bank's balance sheet. See for instance Baltensperger (1980) and Santomero (1984) for a review of these models.

The model presented here is a simplified version of their work, and is primarily based on Monti's article.

1.2.1.1. A presentation of the Monti-Klein model

The Monti-Klein model considers a monopoly bank. The bank has two primary sources of funds : the equity originally invested in the firm, denoted *E*, and borrowed funds secured through the issuance of deposits, denoted as *D*. The amount of deposits collected, *D*, is a positive function of the interest rate on deposits, r_D : the function will be noted $D(r_D)$[2].

Funds are allocated between two types of asset. On the one hand, the bank is granting loans *L*, whose rate of return is r_L[3]. The demand for loans, $L(r_L)$, is a decreasing function of the lending rate. On the other hand, the bank holds reserves, *R*, which are invested in a risk-free asset (government bonds), which yields an interest rate *r*.

The equilibrium constraint is :

$$D + E = L + R \tag{1.1}$$

The cost function of the bank is denoted $C(L,D)$. We can then write the bank profit as:

$$\pi = r_L(L).L - r_D(D).D + r.R - C(L,D) \tag{1.2}$$

in which $r_L(L)$ and $r_D(D)$ are the inverse demand functions of loans and deposits.

[2] In Klein (1971), banks issue two types of deposits, *demand deposits*, on which law precludes the payment of explicit interest, and *time deposits*, on which interests are paid. However, to simplify the presentation, supplies of both types of deposits are supposed to be a positive function of the interest rate. Hence, we retain here only one type of deposits.

[3] Klein (1971) assumes an exogenous default risk on loans, which means that banks know with certainty the return on their loans (the rate of return on loans is just smaller than the lending rate). Therefore to simplify the presentation, rate of return and lending rate are supposed to be the same in the next paragraph.

Given that equity funds are exogenous and given equation (1.2), the amount of government bonds held by the bank can be expressed as a function of loans and deposits. We can rewrite the profit equation as follows :

$$\pi = \left(r_L(L) - r\right)L + \left(r - r_D(D)\right)D + r.E - C(L,D) \tag{1.3}$$

The bank chooses the quantity of loans and deposits it issues in order to maximise its profit.

So, the first order conditions which have to be satisfied are :

$$\frac{\partial \pi}{\partial L} = r_L(L) - r + r_L'(L).L - C_L'(L,D) = 0 \tag{1.4}$$

$$\frac{\partial \pi}{\partial D} = r - r_D(D) - r_D'(D).D - C_D'(L,D) = 0 \tag{1.5}$$

Given $L(r_L)$ and $D(r_D)$ respectively the demand functions of loans and deposits, and $r_L(L)$ and $r_D(D)$ the inverse demand functions of loans and deposits, we have the following relationships :

$$r_L'(L) = \frac{1}{L'(r_L)} \qquad \text{and} \qquad r_D'(L) = \frac{1}{D'(r_D)} \tag{1.6}$$

Therefore, if we take into account the elasticity of demand for loans, ε_L, and for the supply of deposits, ε_D, such that :

$$\varepsilon_L = -\frac{r_L L'(r_L)}{L(r_L)} > 0 \text{ [4]} \quad \text{and} \quad \varepsilon_D = \frac{r_D D'(r_D)}{D(r_D)} > 0 \tag{1.7}$$

[4] The minus sign is only there to ensure that the elasticity ε_L is positive, which is the more usual and more convenient convention.

Solutions of equations (1.4) and (1.5) can be characterised by :

$$\frac{\left(r_L^* - r\right) - C_L'}{r_L^*} = \frac{1}{\varepsilon_L\left(r_L^*\right)} \tag{1.8}$$

$$\frac{\left(r - r_D^*\right) - C_D'}{r_D^*} = \frac{1}{\varepsilon_D\left(r_D^*\right)} \tag{1.9}$$

The result found here is a traditional microeconomic relationship between the Lerner index and inverse elasticity. Each Lerner index is a measure of the net margin rate, that is the price minus the cost, divided by the price. A bank chooses the volume of loans and deposits such that the Lerner indices equal inverse elasticities of demand for loans and supply of deposits. The greater the market power of the bank on loans (respectively deposits), the higher the Lerner index and the smaller the elasticity[5]. In contrast, the perfect competitive model corresponds to the limit case of infinite elasticities. In which case, we find that prices of loans and deposits are equal to their respective marginal cost.

The intermediation margin (r_L*– r_D*) is increasing with market power. In a competitive market, the interest margin just enables the bank to cover the cost of loans and deposits, whereas in a monopoly market we obtain :

$$\left(r_L^* - r_D^*\right) = \left(\frac{r_L^*}{\varepsilon_L} + \frac{r_D^*}{\varepsilon_D}\right) + \left(C_L' + C_D'\right) \tag{1.10}$$

The intermediation margin is a decreasing function of the elasticities of the demand for loans and the supply of deposits. Hence if substitutes to banking products appear on financial markets, elasticities will increase and the intermediation margin will decline. In other words, the justifications of the existence of margin for Klein (1971) and Monti (1972), are the addition of the marginal cost of loans and the marginal cost of deposits and the monopoly power of the bank.

[5] The intuitive result is that intermediation margins are higher when banks have a higher market power.

1.2.1.2. Separability theorem

The usual outcome of the Monti-Klein model lies in the separability theorem of the determination of the lending and deposit rates. Such a result can be demonstrated if we assume that costs are separable by activity, such as (*cf.* Lobez, 1997):

$$C(L,D) = aL + bD + c \tag{1.11}$$

Then, equations (1.8) and (1.9) can be rewritten :

$$\frac{\left(r_L^* - r\right) - a}{r_L^*} = \frac{1}{\varepsilon_L\left(r_L^*\right)} \quad \Leftrightarrow \quad r_L^* = \frac{r + a}{1 - \frac{1}{\varepsilon_L}} \tag{1.12}$$

$$\frac{\left(r - r_D^*\right) - b}{r_D^*} = \frac{1}{\varepsilon_D\left(r_D^*\right)} \quad \Leftrightarrow \quad r_D^* = \frac{r - b}{1 + \frac{1}{\varepsilon_D}} \tag{1.13}$$

The interest rates on loans and deposits are determined separately and are independent one of the other. The optimal deposit rate is independent of the characteristics of the loan market, and the optimal loan rate is independent of the characteristics of the deposit market. Both the deposit and loan rates are an increasing function of the risk free rate, *r*.

The finding of independence between loan and deposit rates decisions, which is a seminal result of this model, has been obtained under the assumption of monopoly market. A question raised is whether the independency result would still hold under an oligopolistic structure.

1.2.1.3. An oligopolistic structure of the banking market

While loosening the monopoly assumption to an oligopolistic one, we investigate if the separability theorem is relevant. The Monti-Klein model can easily be reinterpreted as a model of imperfect competition *à la* Cournot between a finite number *N* of banks (see, for instance, Freixas and Rochet (1997)). In their model, Freixas and Rochet (1997) consider a banking industry including a number *N* of banks which have the same linear cost function. The only difference between the monopoly case and the Cournot equilibrium is that elasticities are multiplied by *N*. The lending and deposit rates can then be rewritten such as :

$$\frac{\left(r_L^* - r\right) - a}{r_L^*} = \frac{1}{N\varepsilon_L\left(r_L^*\right)} \quad \Leftrightarrow \quad r_L^* = \frac{r + a}{1 - \frac{1}{N\varepsilon_L}} \tag{1.14}$$

$$\frac{\left(r - r_D^*\right) - b}{r_D^*} = \frac{1}{N\varepsilon_D\left(r_D^*\right)} \quad \Leftrightarrow \quad r_D^* = \frac{r - b}{1 + \frac{1}{N\varepsilon_D}} \tag{1.15}$$

The interest rates are sensitive to the market structure. As *N* increases, the deposit rate is more and more sensitive to the risk free rate, the inverse prevailing for the lending rate [6]. In other words, when the intensity of competition increases, the deposit rate set by banks follows more closely a change in the risk-free rate, whilst the inverse prevails for the lending rate. However the separability theorem still holds under an oligopolistic market structure assumption.

To summarise, other things being equal, the margin increases with the marginal cost of deposits and loans, and with banks' market power. Moreover, the setting of lending and deposit rates remains distinct in a non competitive environment. Despite its

6 $\frac{\partial r_L^*}{\partial r} = \frac{1}{1 - \frac{1}{N\varepsilon_L}}$; $\frac{\partial r_D^*}{\partial r} = \frac{1}{1 + \frac{1}{N\varepsilon_L}}$. The first derivative of the loan rate with respect to the risk free rate is an increasing function of *N*. The first derivative of the deposit rate with respect to the risk free rate is a decreasing function of *N*.

fundamental contribution to understanding banks' behaviour with regard to price setting, one main criticism may be addressed to the previous approach. Indeed the "Monti-Klein framework" does not take into account the risk that is inherent in banking activities. The latter being a main focus of our work, we will now survey the contributions which aimed to include risk inside the Monti-Klein approach. However it should be already noticed that risk in the next models is not influenced by banks' price decisions. Indeed risk is supposed to be given. It is neither a consequence of banks' decisions, nor induced by the nature of banks' activities[7].

1.2.1.4. The explicit introduction of risk in a Monti-Klein model

Obviously risk is a major dimension of the banking activity. Its introduction within the Monti-Klein model can be considered as a necessary improvement. Moreover, it will deeply modify the results reviewed above. The separability theorem between deposit and credit rates setting is no longer true if we take into account default risk (Dermine, 1984) or liquidity risk (Prisman, Slovin and Sushka, 1986; Freixas and Rochet, 1997). We will conclude also that risk should be a determinant of interest rates setting, in other words prices, as we observe that the expected profit of bank is affected by the risk.

Different types of risk have been introduced in the literature previously reviewed, all exogenously. To emphasise the impact of risk on the interest rate margin, we firstly deal with credit risk, and then with liquidity risk.

[7] As it will be seen in section 2, as soon as asymmetric information is introduced, the level of risk is determined also by banking decisions.

- **Introduction of default risk : the end of separability**

Dermine (1984) takes into account the possibility that borrowers default before repaying their loan to the bank. This may happen because borrowers' end-of-period wealth (w) is smaller than the value of loans they were granted, $w < L$. As a result, the bank may become insolvent.

If borrowers default, w is refunded to the bank. There is a value of w, $\tilde{w}$, such that the bank can no longer meet its obligation toward depositors, that is the bank is unable to repay depositors their end-of-period wealth. $\tilde{w}$ is defined as follows :

$$\tilde{w} + R(1+r) = D(1+r_D) \quad \Leftrightarrow \quad \tilde{w} = D(1+r_D) - R(1+r) \tag{1.16}$$

We remind that R stands for the amount of reserves held on the asset side of the balance sheet.

Given the equilibrium constraint (1.1), we can rewrite (1.16) :

$$\tilde{w} = L(1+r) + D(r_D - r) - E(1+r) \tag{1.17}$$

E being the value of equity.

The bank goes bankrupt when borrowers' wealth is smaller than $\tilde{w}$ (equation 1.17). This value of borrowers' wealth depends directly on the amount of loans, $L(r_L)$, which are themselves a function of the lending rate, r_L.

Depositors anticipate the possibility of a bankruptcy, which means that they anticipate the actual deposit rate they will perceive to be smaller than r_D. We call the actual deposit rate perceived by depositor $\hat{r}$. If there is no bankruptcy ($w > \tilde{w}$), depositors will get $D(1+r_D)$. However, if the bank becomes insolvent, depositors will receive the residual value of the bank, that is :

$$w + R(1+r) < D(1+r_D) \tag{1.18}$$

Finally, the value of deposits anticipated by depositors is :

$$D\left(1+\hat{r}\right) < D\left(1+r_D\right) \tag{1.19}$$

The amount that depositors expect to be repaid is a function of borrowers' end-of-period wealth *w*, which depends on the lending rate. Therefore the separability of deposit and credit rates does no longer hold, and the rate of return of depositors is altered by risk.

The author's statement is that risk modifies price setting. In this model, risk only affects the asset side of the bank's balance sheet, but it may also impact on the other side of the balance sheet, like for instance liquidity risk.

- **Introduction of liquidity risk and the determination of interest rates**

Liquidity risk can be introduced by assuming some randomness either in the volume of loans distributed by the bank (Prisman, Slovin, and Sushka, 1986), or in the volume of deposits collected by the bank (Freixas and Rochet, 1997). We assume here that the volume of deposits is subject to random shocks.

Let us consider a random amount of withdrawals, denoted $\tilde{x}$, that will be subtracted at the end of the period. Assuming no other sources of funds are available to the bank, the amount of reserves is :

$$R = E + D\left(r_D\right) - L\left(r_L\right) \tag{1.20}$$

If withdrawals happen to be higher than reserves (i.e. $R < \tilde{x}$), the bank will need to be refinanced at a penalty rate r_P (which can be considered as the money market rate). The expected profit of the bank is thus :

$$\pi = r_L\left(L\right).L - r_D\left(D\right).D + rR - C\left(D,L\right) - r_P \text{Exp}\left[\max\left(0,\tilde{x}-R\right)\right] \tag{1.21}$$

"Exp" stands for expected value.

So, given the equilibrium constraint (1.20) :

$$\pi = \left[r_L(L) - r\right]L + \left[r - r_D(D)\right]D + rE - C(D,L) - r_p \mathrm{Exp}\left[\max\left(0, \tilde{x} - E - D + L\right)\right] \quad (1.22)$$

To determine the optimum value of r_L and r_D that will maximise the profit, we need first to derive the bank profit (equation 1.22) with respect to L and D, and then to introduce the elasticities of the demand for loans and the supply of deposits (see equation 1.7). The optimum values are :

$$r_L^* = \frac{r + a + r_P \Pr\left[\tilde{x} \geq R\right]}{1 - \frac{1}{\varepsilon_L}} \quad (1.23)$$

$$r_D^* = \frac{r - b + r_P \Pr\left[\tilde{x} \geq R\right]}{1 + \frac{1}{\varepsilon_D}} \quad (1.24)$$

Compared to the results obtained in the Monti-Klein model, the lending and deposits rates now include the expected cost of a liquidity shortage, in other words a refinancing cost due to a shortage of liquidity. The refinancing cost is measured by the probability of a liquidity shortage, which depends on the amount of reserves R held by the bank, which itself depends on the difference between loans and deposits. Therefore the lending rate is determined not only as a function of banks' assets but also as a function of the liability side. We also observe the same phenomenon for the deposit rate, which depends on both side of the bank balance sheet. Once more, the separation between the pricing of loans and deposits is invalid, and prices are modified if risk is taken into account.

To summarise, the main contributions brought by the introduction of risk show that the two interest rates cannot be considered to be unrelated and that risk itself is a component of loan and deposit pricing.

However the effect of this introduction is rather mechanical since risk is exogenously introduced and moreover banks are considered as risk neutral. The argument of risk aversion will be introduced in the following subsections, firstly in

revisited versions of the Monti-Klein approach (the micro-model of the banking firm), and secondly within a different paradigm (the dealership approach). These two approaches will highlight the role of risk in a more thorough way than has been done hitherto.

1.2.2. Risk aversion and bank interest margins

As we have previously said, risk in the Monti-Klein model has, until now, been introduced rather mechanically. Indeed banks face given levels of risk, that is risk is independent of banks' behaviour, and they remain risk neutral. To investigate bank risk aversion, Zarruk (1989) uses a model, based on Sealey (1980), which introduces risk and cost considerations to the firm theoretic approach developed by Klein (1971) and Monti (1972). Therefore, in Zarruk's model of bank interest margin, the bank is viewed as a firm in a static setting where demands and supplies of loans and deposits simultaneously clear both markets[8].

1.2.2.1. Default risk, interest rate risk, and regulation

The model, developed here, is primary borrowed from Wong (1997). Let us consider a bank which makes decisions in a single period horizon. The bank can acquire two kinds of assets corresponding to risky non-tradable loans (L) and interbank market loans. The bank holds three types of claims : deposits (D), borrowings on the interbank market, and equity capital (E), which is assumed to be fixed over the planning horizon.

At the beginning of the period, the bank has the following balance sheet :

$$D + E = L + B \tag{1.25}$$

[8] Banks are acting as price or quantity setters in loan and deposit markets, respectively.

where B is a composite variable representing the bank's net position on the interbank market.

On the loan market, a monopoly structure is assumed where the bank sets the interest rate on the loans it grants, r_L. Thus, we simply consider a bank facing a downward sloping loan demand function $L(r_L)$, ($L' < 0$, $L'' \leq 0$) and serving a fixed interest rate as a monopoly. On the deposit market, supply is assumed to be perfectly elastic. The bank can determine the optimal amount of deposits it issues but not the level of the interest rate r_D.

Default risk arises because loans are risky and they are subject to non-performance. Without loss of generality, it is assumed that non-performing loans pay nothing to the bank. The actual value of loan repayments to the bank is therefore $(1-\gamma)(1+r_L)L(r_L)$, which is less than or equal to the value of the total contractual loan repayments, $(1+r_L)L(r_L)$, depending on the realisation of γ at the end of the period[9]. γ is a random variable with support [0,1], with a probability distribution function known by the bank, $f(\gamma)$, and assumed independent of the level of lending. Adverse selection and/or moral hazard problems, that the bank may confront in setting loan rate, are ignored.

Deposits issued by the bank have a maturity shorter than one period, so that the interest rate at which deposits have to be rolled over within the period is unknown to the bank. The bank is therefore exposed to interest rate risk since it funds fixed-rate loans via variable-rate deposits. Within the structure of the model, the sources of interest rate risk are located solely on the liability side of the balance sheet. In this framework the usual assumption of a positive relationship between loan defaults and the deposit rate is adopted[10].

[9] In other words, credit risk is modelled with γ that is a proportion of non-performing loans in the loan portfolio at the end of the period.

[10] Sealey (1980) argues that this assumption "can be justified on the basis of business cycle movements in loan defaults and deposits".

Interest rate risk thus occurs because loans have a longer maturity than deposits, and because of the assumption of a positive relation between deposit rate and credit risk. We therefore have :

$$r_D = r_D(\gamma) + \nu \tag{1.26}$$

where $r'_D(\gamma)>0$ and ν is a white noise independent of γ, defined over $\left[\underline{\nu}, \bar{\nu}\right]$, and with a probability distribution $h(\nu)$ known by the bank.

In order to partially control for banking risk, regulation is imposed and banks have to satisfy the following capital adequacy requirement :

$$E \geq \kappa D\,, \tag{1.27}$$

where κ is the required minimum capital-to-deposits ratio.

The bank's end-of-period profit is given by:

$$\pi = rB + (1-\gamma) r_L L - \gamma L - r_D D - C_L.L - C_D.D \tag{1.28}$$

where r is the money market interest rate, C_L and C_D stand for (respectively) the constant marginal administrative cost of loans and deposits. Costs are assumed to be separable.

Using the balance sheet identity (1.25), equation (1.28) can be rewritten as :

$$\pi = \left((1-\gamma) r_L - r - C_L\right) L + \left(r - r_D - C_D\right) D + rE \tag{1.29}$$

The bank is assumed to be ***risk averse***[11], its aim is thus to maximise the expected utility of its end-of-period profit. Let $U(\pi)$ be the Von Neumann-Morgenstern utility function of the bank defined over the bank's end-of-period profit, π. We suppose $U'>0$, and $U''<0$. The objective of the bank can be written as follows :

$$\max_{r_L} \operatorname{Exp}\left[U(\pi)\right] = \int_0^1 \int_{\underline{\nu}}^{\bar{\nu}} U\left[\pi(\gamma,\nu)\right] f(\gamma)\, h(\nu)\, d\gamma\, d\nu \tag{1.30}$$

[11] Traditional explanations for risk aversion behaviour in banks include : (*i*) the management's inability to diversify its human capital; (*ii*) insufficient owner diversification; (*iii*) incentive problems such as moral hazard and adverse selection which are associated with government regulation (e.g. deposit insurance, etc…). These regulations in turn require banks which enjoy protection to limit risk; and (*iv*) bankruptcy cost resulting from partial or complete default.

1.2.2.2. Risk aversion and optimal bank margins

The first conditions for an optimum are :

$$\frac{\partial \mathrm{Exp}\left[U(\pi^*)\right]}{\partial r_L} = \mathrm{Exp}\left[U'(\pi^*)\left((1-\gamma)\left(1-\varepsilon_L^{*-1}\right)r_L^* - r - C_L\right)\right]L'\left(r_L^*\right) = 0 \qquad (1.31)$$

$$\frac{\partial \mathrm{Exp}\left[U(\pi^*)\right]}{\partial D} = \mathrm{Exp}\left[U'(\pi^*)\left(r - r_D(\gamma) - \varepsilon - C_D\right)\right] = 0 \qquad (1.32)$$

where in equation (1.31) r_L^* is the optimal loan rate, π^* is defined by equation (1.29) which is evaluated at r_L^*, $\varepsilon_L^* = -L(r_L^*) / r_L^* L'(r_L^*)$ is the elasticity of loan demand with respect to the lending rate r_L^* ; and in equation (1.32) π^* is defined by equation (1.29) which is evaluated at D^*.

The optimal bank interest margin is defined as $r_L^* - \overline{r_D}$, where $\overline{r_D} = \mathrm{Exp}(r_D)$. Since $\overline{r_D}$ is not a variable set by the bank, the properties of the optimal bank interest margin are the same as those of the optimal loan rate.

The result of a comparison between a risk-averse versus a risk-neutral bank may be explained in a rather intuitive way : the optimal bank interest margin is larger when the bank is risk averse than when the bank is risk neutral.

Indeed in the risk neutral case, U' (in equation (1.31)) is a constant and thus the first condition becomes :

$$\left(\left(1-\overline{\gamma}\right)\left(1-\varepsilon_L^{-1}\right)r_L - r - C_L\right) = 0 \qquad (1.33)$$

where $\overline{\gamma} = \mathrm{Exp}(\gamma)$, r_L is the loan rate when the bank is risk neutral, C_L and ε_L are respectively the administrative cost and the interest rate elasticity of loan demand evaluated at the risk neutral lending rate. In the case of a risk neutral bank, the optimal loan rate is set such as the expected marginal income on loans equals the interbank market rate, which is the well-known result derived by Klein (1971) under risk neutrality.

In the case of a risk averse bank, Wong (1997) shows that :

$$\left(\left(1-\overline{\gamma}\right)\left(1-\varepsilon_L^{*-1}\right)r_L^* - r - C_L\right) > 0 \qquad (1.34)$$

In other words, when the bank is risk-averse, a risk premium is charged on loans to offset credit risk exposure, and the amount of loans granted is lower than in the case of risk neutrality.

1.2.2.3. The impact of determinants on bank margins

In addition, other results have been demonstrated. We now consider the effects on the optimal rate from changes in the parameters of the model, if the bank's utility function exhibits decreasing absolute risk aversion (DARA) in Ross sense[12].

Since ε_L is proportional to the Lerner index of the bank, ε_L is a measure of the bank's market power (see Tirole, 1993). It can be shown that a size-preserving increase in the bank's market power will increase the optimal bank interest margin.

An increase in the marginal administrative cost of loans, C_L, has two effects. On the one hand the substitution effect captures the change of the lending rate due to an increase in the administrative cost. The effect is unambiguously positive. Indeed an increase in C_L makes loans more costly to grant, therefore the bank has an incentive to reduce the amount of loans it grants by charging a higher lending rate, *ceteris paribus*. On the other hand, the income effect arises because an increase in C_L decreases the bank's profit. The sign of the income effect is usually indeterminate. However under DARA, the sign is positive. In other words, as operating costs increase, income declines and with DARA the bank becomes more risk averse and is unwilling to take on greater

[12] According to Ross (1981), *U* exhibits Decreasing Absolute Risk Aversion (DARA) if, and only if, there exists a positive constant λ such that :

$$-\frac{U'''(\pi)}{U''(\pi)} \geq \lambda \geq -\frac{U''(\pi)}{U'(\pi)} \text{ for all } \pi.$$

risk. Thus the bank rises its lending rate. Therefore we can conclude that an increase in the marginal administrative cost of loans will increase the optimal bank interest margin.

As before, a mean-preserving[13] increase in credit risk, γ, has both a substitution and an income effect. The former arises because greater credit risk increases the relative riskiness of loans compared to lending in the interbank market, encouraging the bank to avoid issuing risky loans even when compensated, to remain at an unchanged level of expected utility. The latter effect occurs because greater credit risk reduces the reachable expected utility under risk aversion. At the greater level of risk, the bank has to be compensated with additional income to obtain the former expected utility level. Therefore the income effect reinforces the substitution effect, and a mean-preserving increase in credit risk will increase the optimal bank interest margin.

A mean-preserving increase in the interest rate risk, measured by ν, has only an income effect in the model[14] similar to the previous one. And thus, a mean-preserving increase in the interest rate risk will increase the optimal interest margin.

The effect of an increase in bank's equity, *E*, depends on the intensity of interest risk. In the absence of interest risk, an increase in equity capital increases the bank's profit. Under DARA, the bank becomes less risk averse and is thus willing to grant more risky loans by lowering the lending rate. However if we suppose interest risk, a countervailing force arises because the enlarged capital base allows the bank to issue more variable rate deposits whilst still satisfying the capital adequacy requirement. This increases the variability of the bank's profit which in turn induces the bank to take on less risky loans by raising the loan rate. Thus, to summarise, if the interest rate risk is not severe, an increase in the bank's equity capital will decrease the optimal bank interest margin. Otherwise, the effect is ambiguous.

[13] A mean preserving spread in the distribution of a random variable redistributes the weight of the distribution from the centre to the tails while keeping the mean of the distribution unchanged (see Rothschild and Stiglitz (1970)).

[14] As the capital adequacy requirement is assumed to be binding, interest rate risk is exogenous in the model and thus substitution effect is absent.

Finally, the effect of an increase in the interbank market rate, *r*, on the one hand makes lending in the loan market less attractive relative to the interbank market. This induce the bank to invest less in loans by charging higher lending rate. On the other hand, depending on the net position of the bank in the interbank market, net borrower or net lender, a rise in the interbank market rate will respectively decrease or increase the bank's profit. In the first case, an increase in the interbank market rate will increase the optimal bank margin, in the second one the effect is ambiguous.

In other words, the authors find that the optimal interest margin is positively related to the bank's market power, to operating costs, to the degree of interest rate risk, and to the degree of credit risk. However, the effect of changes in the money market interest rate on the optimal margin is ambiguous and depends on the bank's net position in the interbank market. Furthermore, the bank's equity capital is negatively related to the margin when interest risk is trivial.

Zarruk and Madura (1992), who have extended the firm theoretic model of bank margins, account for capital regulation and deposit insurance in a more detailed way than Wong. The required capital to deposits ratio is assumed to be an increasing function of the amount of loans held by the bank. The authors also suppose that the bank is fully insured and pays an insurance premium per monetary unit of deposits. Zarruk and Madura show, when deposits are insured, that an increase in the capital to deposits ratio decreases bank margins, assuming decreasing or constant absolute risk aversion (CARA). They also find that an increase in the cost of deposit insurance, through a higher premium, encourages the bank to shift investment to its loan portfolio from interbank market assets. The bank reduces the optimal margin in order to increase the amount of loans it grants, under DARA and CARA.

To summarise, the introduction of risk aversion in firm theoretic models lead to increasing bank interest margin. In addition to standard determinants of interest rates found in the first subsection, and the ones stressed within this subsection, the behaviour of banks towards risk become clearly a major determinant of its price setting. The same

issue, namely bank aversion and banking prices, is addressed within a different framework which will enable us to expose new determinants of banking prices.

1.2.3. Bank interest margins in the dealership approach

A different approach of banking activities was provided by Ho and Saunders (1981). They were concerned about volatility, that is interest rate risk, adapting the financial literature to the liquidity provision issue. Indeed, like the market maker, a bank can be considered as providing liquidity to the market, and it will thus hold illiquid assets. Therefore this approach explains the illiquidity of banks' assets and liabilities.

In this approach, the bank is viewed as a dynamic dealer, setting interest rates on loans and deposits to balance the asymmetric arrival of loan demands and deposit supplies, whilst in the previous models it is assumed that demand for loans and supply of deposits simultaneously clear both markets. A bank is viewed as paying for funds (deposits) at one price (the "bid" price) and lending funds at another (the "ask" price).

Economists, such as Ho and Stoll (1980), have studied the determination of the bid-ask prices as a function of the characteristics of the security, as well as the inventory policy of the trader. Ho and Saunders (1981) analyse the bank's brokerage function, adapting the finance literature on broker bid and ask spreads, to explain the bank's margin, that is the spread between the bid and ask price[15]. The purpose of the model is to provide a simple framework for characterising the risk factors that influence the determination of bank net interest margin.

[15] The framework employed by Ho and Saunders was originally intended for the analysis of the trading activities of security dealers. As stated by Zarruk (1989), they thus fail to consider some appropriate aspects of a bank's operation. Some relevant features of banks are not taken into account by the dealership approach. First, financial intermediaries evolve in imperfect market structures, asset and deposit markets are not perfectly competitive. Second, the approach ignores the resource costs incurred by financial intermediation.

1.2.3.1. Risk aversion and liquidity uncertainty

In the contribution of Ho and Saunders[16], the bank is viewed as a dealer in the credit market acting as an intermediary between the demanders and suppliers of funds. The planning horizon is a single period during which banks' rates, which are determined prior to observing the demand for immediacy, are held constant. A single transaction in loans and deposits occurs.

In this approach, the bank is considered to be risk averse. The authors assume that the bank maximises its expected utility of terminal wealth. This assumption may be justified on two grounds. First, risk aversion is crucial to justify the existence of interest margin[17]. Second, it ensures a finite bank size, as well as the existence of riskless investments in money market. Without risk aversion, there is no limit to the extent that the bank may engage in arbitrage.

It is assumed that the bank's portfolio consists of two assets and two liabilities: loans outstanding, *L*, the bank's short term net cash or money market position *B* [18], deposits, *D*, and shareholders' funds, *E*. The value of the bank at the beginning of the period is defined as :

$$E_0 = L_0 - D_0 + B_0 \;\Leftrightarrow\; D_0 + E_0 = L_0 + B_0 \tag{1.35}$$

The bank equilibrium constraint, i.e. assets equal liabilities, has to be satisfied.

With no transaction occurring, the terminal value of wealth is:

$$E_T = (1+r_I) I_0 + I_0 \tilde{Z}_I + (1+r) B_0 \tag{1.36}$$

[16] The model which is developed in what follows is adapted from Ho and Saunders (1981).

[17] "Within the dealership framework the margin would always exist because of uncertain liquidity needs of borrowers and depositors.[…] The dealer bank emerges to engage in arbitrage up to a point determined only by its degree of risk aversion. This, of course, presumes that without risk aversion, interest margins would not exist since arbitrage would eliminate the margin (baring transaction costs)." (Angbazo, 1997, *p.58*).

[18] The cash position can be viewed as the net position of the bank in the interbank market, and other short term markets for temporary borrowings and loans.

where (*i*) I_0, the difference between loans and deposits, $I_0 = L_0 - D_0$, is the net credit inventory, (*ii*) r_I is the expected rate of return on net credit inventory, $r_I = r_L \frac{L_0}{I_0} - r_D \frac{D_0}{I_0}$ where r_L and r_D are the interest rates on loans and deposits, (*iii*) r is the expected rate of return on the net cash position, r is the money market risk-free rate as shown below, and (*iv*) $\tilde{Z}_I$ is a random variable impacting on rate of returns, where $\tilde{Z}_I = \tilde{Z}_L \frac{L_0}{I_0} - \tilde{Z}_D \frac{D_0}{I_0}$. The distribution of $\tilde{Z}_I$ is normal with $\mathrm{Exp}\left(\tilde{Z}_I\right) = 0$ and is stationary with respect to the parameters of the model.

The bank in this model is assumed to act as a passive dealer, it only has the power to alter prices as a tool to manipulate demand for its product. The bank is assumed to set on the one hand its net of expense deposit rate, r_D, equal to its expectation of the instantaneous money market risk-free rate of interest for the period, r, minus a deposit service fee, a. On the other hand the net of expense loan rate, r_L, is set equal to the expected instantaneous rate, r, plus a loan service fee, b. Thus :

$$r_D = (r - a) \tag{1.37}$$

$$r_L = (r + b) \tag{1.38}$$

where a and b are fees charged by the bank in order to provide deposit and loan immediacy, and to bear interest rate risk.

Indeed, suppose a deposit arrives before a new loan demand, the bank will have to temporarily invest the funds in the money market at the short term risk-free rate r. The bank faces then reinvestment risk at the end of the decision period should the short term rate fall. Similarly, if the demand for a new loan is met by the bank without a contemporaneous inflow of deposits, the bank would have recourse to short term borrowing in the money market at a rate r to fund the loan, thereby facing interest rate risk if the short term interest rate rises.

Using the Taylor series expansion around the expected level of wealth [i.e. $\mathrm{Exp}(E) = \overline{E}$], the end of period expected utility of wealth is given by :

$$\mathrm{Exp}U\left(E_T\right) \tilde{} \; U\left(\overline{E}\right) + \frac{U''\left(\overline{E}\right)}{2}\left[\sigma_I^2 I_0^2\right] \qquad (1.39)$$

where σ_I^2 is the variance of the interest rate on deposits and loans.

The probabilities of a new deposit supply, λ_a, and a new loan demand, λ_b, arriving at the bank depend on the respective sizes of the two fees *a* and *b*. For example, by increasing *b*, the loan rate rises and new loan demand is discouraged. Transactions in loans and in deposits have the same size, *Q*. The time (or rate) of arrival of loan demand and deposit supply are generated by independent Poisson[19] processes with interest margin-dependent parameters :

$$\lambda_a = \alpha - \beta \times a$$

$$\lambda_b = \alpha - \beta \times b$$

α and β are respectively the intercept and the slope of the symmetric deposit and loan arrival functions of the bank. A symmetric and linear supply of deposit and demand for loan functions is assumed.

If a deposit of size *Q* is accepted during the period, and there are no transaction costs associated with providing immediacy, then the bank's credit inventory is $I_0 - Q$. The short term money market position is $B_0 + Q + Qa$, that is the initial cash position and the deposit inflow and the fee charged for depository immediacy multiplied by the size of deposit. The change in expected utility, given that a deposit transaction is accepted, is :

$$\mathrm{Exp}U(\Delta E_T \,|\mathrm{deposit}) = U'\left(\overline{E}\right)Qa + \frac{U''\left(\overline{E}\right)}{2}\left[\left(Qa\right)^2 + \sigma_I^2 Q^2 + 2\sigma_I^2 I_0 Q\right] \qquad (1.40)$$

[19] λ_a and λ_b may be interpreted as the rate of occurrence of the event (respectively a new deposit supply and new loan demand). In other words, there are a large number of occasions on which the event can occur, but only a small probability that the event in question occurs (that is either a deposit supply or a loan demand).

When a new loan transaction is made, the bank's inventory is $I_0 + Q$, and its money market position is $B_0 - Q + Qb$. The change in expected utility is :

$$\mathrm{Exp}U(\Delta E_T \,|\mathrm{loan}) = U'\left(\overline{E}\right)Qb + \frac{U''\left(\overline{E}\right)}{2}\left[(Qb)^2 + \sigma_I^2 Q^2 - 2\sigma_I^2 Q I_0\right] \qquad (1.41)$$

Since the probability of a deposit or loan transaction is respectively given by λ_a and λ_b , the objective is to select optimal fees *a* and *b* which maximise the expected utility of the net change in the terminal wealth of the bank, conditional on a single transaction occurring and assuming that the second order of deposit ($(Qa)^2$) and loan ($(Qb)^2$) fees are negligible :

$$\max_{a,b} \mathrm{Exp}U\left(\Delta E_T\right) = \lambda_a \mathrm{Exp}U\left(\Delta E_T \,|\mathrm{deposit}\right) + \lambda_b \mathrm{Exp}U\left(\Delta E_T \,|\mathrm{loan}\right) \qquad (1.42)$$

1.2.3.2. The optimal bank margin

Substituting λ_a and λ_b by their value, we obtain the optimal spread *s*, which is defined as the sum of the deposit service fee and the loan service fee, $s = (a+b)$:

$$s = \frac{\alpha}{\beta} - \frac{1}{2}\frac{U''}{U'}\sigma_I^2 Q \qquad (1.43)$$

If we define the coefficient of absolute risk aversion[20] by $A = -\frac{U''}{U'}$, then

$$s = \frac{\alpha}{\beta} + \frac{1}{2}A\sigma_I^2 Q \qquad (1.44)$$

The first term, α/β, measures the bank's neutral spread. A large α and a small β will result in a large α/β and hence, in a large spread (*s*). That is, if a bank faces relatively inelastic demand and supply functions in the markets in which it operates, it

[20] As defined by Arrow (1965) and Pratt (1964).

may be able to exercise monopoly power by requiring a greater spread than it could obtain if banking markets were competitive (low α/β ratio).

The ratio α/β provides some measure of the producer's surplus or monopoly rent in bank spreads or margins. The second term is a first-order risk adjustment term and depends on three factors : (*i*) *A*, the bank management's coefficient of absolute risk aversion; (*ii*) *Q*, the size of bank transactions; and (*iii*) σ_I^2, the instantaneous variance of the interest rate on deposits and loans, i.e. the variability of interest rates. The bank margins are an increasing function, *ceteris paribus*, of the degree of risk aversion, the size of transactions, and the variance of interest rates. Finally, the volume of inventories, *I*, does not affect the spread *s*, see equation (1.44). The credit inventory rather affects the adjustment of the spread (*d*) relative to the risk-free rate :

$$d = b - a = -\frac{1}{2} A\sigma_I^2 I \qquad (1.45)$$

If deposit inflows are higher than loan demand so that the bank has to increase its short-term market investments, the bank reacts by adjusting its deposit fee, *a*, upwards to discourage additional deposits (smaller deposit rate), and its loan fee, *b*, downwards to encourage extra loans (smaller lending rate). Consequently its fee spread, *a* + *b*, remains the same[21]. By adopting such a price behaviour, the bank is trying to match the duration of its assets and liabilities.

In summary, the key determinants of the interest rates are as follows :

- variables which positively affect the interest margin, i.e. the difference between the loan rate and the deposit rate, are risk aversion, market power, volatility of interest rates, and market size;
- variables, which determine the value of interest rates (that is the value of the lending rate and the value of the deposit rate) and not the value of bank margins (that is the difference between the loan rate and the deposit rate), are the net credit inventory, risk aversion, and the interest rates volatility.

[21] A similar reasoning can be made when loan demand is greater than deposit supply.

Moreover, the Ho and Saunders model has been further extended :

- Allen (1988) considers the case of loan heterogeneity. With interdependent demands, the probability of a new loan arrival is affected by the price spreads on alternative loans. Therefore when the loan rate increases for a type of loans, on the one hand the demand for this type of loans decreases, and on the other hand this increase of the lending rate causes a shift to substitute loans. Allen shows that the substitution effect between alternative loan products reduces that pure interest spread;
- Angbazo (1997) has introduced, in the dealership approach model, loan default risk. The author finds that banks with more risky loans and higher interest rate risk exposure select higher loan and deposit rates as a higher bank rate spread is required.

The insights gained from the analysis of the stock trading model is that the spread between the bid and the ask is the price of immediate liquidity and that a spread remains as long as transaction uncertainty remains. The level of the deposit and loan rates are also function of the net credit inventory.

*

* *

In this section we have highlighted the main determinants of bank interest rates and interest margins, that have been analysed either in the Monti-Klein model and its extensions or in the dealership approach. These contributions are highly relevant to our

purpose which consists in investigating the determinants of bank price setting in the loan and deposit markets.

To briefly summarise, models reviewed underline as determinants of bank interest margins, risk factors (default risk, interest rate risk, and bank risk aversion), market structure variables (market power and size of deposit/loan transactions) and cost considerations (marginal cost, also named operating cost of loans and deposits, interbank market rate, and cost of deposit insurance).

However, the common point of all these models reviewed hitherto – in addition to the fact that they explicitly deal with bank price setting – is that they do not take into account two major points of our concern. Firstly, they only investigate traditional bank products, i.e. loans and deposits. Secondly, risk is only considered as an exogenous variable which hinders further investigations into the incentives of banks to grant loans to more risky projects. Those two points, cross-subsidisation and the modelling of risk in the lending market, will be addressed in the next two sections, beginning with asymmetric information.

1.3. Asymmetric information in the loan market : banks' incentives and price setting

As we have seen in the previous section, among all the determinants of bank pricing we have highlighted, risk plays a key role. However, in the literature studied before, risk has been introduced as a given factor of banking activities. Banks have to cope with it, but their own decisions do not affect its level. With regard to the banking literature, the approach to risk has been heavily influenced by the asymmetric and imperfect information paradigm. Introducing the latter will enable us to account more accurately for risk, which is essential for our purpose. Indeed if interest rate decisions do not impact only on prices but also induce sharp modifications in the level of risk, as we intend to demonstrate in the forthcoming section, then banks' incentives are deeply modified.

The question raised here is how asymmetric information affects bank incentives. Under asymmetric information, prices no longer reflect all the information available to the different market participants[22].

Because of asymmetric and imperfect information, Stiglitz and Weiss (1981) argue that the loan rate affects the riskiness of the bank's loan portfolio in two ways. First, raising the loan rate above some critical level will deter the safest borrowers (adverse selection effect). Second, a higher loan rate motivates borrowers to undertake riskier projects (incentives effect or moral hazard effect). The authors show that rationing credit supply in order to reduce adverse selection is then a possible optimal outcome.

[22] If the asymmetry of information arises on the agent's characteristics, that is hidden information, we deal with adverse selection. This situation is equivalent to an ex-ante contract asymmetry. Adverse selection is a form of market failure, the principal cannot distinguish for example between high risk and low risk individuals. If the asymmetry of information arises on the agent's behaviour, that is hidden action, we speak about moral hazard. It is equivalent to an ex-post contract asymmetry. Moral hazard appears when an insured party whose actions are unobserved can affect the probability or magnitude of a payment associated with an event.

In the neoclassical theory, a lack of available credit is not a concern. According to the standard paradigm, demand equals supply at the equilibrium price, and the lending rate should be set at the marginal cost of loans. However situations in which loan demand exceeds loan supply at the prevailing interest rate, which refer to credit rationing, have been observed[23]. Equilibrium or pure credit rationing[24] occurs whenever some borrowers' demand for credit is not fulfilled, even if this borrower is willing to pay all the price and non-price elements of the loan contract. The latter is a concern that matters deeply while trying to explain banks' behaviour, and must consequently be taken into account in this chapter.

The issue is addressed in Wong (1997). He attempts to take into account asymmetric information. Indeed credit risk was assumed independent of the loan rate charged by the bank. However incentive problems are introduced indirectly in the model through the probability of default. Wong assumes that the cumulative distribution function of credit risk shifts in the sense of first-order stochastic dominance as the lending rate changes. In other words, an increase in the lending rate increases the likelihood that the higher values of credit risk will be realised. Thus it gives rise to a deterioration in borrowers' credit worthiness. The author finds that other things being equal, an introduction of incentive problems among borrowers lowers the optimal bank interest margin. The presence of the incentive problems in the lending market penalises any aggressive loan pricing behaviour of the bank. As a consequence, the bank sets a lower lending rate in order to partially protect itself against the opportunistic behaviour of borrowers. However asymmetric information is not explicitly introduced as is the case in the next model.

[23] The first attempt to explain credit rationing is due to Hodgman (1960). He develops a default risk argument to show that an intermediary's supply of credit becomes perfectly inelastic and even backward bending at some interest rate, so that no increase in the loan rate could induce the lender to raise credit supply. An interesting review of credit rationing can be found in Devinney (1986).

[24] There are a number of different types of credit rationing. We are going to list here several common definitions (Jaffee and Stiglitz, 1990), the last one is retained here as the definition of credit rationing : (*i*) interest rate (or price) rationing, that is a borrower may receive a loan of a smaller size than desired at a given loan rate ; (*ii*) divergent views rationing, that is some individuals cannot borrow at the interest rate they consider appropriate based on what they perceive to be their probability of default ; (*iii*) redlining, that is given the risk classification, a lender will refuse to grant credit to a borrower when the lender cannot obtain its required return at any interest rate ; (*iv*) finally pure credit rationing, there may be instances in which some individuals obtain loans, while apparently identical individuals, who are willing to borrow at precisely the same terms, do not.

1.3.1. Asymmetric information, risk and lending rate

The seminal article of Stiglitz and Weiss (1981) shows that it might not be optimal to equate, at the equilibrium in the loan market, supply and demand. Indeed the level of interest rates impacts on the level of the project risk due to asymmetric information effects.

1.3.1.1. Asymmetric information and adverse selection

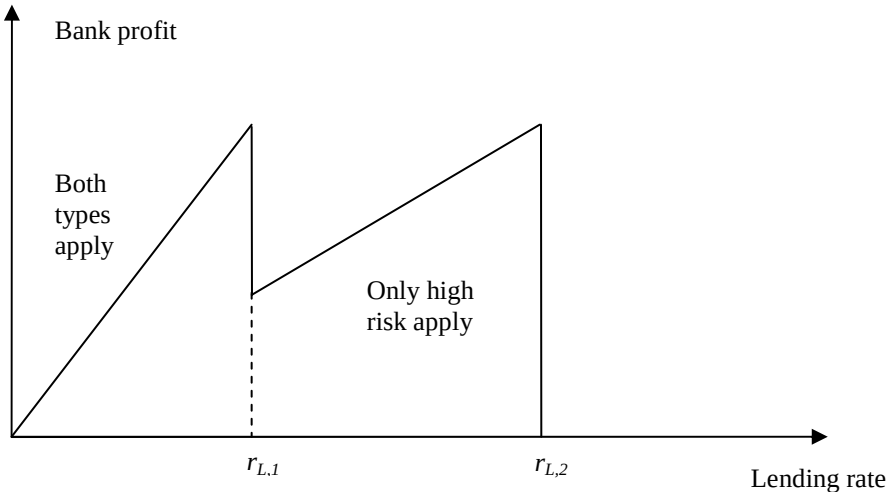
In their model, it is assumed that there is a portfolio of projects, θ, distributed on [0;1] according to a distribution function, F[25]. The distribution cannot be altered by the borrower. Project needs an investment I, and it yields a return, $P(\theta)$, with probability $(1 - \theta)$, and zero with probability θ. All projects have the same expected return, that is $(1 - \theta)P(\theta) = \Sigma$ for all θ, in other words the authors assume that a greater value of θ corresponds to greater risk in the sense of mean preserving spread (Rothschild and Stiglitz, 1970)[26]. Both borrowers and lenders are supposed risk neutral.

The entrepreneur knows the probability that the project fails, θ, but banks only know the statistical distribution of θ among the population of potential borrowers. In addition, *ex post*, the bank will only learn whether or not the project failed, but the risk and the return of the project remain unknown to lenders. Moreover all firms are assumed to bring the same amount of collateral, which can therefore not be used as a screening device. Thus the repayment obligation $\overline{P}$ cannot be conditioned on θ, and firms are only subject to limited liability. Being unable to observe θ, banks cannot discriminate among firms. They offer the same standard debt contract, in which all firms have to repay the fixed amount $\overline{P}$ (if they can). Given $\overline{P}$, an entrepreneur with project θ only decides to apply for a loan of value I if :

$$P(\theta) \geq \overline{P}, \text{ i.e. } (1 - \theta) \leq \Sigma / \overline{P} \qquad (1.46)$$

[25] The firm that undertakes the project θ will be noted firm θ.
[26] *Cf.* footnote 13.

Raising the repayment obligation $\overline{P}$, i.e. the interest rate $\overline{r_L}$, is twofold : on the one hand it increases the profit the bank makes on any individual loan granted to a given firm θ. On the other hand it implies an increase in θ, i.e. a decrease in the probability that the project succeeds, to satisfy the application constraint (1.46), and therefore it raises the overall riskiness of all applicants. To see this most simply, in figure 1.1. we assume two types of borrowers, those with low-risk profile borrowing only at a lending rate smaller than r_1, and the others with a high-risk profile borrowing up until r_2.



Source : Stiglitz and Weiss (1981)

Figure 1.1. Adverse selection

Let us suppose that the bank's profit is the same at $r_{L,1}$ and $r_{L,2}$. When the loan rate is raised slightly above $r_{L,1}$, the mix of applicants change dramatically. All low risk applicants withdraw.

Therefore the distribution of θ plays an important role. For some of these distributions, the banks' expected return on loans will be single peaked, with a maximum for a loan rate r_L*. It results in a nonmonotonic profile (see figure 1.2).

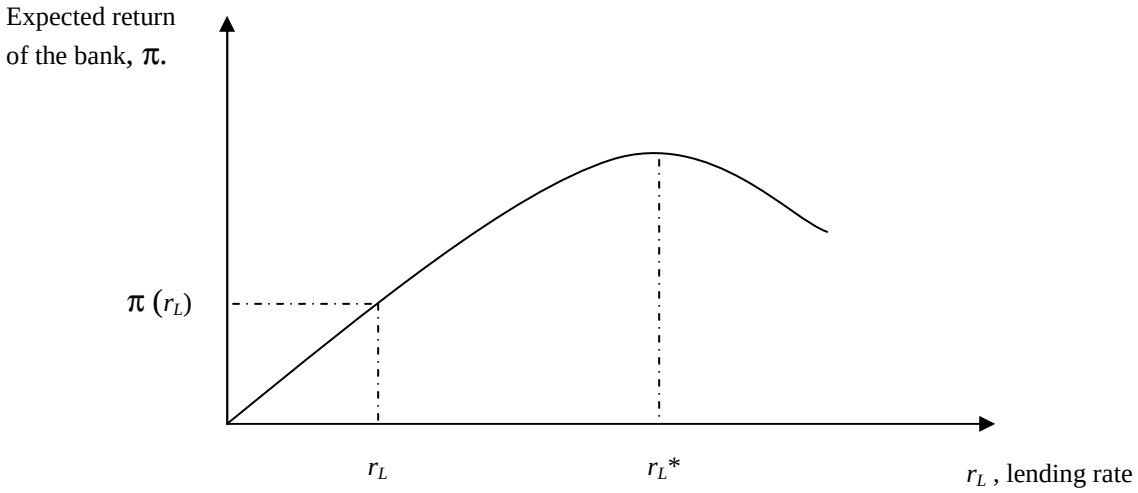


Figure 1.2. Expected return of a bank as a function of the loan rate.

Stiglitz and Weiss also discussed the case where the behaviour of the borrower changes once the loan is agreed to the borrower[27].

1.3.1.2. Asymmetric information and moral hazard

The moral hazard problem arises when the entrepreneurs have received the desired funds, but do not invest them in the initial project, but in a more risky project. There is a conflict of interest between the lender and the borrower. The borrower is only concerned with returns on the investment when the firm does not go bankrupt. The lender is concerned with the actions of the firm to the extent that they affect the probability of bankruptcy, and the returns the lender can expect if the firm goes bankrupt.

[27] With regard to credit rationing due to moral hazard, the reader can refer to Jaffee and Russel (1976), in which the firm's capacity to repay the loan can be manipulated, and also to the model of Bester and Hellwig (1987) in which the firm is free to choose its technology (and therefore the cash flow distribution).

The authors discuss an example similar to the following one. The entrepreneur, who has raised an investment I to invest in a project, has a portfolio of investment projects available. Project θ yields a return $P(\theta)$, with probability $(1 - \theta)$, and zero with probability θ. In contrast with the approach above, the entrepreneur can choose his level of risk, θ.The choice of θ is not observable to lenders : they just learn whether the project was successful or not. Consequently, the contract between lenders and the entrepreneur specifies that the latter will pay back a fixed amount $\overline{P}$, in case the project is successful, and nothing otherwise.

The efficient project is the one that maximises the expected return $(1 - \theta)P(\theta)$. The entrepreneur, however, does not have the incentive to maximise the social surplus, but rather its expected net return $(1-\theta)(P(\theta) - \overline{P})$. In most cases, the project that will be undertaken by the entrepreneur will not be the efficient one. The entrepreneur will choose a project that is too risky, i.e. one with the probability of success being small but with a high pay-off in case of success. Therefore lenders are unwilling to raise $\overline{P}$ since this could lead to more risky projects selected by the entrepreneur and to lower profits for lenders. It results in the same nonmonotonic profile as depicted previously (see figure 1.2.).

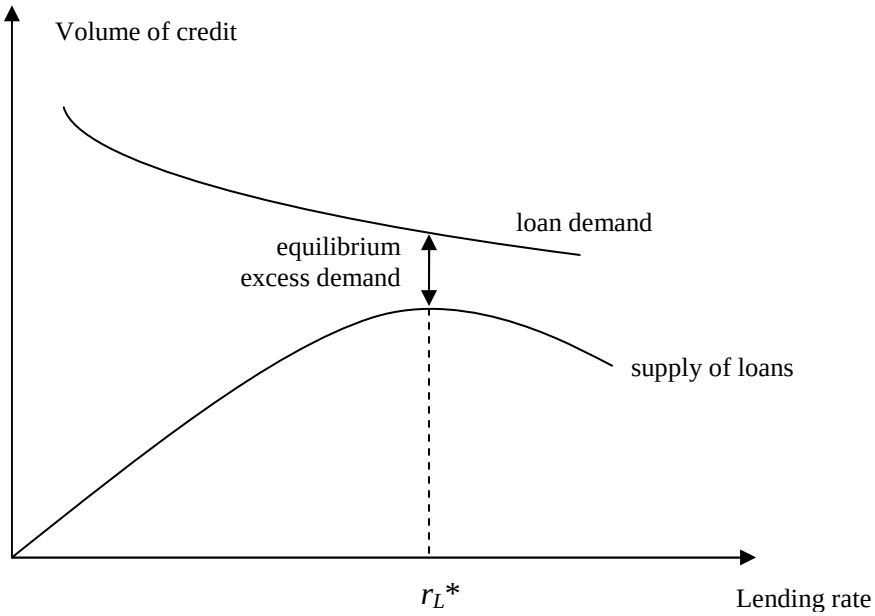
The interest rate which an individual is inclined to pay may operate as an incentive mechanism. As the interest rate and other terms of the contract change, the behaviour of the borrower is likely to change. Raising the interest rate increases the relative attractiveness of riskier projects, for which the return to the bank may be lower. Raising the interest rate may lead borrowers to take actions which are contrary to the interests of lenders, that is higher interest rates induce borrowers to switch from safe to risky projects. This switch occurs because the probability of interest being paid is lower for projects that are more likely to fail. The cost of an increase in the interest rate, for the borrower, is less deterrent if the probability of default is high.

1.3.1.3. Synthesis on the effect of asymmetric information

To summarise, the interest rate which a borrower is willing to pay may act as a negative screening device (adverse selection): those who are willing to pay high interest rates may, on average, be more risky. They are willing to borrow at high interest rates because they perceive their probability of repaying the loan to be low. As the interest rate rises, the average riskiness of those who borrow increases, possibly lowering the bank's profits. In the mean time, raising the interest rate decreases the return on projects which may be expected to succeed[28] and thus discourage the best borrowers. Higher interest rates induce firms to undertake projects with lower probabilities of success but higher payoffs when successful (moral hazard).

One way to understand the Stiglitz and Weiss model is to consider that credit rationing emanates from a lack of information faced by banks. Actually, the supply of funds by banks does not equal the demand, otherwise banks have to offer a level of the lending rate that would imply an increase in the default risk, which would lower their profits. As banks are unable to appreciate exactly the level of risk of each borrower, they may prefer not to increase the lending rate in order to maximise their profits. Doing so, they are not satisfying all the demand for credit which is made by borrowers, at the present price (figure 1.3.).

[28] To be clear, the projects concerned are those that the entrepreneur may undertake.



Source : Freixas and Rochet, 1997

Figure 1.3. Equilibrium with credit rationing

It can be seen, from the comparison between a classical equilibrium and an asymmetric information one, that risk has an effect on the price setting of loans by banks. Thus it becomes a major determinant of the behaviour of banks which know that their decisions are affecting the level of risk, which itself affects the real rate of return and thus this optimal decisions.

On the one hand, the lack of information leads banks to modify their decisions with regard to what they would have done if perfectly informed. On the other hand, some borrowers face credit rationing ever though willing to pay the full price of the loan.

Given such a situation, we may consider that agents (borrowers or lenders), or at least some of them, would induce information transfer in order to decrease the asymmetry. The latter can be produced either by the informed agent, in our case the borrower, or by the non-informed agent, the bank.

1.3.2. Asymmetric information and risk management

One way to alleviate the problem caused by asymmetric information is to produce more information. The production of information can be initiated either by the borrowers as we will see in the next subsection, or by the lender, in the following one.

1.3.2.1. Lending rate and signalling

Leland and Pyle (1977) argue that lenders can obtain some information about the quality of a project by observing the willingness of the insider, the entrepreneur, to invest equity capital in the endeavour, in the presence of imperfect information concerning the value of the underlying project.

Leland and Pyle (1977) consider an investment project which involves a capital *K* and a future return $(\mu + \tilde{x})$, where μ is the expected end-of-period value of the project and $\tilde{x}$ is a random variable with zero mean and variance σ^2.The entrepreneur has information that leads him to assign a specific value to μ. Borrowers typically know their collateral, and moral rectitude better than lenders do. Lenders would benefit from knowing the true characteristics of borrowers. But moral hazard hampers the direct transfer of information between market participants. The entrepreneur who wants to undertake his investment project, plans to hold a fraction φ of the firm's capital, raising the reminder of the capital from lenders. The total market value of the project *V*, is equal to:

$$V(\varphi) = \frac{1}{1+r}\left[\mu(\varphi) - \omega\right] \tag{1.47}$$

where *r* is the risk free rate, $\mu(\varphi)$ is the market's perception of the true expected return as a function of φ, and ω is the market's adjustment for the risk of the project.

In addition to the possibility of investing in his own project, the entrepreneur can invest in the market portfolio or in the risk free asset. The entrepreneur's objective is

then to maximise his expected utility of wealth with respect to the financial structure of the project or firm (debt/capital), to his holding of equity in the project or firm, and to his holding of the market portfolio and the riskless asset [29].

The authors show that borrowers will invest in their project more than they would do if they could transfer credibly and freely the information they hold. The cost of signalling for borrowers is equivalent here to a sub-optimal portfolio diversification.

If we assume that every borrower raises enough personal funds to invest in his own project, then he has the ability to signal the quality of his investment and therefore increases the probability of being financed by a bank. This conclusion is not closely related to our issue, but as borrowers' signal impacts on banks' behaviour with regard to risk, it must be underlined as a determinant of bank decisions. However we may say that we are facing an indirect link between risk and bank behaviour (as the active agent here is firstly the borrower : the one that copes directly with reducing the asymmetry of information). In the next subsection we will review a matter that is closer to our concern, the direct reaction of banks to endogenous risk.

1.3.2.2. Lending rate and collateral as a sorting device

Bester (1985) assumes a similar environment as Stiglitz and Weiss with regard to imperfect information about borrowers. However he supposes that banks will try to reduce this information asymmetry by offering to borrowers a set of contracts, within which a specific level of the lending rate is associated to a specific level of collateral[30].

[29] The authors extend their approach to financial intermediation, justifying its '*raison d'être*' by the existence of signalling interference. The lack of information on the quality of financial assets (the difficulty to credibly transfer the information) requires some firms to specialise in the production of information. However once the entrepreneur's signal has been correctly interpreted, the produced information, which has the same particularity as a public good, is publicly available without cost. The firm therefore has difficulty obtaining the return associated with its value. They argue that capturing a return to information is possible if the firm that gathers the information becomes an intermediary, holding assets which are of sufficient value.

[30] This idea has also been explored by Wette (1983), Chan and Kanatas (1985), and Deshons and Freixas (1987).

We consider two projects θ_1 and θ_2, which require the same amount of investment *I*. They yield respectively an expected return of $P(\theta_1)$ and $P(\theta_2)$ with (respectively) probability $p(P(\theta_1))$ and $p(P(\theta_2))$, and zero with probability $(1 - p(P(\theta_1)))$ and $(1 - p(P(\theta_2)))$. Project θ_2 is supposed to be the more risky, that is :

$$P(\theta_2) > P(\theta_1) \tag{1.48}$$

$$\text{and } p\left(P(\theta_1)\right) > p\left(P(\theta_2)\right). \tag{1.49}$$

All projects have the same expected return, that is $p(P(\theta_1)) \times P(\theta_1) = p(P(\theta_2)) \times P(\theta_2)$, in other words the authors assume that θ_2 corresponds to greater risk than θ_1 in the sense of mean preserving spread[31]. Entrepreneurs have an initial wealth endowment of $W < I$. They finance their project by borrowing the amount $L = I - W$. Given the loan size *L*, a credit contract (r_L, *C*) is specified by the interest rate r_L and the collateral *C* charged by the bank.

We denote π the expected profit of the bank, and π_i the expected profit of the firm :

$$\pi\left(r_L, C\right) = C\left(1 - p\left(P(i)\right)\right) + \left(1 + r_L\right) L \times p\left(P(i)\right) \qquad i = \theta_1, \theta_2 \tag{1.50}$$

$$\pi_i\left(r_L, C\right) = -C\left(1 - p\left(P(i)\right)\right) + \left(P(i) - \left(1 + r_L\right) L\right) p\left(P(i)\right) \tag{1.51}$$

Equations (1.50) and (1.51) can be interpreted in the following way :

- with a probability $(1 - p(P(i)))$, the project fails causing the firm bankruptcy and the transfer of the collateral to the bank;
- with probability $p(P(i))$, the project is a success. The firm repays its loan, and keeps the residual value $((P(i) - (1 + r_L) L)$.

The following conditions have to be satisfied to ensure the contracts are separated :

$$\pi_{\theta_1}\left(r_{L,\theta_1}, C_{\theta_1}\right) \geq \pi_{\theta_1}\left(r_{L,\theta_2}, C_{\theta_2}\right) \tag{1.52}$$

$$\pi_{\theta_2}\left(r_{L,\theta_2}, C_{\theta_2}\right) \geq \pi_{\theta_2}\left(r_{L,\theta_1}, C_{\theta_1}\right) \tag{1.53}$$

[31] See Rothschild and Stiglitz (1970).

Therefore the contracts should have the following properties :

$$C_{\theta_1} \geq C_{\theta_2} \tag{1.54}$$

$$r_{L,\theta_2} \geq r_{L,\theta_1} \tag{1.55}$$

In the framework of credit markets under imperfect information, Bester shows that no borrower will be denied credit if banks use the collateral requirements of their loan contracts as a signalling mechanism. However the applicability of self selection mechanisms has been established under assumptions which are stronger than those of Stigltiz and Weiss. First, a signalling equilibrium in the credit market requires a monotonic relationship between the riskiness and preferences of different borrowers. Second, low-risk entrepreneurs have been assumed to be able to raise sufficient amount of collateral to distinguish themselves from high risk ones. Perfect sorting in a credit market equilibrium may be impossible if some low risk firms face a binding constraint on the amount of collateral they can provide. If the necessary conditions for market signalling are not fulfilled, thus only partial screening may be possible and adverse selection could still arise. Deshons and Freixas (1987) show that even with separating contracts, rationing can still occur. Rationing is stronger for firms which have the safest projects.

*

* *

The major point of this section is that risk is a key feature of banking. Indeed banks have to consider not only a level of price but also a level of risk induced by the former, as these two variables influence each other. In other words, risk is an endogenous

element of financial intermediation activities. This determinant deeply affects banks' behaviour.

A major consequence is whatever influence banks' decisions on price setting will affect the level of risk at equilibrium. That concern must clearly be taken into account whilst investigating potential determinants of banks' behaviour.

However it must be noted that all the elements explaining bank pricing, we have stressed in the first two sections, are entirely related to loan and deposit activities themselves. Indeed banks' decisions are analysed as if the financial intermediation activities were the only ones, or as if they were dissociated from other activities banks can engage in.

If banks are considered to be multi-product firms, we may wonder if loan and deposit production may affect, or be affected by the production of services. For example, banks may be willing to use a product as a "calling product"[32] or a "loss leader", in order to attract new clients and establish a relationship that will enable them to sell other products. Such a practice may affect banks' incentives with regard to price setting and the level of risk. This issue will be studied in the next section of this chapter.

[32] For instance, we mean that products are under-priced.

1.4. The bank as a multi-product firm : cross-subsidisation in the banking market

The aim of this section is to review the literature highlighting cross-subsidy effects when several banking activities are considered simultaneously. Interest margin setting is then not only dependent on the previously outlined determinants specific to loan and deposit markets, but also on strategic interactions that can lead a bank to decrease prices on some products in order to capture new clients on other markets.

A firm is considered as a multi-product firm as soon as it sells more than one product. Without more assumptions on the two products supplied, we find the standard microeconomic result for profit maximisation, that is marginal cost equals marginal revenue. However in presence of interrelated demand or non-separable cost functions, "cross-subsidisation" may appear (Koutsoyiannis, 1979, Mattei, 1989, Carlton and Perloff, 1998).

The multi-product nature of banking firm may be analysed by the introduction of other activities than intermediation one within the framework. However, even if we keep on focusing only on loan and deposit activities, multi-production and cross-subsidisation issues can be addressed. Indeed the production approach defines banking activities as the production of services to depositors and borrowers, deposits and loans are then considered as two outputs of the banking firm (Lindley and Sealey, 1977, Nguyen The Van, 1993). Thus the multi-product nature of banking activities is recognised. In the first subsection, we underline the emergence of cross-subsidisation between the two outputs that are deposits and loans.

1.4.1. Loans and deposits

In this subsection, we intend to underline cross-subsidisation while still dealing with only traditional activities, i.e. deposits and loans.

This issue can be addressed if we introduce deposit rate regulation within a Monti-Klein framework. If it can be shown that under a management cost function which is separable, a ceiling on deposit rates has no effect on lending rates, the lending rate is affected if there is an interdependence between deposits and loans (Freixas and Rochet, 1997). More precisely a ceiling on deposit rates will induce "cross-subsidisation", that is a decrease in the lending rate, if $\frac{\partial^2 C}{\partial r_L \partial r_D} > 0$, C being the cost function of the bank. This condition corresponds to the case in which loans and deposits are substitutes in the sense that when the volume of loans increases, i.e. when r_L decreases, the marginal profitability of collecting deposits decreases. However this condition is the opposite to the one needed to explain the existence of universal banks (we need cost complementarity, that is $\frac{\partial^2 C}{\partial r_L \partial r_D} < 0$), and therefore the result obtained may appear disappointing. We will study an issue close to this one in the next model.

Chiappori, Perez-Castrillo, and Verdier (1995) develop a model of imperfect competition among banks in a regulated environment. Their aim is then to evaluate the consequences of deposit rate regulation. In this setting of a multi-product firm and of an imperfect competition market, they emphasise the emergence of subsidising sales between deposit and credit interest rates : deposit rate ceiling subsidises the lending rate.

- **Spatiality, tied-up contracts and cross-subsidisation**

A spatial model *à la* Salop (1979) enables Chiappori *et al.* (1995) to take into account imperfect competition in the banking industry. The authors consider an economy where a continuum of customers are located uniformly (with density 1)

around a unit circle. There are *n* banks (indexed by $i = 1,\ldots, n$), located on the circle ; *C* denotes the fixed cost of each installation.

Each customer on the circle has one unit of cash, that must necessarily be deposited in a bank, and which pays an interest rate r_D. They suppose that depositors have a transportation cost α per unit of length. In addition to collecting funds, each bank can also make loans to customers. The loan interest rate at which a bank lends its funds is denoted r_L, β is the unit transportation cost for loans. β is not necessarily equal to the transportation cost for deposits, α ; in other words, the respective price elasticities of deposits and loans can differ. Depositors are also borrowers, with an inelastic credit demand *L*. Assume $L<1$. The money market rate, *r*, is fixed exogenously by the monetary authorities.

The total utility of a typical consumer (that is depositor-borrower) is therefore:

$$U = (1+r_D) - \alpha t_D - (1+r_L)L - \beta t_L \tag{1.56}$$

where t_D (respectively t_L) is the distance from the bank in which the consumer's cash has been deposited (respectively where the consumer's loan has been granted).

If *n* banks enter the market simultaneously, located symmetrically on the circle, and compete in deposit rates and loan rates, the equilibrium is symmetric.

A depositor located at distance $t_D \in [0,1/n]$ of bank *i* is indifferent between *i* and i+1 (or $i - 1$) if

$$\alpha t_D - r_D^i = \alpha\left(\frac{1}{n} - t_D\right) - r_D^{i+1} \tag{1.57}$$

Similarly, a borrower located at distance $t_L \in [0;1/n]$ of bank *i* is indifferent between *i* and i+1 (or $i - 1$) if

$$\beta t_L + r_L^i L = \beta\left(\frac{1}{n} - t_L\right) + r_L^{i+1} L \tag{1.58}$$

We therefore obtain the following supply of deposits, S^D, and demand for loans, D^L, functions :

$$S^D = \frac{1}{n} + \frac{2r_D^i - r_D^{i+1} - r_D^{i-1}}{2\alpha} \tag{1.59}$$

$$D^L = \frac{1}{n} - \frac{2r_L^i - r_L^{i+1} - r_L^{i-1}}{2\beta} L \tag{1.60}$$

The profit of bank *i* is thus :

$$\pi^i = \left(r_L^i - r\right)\left(\frac{1}{n} + \frac{2r_L^i - r_L^{i+1} - r_L^{i-1}}{2\beta} L\right) + \left(r - r_D^i\right)\left(\frac{1}{n} + \frac{2r_D^i - r_D^{i+1} - r_D^{i-1}}{2\alpha}\right) - C \tag{1.61}$$

Since the model uses a circle, the following conventions are adopted : $r_D^{n+1} = r_D^1$, $r_D^n = r_D^0$, $r_L^{n+1} = r_L^1$, $r_L^n = r_L^0$.

All banks offer the same interest rates :

$$r_D^e = r - \frac{\alpha}{n} \quad \text{and} \quad r_L^e = r + \frac{\beta}{nL} \tag{1.62}$$

The number of active banks in a free entry equilibrium is determined by a profit equal to zero, which gives :

$$n^e = \sqrt{\frac{\beta / L + \alpha}{C}} \tag{1.63}$$

Thus, it can be observed that loans and deposits are independently priced : if deposit rates are regulated (that is $\overline{r_D}$ smaller than the equilibrium deposit rate), this has no impact on r_L in the short term. Under deposit rate regulation, banks make more profit on deposits, so that more banks enter the market in the long term.

Up to now, the determinants of the margin still remains rather close to the ones of Monti-Klein to the extent that the rates are independent, and determined by transport costs, that is market power.

However, another pattern appears if banks are allowed to sell tied-sales contracts, still under deposit rate regulation[33]. This specific contract stipulates that agents applying for a loan must simultaneously deposit their cash balances in the bank. Applications for loans only (without simultaneous deposits) will be either rejected, or charged with a higher interest rate. The potential advantage of such a contract is that it allows the bank, by lowering interest rates, to attract not only new borrowers, but new depositors as well.

Since the regulated deposit rate is smaller than the equilibrium deposit rate, the bank profit increases. The rent on deposits is so high that, whenever it is possible to capture the deposits of new borrowers through tied-sales contracts, it is worthwhile to attract new borrowers by increasing cross-subsidies and lowering credit rates. Because of tied-sales, the transport cost incurred by bank clients is the sum of their transport cost of loans and deposit, that is $\alpha + \beta$.

A depositor-borrower located at distance $t \in [0,1/n]$ of bank i is indifferent between i and i+1 (or $i-1$) if :

$$(\alpha+\beta)t + \tilde{r}_L^i L = (\alpha+\beta)\left(\frac{1}{n}-t\right) + \tilde{r}_L^{i+1} L \tag{1.64}$$

The profit of bank i is given by :

$$\pi^i = \left[\left(r-\overline{r_D}\right)+\left(\tilde{r}_L^i - r\right)\right]\left(\frac{1}{n}+\frac{2r_L^i - r_L^{i+1} - r_L^{i-1}}{2(\alpha+\beta)}L\right) - C \tag{1.65}$$

In a symmetric equilibrium, the maximisation of π^i with respect to $\tilde{r}_L^i$ gives the following new equilibrium loan rate :

$$\tilde{r}_L = r + \frac{1}{L}\left(\frac{\alpha+\beta}{n} - \left(r-\overline{r_D}\right)\right) \tag{1.66}$$

[33] The authors show that such contracts would never emerge at equilibrium if banks were unregulated. Under unregulated competition, the interest rates charged are the same either with or without tied-sales contract. Indeed the existence of tied-sales contract does not increase profit.

The lending rate can be rewritten such as :

$$\tilde{r}_L = \left(r + \frac{\beta}{Ln} \right) - \frac{1}{L}\left(r - \frac{\alpha}{n} \right) \tag{1.67}$$

This value of the lending rate is smaller than the one found in an unregulated environment.

Under deposit rate regulation, attracting depositors is highly profitable to the banks. Therefore, banks are willing to subsidise credit in order to do so. Banks offer tied-sales contracts with lower lending rates than in the unregulated case. Therefore, under regulation, tied-sales contracts lead to decreasing credit rates. Chiappori *et al.*(1995) also show that in the long run the number of banks decreases. Efficiency considerations suggest that tied-sales contracts should not be forbidden, since the regulated economy suffers from oversized networks[34].

From Chiappori *et al.* (1995), we can already say that cross-subsidisation must be considered in order to determine bank interest margin. However, our concern remains the effect of other activities, such as current account management, consulting activities, payment transactions …, on the traditional ones, i.e. loans and deposits. This issue is addressed in the next subsections.

1.4.2. Payment services and deposits

If the traditional activity of banks is granting loans and receiving deposits from the public, the management of the means of payment is tied to the supply of deposits[35]. The neo-classical price theory, built on assumptions of efficient markets and competition,

[34] Chiappori, Perez-Castrillo, and Verdier (1995) also show that monetary policy is only partially effective in the presence of tied-sales contracts. However it is out of our purpose here and it is consequently not developed.

[35] However it does not mean that deposit-taking and chargeable services are necessarily conjoined. Both activities can be offered separately : a deposit account can be opened without the sale of means of payment, and inversely means of payment can be offered by a financial intermediary that is not in charge of the customer's account.

states that the deposit interest rate should be equal to the rate of return earned by the bank from re-investing the deposited funds (Black, 1975, Fama, 1980, and Fischer, 1983). Similarly the users of payment services should be charged according to the marginal cost principle.

- **Reasons for implicit interest payments**

As stated by Tarkka (1995), an important issue which became topical during the period of deposit rate regulation was whether banks circumvented the prohibition of the payment of interest on demand deposits, partly or entirely, by paying "implicit interest". The method most frequently used to pay implicit interest is the provision of payment services to depositors either free of charge or at prices below cost.

Many economists believed that the cross subsidies would disappear following the deregulation of deposit rates (Saving, 1979; Fischer, 1983). However after the international wave of interest rate deregulation in the 1980s, significant interest margins were still existing. One explanation for the continued viability of "implicit interest" relied on a tax-maximisation argument. In many fiscal systems, interest income is taxable, but the benefit of free or under-priced banking services is not taxed. This kind of systems encourages banks to compete for deposits with tax-free implicit interest instead of taxable explicit interest (Walsh, 1983). Imperfect competition has been considered as an alternative or complementary explanation. There are a number of studies which have applied models of imperfect competition to explain deposit pricing, starting from Klein (1971). Those which have taken the pricing of payments services explicitly into account include the spatial competition model of Baxter, Cootner, and Scott (1977), Mitchell's (1988) monopoly model of service charge determination and Whitesell's (1992) monopoly model of both demand deposit pricing and service charges.

The implicit interest literature studies the equilibrium which emerges in the bank deposit market if price competition for deposits is repressed by regulation, cartel, or by a tax system which discriminates against explicit interest payments or favours implicit

interest. The problem appears in its simplest form if one assumes that depositors demand chargeable services. In the unregulated (nondistorted) equilibrium, that demand would give rise to a flow of service charges. In the distorted equilibrium, explicit interest could be replaced by remissions of service charges, made conditional on deposit balances. Then, if the underlying service charge flow was large enough, the interest rate ceiling could in principle be completely ineffective[36].

The implicit interest issue, that we have just been explaining, has been conceived in slightly different ways elsewhere in the literature.

- **Modelling implicit interest payments**

The first approach might be called the "quantity-setting model". This kind of model does not consider the determination of service charges, but it only assumes that there is a flow of free services which is delivered to depositors in a quantity which is set by the bank. In Startz (1983), deposit rate regulation induces the bank to offer implicit interest in the form of free services rendered in some given proportion to deposit balances. Formally, this way of conceiving the implicit interest question is equivalent to the general models of non-price competition by non bank firms (Stigler, 1968; Schmalensee, 1976). The usual finding of such models is that the regulated good is under-produced, and the "free" good, here payment services, is over-produced, reducing customer welfare compared with the unregulated equilibrium.

A second way of looking at the implicit interest issue has been the use of what might be called "the price-setting model". The bank's decision is taken with respect to the price of transaction services, and the depositor makes an independent decision concerning the use of transaction services. It is important to notice that the ratio of transaction services to deposit balances is beyond the control of the bank. The central

[36] The pioneering empirical study of Barro and Santomero (1972) outlined this issue. In an extremely simplified form, this approach of "implicit interest" is also suggested in Klein (1971).

papers are Mitchell (1979, 1988) and Merris (1985)[37]. They analyse the determination of the service charge per cheque in a monopoly situation where the interest rate on chequable deposits is regulated. The downward-sloping demands for bank services are either specified *ad hoc* (Mitchell, 1979) or derived from an extended Baumol-Tobin money demand framework (Merris, 1985; Mitchell, 1988).

The results obtained by Mitchell (and discussed by Merris) suggest that the service charge can, in principle, be either an increasing or decreasing function of the regulated deposit rate. Explicit and implicit interest may thus be either complements or substitutes, in contrast with the perfectly competitive equilibrium where an increase in the deposit rate must reduce the amount of implicit interest. Complementarity between explicit and implicit interest may arise if the ratio of transactions to deposit balances is strongly negatively affected by the explicit rate. An increase in the deposit rate will then cause a decrease in the relative benefit of service under-pricing, and the bank may find it optimal to offset this by lowering the service charge.

The multi-product approach to the pricing of current accounts constitutes the ***third approach*** to modelling implicit interest. It can be defined as a simultaneous analysis of the determination of both deposit rates and service charges, taking into account that these services are neither produced nor used in fixed proportions, but quantity can differ per consumer (depositor) independently of each other. Baxter, Cootner and Scott (1977) use the multi-product approach and try to explain the observed pricing patterns in the deposit markets (the market for current accounts in particular). The price system which emerges in their model is the perfectly discriminating two-part tariff. The interest rate spread constitutes the "entry fee" component of the tariff, the burden of which happens to coincide with the customers' willingness to pay for bank services in excess of the marginal costs of service. The service charge can be interpreted as the variable part of the tariff, and it can be identified to the cost of serving the marginal (most mobile) customers.

[37] Shaffer (1984) presents a related analysis. He studies cases where depositor heterogeneity (with respect to the velocity of deposit balances) may give rise to an equilibrium where one depositor group is effectively subsidizing the transactions of another group.

The multi-product approach reappeared in the literature in the work of Whiteshell (1988, 1992). Whiteshell considers the price setting problem of a bank which is in a monopoly position *vis-à-vis* its depositors. The deposit rates and service charges are assumed to be parametric constants. The demand elasticities which determine the bank's optimal pricing policy relate to the competition from alternative means of payment, either currency, cheques and credit cards. Whiteshell presents a model in which individuals have an exogenous size distribution of payments and use different means of payment, depending on the size of the payment in question. In the monopoly equilibrium, the bank sets service charges below service costs. The reason is that, by providing a cheap service, the bank is able to attract balances which would otherwise be kept in the form of currency. This is profitable, because the optimal deposit rate may be below the rate the bank can earn from reinvesting funds.

In all these models, interactions between different banking markets exist. Cross-subsidisation is considered as part of the explanation of the behaviour of banks concerning their financial intermediation activities. However it must be stressed that banks are considered to be somehow using services to attract deposits perhaps by under-pricing services to circumvent regulation or taxes on the traditional deposit activity.

We may wonder if the opposite can happen, namely if banks might be willing to under-price loans to attract clients for fee-based activities. This issue is addressed by Cukierman (1978), while studying credit rationing.

1.4.3. Banking services and lending rate

The production of a variety of services by banking institutions has long been studied. Adar, Agmon, and Orgler (1975), who study jointness in production in the banking firm, cite previous bank cost studies undertaken in the 1960s such as Horvitz (1962), Greenbaum (1967), Benston (1965,1969), and Bell and Murphy (1968). In these approaches banks are multi-product firms which handle besides credit, a number of

other activities like checking accounts, savings accounts, and possibly also brokerage and foreign trade transactions, and any other banking services which are not credit.

Payment services have been taken into account when studying the relationship between payment services and deposit pricing, as we saw in subsection 3.2. However Cukierman (1978) considers another effect of the sale of services by banks to their clients, that is the impact on the amount of credit allocated to a client who is buying other facilities offered by its bank.

Cukierman (1978) states that : "it is widely recognized that there is a positive association between the propensity of a customer to generate various businesses in the bank and the amount of credit that he obtains from the bank". In other words, customers with more business would obtain more credit, better terms, or both.

- **Propensity to buy services and credit rationing**

We consider a bank which sells two products only : credit and a single banking service, the demand for which, by any single customer, depends on the amount of credit the customer gets from the bank, what will be referred to demand dependencies. It is supposed further that the bank operates in an oligopolistic environment.

The bank faces a downward-sloping demand curves for both of its products which may differ for each customer. Cukierman assumes that the price of the service is fixed at a level above its marginal costs, but it does not decrease to its competitive level because of the non-competitive structure of the banking industry. The price of credit, however, is a decision variable of the individual bank and depends, as in monopolistic competition, on the demand facing it. It is also assumed that the risk of default is equal to zero for all customers considered by the bank. The author focuses on the behaviour of a single bank without trying to study the interactions amongst banks within the industry.

The bank is supposed to maximise its expected profit. We then suspect that it may be profitable for the bank to give more credit to customers who tend to respond by

increasing their demand for the bank service and to ration those for whom this response is low.

The bank decision variables are the lending rate and the amount of credit granted to each customer. The demand of customer *i* (*i*=1,…,*n*) for credit and for the banking service is respectively :

$$L^i(r_L),\ \ L^i_{r_L}{}' < 0 \tag{1.68}$$

$$Se^i(C_i, f'),\ \ Se^i_{C_i}{}' > 0 \tag{1.69}$$

where r_L is the lending rate, C_i the amount of credit that customer *i* gets, L^i is the demand for credit, *f'* the price of one unit of the banking service, and Se^i the demand for banking services of customer *i*. Condition (1.68) means that credit demand decreases when its price increases, and condition (1.69) reflects the positive effect that the extension of more credit to customer *i* has on his demand for the bank service.

Let *CL* and *CSe* be respectively the marginal costs of producing loan and the banking service. Defining $f \equiv f' - CSe$, the bank profit maximisation problem can be written as :

$$\max_{r_L, C_1, \ldots, C_n} \pi = \sum_{i=1}^{n} r_L C_i + f.Se^i(C_i) - CL.\sum_{i=1}^{n} C_i \tag{1.70}$$

subject to

$$C_i - L^i(r_L) \le 0,\ i = 1, \ldots, n.$$

The first two terms in the sum (equation 1.70) represent the revenue from loans and the profit from the banking service respectively. The last term is the total cost of "producing" the credit to the bank. The constraint reflects the fact that the bank is constrained by the demand of each customer in the allocation of credit. For a given interest rate, the bank may choose to give the customer all the credit he wants or less, but it cannot sell him more than the borrower desires to buy at the interest rate.

Applying the Kuhn-Tucker theorem, the following necessary conditions are obtained :

$$r_L + f.Se^i_{C_i}{}' - CL - \lambda_i = 0 \quad (1.71)$$

$$\lambda_i \left[C_i - L^i(r_L) \right] = 0 \quad (1.72)$$

$$\sum_{i=1}^{n} C_i + \sum_{i=1}^{n} \lambda_i L^i_{r_L}{}' = 0 \quad (1.73)$$

$$\lambda_i \geq 0, \; C_i - L^i(r_L) \leq 0 \quad \text{for } i = 1 \ldots n \quad (1.74)$$

λ_i measures the contribution that an increase in the demand for credit by customer *i*, at the equilibrium interest rate, makes to profit. For rationed customers, this contribution is zero, and for fully satisfied borrowers it is positive. Rearranging (1.71), we obtain :

$$\lambda_i = r_L - CL + f.Se^i_{C_i}{}' \quad (1.75)$$

The contribution λ_i is thus composed of the direct contribution that an increase in the credit granted to the borrower *i* makes to profit (r_L - *CL*), and an indirect contribution ($f.Se^i_{C_i}{}'$) through the increase in the demand for services of borrower *i*, due to the increase in the equilibrium credit he is granted.

Without such a demand dependency, that is the demand for services is an increasing function of the amount of credit granted, equation (1.75) is :

$$\lambda_i = r_L - CL \quad (1.76)$$

If for simplicity and without loss of generality we assume the demand functions for credit of all customers are alike, the author obtains the following results[38] :

- there will be some credit rationing at the optimum even when there is no risk of default. Since all demand functions for credit are alike, this discrimination between customers is caused because of the different value that a unit of credit extended to different customers has, and because of the different marginal

[38] We do not develop here the results found by the author, when he considers the effect of monetary policy, as it is out of our purpose.

propensities of different customers to spend on service when granted more credit;

- given the same demand functions for credit and the same value of the marginal costs for producing credit, a bank with demand dependencies[39], which finds it optimal to ration some of its customers, will set an interest rate which is lower than the rate set by a bank which does not face such dependencies[40]. Moreover, the interest rate in the first case will be lower than the cost of producing credit. The intuitive explanation of a decrease of the lending rate is that, in order to take advantage of the demand dependency of a customer *i*, the bank has to entice him to take more credit;

- for a particular customer, an infinitesimally small increase in his dependency of the demand for banking services on the amount of credit he gets, decreases the equilibrium interest rate, and increases the amount of credit he obtains, in comparison to a position of no such dependencies.

To summarise, Cukierman (1978) shows that, even without default risk, equilibrium rationing will develop if customers have different propensities to buy banking services when granted credit.

Even thought not theoretical, the contribution of Drucker and Puri (2002) manages to underline another possible determinant of cross subsidisation between services and the lending rate. Using an empirical study, they examine the practice of "tying", which occurs when a bank provides a loan to an issuer in order to secure underwriting business. In practice, they identify this phenomenon of "tying" to the supply of loan to a firm which need underwriting around the time of a public securities offering. The authors study the US market over the 1996-2001 period. Through the empirical study, Drucker and Puri find that banks, which are tying lending to underwriting, offer price

[39] We remind the reader that the demand for banking services by a customer is a function of the amount of credit that he gets. In other words, the demand of services faced by the bank is dependent of loans they grant.

[40] If there is credit rationing then λ_i is equal to zero, and from equation (1.71) we have :

$$r_L = CL - f.Se^i_{C_i} \text{ '}$$

discounts[41]. It appears from this article that cross-subsidisation can occur whenever loans enable banks to offer other products. Therefore, this study confirms that activities supplied by banks, which generate fees and commissions, may influence banks' behaviour in their financial intermediation activities.

*
* *

From the forgoing, it is clear that, via incentive effects, commission and fee-based activities influence the degree of credit rationing and interest rate decisions (Cukierman, 1978, Drucker and Puri, 2002). It appears that the influence of service activities should be explicitly taken into account when trying to explain banks' behaviour in supplying and pricing traditional activities, i.e. loans and deposits. The incentive effects must supplement the previously discussed determinants if a full explanation of margin determination is to be arrived at.

However the literature reviewed in this section, while underlining incentives to cross-subsidise, failed to address problems such as asymmetric information. Nothing has been said about risk, the fact that it is inherent to banks' choices, and consequently, that fee-based activities can have effects not only on prices but also on the level of risk in banking.

[41] The kind of price discounts depends on the nature of banks, commercial or investment ones. Commercial banks offer discount loan yield.

1.5. Conclusion

The aim of this survey was twofold. First, the price setting of banks on the loan and deposit markets has been analysed. The objective was to underline the determinants of these prices and the influence of risk on their setting. Indeed risk is a key characteristic of the banking activity. Second, we study the impact on loan and deposit price setting of the supply by banks of additional products, particularly services. Our goal was then to demonstrate that cross-subsidisation is a practice which is likely to be prevalent in banking.

As seen in the general introduction, either in the USA or in Europe, commission and fee-based activities have been expanded greatly by banks since the eighties. Whilst the share of net interest revenue has decreased, the share of commission and fee revenue has increased. In light of these facts, we aimed to point out with this survey that the link between the lending activity and the supply of services by banks needs to be investigated. Indeed, the determinants of bank pricing on the loan market may be further explored, as the findings of Cukierman (1978) invite us to suspect cross-subsidisation between the lending rate and the revenue earned from the sale of services. The role of services, as a determinant of banking prices due to cross-subsidisation, appears in our third section to be crucial when investigating the evolution of the banking market over the last two decades. However the omission of risk from models of cross-subsidisation between loans and services could lead us to disregard some fundamental issues in the relation “commission and fee-based activities and bank’s incentives”.

To be more specific, the sale of services can imply some sharp modifications of banks’ incentives, notably with regard to risk exposure. For instance, banks have to undertake several actions in order to collect information. Moreover, one must acknowledge that this gathering of information is not costless. To determine the optimal rate, banks have also to take into account the cost of reducing risk. Among others, the sale of services could modify banks’ incentives.

If we wonder whether the opportunity for banks to increase their profit from other activities is facilitated by traditional ones (i.e. selling services is easier when a client relationship already exists on the loan or deposit market for example), and may affect risk behaviour and pricing, this survey indicates that the causality stressed by the current literature (competition leads to the decrease of margins, and that induces the development of services) may not be complete. The preceding review suggests that the effect of the sale of services on traditional products should be explicitly addressed in an asymmetric information framework, in which the bank is a multi-product firm.

Before developing (chapter 3) and testing (chapter 4) a model that aims to do this, we must first, in the subsequent chapter, investigate service provision and its impact on bank interest margins in order to assess empirically if such a link is consistent with stylised facts.

CHAPTER 2.

COMMISSION AND FEE INCOME AND BANK INTEREST MARGINS : A PRELIMINARY EMPIRICAL INVESTIGATION FOR THE E.U.

2.1. Introduction

As alleged in the previous chapter, our point is to study how the development of the sale of services can affect banks' behaviour. We have shown with regard to the modelling of bank margins that little has been done explicitly to take into account the rise of commission and fee-based activities. However our survey leads us to suspect that cross subsidisation could be a determinant of banks' behaviour, especially of margin setting. Nevertheless, before further investigating such theoretical issues, we first look for some empirical support. To show that the sale of services can be a significant determinant of bank margins, we use the existing literature as a background. In addition to the standard empirical determinants of bank margins, the sale of services can be considered as a significant variable.

We suspect that given the substantial changes that have been undertaken in commercial banking in the last twenty years, one way to strengthen bank margins explanation could be the introduction of the sale of services as an explanatory variable. Indeed, we have observed both stronger competition in the credit market and increasing growth in the share of non-interest income of banks' revenue[1]. The question raised is how banks' decisions are affected by the new environment in which they compete. We suspect that this new service activity could have become a new determinant of banks' behaviour, as seen implicitly in the first chapter.

Specifically, this chapter investigates empirically, for a set of twelve European countries over the period 1989-1999, the determinants of bank interest margins. More precisely our aim is to consider here the effect of the sale of services on bank margins when taking the standard theoretical determinants into account[2].

[1] The literature cited next details either the evolution of the European or US banking sectors, or the implications of this evolution : Kaufman (1992), Norton *et al.* (1994), Boyd and Gertler (1994), Edwards and Mishkin (1995), Lewis and Pescetto (1996), ECB (1999), Rogers and Sinkey (1999), De Young and Roland (2001) and Dermine (2003).

[2] We do not intend to undertake a study in the field of Hanson and Rocha (1986), Barth *et al.* (1997), Demirguc-Kunt and Huizinga (1998)… In these studies, the authors emphasise the macroeconomic

To do so, we review in a second section the main empirical studies in order to highlight the standard determinants used in bank margins determination. Then in a third section we present the data, the variables chosen in order to undertake our empirical study, including standard determinants and service revenue ; and finally, in a fourth section, we expose and comment the results of our empirical study, and stress the direct influence of the sale of services on bank margins[3].

determinants of interest spreads such as taxation, the structure of the financial system and financial regulations. Therefore bank margins are explained by macroeconomics and banking ratios indicators, and are used as a mean to measure banks' profitability. In contrast, we have a microeconomic approach of the margin.

[3] The aim of the test is to analyse the effect of the sale of services on the determination of the loan interest rate. One of the concern of our work is the effect of deregulation that we are careful correct for when undertaking our empirical work.

2.2. Relevant empirical literature

In this section, we will review the empirical work based on the theoretical modelling of the margin reviewed in the second section (1.2.) of the previous chapter. We will focus our empirical review on two major approaches : on the one hand, the dealership approach ; and on the other hand, the banking firm theoretical approach.

Some relevant empirical work has been undertaken with regard to the Monti-Klein's framework. Slovin and Sushka (1983) and Dermine (1984), for example, using the separability theorem showed that the lending rate is a function of a specific market rate. Both articles search for the most appropriate rate that explains the loan rate, as well as the time adjustment between the lending rate and the market rate that appears to be the most explanatory. In Slovin and Sushka (1983), the commercial loan rate is primary function of interest rates on open market securities, and in Dermine (1984), the lending rate is primary function of the 4 month-certificate interest rate.

These contributions will not be reviewed here as the two approaches that will be developed, which are either an extension of the Monti-Klein's framework or an alternative explanation, give a more thorough analysis of bank margins. Our objective in this section is to point out the relevant determinants of net interest margins.

We will focus first on the dealership approach. Two different econometric methods have been used to study margins within this framework. The first set of empirical studies that will be presented here follows a two-stage process. In the first stage, the effect of explanatory variables of bank margins, not explicitly introduced into the theoretical model (chapter 1, section 1.2.3., p.36), is controlled in order to obtain an estimate of the "pure" margin. The second stage analyses the relationship between this "pure" margin, measured by the constant of the first regression, and the variables assumed by the theoretical model. Then the second set of empirical studies uses a single-stage approach, including in the explanation of the margin both the variables of the theoretical model and the additional variables that reflect other aspects not incorporated into the modelling of the pure margin (regulation or imperfection).

Using the two-stage specific procedure, Ho and Saunders (1981) apply their model to quarterly data for a set of 53 US commercial banks for the period 1976 to 1979.

The authors assume that the coefficient of risk aversion, *A* (see table 2.1.), as well as the size of transactions, *Q*, change relatively slowly over time, therefore they do not include proxies for these variables. Market power (α/β) is implicitly measured by the constant of the second regression γ_0. In addition, they take into account institutional imperfections they have omitted in their theoretical model, that is implicit interest payments, the opportunity cost of required reserves and default premiums on loans.

Table 2.1. Dealership and two-stage process, Ho and Saunders (1981)

Theoretical margin	Empirical specification
$s = \frac{\alpha}{\beta} + \frac{1}{2} AQ\sigma_I^2$	$NIM_{it} = \delta_0 + \delta_1 \text{implicit interest}_{it} + \delta_2 \text{opportunity cost}_{it}$ $+ \delta_3 \text{default premium}_{it} + u_{it}$ i=1..N (banks) t=1..T (time)
	$(\delta_0)_{it} = \gamma_0 + \gamma_1 (\sigma_I)_{it}^2 + \varepsilon_{it}$

s : interest margin of banks ; α/β : market power ; *A* : coefficient of absolute risk aversion ; σ_I^2 : variance of interest rate on deposits and loans ; *NIM* : net interest margin

The bank interest margin is defined as the ratio of interest income minus interest expense to total earning assets. The implicit interest payments variable is measured as non-interest expense minus non-interest revenue divided by total earning assets. This variable should be regarded as an extra interest expense, and is therefore expected to affect positively the margin. The second imperfection considered, is the bank's opportunity cost of holding required reserves and is defined as the ratio of non-interest bearing reserve to total earning assets, times the average treasury bill rate. The existence of non-interest bearing reserve requirements increases the economic cost of funds, and is likely to increase the margin. As there is some probability of borrowers defaulting on loans, which is defined as the ratio of net loan charge offs to total earning assets, an additional default premium may be added to the rate on loans and implies therefore higher margin[4]. Finally volatility is measured as the variance of interest rates on treasury bonds of different maturities (3 months, 1,2,3 or 5 years). Volatility is expected to positively affect bank margins.

[4] The greater the probability of loan charge-offs, and, therefore, potential loss of capital and interest, the greater the default premium likely to be demanded.

Table 2.2. Ho and Saunders (1981) results

Explanatory variables	Expected effect	Empirical result
Implicit interest	+	+
Opportunity cost	+	NS
Default premium	+	NS
Volatility (1 year bond interest rate)	+	+

NS : not significant

The results show that the margin is positively and significantly related to the volatility of the one year bond interest rate, and to implicit interest payments. The proxy for market power, γ_0, has always a significant positive effect on the margin.

Still using the two-step procedure, and including dummy variables reflecting different market structures, the same issue has been further studied by Saunders and Schumacher (2000). The study applies to a different set of countries and to another period. The authors analyse the impact of the structure of bank competition and interest rate volatility on interest margins using data from a sample of seven OECD countries' banks, that is France, Germany, Italy, Spain, Switzerland, the UK, and the US, over the 1988-1995 period.

Table 2.3. Dealership and two-stage process, Saunders and Schumacher (2000)

Theoretical margin	Empirical specification
$s = \frac{\alpha}{\beta} + \frac{1}{2} AQ\sigma_I^2$	$NIM_{it} = \delta_0 + \delta_1 \text{implicit interest}_{it} + \delta_2 \text{opportunity cost}_{it} + \delta_3 \text{capital}_{it} + u_{it}$
	$(\delta_0)_{it} = \gamma_0 + \gamma_1 (\sigma_I)_{it}^2 + \sum_{c=1}^{6} \eta_c + \varepsilon_{it}$

η_C : dummy for countries

The authors suppose that actual bank margins consist of a pure spread, reflecting bank market structure and interest risk, and variables which take into account imperfection and regulation in the banking market, that is implicit interest payments, opportunity cost of required reserves and capital requirements for credit risk exposure. The implicit interest payments variable is measured as non-interest expense minus other operating income divided by total assets, and is thus different from the previous study. The second variable considered, is the bank's opportunity cost of holding required

reserves and is defined as non-interest earning assets to total assets. The effects of these variables are those defined previously. The third factor, that is bank capital defined as equity to total assets, is held by banks to insulate themselves against expected and unexpected credit risk. Holding equity capital is relatively costly compared to debt, thus banks that have relatively high capital ratio can be expected to impose an extra premium in the bank interest margin. In the second regression, six dummy countries η_c are introduced to reflect differential market structures. Short-rate volatility is calculated as the annual standard deviation of weekly interest rates on 3-month securities in each country, and the long-rate volatility on one year securities (depending on the country, these rates are from the money, the interbank or the treasury bill markets) [5].

Table 2.4. Saunders and Schumacher (2000) results

Explanatory variables	Expected effect	Empirical result
Implicit	+	+
Opportunity cost	+	+
Capital	+	+
Volatility	+	+

The three control variables, implicit interest payments, opportunity cost of reserves, and bank capital asset ratios are generally significant and have the expected positive sign. It should be noted that the first of these three variables is highly significant. Saunders and Schumacher find that interest-rate (either the short-rate or the long-rate) volatility has a significant impact on net bank interest margins, for the seven countries. The effect of market structure on bank spreads appears to vary across countries whilst considering the dummy variables : segmented or restricted banking systems, in terms of geographic restrictions on branching and universality of banking services, imply larger market power of existing banks and therefore a higher spread is required.

It has to be noted that the two-stage procedure is really specific to the dealership approach, and give more emphasis to market power and volatility. The Ho and Saunders (1981) approach has also been studied using a single-stage process.

[5] As stated in their article, the authors have problems in estimating risk aversion, *A*, and transactions size, *Q*, parameters. They therefore concentrate on the effects of market structure and volatility on the so-called "pure" margin.

We first consider the study of Mc Shane and Sharpe (1985) in the context of Australian banks. Their empirical study covers the period 1962 to 1981, with yearly data, for 8 banks. As the authors do not have information with regard to the interest margin (interest income and interest expense are not available), they need to estimate the interest margin using different variables, which are loans, deposits, shareholder funds, funds lodged in statutory reserve and total other assets. A very simplified presentation of the regression is shown in table 2.5.

Table 2.5. Dealership and single-stage process, McShane and Sharpe(1985)

Theoretical margin	Empirical specification
$s = \frac{\alpha}{\beta} + \frac{1}{2} AQ\sigma_I^2$	$IM_{it} = \delta_0 \left(\frac{\alpha}{\beta} \right)_{it} + \delta_1 \frac{1}{2} \left(\sigma^2_{i,t-1} A_{i,t-1} \right) + \delta_2 IM_{i,t-1} + u_{it}$

IM : interest margin

The authors define market power (α/β) as deposits of a bank *i* to all bank deposits, that is the bank's share of the deposit market. The degree of risk aversion, *A*, or bank's coefficient of absolute risk aversion, is broadly approached by the ratio of shareholders' funds to total assets of the bank. And volatility is defined by the standard deviation of the monthly weighted average interest rate on deposits. The authors assume that the average transaction size, *Q*, is invariant. Finally, McShane and Sharpe suppose that the interest margin will adjust with a lag to the desired level, as banks can allocate only a small proportion of their earning assets in the short run.

Table 2.6. McShane and Sharpe(1985) results

Explanatory variables	Expected effect	Empirical result
Market power	+	+
Risk aversion	+	+
Volatility	+	+

On the whole, tests lead to underline the existence of a positive and significant effect of market power, degree of absolute risk aversion, and of interest rate uncertainty measures on Australian bank margins.

Angbazo (1997)[6] undertakes an empirical study on 286 American commercial banks for 1989-1993 using also a single-stage approach. The empirical specification focuses on the reported net interest margins, which is assumed to be a function of the desired spread, but also on bank specific factors. The bank margin is defined as net interest revenue on total earning assets.

Table 2.7. Dealership and single-stage process, Angbazo (1997)

Theoretical margin
$s = \frac{\alpha}{\beta} + \frac{1}{4} A\left[\left(Q + 2L_0\right)\sigma^2\left(L\right) + 2Q\sigma^2\left(C\right) + 2\left(C_0 - Q\right)\sigma\left(C.L\right) \right]$
Empirical specification
$NIM_{it} = \delta_0 + \delta_1 \text{default risk}_{it} + \delta_2 \text{interest rate risk}_{it} + \delta_3 \text{liquidity risk}_{it} + \delta_4 \text{capital}_{it} + \delta_5 \text{implicit interest}_{it}$ $+\delta_6 \text{opportunity cost}_{it} + \delta_7 \text{management efficiency}_{it} + \delta_8 \text{regulation}_{it} + u_{it}$

$\sigma^2(L)$ is a measure of pure default risk ; C a measure of cash assets ; and $\sigma^2(C)$ a measure of money market interest risk.

The author explores the relationship between net interest margins and risk factors which banks face when providing immediacy. The empirical specification retains default risk and interest rate risk as risk factors, and liquidity risk, capital, implicit interest payments, non-interest bearing reserves, management quality, and branching restrictions as bank-specific control variables. Default risk is measured as the ratio of net charge-offs on average loans, and interest rate risk exposure is the net position in short term assets deflated by the book value of total equity capital. Angbazo uses the maturity-mismatch hypothesis which suggests that interest rate risk exposure is negatively correlated to the average maturity of assets. The higher the relative level of short term assets, the lower the sensitivity to near-term interest rate changes. Instead of taking a proxy of liquidity risk, the author chooses a variable that can be interpreted as the opposite of liquidity risk, that is the ratio of liquid assets to total liabilities. As the ratio increases, liquidity risk decreases, and the margin should decrease. Capital is measured as the ratio of equity on total assets. An increase in equity capital may increase the average cost of capital, and therefore higher net interest margins is required. As in Ho and Saunders (1981), implicit interest payments are defined as non-interest expense minus non-interest revenue divided by total assets. The author expects

[6] Angbazo includes default risk in the Ho and Saunders theoretical model.

higher margins when higher implicit payments, as they increase the cost of funds. The opportunity cost of holding reserves, measured as non-interest bearing assets on total earning assets, increases the cost of funds and is compensated by higher margins as well. The ratio of earning assets to total assets is included to estimate management efficiency. Angbazo assumes that high quality management increases the share of earning assets, and is reflected in higher interest margins. Finally, a dummy variable captures the role of regulation, and takes the value of one if a bank is headquartered in a state with some barriers to branch expansion. Regulation limits the economies of scale, thereby reducing interest margins.

Table 2.8. Angbazo (1997) results

Explanatory variables	Expected effect	Empirical result
Default risk	+	+
Interest rate risk	+ (proxy -)	NS
Liquidity risk	+ (proxy -)	+ (-)
Capital ratio	+	+
Implicit interest	+	NS
Opportunity cost	+	+
Management efficiency	+	+
Branching regulation	-	-

NS : not significant

Results are consistent with the hypothesis that bank interest margins reflect default risk premium (as risk increases, the margin increases). Moreover, there is evidence that margins are positively linked to liquidity risk, to capital ratio, to opportunity cost and to management efficiency.

Following the process used by Angbazo (1997), Drakos (2003) similarly studies the banking system efficiency of Central and Eastern European countries and Former Soviet countries (11 countries) using a dealership approach and a data set of 283 banks, covering the period 1993-1999.

Table 2.9. Dealership and single-stage process, Drakos (2003)

Theoretical margin

$$s = \frac{\alpha}{\beta} + \frac{1}{4} A\left[\left(Q + 2L_0 \right) \sigma^2 \left(L \right) + 2Q\sigma^2 \left(C \right) + 2\left(C_0 - Q \right) \sigma \left(CL \right) \right]$$

Empirical specification

$$NIM_{it} = \delta_0 + \delta_1 \text{default risk}_{it} + \delta_2 \text{interest rate risk}_{it} + \delta_3 \text{liquidity risk}_{it} + \delta_4 \text{capital}_{it} + \delta_5 \text{time trend}_t + \delta_6 \text{state dummy} + \delta_7 \text{foreign dummy} + u_{it}$$

The net interest margin is defined as the ratio of interest income minus interest expense to total assets. The explanatory variables retained by the author which are interest rate risk, liquidity risk, and capital ratio, are defined as in Angbazo (1997). Default risk is measured as loan loss provisions on loans. Drakos also takes into account a linear trend that accounts for the observed non-linear dynamics of net interest margins due to the transition process. He expects the transition process, through higher efficiency, to decrease margins. A first dummy variable is included and is equal to one if the bank is state owned. A second one equals one if the bank is a foreign one. The author assumes that the entry of foreign banks increases competition, and thereby decreases interest margins. Drakos wants to test if margins are dependent of the ownership status and if the entry of foreign banks decreases margins.

Table 2.10. Drakos (2003) results*

Explanatory variables	Expected effect	Empirical result
Default risk	+	+
Interest rate risk	+ (proxy -)	+ (-)
Liquidity risk	+ (proxy -)	+ (-)
Capital	+	+
Trend	-	-
Dummy state owned	?	-
Dummy foreign bank	-	-

* Results are less significant when the author considers a set of data including only the Central and Eastern European countries, and another one including only the former soviet union countries.

All variables appear to be usually significant, with the expected sign. The result on the linear trend shows a downward trend reflecting to a certain extent the effectiveness of the reform. Given the results on dummy variables, it is cleared that ownership status

matters. State owned banks set lower interest margins than private banks. The results also show that foreign banks set lower interest margins.

The previous studies investigate the empirical determinants of the margin, using the dealership approach as a theoretical background. The first two studies emphasise the role of market power and volatility, whereas in the last studies reviewed, risk is taken into account in more thorough way. This issue was also of primary importance in Wong (1997).

Finally, we review Goyeau *et al.* (1999), that apply an extension of the Monti-Klein approach (Wong, 1997) to the context of Central and Eastern European countries. The test is carried out for nine countries and covers the period 1992-1996.

Table 2.11. Banking firm theoretic approach, Goyeau *et al.* (1999)

Theoretical margin
$NIM_i = \dfrac{rE + \left((1-\gamma) r_L - r\right) L + \left(r - r_D\right) D}{\text{Total Assets}}$
Empirical specification
$NIM_i = \delta_0 + \delta_1 \text{default risk}_i + \delta_2 \text{maturity risk}_i + \delta_3 \text{capital}_i + \delta_4 \text{opportunity cost}_i + \delta_5 \text{admin cost}_i + u_i$

r : risk-free rate ; r_L : lending rate ; r_D : deposit rate ; γ : non performing loans, E : equity ; L : loans ; D : deposits

They are able to specify two groups of factors that influence the net interest margin, which is measured as net interest income on total assets. The first group contains the variables which explain the desired spread under uncertainty, this set of variables reflects the mark-up required by banks to offset their exposure to interest rate risk and credit risk. Default risk is measured by the ratio of loan loss reserves to gross loans. As the authors could not measure interest rate risk, they use a proxy which also accounts for liquidity risk. When this maturity risk proxy, which is defined as the ratio of loans to bank's customer and short term funding, increases, higher margins are required. The second group is assumed to capture the effects of prudential regulation, the effects of active portfolio reshuffling, and operating costs. The capital ratio is measured by the ratio of equity to total loans. The variable, which is supposed to capture substitution effects between marketable assets and loans, is the interest rate on 3-month treasury bills. Finally, administrative costs are measured as the sum of personnel expenses and

non-interest expenses deflated by total assets. As costs increase, higher margins are required by banks.

Table 2.12. Goyeau *et al.* (1999) results

Explanatory variables	Expected effect	Empirical result
Default risk	+	+
Maturity risk	+	+
Capital	+	NS
Opportunity cost	?	+
Administrative costs	+	NS

NS : not significant

The authors find that the three determinants which significantly affect the bank margin, are credit risk, maturity risk, and arbitrage opportunities related to changes in risk-free market interest rates.

*
* *

The aim of this section was to determine which variables have been identified in the empirical literature as significantly affecting the setting of bank interest margins. In the next section, we undertake an empirical study of bank interest margins in the context of Europe, based on Wong (1997), who stresses the role of risk in a micro-model of bank margins. As this survey shows, the study based on Wong is econometrically closed to the one of Angbazo (1997) and Drakos (2003). The framework allows us to obtain a general explanation of bank margins.

In the study that is next undertaken, a first set of explanatory variables includes risk factors, that is default risk, interest rate risk and liquidity risk. A second set of bank specific variables consists in a measure of financial leverage, administrative costs, and opportunity cost. We consider as well commission and fee-based activities in the light of the changes that happened the last two decades. Indeed banks have increased the

share of the cost of services they charged to clients (Jacolin and Pasquier, 1995), and we wonder if it may impact on bank margins. We thus take into account net commission and fee revenue as an explanatory variable, as others have retained implicit interest (see for instance the empirical studies of Angbazo, 1997, Ho and Saunders, 1981, Saunders and Schumacher, 2000,…). The aim of this study is to highlight the potential explanatory power of services, whilst dealing with a general empirical specification of bank margin determination.

We therefore retain the following general form :

NIM_{it} = *f* (interest rate risk, liquidity risk, credit risk, administrative costs, opportunity cost, equity capital, net commission and fee income).

2.3. Commission and fee income as a determinant of bank margins : A European study.

Now that we have determined the standard empirical determinants of bank interest margins, we assess, in this section, the effect of commission and fee revenue. In other words, we intend to determinate a possible effect of the sale of services on intermediation activities. We study a set of twelve European countries belonging to the European Union, over the period 1989-1999.

2.3.1. The data

The data for this study have been obtained from Fitch-IBCA's Bankscope database which provides series from individual bank balance sheets and income statements. Our study covers yearly data for the period 1989-1999. More precisely, the sample includes commercial banks only[7], i.e. institutions relying more heavily on loan and deposit activities in order to focus on intermediation, which generates interest margins. One of the main advantage of Bankscope is its attempt to standardise financial statements across countries, so as to enable reasonable cross-country comparison[8].

The empirical study is carried out for each of the twelve European countries selected, all belonging to the European Union. The number of banks in the sample for each country is as follows before excluding outliers of the database : Belgium (58), Denmark (51), France (315), Germany (247), Greece (22), Ireland (27), Italy (154), Luxembourg (127), the Netherlands (63), Portugal (45), Spain (116) and the U.K. (211).

[7] *IBCA-Fitch definition of commercial banks* : "The country specific specialisations are available for the 15 EU countries as well as for Switzerland and Japan. For banks of the EU and the EFTA countries, the Official Journal of the EU provides a classification of the listed banks according to their specialisation. These categories vary from one country to another since they are based on the declarations made to the European Commission by the relevant professional organisation of the member states. For Swiss banks, the classification is provided by the Commission Fédérale des Banques. For Japanese banks, it is supplied by the Federation of Bankers' Associations of Japan (Zenginkyo)."

[8] If Ehrmann *et al.* (2002) argue that the Bankscope database suffers from a composition bias compared to the databases collected by the respective national central banks, Fitch-IBCA has proceeded to the construction of a consistent database for reasonable cross-country comparison.

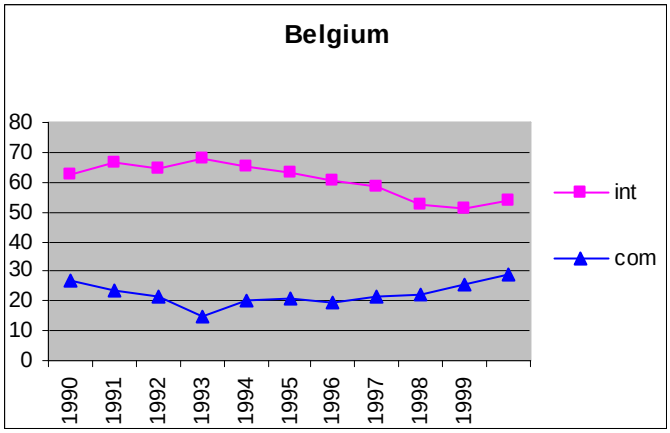
We have eliminated banks which, over the sample period, had less than four years of balance sheet observations, in order to control for the consistency of bank reporting. Then, in order to minimize the effects of measurement errors, we have excluded all the outliers by eliminating observations that did not meet a ratio of total loans over total assets higher than 10% and smaller than 95%, and observations when the equity variable was negative[9]. To have a global overview of our database, appendix A provides summary statistics on key characteristics.

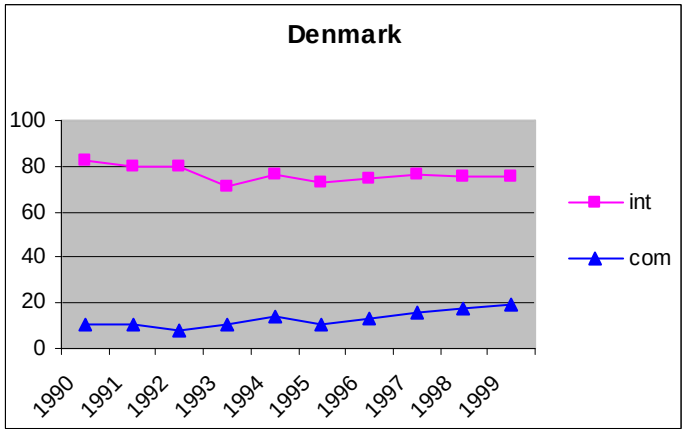
The number of banks after using the procedure above is [10] : Belgium (27), Denmark (42) , France (170), Germany (139), Greece (9), Ireland (11), Italy (116), Luxembourg (42), the Netherlands (34), Portugal (34), Spain (39) and the U.K. (55).

2.3.2. The evolution of bank margins and service revenue

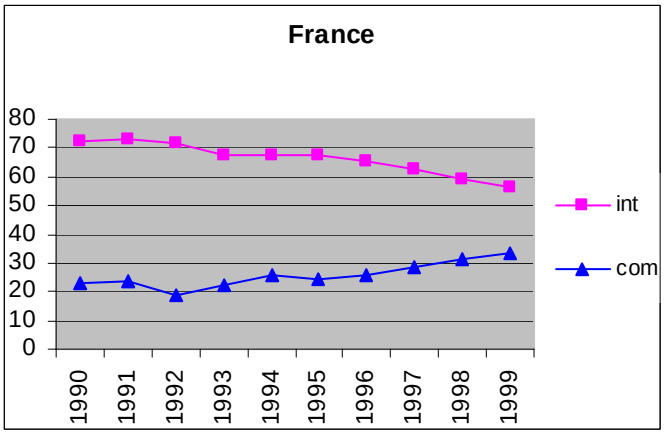
As we have seen in the general introduction, in the case of Europe, the share of net interest revenue in the profit function of banks is decreasing, whilst the share of commission and fee revenue is increasing (ECB, 2000a).

We present below these two main variables, built from our database, defined respectively as the ratios of net interest revenue, and commission and fee revenue, on total operating income, for each country studied.





[9] Such a procedure has been used by Cavallo and Majnoni (2001).
[10] The number of observations per year and per country is available appendix B, table 2.16.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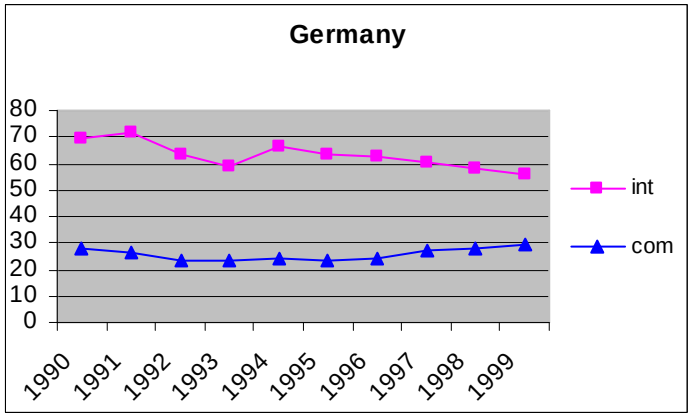
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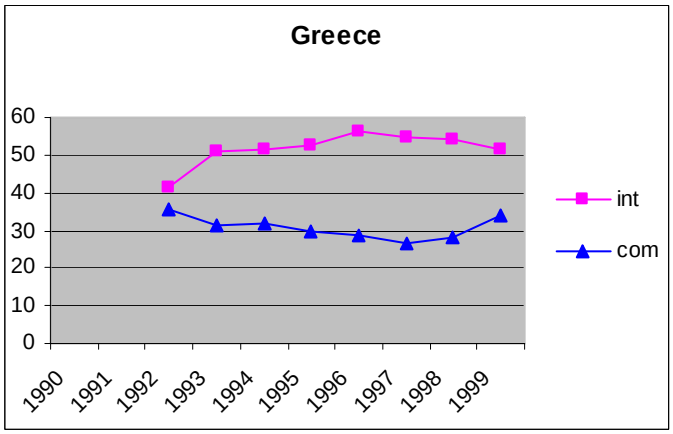
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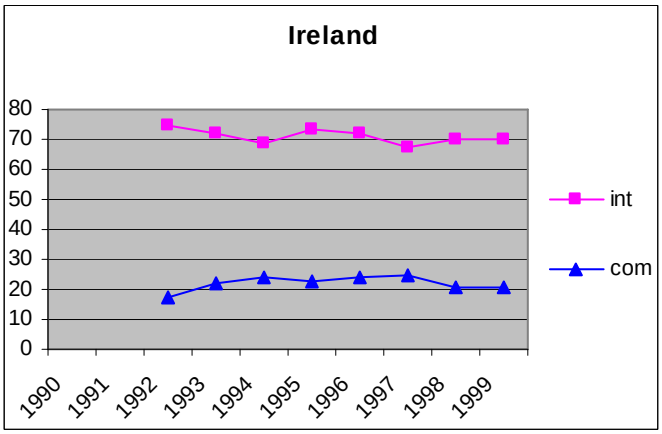
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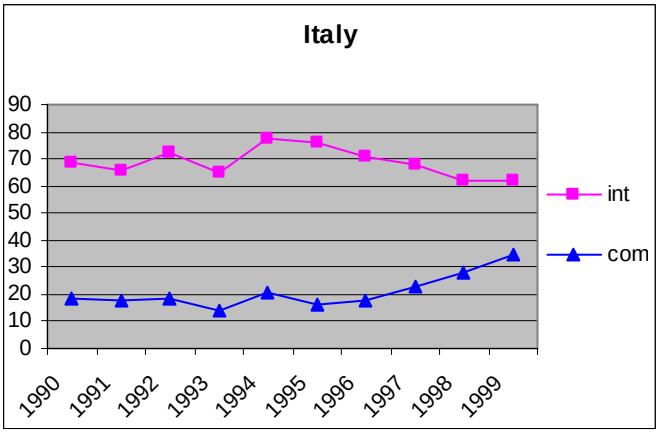
Italy
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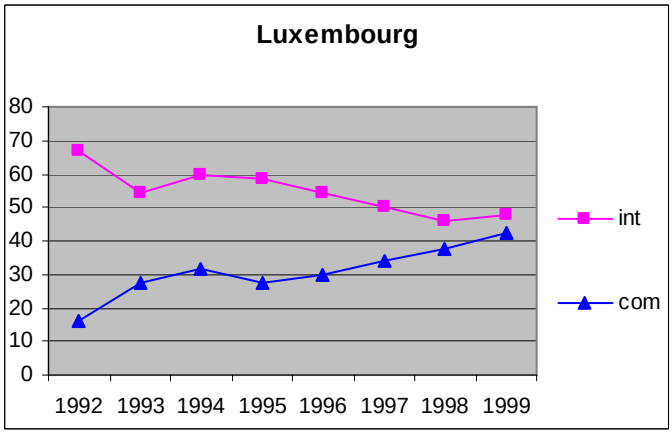
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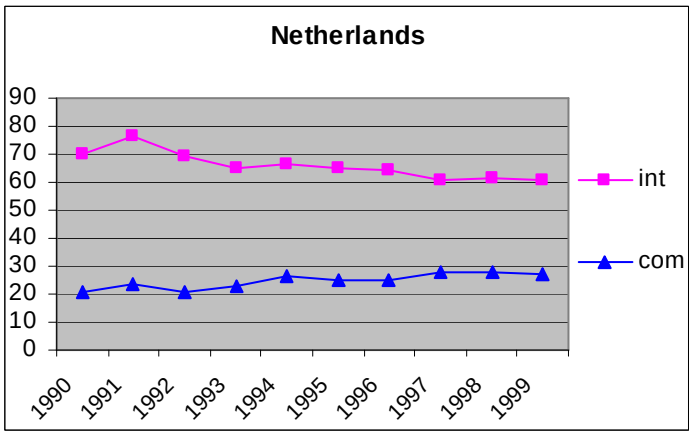
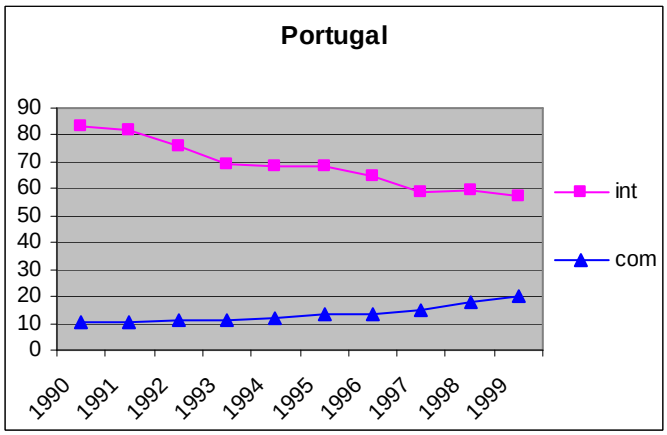
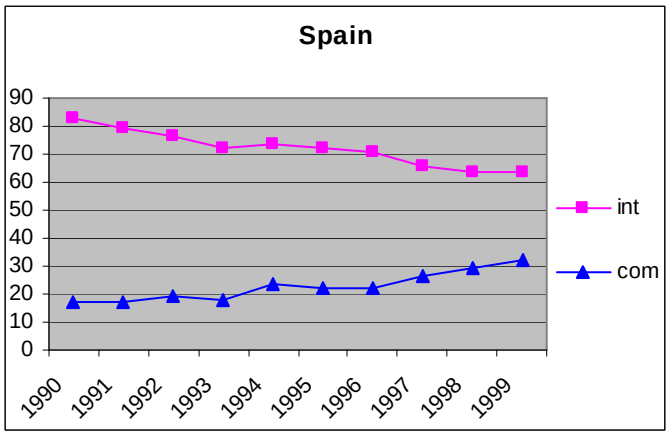
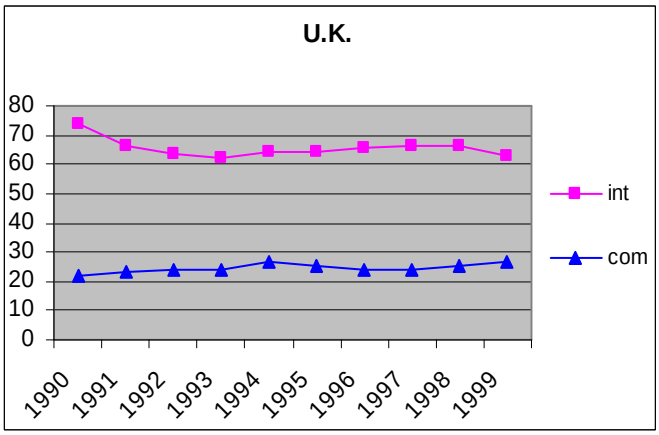








As in the literature, we observe for all countries studied, except Greece[11], a decrease of banks' interest revenue and an increase of commission and fee revenue over the period, the effect being more significant the second half of the nineties.

2.3.3. Definition of variables

As explained in section 2.2., our empirical study is based on Wong (1997). This approach uses determinants similar to the dealership approach if we compare our work to the one of Angbazo (1997). Therefore the explanation of the margin we obtain also encompasses the determinants of the margin underlined in the dealership approach.

[11] When we consider the ratio used in our study, see subsection 2.3.4. and appendix C, we find the usual result of a decrease in net interest margins and an increase in service revenue.

Net Interest Margin

An explicit measure of the net interest margin could be the difference between interest received from loans to gross loans and interest payable on deposits to total deposits. However such an information is scarcely available. Therefore, our proxy is an implicit measure of the net interest margin often used in the empirical literature and defined as the ratio of net interest revenue (interest income – interest expense) to total assets[12]. Given that we have retained only commercial banks, and given our restrictions, this ratio is not very different to the ratio of net interest revenue to total earning assets.

Administrative costs (admin costs)

The variable reflecting changes in administrative costs is defined as the sum of personnel expenses and non-interest expenses deflated by total assets.

The theoretical model suggests that the administrative costs of loans should be separated from the administrative costs of issuing deposits. Unfortunately the data set does not allow for such a distinction. According to the literature, the rise of administrative costs leads to higher margins, and we thus expect the coefficient to be positive. However if we consider that these expenses enable banks to reduce the asymmetry of information, thereby reducing risk, we may expect either an increase or a decrease in the lending rate whether default risk was under-estimated or not.

Interest rate risk (transformation risk)

Interest rate risk arises because given their maturity and their rate definition, assets and liabilities will be affected differently by market interest rate variation. Therefore a measure of interest rate risk should capture the maturity gap. Consistent with Flannery and James (1984) and Angbazo (1997), the standard measured exposure is the net position in short term assets (12 months or less) deflated by the value of equity capital.

[12] See appendix C for summary statistics and graphs of net interest margin and commission and fee revenue variables such as defined in our empirical study.

Unfortunately, such a variable cannot be calculated from the data available for our countries. In fact the variables that can be calculated can only implicitly capture effects related to bank balance sheet structures, and thus transformation risk, without explicitly distinguishing interest rate risk from liquidity risk. The latter is the risk of not having sufficient cash or borrowing capacity to meet deposit withdrawals or new loan demand, thereby forcing banks to borrow emergency funds at excessive cost. The ratio of loans to the bank's customer short term funding is used as a proxy of transformation risk. Thus, an increase in the amount of loans implies a higher transformation risk, and a greater premium is required on bank interest margins.

Bank capital or leverage (capital)

The capital ratio is measured by the ratio of equity capital to total loans.

Since equity is a more expensive funding source than debt, an increase in equity capital may increase the average cost of capital. Therefore, higher net interest margins could be required ex-ante. However Wong (1997) shows that if we suppose that interest rate risk is not severe, an increase in equity capital increases the bank's profit. The bank becomes less risk averse and is thus willing to grant more risky loans by lowering the lending rate, and thereby the margin.

Credit risk (default risk)

Default risk is normally measured as the ratio of non performing loans to gross loans. However such an information is available only for three of the twelve countries. Therefore we have considered two other measures of the credit risk exposure, which is approximated either by the ratio of loan loss provisions to gross loans or by loan loss reserves to gross loans[13].

The idea is that banks, whose loans are more risky, will require a higher net interest margin to compensate for higher risk of default.

[13] The database does not provide as much information on the ratio loan loss reserves to gross loans than for the ratio loan loss provisions to gross loans (for example we do not have the reserves ratio for Germany). Therefore we present only the results for the loan loss provisions ratio.

Opportunity cost (3-month Tr. Bill)

The opportunity cost, which is supposed to capture substitution effects, is measured by the interest rate of the interbank market. The latter will be approximated by the 3-month interbank rate. Series are supplied by DataStream International, except for Portugal, which was collected from the OECD statistics (Main Economic Indicators).

According to Wong (1997), one would expect the sign of the coefficient to depend on the bank's net position in the interbank market.

Revenue from services (com and fees)

The revenue from the sale of services is measured as net commission and fee revenue (i.e. commission and fee income less commission and fee expense) deflated by the total of assets.

We attempt here to show that the sale of services is a determinant of the net interest margins. As we suspect "cross-subsidisation" to occur, we expect a negative impact of this variable on bank margins.

Time effect

We introduce a time effect that should account for the competitive pressure that was increasing in banking sector over the period. As competition increased in the lending and deposit markets, we expect the bank margin variable to decrease. In the mean time, the increase of commission and fee revenue has been observed. Therefore either a trend or dummies have been included, whenever relevant[14], to capture this effect. As competition increases, the net interest margin decreases and we therefore expect a negative coefficient in front of the trend or dummies variable.

[14] To take into account the time effect, we first include a trend in the regression. If the trend variable is not significant, then we replace it by time dummies. Such a procedure enables us to eliminate any possible time effect.

We summarise in table 2.13. our explanatory variables as well as their expected impact on bank interest margins :

Table 2.13. Explanatory variables and expected effects on net interest margins

Explanatory variables	Expected effect	Explanatory variables	Expected effect
Administrative costs	+ or -	Opportunity cost	+ or -
Transformation risk	+	Com and Fees	-
Capital	+ or -	Time effect	-
Default risk	+		

Now that we have defined the variables included in our empirical work, we can proceed to our empirical estimation.

2.3.4. Methodology and the equation estimated

Given the structure of our database, the question is whether to pool or not the data. In order to answer this question we need to undertake the tests for poolability, which are explained in appendix D. However in the process to test for poolability, we were unable to compute two of the three tests, that is H_0^1 and H_0^2 (*cf.* appendix D)[15]. Therefore we present in appendix D the results for the last test H_0^3, which tests for :

Test H_0^3 : $\alpha_i = \alpha \quad \forall i \in [1, N]$ against $\alpha_i \neq \alpha \quad \forall i \in [1, N]$

Results (in table 2.19, appendix D) show that the hypothesis H_0^3 is rejected at the 1% level for the twelve countries. Therefore we will use panel regression estimations for our sample.

The methodology of panel regression may be explained as follows : a panel data set contains repeated observations over the same units, here banks which numbers (N_j, j=1…12) differ from one country to another, collected over a number of periods, in our case T=11 years. However individuals are not observed over the entire sample period,

[15] As we use the software Eviews, the Fischer tests for poolability are not provided, and we need therefore to compute them.

which implies missing observations. We therefore have to deal with the so-called "unbalanced" or "incomplete" panels.

The benefit of panel data is to control for individual heterogeneity. Let us consider the following example :

$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it}$ where *i* represents the bank, and *t* the year.

The individual effect is captured through the constant α_i, while the coefficients of explanatory variables, β, are supposed to be the same for all individuals. Then we can use the next two methods to estimate the regression, either the fixed effects model which estimates different constants for each cross-section (we obtain N_j α_i), or the random effects model which assumes that the term α_i is the sum of a common constant α and a time-invariant cross-section specific random variable u_i that is uncorrelated with the residual ε_{it}. The fixed effects are computed by Least Squares with Dummy Variables (LSDV), and the random effects by Generalised Least Squares (GLS).

To test the fixed effects versus random effects regression, we employ the Hausman specification test (appendix E). When the constant coefficient is missing in table 2.14. below, it means that the fixed effects estimation has been chosen.

We also perform tests for heteroskedasticity and autocorrelation. A White test is used for homoskedasticity. The null hypothesis of homoskedasticity for Belgium, Ireland and the U.K. (see appendix F) is not rejected. Therefore whenever relevant we take into account cross section weights (the estimated coefficients values are then given by the standard GLS estimator). We also consider heteroskedasticity which is due to variances within a cross-section.

A Durbin-Watson test for panel data has been performed and shows autocorrelation of order one for all countries (see appendix G). To correct for autocorrelation we include a lagged dependent variable. However the presence of a lagged dependent variable as an exogenous variable in the regressions implies bias in the observed coefficients. For LSDV estimations, the coefficients of the exogenous variables are over-estimated if positive and under-estimated if negative. The coefficient of the lagged variable is under-estimated if positive. For GLS estimations, the coefficients of the exogenous variables are under-estimated if positive and over-estimated if negative, and

the coefficient of the lagged dependent variable is over-estimated (Baltagi, 2001, Sevestre, 2002).

The ensuing analysis interpret the regression results as being descriptive : rather than focusing specifically on the magnitude of the coefficients, the signs of the coefficients are receiving emphasis.

The estimated equation is :

$$\text{NIM}_{it} = \alpha_i + \beta_1 \text{ Admin Cost}_{it} + \beta_2 \text{ Transformation Risk}_{it} + \beta_3 \text{ Capital}_{it} + \beta_4 \text{ Default Risk}_{it} + \beta_5 \text{ Opportunity Cost}_{it} + \beta_6 \text{ Com and Fees}_{it} + \beta_7 \text{ Trend} + \beta_8 \text{ NIM}_{i,t-1} + \varepsilon_{it}$$

The letter "*i*" represents the index for banks, and the letter "*t*" the index for years.

In the light of our previous discussion, the expected signs are $\beta_1>0$, $\beta_2>0$, $\beta_3>0$[16], $\beta_4>0$, β_5 may be positive or negative, we expect β_6 to be negative, $\beta_7<0$, $\beta_8>0$.

2.3.5. Estimation results

[16] We remind the reader that when the effect of transformation risk is not severe on the net interest margin, the capitalisation variable has a negative impact on the bank interest margins.

Table 2.14. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Net Interest Margin[a,b]

	Constant	Administra-tive costs	Transfor-mation risk	Capital	Default risk	Opportunity cost	Com and Fees	NIM (-1)	Adjusted R^2	Observa-tions
Belgium		0.152 (2.161)**	0.007 (1.70)*	0.0004 (0.177)	0.0002 (1.0933)	0.002 (0.127)	-0.072 (-1.676)**	0.214 (2.808)***	0.95	173
Denmark		0.611 (11.59)***	0.00001 (4.634)***	-0.005 (-1.177)	0.001 (5.885)***	0.027 (3.324)***	-0.131 (-3.145)***	0.377 (10.21)***	0.97	311
France	-0.001 (-1.262)	0.332 (15.06)***	0.006 (5.981)***	0.0001 (0.507)	0.0003 (3.441)***	0.019 (1.665)*	-0.271 (-10.99)***	0.569 (29.01)***	0.67	1244
Germany	0.011 (3.048)***	0.456 (22.41)***	0.004 (2.861)***	-0.001 (-2.931)***	0.011 (3.698)***	-0.120 (-3.404)***	-0.364 (-13.05)***	0.562 (28.58)***	0.90	803
Greece		0.357 (2.855)***	0.032 (4.306)***	0.017 (1.972)**	-0.0003 (-1.065)	-0.020 (-0.728)	-0.364 (-5.023)***	0.283 (4.453)***	0.91	54
Ireland		0.961 (6.467)***	0.001 (0.398)	0.002 (0.291)	-0.0005 (-0.257)	0.053 (1.495)	-0.858 (-4.895)***	0.356 (3.822)***	0.98	55

(continued on next page)

[a] Figures in parentheses are the t-statistics, asterisks (***), (**) and (*) indicate respectively significance at the 1%, 5% and 10% level.
[b] All regression estimates are heteroskedastic consistent and are based on the revised covariance estimate of White (when relevant).

Table 2.14. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Net Interest Margin. (*continued*)

	Constant	Administra-tive costs	Transfor-mation risk	Capital	Default risk	Opportunity cost	Com and Fees	NIM (-1)	Adjusted R^2	Observa-tions
Italy	-0.010 (-3.829)***	0.414 (14.41)***	0.004 (3.427)***	0.012 (5.683)***	0.001 (2.466)***	0.086 (2.927)***	-0.102 (-1.783)*	0.521 (23.99)***	0.87	857
Luxembourg	-0.0001 (-0.058)	0.004 (0.236)	0.006 (5.457)***	0.005 (3.686)***	0.0003 (2.470)***	0.036 (3.873)***	0.018 (0.558)	0.390 (10.21)***	0.71	266
Netherlands	0.009 (5.823)***	0.068 (1.311)	0.0003 (0.628)	-0.007 (-3.262)***	0.136 (4.988)***	-0.090 (-4.374)***	-0.068 (-0.877)	0.756 (18.97)**	0.78	233
Portugal	0.002 (1.151)	0.226 (5.704)***	0.004 (1.658)*	-0.009 (-2.063)**	0.074 (2.510)***	-0.0004 (-0.032)	-0.194 (-1.764)*	0.632 (15.27)***	0.76	222
Spain		0.458 (7.377)***	0.007 (3.746)***	0.025 (4.845)**	-0.0002 (-0.832)	0.055 (4.061)***	0.118 (0.977)	0.262 (6.752)***	0.95	349
UK	-0.007 (-2.238)**	0.553 (11.83)***	0.015 (7.071)***	0.006 (2.971)***	-0.0001 (-0.281)	0.047 (1.018)	-0.522 (-8.444)***	0.450 (12.39)***	0.95	344

Effects of standard determinants

Table 2.14 presents our estimation results. If the goodness of fit coefficients (R^2) are reasonably high, between 0.67 and 0.98, their explanation in a panel data regression is rather difficult (Sevestre, 2002). Therefore to analyse the results we should prefer to concentrate on the significance of regression coefficients (*t*-statistics).

The time effect (see appendix H for coefficients of the time effect variable) is not significant for Belgium, France, Luxembourg, Portugal and the U.K.. On the contrary, we have a negative and significant trend for Germany, Greece and Spain. Dummy variables show a negative and significant effect at the end of the period considered for Denmark, Ireland and the Netherlands. However, if we do observe negative dummy coefficients for the beginning of the period for Italy, dummy coefficients are positive for the end of the period[17].

For all countries, the bank interest margin reacts positively to the administrative costs variable, coefficients are significant at the 5% level, except for Luxembourg and the Netherlands. The theoretical effect is thus not rejected, and therefore we meet the previously found result in the literature that an increase in the administrative costs implies a higher bank interest margin.

The transformation risk variable, which has been retained as a proxy of interest rate risk, has the expected positive sign in all the countries but the coefficient is not significant at the 10% level for two of them, Ireland and the Netherlands.

We also observe that when the effect of transformation risk is not severe on the net interest margin we indeed find as shown in Wong (1997) that the capitalisation variable has a negative impact on bank interest margins in the case of Portugal. The coefficient of the capital ratio is negative and significant.

[17] Given the structure of the net interest margin variable (appendix C), we did not expect dummy coefficients to be positive. We then wonder if it has been caused by an increased of banks monopoly power following consolidation in the Italian banking market.

For Greece, Italy, Luxembourg, Spain and the U.K., the variable which is a proxy for the capital requirement has a positive sign, with a significant effect. The coefficient is still positive but not significant for Belgium, France and Ireland. Thus, a higher capital ratio is compensated for these countries by a higher net interest margin. In other words banks increase their capital in order to face higher risk or more stringent regulation, and they require higher margins.

The default risk proxy is positive and significant for Denmark, France, Germany, Italy, Luxembourg, the Netherlands and Portugal. For Belgium the coefficient is positive but not significant. However for Greece, Italy, Spain and the U.K., the coefficient is negative but not significant. Regressions were also estimated using the ratio of loan loss reserves to gross loans, available only for a limited number of countries. Whenever the comparison was possible, either income statement (loan loss provisions) or balance sheet (loan loss reserves) information led to the same results.

The opportunity cost variable is significant for seven of the twelve countries. However the sign of the coefficient is either positive or negative, and therefore the effect on bank interest margins is ambiguous.

Effects of the commission and fee variable

We now consider our variable of interest, that is the net commission and fee revenue variable. This variable has a negative impact on net interest margins in all countries but Luxembourg and Spain. In other words, results show for most countries a negative impact of the sale of services on the pricing of net interest margins. The study therefore strengthens the intuition of “cross-selling”.

From the presence of a time effect in each regression, which should capture competition effect, we can conclude that the inverse relationship observed between the ratio net fee and commission revenue to total assets and net interest margins is not due to a positive trend in the former variable, and a negative one in the latter.

Therefore, the result we found can legitimate the idea of “cross-subsidisation”, and its effect on the determination of bank margins. Indeed the empirical study undertaken

enables us to state that the decrease of bank interest margins is not only due to deregulation and disintermediation, but that part of the margin decrease can come from the rise of the sale of services. Actually the result found gives us a strong incentive to investigate such a relation between the lending rate and the sale of services.

2.4. Conclusion

The aim of this chapter was to carry out an empirical analysis of the behaviour of banks in terms of pricing strategy. Banking activities have dramatically changed over the last two decades : the share of non-interest income of bank revenue has become a substantial part of banks' profit. We therefore wondered how determinants of bank interest margins have been affected in European countries.

Specifically, we conducted Generalised Least Squares or Least Squares with Dummy Variables estimations on pooled samples for twelve European countries over the period 1989-1999. Both the theoretical and empirical literatures on optimal bank interest margins emphasise risk factors. Among the various measures introduced in empirical studies, we selected default risk and transformation risk as risk factors determinants. We also considered a set of exogenous variables, namely opportunity cost, capital ratio and administrative costs variables. Our results show a positive and significant impact of default risk, administrative costs and transformation risk on bank margins, in most European countries. On the whole, the results found here confirm those previously obtained in the literature concerning other countries.

To take into account the changing structure of banks' profits, we included a commission and fee variable in our empirical estimation. The results show that an increase in service provision reduces interest margins. This finding invites us to determine the relationship between this two variables in the field of the cross-subsidisation literature we exposed earlier. As we observe an empirical effect on the net interest margin, a theoretical investigation may highlight the existence of a possible cross-selling.

De Young and Roland (2001), Drucker and Puri (2002), as well as American regulators (Dingbell, 2002) have already raised the issue of credit provision to borrowers at reduced lending rates, compensated by high commission and fee business.

The cross-subsidisation literature in the banking market may also give some indications. Several authors, as Barro and Santomero (1972), Mitchell (1979) and Whitesell (1992), have shown that deposit interest rate regulations have implied “implicit interest” in the form of services rendered at prices below cost. As discussed in chapter 1, an alternative consideration of the commissions and fees and lending rate relationship is addressed by Cukierman (1978), who showed that borrowers who are buying more services than others from a same bank are less prone to credit rationing. With reference to our study, this implies that we should consider the effects of the sale of services on the determination of the lending rate.

All this literature suggests that the rise of non traditional activities can alter banks’ behaviour, and that consequently regulators should take it into account. Nevertheless, a key issue that remains to be fully investigated is the influence of commissions and fees on bank pricing and risk strategy in an asymmetric information environment. The model constructed in the next chapter is devoted to this issue.

Appendix A. Summary statistics

Table 2.15. Descriptive Statistics

	Mean	Standard deviation	Minimum	Maximum
Belgium				
Total Assets	$ 15.83 B	$ 43.71 B	$ 52 M	$ 342 B
Deposit / TA	89.27	4.87	0.53	95
Loans / TA	35.84	18.38	10.03	85.67
Denmark				
Total Assets	$ 3.88 B	$ 13.56 B	$ 34.3 M	$ 94.5 B
Deposit / TA	83.05	3.72	59.70	91.06
Loans / TA	56.43	12.96	10.39	82.04
France				
Total Assets	$ 9.98 B	$ 43.64 B	$ 5.52 M	$ 702 B
Deposit / TA	78.01	15.77	10.04	95
Loans / TA	54.87	23.88	10.01	95
Germany				
Total Assets	$ 6.45 B	$ 27.99 B	$ 10.8 M	$ 289 B
Deposit / TA	77.60	18.12	10.25	95
Loans / TA	50.39	22.71	10.09	95
Greece				
Total Assets	$ 6.42 B	$ 10.97 B	$ 88 M	$ 46.55 B
Deposit / TA	85.40	6.50	58.23	95.58
Loans / TA	40.67	11.97	11.54	71.91
Ireland				
Total Assets	$ 7.84 B	$ 13.49 B	$ 117 M	$ 65.55 B
Deposit / TA	82.87	17.53	12.59	95
Loans / TA	55.10	19.83	12.71	85.51

(continued on next page)

Table 2.15. (*continued*)

	Mean	Standard deviation	Minimum	Maximum
Italy				
Total Assets	$ 11.48 B	$ 30.21 B	$ 35.9 M	$ 330 B
Deposit / TA	76.64	8.91	16.23	95
Loans / TA	47.12	10.67	10.60	95
Luxembourg				
Total Assets	$ 4.51 B	$ 6.68 B	$ 47.9 M	$ 37.2 B
Deposit / TA	87.25	9.82	11.81	95
Loans / TA	30.05	17.46	10.00	94.79
Netherlands				
Total Assets	$ 18.22 B	$ 61.33 B	$ 25.9 M	$ 504 B
Deposit / TA	80.44	16.15	13.59	95
Loans / TA	52.15	22.77	10.90	95
Portugal				
Total Assets	$ 6.48 B	$ 10.02 B	$ 53.4 M	$ 57.6 B
Deposit / TA	79.96	13.81	15.72	95
Loans / TA	45.90	15.05	11.22	83.78
Spain				
Total Assets	$ 10.44 B	$ 29.77 B	$ 16.4 M	$ 237 B
Deposit / TA	81.91	13.43	11.85	95
Loans / TA	51.25	20.11	10.09	95
UK				
Total Assets	$ 5.53 B	$ 12.96 B	$ 8.3 M	$ 164 B
Deposit / TA	77.29	14.71	10.24	95
Loans / TA	50.53	27.62	10.04	95

Source : Fitch IBCA (1997, 2001) / own calculations

All figures are in percentages unless stated otherwise.

Appendix B. Number of observations

Table 2.16. Number of observations per year and per country

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	23	22	26	26	35	43	45	44	43	34	31
Denmark	14	16	18	33	36	43	48	49	49	49	47
France	121	133	141	237	265	276	274	264	242	225	178
Germany	57	67	90	111	160	186	195	202	199	181	142
Greece	6	6	8	5	7	11	11	13	19	17	14
Ireland	2	2	2	6	9	12	14	15	17	16	13
Italy	70	77	78	69	104	113	119	129	126	120	110
Luxembourg	35	63	71	75	97	104	104	107	107	102	98
Netherlands	27	28	29	35	41	49	54	55	48	44	37
Portugal	6	13	16	32	33	34	39	41	41	38	32
Spain	62	73	83	57	61	63	74	93	97	92	83
UK	13	17	25	104	130	135	148	161	149	141	119

Source : Fitch IBCA (1997, 2001) / own calculations

Appendix C. Net interest margins and commission and fee revenue

The net interest margin is defined as interest revenue minus interest expense on total assets. Table 2.17. below shows the statistics used :

Table 2.17. Net Interest Margins [a]

		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	mean	1.909	1.710	1.647	1.781	1.924	1.820	1.981	1.969	1.726	2.136	2.409
	std dev	1.781	1.172	1.166	1.166	1.823	1.575	1.820	1.775	1.533	2.200	2.724
Denmark	mean	4.446	4.608	4.270	4.963	5.189	5.143	4.905	4.594	4.356	4.237	4.209
	std dev	1.279	1.524	1.541	1.640	1.574	4.466	2.027	1.915	1.821	1.804	1.818
France	mean	3.061	2.950	3.155	3.608	3.341	3.059	2.992	3.041	2.953	2.935	2.637
	std dev	1.796	2.474	1.865	2.379	3.014	2.080	1.977	2.300	2.585	2.604	2.194
Germany	mean	3.914	3.646	3.948	2.636	2.510	2.731	2.599	2.681	2.316	2.365	2.162
	std dev	8.086	6.461	6.952	1.993	1.885	2.187	2.156	2.650	2.271	2.334	1.775
Greece	mean	4.998	5.903	4.049	NA	3.410	2.504	2.676	2.831	2.976	2.664	2.423
	std dev	1.119	1.804	2.169		1.937	1.557	1.720	1.284	1.059	0.886	0.880
Ireland	mean	NA	NA	NA	3.653	3.077	2.261	2.596	2.132	1.767	1.860	1.676
	std dev				1.511	1.523	1.444	2.086	1.491	1.240	1.281	1.399
Italy	mean	3.474	3.513	3.517	3.789	3.864	3.761	4.146	3.688	3.160	3.029	2.698
	std dev	0.993	1.071	1.101	1.150	1.217	1.187	1.224	1.073	1.201	0.889	0.939
Luxembourg	mean	0.335	0.306	0.561	0.729	0.952	0.894	0.851	0.822	0.817	1.016	0.940
	std dev	1.536	1.126	1.185	1.185	0.619	0.458	0.423	0.435	0.264	2.030	1.109
Netherlands	mean	1.463	1.383	1.588	1.396	1.683	1.546	1.526	1.394	1.344	1.588	1.639
	std dev	1.215	1.273	1.299	0.751	1.889	0.883	0.781	0.687	0.605	0.795	0.869
Portugal	mean	NA	4.274	4.467	3.533	3.145	2.832	2.235	2.057	1.986	1.928	2.006
	std dev		1.962	1.698	1.119	1.053	1.745	1.141	1.108	1.268	1.117	1.396
Spain	mean	4.084	4.177	4.171	4.841	3.970	3.460	3.976	3.471	3.092	2.887	2.629
	std dev	1.902	2.389	2.585	4.836	2.355	1.780	2.720	2.431	1.998	2.064	1.744
UK	mean	2.453	2.741	5.560	2.868	3.015	2.803	2.864	2.864	2.897	3.262	2.815
	std dev	1.641	1.881	3.058	2.867	3.614	3.285	3.297	3.456	3.450	4.763	2.920

Source : Fitch IBCA (1997, 2001) / own calculations

[a] The sample is issued from the Bankscope database. More precisely data from 1989 to 1991 comes from another support than the data from 1992 to 1999. Therefore, the value obtained for the first three years might be quite different from the ones that are following. The case is the same for the next table.

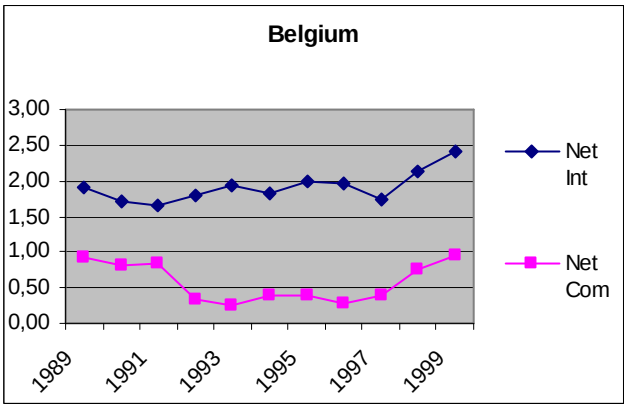
The variable is defined as net commission and fee revenue on total assets. Statistics are displayed in table 2.18. :

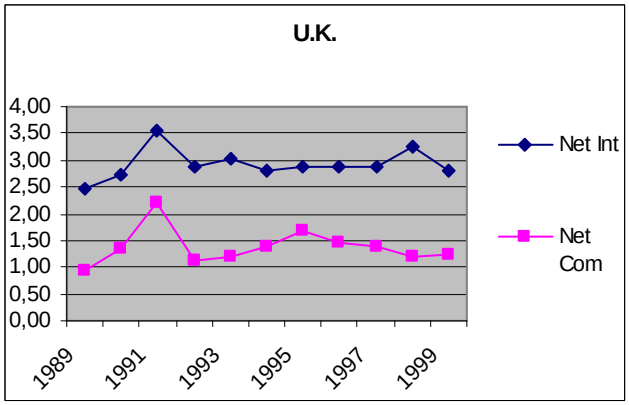
Table 2.18. Commission and fee revenue as a percentage of total assets

		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	mean	0.923	0.813	0.837	0.340	0.251	0.382	0.387	0.294	0.380	0.748	0.959
	std dev	0.460	0.540	0.764	0.473	0.487	0.599	0.737	0.598	0.593	1.313	1.972
Denmark	mean	NA	0.369	0.403	0.567	0.698	0.889	0.752	1.055	1.241	1.566	1.504
	std dev	NA	0.242	0.235	0.272	0.314	0.544	0.370	1.525	2.396	3.827	2.861
France	mean	1.066	0.938	0.828	1.392	1.608	1.792	1.482	1.610	1.850	1.955	2.424
	std dev	3.124	2.594	2.489	5.315	4.225	4.583	3.191	3.573	4.256	4.707	7.441
Germany	mean	3.540	3.816	2.708	1.068	1.812	1.201	1.198	1.193	1.243	1.685	1.685
	std dev	8.434	8.299	10.178	1.896	1.986	2.314	2.580	2.583	2.910	4.404	3.332
Greece	mean	NA	NA	1.458	NA	1.523	1.554	1.523	1.446	1.423	1.362	2.388
	std dev			1.252		0.954	0.747	0.800	0.816	0.809	0.543	1.698
Ireland	mean	NA	NA	NA	NA	0.577	0.529	0.586	0.820	0.685	0.461	0.426
	std dev					0.735	0.617	0.577	0.881	0.803	0.624	0.487
Italy	mean	0.606	0.684	0.704	0.822	0.691	0.760	0.733	1.514	1.141	1.277	1.483
	std dev	0.314	0.336	0.360	0.375	0.388	0.507	0.498	9.102	2.995	1.154	1.081
Luxembourg	mean	NA	NA	NA	0.331	0.540	0.663	0.672	0.649	0.801	1.194	1.072
	std dev				0.649	0.995	1.408	1.460	1.039	1.243	3.915	2.080
Netherlands	mean	0.709	0.615	0.615	0.694	0.717	0.782	0.770	0.769	0.788	1.113	1.685
	std dev	0.873	0.712	0.609	0.862	0.929	1.259	1.417	1.450	1.469	2.286	3.769
Portugal	mean	NA	0.493	0.682	0.447	0.449	0.505	0.409	0.425	0.597	0.686	0.960
	std dev		0.515	0.501	0.307	0.242	0.322	0.423	0.314	0.525	0.476	1.093
Spain	mean	NA	0.784	0.981	0.812	0.767	0.810	0.776	0.635	0.761	0.956	1.091
	std dev		0.668	1.123	0.714	0.675	0.692	1.232	0.545	0.743	1.021	1.229
UK	mean	0.938	1.334	2.202	1.126	1.204	1.373	1.685	1.443	1.373	1.187	1.237
	std dev	0.614	2.005	6.814	1.507	1.779	2.304	3.539	2.951	2.705	2.702	1.459

Source : Fitch IBCA (1997, 2001) / own calculations

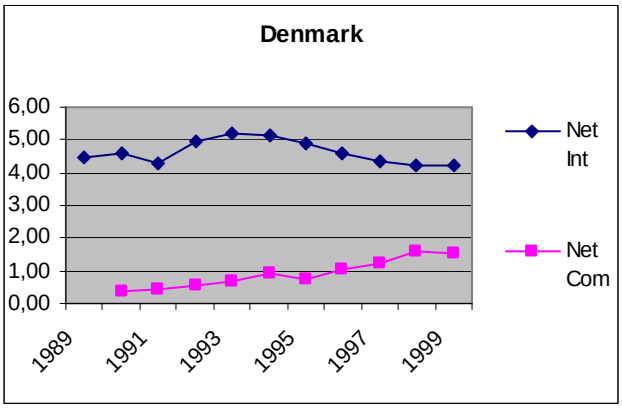
We observe two distinct sets of countries. In the first set consisting in Belgium and the U.K., the two ratios, net interest margin and commission and fee revenue on total assets, have a similar pattern.

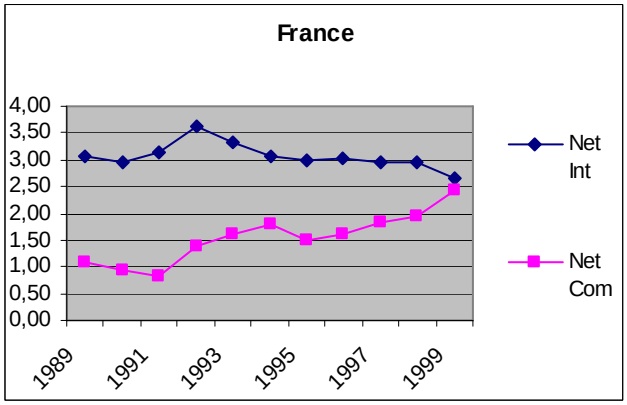


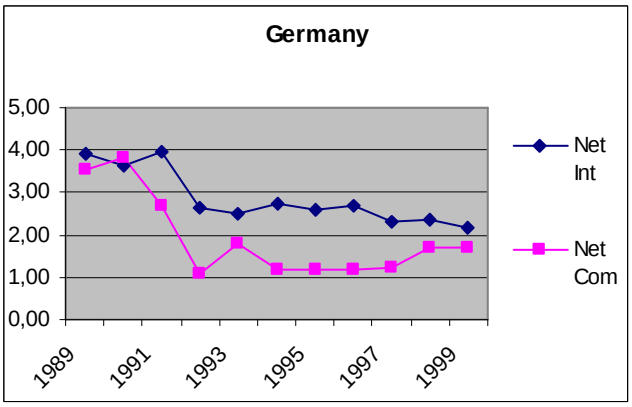


The two countries are characterised roughly by a similar progression of both series, apart in 1992 in Belgium. As we will see later on, the time effect variable is not significant for these two countries.

The second set of countries includes all the other countries. This group is characterised by the convergence of both series, that is we observe a decrease of the interest margin of banks and an increase of the ratio service revenue on total assets.



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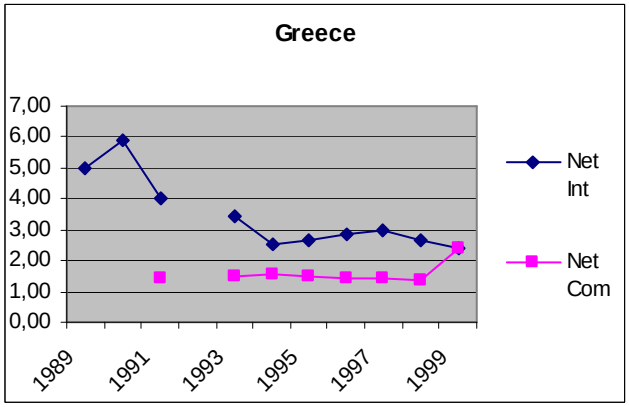
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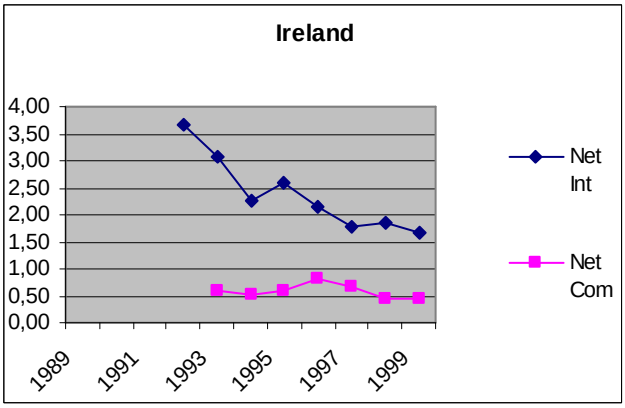
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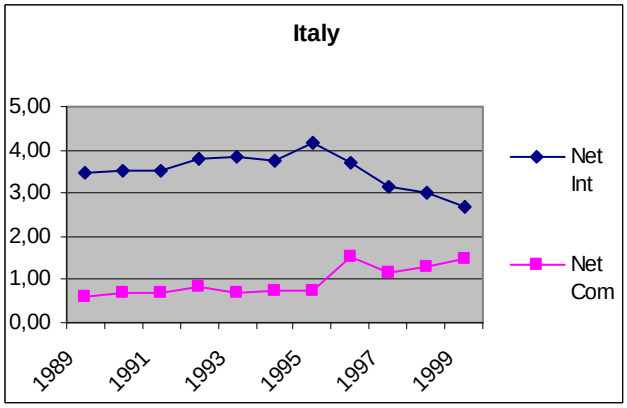
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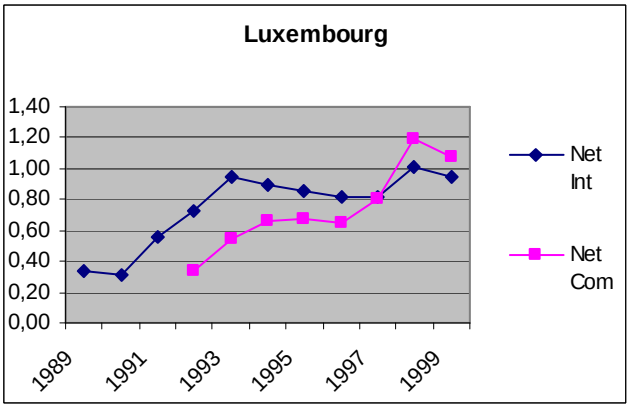
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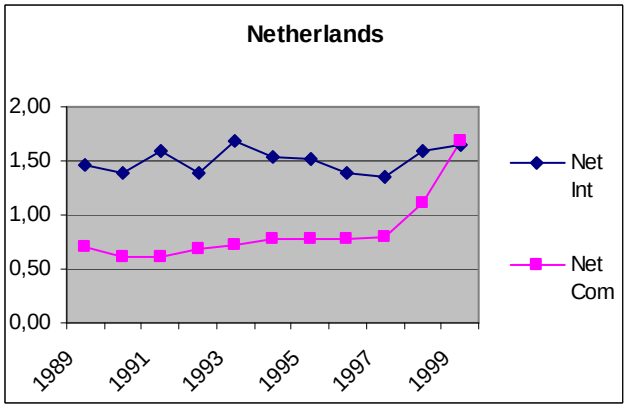
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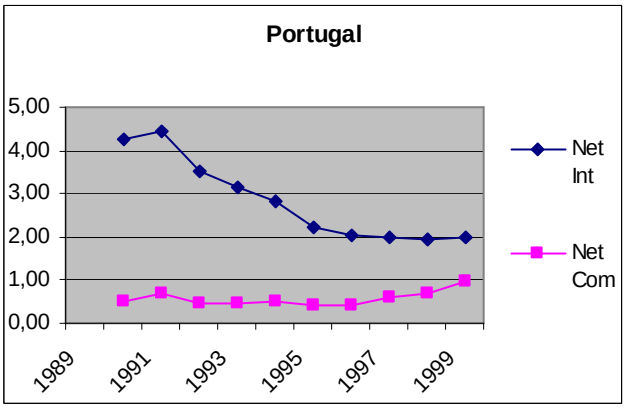
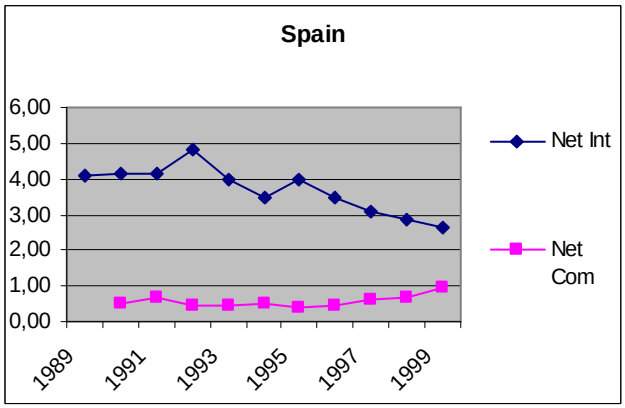




The pattern of the "Net Com" ratio seems rather peculiar beginning of the nineties for some countries (especially Germany), it may be certainly explained by our database, as we do not find such a shape in ECB (2000a).

We can also observe for Denmark and Italy that the decrease of bank margins and the increase of service revenue took place at the end of the nineties .

Appendix D. Tests for poolability

Let us consider the following example :

$y_{it} = \alpha_i + \beta_i x_{it} + \varepsilon_{it}$ where i=1…N represents the bank, and t=1…T the year.

Testing for poolability implies to undertake the next three Fischer tests briefly presented in the next figure (figure 2.1.) :

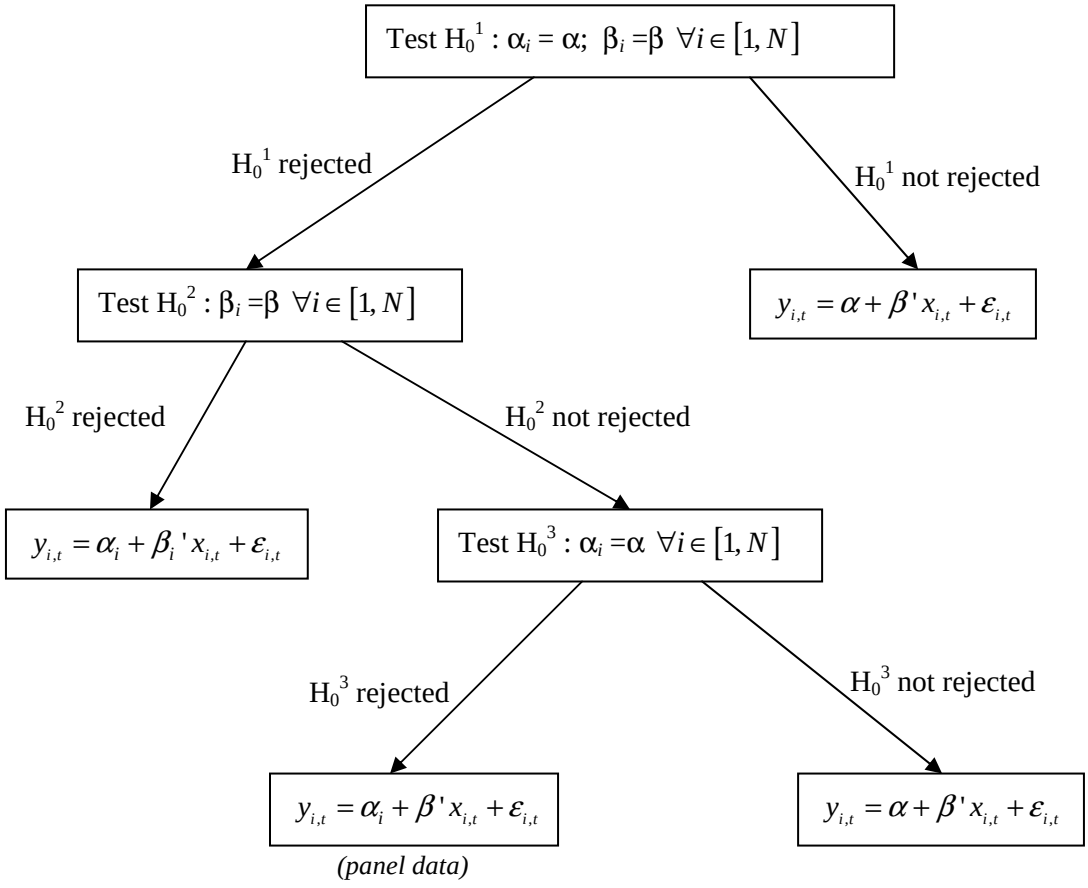


Figure 2.1. Poolability tests

We were able to compute only the test H_0^3. Results are presented in the table 2.19. below. When the Fischer calculated is above the value of the Fischer distribution, it

means that H_0^3 is rejected, and then panel data regressions are preferred to regressions where banks are not identified.

Table 2.19. Fischer test results for poolability

Country	**Fischer test**	**Fischer table** (1 % level)	**Result**
Belgium	6.563	1.95	Panel Data
Denmark	7.944	1.76	Panel Data
France	4.560	1.53	Panel Data
Germany	12.42	1.53	Panel Data
Greece	4.509	2.82	Panel Data
Ireland	9.294	2.63	Panel Data
Italy	7.111	1.53	Panel Data
Luxembourg	10.98	1.76	Panel Data
Netherlands	4.937	1.86	Panel Data
Portugal	4.535	1.86	Panel Data
Spain	7.511	1.86	Panel Data
U.K.	20.17	1.76	Panel Data

Appendix E. Specification : Hausman test

Table 2.20. Hausman test results

Country	Hausman test	P-value	Result
Belgium	152	0.000	Fixed effects
Denmark	15.77	0.04	Fixed effects
France	0.01	0.98	Random effects
Germany	4.77	0.573	Random effects
Greece	0.001	0.99	Random effects*
Ireland	5.296	0.506	Random effects*
Italy	4.30	0.636	Random effects
Luxembourg	0.02	0.99	Random effects
Netherlands	4.179	0.652	Random effects
Portugal	0.654	0.99	Random effects
Spain	13.21	0.04	Fixed effects
U.K.	8.82	0.184	Random effects

* Given the number of data available and the number of coefficients to estimate, it was not possible to compute the random effect regression. Therefore, we have chosen to present the fixed effects regression.

Appendix F. Diagnostic test against heteroskedasticity

Table 2.21. White test results

Country	White test	Nb of expla. var. *	Chi-2 table	Result
Belgium	4,58	6	12,6	homoskedasticity
Denmark	306	12	21	heteroskedasticity
France	1307	7	14,1	heteroskedasticity
Germany	866	7	14,1	heteroskedasticity
Greece	54,66	7	14,1	heteroskedasticity
Ireland	15,61	13	22,4	homoskedasticity
Italy	857	14	23,7	heteroskedasticity
Luxembourg	263	7	14,1	heteroskedasticity
Netherlands	264	14	23,7	heteroskedasticity
Portugal	244	7	14,1	heteroskedasticity
Spain	377	7	14,1	heteroskedasticity
U.K.	6,88	6	12,6	homoskedasticity

* Number of explanatory variables

Appendix G. Diagnostic test against correlation

Table 2.22. Durbin Watson test results

Country	**DW test**	**DW table** (lower bound)*	**Result**
Belgium	0,89	1,839	+ correlation
Denmark	1,10	1,839	+ correlation
France	1,52	1,9076	+ correlation
Germany	1,41	1,9076	+ correlation
Greece	1,45	1,839	+ correlation
Ireland	1,45	1,839	+ correlation
Italy	0,94	1,8862	+ correlation
Luxembourg	1,22	1,839	+ correlation
Netherlands	0,80	1,839	+ correlation
Portugal	1,03	1,839	+ correlation
Spain	0,88	1,839	+ correlation
U.K.	1,20	1,839	+ correlation

* If the Durbin Watson found is smaller than the lower bound of the inconclusive region, positive autocorrelation has been detected.

“ + correlation ” : positive correlation.

Appendix H. Time effect coefficients

Only **significant** time effect variables are presented here. A trend is significant for Germany, Greece and Spain :

Table 2.23. Time effect results (*to be continued*)

	coefficient	t-statistics
Germany	- 0.001	-2.653
Greece	-0.001	-2.120
Spain	-0.001	-2.740

In Denmark, Ireland, the Netherlands and Spain, the time effect is measured by dummies, only the **significant** one are displayed :

Table 2.23. Time effect results (*continued*)

Denmark			Ireland		
	coefficient	t-stats		coefficient	t-stats
1991	-0.002	-3.145	1990	-0.006	-2.083
1993	0.001	2.944	1991	-0.006	-2.710
1994	0.004	10.47	1992	-0.006	-2.833
1995	0.002	5.401	1994	-0.006	-1.902
1997	-0.001	-4.088	1997	-0.002	-3.659
1999	-0.001	-2.117	1999	0.001	2.468

Italy			Netherlands		
	coefficient	t-stats		coefficient	t-stats
1993	0.002	2.146	1991	0.004	3.606
1994	0.001	3.298	1992	0.002	2.046
1995	0.004	4.873	1995	-0.002	-2.298
1998	0.002	2.054	1996	-0.003	-3.465
			1997	-0.004	-3.616
			1999	-0.003	-2.867

CHAPTER 3.

SERVICE PROVISION, LOAN PRICING AND BANK RISK : A THEORETICAL MODEL

3.1. Introduction

The previous chapter prompts us to further investigate the link between lending rate and commission and fee-based activities. Therefore the aim of this chapter is to analyse this link, which may provide further explanations regarding the determinants of bank interest margins. Our view is that recent years may have seen the development of a new strategy : when competing for market share on the loan market, banks anticipate the potential sale of services in future periods. The starting point of the model developed in this chapter is the hypothesis that services can be sold only to borrowers. Then, as banks' decisions, with regard to loans, can yield not only real interest revenue but also some "linked" commission and fee revenue, we might suspect banks to modify their behaviour. Specifically, we focus on banks/borrowers incentives to control the riskiness of projects funded by banks and more generally their implications on banks' risk. Indeed, other things being equal, banks may have fewer incentives to screen potential borrowers to assess their riskiness. While dealing with the introduction of commission and fee-based activities, studying banks' behaviour changes appears essential. Given the evolution observed in banks' income structure, two questions naturally arise : how has the role of banks been modified and how has the bank-customer relationship been affected ?

The modification of banks' incentives lies in the fact that different types of activities can interact one with another, and affect the decisions that would have been taken otherwise. In fact, such modifications can only be investigated if dealing with multi-product banking firm.

Multi-production and cross-selling have been studied in the banking literature, starting with the literature on "implicit interest". One of the difficulties concerning the multi-product provision of banking services is that the pricing of services has been subject to government interference/regulation. For example Klein (1971), and Barro and Santomero (1972), as noted in chapter 1, have studied the demand for deposits and have pointed out that when the government imposes an interest rate ceiling on current and

saving accounts, banks pay an implicit interest rate by setting charges for services below the competitive price.

Joint production in banking can also be achieved through the production of deposits and credits. Chiappori *et al.* (1995) underline the emergence of subsidisies between regulated deposit rates and lending interest rates[1]. They also argue that without a deposit interest rate ceiling, the credit rate increases. In the literature, the relationships between service provision and deposit interest rates, and between deposit and credit rates, have been widely considered, in contrast to the relationship between service provision and lending rates.

Regulation that limits deposit interest rates implies lower service charges and/or lower credit interest rates than the ones that prevail in the absence of regulation. Nevertheless, if cross-subsidisation is stressed, this one remains induced by regulation at first step. Moreover, it is the link deposit rate – current account services that is affected by possible cross-subsidisation. However as a consequence of deregulation, banks have increased the share of the cost of service provision they charge to clients (Jacolin and Pasquier, 1995, and De Young and Roland, 2001). From implicit interest rate payments, banks have tended to switch to the payment of explicit interest rates and the billing of services provided[2].

Not so much attention has been given to services and lending rates. The joint production of banking services and credit has been theoretically addressed by Cukierman (1978). He shows that customers who have the highest marginal propensity to buy banking services, when granted credit, will not be credit rationed. Indeed as the borrowers' demand for services is an increasing function of the amount of loans they receive, banks will choose to grant credit to those who have a high propensity to buy services. Cukierman also shows a decrease in the lending rate when such a demand for services is taken into account. However, in his work, no attention has been paid to loan default under asymmetric information between lenders and borrowers. As the modification of incentives brought by possible cross-subsidisation may imply sharp

[1] Under regulated deposit rates, banks will decrease their lending rate if they can sell tied-up contracts, which stipulate that agents applying for a loan must simultaneously deposit their cash balances in the bank.

[2] Another issue could be the effect in terms of efficiency. When banks charge the real price for services they provide to their clients, they eliminate cross-subsidisation between clients.

changes with regard to risk exposure, this issue is of a major importance, and will be addressed in this chapter.

To answer the questions we raised, we build a model where the existence of banks is justified by their capacity to reduce asymmetric information. More precisely, their role consists in screening the applicants for loans. We consider service provision as a bank activity : more specifically we assume that services are bought from banks because of an already existing bank-firm relationship. The resulting relationships allow banks to "cross-sell" services and other products to their clients. To our knowledge, the introduction of risk in "cross-subsidisation" models has not been addressed in the theoretical literature.

To investigate the potential effects of services, in section 3.2., we first present the framework of our model, based on a principal-agent structure with adverse selection. The key feature of the model developed in this section is the introduction of services in the profit function of banks, and the conditionality of the sale of services upon the success of the project undertaken by borrowers (firms). Firms are assumed to have a choice between undertaking either a low risk or a high risk project, and banks have the opportunity to screen firms, but at a cost. If the firm succeeds it is then assumed to be a potential client for the bank (consuming bank services). If the firm fails, then the bank cannot sell services. Such a framework enables us to analyse not only the bank's decisions with regard to lending rate setting, but also the behaviour of the bank and of the borrower towards risk.

Then, in section 3.3., we analyse the bank's incentives with regard to its decision of screening and the borrower's incentives concerning the choice of the level of risk of his project. Two possible equilibriums emerge. In each of them, the probability of screening and the probability of choosing the low risk project are calculated.

In section 3.4., we determine the lending rate under different market assumptions for the banking industry (monopoly or competitive lending market). The analysis of the model enable us to draw specific implications of the introduction of services with regard to loan pricing and risk.

The aim of this model is then to facilitate the analysis of how commission and fee revenue influences : *(i*) the behaviour of entrepreneurs when choosing between projects of different levels of risk ; (*ii*) the level of loan interest rate and thus the price strategy that banks adopt ; and (*iii*) finally banks' incentives when choosing their level of screening.

3.2. Adverse selection and multi-product bank

The model developed builds on the article of Covitz and Heitfield (1999). The issue they were concerned with, related to moral hazard between depositors and banks, on the one hand, and between banks and the deposit insurance authorities, on the other hand. We have transposed their setting (i.e. principal agent structure with adverse selection) to the bank-firm relationship, allowing us to take into account service provision by banks in addition to intermediation activity.

In our model we focus on the relationship between "*one borrower – one bank*"[3].

Consider the following sequence of events. At time T=0, the firm chooses the project it wants to undertake and therefore the risk it takes, and then applies for a loan. The bank decides whether or not to engage in screening. At time T=1, the borrower earns a return on his project, if it has been successful and if it has been funded. While lending to the firm, the bank develops a banking relationship with its client that may potentially enable the bank to sell services at time T=2. Our aim is to understand how selling services can alter the firm's behaviour towards project risk and the bank's screening incentives.

3.2.1. Agents

3.2.1.1. Firm

- **Project**

The firm is managed by an entrepreneur who may undertake two kinds of project : a low risk project which yields a gross return l with a probability γ, Pr (**return** = l) = γ ,

[3] We abstract from issues related to portfolio diversification, which is a common assumption in the literature on asymmetric information problems in bank lending (see for example, Boyd, Chang and Smith, (1998)).

or zero with a probability (1-γ), and a high risk project which yields either a gross return h with probability θ or zero with probability $(1 - \theta)$, Pr (**return** = h) = θ.

The relationship between the distribution of the return of projects is governed by the following assumptions :

- $l < h$, the return of the low risk project is lower than the return of the high risk project,
- $\gamma > \theta$, the probability that the low risk project is successful is higher than the one of the high risk project.

- **Funding**

To finance its project, the (non-bank) firm needs one monetary unit, which is borrowed entirely from its bank[4,5]. The firm will repay its loan at time T=1 and is assumed to be risk neutral.

The firm is subject to limited liability. We assume that the value of the entrepreneur's equity is normalised to zero. In case of firm failure, the value of the loan is equal to the value of the remaining assets, which are kept by the bank.

3.2.1.2. Bank

Let r_f denote the gross risk-free interest rate in the economy, and the interest rate paid on current accounts. This cost of funds also represents the opportunity cost for a bank.

The bank is assumed to be neutral towards risk.

[4] The firm cannot be financed by equity contract. Of course, if such a possibility was considered, then the conflict of interest between the firm and the bank would be lessened, but a new form of agency cost would arise between the entrepreneur and the new outside equity holders.

[5] Another comparable situation could be the opening of a credit line by the bank. Then if the bank decides to screen and if it detects a high risk project, it can close the credit line or require a refund if the option of borrowing has been exercised in the meanwhile.

The bank[6] operates under limited liability : if it fails, it does not have to entirely reimbursed depositors. However deposits are guaranteed by a deposit insurance system, hence depositors do not monitor banks. The price of the deposit insurance is fixed and normalised to zero. Because of the existence of a deposit insurance scheme with a fixed rate premium, the bank may choose to take on too much risk, and in this case we would say that it adopts a strong moral hazard attitude towards the deposit insurance fund. We suppose that prudential regulation is in place to limit this risk.

The following condition is necessary to guarantee that both projects have a positive probability of being undertaken and that the bank will lend funds to an entrepreneur who wishes to undertake one of them :

Assumption 1

$$0 < \gamma\left(l - r_f\right) < \theta\left(h - r_f\right)$$

where r_f stands for the risk-free interest rate.

This assumption implies firstly, that from the firm point of view, the high risk and low risk projects have a higher return than the risk-free asset, and secondly that the firm has an incentive to choose the high risk project.

3.2.2. Adverse selection

Given the risk neutrality of both agents, the limited liability of the bank and assumption 1, on the one hand the firm will always have the incentive to choose the high risk project ; and on the other hand, the bank would not prefer the firm to choose the low risk project[7].

We assume a social cost to the bank's failure, and we study in this subsection the modifications of the bank's incentives.

[6] In the economy, we will consider that there is one bank or an infinity depending on the structure of the lending market.

[7] In such a situation, the bank knows that the probability that the firm chooses the low risk project is equal to zero. Thus the lending rate will be set given this information and depending on the lending market structure. Given its limited liability, the bank will not look for the firm to undertake the low risk project.

3.2.2.1. Origin of the conflict of interest

Given the existence of a deposit insurance scheme, there is a social cost to the bankruptcy of the bank.

Let us call *C* the cost of the bank's failure. We assume that the low risk project is socially valuable :

$$\gamma l - (1-\gamma)C > \theta h - (1-\theta)C$$

$$\Leftrightarrow \quad \gamma l > \theta h - (\gamma - \theta)C$$

The term $(\gamma - \theta)C$ is the additional cost due to bank failure when the high risk project is chosen instead of the low risk one.

Therefore there is a conflict of interest between the optimal social choice of the project and the one made by the firm which is funded by the bank.

3.2.2.2. The bank's incentives

In order to prompt the bank to valuate the low risk project, the banking sector is regulated (prudential regulation), and therefore, the bank needs to hold an amount ***k*** of shareholder capital in proportion of total assets.

Formally let *k* stand for the ratio of capital to total assets. A bank needs to collect only an amount $(1 - k)$ of deposits to lend one monetary unit to a firm[8], the bank can lend fund only to one firm.

Therefore given the regulation of the banking industry, a possible conflict of interest between the bank and the firm can arise. Indeed if the firm has an incentive to always undertake the high risk project, the bank may prefer the firm to undertake the low risk project or not, depending on the value of the lending rate.

[8] We ignore any deposit reserve requirement.

One way for the bank to induce the firm to choose the low risk project is to screen a loan it may agree upon, but it has a present discounted cost equal to ***s***.

Ex-ante the bank cannot observe which project is chosen, but it can screen at time T=0, i.e. before granting a loan, at cost *s* (the project return is realised at time T=1). If the firm has chosen to undertake the high risk project, screening will enable the bank to detect it, and thus it will not lend funds to the firm.

If the bank observes that the high risk project has been chosen, it will not offer the firm a loan to undertake the low risk project. The reason is a credibility constraint : if the bank lends funds for the low risk project after detecting that the firm had planned to undertake a high risk project, then the strategy of the entrepreneur would be to always consider the high risk project first, and then, if screened, to move on to the low risk one[9]. Alternatively one could assume that the initial choice of a project is irreversible. To encourage the firm to choose the low risk project, the bank must exclude it in case it chooses the high risk project, but again, this is a state that the bank can only observe by screening[10].

Assumption 2

$$s < (\gamma - \theta) k.r_f < \theta h$$

$(\gamma - \theta).k.r_f$ represents the ex-ante additional cost for the bank when the firm's project fails, and the borrower (the firm) has undertaken the high risk project instead of the low risk one[11].

Given that *s* is the cost of screening, the first inequality of the assumption is a necessary condition for screening to occur with some positive probability. It states that the cost of screening a loan is smaller than the expected loss in capital to a bank that lends to an entrepreneur who undertakes the high risk project. Assumption 2 ensures that the bank has an actual incentive to screen the firm at cost *s*.

[9] Screening and sanctions would then be necessary to assure that the firm chooses the low risk project.
[10] To satisfy the condition that the bank will find it more profitable to implement screening, the interest rate that the bank charges for loans to the firm, *r*, should be not to high. We will see later that this condition is satisfied when screening is a profitable option for the bank.
[11] When the low risk project fails, the cost for the bank is equal to $(1-\gamma)k.r_f$. When the high risk project fails, the cost for the bank is then equal to $(1-\theta)k.r_f$. As $\gamma < \theta$, $(1-\theta)$ is higher than $(1-\gamma)$, the ex-ante additional cost for the bank, when the high risk project is chosen, is thus equal to $[(1-\theta)-(1-\gamma)]k.r_f$.

However the second inequality means than the expected additional loss in capital is smaller than the expected return of the high risk project. In other words, depending on the value of the lending rate, the bank may find profitable that the firm undertakes the high risk project even if the probability that this project fails is higher than the one of the low risk project[12].

3.2.3. Sale of services

In this model, the bank is considered to be a specialist enterprise which sells loans and services (the latter is defined as generating commissions and fees).

The bank has the possibility to sell services to its borrower. Services offered might be consulting activities, payment transactions, securities transactions, guarantees, current account management, credit card business. An entrepreneur (a firm), which has a need for services, can address his demand to different providers[13]. However he has an incentive to address it to the bank lending to him, if we assume that the firm suffers disutility from a multiplicity of suppliers. The disutility, that the agent suffers from, can be explained by transport cost and/or switching cost[14, 15]. The price set for services, in such an environment, is the cost of producing services plus the agent's disutility. In other words, the price set for services is above the marginal cost. In the case of this model, when the bank grants one unit of loan to a borrower, it can sell at most one service to this potential client. The sale of services, in T=2, is conditional upon the success of the entrepreneur's project, in T=1. Indeed in the case of an unsuccessful project, the borrower fails and he is unable to buy services in future periods. The

[12] As it will become clear below, the bank may not have always the incentive to screen especially if it can capture all the return of the high risk project (*cf.* section 3.4.).
[13] We take the demand for services by the firm as granted. We do not aim, in this model, to make it endogenous.
[14] With regard to the issue of transport cost, see Rochet (1992), Grimaud and Rochet (1994), and Saïdane (1997). One could assume, for example, a spatial competition model to formalise the service activity (transport cost can be also associated to differentiated products, from one seller to another). However the purpose of our model is not to model the price of services. Modelling the demand of services as explained before will not make the demand endogenous, which is nor our aim.
[15] With regard to the issue of switching cost, we refer to Klemperer (1995) for a general explanation of the phenomenon, and to Kim *et al.* (2003) for the case of banking.

expected discounted level of both commission and fee income, earned from this activity, is denoted by *f*.

f represents the gross expected discounted level of commission and fee revenue for the bank, and is defined as follows :

$$f = c + t \tag{3.1}$$

where *c* is the expected discounted level of cost of producing services, and *t* the expected present level of the transport cost and/or switching cost. Thus *t* is a measure of the disutility that the agent suffers when changing provider of services. In other words, the bank will be able to make a profit on its service activity, which equals to *t* per borrower.

The cost of services for the firm, *f*, does not appear in its profit function as we assume it is part of the cost of its production activity. In other words, the fact that the firm buys services does not affect the gross return of its project. When buying services from the bank, we suppose that the entrepreneur either uses services for a better management of the firm and/or has changed the provider of services (that is the firm is purchasing, from the bank, services it previously bought from another seller).

To summarise, we have the following sequence of events :

- At T=0, the firm chooses its project risk {low risk, high risk} and then applies for a loan from the bank. The bank decides or not to screen the demand for loan. If it does so, and discovers that the firm considers a high risk project, it decides not to grant the loan.

- At T=1, if the firm has been successful whilst applying for a loan, then the project return is realised.

- At T=2, the bank charges *f* for services, if the project, and thus the loan, has been successful.

The bank sets the lending rate, depending on the credit market structure assumption, before the game takes place. When a monopoly on the lending market, the bank is price-maker, and in the competitive case the bank is price-taker. Both the entrepreneur and/or the bank can accept or refuse this credit rate. If they agree on the rate, the bank has two possibilities ; (*i*) it screens the loan, and if the high risk project has been chosen, it decides not to grant the loan ; or (*ii*) it does not screen the loan.

The common practice is to solve this game by backward induction (see appendix A for a game tree). We first determine the probabilities that the firm chooses the low risk project and that the bank screens for a given level of the lending rate. Then, given the probabilities that the firm chooses the low risk project and the bank screens the loan, interest rates are determined as agents' behaviour is anticipated.

3.3. Partial equilibrium : Service fees and incentives to screen

In this section, commission and fee income, as well as the lending rate are taken as given[16]. We aim to determine the equilibrium, in which the bank screens the loan with a probability p_s and the firm chooses the low risk project with a probability p_l. To do so, we need first to characterise agents' strategy.

3.3.1. The bank and firm's profits

We first present the bank and firm's profits in order to determine the behaviour of both agents.

Let us envisage the bank and firm earnings, respectively, in the pay-off matrix :

	Bank	
	screening (p_s)	not screening ($1 - p_s$)
Firm : low risk project (p_l)	$\begin{bmatrix} \gamma(r - r_f + t) \\ -(1-\gamma)k.r_f - s \end{bmatrix}$ $\left[\gamma(l-r)\right]$	$\begin{bmatrix} \gamma(r - r_f + t) \\ -(1-\gamma)k.r_f \end{bmatrix}$ $\left[\gamma(l-r)\right]$
Firm : high risk project ($1 - p_l$)	$[-s]$ $[0]$	$\left[\theta(r - r_f + t) - (1-\theta)k.r_f\right]$ $\left[\theta(h-r)\right]$

l and h being respectively the return of the low and high risk projects, γ and θ the probabilities that, respectively, the low and high risk projects succeed, s the cost of screening, and t the profit on service revenue.

[16] We do not consider in this section the effects of the sale of services on the lending rate. This will be done in the next section.

p_l refers to the probability of the firm choosing the low risk project, whereas $(1 - p_l)$ will refer to the probability of it choosing the high risk one.

p_s refers to the probability that the bank screens the demand for loans whereas $(1 - p_s)$ will refer to the probability of not screening.

We can then rewrite the bank and firm profits depending on their respective behaviour (screening or not, low or high risk project).

Bank profit :

- when the bank screens the loan, its expected profit (π_s^B) is :

$$\pi_s^B = p_l\left[\gamma\left(r - r_f + f - c\right) - \left(1-\gamma\right)k.r_f - s\right] - \left(1 - p_l\right)s \qquad (3.2)$$

Simplifying and substituting *(f – c)* by *t*, *cf.* equation 3.1., and we thus have :

$$\pi_s^B = p_l\gamma\left(r - r_f + t\right) - p_l\left(1-\gamma\right)k.r_f - s \qquad (3.3)$$

Note that if the bank discovers that the firm has undertaken a high risk project when screening, lending does not take place.

- when the bank does not screen the loan, its expected profit (π_{ns}^B) is :

$$\pi_{ns}^B = p_l\left[\gamma\left(r - r_f + f - c\right) - \left(1-\gamma\right)k.r_f\right] + \left(1 - p_l\right)\left[\theta\left(r - r_f + f - c\right) - \left(1-\theta\right)k.r_f\right] \qquad (3.4)$$

We can substitute *(f – c)* by *t*, *cf.* equation 3.1., and we then obtain :

$$\pi_{ns}^B = p_l\left[\gamma\left(r - r_f + t\right) - \left(1-\gamma\right)k.r_f\right] + \left(1 - p_l\right)\left[\theta\left(r - r_f + t\right) - \left(1-\theta\right)k.r_f\right] \qquad (3.5)$$

Firm profit :

- when the low risk investment is chosen, the expected firm's profit (π_l^F) is :

$$\pi_l^F = p_s\gamma\left(l - r\right) + \left(1 - p_s\right)\gamma\left(l - r\right) = \gamma\left(l - r\right) \qquad (3.6)$$

- when the high risk project is chosen, the expected firm's profit (π_h^F) is :

$$\pi_h^F = p_s \times 0 + \left(1 - p_s\right)\theta\left(h - r\right) = \left(1 - p_s\right)\theta\left(h - r\right) \qquad (3.7)$$

If we analyse the bank and firm's behaviours, we observe that when the firm chooses the low risk project, the bank's profit is always higher when it has decided not to screen (because of the cost of screening). Therefore we first concentrate on the case where the firm chooses the high risk project. Given the firm's potential choices, the bank has two possibilities : screening or not screening.

We now have to determine the equilibrium, that is the optimal strategies of the bank and the firm, depending on the value of parameters.

The bank is indifferent to screening or not screening if :

$$\pi_s^B = \pi_{ns}^B$$

$$\Leftrightarrow \quad p_l\gamma\left(r - r_f + t\right) - p_l\left(1-\gamma\right)k.r_f - s = p_l\gamma\left(r - r_f + t\right) + \left(1-p_l\right)\theta\left(r - r_f + t\right) - \left(1-p_l\right)\left(1-\theta\right)k.r_f - p_l\left(1-\gamma\right)k.r_f \qquad (3.8)$$

$$\Leftrightarrow \quad \theta r_f - \theta t + \left(1-\theta\right)k.r_f - \frac{s}{1-p_l} = \theta r$$

$$\Leftrightarrow \quad \tilde{r} = r_f - t + \frac{\left(1-\theta\right)}{\theta}k.r_f - \frac{s}{\theta\left(1-p_l\right)} \qquad (3.9)$$

Let us refer to $\tilde{r}$ as the interest rate limit. Given equation (3.9), we are now able to determine the different equilibriums comparing the lending rate with the interest rate limit.

- $r > \tilde{r}$

When the loan interest rate is greater than the calculated value, that is for high values of interest rates, the return from a successful loan is so high that the best bank strategy consists in not screening the project, $p_s = 0$. The optimal strategy is therefore for the firm to choose the high risk project $p_l = 0$. We have a pure equilibrium[17].

[17] We say that an equilibrium is pure when each player has a dominant strategy. In other words, the strategy of each player does not depend on the other agents' strategy.

- $r = \tilde{r}$

When the loan interest rate is equal to the calculated value, the bank does not have a dominant strategy with regard to its choice of screening or not (indeed the profit is the same under both strategies). In such a situation, the firm does not have, neither, a dominant strategy when choosing for the low or high risk project. The probabilities that the bank screens and the firm chooses the low risk project are determined under a mixed strategy equilibrium[18].

- $r < \tilde{r}$

When the loan interest rate is lower than the calculated value, then the bank decides to always screen and $p_s = 1$. If the bank always screens, then the firm will always choose the low risk project, and $p_l = 1$. However, if $p_l = 1$, it is no longer optimal for the bank to screen, as it is costly. And if the bank does not screen, then p_l is no longer equal to one. In fact, in such a situation, there is no equilibrium.

We next characterise the two equilibriums found, that are the pure and mixed equilibriums.

3.3.2. Screening and project risk at equilibrium

In this subsection, we identify and characterise the optimal strategy of both agents, depending on their respective behaviour.

[18] We say that an equilibrium is mixed, when the strategy of one player depends on the strategy of the other player, and *vice-versa*.

3.3.2.1. Pure equilibrium with no screening

When r > $\hat{\hat{r}}$, the bank has a pure strategy, that is no screening, and therefore $p_s = 0$.

The firm profit is $\gamma(l - r)$ if it has chosen the low risk project, or θ $(h - r)$ if the high risk one is selected. Therefore the firm will always choose to undertake the high risk project (given assumptions on θ, γ, h, l). And thus p_l equals zero.

When the bank does not screen, we have just seen that $p_l = 0$. Therefore we can rewrite the interest rate limit for which the bank is indifferent between screening or not (equation 3.9) as :

$$\hat{\hat{r}} = r_f - t + \frac{1-\theta}{\theta} k.r_f - \frac{s}{\theta} \qquad (3.10)$$

In the figure (3.1.), we represent the lending rate for which the bank is indifferent between screening or not, depending on the value of the probability that the firm chooses the low risk project :

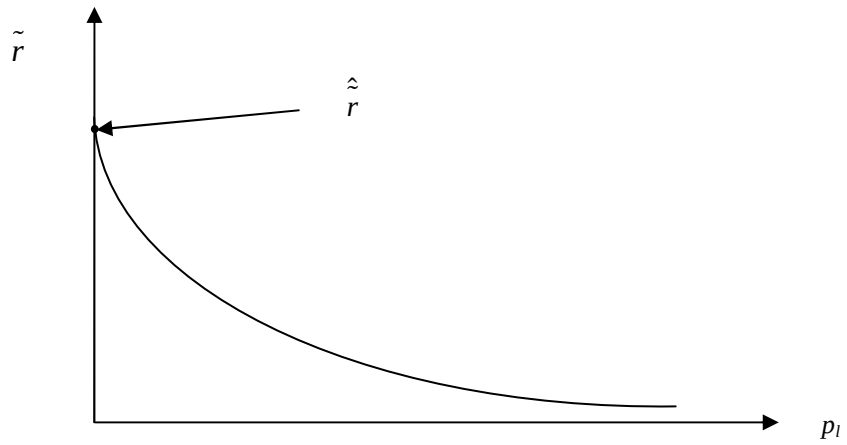


Figure 3.1. Interest rate limit and probability that the firm chooses the low risk project

For a value of the loan rate higher than $\hat{\hat{r}}$, the bank and the firm have a dominant strategy (pure equilibrium). The bank will prefer to not screen the loan even if the firm chooses the high risk project.

For a value of the loan rate lower than $\hat{\hat{r}}$, the bank is indifferent between screening or not for positive value of the probability that the firm chooses the low risk project. This situation refers to the mixed strategy equilibrium that will be study below.

It has to be underlined that this critical interest rate is lower than the critical interest that would prevail if the bank was not selling services, which would be in that case $\hat{\hat{r}} = r_f + \frac{1-\theta}{\theta} k.r_f - \frac{s}{\theta}$. The region in which the pure equilibrium takes place is broadened, and thus the bank takes higher risk in the loan market when it sell services.

For a value of the credit rate higher than $\hat{\hat{r}}$, there is a pure strategy : the bank does not screen the loan and the firm chooses the high risk project.

3.3.2.2. Mixed strategy equilibrium

At the mixed strategy equilibrium, the behaviours of the bank and the firm are analysed for values of the credit rate ranging from (r_f -t) [19] to $\hat{\hat{r}}$.

In this interval, the probability that the bank screens the loan is no longer equal to zero. We now have to determine the strategy of the firm given that p_s is positive.

[19] The credit rate r has to be higher than ($r_f - t$), and not r_f (it is a necessary but not a sufficient condition). The reason is the anticipation of the sale of services by the bank, sale of services conditional on an already existing bank-firm relationship. We remind the reader that r has to be higher than r_f (in a model without services) otherwise it would be more profitable for banks to hold the risk-free asset rather than granting a loan.

This equilibrium is defined under mixed strategy.

The firm is indifferent between undertaking the low risk project or the high risk project when :

$$\pi_l^F = \pi_h^F$$

$$\gamma(l-r) = (1-p_s)\theta(h-r) \qquad (3.11)$$

The choice of the firm will depend on the bank's behaviour with regard to screening.

Figure 3.2. shows the best reaction functions of each agent.

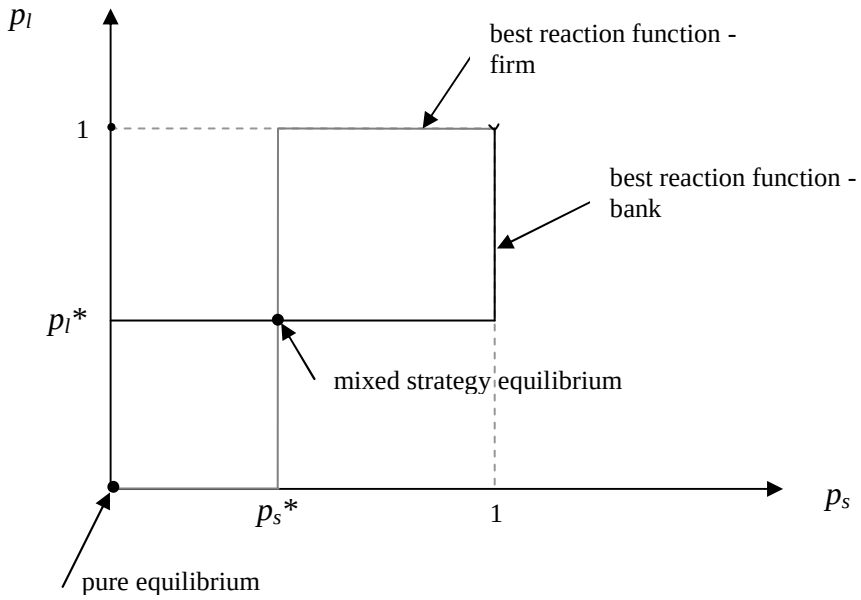


Figure 3.2. Agents' best reaction functions and equilibriums

From (3.11) we get the probability of screening, p_s*, and from (3.8) we get the probability of choosing the low risk investment, p_l*.

We obtain therefore at the equilibrium :

$$p_s^* = 1 - \frac{\gamma(l-r)}{\theta(h-r)} \qquad (3.12)$$

$$p_l^* = 1 - \frac{s}{(1-\theta)k.r_f - \theta(r - r_f + t)} \qquad (3.13)$$

To rule out the possibility that it is never profitable to undertake the low risk investment, that is to consider the case $\hat{\hat{r}} > l$, we suppose :

Assumption 3

$$\hat{\hat{r}} < l$$

The expected gross **return** of the low risk investment is high enough for the firm to repay the loan. This condition is sufficient but not necessary.

Proposition 1 *The equilibriums we obtain are defined as follows* :

- for an interest rate r, such that $\hat{\hat{r}} < r < h$*, there exists a pure strategy equilibrium which corresponds to high values of the lending rate. The probability of screening loans and the probability of choosing the low risk investment are both equal to zero;*

- for an interest rate r, such that $(r_f - t) < r < \hat{\hat{r}}$*, there exists a mixed strategy equilibrium* (p_s^*, p_l^*)*. The probability of choosing the low risk investment is inversely related to the lending rate r, and is an inverse function of the service commissions and fees*[20].

We next summarise the effects of the sale of services by the bank on agents' behaviour.

[20] The derivative of the probability of choosing the low risk project with respect to the lending rate is equal to : $\frac{\partial p_l^*}{\partial r} = \frac{-s.\theta}{\left[(1-\theta)k.r_f - \theta\left(r - r_f + t\right)\right]^2}$. The probability of choosing the low risk project is a decreasing function of the lending rate. For a given level of the lending rate, the derivative of p_l with respect to service revenue is equal to : $\frac{\partial p_l^*}{\partial t} = \frac{-s.\theta}{\left[(1-\theta)k.r_f - \theta\left(r - r_f + t\right)\right]^2}$. The probability of choosing the low risk project is a decreasing function of the cost of services (we consider services here from the firm point of view).

3.3.3. Consequences of the introduction of services : first results

We summarise here our first findings concerning the limit between the two types of possible equilibriums (pure or mixed). We stress the modifications of these regions and agents' incentives brought about by the introduction of services.

A first consequence of the introduction of services is the modification of equilibriums' region. We can notice that the interest rate limit $\hat{\hat{r}}$, (equation 3.10), is a decreasing function of the price of services, which means that the higher the profit the bank can make on services, *t*, the lower the value of the interest rate limit, $\hat{\hat{r}}$. In other words, the sale of services affects the bank incentives of screening.

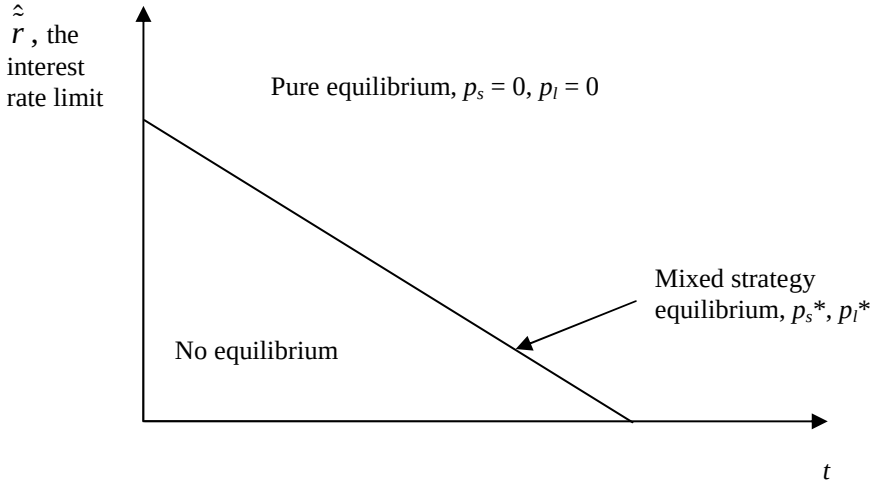


Figure 3.3. Market power on services and screening choices

As shown in figure 3.3., an increase in the value of *t* makes the bank less likely to screen. Therefore, incentives to screen are higher when *r* is high[21], and when *t* is small[22], which is the new effect that we highlight in this model. The intuition is clear : the possibility to sell services to a successful borrower increases the opportunity cost for

[21] Let us derive p_s with respect to r : $\frac{\partial p_s}{\partial r} = \frac{\theta\gamma(h-l)}{[\theta(h-r)]^2}$. p_s is an increasing function of *r*.

[22] As t increases, the region in which the pure equilibrium takes place expands.

the bank not to lend to the entrepreneur. It creates an incentive to reduce screening in order to increase funding.

With regard to the bank's behaviour, the introduction of commission and fee revenue in our model, for a given level of the interest rate, changes the regions where a type of equilibrium exists.

A second and direct effect, is the influence of the sale of services by the bank on the firm's behaviour (for a given level of the lending rate).

To complete our analysis, it might be useful to compare the probability that the bank screens the firm and the probability that the firm chooses the low risk project, when the bank sells services, to their value in the case of the bank does not sell services. Given (3.12), (3.13) and t=0, probabilities that the bank screens and that the firm chooses the low risk investment are for $r_f < r < \hat{\hat{r}}$[23] :

$$p_s^* = 1 - \frac{\gamma(l-r)}{\theta(h-r)}$$

$$p_l^* = 1 - \frac{s}{(1-\theta)k.r_f - \theta(r-r_f)}$$

Firstly, we observe that the value of the probability that the bank screens the loan application, in case it does not sell services, is the same as when it sells services. However, we have to remind that we do not take into account in this subsection the effect of service provision on the interest rate level. We only compare agents' behaviour for a given level of interest rate. Thus, there is no specific direct effect of commissions and fees here.

Secondly, we notice that when considering service activity, the behaviour of the firm changes with regard to project choice. The probability of choosing the low risk project p_l is a decreasing function of service fees for a given level of the credit rate. In

[23] If the bank does not sell services, the interest limit is equal to : $\hat{\hat{r}} = r_f + \frac{1-\theta}{\theta} k.r_f + \frac{s}{\theta}$. This value is higher than the one we found, $\hat{\hat{r}} = r_f - t + \frac{1-\theta}{\theta} k.r_f - \frac{s}{\theta}$.

other words, the firm has more incentives to choose the high risk project when the bank sells services.

Thirdly, we also find a common standard effect which is : the probability that the firm chooses the low risk project decreases as the lending rate increases. Nevertheless we highlight a service specific effect, that is the sale of services by banks to firms influences the attitude of borrowers towards risk : for the same level of the interest rate, banks now finance more high risk projects than when they were just selling loans. The bank's desire to supply services increases the risk in its balance sheet. This service specific effect is all the more important as the disutility that the entrepreneur suffers from changing providers is important, i.e. t increasing. This disutility gives the bank some market power.

3.4. Equilibrium Analysis : Interest rate settings

With regard to the banking literature, competition on the credit market is considered as imperfect[24]. One way to circumvent this aspect is for us to consider the two extreme cases, that is a monopoly lending market and a competitive lending market. Our aim here is to analyse the lending rate, *r*, and its determinants, depending on the market structure of the economy.

In section 3.3., we have underlined that two equilibriums can occur. The objective of this section is to determine the value of the lending rate under both equilibriums, as we assume that exogenous constraints will enforce or not the bank to choose the low risk equilibrium (i.e. the mixed strategy equilibrium).

3.4.1. Monopoly lending market

The entrepreneur has no choice other than borrowing from one specific bank[25]. Therefore the bank chooses the loan interest rate which maximises its profit subject to participation of the firm. The firm's profit will always be positive or null, given assumptions 1 through 3 of the model.

[24] The credit market is often considered as monopolistic or oligopolistic in USA and Europe (Lewis and Pescetto, 1996, ECB, 2000b).

[25] It should be noticed that the bank has a monopoly power only on the lending market. With regard to the service market, its market power remains the transport and/or switching cost(s) for buyers. Services can be offered by other agents such as other financial intermediaries, other firms or they might be produced by the firm itself.

3.4.1.1. The case of the pure strategy equilibrium

As seen previously, r is higher than $\hat{\hat{r}}$ and the probability of screening p_s equals zero and the probability of choosing the low risk project p_l equals zero.

The bank profit can be written as follows :

$$\pi^B = \pi^B_{ns} = \theta\left(r - r_f + t\right) - \left(1-\theta\right)k.r_f$$

Profit is an increasing linear function of the lending rate r. Therefore the interest rate that will maximise the bank profit under the firm's participation is the one that will seize all the firm's profit.

Proposition 2 *A first equilibrium is no screening from the bank and only the high risk investment undertaken by the firm. The bank's profit is then maximum for* $\overline{r_m} = h$. *Incentives to screen and the lending rate at equilibrium are not affected by the sale of services*[26].

In such an equilibrium, the bank will capture all the firm's profit. The interest rate, charged here, is the same as when no service is sold, but the bank's profit is higher. This increase in profit depends on the level of commissions and fees earned from services, and on the probability that the high risk project succeeds.

The only effect of the sale of services is to widen the region where the pure equilibrium exists ($\hat{\hat{r}}$ with services < $\hat{\hat{r}}$ without services) as it has been shown in section 3.3.

[26] The value of the lending rate, as well as the value of the probability of screening (p_s=0) and the probability of choosing the low risk investment (p_l =0) are not affected by the sale of services.

3.4.1.2. The case of the mixed strategy equilibrium

At equilibrium, r is ranging from (r_f - t) to $\hat{\hat{r}}$, and the probabilities that screening takes place and that the firm chooses the low risk project are respectively :

$$p_s^* = 1 - \frac{\gamma(l-r)}{\theta(h-r)}$$

$$p_l^* = 1 - \frac{s}{(1-\theta)k.r_f - \theta(r - r_f + t)}$$

Given the definition of a mixed strategy, for these values of p_s* and p_l*, the bank is indifferent between screening and not screening, that is the level of profit is the same in both cases. Therefore we choose the simplest way of writing profit in order to determine the level of the lending rate :

$$\pi^B = p_l^* \gamma(r - r_f + t) - p_l^* (1-\gamma) k.r_f - s$$

In order to assure a positive bank profit we made the following assumption :

Assumption 4

$$\left[\sqrt{(1-\theta)k.r_f} - \sqrt{s}\right]^2 \geq \frac{\theta}{\gamma} s$$

Justification. See appendix B.

Proposition 3 *The value of the lending rate which maximises the bank's profit is :*

$$\underline{r_m} = r_f - t + \frac{1-\theta}{\theta} k.r_f - \frac{1}{\theta}\sqrt{s.k.r_f\left(1 - \frac{\theta}{\gamma}\right)}$$

Proof. See appendix C.

The lending rate is determined by a new variable, which is the commissions and fees charged by the bank while selling services. More precisely, the credit rate is a decreasing function of the sale of services, that is a decreasing function of the net profit

that the bank makes on services. As the disutility of changing the supplier of services, *t*, increases, the bank can set up a lower interest rate on the loan market.

At this equilibrium, when implementing the new value of the interest rate found inside the probabilities of choosing the low risk project and screening found in section 3.3., we find that the probability that the firm chooses the low risk project remains identical to the situation where the bank sells only loans ; but the probability that the bank screens the firm's project decreases[27]. This distortion in the bank's incentives to screen increases, that is the bank has less incentives to screen, as the agent's transport cost and/or switching cost raise.

Thus, the lending rate is less than the one charged when the bank does not sell services, and the difference comes from the existence of services. Because of the revenue the bank gets from its service activity, it can charge a lower interest rate on loans. Therefore, we can say that services subsidise the credit activity of the bank.

To summarise, in the case of a monopoly lending market, the sale of services does impact on the credit rate charged in the mixed strategy equilibrium. Therefore taking into account the new probabilities determined in the previous section, and the new value of the interest rate, we can say, still in the case of the mixed strategy equilibrium, that on the one hand, the sale of services cross-subsidise the lending rate. On the other hand, this sale of services does also affect the bank's incentives, leading it to take on more risk as it decreases its probability of screening loans it agrees to grant.

We are now going to study what happens in the competitive lending market structure.

[27] When *t* increases, the lending rate decreases. And we have seen in footnote 21 that the probability that the bank screens is an increasing function of *r*. Thus when *t* increases, p_s decreases.

3.4.2. Competitive lending market

In this case, the firm can choose from whom it borrows, hence the economy-wide credit rate is determined by maximising the firm's profit subject to the bank's participation. The bank will participate in the firm's project if and only if its expected profit is non-negative.

3.4.2.1. The case of the pure strategy equilibrium

At this equilibrium, r is higher than $\hat{\hat{r}}$, and the probability of screening p_s equals zero and the probability of choosing the low risk project p_l equals zero as well.

We know that the firm's profit is a decreasing linear function of the lending rate. Under perfect competition, a bank is forced into decreasing its lending rate until its profit equals zero.

A bank's profit is as follows : $\pi^B = \theta\left(r - r_f + t\right) - \left(1-\theta\right)k.r_f = 0$.

Proposition 4 *The interest rate accepted by the firm is such that the bank profit is equal to zero, that is:* $\bar{r}_c = r_f - t + \frac{1-\theta}{\theta}k.r_f$.

Proof. See appendix D.

At the pure strategy equilibrium, the lending rate is a decreasing function of the sale of services, and more precisely, a decreasing function of the agent's disutility of changing provider of services. As the agent's transport cost and/or switching cost, *t*, increase, a bank can set up a lower interest rate on the loan market.

The probability of choosing the low risk project and the probability that a bank screens the loan it agrees to grant are both equal to zero, and therefore they have not been modified by the new value of the lending rate.

Thus the loan interest rate is lower than when the bank sells only credit. When considering acceptance of the credit rate, the firm takes into account that the bank has different sources of revenue[28]. However there is no change in either the bank or firm's behaviour, which seems logical as they already have the riskiest behaviour. Nevertheless one must keep in mind that this riskiest behaviour is more widespread when the sale of services is taken into account.

3.4.2.2. The case of the mixed strategy equilibrium

At equilibrium, r is ranging from (r_f - t) to $\hat{\hat{r}}$, and the probability of screening and the probability of choosing the low risk project are determined by the couple (p_s*, p_l*).

The bank profit is : $\pi^B = p_l^* \gamma\left(r - r_f + t\right) - p_l^* \left(1-\gamma\right) k.r_f - s = 0$.

As previously, the interest rate will be set in order to ensure the bank's participation, i.e. $\pi^B = 0$.

Proposition 5 *Under a competitive lending market, the mixed strategy lending rate is :*

$$\underline{r}_c = r_f - t + \frac{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f - (\gamma-\theta)s\right]}{2\gamma\theta} - \left[\frac{\sqrt{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f - (\gamma-\theta)s\right]^2 - 4\gamma\theta.k.r_f\left[(\gamma-\theta)s + (1-\theta)(1-\gamma)k.r_f\right]}}{2\gamma\theta}\right]$$

Proof. See appendix E.

[28] We remind the reader that the cost of services does not affect the gross return of the firm's project. The entrepreneur uses services for a better management of his firm, and/or has changed the supplier of services.

Again we find that the lending rate is a decreasing function of the sale of services, and more precisely, of the disutility the agent suffers when he changes to another supplier of services. It is also clear that as the agent's transport cost and/or switching cost, *t*, increase, the bank can set up a lower interest rate on the credit market. Once again, when using this level of the interest rate to determine the probabilities of choosing the low risk project and screening, we obtain the result that the probability the firm chooses the low risk project remains identical to the situation where the bank sells only loans, but the probability of screening decreases. So, in comparison with the case without services, the equilibrium lending rate is lower, the level of risk taken by the bank is higher, but the risk of firms' projects in the economy remains the same.

We observe, as under the monopoly lending market and the mixed strategy equilibrium, a lower interest rate than when the credit activity is the only source of revenue for the bank. As the market power of the bank in service provision increases, through higher transport cost and/or switching cost, the decrease of the lending rate is significant. The bank profit is still equal to zero, however the structure of the bank's revenue has changed. The share of interest revenue has decreased relative to commissions and fees. Finally, as in the monopoly case, we observe a change in the risk incentives of the bank : in decreasing its probability of screening, the bank is willing to take on more risk.

3.4.3. Effects of commission and fee revenue

We can summarise and generalise the results of this section, that is the impact of commissions and fees on the lending rate, and then on the behaviour of banks and firms, using the following table 3.1. [29] :

[29] We compare the results found in this model to the initial situation where banks do not sell services.

Table 3.1. Impact of service revenue on the lending rate and agents' behaviour

	Monopoly lending market		Competitive lending market	
	Pure equilibrium	Mixed strategy equilibrium	Pure equilibrium	Mixed strategy equilibrium
Lending rate	→	↘	↘	↘
Probability of screening	→	↘	→	↘
Probability of choosing the low risk investment	→	→	→	→

In the case of the pure equilibrium, the region in which it applies has been widened by the introduction of the sale of services.

Only in the case of a competitive lending market does the lending rate decrease compared to the case in which banks do not sell services. However, under either a monopoly or a competitive structure of the loan market, the probability that banks screen remains equal to our initial situation where banks do not sell services.

Given the level of the lending rate found, we obtain that the behaviour of banks is not altered by the introduction of the sale of services.

In the case of the mixed strategy equilibrium, the region in which it applies has been reduced by the introduction of the sale of services.

Under both lending market structures, the loan interest rate decreases. In both situations, services "subsidise" loans.

Moreover we underline a modification of banks' incentives. Their probability of screening loans they agree upon is a decreasing function of commission and fee revenue. In other words, the sale of services encourages them to take on more risk.

In both types of equilibrium, the probability that firms choose the low risk project are not altered by the introduction of services in our model. However one must keep in mind that the lending rate, which depends on the equilibrium and the market structure,

can change compared to the initial case without sale of services. We can conclude that, despite the modifications of the lending rate and the probability that banks screen loans, the intrinsic level of risk has not changed either for the low or high risk project. The level of risk banks face has increased, not because of an increase in risk of projects, but because of a decrease in screening.

Thus we may extrapolate our results to the case of an oligopolistic competition. Both under the pure and the mixed strategy equilibrium, we find that the lending rate is a decreasing function of commission and fee revenue, in other words a decreasing function of the sale of services. We therefore stress a cross-subsidisation between service fees and lending rates (commissions and fees subsidise a lower lending rate).

In the case of the pure equilibrium, there is no change neither in the bank nor the firm behaviours. They already exhibit the riskiest attitude. We can easily imagine that this equilibrium is hampered by the existing regulation. The fact remains however that this pure equilibrium area is widened by the sale of services.

Given the probability of choosing the low risk project and the probability of screening that we have found, and the new values of the lending rate, we can highlight a change in banks' incentives, in the mixed strategy equilibrium. Indeed, under both extreme market structures, the probability that banks screen loans is lower than the probability that prevails without sale of services. So we can say that banks take on more risk, as they increase their probability of financing riskier projects.

Therefore in our model the sale of services by banks, either by entering new markets or by charging for services which were free before, does not only affect the pricing of loans, as we could suspect, but also modify the behaviour of banks with regard to risk, as their incentives to screen decrease.

3.5. Conclusion

The main objective of this theoretical investigation was to capture the effect of banks' service provision on the behaviour of banks and firms when considering lending relationships. More precisely, we consider implications for interest rates, firms' project risk and banks' screening (and therefore credit risk) when banks provide and charge for services.

Two extreme market structures have been considered, a monopoly and a competitive lending market. In both structures, there are two local maxima depending on the bank's strategy. A first equilibrium is characterised by no screening, and only the high risk project is undertaken. We showed that the region where the pure equilibrium takes place is extended.

In the second equilibrium, i.e. on the mixed strategy equilibrium, screening takes place and both type of projects can be undertaken. Once it is assumed that agents suffer disutility from buying services available at their banks from another firm, banks have the opportunity to sell services above their marginal cost, and the price can be raised as agents' transport cost and/or switching cost increase.

Under both market structures, the interest rate charged by banks for a loan is a decreasing function of the sale of services. At equilibrium, the lending rate is lower than the rate that prevails without the sale of services. Such a result can be explained by the desire of banks to attract new clients using cheaper loans in order to cross-sell them services.

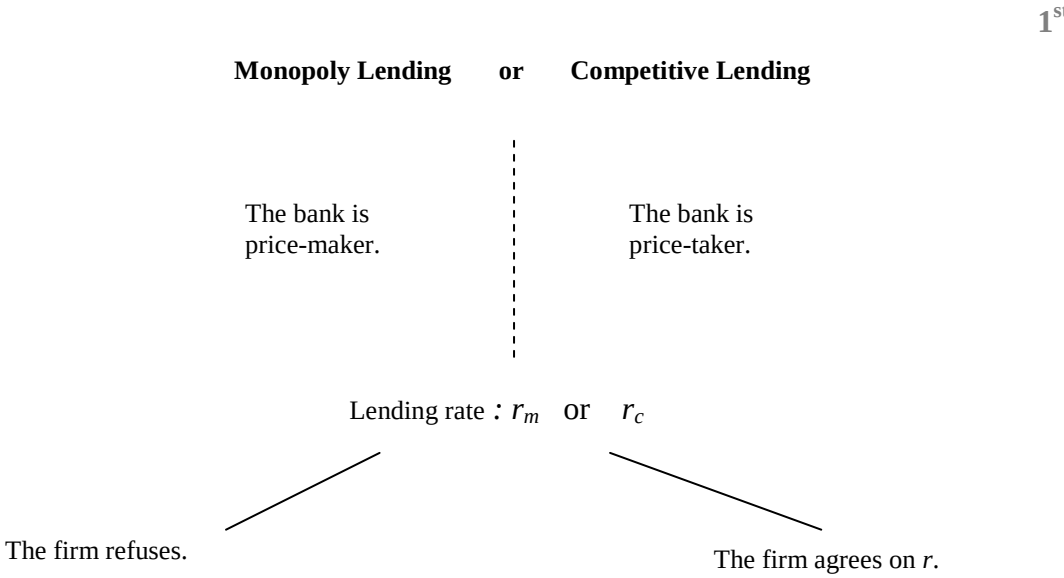
A second effect of the sale of services is a change in banks' behaviour. Following the decrease of the lending rate, the probability that banks screen loans is lower than when banks do not sell services. As the price of services increases, the incentive to screen decreases. As a consequence, banks' balance sheets bear higher credit risk, and *ceteris paribus* higher risk of default. Because similar results are obtained under both market structures, we can extrapolate our findings to the case of an oligopolistic

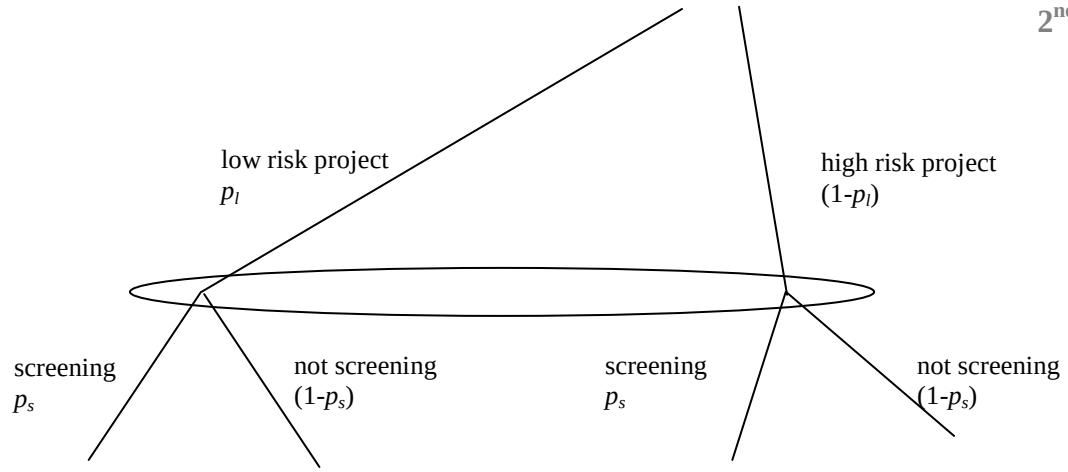
environment, which depicts the general environment in which banks operate in the USA and in Europe (Lewis and Pescetto, 1996, Plihon, 1998, ECB, 2000b, Belaisch *et al.*, 2001).

One of the issues of our work was whether the sale of services enables banks to subsidise their credit activity. Cross-subsidisation concerning deposit interest rates and services has long been investigated in the literature. But our model shows, as Cukierman (1978) suggested, that the billing practices for services may also imply some kind of "cross-subsidisation" on the loan market.

In addition to the cross-subsidisation highlighted between the sale of services and loan rates, we are able to show a new effect which is the impact of the sale of services on the risk exposure of banks. Indeed, higher credit risk is a direct consequence of a modification of banks' behaviour. Even if the level of firms' project risk is still the same in the economy, the probability that banks screen loans decreases. The implicit idea behind this result is that banks compete firstly on the loan market because they will be able to sell services only to the firms they have lent funds to. They may thus be willing to accept more "high risk" projects than they would if they were only selling loans. Hence, the credit risk borne on banks' balance sheets is greater when they sell services. This may be of concern to regulatory authorities, since the share of commission and fee revenue suggests that service activity have become another major field for banks.

Appendix A. Game tree





Firm expected earning			
$(l-r) \times \gamma$ + $0 \times (1-\gamma)$	$(l-r) \times \gamma$ + $0 \times (1-\gamma)$	The bank does not lend funds to the firm.	$(h-r) \times \theta$ + $0 \times (1-\theta)$
Total bank expected earning (1st and 2nd period)			
$(r - r_f + t) \times \gamma$ - $k.r_f \times (1-\gamma)$ - s	$(r - r_f + t) \times \gamma$ - $k.r_f \times (1-\gamma)$	$-s$	$(r - r_f + t) \times \theta$ - $k.r_f \times (1-\theta)$

Appendix B. Justification assumption 4.

For a value of r in the interval $[(r_f - t), \hat{\hat{r}}]$, we check when the bank's profit is positive :

$$\pi^B = p_l \gamma \left(r - r_f + t \right) - s$$

We first simplify p_l :

$$p_l = 1 - \frac{s}{(1-\theta) k.r_f - \theta \left(r - t + \frac{1-\theta}{\theta} k.r_f - \frac{1}{\theta} \sqrt{(1-\theta) s.k.r_f} - r_f + t \right)}$$

$$p_l = \frac{\sqrt{(1-\theta) s.k.r_f} - s}{\sqrt{(1-\theta) s.k.r_f}}$$

Then, the bank's profit is equal to :

$$\pi^B = \gamma \left(\frac{\sqrt{(1-\theta) s.k.r_f} - s}{\sqrt{(1-\theta) s.k.r_f}} \right) \left(r_f - t + \frac{(1-\theta) k.r_f}{\theta} - \frac{1}{\theta} \sqrt{(1-\theta) s.k.r_f} - r_f + t \right) - s$$

$$\pi^B = \frac{\gamma}{\theta} \left[\left(\frac{\sqrt{(1-\theta) s.k.r_f} - s}{\sqrt{(1-\theta) s.k.r_f}} \right) \left((1-\theta) k.r_f - \sqrt{(1-\theta) s.k.r_f} \right) \right] - s$$

$$\pi^B = \frac{\gamma}{\theta} \left[(1-\theta) k.r_f + s - 2\sqrt{(1-\theta) s.k.r_f} \right] - s$$

$$\pi^B = \frac{\gamma}{\theta} \left[\sqrt{(1-\theta) k.r_f} - \sqrt{s} \right]^2 - s$$

Appendix C. Proof proposition 3. Monopoly lending : Value of the lending rate at the mixed strategy equilibrium.

We look for the interest rate which maximises the bank's profit in the interval $(r_f - t) < r < \hat{\hat{r}}$:

$$\pi^B = p_l \gamma \left(r - r_f + t\right) - p_l \left(1-\gamma\right) k.r_f - s$$

$$\frac{\partial \pi^B}{\partial r} = 0 \Leftrightarrow p_l \gamma + \left(r - r_f + t\right)\gamma p_l^{'} - p_l^{'}\left(1-\gamma\right) k.r_f = 0$$

$$\Leftrightarrow \left(1 - \frac{s}{\left(1-\theta\right)k.r_f - \theta\left(r - r_f + t\right)}\right)\gamma + \left(r - r_f + t - \frac{1-\gamma}{\gamma}k.r_f\right)\left(\frac{-\theta s}{\left[\left(1-\theta\right)k.r_f - \theta\left(r - r_f + t\right)\right]^2}\right)\gamma = 0$$

$$\Leftrightarrow \theta^2\left(r - r_f + t\right)^2 - 2\theta\left(1-\theta\right)k.r_f\left(r - r_f + t\right) + \left[\left(1-\theta\right)k.r_f\right]^2 - s\left(1-\theta\right)k.r_f + \theta s\frac{\left(1-\gamma\right)}{\gamma}k.r_f = 0$$

$$\Delta = 4\theta^2\left[\left(1-\theta\right)k.r_f\right]^2 - 4\theta^2\left[\left[\left(1-\theta\right)k.r_f\right]^2 - s.k.r_f\left(1 - \frac{\theta}{\gamma}\right)\right]$$

Given assumption 2, we have :

$$r_1 = r_f - t + \frac{2\theta\left(1-\theta\right)k.r_f + 2\theta\sqrt{s.k.r_f\left(1-\frac{\theta}{\gamma}\right)}}{2\theta^2} \qquad r_1 \notin \left[r_f - t, \hat{\hat{r}}\right]$$

$$r_2 = r_f - t + \frac{2\theta\left(1-\theta\right)k.r_f - 2\theta\sqrt{s.k.r_f\left(1-\frac{\theta}{\gamma}\right)}}{2\theta^2} \qquad r_2 \in \left[r_f - t, \hat{\hat{r}}\right]$$

Appendix D. Proof proposition 4. Competitive lending : Value of the credit rate at the pure equilibrium.

We need to find the interest rate that equals the bank's profit to zero:

$$\pi^B = 0$$

$$\theta\left(r - r_f + t\right) - \left(1-\theta\right) k.r_f = 0$$

We obtain :

$$r = r_f - t + \frac{1-\theta}{\theta} k.r_f$$

Appendix E. Proof proposition 5. Competitive lending : Value of the credit rate at the mixed strategy equilibrium.

We look for the interest rate which satisfies the bank's participation in the interval $(r_f - t) < r < \hat{\hat{r}}$:

$$\pi^B = 0$$

$$\Leftrightarrow \quad p_l\gamma\left(r - r_f + t\right) - p_l\left(1-\gamma\right)k.r_f - s = 0$$

$$\Leftrightarrow \quad \left(1 - \frac{s}{\left(1-\theta\right)k.r_f - \theta\left(r - r_f + t\right)}\right)\left[\gamma\left(r - r_f + t\right) - \left(1-\gamma\right)k.r_f\right] - s = 0$$

$$\Leftrightarrow \quad -\gamma\theta\left(r - r_f + t\right)^2 + \left[\left[\gamma\left(1-\theta\right) + \theta\left(1-\gamma\right)\right]k.r_f - \left(\gamma-\theta\right)s\right]\left(r - r_f + t\right)$$
$$+ k.r_f\left[-\left(\gamma-\theta\right)s - \left(1-\theta\right)\left(1-\gamma\right)k.r_f\right] = 0$$

$$\Leftrightarrow \quad -\gamma\theta\left(r - r_f + t\right)^2 + \left[\left[\gamma\left(1-\theta\right) + \theta\left(1-\gamma\right)\right]k.r_f - \left(\gamma-\theta\right)s\right]\left(r - r_f + t\right) - k.r_f\left[\left(\gamma-\theta\right)s + \left(1-\theta\right)\left(1-\gamma\right)k.r_f\right] = 0$$

$$\Leftrightarrow \quad \gamma\theta\left(r - r_f + t\right)^2 - \left[\left[\gamma\left(1-\theta\right) + \theta\left(1-\gamma\right)\right]k.r_f - \left(\gamma-\theta\right)s\right]\left(r - r_f + t\right) + k.r_f\left[\left(\gamma-\theta\right)s + \left(1-\theta\right)\left(1-\gamma\right)k.r_f\right] = 0$$

$$\Delta = \left[\left[\gamma\left(1-\theta\right) + \theta\left(1-\gamma\right)\right]k.r_f - \left(\gamma-\theta\right)s\right]^2 - 4\gamma.\theta.k.r_f\left[\left(\gamma-\theta\right)s + \left(1-\theta\right)\left(1-\gamma\right)k.r_f\right] = 0$$

We obtain :

$$x_1 = \frac{\left[\left[\gamma\left(1-\theta\right) + \theta\left(1-\gamma\right)\right]k.r_f - \left(\gamma-\theta\right)s\right]}{2\gamma\theta}$$
$$+ \left[\frac{\sqrt{\left[\left[\gamma\left(1-\theta\right) + \theta\left(1-\gamma\right)\right]k.r_f - \left(\gamma-\theta\right)s\right]^2 - 4\gamma.\theta.k.r_f\left[\left(\gamma-\theta\right)s + \left(1-\theta\right)\left(1-\gamma\right)k.r_f\right]}}{2\gamma\theta}\right]$$

$$x_2 = \frac{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f-(\gamma-\theta)s\right]}{2\gamma\theta}$$

$$-\left[\frac{\sqrt{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f-(\gamma-\theta)s\right]^2-4\gamma.\theta.k.r_f\left[(\gamma-\theta)s+(1-\theta)(1-\gamma)k.r_f\right]}}{2\gamma\theta}\right]$$

$$r_1 = r_f - t + x_1 \qquad r_1 \notin \left[r_f - t, \hat{\hat{r}}\right]$$

$$r_2 = r_f - t + x_2 \qquad r_2 \in \left[r_f - t, \hat{\hat{r}}\right]$$

CHAPTER 4.

NON-INTEREST INCOME, LENDING RATE AND CREDIT RISK : AN EMPIRICAL ANALYSIS FOR THE E.U.

4.1. Introduction

Two major results have been highlighted in the previous chapter, in which the link between the lending rate, incentives to screen and service revenue have been studied.

First, our theoretical model underlined that banks use loans as loss leaders, which means that they have incentives to decrease their margin on lending in order to capture clients. Their aim is to sell services to those new clients the following period. Banks are willing to decrease their lending rate as they expect to make a profit got from their sale of services.

Second, if the sale of services by banks is anticipated, it means that banks expect their overall revenue (interest revenue and commission and fee revenue) to increase as well. In order to establish a relationship with clients, by granting a loan, banks are willing to decrease their screening activity (thus rejecting fewer loan applications), and thereby they increase the probability of funding risky projects. In other words, the theoretical model showed that the sale of services alters banks' behaviour with regard to their incentives to screen.

Our aim in this chapter is to test empirically the results obtained in the theoretical model (chapter 3). The objective is to analyse the extent to which services can be considered as a determinant of the price competition in which banks are engaged in Europe, and to draw implications regarding their risk taking.

In a second section, we assess whether banks actually decrease their lending rate, as they aim to sell more services to their clients in the future. For this purpose, we study the twelve European countries previously considered in chapter 2, over the period 1989-1999. Specifically we focus on the price determinants of loans. In this sense this study differs from the one in chapter 2 as, on the one hand, we test the finding on the lending rate obtained in our theoretical model. On the other hand, we assess the determinants of the pricing of loans, independently of the pricing of deposits assuming that banks are price taker, that is quantity setter on deposits, unlike our estimation in chapter 2 which focused on the determinants of margins rather than loan rates.

Our aim, in a third section, is to determine if banks have less incentives to screen borrowers when they expect to sell more services, which consequently implies that they take on more risk. Data are not sufficiently detailed to measure banks' incentives to screen, and we are therefore not able to test the specific link between the opportunity to sell services and the frequency of screening. Nevertheless, our theoretical model (chapter 3) showed that, when banks have less incentive to screen, they take on more risk. Hence we can assess the modification of banks' incentives towards screening, due to the sale of services, by testing the link between credit risk and service revenue. Moreover, the relation between risk and sale of services is much more important in terms of banks' behaviour and of policy implications.

4.2. Commission and fee income and lending rate

One of the main focuses of our theoretical model is the link between the loan interest rates and the expected income from the sale of services. Banks may subsidise the lending rate they offer in order to increase their sale of services. Our estimation differs from the one performed in chapter 2 as we concentrate on the impact of the sale of services on lending rates, rather than on the margins. Moreover, the empirical specification of our test is derived from our model developed in chapter 3.

Cross-subsidisation takes place in the two lending market structures analysed in chapter 3 : monopoly or competitive. Thus, the objective of the empirical work undertaken here is to observe if data sustain this result : does the sale of services have a negative impact on the level of the loan interest rate ?

4.2.1. The data

One of the hypothesis of our theoretical model outlined that banks which develop a credit relationship in the first period, will have the opportunity to sell services to their new borrowers in the second period. Therefore to satisfy our previous requirement of a “long term” bank-customer relationship, only commercial banks are considered.

The data used in this chapter, as well as the restrictions imposed on data, are the same as those described in chapter 2 (section 2.3., p.88). The source of data for this study is balance sheet and income-statement information derived from Fitch-IBCA’s Bankscope Database and interest rate series that come from DataStream International and OECD statistics (Main Economic Indicators). Our data are yearly data and cover the period 1989-1999. We selected the 3 month Treasury Bill rate for each country. We study the same twelve European banking systems as in chapter 2.

4.2.2. Definition of variables

Dependent variable : lending rate

In our theoretical model, we showed that under certain conditions banks can decrease their lending rate in order to attract new clients who may buy services. We therefore study first the determinants of the lending rate. The proxy used to measure the lending rate is the ratio of interest revenue to total earning assets. Therefore our measure of the lending rate is an ex-post rate. A more accurate measure of the lending rate would have been the ratio of interest received from loans over gross loans. However such an information is rarely available.

Appendix A (table 4.4.) provides summary statistics concerning the ratio of interest revenue to total earning assets. In Europe, and since the beginning of the period under study, this ratio has decreased from 11.6 percent in 1990 to 7 percent on average in 1999.

Explanatory variables

Revenue from services (Com and Fees)

The revenue from the sale of services is measured as the ratio of net commission and fee revenue to total assets. In our theoretical model, a desired increase in commission and fee revenue implies a decrease in the current lending rate. Indeed by decreasing their lending rate, banks intend to capture clients to whom they can sell services later on. Therefore we take into account revenue from services at time $t+1$, which should negatively impact on the lending rate at time t.

Capital

By regulation, the bank is due to hold "own funds". Capital is measured by the ratio of equity to total assets.

The effect of capital in our theoretical model is ambiguous (see appendix B for the derivative). If we consider first that banks are in a mixed strategy equilibrium, the derivative of the lending rate with respect to capital is first negative for relatively low values of the capital ratio, and then positive. However if we consider that an increase in the capital ratio will alter banks' incentives, they may choose the high risk equilibrium, which implies therefore a higher lending rate[1].

Cost of screening (personnel expenses)

In the model, the bank faces screening cost in the process of granting loans. We measure this cost by the ratio of personnel expenses to total assets. A more appropriate proxy would have been the ratio of personnel expenses to the number of employees, but such an information was not sufficiently available for our sample.

In our theoretical model, an increase in the cost of screening negatively affects the lending rate. This effect stems from the risk behaviour of the firm regarding its project. When the cost of screening increases, firms anticipate a lower probability of screening and therefore their incentives to choose the low risk project decreases. One way to circumvent this behaviour is for the bank to decrease the lending rate. In doing so, banks may prompt firms to choose the low risk project. We may also consider that an increase in the screening cost will induce banks to move on to the high risk equilibrium implying a higher lending rate.

The effect of an increase in the cost of screening is ambiguous depending on whether the rise of the screening cost leads to a shift from the mixed to the pure equilibrium or not.

[1] We should notice that we analyse the behaviour that a bank may adopt following a change in one of the variables. However our estimations will give us aggregated behaviours.

Opportunity cost (3-month Tr. Bill)

The opportunity cost measures the interest that banks would have received investing in the risk-free asset instead of loans. The variable used is the 3-month treasury bill rate except for Portugal, where we took as variable the 3-month interbank rate.

The sign of the expected coefficient associated to the opportunity cost derived from our model is unknown (see appendix B for the derivative). The analysis of an increase in the risk-free rate is the same as for capital, this sign is ambiguous. However when looking at the derivative of both variables, it appears that if the sign of the derivative of the lending rate with respect to the risk-free rate is negative the same sign should be observed for the derivative of the lending rate with respect of capital. And inversely, if the derivative of the lending rate with respect to capital is positive, the derivative of the lending rate with respect to the risk-free rate should be as well positive.

4.2.3. Estimation results

As in chapter 2, the question is whether to pool the data or not. While undertaking the poolability tests, we were unable to compute some of the Fischer tests (*cf.* chapter 2, appendix D, p.113, for a description of the different hypothesis to test). We present in appendix C (table 4.5.) the results for the one we were able to compute, and that show that the panel regressions have to be used.

We tested then for the presence of fixed effects, LSDV estimators, versus random effects, GLS estimators (appendix D, table 4.6). The results show that the fixed effect estimation procedure is relevant for Belgium, Denmark, Greece and Italy.

We also tested for heteroskedasticity and autocorrelation. The results for the White test (appendix E.1, table 4.7) show homoskedasticity for France, Portugal, Spain and the U.K., and therefore cross section weights were taken into account whenever relevant (GLS estimators). We also corrected for heteroskedasticity within cross-sections.

The Durbin Watson test for autocorrelation (appendix E.2, table 4.8) shows positive autocorrelation for all countries except Ireland. To correct for autocorrelation we included a lagged dependent variable. However, as already mentioned in chapter 2, the presence of a lagged dependent variable as an exogenous variable in the regressions implies bias to the observed coefficients. However in our analysis we will emphasise the signs of the coefficients.

The estimated equation is :

$$\text{Lending rate}_{it} = \alpha_i + \beta_1 \text{Com and Fees}_{i,t+1} + \beta_2 \text{ Capital}_{it} + \beta_3 \text{ Personnel Expenses}_{it} + \beta_4 \text{ Opportunity Cost}_{it} + \beta_5 \text{Lending Rate}_{i,t-1} + \varepsilon_{it}$$

The letter "*i*" represents the index for banks, and the letter "*t*" the index for years.
The expected signs are as follows : $\beta_1<0$, $\beta_5>0$, β_2 , β_3 and β_4 : ambiguous.

Our results are shown in table 4.1. :

Table 4.1. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Interest Revenue / Total Earning Assets [a,b]

	Constant	Com and Fees (+1)	Capital	Personnel Expenses	3-month Tr. Bill	Lag value	Adjusted R^2	Observa-tions
Belgium		-0.057 (-2.990)***	0.001 (0.217)	0.245 (2.745)***	0.387 (18.11)***	0.254 (7.854)***	0.82	155
Denmark		-3.006 (-18.22)***	0.001 (0.155)	-0.961 (-6.897)***	0.027 (3.657)***	0.488 (17.88)***	0.70	204
France	0.008 (2.438)**	-0.198 (-2.943)***	0.001 (0.962)	0.109 (1.301)	0.147 (3.492)***	0.784 (43.66)***	0.40	1253
Germany	0.021 (8.279)***	-0.145 (-4.716)***	0.001 (0.274)	0.109 (2.563)**	0.236 (7.516)***	0.521 (18.60)***	0.71	755
Greece		0.946 (2.147)**	0.088 (1.912)*	1.546 (2.387)**	0.381 (6.001)***	0.129 (1.018)	0.82	45
Ireland	0.035 (4.869)***	-1.957 (-4.467)***	-0.010 (-7.093)***	2.012 (4.124)***	0.535 (9.221)***		0.93	52

(continued on next page)

[a] Figures in parentheses are the t-statistics, asterisks (***), (**) and (*) indicate respectively significance at the 1%, 5% and 10% levels.
[b] All regression estimates are heteroskedastic consistent and are based on the revised covariance estimate of White (when relevant).

Table 4.1. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Interest Revenue / Total Earning Assets *(continued)*

	Constant	Com and Fees (+1)	Capital	Personnel Expenses	3-month Tr. Bill	Lag value	Adjusted R^2	Observa-tions
Italy		-0.629 (-10.23)***	-0.015 (-4.556)***	1.697 (23.95)***	0.456 (58.41)***	0.162 (9.355)***	0.79	734
Luxembourg	0.014 (3.131)***	0.132 (0.488)	-0.008 (-1.146)	-0.252 (-0.519)	0.215 (3.419)***	0.589 (13.39)***	0.62	269
Netherlands	0.024 (3.115)***	-0.005 (-0.033)	0.015 (3.058)***	-0.029 (-0.094)	-0.287 (-2.159)**	0.796 (9.215)***	0.46	165
Portugal	0.021 (4.317)***	0.076 (0.248)	0.010 (0.821)	0.447 (2.047)**	0.334 (6.119)***	0.386 (9.388)***	0.42	192
Spain	-0.001 (-0.119)	0.046 (0.223)	-0.016 (-1.014)	0.109 (0.712)	0.409 (12.23)***	0.598 (14.89)***	0.68	318
U.K.	0.010 (1.429)	-0.300 (-4.633)***	-0.007 (-1.513)	1.464 (12.42)***	0.361 (3.586)***	0.420 (11.51)***	0.86	299

We first analyse the effect of our variable net commission and fee revenue. The variable has a negative and significant impact on the lending rate, as expected, for seven of the twelve countries (Belgium, Denmark, France, Germany, Ireland, Italy and the U.K.). We only observe a positive and significant impact for two countries (Greece and the Netherlands).

Thus our results cannot reject our hypothesis that, in Europe, some banks may adopt as a strategy to subsidise the loans they grant in order to capture clients to whom they may sell services. We can notice that in the four largest countries, France, Germany, Italy, and the U.K., results show that some banks have decided to adopt the strategy described in our theoretical model.

However we should keep in mind that, during this period, the banking systems have been deregulated. To confirm that deregulation is not the cause of the negative relationship found between the lending rate and services, we have considered a year by year analysis (given the definition of the variable we need at least three years to undertake one regression). Results are relatively consistent over the period, we should notice that we found weaker significance at the middle of the period. Results for the sub-period 1997-1999 are displayed in appendix F (table 4.9).

Therefore, the decrease in the lending rate observed on the lending market can be explained not only as a consequence of the deregulation process, but as a mean for banks to compete for clients.

The impact of the capital ratio on the lending rate is significant for only four of the twelve countries (Greece, Ireland, Italy and the Netherlands). The coefficient is positive and significant for Greece and the Netherlands, an increase in the capital ratio is compensated in these countries by a higher lending rate.

The coefficient for the opportunity cost variable is positive and significant for eleven of the twelve countries. In other words, banks increase their lending rate as the risk-free rate increases. When the risk-free rate increases, the opportunity cost for banks to lend funds increases, leading them to increase their interest rate on loans. The risk-free rate has a negative significant impact on the lending rate in only one country the Netherlands. Therefore we would have expected the sign of the coefficient for the capital ratio to be negative, which is not the case here.

The coefficient of the proxy for the screening cost is positive and significant in seven of the twelve countries. It is negative and significant only for the Danish banks. Therefore the results we obtain are the opposite of that expected (unless if we consider that most of banks moved on to the high risk equilibrium). One can argue that the proxy used is more relevant for the quantity of screening than the cost of screening. We could perhaps have used the ratio of personnel expenses to loans, however this ratio is biased if credit activity does not represent a substantial share in the bank's balance sheet.

We have highlighted in this section that our empirical study does not reject one of the main results of our theoretical model. Therefore we offer an alternative explanation of the competition observed in the banking industry : banks compete in the lending market for clients, and to do so they subsidise their lending rate. They decrease their lending rate as they expect to sell borrowers other services, which generate commission and fee revenue.

In the next section, we test our second result, that is the link between credit risk and service revenue.

4.3. Commission and fee income and risk

In this section, we aim to study the link between credit risk and the expected income from the sale of services, underlined in our theoretical model. Indeed we showed that under certain conditions (chapter 3, section 3.3., p.132) the incentives of banks to screen before granting a loan are altered because they expect to sell fee earning services to potential clients. Therefore the second objective of the work undertaken in this chapter is to analyse the impact of the sale of services on the risk taken by banks.

4.3.1. Definition of variables

Dependent variable : credit risk

Our theoretical model shows that the decrease in banks' incentives to screen implies higher credit risk[2] taken by the banks. Thus our dependent variable should reflect **a change** in the credit risk of banks. Different balance sheet proxies can be used : loan loss reserves, non performing loans (these two variables are balance sheet data) or loan loss provisions (income statement data)[3]. Given the lack of sufficient data for loan loss reserves and non performing loans, we have mainly used the ratio of loan loss provisions to gross loans. However we will present the results we obtained with the ratio of non performing loans to gross loans, which is available only for three countries,

[2] The functional form of credit risk in our theoretical model is the ex-ante probability than the borrower defaults : $(1-\theta)(1-p_s)(1-p_l)+(1-\gamma)\,p_l$. In order to find the derivatives with respect to our different variables (commission and fee revenue, capital, screening cost and risk-free rate), we can use the property that these variables influence the level of risk through the lending rate, *r*, which itself impacts on the probability of screening, p_s, and the probability of choosing the low risk project, p_l. We can therefore just use the following properties, $\frac{\partial p_s}{\partial x}=\frac{\partial p_s}{\partial r}.\frac{\partial r}{\partial x}$ and $\frac{\partial p_l}{\partial x}=\frac{\partial p_l}{\partial r}.\frac{\partial r}{\partial x}$, to determine the sign of each derivative. The derivatives of p_s and p_l with respect to the lending rate are both positive. With regard to the influence of the different variables on the lending rate, see appendix B.

[3] We could have also used market variables, however it requires banks to be listed on the financial market. As a consequence, we would not have been able to undertake an estimation for each country.

Denmark, France, and Italy, as it is a common measure frequently used for default risk in the literature (for example, Acharya *et al.* 2002).

Our dependent variable is suppose to measure a change in the behaviour of banks. Therefore the dependent variable, that we use, is the difference in the ratio of loan loss provisions to gross loans between year *t* and year *t-1* in order to "better" capture **a change** in the risk taken by banks.

As for the ratio of loan loss provisions to gross loans, we calculate for the ratio of non performing loans to gross loans the variation between year *t* and year *t-1*.

Appendix G (table 4.10.) provides some descriptive statistics for the dependent variables given our estimation sample. As a percentage of gross loans, loan loss provisions are on average, over all countries and all years, equal to 1.3 percent. Loan loss provisions average 1.5 to 1.9 percent of gross loans between 1992 and 1994, whilst banking systems experienced a severe crisis in Europe (*cf.* the collapse of real estate prices).

Non performing loans represent 7.5 percent of gross loans on average over the sample period. It has to be noticed that, in France, non performing loans are on average equal to 14 percent of gross loans over the period. As for loans loss provisions, the level of non performing loans is higher in 1993 and 1994 compared to the other years.

Explanatory variables

Theoretical variables

Revenue from services (Com and Fees)

Our theoretical model demonstrates that the desire to increase the sale of services alters current banks' screening incentives. The revenue from the sale of services is measured as the ratio of net commission and fee revenue to total assets. To capture a change in banks' strategy with regard to the expected sale of services, we thus consider the variable in difference between year *t* and year *t+1*.

If banks expect to receive more revenue from their sale of services, then they are likely to be willing to screen less, because by granting more loans, they attract more clients to whom they can sell services. If banks screen less, they will have a lower probability of detecting risky loans, and they may fund projects they would otherwise have rejected. We therefore expect a positive impact of our commission and fee variable on credit risk.

Capital

Capital is measured by the ratio of equity to total assets.

In the model, the effect of the capital requirement on default risk is ambiguous. As in the previous section, if we consider first that banks are in a mixed strategy equilibrium, the derivative of the lending rate with respect to credit risk is first negative and then positive. However if we consider that an increase in the capital ratio will alter banks' incentives, they may choose the high risk equilibrium, which implies therefore a higher credit risk.

Cost of screening (personnel expenses)

As in section 4.2., we measure the cost of screening by the ratio of personnel expenses to total assets. However we know that we need to be cautious when interpreting the coefficient for this variable because this ratio may not be the more appropriate proxy.

In our model, an increase in the cost of screening induces the banks to screen their loans applicants less frequently (this result holds if we consider that banks are induced to move from the low risk equilibrium to the high risk equilibrium). Therefore an increase in the cost of screening should imply a higher default risk.

Opportunity cost

The risk-free rate is measured, as in section 4.2., by the 3-month Treasury Bill rate except for Portugal where we took the 3-month interbank rate.

The effect of the risk-free rate on default risk is ambiguous. In our theoretical model, the derivative is first negative and then positive. However, if the impact on risk of an increase in the opportunity cost is negative then the impact of an increase in the capital ratio on risk should also be negative. And if the impact on risk of the capital ratio is positive, the effect on risk of the opportunity cost should also be positive. But we should also consider that an increase in the risk-free rate will prompt banks to move on to the high risk equilibrium, implying there higher credit risk.

Control variables

Our proxy of the credit risk is not very accurate. Therefore we introduced control variables as our aim is to explain changes in credit risk of banks owing to their own strategy and not to macroeconomic or industry specific shocks[4].

GDP growth rate

The ability of borrowers to repay bank debt is likely to reflect the macroeconomic environment (Cavallo and Majnoni, 2001, Pain, 2003). Household and firms' cash flows/health will vary with the economic cycle and therefore so will their ability to repay their debt. Therefore lower GDP growth is associated with a higher provisions charge ratio.

Mean of the ratio of loan loss provisions to gross loans (Mean of provisions)

Our objective by including this variable in the regression, is to take into account the macroeconomic shocks that have affected the banking sector. We therefore take the mean of the ratio of loan loss provisions to gross loans, of the largest banks[5], in each country.

[4] Such control variables were not introduced in the previous section, as our proxy of the lending rate is more precise than the one retained in this section.
[5] We retained as the largest banks, those which were belonging to the first decile in terms of total assets in 1998. We have decided to keep only these banks as they react more rapidly to a change in the environment than the smaller ones.

This variable may be highly correlated to the previous one, that is to the GDP growth rate (see appendix H). Therefore except for France, Germany, Greece and Luxembourg, we orthogonalise this variable. We regress this variable on the GDP growth rate[6], and we use the series of residuals as explanatory variables.

When the ratio of non performing loans to gross loans is used as a proxy of credit risk, we introduce instead the mean of the ratio of non performing loans to gross loans (*mean of NPL*). As for the ratio of loan loss provisions to gross loans, this variable is first regressed on the GDP growth rate for France and Italy and then the series of residuals will be used as explanatory variables (*cf.* appendix I for the correlation coefficients).

Bank size (log TA)

Portfolio diversification can help to limit the overall scale of bank provisions (Pain, 2003). A less diversified loan portfolio is likely to be associated with higher credit risk and therefore higher loan loss provisions. The natural logarithm of total assets is introduced in the regression to capture diversification effects.

4.3.2. Estimation results

Results for poolability (appendix J, table 4.12.) show that the data had to be pooled. Therefore we undertook panel estimations.

Then the Hausman specification test (appendix K, table 4.13.) indicates that the fixed effects procedure is relevant for Denmark, France, Ireland, Italy, Luxembourg, the Netherlands and the U.K.

The White test (appendix L.1, table 4.14.) is undertaken to detect heteroskedasticity. Results indicate homoskedasticity for Belgium, Ireland and the U.K..

[6] In other words, we assume that the mean of the ratio of loan loss provisions to gross loans is explained by the GDP growth rate, and not the other way round.

Cross section weights are thus taken into account whenever relevant. We also corrected for heteroskedasticity within cross-sections.

Finally, the Durbin Watson test for autocorrelation does not detect autocorrelation in any of the countries (appendix L.2, table 4.15.).

The estimated equation is [7] :

$$\Delta(\text{Credit risk})_{it} = \alpha_i + \beta_1\ \Delta(\text{Com and Fees})_{i,t+1} + \beta_2\ \text{Capital}_{it} + \beta_3\ \text{Personnel Expenses}_{it} + \beta_4\ \text{3-month Tr. Bill}_{it} + \beta_5\ \text{Mean of provisions } \underline{\text{or}} \text{ residual series} + \beta_6\ \text{GDP growth rate} + \beta_7\ \log \text{TA} + \varepsilon_{it}$$

The letter "*i*" represents the index for banks, and the letter "*t*" the index for years.

The expected values are $\beta_1>0$, $\beta_3>0$, β_2 and β_4 either negative or positive, $\beta_5>0$, $\beta_6<0$, $\beta_7<0$.

Table 4.2. and table 4.3. display the results.

[7] In order to test our model, we need to capture a change in the bank behaviour with regard to risk. For this purpose, we have also used an alternative specification, to the one we present here. More precisely, we relied on a structure derived from the market model (Sharpe, 1963). We regressed then the ratio of loan loss provisions to gross loans on its yearly mean and on the country GDP growth rate (the ones defined in this section). The aim of such a regression is to dissociate the risk due to macroeconomics shocks, and the risk due to the bank strategy, which is captured by the residual of the regression.
Then the dependent variable is defined as the difference in the residual. The explanatory variables are the ones defined in subsection 4.3.1. (except the yearly mean of loan loss provisions to gross loans and the GDP growth rate).
This specification gives relatively the same result than the one we expose. We have decided to present the "simplest" specification.

Table 4.2. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Δ (Loan Loss Provisions / Gross Loans) [a,b]

	Constant	Δ Com and Fees (+1)	Capital	Personnel Expenses	3-month Tr. Bill	Mean of provisions	GDP growth rate	Log TA	Adjusted R^2	Observa-tions
Belgium	-0.014 (-0.646)	0.126 (0.509)	0.141 (1.491)	-0.410 (-1.167)	0.046 (0.491)	0.019 (1.143)	-0.040 (-0.284)	0.001 (0.553)	0.12	127
Denmark		-1.813 (-12.37)***	0.041 (1.630)	-0.284 (-2.245)**	-0.094 (-2.085)**	0.001 (0.634)	-0.561 (-8.302)***	0.002 (1.840)*	0.45	240
France		0.431 (40.20)***	-0.086 (-9.589)***	-0.079 (-1.889)**	0.035 (14.51)***	-0.002 (-10.28)***	0.006 (2.288)**	-0.004 (-16.24)***	0.95	1011
Germany	0.022 (0.848)	0.001 (0.001)	-0.076 (-2.880)***	0.489 (3.013)***	-0.987 (-0.612)	0.987 (1.075)	-0.144 (-0.794)	-0.002 (-1.135)	0.23	610
Greece	0.056 (1.377)	0.328 (0.411)	-0.009 (-0.317)	0.106 (0.899)	-0.294 (-1.826)*	-0.010 (-0.615)	-0.489 (-1.186)	0.0002 (0.259)	0.08	39
Ireland		0.264 (1.395)	0.043 (2.542)**	-0.304 (-2.215)**	-0.249 (-5.467)***	0.016 (8.623)***	-0.120 (-7.442)***	0.0004 (1.053)	0.56	40

(continued on next page)

[a] Figures in parentheses are the t-statistics, asterisks (***), (**) and (*) indicate respectively significance at the 1%, 5% and 10% levels.
[b] All regression estimates are heteroskedastic consistent and are based on the revised covariance estimate of White (when relevant).

Table 4.2. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Δ (Loan Loss Provisions / Gross Loans) (*continued*)

	Constant	Δ Com and Fees (+1)	Capital	Personnel Expenses	3-month Tr. Bill	Mean of provisions	GDP growth rate	Log TA	Adjusted R^2	Observa-tions
Italy		0.003 (0.121)	0.002 (0.250)	0.028 (1.164)	0.027 (7.032)***	0.011 (28.84)***	-0.086 (-9.698)***	0.002 (7.452)***	0.95	670
Luxembourg		-0.057 (-0.673)	0.011 (0.248)	0.743 (3.256)***	-0.074 (-4.326)***	0.003 (6.708)***	0.011 (1.156)	0.011 (5.466)***	42	218
Netherlands		0.220 (4.367)***	0.020 (2.009)**	0.451 (5.318)***	0.034 (9.142)***	0.521 (7.577)***	-0.015 (-3.179)***	0.004 (9.829)***	0.96	197
Portugal	-0.001 (-0.073)	1.337 (3.051)***	0.003 (0.079)	0.103 (0.539)	-0.040 (-0.595)	-0.175 (-0.125)	-0.048 (-0.380)	0.0001 (0.175)	0.10	186
Spain	-0.004 (-1.105)	0.428 (4.557)***	0.008 (0.856)	0.013 (0.271)	0.008 (0.531)	0.010 (3.136)***	-0.075 (-2.648)***	0.0001 (1.344)	0.11	297
U.K.		0.004 (0.827)	0.015 (2.701)***	0.118 (5.404)***	0.154 (18.03)***	-0.004 (-10.62)***	-0.060 (-7.520)***	0.004 (6.621)***	0.41	287

We first analyse the impact of the variable of our interest, that is the variation of the commission and fee revenue. We can observe that a desire increase in the sale of services implies higher default risk in four countries : France, the Netherlands, Portugal and Spain. Only in Denmark, does the desired sale of services imply lower credit risk. In the other countries the effect is not significant.

The results found concerning the link between credit risk and sale of services is improved if we consider the countries for which the non performing loans data are available. Indeed, as shown in table 4.3., in this case a desired increase in the sale of services implies a higher credit risk in all countries, even in Denmark for which the data is available. Therefore if we consider the results found with regard to risk but also with regard to pricing, we can say that in these three countries, France, Denmark, and Italy, some banks have decided to adopt the strategy to subsidise their lending rate whilst intending to sell services afterwards to their new borrowers, implying thus higher credit risk.

Therefore the results found with the loan loss provisions ratio (table 4.2.) and with the non performing loans ratio (table 4.3.) justify our interrogation about the effect of the sale of services on banks' behaviour. One of the main results of our theoretical model cannot be rejected empirically : a strategy aiming at further increasing the sale of services implies a higher risk borne by banks on their loan portfolio.

The capital ratio impact on default risk is negative and significant for France and Germany, and its effect on credit risk is positive and significant for Ireland, the Netherlands and the U.K.. For the other seven countries, the effect of the variable on risk is not significant.

An increase in the risk-free rate implies higher credit risk in four of the twelve countries (France, Italy, the Netherlands and the U.K.), and implies a lower credit risk in other four countries (Denmark, Greece, Ireland, and Luxembourg). The effect of this variable is therefore ambiguous. In Ireland, we find that an increase in the capital ratio implies higher credit risk whilst an increase in the risk-free rate implies a lower credit risk, which is in contrast with the findings from our theoretical model.

Table 4.3. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Δ (Non Performing Loans / Gross Loans) [a,b]

	Constant	Δ Com and Fees (+1)	Capital	Personnel Expenses	3-month Tr. Bill	Mean of NPL	GDP growth rate	Log TA	Adjusted R^2	Observa-tions
Denmark		2.516 (3.611)***	-0.272 (-3.013)**	-2.229 (-4.555)***	-0.005 (-0.466)	-0.001 (-0.280)	-0.386 (-2.295)**	-0.002 (-2.511)	0.90	30
France		0.226 (14.19)***	-0.024 (-1.871)*	-0.358 (-6.259)***	0.030 (7.138)***	0.0001 (9.873)***	-0.090 (-15.28)***	0.002 (2.432)**	0.95	383
Italy		0.358 (12.76)***	0.031 (2.186)**	0.650 (8.085)***	0.161 (24.45)***	0.003 (19.32)***	0.528 (16.40)***	0.007 (7.093)***	0.90	364

(continued on next page)

[a] Figures in parentheses are the t-statistics, asterisks (***), (**) and (*) indicate respectively significance at the 1%, 5% and 10% levels.
[b] All regression estimates are heteroskedastic consistent and are based on the revised covariance estimate of White (when relevant).

The proxy for screening cost has the expected significant positive effect on risk in four countries, Germany, Luxembourg, the Netherlands and the U.K.. However in four countries the proxy has a negative and significant impact. As we have seen in section 4.2., we should be very careful about our empirical results concerning this variable as it may not well measure the cost of screening.

We then consider the control variables.

Only in France does the coefficient for the bank size variable have the negative and significant expected sign. This result can be interpreted as a lack of diversification in our sample. According to the "too-big-too-fail" argument, we may also argue that largest banks have an incentive to take on more risk to take advantage of higher expected returns.

In Denmark, Ireland, Italy, the Netherlands, Spain, and the U.K., the GDP growth rate variable has a negative and significant impact on credit risk. The GDP growth rate has a positive and significant impact on credit risk in France, however we should notice that when we use a more appropriate measure of default risk, that is the ratio of non performing loans to gross loans (table 4.3.) we find the expected negative sign.

With regard to the final control variable, that is the mean of the ratio of loan loss provisions to gross loans, the coefficient of the variable is positive and significant for five of the twelve countries. The sign is negative for France and the U.K., but once more if we consider the non performing loans ratio (we have this information for France, but not for the U.K.) an increase in the mean of the ratio of non performing loans to gross loans implies the expected increase in credit risk.

4.4. Conclusion

Our objective, in this chapter, was to carry out an empirical test of our theoretical model focusing on its major implications. We have therefore conducted an analysis which studies on the one hand the link between the loan rate and service revenue, and on the other hand the link between credit risk and service revenue.

In section 4.2., we tested our hypothesis that loans are used as a "calling product" in order to capture clients so that services can be sold to earn commissions and fees. Our pooled estimations, on a set of twelve European countries all belonging to the European Union and over the period 1989-1999, do not reject our result that banks decrease their lending rate as they expect to increase their service revenue. This result, in line with the one of Drucker and Puri (2002)[8], therefore supports our theoretical result of cross-selling. Loans may be used as a mean to compete as loss leaders for clients in the banking industry.

Then, in section 4.3., our purpose was to assess a change in the strategy of banks with regard to the risk they take. The results found with the ratio of non performing loans to gross loans (that we have for a limited number of countries) support the results found with the other credit risk proxy, that is the ratio of loan loss provisions to gross loans. Therefore our findings corroborate our theoretical result that when seeking to sell services to potential borrowers, banks have less incentives to screen the loans they may grant, which implies an increase in default risk. This result may be compared to some of the current literature which aims to empirically assess the effect of a change in the income statement structure of banks (Kwan, 1998, De Young and Roland, 2001, Acharya *et al.*, 2002, Stiroh, 2002a). Indeed in these studies, it is shown that commission and fee-based activities increase the volatility of banks' revenue and banks'

[8] These authors are mentioned in chapter 1. They empirically study the possibility of tying contracts when commercial or investment banks supply underwriting activity. Using qualitative econometrics, the authors aimed to underline cross-subsidisation between the underwriting and lending activities. They also show that commercial banks decrease their lending rate in order to get underwriting.

earnings. In other words, service activity does not imply lower risk for banks. Therefore our theoretical and empirical findings supports the belief that diversification[9] is not necessarily beneficial in terms of risk reduction in the banking industry.

[9] The question on the benefit of bank diversification has been raised for some time. Saunders and Walter (1994), for example, review eighteen studies that examine whether non bank activities reduce bank holding company risk, and conclude that nine answer yes, six answer no, and three provide mixed results.

Appendix A. Descriptive Statistics

Table 4.4. Mean and standard deviation of interest revenue on total earning assets

		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	Mean	0.097	0.097	0.097	0.096	0.079	0.074	0.072	0.068	0.065	0.084	0.094
	Std dev.	0.013	0.015	0.011	0.020	0.027	0.022	0.017	0.018	0.020	0.091	0.163
Denmark	Mean	0.098	0.124	0.112	0.100	0.097	0.093	0.088	0.083	0.084	0.079	0.064
	Std dev.	0.027	0.033	0.029	0.022	0.020	0.016	0.018	0.018	0.061	0.062	0.048
France	Mean	0.108	0.113	0.113	0.113	0.107	0.090	0.092	0.086	0.089	0.082	0.073
	Std dev.	0.044	0.044	0.039	0.040	0.048	0.051	0.046	0.056	0.089	0.056	0.057
Germany	Mean	0.067	0.073	0.077	0.093	0.087	0.079	0.075	0.067	0.065	0.067	0.056
	Std dev.	0.024	0.030	0.035	0.029	0.024	0.028	0.027	0.031	0.028	0.029	0.021
Greece	Mean	NA	NA	NA	0.129	0.150	0.149	0.129	0.120	0.106	0.109	0.090
	Std dev.	NA	NA	NA	0.026	0.030	0.033	0.030	0.026	0.016	0.021	0.021
Ireland	Mean	NA	NA	NA	0.120	0.096	0.074	0.077	0.075	0.066	0.069	0.057
	Std dev.	NA	NA	NA	0.021	0.040	0.023	0.019	0.015	0.010	0.011	0.007
Italy	Mean	0.101	0.104	0.103	0.112	0.109	0.097	0.105	0.097	0.081	0.067	0.051
	Std dev.	0.018	0.017	0.016	0.018	0.014	0.014	0.012	0.013	0.008	0.009	0.009
Luxembourg	Mean	0.089	0.100	0.095	0.094	0.076	0.067	0.069	0.061	0.061	0.061	0.059
	Std dev.	0.020	0.029	0.025	0.027	0.020	0.021	0.018	0.019	0.023	0.027	0.041
Netherlands	Mean	NA	NA	NA	0.081	0.070	0.064	0.066	0.060	0.068	0.086	0.091
	Std dev.	NA	NA	NA	0.018	0.020	0.018	0.021	0.025	0.021	0.047	0.073
Portugal	Mean	0.130	0.199	0.168	0.152	0.134	0.112	0.095	0.093	0.082	0.074	0.063
	Std dev.	0.028	0.099	0.046	0.028	0.024	0.031	0.024	0.028	0.023	0.013	0.021
Spain	Mean	0.115	0.134	0.137	0.129	0.123	0.097	0.102	0.094	0.077	0.065	0.054
	Std dev.	0.018	0.022	0.024	0.022	0.024	0.011	0.015	0.013	0.029	0.028	0.024
U.K.	Mean	0.111	0.102	0.129	0.108	0.091	0.083	0.094	0.091	0.090	0.111	0.083
	Std dev.	0.018	0.012	0.046	0.042	0.054	0.051	0.047	0.057	0.049	0.092	0.041
Average		0.102	0.116	0.114	0.111	0.101	0.090	0.089	0.083	0.078	0.080	0.070

Appendix B. Capital and risk-free rate derivatives of the lending rate

In our theoretical model, the lending rate takes four different values depending on the market structure and the equilibrium (pure or mixed strategy).

We do not present here the derivative of the lending rate with respect to commissions and fees, and screening cost as they are obvious.

- **Monopoly lending market**

Pure equilibrium

$r = h$

The lending rate is independent of the capital ratio and of the risk-free rate.

Mixed strategy equilibrium

$$r = r_f - t + \frac{1-\theta}{\theta} k.r_f - \frac{1}{\theta}\sqrt{s.k.r_f\left(1-\frac{\theta}{\gamma}\right)}$$

The derivatives of the lending rate with respect to commission and fee revenue on the one hand, and with respect to screening cost on the other hand are both negative.

The derivative with respect to capital is :

$$\frac{\partial r}{\partial k} = \frac{1-\theta}{\theta} r_f - \frac{1}{2\theta}\left[\left(1-\frac{\theta}{\gamma}\right)s.r_f\right]^{-1/2} k^{-1/2}$$

For low values of k the derivative is negative, and then positive.

The derivative with respect to the risk-free rate is :

$$\frac{\partial r}{\partial r_f} = 1 + \frac{1-\theta}{\theta} k - \frac{1}{2\theta}\left[\left(1-\frac{\theta}{\gamma}\right)s.k\right]^{-1/2} r_f^{-1/2}$$

For very low value of r_f the derivative is negative, and then positive.

- **Competitive lending market**

Pure equilibrium

$$\bar{r}_c = r_f - t + \frac{1-\theta}{\theta} k.r_f$$

The derivative of the lending rate with respect to commissions and fees is negative. In this equilibrium, the bank does not screen, therefore the cost of screening does not appear as a determinant of the lending rate.

The derivative with respect to capital is :

$$\frac{\partial r}{\partial k} = \frac{1-\theta}{\theta} r_f$$

The derivative is positive.

The derivative with respect to the risk-free rate is :

$$\frac{\partial r}{\partial r_f} = 1 + \frac{1-\theta}{\theta} k$$

The derivative is positive.

Mixed strategy equilibrium

$$\underline{r}_c = r_f - t + \frac{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f - (\gamma-\theta)s\right]}{2\gamma\theta}$$
$$- \left[\frac{\sqrt{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f - (\gamma-\theta)s\right]^2 - 4\gamma\theta.k.r_f\left[(\gamma-\theta)s + (1-\theta)(1-\gamma)k.r_f\right]}}{2\gamma\theta} \right]$$

An increase in commission and fee revenue or in screening cost implies both a decrease of the lending rate.

The derivative with respect to capital is :

$$\frac{\partial r}{\partial k} = \frac{\gamma(1-\theta)+\theta(1-\gamma)}{2\gamma\theta} r_f$$

$$-\frac{1}{2\gamma\theta}\left[\frac{2\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f-(\gamma-\theta)s\right]r_f\left(\gamma(1-\theta)+\theta(1-\gamma)\right)-4\gamma\theta r_f\left[(\gamma-\theta)s+4(1-\gamma)(1-\theta)kr_f\right]}{\sqrt{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f-(\gamma-\theta)s\right]^2-4\gamma\theta.k.r_f\left[(\gamma-\theta)s+(1-\theta)(1-\gamma)k.r_f\right]}}\right]$$

For low values of *k* the derivative is negative, and then positive.

The derivative with respect to the risk-free rate is :

$$\frac{\partial r}{\partial k} = 1+\frac{\gamma(1-\theta)+\theta(1-\gamma)}{2\gamma\theta} k$$

$$-\frac{1}{2\gamma\theta}\left[\frac{2\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f-(\gamma-\theta)s\right]k\left(\gamma(1-\theta)+\theta(1-\gamma)\right)-4\gamma\theta k\left[(\gamma-\theta)s+4(1-\gamma)(1-\theta)kr_f\right]}{\sqrt{\left[\left[\gamma(1-\theta)+\theta(1-\gamma)\right]k.r_f-(\gamma-\theta)s\right]^2-4\gamma\theta.k.r_f\left[(\gamma-\theta)s+(1-\theta)(1-\gamma)k.r_f\right]}}\right]$$

For very low value of r_f the derivative is negative, and then positive.

In the next table, we summarise the impact on the lending rate of the different variables (we do not take into account here that their increase could change the incentives of banks with regard to low risk and high risk equilibrium).

	Monopoly lending market		**Competitive lending market**	
	pure equilibrium	mixed equilibrium	pure equilibrium	mixed equilibrium
t	↘	↘	↘	↘
s	↘			↘
k	↘ or ↗	↗	↘ or ↗	
r_f	↘ or ↗	↗	↘ or ↗	

Whenever the cell is blank means that the variable does not influence the setting of the lending rate.

Appendix C. Tests for poolability

We were able to compute only the test H_0^3 ($y_{i,t} = \alpha + \beta x_{i,t} + \varepsilon_{i,t}$ ≠ $y_{i,t} = \alpha_i + \beta x_{i,t} + \varepsilon_{i,t}$). We present here the results for H_0^3, which tests for :

Test H_0^3 : $\alpha_i = \alpha \quad \forall i \in [1, N]$ against $\alpha_i \neq \alpha \quad \forall i \in [1, N]$

Table 4.5. Fischer test results for poolability

Country	**Fischer test**	**Fischer table** (1 % level)	**Result**
Belgium	11.06	1.95	Panel Data
Denmark	3.229	1.76	Panel Data
France	2.905	1.53	Panel Data
Germany	6.678	1.53	Panel Data
Greece	3.357	2.82	Panel Data
Ireland	30.65	2.63	Panel Data
Italy	3.282	1.53	Panel Data
Luxembourg	3.436	1.76	Panel Data
Netherlands	3.372	1.86	Panel Data
Portugal	2.198	1.86	Panel Data
Spain	2.206	1.86	Panel Data
U.K.	9.873	1.76	Panel Data

Results show that the hypothesis H_0^3 is rejected at the 1% level for the twelve countries. Therefore we will use panel regression for our sample.

Appendix D. Specification : Hausman test

Table 4.6. Hausman test results

Country	**Hausman test** (4 d.f.)	**P-value**	**Result**
Belgium	46.28	0.000	Fixed effects
Denmark	10.97	0.027	Fixed effects
France	0.05	0.99	Random effects
Germany	1.187	0.88	Random effects
Greece	11.31	0.023	Fixed effects
Ireland	7.427	0.115	Random effects
Italy	15.69	0.003	Fixed effects
Luxembourg	6.67	0.154	Random effects
Netherlands	0.02	0.99	Random effects
Portugal	1.397	0.85	Random effects
Spain	2.82	0.59	Random effects
U.K.	0.2688	0.99	Random effects

Appendix E.1. Diagnostic test against heteroskedasticity

Table 4.7. White test results

Country	White test	Nb of expla. var. k	Chi-2 table	Result
Belgium	213	4	9.49	heteroskedasticity
Denmark	194	4	9.49	heteroskedasticity
France	0.91	4	9.49	homoskedasticity
Germany	985	4	9.49	heteroskedasticity
Greece	61	4	9.49	heteroskedasticity
Ireland	61	4	9.49	heteroskedasticity
Italy	878	4	9.49	heteroskedasticity
Luxembourg	255	4	9.49	heteroskedasticity
Netherlands	224	4	9.49	heteroskedasticity
Portugal	0.34	4	9.49	homoskedasticity
Spain	1.18	4	9.49	homoskedasticity
U.K.	3.30	4	9.49	homoskedasticity

Appendix E.2. Diagnostic test against correlation

Table 4.8. Durbin Watson test results

Country	DW test	DW table (lower bound)	Result
Belgium	0.65	1,8338	+ correlation
Denmark	1.54	1,8338	+ correlation
France	1.20	1,9076	+ correlation
Germany	1.15	1,9076	+ correlation
Greece	1.17	1,8338	+ correlation
Ireland	2.07	1,8338	no correlation
Italy	1.31	1,8862	+ correlation
Luxembourg	0.80	1,8338	+ correlation
Netherlands	0.57	1,8338	+ correlation
Portugal	1.63	1,8338	+ correlation
Spain	0.73	1,8338	+ correlation
U.K.	1.29	1,8338	+ correlation

Appendix F. Lending rate analysis : Sub-period 1997 - 1999

Table 4.9. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Interest Revenue / Total Earning Assets [a,b]

	Constant	Com and Fees (+1)	Capital	Personnel Expenses	3-month Tr. Bill	Adjusted R^2	Observa-tions
Belgium		-0.565 (-7.873)***	0.001 (11.44)***	6.017 (79.19)***	0.464 (7.875)***	0.89	70
Denmark		-1.848 (2.112)*	0.030 (0.195)	3.311 (2.610)**	1.248 (9.679)***	0.86	27
France	-0.011 (-0.346)	-0.112 (-1.688)*	-0.004 (-0.316)	0.020 (0.080)	1.167 (1.149)	0.15	389
Germany	-0.011 (-0.586)	-0.812 (-9.274)***	0.004 (2.959)***	1.520 (11.39)***	0.972 (1.844)*	0.83	204
Greece		0.128 (5.522)***	-0.074 (-3.520)***	-0.273 (-0.248)	0.009 (0.099)	0.91	26
Ireland	0.033 (4.047)***	-1.908 (-2.761)***	0.187 (2.207)**	1.599 (2.365)**	0.327 (3.384)	0.82	33

(continued on next page)

[a] Figures in parentheses are the t-statistics, asterisks (***), (**) and (*) indicate respectively significance at the 1%, 5% and 10% levels.
[b] All regression estimates are heteroskedastic consistent and are based on the revised covariance estimate of White (when relevant).

Table 4.9. Panel estimation results with GLS or LSDV. 1989-1999. Dependent variable: Interest Revenue / Total Earning Assets *(continued)*

	Constant	Com and Fees (+1)	Capital	Personnel Expenses	3-month Tr. Bill	Adjusted R^2	Observa-tions
Italy		-0.200 (-9.493)***	0.001 (0.317)	3.097 (195;5)***	0.475 (105.9)***	0.89	192
Luxembourg	-0.013 (-0.854)	-0.190 (-0.360)	0.032 (2.120)**	-0.557 (-0.494)	0.271 (0.783)	0.81	112
Netherlands	0.008 (0.480)	0.059 (0.273)	0.018 (3.002)	-0.147 (-0.324)	0.164 (0.372)	0.46	111
Portugal	0.019 (1.062)	-0.695 (-1.467)	0.083 (3.260)***	0.811 (1.706)*	0.708 (2.127)**	0.63	56
Spain	0.015 (1.413)	-0.551 (-3.212)***	0.027 (1.065)	0.516 (0.962)	1.088 (8.699)***	0.87	70
U.K.	-0.032 (-0.829)	-0.266 (-1.741)*	-0.006 (-0.519)	1.624 (6.581)***	1.258 (2.257)**	0.80	82

Appendix G. Descriptive Statistics

Table 4.10. Mean and standard deviation of the ratio loan loss provisions to gross loans

		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium	Mean	0,006	0,001	0,007	0,009	0,011	0,009	0,014	0,009	0,009	0,009	0,005
	Std dev.	0,004	0,010	0,005	0,005	0,006	0,016	0,033	0,011	0,017	0,014	0,018
Denmark	Mean	NA	NA	NA	NA	NA	0,089	0,015	0,009	0,005	0,006	0,005
	Std dev.	NA	NA	NA	NA	NA	0,147	0,007	0,004	0,003	0,005	0,002
France	Mean	NA	NA	NA	0,030	0,031	0,021	0,024	0,021	0,018	0,015	0,008
	Std dev.	NA	NA	NA	0,022	0,033	0,025	0,042	0,044	0,051	0,025	0,013
Germany	Mean	NA	NA	NA	0,013	0,013	0,016	0,013	0,017	0,011	0,017	0,005
	Std dev.	NA	NA	NA	0,014	0,027	0,038	0,059	0,085	0,022	0,028	0,024
Greece	Mean	NA	NA	NA	0,016	0,030	0,027	0,015	0,011	0,013	0,013	0,016
	Std dev.	NA	NA	NA	0,002	0,041	0,043	0,021	0,005	0,009	0,007	0,009
Ireland	Mean	NA	NA	NA	0,015	0,010	0,006	0,003	0,003	0,004	0,003	0,003
	Std dev.	NA	NA	NA	0,003	0,005	0,005	0,002	0,002	0,005	0,003	0,003
Italy	Mean	0,010	0,010	0,009	0,005	0,017	0,014	0,014	0,012	0,013	0,012	0,009
	Std dev.	0,008	0,009	0,008	0,005	0,019	0,012	0,011	0,011	0,009	0,009	0,007
Luxembourg	Mean	0,018	0,021	0,017	0,014	0,012	0,000	0,004	0,002	0,003	0,007	0,003
	Std dev.	0,036	0,034	0,020	0,022	0,018	0,020	0,010	0,012	0,018	0,006	0,016
Netherlands	Mean	0,005	0,007	0,006	0,008	0,009	0,009	0,005	0,005	0,004	0,009	0,005
	Std dev.*	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Portugal	Mean	0,030	0,038	0,028	0,020	0,020	0,015	0,011	0,010	0,003	0,007	0,009
	Std dev.*	0,000	0,001	0,001	0,001	0,000	0,000	0,000	0,000	0,003	0,000	0,000
Spain	Mean	0,008	0,007	0,011	0,014	0,016	0,012	0,009	0,007	0,005	0,004	0,003
	Std dev.	0,002	0,001	0,002	0,004	0,006	0,005	0,003	0,002	0,001	0,005	0,001
U.K.	Mean	0,034	0,019	0,026	0,023	0,012	0,010	0,007	0,006	0,008	0,018	0,009
	Std dev.	0,235	0,043	0,047	0,072	0,088	0,018	0,010	0,014	0,008	0,304	0,040
Average		0,016	0,015	0,015	0,015	0,016	0,019	0,011	0,009	0,008	0,010	0,007

* The standard deviation is not equal to zero, but its value is very small.

Note : for Germany, the Netherlands and Portugal the information for gross loans is not available, therefore we have deflated the loan loss provisions by the total of loans. The total of loans is net of loan loss reserves.

Table 4.11. Mean and standard deviation of non performing loans on gross loans

		1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Denmark	Mean	NA	NA	NA	NA	NA	0,043	0,034	0,022	0,017	0,012	0,010
	Std dev.	NA	NA	NA	NA	NA	0,023	0,019	0,010	0,008	0,006	0,005
France	Mean	NA	NA	NA	0,100	0,171	0,170	0,154	0,182	0,133	0,131	0,082
	Std dev.	NA	NA	NA	0,036	0,102	0,160	0,156	0,223	0,200	0,203	0,107
Italy	Mean	0,045	0,039	0,040	0,036	0,057	0,067	0,067	0,082	0,081	0,083	0,075
	Std dev.	0,037	0,033	0,033	0,036	0,058	0,059	0,048	0,055	0,053	0,055	0,049
Average					0,068	0,114	0,093	0,085	0,095	0,077	0,075	0,056

Appendix H. Correlation coefficients between GDP growth rate and yearly mean of the ratio of loan loss provisions to gross loans (calculated only with the largest banks)

	Correlations between GDP growth rate and mean of provisions
Belgium	-0.817
Denmark	-0.613
France	-0.272
Germany	-0.109
Greece	0.021
Ireland	-0.594
Italy	0.421
Luxembourg	-0.247
Netherlands	-0.586
Portugal	-0.609
Spain	-0.889
U.K.	-0.886

Appendix I. Correlation coefficients between GDP growth rate and yearly mean of the ratio of non performing loans to gross loans (calculated only with the largest banks)

	Correlations between GDP growth rate and mean of NPL
Denmark	-0.198
France	-0.433
Italy	0.678

Appendix J. Tests for poolability

Table 4.12. Fischer test results for poolability

Country	**Fischer test**	**Fischer table** (1 % level)	**Result**
Belgium	5.654	1.95	Panel Data
Denmark	2.530	1.76	Panel Data
France	5.761	1.53	Panel Data
Germany	3.335	1.53	Panel Data
Greece	3.163	2.82	Panel Data
Ireland	3.417	2.63	Panel Data
Italy	4.295	1.53	Panel Data
Luxembourg	2.655	1.76	Panel Data
Netherlands	3.297	1.86	Panel Data
Portugal	1.919	1.86	Panel Data
Spain	3.328	1.86	Panel Data
U.K.	2.786	1.76	Panel Data

Appendix K. Specification : Hausman test

Table 4.13. Hausman test results

Country	**Hausman test** (7 d.f.)	**P-value**	**Result**
Belgium	2.30	0.59	Random effects
Denmark	23.12	0.001	Fixed effects
France	14.47	0.02	Fixed effects
Germany	1.20	0.84	Random effects
Greece	0.02	0.99	Random effects
Ireland	19.99	0.005	Fixed effects
Italy	190	0.000	Fixed effects
Luxembourg	114	0.000	Fixed effects
Netherlands	40.40	0.000	Fixed effects
Portugal	0.05	0.99	Random effects
Spain	2.63	0.54	Random effects
U.K.	430	0.000	Fixed effects

Appendix L.1. Diagnostic test against heteroskedasticity

Table 4.14. White test results

Country	White test	Nb of expla. var. k	Chi-2 table	Result
Belgium	3.36	7	14.1	homoskedasticity
Denmark	233	7	14.1	heteroskedasticity
France	993	7	14.1	heteroskedasticity
Germany	594	7	14.1	heteroskedasticity
Greece	38.76	7	14.1	heteroskedasticity
Ireland	10.58	7	14.1	homoskedasticity
Italy	662	7	14.1	heteroskedasticity
Luxembourg	216	7	14.1	heteroskedasticity
Netherlands	196	7	14.1	heteroskedasticity
Portugal	185	7	14.1	heteroskedasticity
Spain	294	7	14.1	heteroskedasticity
U.K.	5.15	7	14.1	homoskedasticity

Appendix L.2. Diagnostic test against correlation

Table 4.15. Durbin Watson test results

Country	DW test	DW table (upper bound)	Result
Belgium	1.944	1.8769	no
Denmark	1.987	1.8769	no
France	2.039	1.9244	no
Germany	1.970	1.9076	no
Greece	1.981	1.8769	no
Ireland	1.945	1.8769	no
Italy	1.955	1.9081	no
Luxembourg	1.924	1.8769	no
Netherlands	1.912	1.8769	no
Portugal	1.989	1.8769	no
Spain	1.979	1.8769	no
U.K.	1.904	1.8769	no

GENERAL CONCLUSION

In this thesis, we aimed to analyse the determinants of banks' behaviour in the light of the structural reform that occurred in the European banking system in the last two decades. Specifically, this thesis intended to investigate the relationship between the sale of services and banks' incentives relating to their intermediation activity. This has been virtually unexplored in the literature until now. We studied the influence of the increase of commission and fee-based activities on the decisions of banks with regard to loan pricing and credit risk exposure.

Banks can no longer be considered as institutions dealing with intermediation process only. The rise of other activities, to offset the decrease in interest revenue, has sharply affected the definition of banking. This observation led us to raise about a special issue : are there some reasons to think, as banking activity has changed, that the way banks behave with regard to their traditional activity, i.e. intermediation, may be influenced by this evolution ? In other words, the rise of other activities, and more precisely services, may not only be a consequence of the evolution of the environment in which banks compete, but may in turn influence the intermediation activity. Hence, the desire of banks to sell services could lead them to under price-credit to settle a client relationship.

This potential causality had to be investigated. For this purpose, we first needed to understand the price setting of banks with regard to their intermediation activity. We underlined, as determinants of bank margins, risk factors (default risk, interest rate risk and bank risk aversion), market structure variables (market power and size of deposit/loan transactions), and cost considerations (operating cost of loans and deposits, interbank market rate and cost of deposit insurance). Then we stressed, in line with the modern theory of banking, the crucial role of banks in reducing asymmetric information

among borrowers and lenders. This paradigm enabled us to account for risk more accurately. Indeed, as the seminal article of Stiglitz and Weiss (1981) shows, risk is an inherent consequence of the intermediation activity of banks. The level of the lending rate influences the level of the risk of projects undertaken by borrowers. Nevertheless in this literature, potential interactions with products other than loans and deposits are not taken into account as determinants of bank margins. According to Barro and Santomero (1972), Mitchell (1979, 1988), Saving (1979), Fischer (1983), and Whiteshell (1988, 1992) for example, cross-subsidisation may take place between service fees and deposit rates. These authors show that one way to circumvent regulation or taxes is to charge services below cost.

This issue constituted a first support to a potential influence of service production on traditional intermediation, as the former are used to overcome regulation concerning the latter. However in that case, services are subsidised by intermediation which is in contradiction with the fact that an increasing share of the cost of services are now charged to clients (Jacolin and Pasquier, 1995, and De Young and Roland, 2001).

Cukierman (1978) was the first to suggest that the provision of services could affect intermediation activities. Indeed, he emphasised that clients with a higher propensity to buy services could be less rationed than they would otherwise be, and that banks offer lower lending rates when selling services. In that case, clearly, the existence of commission and fee-based activities may modify banks' incentives with regard to their traditional intermediation products. Nevertheless, if the influence of service production on deposit and loan pricing is suggested in Cukierman's contribution, their overall effect with respect to pricing and risk exposure has not been yet analysed.

Given the increase of the share of commission and fee revenue in banks' income statements, the crucial role played by risk and asymmetric information in the banking theory, and finally the potential effect of services on intermediation activities, it appeared important to investigate the link between sale of services and banks' incentives with regard to their traditional activities.

With the support of our theoretical review, the first step towards consideration of the role of services on banks' intermediation decisions was to show empirically that such a link was consistent with stylised facts.

Indeed, bank interest rate margins and their determinants can be considered as indicators that reflect banks' behaviour modifications and their reaction to the changing environment. Hence, our approach was first to review the empirical studies relating to how banks' decisions are affected by the environment in which they compete.

This empirical survey then allowed us, on a second step to go through the various determinants used in the literature to explain banks' behaviour, in order to obtain, as a background, a general empirical explanation of bank margins. The inclusion of services in a general regression model, enabled us to test if they are an additional determinant of bank margins. For this purpose, we studied a set of twelve European countries all belonging to the European Union, and over the period 1989-1999.

The results from our regressions, including the commission and fee variable, showed that the provision of services reduces the interest rate margin. Therefore, in addition to our theoretical review, our preliminary empirical findings justified the theoretical investigation of a link between intermediation activities and commission and fee-based activities.

Our objective was to build a specific framework that would give us the means to properly investigate the influence of the sale of services on banks' incentives, namely the impact of service revenue on their intermediation activity.

For that purpose, we constructed a microeconomic model of the banking firm, within a principal-agent framework, in line with the modern theory of banking. This model allowed us to explore pricing and risk issues related to the sale of services with regard to loans, i.e. to analyse banks' incentives with regard to their intermediation activity. The bank was thus considered as a multi-product firm which sells loans and services.

In our model, adverse selection problems arise because the bank cannot observe the risk of the project undertaken by the firm until it has been screened. And as screening is not costless, the bank has to decide if it engages or not in screening. We then supposed that the bank has the opportunity to sell services only if the firm's project has been successful.

We hypothesised that customers suffer transport and/or switching costs which gives the bank the opportunity to set its price on services above the marginal cost. It is thus profitable for the bank to sell services.

This general framework enabled us to highlight several results, applied to two extreme market structures : monopoly and competitive lending markets.

Our analysis showed that two equilibriums are possible. The pure one implies no screening from banks in which case only high risk projects are undertaken by firms. A mixed strategy equilibrium is also discovered in which projects are screened with a positive probability, implying that low risk projects can also be undertaken by firms.

The inclusion of service provision implies a lower lending rate as a result of the desire of banks to attract new potential clients in order to sell them fee-based products.

Then, lastly, it can be observed that banks' incentives to screen decrease as the lending rate decreases. In other words, the sale of services by banks reduces the incentives of banks to screen as it becomes more profitable to grant a loan, even to fund a risky project, as a result to cross-selling. As a consequence, the probability that banks fund risky projects increases, and then implies a rise in the credit risk borne on banks' balance sheets.

We succeeded in highlighting on the one hand cross-subsidisation between loans and services, and on the other hand an alteration of banks' incentives to screen inducing higher credit risk.

Having shown theoretically that the sale of services implies modifications of pricing and risk exposure, the last step of our thesis was to assess our findings empirically.

We aimed to determine the effects of the sale of services on the lending rate and on credit risk given the theoretical framework developed previously, using the same set of European countries studied before and covering the period 1989-1999.

Firstly, we conducted for each country under study, panel estimations which aimed to assess the effect of the sale of services on the lending rate. This empirical analysis differed from the one carried out previously as our test was derived from our theoretical model, and we directly analysed the impact of commissions and fees on the lending rate. Our results show that we cannot reject our hypothesis that some banks may adopt as a strategy the use of loans as loss leaders in order to gain new borrowers, and therefore new clients for their services. Sub-period analyses allowed us to conclude that this effect is not just a consequence of the deregulation process.

Secondly, we also performed panel estimations in order to assess the impact of commission and fee revenue on the credit risk of banks. Our regressions intended to capture the effect of the sale of services on credit risk resulting from banks' own strategy. Once more, our results cannot reject the strategy that the desire to sell services implies higher default risk for some banks. More precisely, a strategy aiming at further increasing the sale of services implies higher credit risk.

Both our theoretical and empirical investigations prompt us to consider, as an answer to our initial interrogation, that banks do subsidise loans to cross-sell services, and they are therefore willing to accept a higher risk exposure.

Whilst the prudential regulatory framework is under revision (*cf.* New Basel Capital Accord) this issue appears of a particular interest. Indeed we may wonder if regulators should take such cross-selling strategies into account when aiming to control for credit risk.

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