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# **BANK COMPETITION AND MONETARY POLICY IN SWEDEN**

**AUTHORS**

**ALEXANDER HOLCK**

**ANNA LIDBERG**

**SUPERVISOR**

**KLAS FREGERT,**

**ASSOCIATE PROFESSOR**

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## **Abstract**

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This study focuses on how the level of competition in the Swedish mortgage banking industry affects the monetary policy through the transmission mechanism. The level of competition on the Swedish banking market is measured by the use of the Herfindahl-Hirschman Index, which is a structural competition model, and by the use of Panzar-Rosse's H-statistic, a non-structural competition model. The level of competition is found to be closer to perfect competition than to a monopoly market. It is also found that the correlation between concentration and competition is extremely low, why it is concluded that structural and non-structural measures are used to measure quite different things.

There is theoretical divergence whether monetary policy transmission is affected by the degree of bank competition. Time series data is used to test if the monetary policy transmission in Sweden is affected by degree of competition on the domestic banking market. Two different approaches are applied: first, the correlation between the time series of monetary policy shocks and the H-statistics is analyzed. Secondly, bank lending is regressed on the interaction of monetary policy shocks and bank competition. Monetary policy shocks are measured through a VAR-model. The shocks for the variables bank lending, GDP, money supply and the price level are regressed against the H-statistics to find out if the monetary policy transmission into the real economy is affected by the level of bank competition on the Swedish market. None of the approaches suggest that the state of bank competition has had an impact on the transmission of monetary policy over the years 1997-2007.

*Keywords:* Competition, concentration, impulse responses, monetary policy, Panzar-Rosse, Swedish banking sector, transmission mechanism, VAR.

# **1. Introduction**

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The Swedish banking system is dominated by a few large national banks. The four largest banks account for 78 percent of the total market share of mortgage loans to households. The Swedish banking system can thus be said to be quite highly concentrated. However, in some competition models concentration is not explicitly used to calculate the degree of competition, and the question is if the level of competition is correspondingly low in the Swedish banking sector. Also, in the last years, the number of foreign banks expanding their business in Sweden has rapidly increased. It is possible that this development has had an effect on the competition on the Swedish banking market. Following financial market deregulations in the 1980's, the banking industry in many countries experienced mergers, new entries and expansion into new business areas as observed in many other markets. Competition may be expected to change as a result of the liberation of a restricted banking system.

Empirical studies show a controversy about the effect of the level of competition of the banking industry on monetary policy. Theoretically, a market with a low degree of competition would normally imply that the monetary transmission mechanism's interest rate channel works to a lesser extent, than on a market where bank competition is greater. In a perfect market setting, changes in the interest rate as set by the national central bank will lead to similar changes in the mortgage rates to customers set by the banks as well as in other variables that are supposed to be affected by monetary policy, such as GDP, money supply and bank lending to households. There are, however, reasons to believe that changes in those variables will not be as affected by monetary policy shocks if the national banking system is characterized by a high level of concentration, than if the banking system was subject of perfect competition.<sup>1</sup>

## **1.1 Problem Discussion**

Previous research has mainly focused on competition measures based on the level of concentration on the Swedish banking market. While this is an interesting approach and important contribution, it can be misleading to use the level of concentration as a proxy for the level of competition, according to some empirical studies of competition. It is of high importance to measure the level of competition correctly, since the Swedish Competition Authority might take wrong actions otherwise. These possibly incorrect decisions could affect the public or the Swedish banking sector in a negative way.

To see how closely related measures of competition based on concentration and performance measures of competition are in the Swedish banking industry, the level of correlation between the

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<sup>1</sup> Gunji et al. (2009)

two types of measures will be estimated. The chosen measure of competition will estimate the degree of competition by estimating the extent to which changes in input prices are reflected in revenues earned by Swedish mortgage lending banks.

Theoretical studies imply that differences in bank competition can cause variation in economic conditions. Therefore it is of immense importance to analyze what happens to the monetary policy transmission mechanism in an economy, depending on the degree of competition on the national banking market. Rapidly rising housing prices as well as bank lending volumes to households in combination with an exceptionally low policy rate, have led to an increasing debate in Sweden whether this development is sustainable or not. Developments in monetary policy, mortgage rates, lending volumes, house prices and the banking sector seem to be closely tied to each other. A way to take this debate one step further is to analyze if and how the Swedish banking sector, as visibly dominated by a few, large, national players, affects those variables.

We will therefore in this paper test the hypothesis that the level of competition in the Swedish banking sector in terms of mortgage lending is quite distant from perfect competition. We will also assess whether there is a relationship between the state of bank competition and monetary policy in the Swedish economy over the considered time period. Our hypothesis is that the competition has had a certain impact on the transmission of monetary policy.

## **1.2 Problem formulation**

*What is the level of competition in the Swedish mortgage banking sector?*

- *What are the developments experienced in the Swedish banking sector from a concentration point of view during the last decades?*
- *Is the degree of competition in the Swedish mortgage banking sector characterized by a monopoly or rather by perfect competition?*

*Does the calculated level of competition affect the monetary policy transmission mechanism to the economy?*

- *How does monetary policy affect the real economy?*
- *Is the transmission of monetary policy in Sweden affected by the degree of competition in the banking sector?*

## **1.3 Purpose**

This study aims to investigate the annual level of competition in Sweden, and how this level of competition affects the effects of monetary policy shocks to the real economy.

## **1.4 Disposition**

The paper is divided in three major parts. Part I, consisting of two chapters, will start with a brief empirical description of the banking sector in Sweden, both in an historical way as well as its current status, followed by theory regarding competition. This chapter will discuss similarities and differences between two different methods of measuring competition and provide a theoretical background; predominantly for the theory of the Panzar-Rosse model and then a brief overview of the so called Boone indicator. These are our two chosen non-structural competition models. The degree of competition is estimated through the use of three commonly applied concentration measures which are our structural competition models.

Part II will theoretically discuss of the efficiency of monetary policy. We will present the, for monetary policy, so crucial transmission mechanism, through which policy changes affect the real economy. An important channel of this mechanism is the interest rate channel, why we will pay this topic some special attention. The last subsections of part II will present empirical evidence of how monetary policy shocks affect the economy if characterized by a concentrated or competitive banking sector respectively.

In the two first chapters of part III, we will conduct our tests. In the first chapter, the level of competition will be estimated by the use of the Panzar-Rosse model in the fifth section. The so called H-statistic will be calculated with a regression model and also the HHI-value. The second chapter will regress this measure of competition against the monetary policy shocks obtained by a VAR impulse response function. In the final chapter of part III, the results will be presented and discussed. Here we will be able to draw conclusions on the degree of competition on the Swedish banking market and if there is a relationship between bank competition and monetary policy shocks.



# **PART I. COMPETITION AND THE SWEDISH BANKING SECTOR**

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Part I will start with a description of the banking sector in Sweden, followed by a presentation of empirical and theoretical measures of competition.

## **2. The Banking Sector in Sweden**

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The Swedish banking sector, as well as the conditions for the banks and the terms of banking, has changed drastically since the 1980's. Though this study focuses on the developments after 1993, it is still important to bear in mind what happened prior to this in Sweden to fully understand our findings and results in the latter sections. This section will therefore initially describe the development in the Swedish banking sector since 1980 up till today. Here we will cover how regulations for lending changed in the middle of the 1980's, as well as what happened for many banks in the aftermath of the economic crisis in 1992. Finally, empirical evidence of the impact of competition on the Swedish banking market will be presented.

### **2.1 Development in the Swedish Banking Sector since 1980**

#### **2.1.1. Structure**

The Swedish banking market consists of several actors of various size. The structure of the market, however, has changed substantially over the last years. In particular, the number of smaller banks has increased and their market share has grown accordingly at the expense of the larger actors' market shares. The banking market of today is nonetheless dominated by four large domestic banks; SEB, Svenska Handelsbanken, Swedbank and Nordea. The largest international bank is Danske Bank, which was successfully established on the Swedish market in 1997 with the acquisition of Östgöta Enskilda Bank and the establishment of so called *province banks*. Many of the Swedish banks have a long history. Nordea, for example, was established almost 200 years ago and is today the largest bank in Scandinavia. The Swedish part of Nordea is the result of the fusion of Nordbanken and PK-banken, which in turn were results of earlier fusions of smaller banks throughout the years. In 1998, Nordbanken and Finnish Merita Bank formed MeritaNordbanken. The new constellation merged in 2000 with Danish Unidenmark and Norwegian Christiania Bank og Kreditkasse. The concern changed its name to Nordea in 2001.

SEB's history starts almost 150 years ago, with the founding of Stockholms Enskilda Bank and Skandinaviska Banken. The two banks merged in 1972 to Skandinaviska Enskilda Banken, which

later became SEB in 1998. The bank of today has an international profile with offices in New York, London, Singapore, Ukraine, Poland, Russia and the Baltic countries.

Handelsbanken was founded in 1871 and is a result of various acquisitions in the beginning of the 20th century. Swedbank also originate from the early 19th century, when the first savings banks, so called sparbanker, were formed in Sweden. The concept of Sparbanker quickly became popular, and at the most there were 498 sparbanker in the country in 1928. To earn market shares, however, the banks soon started to merge and when Sparbanken Sweden was founded in 1990, only 90 single sparbanker stayed outside the new bank. In 1997, Sparbanken and Föreningsbanken merged into Föreningsparbanken. The bank changed name to Swedbank in 2006.

One trend observed is that the home market has grown for these four large Swedish banks. Through acquisitions and fusions, the banks have become increasingly more Nordic than pure Swedish. The home market thus includes Norway, Denmark, Finland and the Baltic countries. The development has continued when, for example, Danske Bank as the second largest bank in the Nordics bought Finnish Sampo Bank. With the changing market structure, numerous new actors have entered the Swedish markets in the last decades, for example Länsförsäkringar Bank, ICA Banken and Skandiabanken.<sup>2</sup>

### **2.1.2. Regulations and Deregulations**

Historically, the banking sector in Sweden has been characterized by a very high level of regulations. The idea behind the regulations was not only to guarantee the stability of the banking system – this idea was mainly imposed after the banking crisis in 1992 – but also to control deposits and lending, as well as the interest rates in the way the government desired. The legal framework was comprehensive, precise and allowed politicians to steer the banking activity to a large extent. From the late 1970's till the beginning of the 1990's, the conditions for bank regulations changed drastically. Deregulations were a fact and the reasons behind these were numerous.

One of the reasons to deregulate the market originated as integration on the international financial markets quickly increased. At the same time, many new financial derivatives were introduced on the market which made some of the existing regulations, for example price and quantity rules, inoperative. The EC early started to remove European regulations, why the Swedish government sped up the deregulations as an adjustment to meet the new European market conditions.

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<sup>2</sup> Svenska Bankföreningen (2007)

The Swedish sovereign debt also increased during those years. The National Debt Office was limited by existing rules and not allowed to borrow as much money as needed. Increasingly, the downside of the regulations became obvious. A contractionary monetary policy, for example, could imply a severe credit crunch where companies with strong accounts could invest while the credit stop quickly hit smaller and indebted companies.

The deregulation process was initiated in 1978, when banks initially were allowed to set the deposit rates without government involvement. In 1985, the lending rates were set free. This year also saw the credit grant being liberalized, with an abolishment of the lending roof. The new lending rules in the end led to a lending boom in Sweden, one of the reasons for the eventual economic crisis in the early 1990's. The boom has later been explained as a result of the banks not being used to set market interest rates nor to judge a normal level of credit grant to customers. In the 1980's, also the bond and money markets went through large reforms, and the exchange market was finally deregulated in 1989.

One of the latest deregulations took place in 2004, when the rules for being classified as a bank on the deposit market were changed. The new Basle II regulations from 2007, and the upcoming Basle III amendments, however, represent a growing urge to return to a more regulated market in the wake of the last years' financial crisis. The new Basle rules impose a higher capital cover ratio than many of the banks possess today. The banks' solidity should be strengthened with the new rules, an adjustment that has been advocated to constitute stability in the somewhat damaged financial system of today.<sup>3</sup>

### **2.3 Competition on the Swedish Banking Market and the Entry of Foreign Banks – Empirical Evidence**

There is less customer mobility in the Nordic banking retail markets than there is in other countries.<sup>4</sup> Before the financial crisis in 2008 many of the Swedish banks had made substantial investments in other neighboring countries, both in the other Nordic countries and in the Baltic States. Between 1993 and 2006, 22 banks entered the Swedish retail market while seven of these left the market during the same period. In terms of increased market shares, Danske Bank is the bank that has performed best of the entry banks. Another trend in recent years has been the emergence of new small players. Some of these new small banks offer only selected services while others offer a full range of bank services. Despite the new developments in the Nordic bank sector, concentration remains high. New banks have been established, but whether this development will

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<sup>3</sup> Svenska Bankföreningen (2007)

<sup>4</sup> Aspinen et al. (2006)

mean lower prices for the consumers is yet to be seen. Consumer's preferences are not only related to prices and charges, but also in a high degree to reputation and convenience.

According to Deutsche Bank Research, the banking systems of the Nordic countries are very highly concentrated.<sup>5</sup> During the latter period of 1995-2004, the largest Swedish banks started to lose market shares. It seems likely that this is due to increased competition. The market share of the five largest Swedish banks was just below 60 percent during the time of 1994-2003. This is about 20 percent above the EU average. In 2003, the Nordic banks had higher returns on assets and high net interest margins compared to many other European countries. Productivity has increased among the Swedish banks during 2001-2006, possibly because of increased competition.

The Swedish banking crisis started in the beginning of the 1990's and also led to an increase in market concentration through mergers and acquisitions.<sup>6</sup> The four largest Swedish banks had a market share of 80 percent in 2007, compared to 85 percent in 1995 and 70 percent in 1990. At the same time, the large banks extended their activities to incorporate pension and life insurances. Insurance companies expanded in the other direction and started to conduct banking activities. The technical developments made it easier for smaller actors to compete since a national coverage of banking offices was no longer necessary as these services could be provided over the phone or over the internet. Additionally, this development made it easier for banks to increase their efficiency by cutting costs. The decomposition of bank sizes was also changed during the 1990's. Instead of the previous middle sized banks the market structure changed to an increasing amount of very large banks and small niche banks.

The deregulation of the Swedish banking market led to an increased number of niche banks and an increased presence of foreign banks.<sup>7</sup> Foreign banks have been allowed to open branch offices in Sweden since 1990. One of the reasons for the high level of mergers between Swedish banks was the increased competition from foreign banks. During this period the number of foreign banks on the Swedish market increased. These foreign banks have established themselves on the Swedish market both by new establishments but also by takeovers. The reasons why more foreign banks haven't yet established themselves on the Swedish market are believed to be that the Swedish banking market is too small for it to be profitable to establish a new bank from scratch, the lack of the euro as national currency and the fact that the market is relatively technically advanced. At the end of 2005, 22 foreign owned branches and subsidiaries were active on the Swedish banking market.<sup>8</sup> The degree of competition for mortgage lending to households has been rather substantial

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<sup>5</sup> Deutsche Bank Research (2004)

<sup>6</sup> The Riksbank (2002)

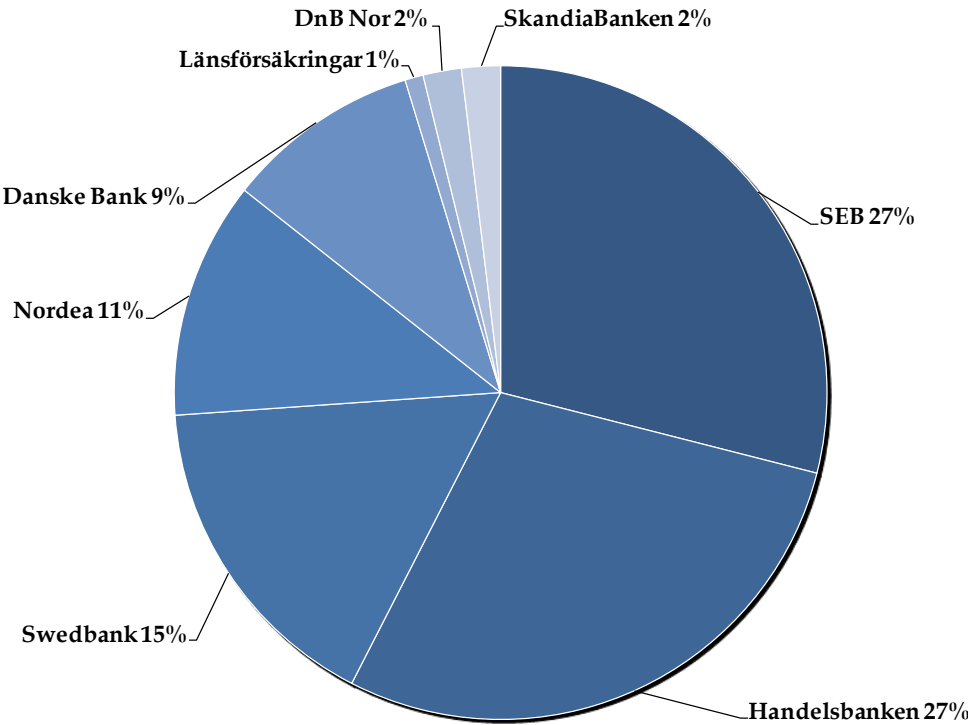
<sup>7</sup> Svenska Bankföreningen (2007)

<sup>8</sup> Danmarks Nationalbank et al. (2006)

in the last few years. The operating profits of the largest banking groups in the Nordic countries have increased significantly in 2004 and 2005. This is due both to tighter cost controls with fewer employees and increased business and asset volumes.

In a study conducted by the Swedish Competition Authority, one of the suggestions to increase the level of competition in the Swedish banking sector was to make it easier for Swedish customers to use foreign banks.<sup>9</sup>

**Figure 2. 1. Market shares of the Largest Banks on the Swedish Mortgage Market in 2009**



Source: Svenska Bankföreningen

<sup>9</sup> Swedish Competition Authority (2009)

### 3. How to Measure Competition

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This section will present theory regarding the measurement of competition and also present some of the most influential models of competition measurement.

There are a number of different ways to measure competition. The problem with the measurement of competition in many industries, and especially in the banking industry, is that there is no public information on for example the costs and profits of individual products. Because of this, competition has to be measured indirectly which makes it considerably more difficult. Also, an important and in many ways not always satisfyingly answered question is just how related different measures of competition are. Hence, the existing measures of competition are all indirect.<sup>10</sup> These measures are divided into structural and non-structural models. The CR<sub>4</sub>, CR<sub>5</sub> and the Herfindahl-Hirschman index (HHI) are examples of a structural model. Examples of non-structural models are the the Panzar-Rosse model, the Boone indicator and the Bresnahan model.

Structural models investigate whether a highly concentrated market causes collusive behavior among the larger banks resulting in greater market performance, and whether it's the efficiency of larger banks that amplifies this performance.<sup>11</sup> These models link competition to concentration. The importance of concentration ratios arises from the fact that they have an ability to capture structural features of a market. Therefore concentration ratios are often used in structural models that explain the competitive performance in the banking industry as the result of market structure. Non-structural models were developed as a reaction to the theoretical and empirical deficiencies of the structural models. These models test competition and the use of market power and focus on the importance of banks' competitive behavior. These models do not use explicit information about the structure of the market (concentration).

Two of the most widely used non-structural measures of competition are the Panzar-Rosse model and the Boone-indicator. In this paper we have chosen to focus on the Panzar-Rosse model as we believe it is more concrete and easier to interpret. The Panzar-Rosse model will enable us to get a value of competition, within a fixed range, for the Swedish banking sector for each year between 1997 and 2007, which is a necessity for the model to measure the effects of monetary policy shocks developed in chapter 6.

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<sup>10</sup> Bikker et al. (2006)

<sup>11</sup> Bikker (2004)

### 3.1. Common problems when measuring competition

#### 3.1.1. Four Problems Identified by Baker

There are four common problems in the measurement of competition.<sup>12</sup> The first problem is the identification of products and competitors, which we here refer to as *the problem of the degree of substitutability*. The method is generally improved when the product is specifically defined, but a precise definition can sometimes be difficult. If there are many substitutes to the given product, the competition is generally high. According to economic theory competition can be high even if there are only rather few companies on the market as long as new companies enter the market as soon as they can make a profit.

The second problem consists of identifying the geographical market, here *the problem of identification*. Which companies that produce the same product and compete on the same market has to be identified. If companies are not in the same market, they cannot be seen as competitors even if they produce identical goods.

Selection of the measurement method of competition is the third difficulty, we call it *the problem of measurement method*. Most studies on competition measures are based either on the number of companies, or on the relative size of the different companies as a measurement of competition. As has been previously mentioned, these measures are measures of concentration and not necessarily ideal measures of competition on that market. In general, more companies on a market is assumed to increase the competition. It is also important that none of the companies has any market power. A market where the companies are about the same size is seen as more competitive compared to one with a few big and some small companies as it limits the market power.

The fourth dilemma is the powers which change traditional competition dynamics. Markets where establishment is difficult will have a lower amount of competition than markets where establishment is easy, here referred to as *the barriers to entry problem*. The threat of entry can be a more important determinant of the degree of competition between market players. The customers' mobility is also important, the question is if they have the energy to look for other options. Horizontal integration in the form of mergers can lower the level of competition. Products that were previously sold separate are now sold as one. Non-profit organizations can also affect the amount of competition. The level of competition will also be affected by governmental regulations, for example license requirements can make it harder for a company to enter a market.

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<sup>12</sup> Baker (2000)

### 3.1.2. Other Potential Problems with Competition Measures

Other theory suggests that performance measures, for example the size of the banking margins of profitability, is not necessarily a good way to measure the competitiveness of a banking system. There are a rather large number of underlying factors that can influence performance measures, an example is a country's macro performance or taxation system. Hence, there is a possibility that these indicators risk to be rather poor in measuring the degree of competition. Instead, the degree of competition within the banking industry should be measured with focus on the actual behavior of the marginal bank.

### 3.2. What to look for in a measure of competition

Claessens and Laeven (2003) find that financial systems receive a higher competitiveness ranking if the entry of foreign banks is greater and market access is unrestricted.<sup>13</sup> No evidence is found to indicate that concentration of the banking system is negatively related to competitiveness. The focus should instead be on contestability to measure the competition in a country's banking sector. This is closely linked to the theory of *potential competition*. Potential competition is the pressure which new and existing firms put on incumbent firms by the possibility of entering a market.<sup>14</sup> If the level of competition is low, the profits are often high and companies will find it profitable to enter the market. If the entry barriers are high, the threat of entry will be lower. According to the theory of potential competition, the threat of entry will have a disciplinary affect the behavior of incumbents.

Leuvensteijn et al. (2007) find that the competition in the banking industry is greatest in Germany and Spain within the EU.<sup>15</sup> It is also shown that competition is most intense between commercial banks because of the competition from foreign banks. There are two ways in which competition can increase within the banking industry. The first case is when entry costs decrease. The second case is when the bank's offered services become closer substitutes.

Increased competition in the financial sector will not necessarily imply lower costs and better efficiency. Instead, it is possible that market power can mean cheaper access to financing. Heavy competition between banks within the industry may even be hurtful to the financial sector performance. If the entry requirements are high, as described in *the barriers to entry problem*, it will decrease the level of competition and lead to lower bank efficiency, higher interest rate margins and increased overhead margins. By restricting foreign bank participation there is a risk of causing bank fragility. Bank efficiency and stability is not determined by the actual level of foreign presence or bank concentration but rather the contestability. In short, it is the threat of entry

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<sup>13</sup> Claessens and Laeven (2003)

<sup>14</sup> Concurrences (2010)

<sup>15</sup> Leuvensteijn et al (2007)



rather than the actual number of the banks present in the industry that increases the level of competition. Competition within an industry can decrease if there are mergers or government regulations like license requirements. The customers also have a responsibility, if the customer mobility is low as it generally is in the Swedish banking sector, the degree of competition will generally be lower.

*The problem of measurement method* can potentially also have a strong effect on the degree of competition. Normally competition is considered to increase if the banks are of similar size. A high concentration can be interpreted as a low degree of competition according to the structural models, while the non-structural models focus less on concentration and more on performance measures. *The problem of the degree of substitutability* will increase if substitute products are hard to define, a banking loan is generally easily defined, but if banks offer cheaper rates when more services are bought in the same bank this might be a problem. Also, potential competitors have become a bit harder to identify in the last years since for example insurance companies have started providing banking services. This relates to the *problem of identification*, which should not be overstated in this context, as most people use banks established in Sweden, either through banking offices or through established subsidiaries.

### **3.3. Structural measures of competition**

The structure of concentration measures can be either discrete or cumulative.<sup>16</sup> Discrete measures are easier to calculate and the data requirements are lower. Users of discrete measures claim that in concentrated markets a few actors dominate the market and the other actors have little effect. Critics on the other hand mean that every bank in a market has a certain influence and that structural changes in the part of the sector cannot be ignored. It is possible that small market players can affect the larger banks behavior.

The number of companies within an industry is the simplest way to measure the degree of concentration. The idea is that more companies on a given market lowers the level of concentration and hence increases the level of competition.

The so called CR<sub>4</sub> or CR<sub>5</sub> concentration indices are the sum of the market share for the four or five largest companies in the specified sector.<sup>17</sup> A problem arises in the arbitrary cut off.

$$CR_{4,5} = \sum_{i=1}^{4,5} s_i \quad \text{Range: } 0 < CR_k \leq 1 \quad (i)$$

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<sup>16</sup> Bikker et al. (2002)

<sup>17</sup> Ibid

The Herfindahl-Hirschman index is the sum of market shares to the power of two for the 50 biggest companies in the industry.

$$HHI = \sum_{i=1}^n s_i^2, \text{ where } s_i \text{ is the market share} \quad \text{Range: } \frac{1}{n} < HHI \leq 1 \quad (\text{ii})$$

HHI gives greater weight to larger banks by squaring the market share of each bank. In the US, HHI is used to decide whether banks have to undergo an investigation ahead of a merger. The post merger HHI cannot surpass 0.18 and the increase in HHI cannot be more than 0.02 for an investigation not to be conducted. There has been substantial criticism against HHI as a measure of competition for a number of reasons. For one thing, it should be noted that different combinations of the number and sizes of banks can give the same HHI value. The value HHI is also sensitive to entrance of new banks. Sometimes HHI can be arguably wrong to use as a measure of competition. If a company lowers its prices, and thereby gains more customers, the value of HHI will increase, even though the level of competition has increased. It is not obvious whether the number of companies or HHI works best as a measure of competition, but HHI is generally better when the companies differ in size.<sup>18</sup>

In some instances however the number of companies within an industry can be closely related to competition. Baker (2000) writes: “For example, some models of medical arms races suggest that hospitals need to adopt new technologies that their competitors’ possess in order to maintain their reputation. In this case, it seems most plausible that the number of competing hospitals with a given technology matters more than their relative sizes.” It is suggested that a use of both HHI and the number of firms in an industry will give the best results on the measure of competition. The study also finds that HHI and the number of firms are highly correlated.

### **3.4. Non-structural measures of competition**

#### **3.4.1. Panzar-Rosse**

Rosse and Panzar (1977) and Panzar and Rosse (1987) have performed some of the most influential studies on non-structural approaches and have also developed a model, the so called Panzar-Rosse model, to measure competition. The model does not translate directly to an econometric form and hence leaves a bit of freedom to the researcher. The P-R model estimates revenue equations by using cross sectional data and assesses competitive behavior in this way. The sum of elasticities of a bank’s total revenues to its input prices provides a measure to test for monopoly against perfect competition. By making some additional assumptions to the model, the

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<sup>18</sup> Baker (2000)

specific level of competition can also be measured, not just whether it's a monopoly market or perfect competition. The most important assumption is that the banking industry equilibrium is most likely to be characterized by a monopolistic competition model.

Firm or bank-level data is used in the P-R model.<sup>19</sup> The model measures the extent to which a change in factor input prices is reflected in (equilibrium) revenues earned by a specific bank. If a bank acts in a monopoly, an increase in input prices will increase marginal costs, reduce equilibrium output, and consequently reduce total revenues. If instead the bank acts on a market where there is perfect competition, an increase in input prices raises both marginal costs and total revenues by the same amount as the rise in costs. The most frequently used dependent variable is a scaled version of bank income which is calculated by revenues divided by total assets.<sup>20</sup> The calculated variable is a proxy for the lending rate or the "price". However, Bikker et al. (2006) use interest income as the dependent variable.

The calculated value of the P-R model is represented by the *H-statistic* which measures the degree of competition within an industry and the value of the H-statistic ranges between  $-\infty$  and 1.<sup>21</sup> A value of 1 constitutes perfect competition, a value of less than 0 a monopoly (in practice the H-statistic will not have a value below 0) and a value between 0 and 1 is an indication of monopolistic competition. The value of the H-statistic can be interpreted as a value of the degree of monopoly power. An assumption is also made that the bank faces a demand with constant elasticity and that it has a Cobb-Douglas technology.

The P-R model has several advantages to other competition models.<sup>22</sup> These are first and foremost that the model uses bank-level data and that it allows for bank-specific differences in the production function. The model also makes it possible to study different types of banks. A disadvantage is that the model assumes that the banking industry is in a long-run equilibrium. Fortunately, there exists a separate test to determine whether this assumption can be made. The model also assumes that the price elasticity of demand is greater than unity as well as a homogenous cost structure. Both the banks and the whole industry are assumed to maximize its profits. In most studies of the European Industry where the Panzar-Rosse model is used, the outcome is monopolistic competition.

Claessens and Laeven (2003) find that the H-statistic generally varies between 0.60 and 0.80.<sup>23</sup> Obviously, this means that monopolistic competition is the predominant form of competition in

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<sup>19</sup> Claessens and Laeven (2006)

<sup>20</sup> Bikker et al (2006)

<sup>21</sup> Claessens and Laeven (2003)

<sup>22</sup> Bikker et al (2006)

<sup>23</sup> Claessens and Laeven (2003)

the surveyed banking sectors. The authors also find that the degree of competition in the banking system increases with the degree of concentration. This is a rather surprising conclusion and indicates that structural and non-structural models of competition are not always highly correlated. Also, if the number of banks is low relative to the population, the competition becomes greater. In order for the P-R model to work, the performance of banks has to be affected by the action of other banks in the market.<sup>24</sup>

The model we have used to calculate the Panzar-Rosse H-statistic is closely based on that proposed by Bikker et al. (2006). However, we have made some modifications when necessary. The biggest difference between the models is that Bikker et al. have used panel data while we have calculated the P-R H-statistic annually, so that we can use the values in the monetary transmission model in chapter 6. There is also support in the literature for our approach.<sup>25</sup>

For the years between 1997 and 2007, the P-R H-statistic is estimated by the use of the following regression, which is an empirical reduced form of bank revenues:

$$\ln II = \alpha + \beta \ln IE/FUN + \gamma \ln PE/TA + \delta \ln ONIE/FA + \eta_1 \ln LNS/TA + \eta_2 \ln ONEA/TA + \eta_3 \ln DPS/F + \eta_4 \ln EQ/TA + \eta_5 OI/II + error \quad (\text{iii})$$

Range:  $-\infty < \text{H-statistic} < 1$

The subscript  $i$  (banks) has been left out for simplicity.<sup>26</sup>

The H-statistic is calculated by summing the coefficients  $\beta$ ,  $\gamma$ , and  $\delta$ . The other variables in the regression model are used as control variables that reflect bank behavior and risk profile which may affect banks' revenues.

- II denotes interest income.
- IE/FUN is the ratio of interest expense to total funds (average funding rate).
- PE/TA is the ratio of annual personnel expenses to total assets (personnel expenses).
- ONIE/FA is the ratio of other non-interest expenses to (modeled) fixed assets (price of capital expenditure).
- LNS/TA is the ratio of customer loans to total assets (credit risk).
- ONEA/TA is the ratio of other non-earning assets to total assets (characteristics of the asset composition).

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<sup>24</sup> Bikker and Haaf (2002)

<sup>25</sup> Vesala (1995)

<sup>26</sup> Bikker et al. (2006)

- DPS/F is the ratio of customer deposits to the sum of customer deposits and short term funding (features of the funding mix).
- EQ/TA is the equity to total assets ratio (leverage reflecting differences in the risk preferences across banks).
- OI/II is the ratio of other income to interest income (banking activities other than financial intermediation).

All models are estimated using ordinary least squares, with White's (1980) heteroskedasticity robust standard errors.

### 3.4.2. Boone Indicator

The Boone indicator measures competition based on firms' profits. The major advantage of the Boone indicator is that it enables the researcher to measure competition on separate product markets like the loan market or a single type of banks, instead of just the whole banking market.<sup>27</sup> Other benefits of the Boone-model is that it requires relatively little data and that it is theoretically robust. The biggest drawback is that the model assumes that banks generally pass on at least part of their efficiency gains to their customers. Also, the possible attractiveness of innovations and differences in offered product quality between banks is not incorporated in the model. Another problem is that the value of the Boone indicator does not have a fixed range. This makes it difficult to use the output in a regression.

The Boone indicator builds on the idea that competition will be beneficial to the most efficient banks while it hurts the worst performing banks. The effects can then be seen in the bank's profits and market shares. A firm's variable profit level is denoted by  $\pi(n)$ , where  $n$  is the efficiency level and the greater  $n$  is the greater the level of efficiency is.<sup>28</sup> Three firms with different efficiency levels denoted  $n'' > n' > n$  are considered, where  $n''$  is the most efficient firm, and the variable  $[\pi(n'') - \pi(n)] / [\pi(n') - \pi(n)]$  is calculated. The idea behind the measure is that the more intense the competition is, the more the value of the calculated variable increases. The reason for this is that the most efficient firm  $n''$  gains more relative to the least efficient firm  $n$ , than what firm  $n'$  does.

The Boone indicator is calculated by the use of the following regression:

$$\ln s_{ilt} = \alpha + \beta \ln mc_{ilt} + \sum_{t=1, \dots, (T-1)} \gamma_t d_t + u_{ilt} \quad (\text{iv})$$

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<sup>27</sup> Leuvensteijn et al (2007)

<sup>28</sup> Boone (2008)

where  $s$  stands for market share,  $mc$  for marginal costs,  $i$  refers to bank  $i$ ,  $l$  to output type *loans*, and  $t$  to year  $t$ ;  $d_t$  is a time dummy and  $u_{it}$  is the *error term*. The coefficient  $\beta$  is the Boone-indicator. The more negative  $\beta$  is the higher the level of competition.

In this section we have reviewed the literature regarding structural and non-structural models of competition. As regards our problem formulation, it seems far from certain that structural and non-structural competition measures are equivalent. We will further assess this question in Part III.

## **PART II. MONETARY POLICY AND BANK COMPETITION**

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This section will thoroughly describe the theory of the monetary policy transmission mechanism, through which monetary policy affects the real economy. The three channels of the transmission will be discussed in the first section of the chapter, followed by how monetary policy shocks and interest rate pass-through are linked to each other. Finally, some empirical evidence on monetary policy shocks and the structure on the banking market are presented and discussed.

### **4. Theory – Monetary Policy**

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The previous section described different ways on how to measure competition on the domestic banking market. Theoretical studies imply that differences in bank competition also can cause variation in economic conditions. One way to analyze those variations is to understand and study the monetary policy transmission mechanism in an economy, showing how developments in monetary policy, mortgage rates, lending volumes, house prices and the banking sector are tied to each other.

#### **4.1. The Monetary Policy Transmission Mechanism**

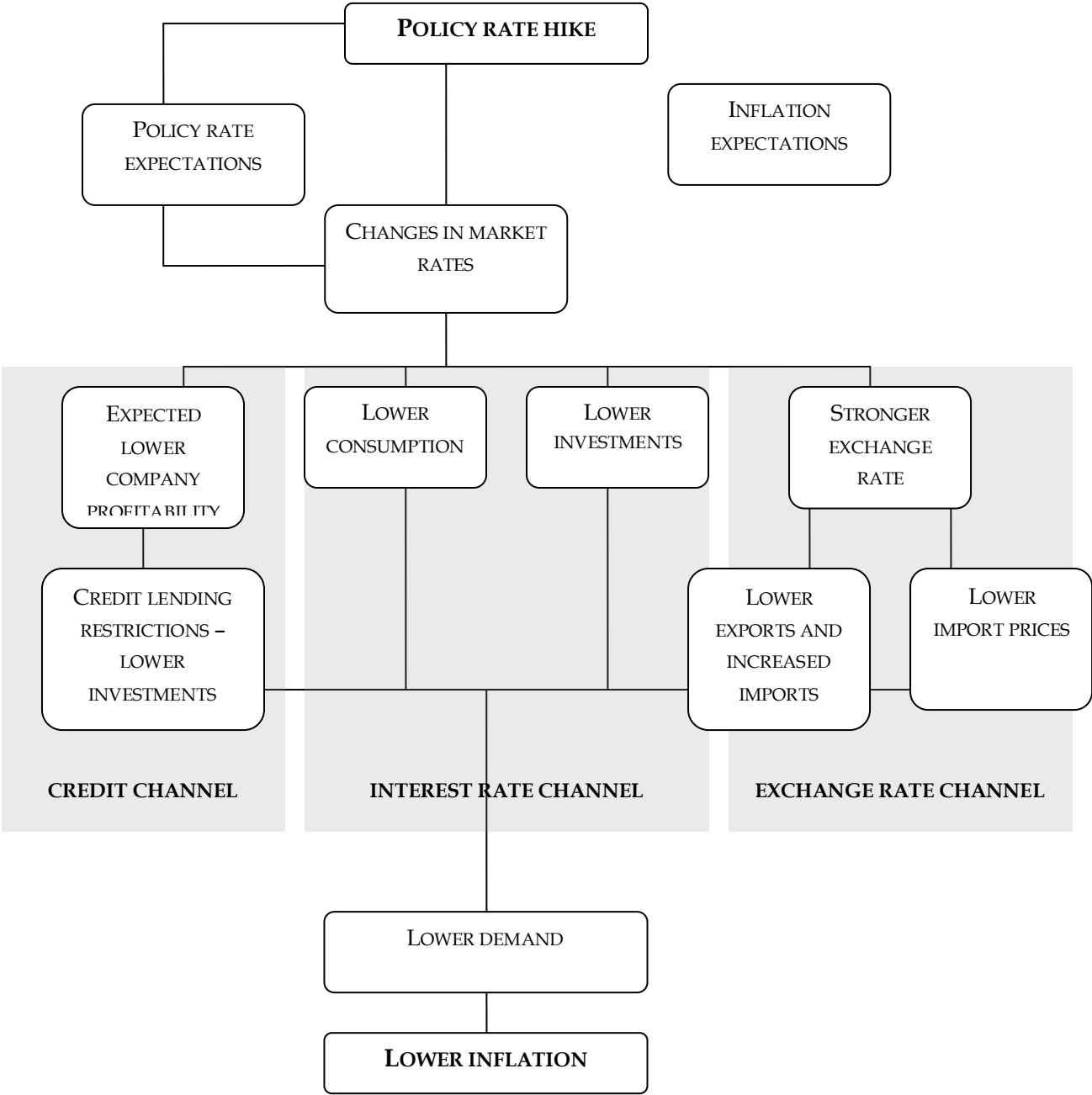
The monetary policy transmission mechanism describes how monetary policy affects the economy, i.e. how changes in the central bank's interest rate influences the real economy. These changes may affect the real economy through consumption, investments and production, as well as inflation in the short run. In the long run, however, the effects of monetary policy are limited. The central bank's first step to affect the economy goes through a hike or cut of the policy rate. This implies that when the Riksbank changes the repo rate, the economy is assumed to be affected through three different channels, so called transmission channels: the interest rate channel, the exchange rate channel and the credit channel (see Figure 4.1.). In practise, it is fairly difficult to make a firm distinction between the three as they are highly linked to each other<sup>29</sup>.

Also, household's and companies' expectations matter for the transmission of monetary policy to the economy. Inflation expectations are for example crucial when households and companies interpret the real rate, on which they base their consumption decisions. If prices and expectations are sticky, a repo rate hike will lead to higher real rates. Those will in turn influence the household's consumption and savings behaviour. It will be more favourable for a household to save when the interest rate is high, and at the same time the lending rate increases why the household will be more reluctant to borrow money. The companies' behaviour is similar: investments are postponed when loans become more expensive. Households' and companies'

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<sup>29</sup> Hopkins et al. (2009a)

**Figure 4. 1. The Monetary Policy Transmission Mechanism**



*Source: The Riksbank*

aversion to consume at a high interest rate will impede the overheated economy, which was the central bank’s aim with the rate hike. This process is called the interest rate channel and will be more closely discussed in the next section<sup>30</sup>.

<sup>30</sup> Hopkins et al. (2009a)



In an open economy with a floating exchange rate regime, monetary policy also affects the real economy through the exchange rate. A policy rate hike normally leads to an appreciation of the exchange rate. This is because a domestic interest rate level higher than the foreign makes it more favourable for investors to invest in domestic financial assets rather than in foreign assets. A strong exchange rate also affects the economy since the nominal exchange rate implies a stronger real exchange rate. Foreign goods will then be cheaper relative to domestic goods, why demand for domestic goods decreases. Inflation also goes down since prices on imported goods decline.

A policy rate change also affects the economy through the credit market, the transmission mechanism's credit channel. A higher repo rate normally leads to a lower present value of financial assets, as well as lower demand for real assets such as mortgages and real estates. This entails lower prices on both financial and real assets, normally used as collateral for loans, why banks become more reluctant to lend when prices decline. Bank's lending rates are therefore to increase more than other interest rates in the economy after a policy rate hike. Higher financial costs may in addition lead to banks directly changing the lending terms, making it harder for companies and households to roll actual loans or to take up new loans. Banks may also choose to decrease their outstanding amount of loans since lower asset prices make it more profitable to buy equities and bonds instead of lending money. An uncertainty part consisting of future lower household incomes and company earnings arises when demand for employment, goods and services decrease. This uncertainty also makes banks more reluctant to lend money when the interest rate increases, why consumption and investment decline when the central bank hikes the policy rate. The hike therefore lowers demand and also inflation, which was the purpose with the contractionary monetary policy<sup>31</sup>.

Lensink et al. (2002) argue that for the credit channel to work, three conditions have to be met. First, nominal rigidity must exist for monetary policy to be effective. Second, some firms need to condition their financing on bank loans as they cannot access the market. Third, the central bank must be able to shift the loan supply schedules of private banks. Lensink et al. (2002) note that the last two assumptions are discussable. Many banks and firms are to some extent able to go around the effects of a monetary contraction by replacing some loans by other types of market funding such as certificates, corporate bonds or equities by banks that do not require reserve backing. This is, however, not true for firms that cannot access the market for different reasons. Lensink et al. (2002) take the credit channel one step further by also introducing a balance sheet channel, which links the lending contract with the financial health of the borrowing firm.

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<sup>31</sup> Hopkins et al. (2009a)

The idea is that the external finance premium is inversely related to the borrowers' net worth, why the borrowers' financial position may be affected by a, for example, contractionary monetary policy due to an increase in interest expenses, as well as to a decline in the value of collateral following declining asset prices or a decline in consumer spending. The balance sheet channel offers another approach on how to view the credit channel, but the reasoning is similar.

Hopkins et al. (2009a) also discuss a fourth transmission channel; the cost channel which describes how the central bank through monetary policy is able to control the inflation rate without first affecting demand. Since many companies to a large extent are financed through bank loans, interest rate changes may directly affect the companies' costs. Through a policy rate hike, the interest rates that companies meet from banks increase, which increase the financial costs for the companies which in turn have to raise prices as to compensate for the higher costs.<sup>32</sup>

#### **4.1.1. The Transmission Mechanism's Interest Rate Channel**

The monetary policy transmission mechanism will later in this paper be tested against the Panzar-Rosse H-statistics measuring how the impact of interest rate shocks on GDP, money supply, price level, bank lending and mortgage rates are affected by the level of competition on the Swedish banking market. As interest rate pass-through is crucial for the policy rate change to affect household mortgage rates, the transmission mechanism's interest rate channel will be described in greater detail below.

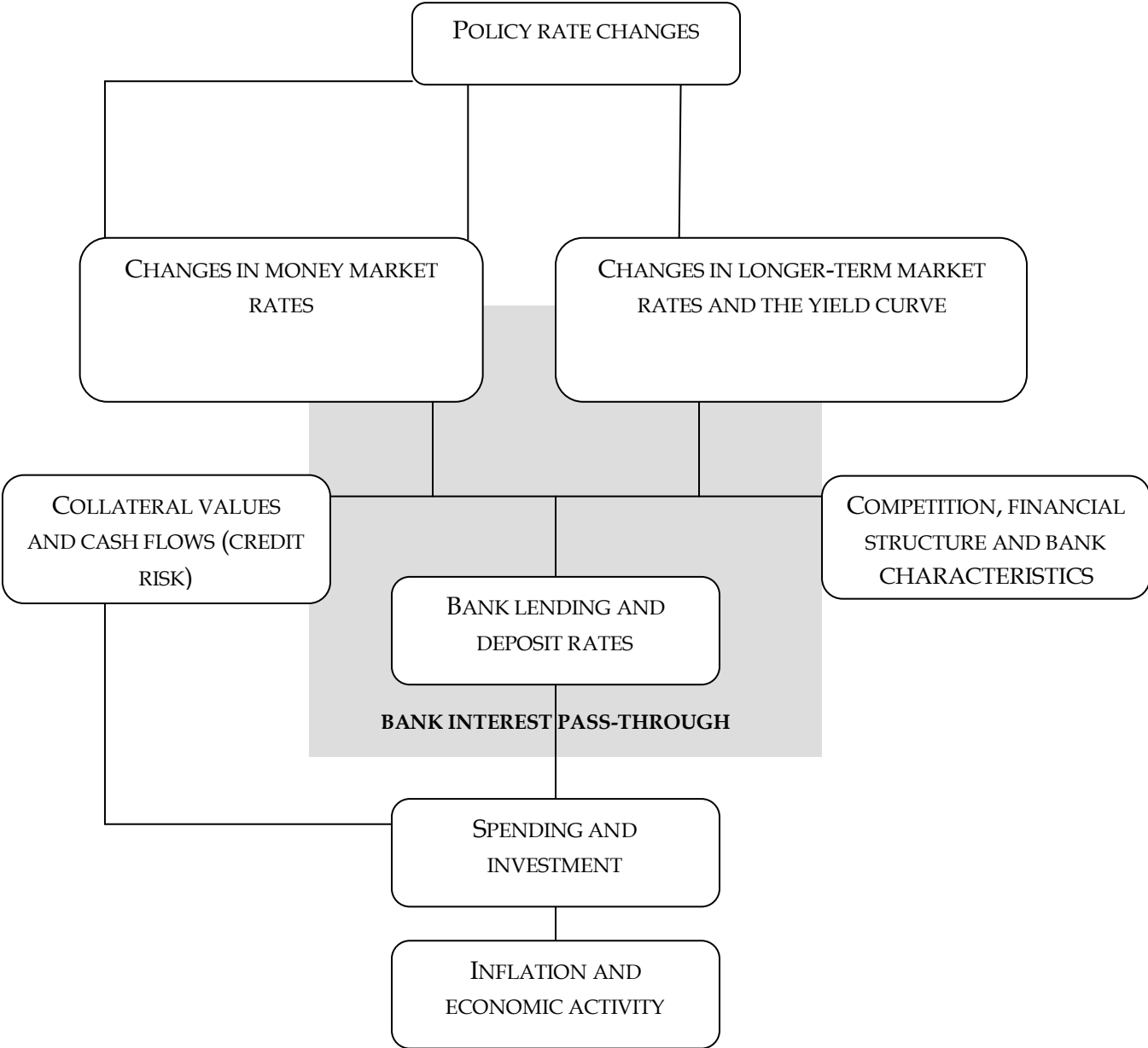
When the central bank changes the policy rate, other nominal interest rates in the economy are affected. After a rate hike, interest rates in the economy increase which makes it more favourable to save, and less beneficial to borrow money. The pass-through from the official policy rate to money and capital market rates is found to be an efficient and complete process, especially for shorter maturities. Bank mortgage and other retail rates are also expected to adjust according to changes in the policy rate. However, this is an assumption valid under conditions of perfect competition, full information transparency and absence of transaction costs. Since banking markets often suffer from different asymmetries and various market shares, this is often a too strong assumption to make for mortgage and retail markets. The reactions in bank mortgage and retail rates are therefore often found to be sluggish and incomplete, which has important implications for monetary policy.<sup>33</sup>

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<sup>32</sup> Hopkins et al (2009)

<sup>33</sup> Von Borstel (2008)

**Figure 4. 2. Transmission of Policy Rate Changes to Bank Rates**



*Source: The ECB*

A number of studies also find evidence of asymmetry in the pass-through over the interest rate cycle, where loan rates appear to be stickier when market rates decline, and deposit rates react more sluggishly when market rates increase. It has been argued that this depends on the degree of demand elasticity and bank competition.<sup>34</sup>

It is also worth mentioning that there are many factors that influence the adjustment of bank interest rates. We have already mentioned this adjustment to be somewhat sluggish. Some of the reasons beyond this have been discussed earlier in this paper: marginal pricing costs, expected

<sup>34</sup> ECB (2009a)

bank exposure to interest rate risk, credit and other risk premium, competition and regulation in different segments of the deposit and credit market, bank-customer relations, the administrative cost of effectively changing interest rates, the degree of passive behaviour on the part of deposit holders and borrowers are some examples to explain adjustment sluggishness.<sup>35</sup> There exist a number of theories that explain rigidity or sluggishness in the financial markets, where the most important are the agency cost theory, the adjustment cost theory, the switching cost theory and the risk sharing theory.<sup>36</sup> In this paper, we will also argue that interest rate rigidity arises from the competition level on the domestic banking market. A more monopolistic banking sector is able to obtain larger interest margins. Such monopolistic pricing by banks will not transmit changes of central bank interest rates as fully as perfect competition pricing would do.<sup>37</sup> As argued, this is expected to weigh down on monetary policy to some extent.

As seen, monetary policy alone cannot explain all movements in bank lending rates to households. Karlsson et al (2009) discuss some factors that also affect the lending rates in a recent paper. They find that above the risk free interest rate, also a risk premium, deposit margins, administrative costs, expected losses, earning margins as well as risk capital as to cover potential credit losses explain some of the adjustment sluggishness in bank lending rates. Monetary policy affects the lending rates through the risk free rate, however Karlsson et al (2009) show that monetary policy has been crucial when it comes to initiate the movement, but can only explain parts of the changes in the lending rates.

## **4.2. Empirical Evidence**

Literature and previous studies use many different approaches on how to measure interest rate pass-through on the banking market. One approach focuses on the speed and completeness of the pass-through from market rates to bank interest rates. von Borstel (2008) and de Bondt (2005) use a VECM for this purpose, while Liu et al (2008) estimate the pass-through with Phillips-Loretan estimates of cointegrating regressions. An advantage with the VECM is that it allows for simultaneously modelling of both stages of the interest rate pass-through process, and therefore can make a distinction between the short-term dynamics and the long-term (equilibrium) relationships. However, largely independently of the estimation method, most empirical studies on interest pass-through confirm to various degrees that retail bank interest rates respond sluggishly to changes in policy and market rates<sup>38</sup>.

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<sup>35</sup> de Bondt (2005)

<sup>36</sup> Panagopoulos et al. (2010)

<sup>37</sup> Lensink et al (2002)

<sup>38</sup> See for example von Borstel (2008), de Bondt (2005) and Liu et al. (2008)

This chapter has described how monetary policy affects different variables in the real economy. There are, obviously, numerous variables that are affected by a policy rate change, directly or indirectly. We have therefore chosen, and more closely been analyzing the variables bank lending to households, house price level, money supply, GDP and mortgage rates (see Appendix C for figures over the development of those variables over the considered time period). Connecting changes in those variables, based on a monetary policy shock, to the banking market may also have various approaches. This paper has already discussed the differences and similarities of a high degree of concentration and competition on the banking sector. There is a wealth of empirical literature focusing on either approach. Below will be presented some previous findings on how the market structure affects the effect of a monetary policy shock.

#### **4.2.1 Monetary Policy Shocks and Interest Rate Pass-through**

The central bank normally controls the interest rate level in the economy through the overnight rate, i.e. the rate to which banks lend to each other on different maturities. Through the overnight rate, interest rate changes are passed on to other interest rates with shorter maturities in the economy. Changes in the policy rate are, however, not expected to affect the economy immediately as it takes time before changes in the interest rate have a full impact on inflation and the real economy since prices are assumed to be sticky. Although the Swedish Riksbank recently abandoned the exact two year-horizon within which the bank aims to ensure inflation is on target, it may take monetary policy a shorter or longer time to reach its goal.<sup>39</sup>

A monetary policy shock is normally defined as the change in the short maturity yield, in some studies characterised by the Swedish 3-month interbank rate, Stibor. The short-term money market rates normally follow alterations in the repo rate closely (Figure 4.3.). A contractionary monetary policy shock is defined as a positive deviation of the interest rate from the average reaction function of the central bank for the sample period.<sup>40</sup>

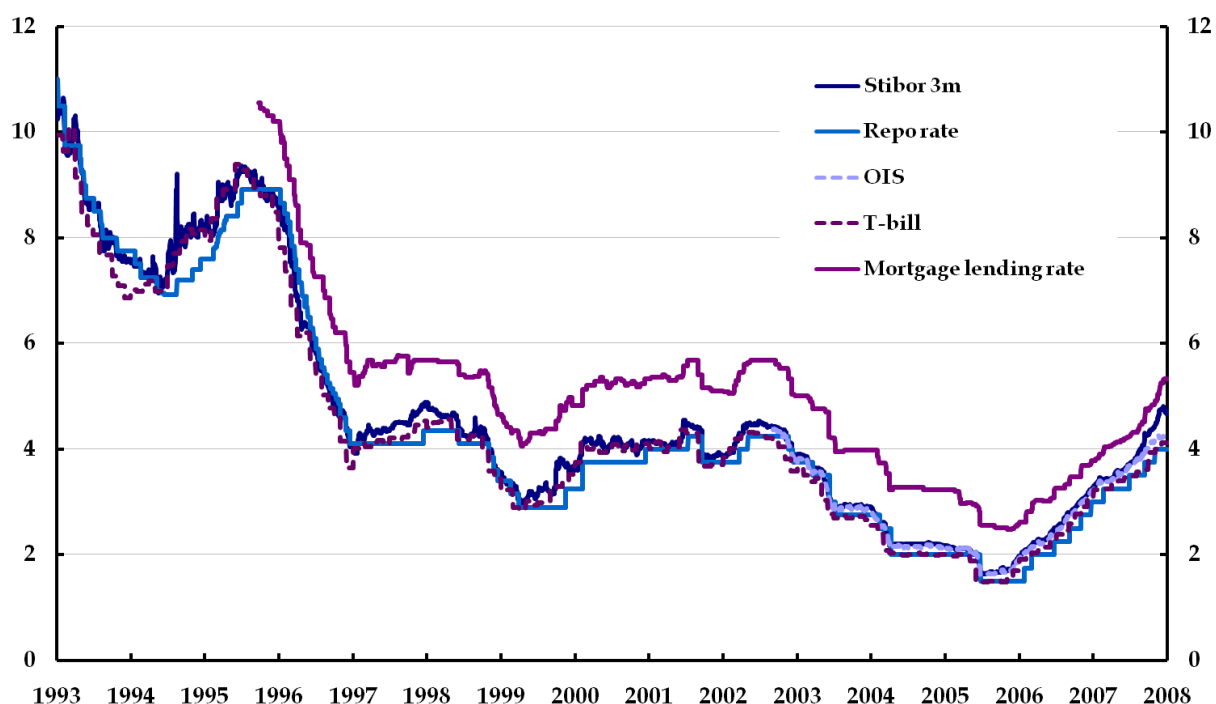
Controlling of short-term money market rates is the central bank's first step of the transmission mechanism from the repo rate to interest rates in the financial market. Disturbances in this first step of the transmission may be visible as interest rate deviations from the repo rate. In Figure 4.3., it is clear that the interbank rate (Stibor) as well as the overnight index swap (OIS) and the risk free rate (treasury bill) with three month maturity do follow the repo rate path closely. Although almost a percentage point higher, the mortgage rate certainly correlates with the repo rate. Normally, the repo rate lags the market rates somewhat. This is because market rates mirror market expectations of changes in the repo rate, as well as to the fact that the repo rate change

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<sup>39</sup> Sveriges Riksbank (2010 a)

<sup>40</sup> Mojon et al. (2001)

**Figure 4. 3. Money Market Interest and Mortgage Rates**



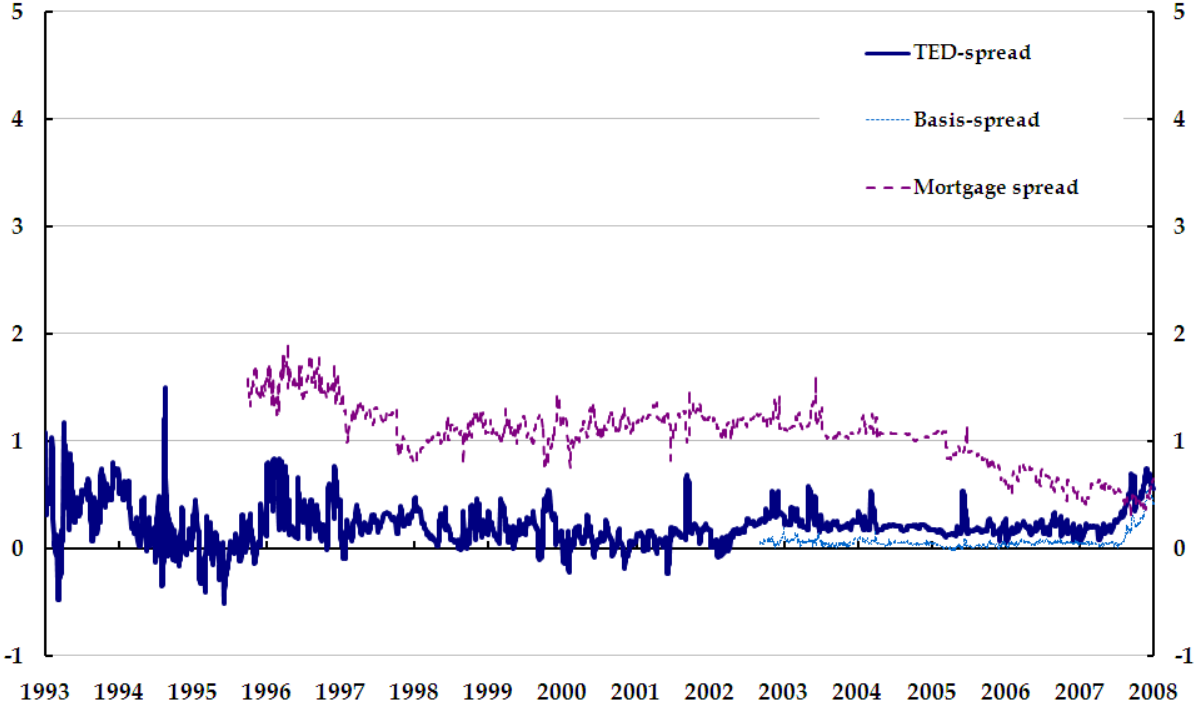
*Source: The Riksbank*

generally is effectuated a few days after the announcement of a change in the policy rate. Market rates respond to the new information rather than to the actual change in monetary policy.

During periods of tensions in the financial markets, deviations arise between the policy rate and the money market rates (Figure 4.4.). Two common ways to measure liquidity and credit risk on financial markets are carried out by studying the spread between the unsecured interbank lending rate (Stibor) and the Treasury bill rate; the TED-spread, and the spread between the unsecured interbank lending rate and the overnight indexed swap rate; the Basis-spread. The former measures credit risk as the extra return an investor requires for lending to a bank rather than to the government. As seen in Figure 4.4., this spread has been low and mostly stable since the beginning of 1994. In the end of 2007, rising tensions due to the approaching financial crisis are visible through an increasing TED-spread. The basis-spread, too, provides a measure of credit risk, but also of liquidity risk on the market. The interbank rate is considered more risky than the OIS, as the interbank rate measures banks' willingness to lend to each other while the overnight index swap is risk-free to the extent that the parties in the OIS contract only swap a floating interest rate for a fixed rate. The floating rate is coupled to the overnight rate. Just as with the TED-spread case, the basis-spread has been low and stable until the middle of 2007. Rising spreads are important to interpret as to understand how the interest rate pass-through may be disturbed by

financial tensions in the market. In the model we will use to test how monetary policy is affected by bank competition. One of the variables included in the model is bank lending to households.

**Figure 4. 4. Money Market and Mortgage Spreads**



*Source: The Riksbank*

Arising financial tensions may lead to banks being reluctant to lend to each other, due to either lack of trust or to the fact that the borrowing bank may actually be in bad shape, and raise the costs for interbank loans. This is in Figure 4.3 and 4.4 mirrored by rising interbank rates and increasing TED- and basis-spreads. When interbank rates rise, bank funding becomes more expensive which also affects mortgage rates which in turn may be raised even though the policy rate has not been changed. Data and Figures 4.3 and 4.4 show that the spreads have been almost negligible during the review period of this paper, why we need not take this into account in the further analysis of the interest rate pass-through. The mortgage spread, however, started to decrease in 2005, but picked up again in late 2007 following the reasoning above. The decline was due to a couple of reasons. First, the series is an average of the fixed three month lending rates from Nordea, SEB, Stadshypotek and SBAB, with data from SEB and Stadshypotek only available from 2004 and 2005 respectively. However, this does not affect the average notably. Secondly, this period is generally called “The Great Moderation” in economic literature and was characterized by high GDP growth, low inflation and low price on risk taking. The low price on risk increased the bank’s willingness to lend to customers, and the lending rates declined steadily

until the financial crisis led to an abrupt end to “The Great Moderation”. Higher funding rates lead to banks’ mistrusting each other as well as customers at the same time as the policy rate increased, and lending rates started to incline yet again<sup>41</sup>.

Karlsson et al. (2009) note that recent literature find that the relationship between monetary policy and its effects on macro variables differ significantly in a macro model that considers such a variation of spreads as discussed above, than in models that do not consider those aspects. One finding stressed by Karlsson et al (2009) is that the difference between the bank lending rate and the money market rates, where treasury bills and government bonds are assumed to mirror the current monetary policy, may vary a lot, which is visible when analyzing the figures in this section. Our study will have another focus than the mechanics of pure interest rate pass-through, but the reasoning is important to bear in mind.

To analyze the transmission mechanism, a common approach is to use a model assuming a reaction function of the central bank. This paper will analyze the transmission mechanism on the Swedish retail and mortgage market using a VAR-model, a technique which became widely used in the 1980: s. A more detailed description of VAR-models will follow in section 6. Comparison with previous studies and methods of measuring interest rate pass-through and monetary policy shocks follow in the sections below.

#### **4.2.2. Monetary Policy Shocks on a Concentrated Banking Market**

The industrial organisation of the banking sector has become an important aspect when it comes to analyze the effectiveness of monetary policy. Kashyap and Stein (1997) stress that the banking system’s concentration, which as previously mentioned is a measure of competition, as well as the health state of the banks, are crucial to the analysis of the monetary policy’s effectiveness. The authors study cross-country data in the European Union and find that, because of the substantial national differences in the EMU, the impact of the ECB’s monetary policy also diverge between the different member countries. Countries where the concentration ratio is high, or dominated by a few, larger banks, are affected less by the credit channel. Normally, the market power of large banks in countries with this type of market structure tend to increase the more concentrated the market, also called the efficient structure hypothesis. Lensink et al. (2002) contribute to this analysis by discussing a structure-performance hypothesis, which suggests that banks in an oligopoly market are able to charge almost monopoly rates. Despite banks charging lower deposit as well as loan rates, their profit maximising is higher than under perfect competition. This is true even when a monetary policy shock occur. Market power rather than monetary policy set the

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<sup>41</sup> For a further discussion on credit and liquidity risk and interest rate behavior, see for example Holmfeldt et al. (2009), Hopkins et al. (2009b), and Soutanaeva and Strömqvist (2009)



interest rates. According to the authors, it is likely that smaller banks on a highly concentrated market to a larger extent are forced to implement changes in monetary policy more rapidly. However, many previous studies focus on measuring the concentration on the banking market rather than the impact of monetary policy on an oligopoly/ monopoly market. This paper certainly raises the issue, but since competition is the main focus, monetary policy effectiveness on a highly concentrated banking market is of greatest interest for further analysis.

#### **4.2.3. Monetary Policy Shocks on a Competitive Banking Market**

Empirical evidence show a discrepancy between the effects of monetary policy shocks on economies with various competitive banking sectors. Various studies have confirmed this picture. Gunji et al. (2009) refer to for instance Stiglitz and Greenwald (2004, part I), who investigate both competitive and restricted banking system and find that the effect of raising interest rates on bank lending is weaker in a competitive system than in a more restricted environment. In the Stiglitz and Greenwald (2004) study, emphasis is on the wealth effect, but Gunji et al. (2009) draws the conclusion that such an effect is relatively small in a competitive banking system. This implies that the effect of monetary policy is even weaker. Gunji et al. (2009) also refer to Freixas and Rochet (1997, Section 4.2.) who analyze the effects of interbank rates on deposit and lending rates in an oligopolistic banking market. The model used advocates that a high degree of bank competition will decrease the effects of the interbank rate on the lending rate. The consequences of these findings are that if the central bank changes the policy rate, forcing a similar change in the interbank rate, a market characterized by a higher degree of competition will lead to smaller monetary policy effects<sup>42</sup>. Also, Vanhooose (1985) shows that changes in bank competition have no impact on monetary policy on the US banking market. Vanhooose use a microeconomic Cournot model to carry out the banking structure foundation for the analysis<sup>43</sup>. There are, however, a couple of implications with this paper as it studies bank behaviour under a reserve requirement, a requirement which is not yet mandatory in all countries, at the same time as the central bank is assumed to have a monetary aggregate target. The other papers, as well as this one, refer to central banks with an inflation target. These three studies hence draw the same conclusions, which could contradict the findings in the previous section. If we for a moment assume that a highly concentrated market also implies a low degree of competition on the banking market, the effects of monetary policy would naturally be larger on a market characterized by a high degree of competition. However, since previous studies suggest that the degree of competition measured by non-structural models not necessarily correlate with the degree of concentration, one finding does not automatically invalidate another.

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<sup>42</sup> Vanhooose (1985)

<sup>43</sup> Gunji et al. (2009)

Depending on the model undertaken for the analysis, the findings tend to diverge. The two former studies mentioned above both undertake a partial equilibrium analysis. Gunji et al. (2009) also refer to a study of Alencar and Nakane (2004), who criticized the methods previously used. Instead, they investigate monetary policy under perfect competition and monopolistic competition by a dynamic general equilibrium model which in turn showed that a market with a higher bank competition implies an economy more sensitive to changes in the interest rate. Gunji et al (2009) contributes to the field by using two different approaches: a cumulative impulse response function providing an index of the effect of monetary policy shocks, which in line with Vanhoose's (1985) findings provide no relationship between monetary policy shocks and bank competition<sup>44</sup>. The second approach, where Panzar-Rosse's H-statistic is used as an index of the state of bank competition and thereafter on bank lending regressed with the monetary policy shocks, in line with the earlier studies find that competition in the banking industry leads to smaller monetary policy effects on bank lending. Gunji et al. (2009) cover 56 countries where the H-statistic already has been estimated in previous work, and thereafter chose 22 countries where the variables for GDP, price level, monetary aggregates, short-term rates of interest and bank lending are available for the required period. However, evidence support that there exists verification for the hypothesis that the degree of bank competition influences the effect of monetary policy. The remainder of this study will, in accordance to our problem formulation in chapter 1, use the level of competition measured by non-structural models to examine in which way this is applicable and true for Sweden.

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<sup>44</sup> Gunji et al. (2009)

## **PART III. RESULTS AND CONCLUSION**

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In this part we will present our estimated results from the structural and non-structural competition models. We will also present our results from the models of measuring monetary policy and competition. Part III will end with a conclusion and a discussion.

### **5. Model and Results – Concentration and Competition**

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In this section we will estimate the structural and non-structural competition measures presented in Chapter 3 and also assess these results.

Because of the financial crises that hit Sweden in the early 90's and the global financial crisis that struck the world in the second part of 2008, we have chosen to focus on the time period from 1993 to 2007. However, data for the period of 1993-1996 has been close to impossible to acquire and we will therefore estimate competition measures from 1997 to 2007 in our study.

As we pointed out in part I, there are a number of competition measures that can be calculated. Due to the limited scope of this study we have chosen to focus on one non-structural measure of competition, namely the Panzar-Rosse H-statistic. This is a widely used measure of competition which has a relatively modest data demand. As a complement, we have also calculated the value of three structural competition models. These are CR<sub>4</sub>, CR<sub>5</sub> and HHI.

#### **5.1. Estimated Results from Structural Measures of Competition**

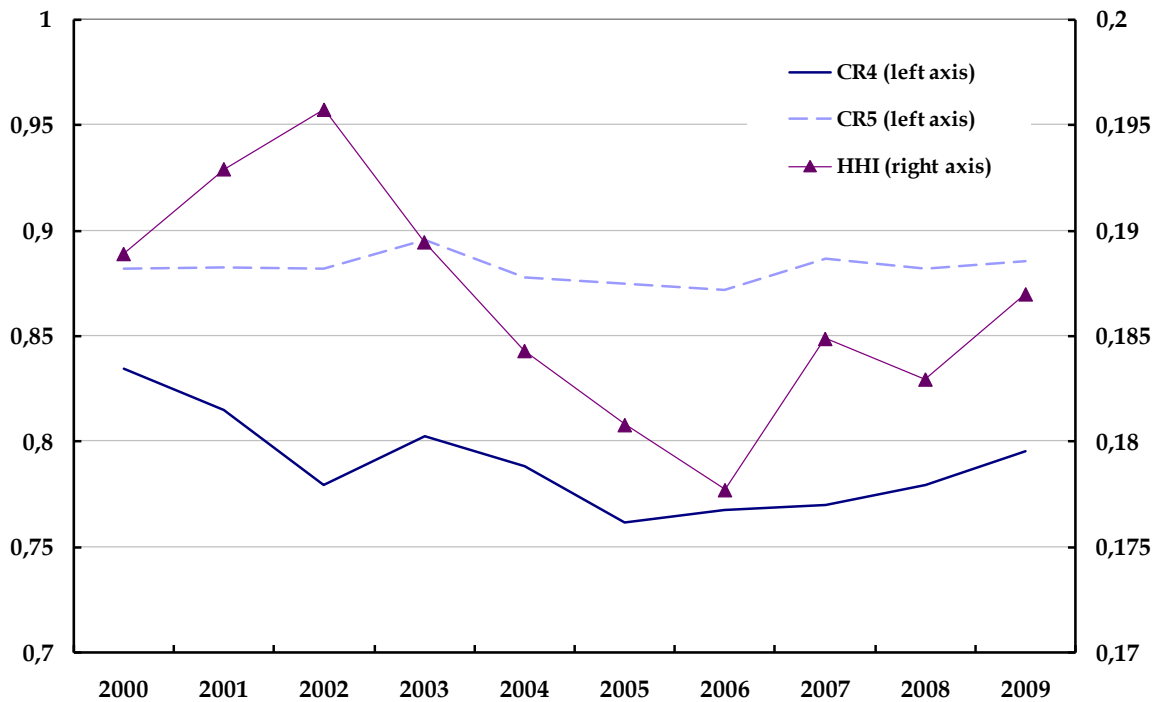
The average HHI-value for the time period is 0.19, while the average values of CR<sub>4</sub> and CR<sub>5</sub> are 0.80 and 0.89 respectively. The data used for calculating these measures has been found on Svenska Bankföreningen<sup>45</sup>, and a list of the banks can be found in Appendix A, Table 9.A.1. We have calculated those measures by equation (i) and equation (ii) in chapter 3.

CR<sub>4</sub>, CR<sub>5</sub> and HHI are calculated between 2000 to 2009, see Figure 5.1 below. The data used is the banks' total lending to the public during the given time period.

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<sup>45</sup> Svenska Bankföreningen (2010)

**Figure 5. 1. CR4, CR5 and HHI**



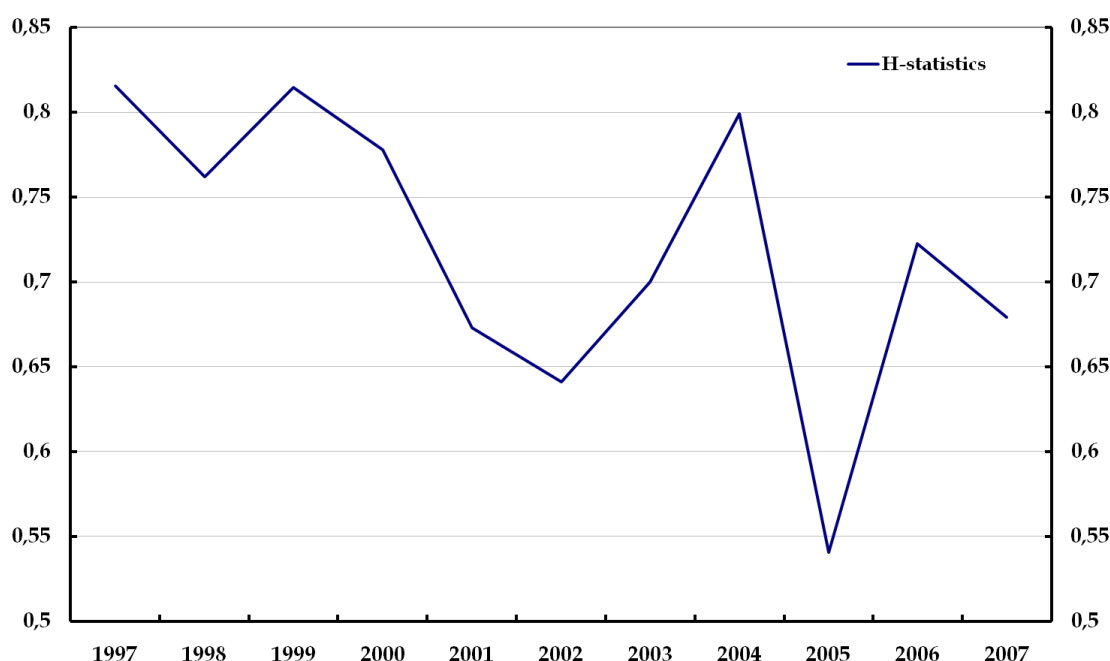
The level of concentration is said to be low if the HHI-value is below 0.10 and high if it's above 0.18.<sup>46</sup> Hence, the Swedish banking market can be said to be highly concentrated. As another indication of the HHI-value, a merger between two or more of the larger Swedish banks would not be allowed according to American competition law. The values of HHI and CR4 and CR5 are quite similar to the values Bikker and Haaf (2002) have found for the Dutch mortgage market. The authors also find that the Swedish banking market is rather highly concentrated. As has been previously mentioned, the data used to calculate HHI is not only mortgage lending to households, but the total lending to the public. However, most of this lending to the public consists of mortgages, why we find it to be a good proxy.

## 5.2. Estimated Results from Non-Structural Measures of Competition

The average value of the H-statistic for the Swedish banking sector between 1997 and 2007 is 0.72 and the range is between 0.53 and 0.82, se Figure 5.2. This statistic is calculated according to equation (iii). This means that the level of competition in the Swedish banking industry is monopolistic competition.

<sup>46</sup> Konkurrensverket (2009)

**Figure 5. 2. H-statistic (Panzar Rosse)**



### 5.2.1. Equilibrium and Robustness Check

As has been previously mentioned, a fundamental assumption of the P-R model is that the banking industry is in a long-run equilibrium. This is tested by a robustness check which applies the same regression as before but instead uses the returns on average assets (ROAA) or the returns on average equity (ROAE) as the dependent variable. The reason for this is that risk-adjusted returns are equalized across banks when the banks are in a state of long-run competitive equilibrium and returns on average assets and returns on average equity are uncorrelated with input prices in equilibrium. A one-sided t-test is used to test the hypothesis  $H_0: H = 0$  (equilibrium) against  $H_1: H < 0$  (disequilibrium). The null hypothesis is never rejected for ROAA and only once for ROAE, in 2007 (see Appendix B, Table B.3). Bikker et al. (2006) find that the null hypothesis is rejected for 17 % of the sample in their study, i.e. for 17 % of the countries in the sample. This implies that the Swedish banking industry can be said to be in a long-run equilibrium, which makes the Panzar-Rosse H-statistic valid.

To take the possibility of misspecification into account, a second version of the regression is estimated by the use of the ratio of interest income and total assets (II/TA) as the dependent variable. The results are presented in Appendix B, Table B.1. As we find this method a bit arbitrary, we have also performed Ramsey's RESET test, which will be presented shortly.

All H-statistic are tested to see if there is a monopoly or perfect competition in the banking system. This is tested by the use of a Wald test, with a one-sided t-test for monopoly:  $H_0: H \leq$

0 versus  $H_1 > 0$  and also a one-sided t-test for perfect competition:  $H_0: H = 1$  versus  $H_1: H \neq 1$ . These results are presented in Appendix B, Table B.2. The null hypothesis of monopoly is rejected once in eleven years and the null hypothesis of perfect competition is rejected in six of eleven years. Bikker et al. (2006) found that the null hypothesis of monopoly was rejected for 72 out of 101 countries in the sample. The null hypothesis of perfect competition was rejected for 62 out of 101 countries in the sample. The interpretation of our results would then be that they are quite in line with Bikker et al.'s (2006) when it comes to perfect competition, but that our results emphasize that the Swedish banking market is not in a monopoly.

To determine the quality of the different annual regressions, we run a battery of diagnostic tests on each one of the used models. We use the Jarque-Bera test to test for normality, White's test to test for heteroskedasticity, Ramsey's RESET test to test for misspecification and we also estimate the adjusted  $R^2$  to see how well the dependent variables explain the independent variable. The reason why it is important that there is no heteroskedasticity, even though the coefficients would still be correct, is that standard errors and hypothesis testing is no longer valid if the error terms are not homoskedastic.<sup>47</sup> Normality is important because the coefficients will not be unbiased if the distribution is found to be non-normal. The model is tested not to be misspecified because the model will otherwise be biased and inconsistent. We generally receive good values for normality and a good  $R^2$ , with the exception being 2006. All the models are homoskedastic according to White's test. This is not a great surprise since we have used White's heteroskedasticity robust standard errors. Lastly, Ramsey's RESET test shows that the regressions for three out of eleven years might be misspecified. In sum, our diagnostic tests show that we have a fairly robust model and the results are presented in Appendix B, Table B.4.

### 5.2.2. Data

The data for the Panzar-Rosse model has been gathered from Bankscope. Where possible we have used the mortgage lending institute of each bank. These have been available for the largest banks but not for the smaller ones. For the smaller banks we have thus been forced to use data for the banks' whole businesses. This is not ideal, but because these banks are comparatively small, the effect should not be overstated. A list of the banks can be found in Appendix A, table 9.A.2. Some of the data had to be recalculated from NOK and DKK to SEK and for that we have used OANDA – Forex trading and exchange rate services.<sup>48</sup>

### 5.2.3. Econometric Difficulties

If the P-R H-statistic is estimated with the explaining variables (the first three independent variables in equation (iii)) as well as the control variables the results of the H-statistic sometimes

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<sup>47</sup> Verbeek (2007)

<sup>48</sup> Oanda (2010)

surpass 1, which is not theoretically possible. Another problem is that the full regression cannot be performed from 2000 and backwards because of the lack of data. Therefore, we have chosen to calculate the H-statistic without using the control variables in the regression. However, we have also estimated the full equations as a reference measure. A similar problem is seen when the ratio of interest income and total assets are used as the dependent variable. These results are presented in the Appendix B, Table B.1., but should be taken with a grain of salt due to the lack of data.

#### **5.2.4. Correlation between Structural and Non-structural Competitions Measures**

Somewhat surprisingly, we find that the correlation between HHI and the H-statistic is extremely low, namely 0.0064. One would think that the correlation would not be very close to 1, although a result of close to 0 is surprising. The result implies that the structural and non-structural models of competition used in this paper measure quite different things. Perhaps the result in part can be explained by the few compared years and the lack of data for the Panzar-Rosse model.

#### **5.2.5. Comparison of our Results to Other Studies**

Bikker et al. (2006) estimates an H-statistic of 0.439 when  $\ln(\text{II})$  is used as the independent variable and 0.690 when  $\ln(\text{II}/\text{TA})$  is used as the independent variable. This means that our value of 0.72 is quite in line to what Bikker et al. (2006) have found, albeit a bit higher. Claessens and Leaven (2004) found that the average H-statistic generally varied between 0.60 and 0.80 for the 50 countries surveyed in their study (Sweden was not included among these countries).

In Chapter 5, we have presented the results of our structural and non-structural competition measures. We are able to draw the conclusion that high degree of concentration doesn't necessarily imply a low degree of competition as measured by the non-structural models, and we also see that the Swedish banking sector is not characterized by neither perfect competition nor a monopoly.

## 6. Model and Results – Bank Competition and Monetary Policy

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As discussed in part II, there are numerous ways to answer to the second part of our problem formulations of chapter 1: how the real economy is affected by monetary policy on the one hand, and how bank competition affects the impact of a monetary policy shock on the other. We have chosen to measure monetary policy shocks through the, for this purpose, commonly used VAR-model. To answer our questions above, we apply two different approaches: initially, we study the correlation between the time series of the H-statistic as computed in chapter 5, and the effects of monetary policy shocks as calculated in this chapter. Secondly, we will regress bank lending on the interaction of bank competition and the effects monetary policy shocks.

The data used to estimate the VAR model for measuring monetary policy shocks has been gathered from Thomson Reuters Ecowin, Statistics Sweden and the Riksbank.

### 6.1. A Model for Measuring Monetary Policy Shocks

We use an impulse response function and a forecast error variance decomposition to measure monetary policy shocks, methods commonly used in monetary policy literature. These methods offer a possibility to analyze the effect of exogenous shocks in the model. In this paper, a monetary policy shock is measured as the impact of the exogenous change in the interest rate on other economic variables. This change will hence be estimated using cumulative impulse response functions. We initially create a VAR-model for this purpose. The mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + B x_t + \varepsilon_t \quad (\text{v})$$

The notation  $y_t$  is a  $k$  vector of endogenous variables,  $x_t$  is a  $b$  vector of exogenous variables,  $A_1 \dots A_p$  and  $B$  are matrices of coefficients to be estimated and  $e$  is a vector of error terms.<sup>49</sup> The shocks are estimated with the error terms.

One disadvantage with VAR models is that they have a status of a “reduced form” model, meaning they have trouble summarizing the dynamic properties of the data. It may be difficult to interpret the model only by looking at the estimates of the VAR system. The model was developed in the 1980’s by Sims (1981, 1986), Bernanke (1986) and Shapiro and Watson (1988) among others<sup>50</sup>. Their contribution to the analysis was to closer study the errors of the system, as interpreted as exogenous shocks. It was therefore possible to analyse the instantaneous relations

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<sup>49</sup> Eviews User Guide. For further information on VAR-models, see for example Enders (2004) or Lütkepohl and Krätzig (2004)

<sup>50</sup> Lütkepohl and Krätzig (2004)



between the variables. There are, however, different approaches on how to identify shocks terms. Cholesky's decomposition is triangular, but one could also form structural equations for the shocks, such as an IS curve where the equations apply to an unexpected part of the variables rather than to the variables themselves. This unexpected part is usually denoted *innovation*. Recent work, conversely, tend to identify shocks by using restrictions on their long-run effects. This is often in line with economic theory which suggests that the effects of the shocks tend to become zero in the long run.<sup>51</sup> A shock in the economy, denoted as a shock to the  $i$ -th variable in equation (v), not only affect the variable itself but is also transmitted to all the other endogenous variables through the dynamics of the VAR. An impulse response function traces such an effect to one of the shocks on current as well as on future values of the endogenous variables. If the assumption that the shocks  $\varepsilon_t$  are contemporaneously uncorrelated is true, the  $i$ -th shock  $\varepsilon_{i,t}$  is interpreted as a shock to the  $i$ -th endogenous variable  $y_{i,t}$ . Usually, the shocks are correlated, which is the reason for the common approach to transform the errors in order to uncorrelate them. The transformation is denoted P:

$$v_t = P\varepsilon_t \sim (0, D) \tag{vi}$$

To transform the errors in this paper, the Cholesky decomposition is used to orthogonalize the impulses. This method is appropriate as it imposes an ordering of the variables in the VAR, and further takes into account all of the effect of any common variable to the variable that comes first in the VAR system.<sup>52</sup> Responses may change depending on the order of the vector, and since we will apply two different versions of one model for our analysis, this decomposition allows for a fair comparison between the two. Sims et al. (1990) show that VAR estimates are consistent even though some variables may contain a unit root. The variables are therefore specified as levels in the VAR analysis that follows.

## 6.2. The Relationship Between Bank Competition and the Effect of Monetary Policy Shocks

### 6.2.1. Model 1

In our first approach we will evaluate the relationship between bank competition and monetary policy in Sweden between 1997-2007. We start by creating two time series: The cumulative impulse response function, as described above, is the series of the effects of monetary policy shocks while the Panzar-Rosse H-index of chapter 3 acts as the series of the state of bank competition. We estimate the cumulative impulse response function one, two and three years after the shocks for the time period 1997-2007. Going further back than 1997 will be a question of too few

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<sup>51</sup> Breitung, Brüggeman and Lütkepohl in Lütkepohl and Krätzig (2004)

<sup>52</sup> Eviews User Guide (2009)

observations for a credible impulse response outcome, why we choose to start the analysis in this year. Once time series are obtained for each variable, we regress the H-statistic on the effects of the monetary policy shocks. All calculations are performed in Eviews unless otherwise stated.

The variables in our VAR model are influenced by contemporary literature, and are hence variables suggested by economic theory that should be affected by the transmission mechanism as discussed in chapter 4. We include the short-term interest rate ( $r$ ), the log of bank lending to households ( $b$ ), the log of the monetary aggregate ( $m$ ), the log of the house price level ( $p$ ) and the log of aggregate output ( $y$ ). We find those measures appropriate as our focus lays on the banks' lending to households for mortgage purposes. We are not able to access data separated between mortgage and other lending to households. However, since a vast majority of bank's lending to households consist of mortgage loans, the total is assessed an appropriate estimation of ( $b$ ). Also, instead of using the price level for the country as a whole, we have modified ( $p$ ) to consist of a house price index. This also seems like a proper development of the model as we focus on prices, rates and loans on the housing market. The monetary policy shock, defined as changes in the three month Stibor interbank rate, is also assumed to have an impact on domestic money supply and real GDP. We define M3 as the measure for Swedish money supply. As stressed, since we have applied an identification strategy (Cholesky's), the order of the variables in the VAR can change the results<sup>53</sup>. Therefore, we apply two variants of Model 1 with different vector orders; called Model A and Model B:

Model A has a vector order of ( $y, p, r, b, m$ ). The intuition behind this model is that the central bank adjusts the policy rate based on contemporaneous output and prices. In such a situation, a monetary policy shock will affect output and prices in the following period, not in the current period. This reasoning is, as mentioned in chapter 4 above, fairly in line with how the Riksbank conducts its monetary policy. Gunji et al. (2009) point out that this assumption may be too strong, as the actual data outcome may not be available for the central bank when applying monetary policy. The Riksbank, however, performs forecasts for the yet unknown variables when applying monetary policy. The Riksbank forecast accuracy is normally quite in line with the actual outcomes in the very short term,<sup>54</sup> why this assumption may be well applicable for this study.

Model B, with a vector order of ( $y, b, m, p, r$ ) implies that the central bank conducts its monetary policy referring to variables observed in the previous period. Monetary policy shocks will then affect the other variables contemporaneously. Though we find Model A more suitable for the Swedish case, Model B provides a post-ex check for the results of Model A. These two approaches

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<sup>53</sup> Gunji et al. (2009)

<sup>54</sup> Andersson et al (2009), and Sveriges Riksbank (2010b)

are commonly used in the literature, why we consider them appropriate also when it comes to making international comparisons. Another important feature is that if the impact of interest rates are to be investigated, the estimates of the Model A impulse response functions do not depend numerically on the order of output and the price level, nor the order of bank lending and the monetary aggregate. Analogously, the estimates of Model B will not depend on the order of any other variables than the policy rate. These two orders of the models make it possible to obtain comprehensive results.<sup>55</sup>

$$y_t = A_1 y_{t-1} + \dots + A_t y_{t-p} + Bx_t + \varepsilon_t \quad (\text{v})$$

Considering Equation (v) above, the two vector orders (y) of Model 1 can simply stated be expressed as follows:

Model A:

$$Y_t = \begin{bmatrix} y_t \\ p_t \\ r_t \\ b_t \\ m_t \end{bmatrix} \quad (\text{vii})$$

Model B:

$$Y_t = \begin{bmatrix} y_t \\ b_t \\ m_t \\ p_t \\ r_t \end{bmatrix} \quad (\text{viii})$$

The effects of the monetary policy shocks for each year of the cumulative impulse response function from the VAR (v) will be regressed on the H-statistics, using a simple OLS regression. The years will be expressed in quarters (4, 8 and 12 steps respectively). This regression has typically the following form:

$$z_i = \alpha + \beta * H_t \quad (\text{ix})$$

$z$  denotes the effect of the interest rate shock on each variable as expressed in  $Y_t$  above, and  $i$  equals the steps of the impulse response function.  $H_t$  is the H-statistic as computed in chapter 5. We will use equation (ix) to test the effect of monetary policy shocks on bank lending, GDP, money supply and the price level respectively, on the H-statistic. If the coefficient  $\beta$  proves to be

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<sup>55</sup> Gunji et al. (2009)

significantly different to zero, this means that there exist a relationship between monetary policy shocks and bank competition.

We compute the cumulative effect of the time specific shocks on different time horizons in accordance to Model 1. These time specific effects are calculated as the sum of the effects of a shock in a certain period.<sup>56</sup>

### 6.2.2. Model 2

In Model 1, we evaluated the relationship between the effects of monetary policy shocks and bank competition. In our second approach, we will test if there exist an interaction between bank competition and the effects of the monetary policy shocks, and if this possible relationship has had an impact on bank lending over the time period<sup>57</sup>. Here the banks are assumed to change their lending depending on the effect of monetary policy shock and the degree of competition on the market. We therefore regress bank lending on the interaction of bank competition and the effects of the monetary policy shocks:

$$\Delta \ln(L_{it}) = \alpha_i + \beta_1 S_{i,t} + \beta_2 S_{i,t-1} + \beta_3 (H_i \times S_{i,t}) + \beta_4 (H_i \times S_{i,t-1}) + c'_{i,t} \gamma + \varepsilon_{i,t} \quad (\text{x})$$

$$(I = 1, \dots, N, t = 1, \dots, T)$$

$L_{i,t}$  is the bank lending of bank  $i$  at year  $t$ ,  $\alpha_i$  is the individual year effect of bank  $i$ ,  $S_{i,t}$  the effect of the monetary policy shock,  $H_t$  is the  $H$ -statistic,  $c_{i,t}$  a vector of control variables and  $\varepsilon_{i,t}$  the disturbance term. The control variables include the lagged ratio of deposits to total assets, a lagged total turnover ratio, the growth rate of deposits, the growth rate of real GDP, the rate of inflation, the  $H$ -statistic and a full set of time dummies. We have chosen to simplify the model by excluding this vector of control variables as they are already included in the model through the variables  $H_t$  and  $S_{i,t}$ , giving the equation:

$$\Delta \ln(L_{it}) = \alpha_i + \beta_1 S_{i,t} + \beta_2 S_{i,t-1} + \beta_3 (H_i \times S_{i,t}) + \beta_4 (H_i \times S_{i,t-1}) + \varepsilon_{i,t} \quad (\text{xi})$$

$$I = 1, \dots, N, t = 1, \dots, T)$$

The second and third terms of the equation on the right-hand side represent monetary policy shocks at times  $t$  and  $t-1$ . We use the residuals from the interest rate equation of the VAR, as an indicator of the effect of a monetary policy shock in order to make this part of the study consistent with the rest of the paper. This is a common approach in other papers, as many regard a disturbance of the interest rate equation as a monetary policy shock in the impulse response

<sup>56</sup> This calculation has been done manually in Excel with data from Eviews

<sup>57</sup> Gunji et al. (2009)

analysis<sup>58</sup>. The fourth and fifth terms in equation (xi) represent the interaction between bank competition and monetary policy shocks, and test the hypothesis that a monetary policy shock tend to have a larger impact on bank lending on a market where the banking industry is more competitive. For example, one percentage point increase in the interest rate at time  $t$  will lead to a 100 times  $\beta_3$  percentage increase in bank lending under a high state of bank competition.  $\beta_4$  shows the percentage increase in bank lending in  $t-1$ , when there is a one percentage point increase in the interest rate. The frequency of data used in Model 1 is quarterly, but while we require annual data to obtain comparable measures with the  $H$ -index in Model 2, we sum the quarterly data of the residuals as well as the data for bank lending.

### 6.3. Results

In this section, we will initially study the correlation between the H-statistic and the monetary policy shocks of through scatter plot figures (figure 6.1. and 6.2.). To extend the analysis, we will thereafter regress the effects of monetary policy shocks on the H-statistic according to Model 1 above, and eventually regress the effects of the shocks and the H-statistic on the variable bank lending as of Model 2. Eventually we will be able to draw a conclusion on whether the degree of bank competition has had an impact on the effect of monetary policy over the time period considered. Our hypothesis is, in accordance with some wings of the literature discussed in chapter 4, that the degree of bank competition does influence the transmission of monetary policy on the real economy in Sweden.

We use quarterly data stretching from the period 1993-2007, obtained from Reuters Ecwin, Statistics Sweden and the Riksbank. The optimal lag length for the VAR is chosen by conducting a number of methods and then pick the lag length selected by most criteria. The tests performed are the likelihood ratio test, the Akaike information criterion (AIC), the Schwartz's Bayesian information criterion (SBIC), the Hannan-Quinn information criterion (HQIC) and the final prediction error (FPE). We find this method of choosing a lag length credible and appropriate. The tests suggest a length of two lags. As we stressed in chapter 3, monetary policy shocks are likely to spread with some time lag. We will therefore estimate the cumulative impulse response function one, two and three years after the shocks.<sup>59</sup> The residuals of the VAR are also tested for serial correlation using the Portmanteau autocorrelation test and the LM test. No serial correlation was found for any of the models. For every year, we have carried out impulse responses for each variable for one, two and three years ahead. Figures of the impulse responses are shown in Appendix C, Table C.3. and C.4., and display responses broadly consistent with existing studies.

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<sup>58</sup> Gunji et al (2009)

<sup>59</sup> Gunji et al. (2009)

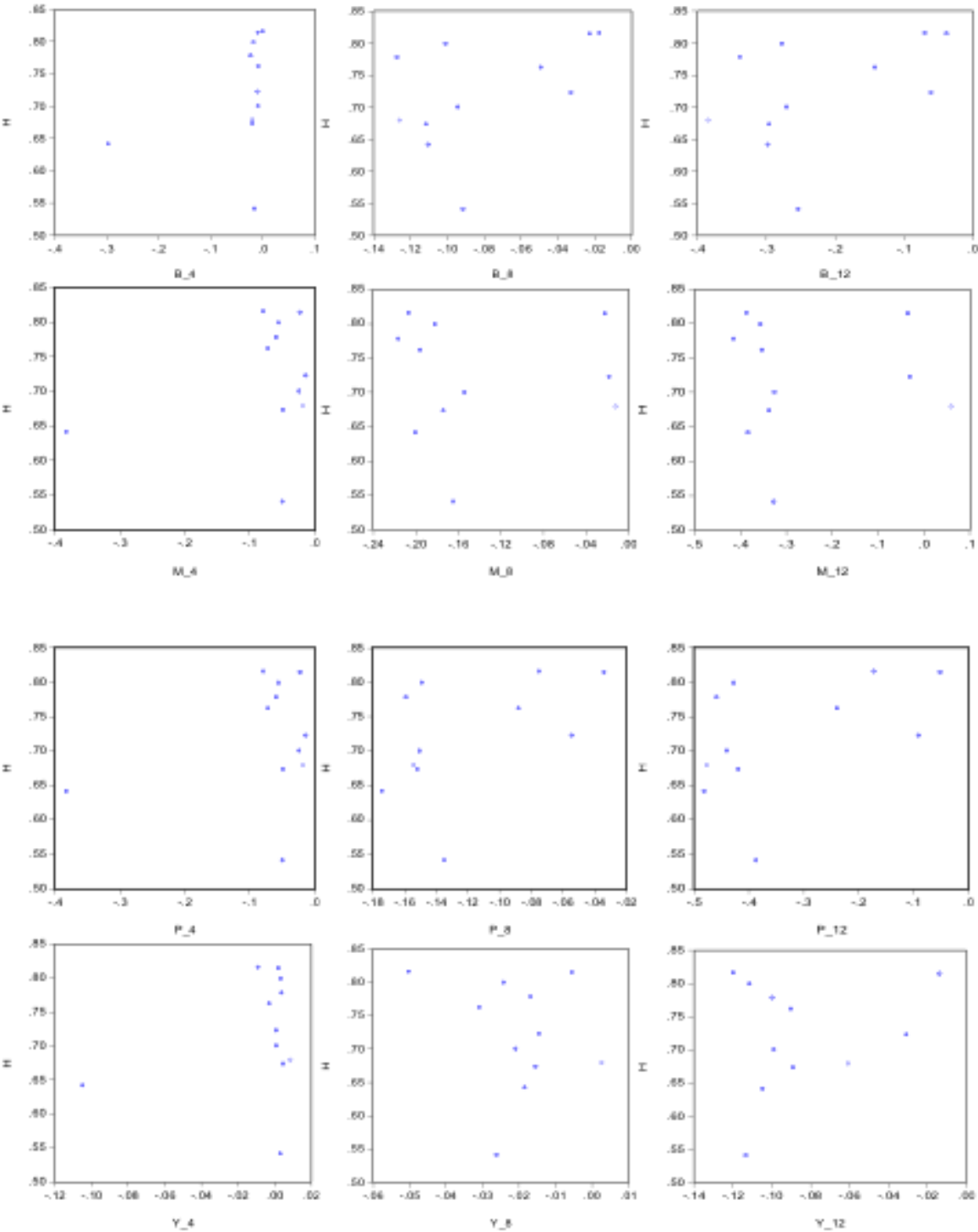
After a temporary change, the variables incline or decline steadily over time, stressing a persistent effect of the monetary policy shock.

Figure 6.1. shows scatter plots of the relationship between the degree of bank competition over the period and the effect on monetary policy shocks in Model A. The figure represents the cumulative impulse response functions for each year in Model A on the x-axis respectively. The effects are summed in time series as of equation (xi). and the H-statistic on the y-axis. If the hypothesis that greater competition in the banking industry will lead to smaller monetary policy effects, the scatter plot curve would visibly slope upwards. If the contrary is true, the curve slopes downwards to the right. If no correlation exists between the variables, the hypothesis of no relationship is applicable.

The three scatter plots in the first row of figure 6.1. show the effects of interest rate shocks on bank lending ( $r-b$ ). There is no clear correlation between those series, which suggest that bank competition does not change the effect of monetary policy shocks on bank lending over the time period. The monetary policy shocks on money supply ( $r-m$ ), the second row in the figure, don't appear to correlate with the degree of bank competition over the years. There are no visible signs either on the third and fourth row of the figure that interest rates shocks on the price level ( $r-p$ ) or on GDP ( $r-y$ ) should be affected by bank competition. One slight tendency to a positive correlation is shown in the impact on GDP in the third period. This suggests that monetary policy shocks to GDP are somewhat affected by the degree of bank competition over the time period.

Table 1 presents the effects of the simple regressions of equation (iv) of the effects of monetary policy shocks for Model A on the H-statistic. The constant is not included in the table. In the first row ( $r-b$ ), we show the regressions where the interest rate shocks on bank lending is the dependent variable. None of the standard errors show a coefficient being significantly different from zero, which implies that there exists no correlation between the variables. We find that neither the effects of monetary policy shocks on money supply, the price level or on GDP are statistically significant from zero, why we cannot prove that a change in the effect of monetary policy over time have had an impact on any of those variables based on the degree of competition in the banking sector.

**Figure 6. 1. H-Statistic and the Effects of Monetary Policy Shocks (Model A)**



*Comment: H-statistic on the y-axis and monetary policy shocks on the x-axis.*

For Model B, the scatter plots in figure 6.2. showing the potential correlation between the degree of bank competition and the effect of monetary policy, provide us with a picture similar to the one

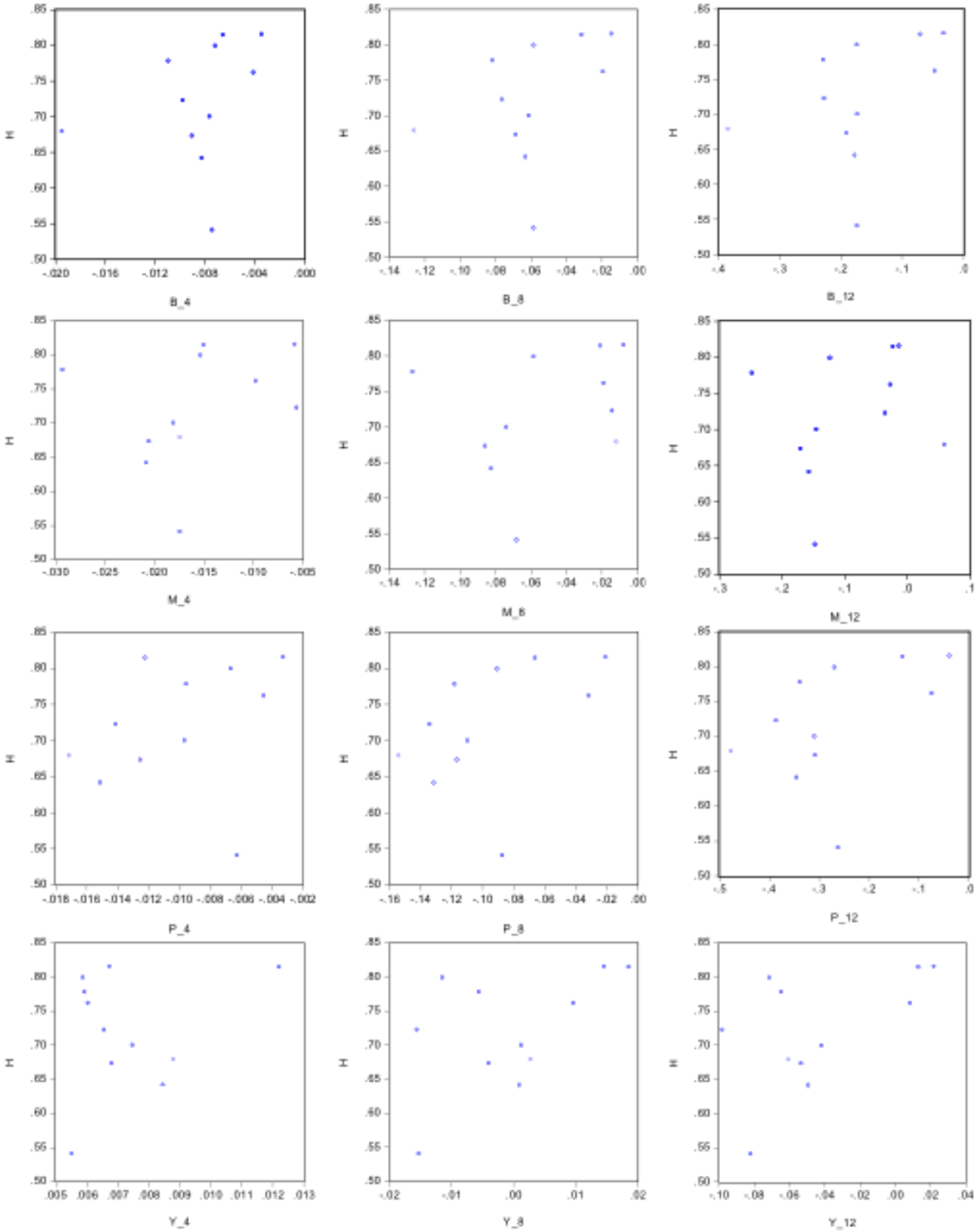
from Model A in figure 6.2. However, the dots seem to show some tendency of a more positive slope for several variables in Model B. Though no strong relationship, our figures suggest there is a weak positive correlation between those variables, disregarding the outliers. The relationship seems to be true for at least the impact of bank competition on the price level and on GDP, but is however less clear for bank lending and money supply. In Table 2, the results of the regressions for each series give the same result as for Model A. Neither in this case, the estimates of the coefficients are proven significant for either of the standard errors.

According to the results of this model, regardless vector order, our findings above are biased to suggest that there have been no correlation between monetary policy shocks and bank competition over the time period considered. Our hypothesis, as stated in chapter 1 and in the beginning of section 6.3, can thus not be verified if measured this way.

When it comes to our second approach, where we measure the interaction of bank competition and the effects of monetary policy shocks on bank lending, we use the model as specified in equation (xii). Table 3 shows the result of the test: the parameter for the contemporaneously monetary policy shock is negative but not significantly different from zero. Also the results show that monetary policy in the previous period is negative but not significant. The negative sign means that a monetary policy shock on average decreases bank lending by 0.1 percentage point in the previous and in the current period. Neither the interaction between the H-statistic and the monetary policy shocks in the previous period are significantly different from zero, but shows a positive sign, that if significant would imply that a monetary policy shock in a more competitive banking market to a lesser extent affects bank lending to households. This should then be in line with the result of somewhat positive sloping scatter dots of figure 2. As the coefficient for H is



**Figure 6. 2. H-statistic and the Effects of Monetary Policy Shocks. (Model B)**



*Comment: H-statistic on the y-axis and monetary policy shocks on the x-axis.*

positive, a high degree of bank competition would lead to an increase in bank lending. However, since they are not significant, the results tell us that bank competition have no impact on the effect of monetary policy shocks, as measured by equation (xi).

This simple OLS regression provides no evidence if our hypothesis of an impact of bank competition on monetary policy transmission is true. Neither the  $R^2$  statistic gives a strong support to the results. This, in combination with the results of Model 1, bring us to the conclusion that the changes of degree of bank competition over the chosen period of time on the Swedish banking market have had less impact on the transmission of monetary policy than we previously had thought.

It is, however, important to stress that there are limitations to the estimates. The  $R^2$  values are fairly small and our sample period is relatively short, why the results may be somewhat weak. In this case, a larger sample would nonetheless have further implications. Monetary policy was from the turn of the previous century and up to 1992 conducted under a fixed exchange rate regime, why the policy rate was not set under the same circumstances as of today. This means that the variables used in this paper would be somewhat inconsistent if using data from before 1992. In 2008, the financial markets were hit by a severe financial crisis that forced financial as well as macro variables to react in ways not imposed by monetary policy, but by fear and irrational crisis behaviour. Some of those risk premium factors were discussed in chapter 4, where we showed that the TED- and the basis spreads started to increase ahead of the crisis only to become historically large in late 2008. Taking those recent variables into account would therefore also have led to biased results as the variables were affected by other factors than monetary policy: interest rates reflected liquidity and credit risk premium and money supply increased due to the Riksbank lending large amounts of money to the banks to provide liquidity in the market. Bank lending decreased as banks were reluctant to lend money to customers due to credit risk, and GDP decreased following a deep drop in exports as international demand temporary ceased in 2008 following the crisis. The degree of bank competition, as well as monetary policy alone, would therefore explain very few of the movements and shocks of those variables, leaving our chosen time period very appropriate.

**Table 6. 1. Simple Regressions of Model A and Model B**Table 1  
Simple regression (Model A). Equation (ix)

Dependent variable	Steps of cumulative IRF		
	4	8	12
r-b	0.215450 (0.342850) [0.5497]	0.371729 (4.363564) [0.9345]	0.153193 (1.487218) [0.9208]
r-m	0.253412 (0.325148) [0.4613]	-0.802783 (2.651901) [0.7709]	0.325127 (1.244916) [0.8015]
r-p	0.065617 (0.357312) [0.8595]	0.779293 (6.636047) [0.9098]	0.003598 (1.932215) [0.9986]
r-y	0.437710 (0.864446) [0.6282]	-3.671435 (2.667111) [0.2111]	1.405778 (1.073611) [0.2317]

Note: The regressor in each equation is the H-statistics. The estimates of intercept are not shown in the table. The classical OLS standard errors in parenthesis and p-statistics in brackets.

Table 2  
Simple regression (Model B). Equation (ix)

Dependent variable	Steps of cumulative IRF		
	4	8	12
r-b	-21.44998 (21.76955) [0.3573]	-3.419588 (12.52407) [0.7927]	2.321031 (3.808749) [0.5615]
r-m	-7.410178 (21.78867) [0.7438]	4.657993 (9.966782) [0.6544]	-1.307440 (3.049511) [0.6810]
r-p	-7.153568 (15.09540) [0.6500]	1.400790 (6.042542) [0.8233]	0.054697 (1.612377) [0.9739]
r-y	-1.672728 (25.93845) [0.9504]	0.488832 (12.13787) [0.9690]	1.049048 (2.934170) [0.7312]

Note: The regressor in each equation is the H-statistics. The estimates of intercept are not shown in the table. The classical OLS standard errors in parenthesis and p-statistics in brackets.

**Table 6. 2. Regression Results for Model 2**

Regression results (Benchmark estimations)	
	Equation (xi)
Monetary policy shock	-0.081107 (0.295354) [0.7915]
Monetary policy shock ( <i>t-1</i> )	-0.016699 (0.009123) [0.1099]
H-statistics times shock	-0.145942 (0.699069) [0.8406]
H-statistics times shock ( <i>t-1</i> )	0.015659 (0.019036) [0.4379]
R <sup>2</sup>	0.190345

*Comment: The estimate of the intercept is not shown in the table. The classical OLS standard errors in parenthesis and p-statistics in brackets.*

#### **6.4. A Benchmark Model**

We have based the disposition and modelling of the possible impact of bank competition on the effects of monetary policy in this paper on a recent study by Gunji et al. (2009). However, our review differs from their study in a few regards. One important difference is that Gunji et al. (2009) use panel data for a number of countries to investigate if the different states of bank competition influence the impact of monetary policy. We, on the other hand, have chosen to compute time series for Sweden as to learn firstly if there has been any changes in the state of bank competition over the considered period, and thereafter if this change has had any impact on monetary policy transmission in Sweden over those years. Another important aspect is that Gunji et al. (2009) do not compute the competition measure themselves, but use already computed data for the H-statistic. The statistics used for Sweden is, however, quite in line with the average of the time series for the Panzar-Rosse statistic we computed in chapter 5.

We have also adjusted the models and equations used in the Gunji et al. (2009) paper to be able to test our hypothesis. For example, we use the log of bank lending to households instead of a wider range of bank lending. We also changed the variable price level to account only for house prices, instead of looking at the price level in the Swedish economy as a whole. Of data availability reasons, we use the wider M3 measure of money supply rather than M2.

Because of those dispersions from the Gunji et al (2009) paper, our findings are not fully compatible with theirs, even though they have a lot in common. They, too, fail to find any

correlation between the degree of bank competition and monetary policy in Model 1, no matter what vector order used. However, we do on the margin find some signs of correlation between the two variables in the scatter plots of figure 6.2. Gunji et al (2009) cannot observe those tendencies at all. We are not able to find evidence of a high degree of bank competition to have an impact on the effect of monetary policy shocks in model 2 either. Here, Gunji et al. (2009) find a suppressive impact and hence draw the conclusion that there is evidence enough to support the hypothesis that the degree of bank competition influences the effect of monetary policy for the 22 countries included in the paper, Sweden included. Though there are some tentative signs of the opposite, we stick to our conclusion that we cannot accept the hypothesis of the state of bank competition to have an impact on the transmission of monetary policy in Sweden over the considered time period.

## 7. Conclusions and Discussion

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Just as previous studies have found, the Swedish banking market is highly concentrated, which according to the structural models mean that the level of competition is low. As previously stated, this paper focuses on non-structural models of competition, as we believe that they measure the level of competition more correctly according to a lot of the previous research on the topic. The calculated Panzar-Rosse H-statistic indicates that the level of competition in the Swedish bank market is closer to perfect competition than what it is to a monopoly, which also means that it can be characterized by monopolistic competition. This result is in the range of what is expected and also close to what other studies have found both for Sweden and internationally. The level of the H-statistic makes it difficult to say whether there should be any concerns of the level of competition in the Swedish mortgage banking sector. The correlation between the structural competition models based on concentration, and the non-structural competition models, here illustrated by the Panzar-Rosse model, is found to be extremely low. This result is in line with previous research, and indicates that structural and non-structural competition models measure quite different things.

To what extent bank competition affects monetary policy has been subject to different views and findings in recent academic literature. We have examined the Swedish case to analyze the correlation between the Panzar-Rosse H-statistic and cumulative impulse responses as effects of the monetary policy shocks. On the margin, we find some evidence of correlation between these two variables. However, when specifying the shocks on bank lending, money supply, price level and GDP and regressing those shocks on the degree of competition on the banking market, we find no indications of a relationship. Neither when regressing bank lending on the interaction between bank competition and the effects of monetary policy shocks, we are able to find this to be significant in the previous period. This implies that there is not enough evidence to support our hypothesis that the degree of bank competition does affect the impact of monetary policy to the real economy.

What regards future research, it would certainly be interesting with a focus of bank competition on businesses lending instead of public lending. Also, more comparison could be done if the same study was conducted on an EU-wide level. What these two research suggestions would require compared to this study, is access to more data that would include more countries and a longer time period. The acquirement and modeling of this data is beyond the scope of this essay. We have also focused on monetary policy on a competitive market. Further it would be of great interest to study how the monetary policy is affected by the level of concentration on the banking market.

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## 9. Appendix

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### Appendix A

**Table A. 1. Banks in Sweden with Public Lending**

<b>Banks with public lending in Sweden</b>
SEB
Handelsbanken
Swedbank
Nordea Bank
Danske Bank, filial
SkandiaBanken
Länsförsäkringar Bank
DnB NOR Bank, filial
GE Money Bank
Carnegie Investment Bank
Dexia Crédit Local, filial
Kaupthing Bank Sverige
Hypo Real Estate Bank Int., filial
ABN AMRO Bank, filial
Calyon Bank, filial
Färs & Frosta Sparbank
Swedbank Sjuhärad
Nordnet Bank
HQ Bankaktiebolag
ICA Banken
Sparbanken Gripen
Citibank, filial
IKANO Banken
Avanza Bank
Bank of Scotland plc, filial
Varbergs Sparbank
Sparbanken Skaraborg
Santander Consumer Bank, filial
Resurs Bank
Sparbanken Lidköping
Eskilstuna Rekarne Sparbank
EFG Investment Bank
Tjustbygdens Sparbank
Bergslagens Sparbank
Toyota Kreditbank, filial
MedMera Bank
Forex Bank
Ölands Bank
Volvofinans Konto Bank
Vimmerby Sparbank

*Source: Bankföreningen (2010)*

*Comment: These banks are used to calculate the HHI-index*

**Table A. 2. Banks in Sweden with Mortgage Lending**

<b>Banks active in mortgage lending in Sweden</b>
SEB Bolån
Stadshypotek
Swedbank hypotek AB
Nordea Hypotek AB
Danske Bank, filial
SBAB
SkandiaBanken
Länsförsäkringar Hypotek AB
DnB NOR Hypotek AB
Kaupthing Bank Sverige
Färs & Frosta Sparbank
Swedbank Sjuhärad
Sparbanken Gripen
IKANO Banken
Varbergs Sparbank
Sparbanken Skaraborg
Resurs Bank
Sparbanken Lidköping
Eskilstuna Rekarne Sparbank
Tjustbygdens Sparbank
Bergslagens Sparbank
Vimmerby Sparbank
EFG Bank

*Source: Bankscope*

*Comment: These banks are used to calculate the P-R H-statistic*

## Appendix B

**Table B. 1. Panzar-Rosse H-statistic with Alternative Specifications**

	<b>Control Variables (full regression)</b>	<b>Full misspecification regression (interest income and total assets is the dependent variable)</b>	<b>Misspecification regression (3 variables) (interest income and total assets is the dependent variable)</b>
<b>1998</b>			0.28
<b>1999</b>			0.19
<b>2000</b>			0.19
<b>2001</b>	0.17	0.30	0.24
<b>2002</b>	0.33	0.02	0.06
<b>2003</b>	2.59	0.13	0.12
<b>2004</b>	0.35	0.10	0.21
<b>2005</b>	6.78	4.11	0.22
<b>2006</b>	1.38	0.39	0.01
<b>2007</b>	2.56	0.58	0.27

*Comment: The H-statistic should have a range between 0 and 1. P-values are shown.*

**Table B. 2. Hypothesis Testing (3 parameters)**

	Year	F-test (p-value)
H=0	2007	0.00
H=1		0.01
H=0	2006	0.98
H=1		0.83
H=0	2005	0.71
H=1		0.01
H=0	2004	0.79
H=1		0.01
H=0	2003	0.66
H=1		0.56
H=0	2002	0.28
H=1		0.02
H=0	2001	0.56
H=1		0.19
H=0	2000	0.57
H=1		0.16
H=0	1999	0.83
H=1		0.18
H=0	1998	0.86
H=1		0.01
H=0	1997	0.19
H=1		0.01

*Comment: The hypothesis  $H=1$  tests whether the  $H$ -statistic equals 1. The hypothesis  $H=0$  tests whether the  $H$ -statistic equals 0.  $P$ -values are shown.*

**Table B. 3. Robustness Check (3 parameters)**

	Year	F-test (p-value)
ROAA	2007	0.73
ROEA		0.00
ROAA	2006	0.38
ROEA		0.10
ROAA	2005	0.60
ROEA		0.72
ROAA	2004	0.29
ROEA		0.32
ROAA	2003	0.45
ROEA		0.41
ROAA	2002	0.63
ROEA		0.44
ROAA	2001	0.07
ROEA		0.85
ROAA	2000	0.78
ROEA		0.92
ROAA	1999	0.62
ROEA		0.82
ROAA	1998	0.06
ROEA		0.82

*Comment: The robustness check test uses a one-sided t-test is used to test the hypothesis  $H_0: H = 0$  (equilibrium) against  $H_1: H < 0$  (disequilibrium). ROAA is returns on average assets and ROAE is the returns on average equity. P-values are shown.*

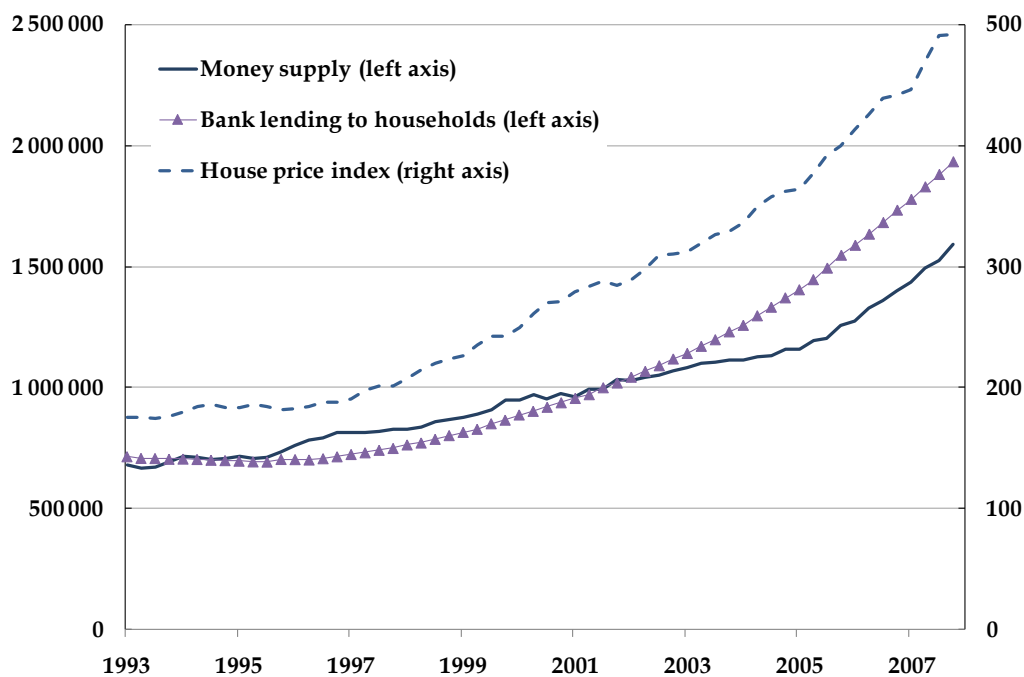
**Table B. 4. Battery of Diagnostic Tests**

Year	Normality	Adjusted R <sup>2</sup>	Heteroskedasticity	Misspecification
2007	0.79	0.68	0.79	0.10
2006	0.57	0.78	0.31	0.05
2005	0.00	-0.11	0.39	0.78
2004	0.05	0.50	0.10	0.60
2003	0.13	0.64	0.23	0.67
2002	0.83	0.76	0.12	0.00
2001	0.74	0.83	0.31	0.01
2000	0.64	0.75	0.96	0.34
1999	0.74	0.65	0.58	0.00
1998	0.81	0.60	0.06	0.11
1997	0.70	0.29	0.35	0.13

*Comment: The Jarque-Bera test is used to test for normality, the regressions are tested for heteroskedasticity by the use of a White's test and misspecification is tested with Ramsey's RESET test (2 fitted terms). P-values are shown except for in the column with the adjusted R<sup>2</sup>.*

## Appendix C

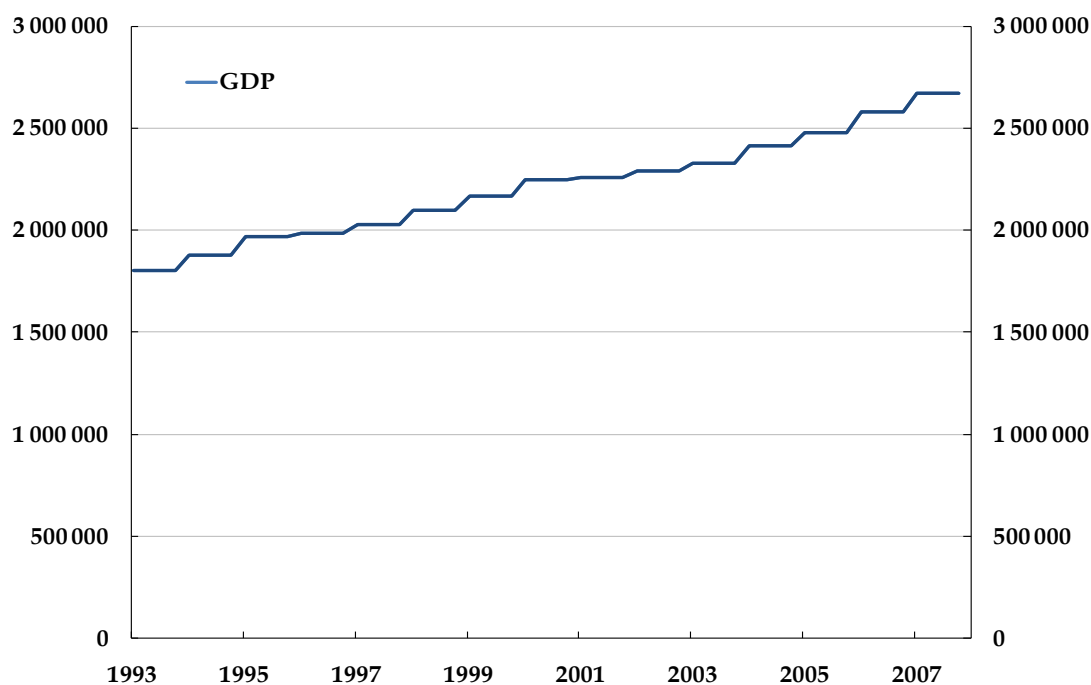
**Table C. 1. Money Supply, Bank Lending and House Price Index**



Source: The Riksbank and Statistics Sweden

Comment: Absolute values of bns of SEK on the left axis

**Table C. 2. Real GDP**



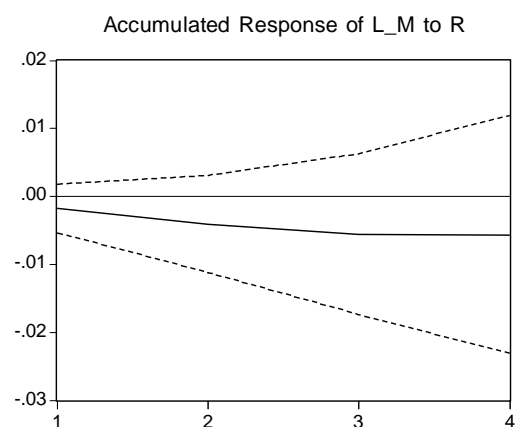
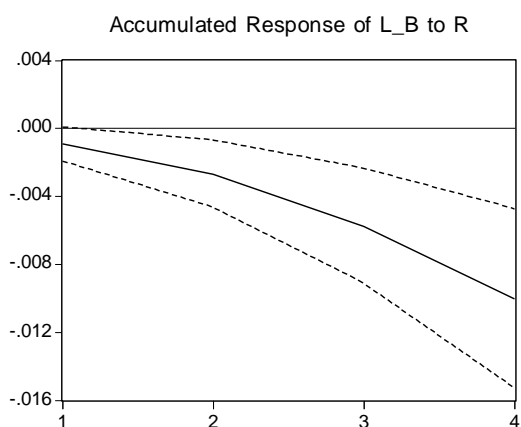
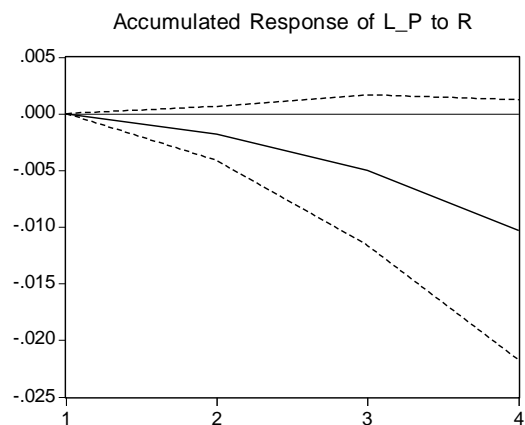
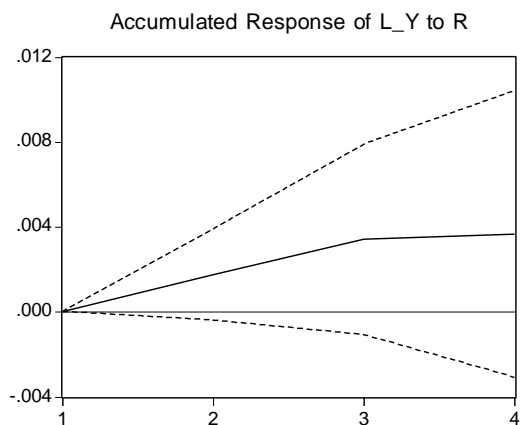
Source: The Riksbank and Statistics Sweden

Comment: Absolute values of bns of SEK

**Table C. 3. Impulse Response Function (Model A)**

1 year (4 quarters)

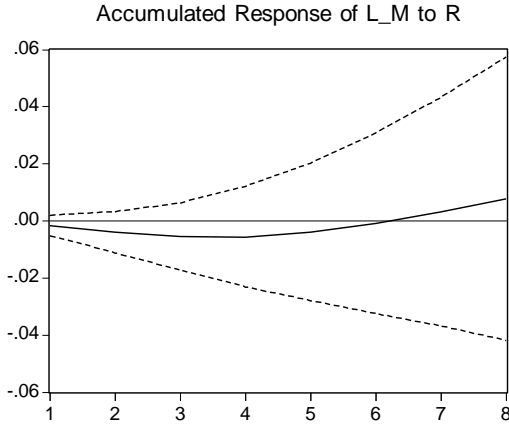
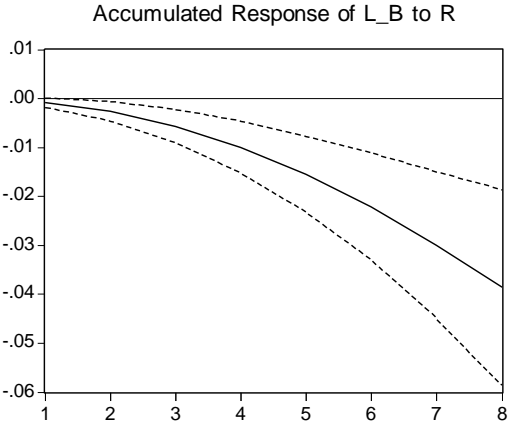
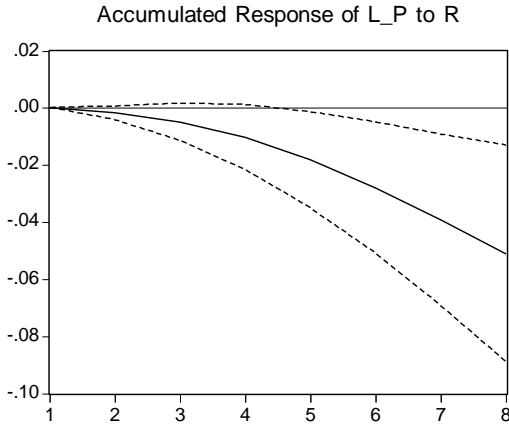
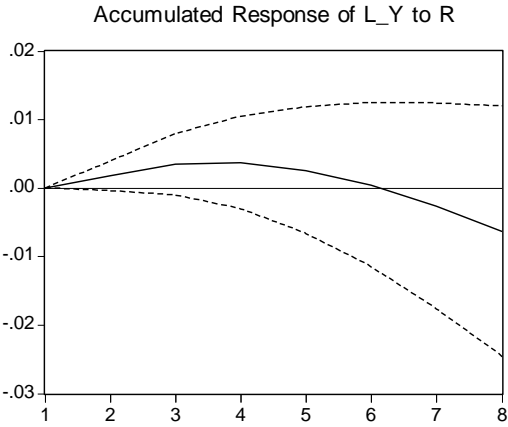
Accumulated Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.





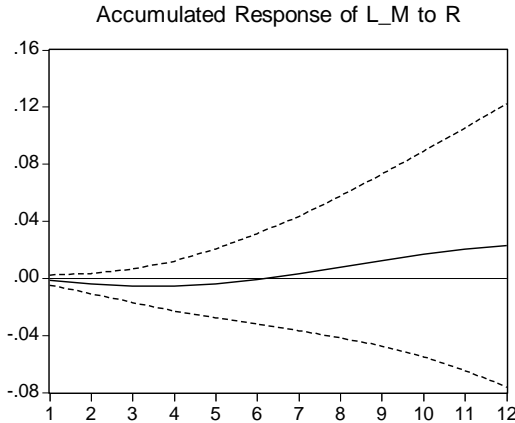
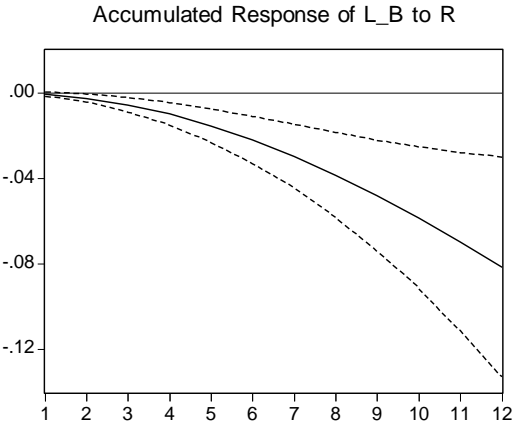
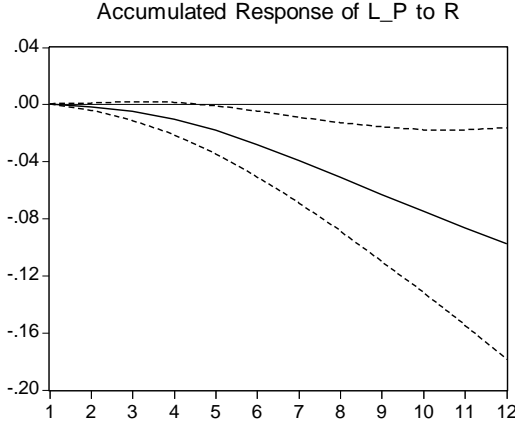
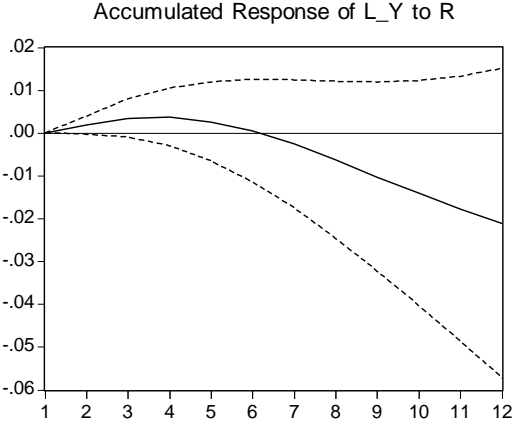
2 years (8 quarters)

Accumulated Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



3 years (12 quarters)

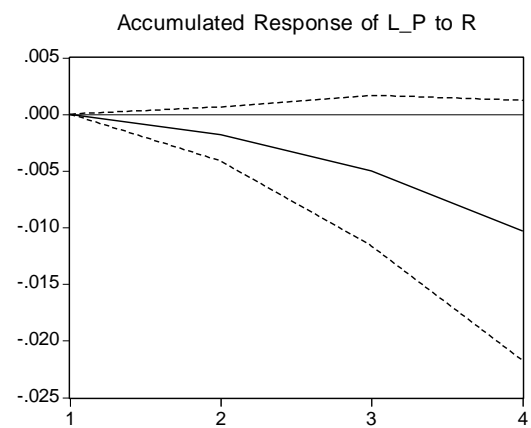
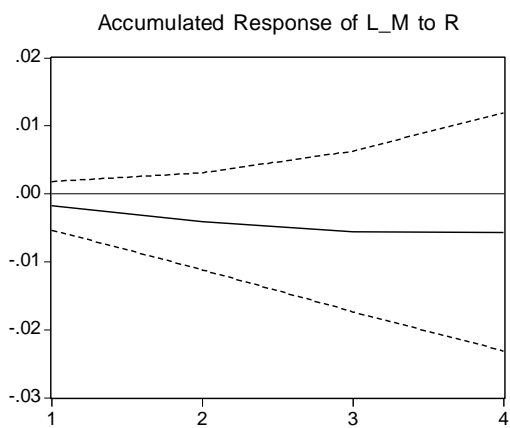
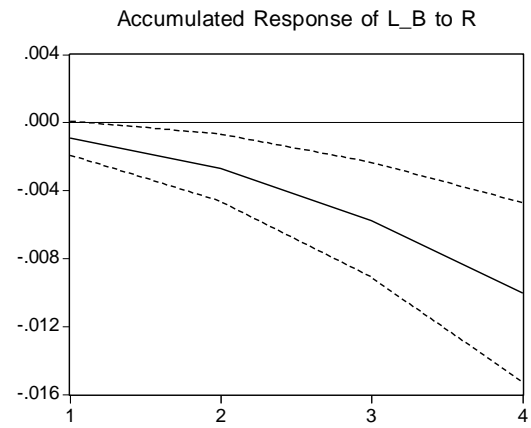
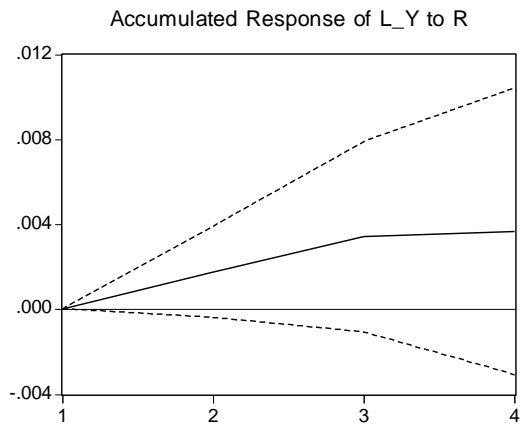
Accumulated Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



**Table C. 4. Impulse Response Function (Model B)**

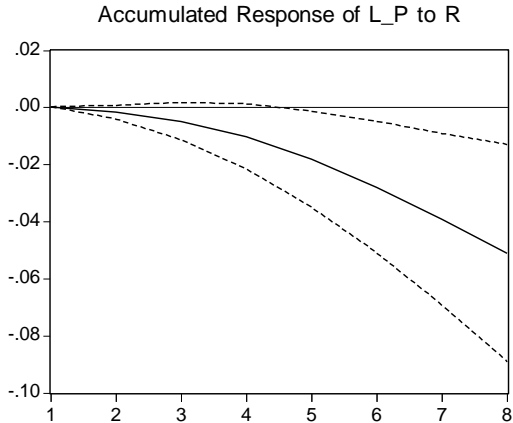
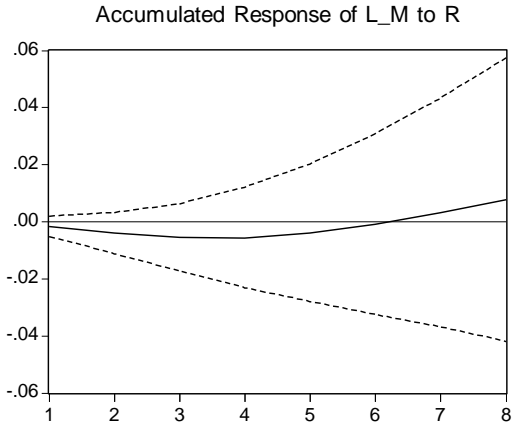
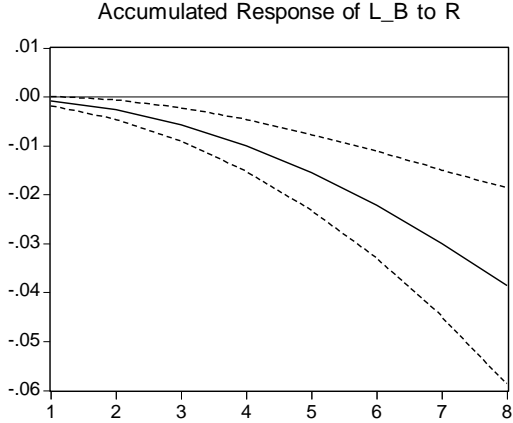
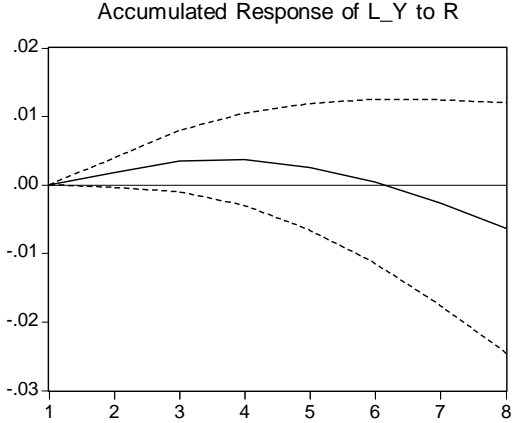
1 year (4 quarters)

Accumulated Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



2 years (8 quarters)

Accumulated Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



3 years (12 quarters)

Accumulated Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

