MONETARY POLICY ISSUES ARISING FROM BANK COMPETITION

by

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The banking sector has been extensively analyzed in economics. On the microeconomic side, research has advanced our understanding of banks and the inverse relationship between market power and bank production. The macroeconomic side of research has focused on the transmission of monetary policy, and it is understood that the financial system, including banks, plays an integral role in transmitting monetary policy decisions to economic variables such as investment, consumption, and GDP. There is limited understanding, however, about how market power and bank concentration affects the transmission of monetary policy. The main

focus of this dissertation is to address this gap in the literature and is achieved by three contributions. First, I develop a theory of banking behavior that accounts for competition and monetary policy. I empirically test the theory and show that banking concentration dampens the impact of monetary policy on lending activity in the short-run. My second contribution involves building a theoretical model with these short-run lending effects incorporated into an endogenous growth model that allows agents, banks, and the central bank to interact. This model shows how short-run lending is tied to growth. Again, monetary policy is less effective in markets with higher concentration. The last contribution is made by empirically testing the second contribution. The empirical findings are consistent with both the first and second contributions; banking markets with less competition adversely affect growth and also diminish the long-run impact of monetary policy.

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CHAPTER I

INTRODUCTION

It is well understood that the financial system and banks specifically, play a fundamental role in macroeconomics. Any principles of economics class teaches that, even in its simplest form, the financial system is important in equating savings and investment by channeling funds from savers to borrowers. The financial system extends and expands credit to the benefit of the entire economy; banks play the largest role.

The recent financial crisis of 2007-2009 has brought the financial system to the forefront of macroeconomics, not only among macroeconomists but in the mainstream media as well. It has brought unprecedented interest in the financial system, both during and after the crisis. Issues have arisen such as regulation, firm size, competition, and differing banking systems that must be dealt with in the near future. The financial crisis has consequent spillover effects on the whole economy that affect everyone now and for years to come. How and why banks interact with each other and the economy is important in understanding not only business cycles, but the long-run health and stability of the overall economy. The micro-structure of banking is essential in answering these questions.

The chapters that follow are an attempt to help fill in the gap between microeconomic (most specifically industrial organization) research done on banking and the research conducted by macroeconomists. Chapter II takes a closer look at how banks make lending decisions in the short-run, or on a period-by-period basis. The chapter begins by building a model in which banks compete in Cournot competition. After solving a bank's profit maximization problem for loans and aggregating to the market level, I show markets with higher banking concentration dampen the effectiveness of monetary policy on lending activity. Then, using U.S. county-level loan data, the theory is tested empirically. The results suggest that monetary policy is indeed dampened in markets with higher banking concentration, or a loosening of monetary policy (lowering of short-term interest rates) does increase lending activity in a market with a high concentration level, but not to the extent that a low concentration market does.

Chapter III builds an endogenous growth model to examine how profit maximizing banks and utility maximizing agents select the amount of lending activity for capital investment in the long-run. Using a simplified version of the banking sector presented in Chapter II, the long-run growth rate of the economy is calculated from the capital accumulation equation. This link between lending activity and capital investment is important. While some models show how bank concentration influences long-run, or steady-state growth, this chapter's fundamental contribution is to analyze how monetary policy flows through banks and how it affects lending activity in the short-run, and ultimately growth of the real economy in the long-run. It should be thought of how the snap-shot of the economy in the short-run built in Chapter II plays out in a dynamic economy over the long-run.

This model provides a simple framework to analyze how monetary authorities interact with economic agents through the banking sector. It theorizes that countries with lower banking concentration have a two-fold positive effect on steady-state growth. First, lower banking concentration (more competition) increases lending and capital investment, or reduces the dead-weight loss associated with monopoly power. Consistently higher (and cheaper) investment in capital generates higher growth rates. Second, lower banking concentration allows monetary policy to play a larger role in the long-run. When there is an expansionary monetary policy change, lending activity increases more in markets with lower bank concentration. Consistently higher lending for investment leads to higher growth rates in the long-run.

Lastly, Chapter IV empirically tests the long-run theory developed in Chapter III. Using cross-country, industry level data, the estimates support the theory that banking concentration creates a lasting effect on steady-state growth rates. Overall, I find that high interest rates and high banking concentration lowers steady-state growth. However, a lowering of interest rates positively affects growth more in countries with lower concentration levels. Higher bank concentration hinders central bankers' abilities to adjust lending and investment activity in markets with higher concentration. This effect also persists into the long-run where the higher lending activity created by central banks occurs more in markets with lower concentration, and ultimately growth is affected more in these economies as well.

The following chapters show that the micro-structure of financial markets does theoretically affect monetary policy; the data confirm these results. In these chapters, banks maximize profits and there are no transaction costs, but the inefficiency of market power is enough to cause central banks to have less potency on the economy when setting short-term interest rates. These inefficiencies are dynamic in nature, which cause lower potency to persist and affect long-run growth rates.

CHAPTER II

MONETARY POLICY EFFECTIVENESS AND BANKING CONCENTRATION

2.1. Introduction

The financial system extends and expands credit to the benefit of the entire economy; banks play the largest role. Beyond equating savings and investment, the microstructure of banks and banking markets causes heterogeneity among banks and the markets in which they operate. Since the financial system is widely viewed as the intermediary through which monetary policy flows to affect the macroeconomy, it is only natural to think that heterogeneous banking markets create heterogeneity in the transmission of monetary policy. In this chapter, I construct a model of a profit-maximizing bank and examine the results of market concentration on the effectiveness of monetary policy. I show that a market with few banking competitors dampens loan adjustment induced by a change in monetary policy. I empirically test this theory using Community Reinvestment Act (CRA) U.S. county-level data. The data provide strong support of the theory; monetary policy's effect on lending is dampened in markets with higher banking concentration.

It is well established that the presence of market power allows firms to mark up prices by restricting quantities, resulting in a socially inefficient outcome. The same logic can be applied to banks that have market power. They may restrict the amount of loans to increase the price on loans, and firms who rely on bank loans for financing can find it more difficult raise funds for investment projects. Investment projects that would have been profitable had they been undertaken may not get access to proper funding. If interest rates on loans are marked up above the marginal product of capital when market power is present, banks may optimally react differently to monetary policy changes than banks that compete in perfectly competitive markets. The degree of competition in the banking industry can alter how banks naturally adjust loans when there are changes in short-term interest rates, and this effect may eliminate investment projects that might have been funded in a different market.

Monetary policy differences due to banking concentration have important impacts, both on loan-dependent borrowers and on a monetary authority's ability to stabilize the real economy. More concentrated markets may not increase lending as much as competitive markets when there is an expansionary monetary policy change. Firms who rely on bank loans to finance investment projects may not have access to adequate funding from banks due to banking concentration. This is an inefficient outcome in investment projects because some socially valuable projects cannot be undertaken due to inadequate financing. The impact on monetary authorities is two-fold. First, short-term interest rates, the primary tool used by central banks to adjust the economy, may be less effective due to increases in bank concentration. Second, monetary policy may not transmit equally through the economy. One region may be impacted more than another due to a change in monetary policy. This poses several challenges in monetary policy since the Federal Reserve only has one national policy variable and cannot make it differ in separate regions. Thus, regional monetary policy differences caused by banking concentration are important to more than just policy makers, but also to individuals and businesses in the economy that rely on the banking system for financing.

Market power in the banking industry has been well documented and findings show banks react differently to market conditions due to competition. Cottarelli and Kourelis (1994) establish that less competitive banking markets are more sluggish in adjusting to short-term interest rate changes than their more competitive counterparts. Corvoisier and Gropp (2001) find that increased concentration in the banking industry across Europe has resulted in less competitive pricing behavior for loans and demand. This implies that more concentrated markets have the ability to mark up prices. Indeed, Angelini and Cetorelli (2003) discover that markups have decreased due to regulatory reforms that have removed barriers to entry. This finding supports previous literature showing that market concentration can give banks a form of monopoly power. Sellon (2002) notes that banking competition has intensified due to the removal of barriers to entry and has affected how banks adjust loan rates to monetary policy. Furthermore, Hart (1982) shows that there is an increasing gap between a firm's demand curve and their marginal revenue curve with respect to market concentration, giving rise to a price markup.

Berlin and Mester (1997) and Boot (2000) provide evidence that banks can gain potential market power through a relationship benefit. When a bank enters a close (e.g. personal) relationship with a firm or individual, that bank gains important information about the probability of default, or credit-worthiness of that entity. This results in better information for the bank as compared to others in the area and can result in a form of market power for the bank. The firm or individual also benefits from this relationship in that it can have possible uninterrupted and larger access to funds when needed. These authors also show that relationship benefits can decrease with the number of competitors. It follows, therefore, that bank concentration is a good proxy for relationship benefits.

Two credit channels in the transmission of monetary policy have been well studied. First, the balance sheet channel describes how an increase in short-term interest rates tend to decrease a firm's net worth and cause lenders to increase their risk premium, or interest rates on financing. Thus, firms with less liquid balance sheets find it harder to undertake investment projects due to a decreased net worth. The second channel, the bank lending channel, states that firms with the ability to internally raise capital are less constrained in financing investment projects when short-term interest rates rise since they are able to shield themselves somewhat from interest rate changes. Firms that are limited to borrowing through bank loans are, therefore, forced to adjust investment more than firms with access alternative financing when there is a change in monetary policy.[1]

This paper combines research on bank behavior from competition and the transmission of monetary policy. Adams and Amel (2005) were the first to empirically study how banking concentration influences monetary policy through the bank lending channel. This paper adds to their research by building a theoretical model and empirically testing, and supporting the theory. Specifically, the theory shows that there is a negative relationship between bank lending and short-term interest rates, but this relationship is increasingly mitigated as market concentration increases in the banking sector. Empirically, this is easily tested through a coefficient on the interaction term of monetary policy and bank concentration. The empirical analysis is quite robust and supports the theory developed in this chapter.

The rest of the paper is organized as follows: Section 2.2 develops a theoretical model showing why market concentration can change a bank's optimal behavior. Section 2.3 provides the empirical methodology and describes the data. Section 2.4 contains the empirical results and Section 2.5 concludes.

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[1]See Ceccetti (1995) or Bernanke and Gertler (1995) for a more detailed explanation of both credit channels.

2.2. Theoretical Framework

2.2.1 General Setup

Banks compete in a Cournot setting and maximize profits via the expected net return on funds taking the choices of other banks as given. Funds can be allocated to assets but to raise additional funds beyond original equity, banks must pay a rate of return on liabilities. There are three assets: loans, reserves, and government securities. There is one liability: deposits. Letting x_{iL}, x_{iR}, and x_{iG} be the proportion of funds that an individual bank i has in loans, reserves, and securities, respectively, a bank seeks to maximize the expected rate of return on funds (profits), or

$$E_{iF} = [W_i + D_i] \sum_k x_{ik} E_{ik} - D_i R_i \tag{2.1}$$

where W_i is original equity of the bank, E_{ik} is the expected rate of return on the k^{th} asset, D_i are deposits, and R_i is the interest paid on deposits by bank i.

With this general framework, I can describe a bank's assets and liabilities in more detail.

2.2.2 Assets and Liabilities

Banks allocate funds over three assets: loans, reserves, and government securities. All yield a rate of return for the bank. Each market has an exogenous distribution of relationship benefits on loans. Therefore, each bank in the market has a different relationship benefit measure. Furthermore, each bank faces a downward-sloping inverse demand curve that is a function of loans and other exogenous bank-specific and market-specific variables, β, or

$$r_i = f\left(\sum_j x_{jL}, \beta\right), \quad f'_1(.) < 0$$

where r_i is bank i's interest rate on loans, x_{jL} is the quantity of loans from bank j, and $\sum_j x_{jL}$ is the total market funds allocated in loans (e.g. market quantity).

Since banks have different relationship benefits which map into differing monitoring costs or probabilities of default, the expected rate of return on loans, E_{iL}, is strictly less than the interest rate on loans. More specifically,

$$E_{iL} < r_i \text{ if } \sigma_{iL} > 0$$

and

$$E_{iL} = h\left(\sum_j x_{jL}, \beta, \sigma_{iL}\right), \text{ where } h'_1(.) < 0, h'_3(.) < 0$$

where σ_{iL} is the monitoring costs or probability of default on loans. It is decreasing in a bank's relationship benefit stance.

Banks also hold a proportion of funds as reserves, x_{iR}. A bank can loan its excess reserves into the federal funds market and receive the overnight rate of interest, the federal funds rate, in return. Letting E_R denote the expected rate of return on reserves, then E_R is the federal funds rate, or a monetary policy measure. It is assumed to be exogenously set by the Central Bank.

Lastly, banks hold government securities, x_{iG}. Government securities are provided with perfectly inelastic supply and unlike loans, do not have a risk of default. The securities pay the risk-free rate of return, E_G, and can be liquidated with relative ease.

Banks raise funds for assets by securing deposits from consumers, D_i. To attract deposits, banks pay an interest rate on the account; deposits are increasing in this interest rate. Therefore,

$$D_i = D(R_i), \quad D'(.) > 0$$

where R_i is the implicit and explicit interest paid on deposits by bank i.[2]

2.2.3 Solution and Optimality Conditions

The details on assets and liabilities from Section 2.2.2 are substituted into the general framework. Thus the bank's maximization problem becomes:

[2]One deposit is assumed without loss of generality. The overall model results do not change if more than one deposit-type is issued, as is shown in Klein (1971)

$$\max_{x_{iL},x_{iR},x_{iG},R_i} E_{iF} = [W_i+D(R_i)]\left[x_{iL}h\left(\sum_j x_{jL},\beta,\sigma_{iL}\right)+x_{iR}E_R+x_{iG}E_G\right]-R_iD(R_i) \tag{2.2}$$

$$\text{s.t.}\quad x_{iL}+x_{iR}+x_{iG}=1$$

The following are the first-order conditions solving the above maximization problem using a Lagrangian, where Γ is the Lagrange multiplier:

$$\frac{\partial\mathcal{L}}{\partial x_{iL}} = [W_i+D(R_i)]\left[h\left(\sum_j x_{jL},\beta,\sigma_{iL}\right)+x_{iL}h_1'\left(\sum_j x_{jL},\beta,\sigma_{iL}\right)\right]-\Gamma=0 \tag{2.3}$$

$$\frac{\partial\mathcal{L}}{\partial x_{iR}} = [W_i+D(R_i)]E_R-\Gamma=0 \tag{2.4}$$

$$\frac{\partial\mathcal{L}}{\partial x_{iG}} = [W_i+D(R_i)]E_G-\Gamma=0 \tag{2.5}$$

$$\frac{\partial\mathcal{L}}{\partial R_i} = D'(R_i)\left[x_{iL}h\left(\sum_j x_{jL},\beta,\sigma_{iL}\right)+x_{iR}E_R+x_{iG}E_G\right]-[D'(R_i)R_i+D(R_i)]=0 \tag{2.6}$$

$$\frac{\partial\mathcal{L}}{\partial\Gamma} = x_{iL}+x_{iR}+x_{iG}=1 \tag{2.7}$$

where $h_1'\left(\sum_j x_{jL}, \beta, \sigma_{iL}\right)$ is the derivative of the inverse demand function with respect to bank i's loans, x_{iL}.

If follows from equations (3)-(5) that the following must hold:

$$\left[h\left(\sum_j x_{jL}, \beta, \sigma_{iL}\right) + x_{iL}h_1'\left(\sum_j x_{jL}, \beta, \sigma_{iL}\right)\right] = E_R = E_G \qquad (2.8)$$

or banks optimally choose to lend until the expected marginal revenue of loans is equal to the opportunity cost of putting that money into other assets: the federal funds rate or the risk-free return on government securities. Equation (2.8) states that banks lend until the expected return from loans (on the margin) is equal to the opportunity cost of loans; either the risk-free rate or the federal funds rate.

2.2.4 Comparative Statics

This section aggregates all of the bank's first order conditions, equation (2.8), and shows a bank market loan response to a change in monetary policy (the federal funds rate) is a function of the Herfindahl-Hirschman index. Moreover, the higher the HHI in a market (e.g. less competitive) the less that market responds to a change in monetary policy.

Defining market quantity as X_L, rearranging equation (2.8), multiplying the right hand side by $\frac{X_L}{X_L}$, and using the fact that $\frac{x_{iL}}{X_L} = s_i$ or market share for bank i, then

$$h(x_{iL}, \beta, \sigma_{iL}) - E_R = -s_i X_L h_1'(x_{iL}, \beta, \sigma_{iL})$$

where

$$X_L \equiv \sum_j x_{jL}$$

Multiplying both sides by market share and aggregating all banks in the market shows

$$h(X_L, \beta, \bar{\sigma}_L) - E_R = -HHI * X_L h_1'(X_L, \beta, \bar{\sigma}_L) \tag{2.9}$$

where $\bar{\sigma}_L$ is the market average default rate, $h(.) - E_R$ is the average market markup, and HHI is the Herfindahl index in the market since $HHI = \sum_i s_i^2$. Equation (9) shows the average markup on loans is increasing in the HHI since $h_1'(X_L, \beta, \bar{\sigma}_L) < 0$.

Furthermore, the market loan response to a change in E_R, the federal funds rate is

$$\frac{dX_L}{dE_R} = \frac{1}{h_1'(X_L, \beta, \bar{\sigma}_L) + HHI[h_1'(X_L, \beta, \bar{\sigma}_L) + X_L h_1''(X_L, \beta, \bar{\sigma}_L)]} < 0 \tag{2.10}$$

or the response is decreasing (in absolute value) with the Herfindahl index. Equation (2.10) is assumed to be strictly negative since Novshek (1985) shows a Cournot equilibrium is guaranteed so long as

$$h_1'(X_L, \beta, \bar{\sigma}_L) + X_L h_1''(X_L, \beta, \bar{\sigma}_L) \leq 0$$

or a bank's marginal revenue is not increasing in its competitor's loans.[3]

Equation (2.10) shows that the higher the market HHI, the less that market responds to a change in monetary policy. Since monopoly banks restrict lending to raise the interest rate on loans, they lend a fraction of the loans that would be achieved in a perfectly competitive market. In essence, when short-term interest rates change, monopoly banks only adjust lending fractionally to a perfectly competitive market. As discussed in Hart (1982), higher concentration increases the gap between a bank's demand curve, $h(.)$ and it's marginal revenue curve, $x_{iL}h'(.) + h(.)$. Since a monopoly's marginal revenue curve is steeper than the market demand curve (creating the gap), monopolies adjust quantities less than perfectly competitive banks due to an associated cost change (monetary policy). Monetary policy effectiveness differs across markets because banks in a monopolistic market react less than banks in a highly competitive market due to differences in marginal revenue curves, not monetary non-neutralities. These findings support Dixon and Rankin (1994) where the presence of imperfect competition does not overturn monetary neutrality.

This basic framework sheds light on how market concentration can skew the transmission of monetary policy. Since a highly competitive market causes loans to contract more than a non-competitive market due to a change in monetary policy,

[3]All equations and calculations for this section are available in Appendix A.1.

there are asymmetric effects on the real economy from changes in the monetary policy stance. In essence, markets that are highly concentrated dampen monetary policy.

2.3. Empirical Methodology and Data

Section 2.2 provides a fundamental relationship between market lending volume, monetary policy, and market concentration. Market lending is the bank "choice" variable while monetary policy and market concentration are given exogenously. Differences in concentration across markets create differing markets responses to monetary policy changes. A reduced form equation is assumed that takes the form

$$Loans_{it} = \alpha_0 + \alpha_1 FFR_t + \alpha_2 HHI_{it} + \alpha_3 FFR_t * HHI_{it} + \Psi X'_{it} + \eta_{it} \tag{2.11}$$

where $Loans_{it}$ is the total lending in market i at time t, FFR_t is the federal funds rate, or monetary policy stance at time t, and HHI_{it} is the Herfindahl-Hirschman Index in market i at time t. X_{it} is a matrix of other explanatory variables. Theory predicts that $\alpha_1 < 0$, or loans are inversely related to the federal funds rate. From equation (10), the coefficient on the interaction term, α_3, determines if markets with different concentrations react differently to monetary policy changes. If more concentrated markets dampen monetary policy, then the interaction term should mitigate that coefficient, or $\alpha_3 > 0$.

It is fundamental to define a banking market before proceeding. The market is determined by two characteristics; the good and the location. Based on the theory outlined above, lending volume is the market output. Furthermore, the bank lending channel suggests a proper market in the context of monetary policy should be lending to businesses and that small businesses are the ones most affected by monetary policy actions. Therefore, the market good is defined as total market lending to businesses.

Since the local market is for business lending, the location is characterized by the banking area in which a (local) business borrows to meet financing needs. The Federal Reserve defines a banking market as a metropolitan statistical area (MSA), as noted by Laderman (2009). For non-MSA districts, the county serves as a banking market. This definition is reasonable, as businesses in rural areas are more likely to seek loans from banks within their county and businesses in urban areas typically borrow within their city or metropolitan area.[4] This definition also is supported by the benefit-relationships literature where businesses typically receive a line of credit over years of operation and continually borrow from the same bank in their market. Lastly, this measure is practical as the Federal Reserve also examines county-level concentration measures for non-MSA districts (see Competitive Analysis and Structure Source Instrument for Depository Institutions, or CASSIDI, at the Federal Reserve Bank of St. Louis). This market definition is

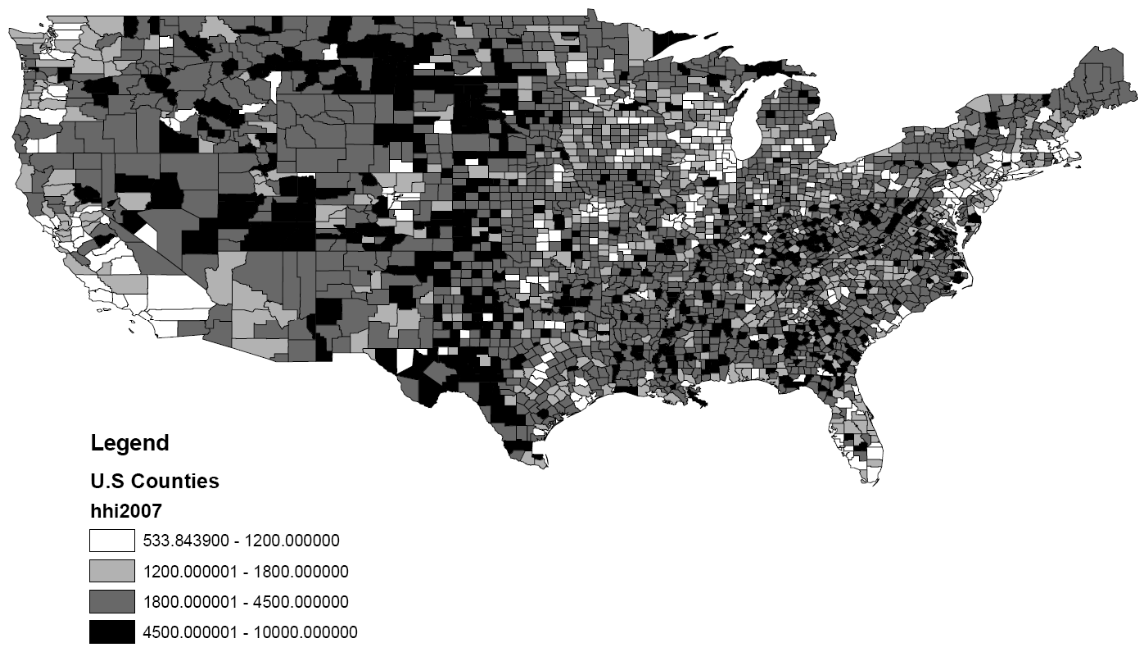
[4]See Laderman (2009) for more detail on this point

also the one used in Adams and Amel (2005) in their analysis of banking concentration on the transmission of monetary policy.

The dependent variable is the total amount of non-farm market lending by banks by year. The data used are Community Reinvestment Act (CRA) data which measure total loans under $1 million to businesses. It spans from 1996 to 2007. Since CRA data are measured at the county level, the data are simply aggregated to the market level. The dataset contains loan data by three categories: loans to businesses ranging from $0 to $100,000, loans from $100,000 to $250,000, and loans from $250,000 to $1 million. Again the data are aggregated across these categories by market to achieve to total amount of loans under $1 million to businesses by market. Lastly, the CRA data also contain the total amount of loans under $1 million to businesses that earn less than $1 million in revenue a year. These data can be used for a robustness measure since it is believed small businesses are the most affected by monetary policy changes via the bank-lending channel.

The monetary policy measure is the federal funds rate; the over-night rate on bank reserves. It is a national yearly variable that is averaged from monthly data. The Herfindahl index is calculated using FDIC deposit data from 1996 to 2007. The FDIC collects data on every bank member in the U.S. once a year. The deposits are aggregated by banking institution and by market to calculate market share. Then the HHI in a market is calculated by summing all squared market shares. Figure 1 shows the distribution of HHIs across the U.S. in 2007. Figure 1 shows that there

FIGURE 1. HHI Across Markets in 2007



is a wide array of concentrations across the U.S. A fair proportion of markets have HHIs lower than 1200 (competitive) while some markets are extremely concentrated with HHIs above 4500. Also, it appears that more populated areas of the U.S. are less concentrated.

Other control variables include the total number of loans made in a market, which is totaled using CRA data, total market assets from FDIC data, market population estimates from the U.S. Census Bureau, and the personal consumption expenditures (PCE) price index. The descriptive statistics for these variables are in Table 1.[5] This table contains the descriptive statistics for all markets, MSA markets, and non-MSA markets.

A market-by-market augmented Dickey-Fuller unit-root test supports only 12% of the markets *not* having a unit root in the dependent variable. A panel unit-root test developed by Levin, Lin, and Chu (2002) also fails to reject the null hypothesis of a unit root in the dependent variable. To accommodate the possibility of a unit root, equation (2.11) is also estimated using first differences:

$$\Delta \ln(Loans)_{it} = \beta_0 + \beta_1 \Delta FFR_t + \beta_2 \Delta \ln(HHI)_{it} + \beta_3 \Delta FFR_t * \Delta \ln(HHI)_{it} + \Phi \Delta X'_{it} + \epsilon_{it} \tag{2.12}$$

The descriptive statistics for these data are in Table 2; it also divides the information by all markets, MSA markets, and non-MSA markets.

[5] All tables are located at the end of each chapter.

2.4. Empirical Results: Monetary Policy Effectiveness on Lending

The coefficient estimates for equation (2.11) are in Table 3. Column 1 is a market fixed-effects regression and column 2 is the random-effects model. Columns 3 and 4 are the same but with a time trend. Hausman tests suggest that the fixed-effects models should be used instead of the random effects. As the theory predicts, the coefficient on the federal funds rate is negative and significant at the 99% level and the coefficient on the interaction between the federal funds rate and the Herfindahl index is positive at the 99% level for all regressions. These specifications also suggest that more concentrated markets restrict lending (i.e. monopolies restrict output) as the coefficient on the Herfindahl index is negative and significant at the 99% level in all columns.

Dickey-Fuller and Levin, Lin, and Chu tests provide evidence of a unit root in the dependent variable, however. Thus the results in Table 3 might arise from a spurious regression. Table 4 contains the results for regression estimates of equation (2.12). Table 4 is identical to Table 3 except for the equations used for estimating. Again, Hausman tests suggest that fixed-effects models should be used (Columns 1 and 3), but the coefficients of interest are robust across the random-effects models as well. The results in Table 4 support the theory that more concentrated banking markets optimally react less to monetary policy, causing changes in monetary policy to be less effective. The coefficient on the interaction term is significantly positive and the opposite sign of monetary policy. Furthermore, the Herfindahl index alone does not appear to significantly affect lending by itself, but rather through monetary policy via the interaction term. The significance and the magnitudes of the coefficients of interest are quite robust across sensitivity-checks.[6]

To give a numerical example from column 1, a 100 basis point (1%) increase in monetary policy can contract loans by 7.22% in a market that did not experience a banking concentration change, but loans will contract by only 6.31% for the same monetary policy change in a market that is 10% more concentrated (assuming that changes in concentration do not affect lending itself). There are asymmetries in monetary policy transmission created by market concentration in the banking sector.

The results above may be driven by the market definition, however. In other words MSA districts may react differently than non-MSA districts. To allow for a possible bias in the results, the market definition needs to be examined more closely. Table 5, column 1 contains the results when adding in an urban dummy variable that is equal to 1 if a market has an MSA classification, and 0 if it is in a non-MSA district (a single county) is added to the model. Columns 2 and 3 present the results of the same regression results as Table 4, column 1 but between MSA (urban) and non-MSA (rural) markets. A Chow test across market definition yields an

[6]It should also be noted that the results do not differ with the inclusion of one or several time lags of variables of interest or exclusion of asset growth or lagged loan growth. Also the results are robust using real loan growth (loans divided by the personal consumption expenditure (pce) index). The results are still nearly unchanged with the inclusion of GDP growth to control for a national economic variable. These regression tables are in Appendix A.2.

F-statistic of 98.5, well beyond the 0.1% critical value of 3.13. This suggests that markets react differently, and that a market-pooled regression is not the ideal specification.

As is seen in Table 5, the sign on the interaction term is still positive and significant for both urban and rural markets, but the coefficient is much larger in magnitude in rural (non-MSA) areas. This suggests that rural markets dampen the effects of monetary policy more than urban markets for a given change in concentration. As Adams and Amel (2005) propose, this could be because the HHI in urban markets tend to lie below the level of "highly concentrated" (1800) as classified by the Federal Reserve, while most rural markets lie above the 1800 mark. This is suggestive of the relationship benefits theory since rural markets generally tend to be more concentrated, and businesses in these markets are more shielded from monetary policy and, therefore, loan changes.

Previous work suggests that the bank lending channel is strongest with small businesses because smaller firms cannot find alternative forms of financing as compared to larger firms. Thankfully, the CRA data contain bank loans under $1 million to businesses with under $1 million in revenue per year. The only difference between these loan data and the loan data used earlier is that it is only to businesses with under a $1 million in revenue. Thus total profits are smaller and these businesses are the ones that should be affected the most if the bank lending channel and balance sheet channel of monetary policy hold true.

Table 6 presents the results using loan data to small(er) businesses. Column 1 reports the regression results for all markets. Column 2 displays the results for urban markets and column 3 for rural markets. Fixed-effects were used for all regressions. The results do not support the theory that small firms are the most credit constrained when monetary policy tightens since the coefficient on the monetary policy measure decreases in magnitude. This counters the bank lending channel theory because small businesses should be the most affected by monetary policy changes instead of the least affected. The results might suggest that relationship benefits play an important role to small businesses since it appears that these businesses are less credit constrained in concentrated markets during a monetary policy tightening, but they also may fail get adequate funding when there is a monetary policy easing.

Lastly, it could be the case that there is a large amount of outside-of-market loans occurring. Up to 10% of loans come from out-of-market banks when markets are defined as MSAs (Laderman (2009)). A business located near a market line (for markets defined in this paper), the nearest bank may be across that line, thus located in a different market. Laderman (2009) suggests a state may be a more appropriate market measure than an MSA due to out-of-market lending. Table 7 presents the results for markets defined at the state level, not the MSA level. The results are strikingly similar to the results earlier; market concentration does not appear to affect bank lending by itself, but higher concentration dampens monetary policy. The interaction term is still positive at the 99% significance level. These results are suggestive that out-of-(MSA)market loans either do not play a large role to small businesses, or that businesses applying for out-of-market loans are not treated differently than in-market businesses.

2.5. Conclusion

This paper examines the effects of monetary policy in local economies in the presence of market-level banking concentration. Using a model of a bank that maximizes the expected return on funds (aka profits), it is shown that markets with lower concentration measures (or higher Herfindahl indices) exhibit dampened effects of monetary policy via loans to local borrowers. Using Community Reinvestment Act (CRA) data, which measure total bank loans under $1 million to businesses, the empirical results support the theory in that more concentrated markets can dampen monetary policy.

These results have important implications for both loan borrowers and the Federal Reserve. When there is an expansionary monetary policy change, businesses that rely on loans from banks cannot get funding for investment projects that would be profitable had they been funded. This result is not the socially optimal result achieved by a perfectly competitive market and might tighten funding for businesses that mainly rely on the banking system. The other implication is that monetary policy is not transmitted equally throughout the economy. Monetary policy has different effects on the economy through banking concentration while holding everything else constant. Thus optimal monetary policy may change in light of these results.

Further research is needed investigating optimal monetary policy when markets have different concentrations. Also spatial aspects should be used to account for possible cross-market correlations. Additional work is also needed to see if the banking concentration effects are dynamic and persist in the long-run by affecting growth rates.

TABLE 1. Data Statistics: 1996-2007

All Markets	Mean	Standard Deviation	Minimum	Maximum
Loans (Thousands of Dollars)	92,827.76	409,455.8	0	13,100,000
FFR (Percentage Points)	4.045	1.705	1.128	6.236
HHI	3,371.544	2,207.865	0	10,000
Number of Loans	2,697.889	14,494.04	0	666496
Assets (Millions of Dollars)	2,950,000	20,600,000	8.808	1,280,000,000
Population (Thousands)	117.69	489.03	.045	11,607.84
PCE (2000=100)	103.81	7.60	93.55	117.66
Number of Markets	2,430			

MSA Markets	Mean	Standard Deviation	Minimum	Maximum
Loans (Thousands of Dollars)	512,145.9	926,353	8,584	13,100,000
HHI	1,562.747	758.910	315.237	8,203.699
Number of Loans	14,720.52	34,151.62	120	666,496
Assets (Millions of Dollars)	17,000,000	494,000,000	3,075.919	1,280,000,000
Population (Thousands)	622.75	1,104.59	42.08	11,607.84
Number of Markets	381			

Non-MSA Markets	Mean	Standard Deviation	Minimum	Maximum
Loans (Thousands of Dollars)	14,857.92	22,772.97	0	303,670
HHI	3,711.88	2,225.33	0	10,000
Number of Loans	462.350	656.417	0	11,171
Assets (Millions of Dollars)	303,000	768,000	8.808	13,400,000
Population (Thousands)	23.78	23.02	.045	188.36
Number of Markets	2049			

TABLE 2. Data Statistics: 1996-2007

All Markets	Mean	Standard Deviation	Minimum	Maximum
$\Delta \ln(Loans)$	0.089	0.531	-4.559	5.966
$\Delta(FFR)$	-0.0254	1.318	-2.348	1.864
$\Delta \ln(HHI)$	-0.0021	0.135	-2.119	1.706
$\Delta(Number\ of\ Loans)$	415.486	4,056.059	-9,608	318,170
$\Delta \ln(Assets)$	0.255	0.757	-9.044	10.144
$\Delta \ln(Population)$ (100s)	0.195	0.016	-0.335	0.182
$\Delta \ln(PCE)$ (Inflation Percentage)	2.085	0.601	0.894	2.900
Number of Markets	2,430			

MSA Markets	Mean	Standard Deviation	Minimum	Maximum
$\Delta \ln(Loans)$	0.068	0.184	-1.667	1.106
$\Delta \ln(HHI)$	-0.0004	0.1934	-2.119	1.706
$\Delta(Number\ of\ Loans)$	2,353.235	10,016.5	-9,608	318,170
$\Delta \ln(Assets)$	0.304	0.504	-4.688	6.197
$\Delta \ln(Population)$ (100s)	1.028	1.259	-27.956	10.014
Number of Markets	381			

Non-MSA Markets	Mean	Standard Deviation	Minimum	Maximum
$\Delta \ln(Loans)$	0.093	.573	-4.559	5.966
$\Delta \ln(HHI)$	-0.0024	0.1213	-1.267	1.623
$\Delta(Number\ of\ Loans)$	55.172	174.765	-1,578	6,001
$\Delta \ln(Assets)$	0.246	0.796	-9.044	10.144
$\Delta \ln(Population)$ (100s)	0.041	1.567	-33.464	18.232
Number of Markets	2049			

TABLE 3. Regression Results for Equation (2.11) Using All CRA Data

(n=26464, No. of Markets is 2412)

	(1)	(2)	(3)	(4)
Dependent Variable	$Loans_t$	$Loans_t$	$Loans_t$	$Loans_t$
$Loans_{t-1}$ (1000s)	0.589***	0.838***	0.588***	0.838***
	(0.004)	(0.002)	(0.003)	(0.002)
FFR_t	-3413.89***	-1539.96***	4145.69***	1954.09***
	(207.6)	(229.6)	(256.2)	(284.9)
HHI_t	-1.943***	-0.918***	-1.972***	-0.921***
	(0.411)	(0.237)	(0.410)	(0.237)
$FFR_t * HHI_t$	0.529***	0.218***	0.529***	0.219***
	(0.050)	(0.055)	(0.050)	(0.055)
$Population_t$ (1000s)	397.2***	72.39***	399.3***	72.42***
	(12.5)*	(1.41)	(12.5)	(1.41)
$Prices_t$ (1000s)	-19.12***	-25.37***	129.3***	58.79*
	(2.76)	(3.09)	(30.6)	(34.4)
$Number\ of\ Loans_t$	8.01***	5.75***	8.02***	5.75***
	(0.058)	(0.053)	(0.058)	(0.053)
$Assets_t$ (Billions)	-0.0009***	-0.001***	-0.0009***	-0.001***
	(0.00003)	(0.00003)	(0.00003)	(0.00003)
$Year_t$	-	-	-3537.3***	-2005.3**
	-	-	(726.6)	(816.7)
$Constant$ (1000s)	9.178**	32.33***	6938***	3960**
	(3.65)	(3.50)	(1423)	(1600)
Fixed Effects?	Yes	No	Yes	No

standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 4. Regression Results for Equation (2.12) Using All CRA Data

(n=24029, No. of Markets is 2409)

	(1)	(2)	(3)	(4)
Dependent Variable	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$
$\Delta\ln(Loans)_{t-1}$	-0.328***	-0.298***	-0.329***	-0.300***
	(0.006)	(0.006)	(0.006)	(0.006)
ΔFFR_t	-0.0722***	-0.0693***	-0.0757***	-0.0728***
	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta\ln(HHI)_t$	0.0410*	0.0366	0.0444*	0.0394*
	(0.024)	(0.023)	(0.024)	(0.023)
$\Delta FFR_t * \Delta\ln(HHI)_t$	0.0913***	0.0970***	0.0849***	0.0915***
	(0.016)	(0.015)	(0.016)	(0.015)
$\Delta\ln(Population)_t$	1.677***	0.865***	1.679***	0.864***
	(0.313)	(0.203)	(0.313)	(0.202)
$Inflation_t$	-1.836***	-1.953***	2.339**	2.084**
	(0.635)	(0.618)	(0.930)	(0.907)
$\Delta Number\ of\ Loans_t$ (100,000s)	0.407***	0.265***	0.419***	0.272***
	(0.086)	(0.070)	(0.086)	(0.070)
$\Delta\ln(Assets)_t$	0.0126***	0.0077*	0.0107**	0.0060
	(0.004)	(0.004)	(0.004)	(0.004)
$Year_t$	-	-	-0.104***	-0.010***
	-	-	(0.002)	(0.002)
$Constant$	0.147***	0.151***	20.898***	20.204***
	(0.014)	(0.014)	(3.38)	(3.31)
Fixed Effects?	Yes	No	Yes	No

standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 5. Regression Results Between MSA and Non-MSA Markets

	Pooled Markets	MSAs	Non-MSAs
Dependent Variable	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$
$\Delta\ln(Loans)_{t-1}$	-0.298***	-0.257***	-0.319***
	(0.006)	(0.015)	(0.006)
ΔFFR_t	-0.070***	-0.070***	-0.065***
	(0.003)	(0.003)	(0.003)
$\Delta\ln(HHI)_t$	0.039*	-0.012	0.037
	(0.023)	(0.015)	(0.030)
$\Delta FFR_t * \Delta\ln(HHI)_t$	0.093***	0.049***	0.094***
	(0.015)	(0.010)	(0.021)
$\Delta\ln(Population)_t$	1.161***	0.165	1.414***
	(0.208)	(0.355)	(0.346)
$Inflation_t$	-1.884***	3.262***	-3.624***
	(0.617)	(0.544)	(0.730)
$\Delta Number\ of\ Loans_t$ (100,000s)	0.351***	0.249***	68.128***
	(0.072)	(0.030)	(2.20)
$\Delta\ln(Assets)_t$	0.008**	-0.007	0.018***
	(0.004)	(0.006)	(0.005)
$UrbanDummy$	-0.052***	-	-
	(0.009)		
$Constant$	0.0156***	0.007	0.152***
	(0.014)	(0.013)	(0.016)
Observations	24029	3810	20219
Number of Markets	2409	381	2028
Fixed Effects?	No	Yes	Yes

standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 6. Regression Results for Loans to Small Businesses

	All Markets	MSAs	Non-MSAs
Dependent Variable	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$
$\Delta\ln(Loans)_{t-1}$	-0.322***	-0.260***	-0.304***
	(0.006)	(0.015)	(0.006)
ΔFFR_t	-0.043***	-0.049***	-0.042***
	(0.004)	(0.003)	(0.003)
$\Delta\ln(HHI)_t$	0.030	-0.007	0.127***
	(0.029)	(0.019)	(0.036)
$\Delta FFR_t * \Delta\ln(HHI)_t$	0.111***	0.047***	0.099***
	(0.020)	(0.013)	(0.025)
$\Delta\ln(Population)_t$	1.838***	-0.222	1.712***
	(0.383)	(0.448)	(0.407)
$Inflation_t$	-9.964***	-5.365***	-11.328***
	(0.777)	(0.691)	(0.856)
$\Delta Number\ of\ Loans_t$ (100,000s)	0.004***	0.002***	0.286***
	(0.0004)	(0.0002)	(0.006)
$\Delta\ln(Assets)_t$	0.006	-0.012	0.009*
	(0.005)	(0.008)	(0.005)
$Constant$	0.311***	0.179***	0.292***
	(0.017)	(0.016)	(0.019)
Observations	23981	3810	20171
Number of Markets	2409	381	2028
Fixed Effects?	Yes	Yes	Yes

standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 7. State-Level Regression Results

(n=510, No. of Markets is 51)

	Fixed-Effects	Random Effects
Dependent Variable	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$
$\Delta\ln(Loans)_{t-1}$	-0.262***	-0.235***
	(0.036)	(0.035)
ΔFFR_t	-0.073***	-0.073***
	(0.004)	(0.004)
$\Delta\ln(HHI)_t$	0.023	0.021
	(0.020)	(0.019)
$\Delta FFR_t * \Delta\ln(HHI)_t$	0.053***	0.053***
	(0.015)	(0.014)
$\Delta\ln(Population)_t$	0.537	2.072***
	(1.07)	(0.486)
$Inflation_t$	5.069***	5.228***
	(0.886)	(0.866)
$\Delta Number\ of\ Loans_t$ (100,000s)	0.049***	0.045***
	(0.008)	(0.007)
$\Delta\ln(Assets)_t$	0.009	0.008
	(0.011)	(0.010)
$Constant$	-0.040*	-0.058***
	(0.023)	(0.020)

standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

CHAPTER III

A THEORETICAL MODEL OF BANKING CONCENTRATION AND MONETARY POLICY WITH ENDOGENOUS GROWTH

3.1. Introduction

This chapter addresses how financial intermediaries affect economic growth and how monetary policy is transmitted through these intermediaries. Chapter II focuses on how profit maximizing banks adjust lending levels in response to monetary policy changes. While the model shows that concentration affects this lending adjustment, it assumes a static demand for loans and a static supply of deposits. This chapter extends that model by taking the same banking sector and building it into an endogenous growth overlapping generations (OLG) model. The model has utility maximizing agents that decide how much to save based on a central bank that targets money growth, and the agents interact and adjust to the banking sector of the economy. Thus, deposits and lending are no longer static, but dynamic and change with monetary policy. Essentially, this chapter considers how monetary policy affects growth, and it shows that countries with higher banking concentration experience lower steady-state growth rates due to lower capital investment. Furthermore, permanent monetary policy changes are neither neutral or superneutral as both levels and rates are affected. The magnitude of the growth effects depend upon the bank concentration measure; economies with lower concentration measures, or more competition, affect growth more than economies with higher bank concentration. Furthermore, if concentration and inflation are both high, then a small increase in the inflation target may, in fact, hinder growth. Overall, concentration dampens monetary policy's effect on growth.

Financial intermediaries are extremely important for investment projects. They channel funds from savers to borrowers, which in turn, enables both short-term and long-term production. Traditionally, financial intermediation was viewed as a simple bypass that allowed savers to find appropriate borrowers in the most efficient manner. Recently, however, the role of the financial system in promoting a healthy economy has been analyzed in greater detail. Specifically, imperfect information, heterogeneous agents, and financial market power have lead to the financial system being more of a "role player" in the economy beyond just matching savers and borrowers. The result of this research has lead to a deeper understanding of how the financial system affects both short-term production and long-term growth.

Cetorelli and Peretto (2000) build a model with heterogenous agents where one type of agent always succeeds at investing and the other type always fails. Oligopoly banks face an adverse selection problem where they do not know what type of agent is applying for credit and, therefore, banks may screen to identify agent type. Bank concentration has two opposing effects: it reduces efficiency due to increased dead-weight loss, but lower concentration makes screening unprofitable, and there is an efficiency reduction due to low-type agents receiving loans. Cetorelli and Gambera (2001) test this hypothesis empirically and do indeed find that monopoly power reduces growth, though this effect is less apparent in countries that have a higher percentage of firms that are reliant on the financial system for investment. They conclude that monopoly power of banks is inefficient and lowers overall growth. But, banks in countries that have firms reliant on lending have an information efficiency gain that mitigates the dead-weight loss to some extent.

Tressel (2003) builds a dynamic macroeconomic model with credit market imperfections to show that financial development depends upon the initial distribution of aggregate wealth. In his framework, the economy may initially grow as banks develop, but due high borrowing costs (collateral requirements) economic growth and bank development stagnate and the economy remains in a low steady-state. On the other hand, banks may come to dominate the financial system, collateral requirements decrease, and the economy reaches a high steady-state. Furthermore Deidda and Fattouh (2005) use an OLG model to show banking concentration affects growth asymmetrically along the level of economic development. Banks incur fixed costs and more banks create fixed-cost redundancies. When a country is in a lower stage of development, the efficiency of more competition (lower dead-weight loss) overshadows redundant fixed costs and growth is inversely related to bank concentration. This efficiency effect diminishes, however, during development and eventually the efficiency gained by more banks fails to outweigh the fixed cost redundancies. Growth is then no longer linked to bank concentration for more developed nations. They support this hypothesis empirically when they find that higher bank concentration only reduces growth in developing nations and bank concentration is not significant on hindering or promoting growth for developed countries.

The role of financial systems in transmitting monetary policy is an important process we should strive to better understand as well. The transmission mechanism of monetary policy has been studied, but the methods used to help understand how financial systems affect growth have not been studied in detail with regards to monetary policy.

Traditionally, monetary policy is viewed as effective in helping to moderate business cycles, or stabilizing short-term production, but neutral in promoting long-term growth. This is usually referred to as the neutrality or long-run neutrality of money because a permanent change in the level of money does not affect real variables. Comparatively, money may also be "superneutral," or a permanent change in the growth rate of money does not lead to a change in real variables such as the capital-labor ratio, output levels, and output growth. Bullard and Keating (1995) site three different classes of models where superneutrality may not hold; models with overlapping generations frictions, cash-in-advance economies, and Lucas-Romer endogenous growth models. They use data from 16 postwar economies to test superneutrality empirically. They find that their sample of postwar economies exhibit superneutrality, with the exception of extremely low-inflation countries. These findings are in support of Gomme (1993), who shows that inflation may hinder output growth, but this effect tends to be small in economies with moderate inflation.

Superneutrality may be overturned, however, if actions monetary authorities undertake have persistent implications for the behavior of the financial system. Azariadis and Smith (1996) construct an OLG model with money growth. By adding in information asymmetries, they effectively show that permanent changes in inflation (i.e. changes in money growth) can permanently raise or lower output levels. When inflation is low, incentive constraints are non-binding and increasing inflation decreases the slack in the constraints. Agents then, reveal their type and output is boosted as a result. If inflation is high on the other hand, the incentive constraints are already binding and increasing inflation leads to higher credit rationing and output suffers.

The rest of the paper is as follows: Section 3.2 details the sectors of the economic model, Section 3.3 defines and solves the equilibrium, Section 3.4 shows the perfect foresight solution, Section 3.5 provides implications of the model with imperfect foresight, and Section 3.6 concludes.

3.2. The Sectors of the Economy

The economy consists of a unit mass of overlapping individuals who live for two periods. When young, the agents optimize expected lifetime utility over consumption, and money holdings. The timing works as follows:

Agents are born at the beginning of period t, and inelastically supply one unit of labor throughout the period. At the end of time t, nominal wages, W_t, are paid in money, agents buy the consumption good c_t at price p_t, hold M_t money, and deposit D_t into a bank which, in turn, makes loans to final good producing firms for capital to be used in the next period. When period $t + 1$ begins, a new cohort of agents are born and begin working. Old agents gain ownership of banks from the previous generation and inherit any bank profits T_t from the previous owner. At the end of period $t + 1$, the final goods producing firms pay back their loans and bank owners store any profits for the next generation of owners. Old agents withdraw their deposits that have since accrued interest, and along with money holdings, buy the final consumption good c_{t+1}.

3.2.1 The Consumption Sector

Agents have preferences for consumption over both periods and real money holdings when young. They derive utility from c_t and c_{t+1}, which represent this period's and next period's consumption of a member living during time t, and from $M_t/p_t = m_t$, or real money holdings where p_t denotes the price of the consumption good at time t. Using lower case lettering for real wages, money holdings, deposits, and bank profits, the agents maximize the following problem:

$$\max_{c_t, m_t, d_t, c_{t+1}} U = \ln(c_t) + \ln(m_t) + \beta E \ln(c_{t+1}) \tag{3.1}$$

subject to:[1]

$$\begin{aligned} c_t &= w_t - m_t - d_t \\ c_{t+1} &= \frac{i_{d,t+1}}{\Pi_{t+1}} d_t + \frac{1}{\Pi_{t+1}} m_t + \frac{1}{\Pi_{t+1}} \tau_t \end{aligned}$$

where $i_{d,t+1}$ is the interest factor on deposits, τ_t is real bank profits inherited from bank ownership, and $\Pi_{t+1} = 1 + \pi_{t+1}$ is the inflation factor p_{t+1}/p_t. Solving this problem yields the following first-order conditions after some rearrangement:

$$c_{t+1} = \beta \frac{i_{d,t+1}}{\Pi_{t+1}} c_t = \beta \frac{i_{d,t+1} - 1}{\Pi_{t+1}} m_t$$

Using the first-order conditions, real money holdings equal

$$m_t = \frac{i_{d,t+1}}{(2+\beta)(i_{d,t+1} - 1)} \left[w_t + \frac{\tau_t}{i_{d,t+1}} \right] \tag{3.2}$$

[1]See Appendix B.1. to see the calculations for turning the nominal constraints into the real constraints seen below.

while total real deposits into banks can be expressed as[2]

$$d_t = \frac{\beta(i_{d,t+1} - 1) - 1}{(2+\beta)(i_{d,t+1} - 1)} w_t - \frac{2i_{d,t+1} - 1}{(2+\beta)(i_{d,t+1} - 1)} \frac{\tau_t}{i_{d,t+1}} \tag{3.3}$$

Since there is a unit measure of households, equation 3.3 gives the volume of bank deposits, which in this model is the only means for capital investment since banks take deposits to issue loans to producers.

3.2.2 The Production Sector

The final consumption good is produced with capital and labor, but has a learning-by-doing externality. The production function for the final consumption good is

$$Y_t = BK_t^{\alpha}(A_t N)^{1-\alpha} \tag{3.4}$$

where $\alpha < 1$, B is a constant technology scalar, and A_t is a labor-augmenting technology. The learning-by-doing externality lies in A_t. Following Romer (1986), it is assumed to be proportional to the capital stock, or $A_t = K_t/N = k_t$. This assumption is based on the idea are knowledge spillovers that cause output to exhibit constant return to scale in capital on the aggregate. Essentially, the more capital laborers have at their disposal, the more they learn and share about capital usage, causing A_t to increase. This technology is taken as given when making decisions

[2]See Appendix B.1. for derivation of this equation

individually since individuals are unaware of the spillovers when making capital decisions. Thus, it is only incorporated after making all decisions. Since output has constant returns to scale on the aggregate capital per worker, A_t is an endogenous accumulation of knowledge and gives rise to endogenous growth in equilibrium; capital does not reach a steady-state, but rather a steady-state growth rate.

Additionally factors are paid according to the value of their marginal product, or

$$i_{L,t} = \Pi_t \alpha B A_t^{1-\alpha} k_t^{\alpha-1} \tag{3.5}$$

$$W_t = p_t B(1-\alpha) A_t^{1-\alpha} k_t^{\alpha} \tag{3.6}$$

where $i_{L,t}$[3] is the nominal rate of return on capital and the interest paid on loans. W_t is the nominal wage rate.

3.2.3 The Banking Sector

Banks are Nash in quantity Cournot competitors, that is they maximize profits taking the decisions of other $J-1$ banks in their market as given. J is assumed to be exogenously given and does not fluctuate with market forces.[4] Banks collect interest on loans and pay interest on deposits collected.

[3]The interest paid on capital would be $p_{t+1}\alpha B A_t^{1-\alpha} k_t^{\alpha-1}$ but since L_t dollar loans can only purchase $p_{t+1}k_{t+1}$ the marginal product of a real dollar in loans today is i_L as described above.

[4]This is consistent with most industrial organization literature as well as who empirically find it is highly unlikely that bank concentration (number of banks) is endogenously determined. note that banks are subject to various regulations and controls that influence the number of banks instead of the usual free entry condition in Cournot models where profits determine J.

Bank j then solves the following one-period ahead expected profit maximization problem

$$\max_{l_t^j, d_t^j} T_{t+1}^e = E_t\{l_t^j(i_{L,t+1}(L_t)) - d_t^j(i_{d,t+1})\} \tag{3.7}$$

s.t

$$l_t^j \leq d_t^j$$

where $i_{L,t+1}(L_t)$ denotes the expected interest factor on loans which is given in equation 3.5, and l_t^j is the dollar amount bank j lends between time t and $t+1$. The interest collected on loans is assumed to be a function of total market lending, $L_t = \sum_{j=1}^{J} l_t^j$. $i_{d,t+1}$ is the nominal interest factor for deposits between time t and $t+1$. d_t^j is the dollar amount of deposits collected by bank j at time t.

The solution to problem 3.7 yields the following first-order condition:

$$E_t\{i'_{L,t+1}(L_t) + l_t^j i_{L,t+1}(L_t)\} = E_t\{i_{d,t+1}\} \tag{3.8}$$

Equation 3.8 simply states that bank j lends such that the marginal benefit of lending another dollar equals the marginal cost of that dollar, which is the interest paid on deposits to collect it.[5]

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[5]Notice that the marginal return on loans *does not* equal the interest factor for loans. This is due to the fact that as a bank increases loans, the interest it can charge falls. Thus the marginal return on loans is strictly less than the interest rate charged on loans due to a wedge between marginal return on loans and the market demand curve.

Now that the individual bank's profit maximization problem is solved, market lending is calculated. Since all banks are identical, symmetry can be invoked and aggregate lending is calculated by summing across all J banks. Because all banks are identical, individual banks loans are equal to market loans over J, or $l_t = \frac{L_t}{J}$.[6] Furthermore, all banks collect the same amount of deposits, and aggregate deposits is equal to individual bank deposits over the number of banks, or $d_t = \frac{D_t}{J}$. Substituting aggregate lending into equation 3.8 and rearranging yields

$$E_t\{i_{L,t+1}(L_t) - i_{d,t+1}\} = E_t\{H\left[-L_t i'_{L,t+1}(L_t)\right]\} > 0 \tag{3.9}$$

Equation 3.9 shows that the markup of loan interest rates over the interest paid on deposits is decreasing in the number of banks since $i'_L < 0$. When $H = 1$, a monopoly markup is obtained. Also, as $H \to 0$ ($J \to \infty$), the interest collected on loans equals the interest paid on deposits and banks earn zero profits.

3.2.4 The Central Bank

The central bank of the economy supplies nominal money according to the rule:

$$M_{t+1} = \sigma_t M_t \tag{3.10}$$

[6]Here the Herfindahl-Hirschman Index (HHI) is simply equal to J^{-1}. I use H to denote the HHI but can be thought of as $H = J^{-1}$. This is mathematically convenient and the results are not dependent upon this assumption. It is shown in Chapter II that the HHI is not symmetric with differences in default rates or monitoring costs, but the results and intuition remain the same.

where $\sigma_t > 1$. In equilibrium, the growth of money determines inflation, or $\sigma_t = \Pi_t$.

Money growth targeting is equivalent to inflation targeting in equilibrium. This method is also equivalent to interest rate targeting using a Taylor rule for inflation. Using starred variables to denote targets and η to denote an error term, then a Taylor rule of $i_t = \pi_t + \theta(\pi_t - \pi_t^*) + \eta_t$ can be solved for inflation, or

$$\pi_t = \frac{i_t + \theta\pi_t^* - \eta_t}{1+\theta}$$

Since π_t is linear with respect to i_t, and i_t is a linear function of inflation in equilibrium, inflation can be expressed solely in terms of the inflation target and an error term.[7]

In this chapter, two options for σ_t are investigated further. Under the benchmark case of perfect foresight in this chapter, $\sigma_t = \bar{\sigma}\ \forall\ t$. This is equivalent to $\eta_t = 0$ for all time periods. For the second case, $\sigma_t = \bar{\sigma} + e_t$ under uncertainty and e_t evolves according to $e_t = \rho e_{t-1} + u_t$ where u_t is i.i.d. mean zero white noise. This model is akin to a policy rule described in Clarida, Gali, and Gertler (2000) where interest rates are smoothed and are set imprecisely. In this case, e_t is a function of η_t and θ above and is AR(1) because the central bank smoothes interest rates.

[7]In equilibrium, the interest rate on lending is $\Pi_t\alpha B$. Plugging this into the equation for inflation above, inflation is $\pi_t = \frac{\alpha B + \theta\pi_t^* - \eta_t}{1+\theta-\alpha B}$. Therefore, without loss of generality, inflation can be written purely as a function of an inflation target and an error term.

3.3. The Equilibrium

With the consumption sector, production sector, banking sector, and central bank, the equilibrium of the economy can now be defined with the following three equilibrium conditions:

1. Labor Market Equilibrium: The nominal wage rate W_t equates labor supply, 1, and labor demand, given by the solution in (3.6).

2. Money Market Equilibrium: The demand for money given by equation (3.2) equals the supply of money set by the central bank divided by the price level p_t.

3. Banking Sector Equilibrium: The demand for deposits given the interest paid on deposits and the supply of loans given the interest rate charged for loans on the aggregate given by (3.9) equals the supply of deposits and the demand for loans by producers, or

$$\begin{aligned} d_t &= L_t/p_t = \Pi_{t+1}k_{t+1} \\ i_{L,t+1} &= \Pi_{t+1}\alpha B \\ i_{d,t+1} &= \Pi_{t+1}(\alpha B - \Pi_{t+1}\alpha(1-\alpha)BH) \end{aligned}$$

With the three equilibrium conditions above, the equilibrium can be expressed solely in terms of k_t, $i^e_{d,t+1}$, Π^e_{t+1}, past variables, and the parameters of the model.

The economy is in equilibrium when the following equations hold:[8]

$$y_t = BA_t^{1-\alpha}k_t^{\alpha} = Bk_t \tag{3.11}$$

$$i_{L,t} = \Pi_t B\alpha A_t^{1-\alpha}k_t^{\alpha-1} = \Pi_t \alpha B \tag{3.12}$$

$$w_t = B(1-\alpha)A_t^{1-\alpha}k_t^{\alpha} = (1-\alpha)Bk_t \tag{3.13}$$

$$i_{d,t} = \Pi_t(\alpha B - \Pi_t \alpha(1-\alpha)BH) \tag{3.14}$$

$$\tau_t = \Pi_t \alpha(1-\alpha)BHk_t \tag{3.15}$$

$$m_t = \frac{i^e_{d,t+1}}{(2+\beta)(i^e_{d,t+1}-1)}\left[w_t + \frac{\Pi^e_{t+1}}{i^e_{d,t+1}}\tau_t\right] \tag{3.16}$$

$$d_t = \frac{\beta(i^e_{d,t+1}-1)-1}{(2+\beta)(i^e_{d,t+1}-1)}w_t + \frac{2i^e_{d,t+1}-1}{(2+\beta)(i^e_{d,t+1}-1)}\frac{\Pi^e_{t+1}}{i^e_{d,t+1}}\tau_t \tag{3.17}$$

$$c_t = w_t - m_t - d_t \tag{3.18}$$

$$c^e_{t+1} = \frac{i^e_{d,t+1}}{\Pi^e_{t+1}}d_t + \frac{1}{\Pi^e_{t+1}}m_t + \frac{1}{\Pi^e_{t+1}}\tau_t \tag{3.19}$$

3.4. Growth with Perfect Foresight

For the perfect foresight case, I assume the central bank targets a constant rate of money growth or inflation of $\bar{\sigma}$. Doing so gives a benchmark case for temporary or permanent changes in the money growth or inflation target. Since perfect foresight is a special case of rational expectations, it is also embedded in the rational expectations case below where the central bank targets money growth with imprecision.

[8]See Appendix B.2. for the derivation of the interest rates and bank profits.

Using the deposit function (3.3) and the terms for wages, profits, and the interest rate paid on deposits, the growth factor under perfect foresight can be expressed as:[9]

$$\Gamma = \frac{(1-\alpha)B}{\bar{\sigma}(2+\beta)(\bar{\sigma}R-1)}\left[\beta(\bar{\sigma}R-1) - 1 - \frac{(2\bar{\sigma}R-1)\alpha H}{R}\right] \tag{3.20}$$

where $R = i_{d,t+1}/\bar{\sigma} = \alpha B - \bar{\sigma}\alpha(1-\alpha)BH$ is the real return on deposits. The growth factor is bigger than or equal to one given that the constant technology scalar, B is large enough. Furthermore, the real return on deposits is decreasing in inflation ($\bar{\sigma}$) for a given concentration measure because banks control the real markup of interest on loans to deposits. But real loans can only purchase $\bar{\sigma}k$ real capital the next period. Thus, as inflation increases, capital must decrease for lending to remain unchanged and interest on deposits in terms of capital decreases.

All else equal, higher market concentration decreases the real return on deposits which causes total deposits, or the amount available to lend for capital investment to fall. Due to the learning-by-doing externality, lower capital investment leads to lower steady state growth. Figure 2 plots how the growth rate varies with bank concentration. The parameters of the model are $\alpha = 1/3$, $\beta = 0.98$, $B = 25$, and $\bar{\sigma} = 1.02$ or a constant money growth of 2%.

[9]See Appendix B.3. for the derivation of the growth factor

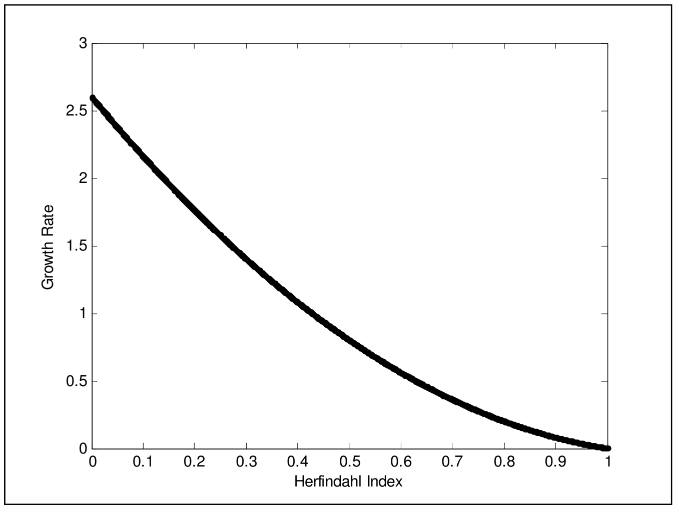

FIGURE 2. Perfect Foresight Equilibrium Growth with Bank Concentration

Furthermore, permanent monetary policy changes are not neutral or superneutral in this model. Growth changes if the central bank is (credibly) committed to changing inflation by altering nominal money growth. Since inflation acts as a tax on nominal money holdings, an increase in inflation lowers the young's willingness to hold money. They instead transfer this difference in money to both consumption and deposits. As deposits increase, lending and capital investment also increase as well as growth due to the learning-by-doing externality.

The economy is simulated to test how monetary policy is affected by bank concentration. If the results from chapter II hold true in an endogenous growth model, then growth should be more affected from a monetary policy shock in an economy with a lower Herfindahl index. A simulation of a perfectly competitive economy and one with a monopoly bank easily shows how a shock in monetary policy affects growth. For comparative reasons, the economies both grow at the same initial rate before the policy shock. The constant technology parameter, B, must therefore be lowered in the perfectly competitive economy so the initial growth rates are equivalent. For the simulation, B in the competitive market is 7.3072 while still 25 for the monopoly economy.

Figure 3 presents the log of capital over time for two economies. The solid plots the log of capital for a market or country with perfect competition, or $H = 0$, and the dashed line shows the same but for a country with a monopoly banking economy, or $H = 1$. The dark dots plot the perfectly competitive market and the circles plot the monopoly market. I also have a thinner line plotting the log of capital for an economy with no monetary policy change. Figure 3 plots the log of capital when $\bar{\sigma}$ permanently increases from 1.02 to 1.025 at time period 20. As the kinked line indicates, even a small increase in the inflation or money target by 0.5% changes capital investment and steady-state growth. If the increase in $\bar{\sigma}$ is temporary, growth would change when the target increased, but revert back to the original rate when the target returns to its initial value.

Surprisingly, the perfect monopoly economy (HHI equal to one) has a lower growth rate after the policy change. This occurs because the decreased real return on deposits from higher inflation decreases deposits more than additional deposits made from channeling money. These results support the findings from Azariadis and

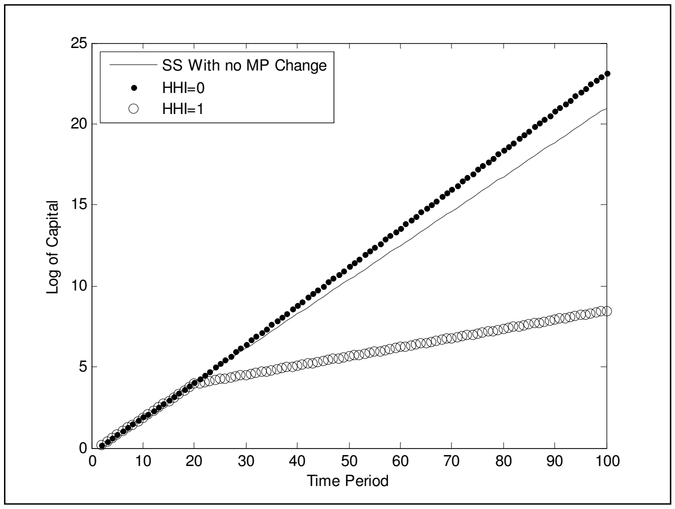

FIGURE 3. Permanent Expansionary MP Shock at t=20 for HHI=0 and HHI=1

Smith (1996). They find that moderate inflation increases from low levels increases growth but can hinder growth when inflation is high. The model built in this chapter has a similar feature present due to the nominal interest on deposits. For low levels of concentration and low levels of inflation, an expansionary policy change increases the nominal return on deposits. However, because the return on deposits is lower than the return on lending, the increase in the nominal return on deposits is not one-to-one with inflation. Thus growth increases, but not monotonically with inflation. When inflation or concentration is high enough, an increase in inflation actually decreases the nominal return on deposits and growth as well. This can be seen in equation 3.14 where the right-hand side is increasing in inflation for the first part, but is decreasing in inflation squared due to the minus sign.

The change in growth due to a change in inflation is summarized by:

$$\frac{\partial\Gamma}{\partial\bar{\sigma}} \begin{array}{ll} > 0 & \text{if } \bar{\sigma}\text{H} < \dfrac{\alpha\text{B}}{\alpha(1-\alpha)\text{B}} \\ = 0 & \text{if } \bar{\sigma}\text{H} = \dfrac{\alpha\text{B}}{\alpha(1-\alpha)\text{B}} \\ < 0 & \text{if } \bar{\sigma}\text{H} > \dfrac{\alpha\text{B}}{\alpha(1-\alpha)\text{B}} \end{array}$$

or if the economy is concentrated enough, small increases in inflation decrease the nominal return on deposits and lowers growth. Also, just as with Azariadis and Smith (1996), for a given Herfindahl Index, $\bar{\sigma}$ might become so high that it actually decreases the nominal rate of return on deposits and lower growth. Small increases in inflation are only expansionary for low to moderate levels of concentration *and* low to moderate levels of inflation.

The last test for the benchmark perfect foresight case is to examine how growth is influenced by a change in the money target for economies with relatively small bank concentration differences. This analysis consists of how an economy with a perfectly competitive banking system would react to an increase in concentration, but not enough to make it a monopoly market. To plot this, I assume that there are two economies with the same initial steady state growth; one with H=0 and one with H=0.4. As compared to Figure 3, $\bar{\sigma}$ increases from 1.02 to 1.03 at time period 20 instead of only 1.025. Technology (B) for the competitive market is 7.3 and the same parameter for the H=0.4 economy is 10.322. Again, to show how much monetary policy changes the evolution of capital, I have included an economy with no policy change for comparison.

Figure 4 shows that the same intuition from Chapter 2 carries through into long-run growth as the perfectly competitive banking economy increases capital accumulation or growth more than the more concentrated economy. Intuitively, an increase in the inflation or money growth target still increases the "tax" on nominal money holdings, but since the real rate of return on the other form of savings (deposits) is lower in more concentrated economies, the optimal decrease in money holdings is less as compared to the competitive market. Since the real return on deposits is lower in the monopolistic economy, agents are less inclined to transfer savings from money to deposits. As the increase in deposits in the monopolistic economy is only a fraction to the deposit increase in the competitive economy, capital investment and growth increases fractionally as well.

3.5. Growth with Monetary Policy Uncertainty

Now the consequences of monetary policy uncertainty are examined. The growth rate between period t and $t+1$ can be written as:

$$\Gamma_{t+1} = \frac{(1-\alpha)B}{\sigma^e_{t+1}(2+\beta)(\sigma^e_{t+1}R^e - 1)}\left[\beta(\sigma^e_{t+1}R^e - 1) - 1 - \frac{(2\sigma^e_{t+1}R^e - 1)\sigma_t \alpha H}{\sigma^e_{t+1}R^e}\right] \quad (3.21)$$

where $R^e = \alpha B - \sigma^e_{t+1}\alpha(1-\alpha)BH$ is the expected real return on deposits.

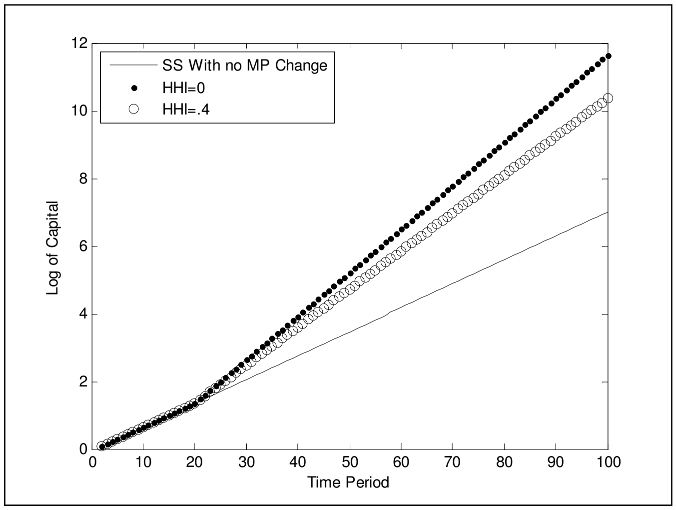

FIGURE 4. Permanent Expansionary MP Shock at t=20 for H=0 and H=0.4

The difference between the equation above and the steady-state perfect foresight growth equation (3.20) is expectations of future inflation. If money growth is set imprecisely, or $\sigma_t = \bar{\sigma} + u_t$ where u_t is i.i.d. mean zero white noise, then growth is only affected by u_t in its effects on profit holdings of old bank owners, and will not affect expected inflation next period. Thus, if $u_t \neq 0$ for one period only, it only affects growth for one period and growth would continue on as in the perfect foresight model. Furthermore, since a perfectly competitive banking economy earns zero profits, growth would be completely unaffected by u_t.

However, if money growth is persistent, such as when:

$$\sigma_t = \bar{\sigma} + e_t$$

$$e_t = \rho e_{t-1} + u_t$$

then u_t also affects future expected inflation. When there is a positive policy shock to inflation, it increases expected inflation or changes expected returns on deposits and money holding decisions into the future. Compared to above, a onetime positive u_t increases deposits and growth increases in the short-run. With persistence, small changes around a target rate exhibits non-neutrality but maintains superneutrality. If money growth target changes, money is non-neutral and non-superneutral as shown in the perfect foresight model.

To examine the effects of persistent monetary policy shocks around a target, I simulate an economy using a perfectly competitive banking sector and one with some concentration; H=0.3 as shown in the perfect foresight model. The parameters are the same as above as well with $\bar{\sigma} = 1.02$ and $\rho = 0.5$. The economy runs 50 periods with $u_t = 0$ and then 150 periods with u_t mean zero and limited to values of -0.075 to 0.075 to adequately show its effects on growth. Overall u_{50-200} has a mean of 0.003 and a standard deviation of 0.0444.

Figure 5 shows the results of the simulation described above. The dark dots represent the perfectly competitive banking economy, the circles plot the economy with HHI=0.4, and the thin solid line is for an economy with u_t equal to zero every time period for comparison. Overall, both economies experience upturns and downturns at the same time and track the perfect foresight economy over time. However, the perfectly competitive economy has wider swings than the economy with some concentration.

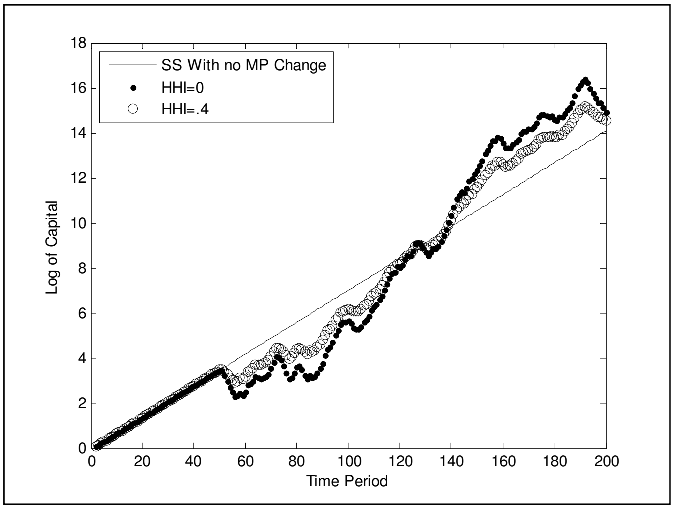

FIGURE 5. Simulation for 200 Periods with $E_t u_{t+1} = 0$

3.6. Conclusion

Chapter II builds a theoretical model of profit maximizing Cournot banks and shows that monetary policy is less influential on lending in markets with higher concentration. However, that model assumes an exogenous static demand function where agents do not interact with banks. The static model presented in that chapter can be thought of as a short-run view of the economy. This chapter extends the model from the previous chapter by taking the same profit maximizing banking sector, but adding lifetime utility optimizing agents to the model. This model enriches the earlier model by allowing agents to adjust to bank changes influenced by monetary policy and can be viewed as a long-run extension of the previous static model. The overall findings are that monetary policy innovations influence capital accumulation and growth less in economies with higher concentration. Thus, as with the model in Chapter II, monetary policy is dampened on short-run lending and these lending changes transform into dampened capital accumulation and growth in the long-run. Higher banking concentration, then, impacts an economy in two ways: first, all else equal, growth is lower overall in these economies, and second, the banking sector dampens monetary policy changes as monetary policy transmits to the agents of the economy.

In the perfect foresight model, changes in the policy target rate of money growth or inflation increase the cost of money holdings, causing agents to transfer savings from money holdings to bank deposits. The increase in deposits enable more lending for capital and in the endogenous growth setting, increases the growth rate. However, the increase in inflation lowers the real rate of return on deposits if the Herfindahl index, H, is greater than zero, or the economy is not perfectly competitive. This, in turn, makes deposits less attractive. In extreme cases with higher concentration measures, the decrease in deposits from a lower rate of return outweigh the increase from money transfers, or an increase in inflation may actually hinder growth. For economies with lower concentration, small concentration increases still see increased growth from higher inflation targets but to a lesser extent than if concentration were lower. In the perfect foresight model, changes in the monetary policy target rate do not exhibit money neutrality nor superneutrality as they affect levels and growth.

Lastly, in the case of uncertainty with persistent policy innovations around a target rate, the same holds true; higher concentration dampens monetary policy. In this case, policy shocks affect levels but not long-run growth rates. Economies with higher concentration measures see levels affected less from the same policy shocks. The model presented in this chapter highlights that the structure of the financial system has important implications on both growth and a central bank's ability to stabilize the economy.

Further research is needed, however, in a number of areas. First, one could develop a monetary policy rule akin to a Taylor rule that makes a money growth target a function of an economic parameter around a target rate. Second, the OLG model of agents has non-neutrality and non-superneutrality of money even when not accounting for the banking sector. The model may change slightly if an infinite horizons money-in-utility agent problem is used. Without a labor/leisure decision, the infinite horizons model typically exhibits neutrality and superneutrality. Third, this model could also easily incorporate supply-side shocks in the production function. One important question not answered in this chapter is whether concentration dampens, enhances, or has no effect on other changes in the economy beyond monetary policy changes. Production shocks could further enhance and enrich this model into one that has implications for direction and magnitude of monetary policy changes due to production shocks.

CHAPTER IV

MONETARY POLICY, BANK CONCENTRATION, AND LONG-RUN ECONOMIC GROWTH: AN EMPIRICAL ANALYSIS

4.1. Introduction

The micro-structure of banks affects monetary policy during business cycles, and the difference in effectiveness may persist and affect the overall health and stability of the economy in the long-run by influencing growth. While many studies examine how financial development, specifically banking concentration can induce or hinder economic development, no one has studied how the transmission of monetary policy through banks influences economic development. This chapter adds to the empirical research not only on monetary policy's effect on long-run growth and how banking concentration affects growth, but also on how monetary policy becomes more or less effective due to banking market characteristics.

This chapter empirically tests the theoretical model developed in Chapter III. I test for monetary policy's persistent effect on long-run growth with an interaction term of monetary policy, measured as the money market interest rate, and a bank concentration ratio. While I find evidence that monetary policy itself affects country-level industrial growth, the magnitude of this effect depends upon the level of bank concentration. Overall, I find that 1% decrease in the monetary policy interest rate from the sample average increases long-run economic growth by 0.0058% when the 3-bank concentration ratio is equal to the sample average, but the same change in monetary policy increases long-run growth by 0.0070% if bank concentration is only 1% lower than the sample average, all else equal. Since the average compounded growth rate is only 0.67% over the sample period, this effect may be quite substantial over time due to compounding.

In the short-run, monetary policy is less effective on expanding or contracting lending activity in markets with higher levels of banking concentration. When there is an expansionary change in monetary policy (lower interest rates), markets with lower levels of concentration reap the benefits of higher lending as compared to their higher concentrated market counterparts. In the endogenous growth setting in Chapter III, more lending leads to more investment and higher long-run steady-state growth too. In the short-run, expansionary monetary policy changes increase lending more in markets or countries with lower levels of banking concentration. The dynamic effects of a higher lending volume leads to higher long-run growth rates.

The implications of monetary policy's impact on economic growth due to banking concentration are robust. Central banks in countries with higher bank concentration face additional challenges while attempting to stabilize the economy not only over business cycles but in the long-run as well. Regulators of bank mergers, acquisitions, failures, and starts also have further difficulties as a merger that increases banking concentration may have adverse consequences to the entire economy. Additionally, the lower growth rates associated with higher bank concentration affect everyone in the economy, even future generations.

The rest of the paper is organized as follows: Section 4.2 summarizes previous literature, Section 4.3 describes the empirical framework and summarizes the data, Section 4.4 contains replication tables and procedures based on previous papers, Section 4.5 exhibits the empirical results and Section 4.6 concludes.

4.2. Previous Literature

Recent studies investigate how banking concentration influences monetary policy effectiveness. Specifically, Adams and Amel (2005) find that banking concentration alone does not affect bank loans, but affects loans through monetary policy. In essence, markets with higher banking concentration tend to dampen monetary policy's effect on bank loans. Thus, if monetary policy eases in the United States, firms dependent on bank lending for investment have more access to financing in competitive banking markets when compared to similar firms in more monopolistic banking markets. A natural extension to the issues raised above is focuses on banking concentration, monetary policy, and economic growth. Several papers offer some suggestions as to why banks might affect monetary policy's flow.

Pagano (1993) builds banking into a simple AK endogenous growth model. Banks play the role of equating savings to loans for investment in new capital. He assumes some portion of savings is "lost" in financial intermediation (i.e. monitoring costs, transaction costs, etc.). He finds that banks can influence long-run growth in three ways. First, banks can become more efficient by decreasing the savings lost in financial intermediation so total investment will be higher. Second, banks can target loans to the most efficient investment projects, thereby increasing technology, at a faster rate than if banks did not select the most efficient projects for financing. Last, banks may have influence over the savings rate through several methods such as risk sharing, household borrowing, or the interest rate.

Berger and Hannan (1998) show that banks in concentrated markets are less efficient, as calculated by X-Efficiency. Monopoly banks are less efficient because they have higher prices and higher costs as well. Therefore, banks do not profit maximize. Several studies (Berger, 1995; Berger & Hannan, 1989; Berger & Hannan, 1997; Hannan, 1991) empirically support this theory. Each loan costs monopoly banks more than competitive banks and this inefficiency loss is estimated to be up to three times larger than the typical dead-weight loss associated with market power. These inefficiencies can effect long-run growth directly and allow monetary policy to influence growth by its inefficient flow through these banks.

Rajan and Zingales (1998) test whether industrial sectors more dependent on external finance grow faster in countries with more developed financial markets. The authors find that firms more reliant on the financial system for investment develop and grow faster in countries that are more financially developed. This paper is a seminal paper in the field because it shows the financial system and the development of the financial system can enhance or hinder economic progress. It also led to a line of papers examining how the financial system, banks specifically, enhance or hinder growth.

Cetorelli and Gambera (2001) find two relationships at work when bank concentration is analyzed in the Rajan and Zingales (1998) framework. First, higher banking concentration negatively affects growth, but this effect is somewhat mitigated in industries that are externally dependent on banks for financing. Cetorelli and Gambera say this can possibly be explained by relationship benefits, where banks in a concentrated market develop lasting relations with firms and can give them access to more credit due to better information. Thus, while high banking concentration negatively impacts growth, it's not as hindered in countries where firms use the financial system more often. Claessens and Laeven (2005) also find that bank concentration boosts growth to more externally dependent firms using more disaggregated data.

Contrary to Cetorelli and Gambera (2001), Deidda and Fattouh (2005) build an OLG model and show bank concentration affects growth asymmetrically along the level of economic development. Banks incur fixed costs and more banks create fixed-cost redundancies. When a country is in a lower stage of development, the efficiency of more competition (lower dead-weight loss) overshadows redundant fixed costs and growth is inversely related to bank concentration. This efficiency effect diminishes, however, during development and eventually the efficiency created by more banks does not overtake the fixed costs and growth is no longer linked to bank concentration. Using the same data as Cetorelli and Gambera (2001), they find that banking concentration negatively impacts economic growth in low-income countries only and appears to have no impact in high-income countries.

4.3. Empirical Strategy and Data

To empirically test the theory developed in Chapter III, I use two strategies. The first strategy employed in this chapter uses data that are averaged over a long time frame as the dependent variable and uses control variables from the early sample period as regressors. It involves testing how a control variable from the beginning of the sample period affects growth over a long time period. This framework is the one used in several papers, including Cetorelli and Gambera (2001), CG2001 from here-on-out. The main contribution of this chapter is to add monetary policy and the interaction of monetary policy and banking concentration into the regressions used by CG2001. More formally, the estimation equation takes the form of

$$\begin{aligned} Growth_{j,k,1993-2005} = \; & cons + \textstyle\sum_J \beta_j D_j + \gamma_2 MP_{k,1994} + \gamma_3 BankConcentration_k \\ & + \gamma_4 MP_{k,1994} * BankConcentration_k + \textstyle\sum_I \gamma_i X^i_{j,k} + \epsilon_{j,k} \end{aligned} \tag{4.1}$$

where $Growth_{j,k,1993-2005}$ is the average compounded growth of value added of industry j in country k from 1993-2005, D_j is a set of industry dummy variables, $MP_{k,1994}$ is the monetary policy stance in 1994, $BankConcentraion_k$ is the average 3-bank concentration ratio (CR_3) over the sample period, and $X^i_{j,k}$ is a set of other control variables. The monetary policy stance, or short-term interest rates in 1994 is used instead of sample-average interest rates because it captures how interest rates in 1994 effect growth over the sample period, or how monetary policy today effects growth in the foreseeable future.

From Chapter III and CG2001, the coefficient γ_3 is expected to have a negative sign as higher bank concentration lowers growth. This occurs because higher concentrated countries have more dead weight loss in lending and, as a result, these countries experience less capital growth. Exactly how monetary policy affects growth is more ambiguous in this framework, but if monetary policy is neutral in the long-run, then γ_2 should be zero as differences in interest rates would not affect growth. However, the theory developed in the previous chapter suggests lower inflation (or higher interest rates)deter investment and, therefore, economic growth too. This suggests that γ_2 should be negative. Overall, this coefficient should be non-positive. Interest rate changes should change growth at least in the short-run, but this effect should not be as large in countries with higher concentration. Thus, the coefficient on the interaction term, γ_4, is expected to be positive as monetary policy should have less of an impact in countries with higher concentration.

Data for economic growth come from the United Nations Industrial Development Organization (UNIDO) Industrial Statistics Database. It contains 4 digit ISIC codes on value-added for manufacturing sectors by country. Growth of an industry in a country is the average compounded growth rate of real value-added from 1993-2005.[1] Real value-added is value-added divided by the producer price index, obtained from the International Financial Statistics (IFS) CD published by the International Monetary Fund (IMF). The sample of countries is limited to OECD members in 2005 due to development differences during the sample period for countries that joined after 2005. Due to data limitations, the United States, Luxembourg, Switzerland, Iceland, Australia, and New Zealand are not included in the sample and data on the 24 remaining OECD members are used. Lastly, it should be noted that CG2001 use the same measure of growth from the same dataset, but from 1980-1990. As a result, ISIC codes in CG2001 are revision 2. In 1990, the United Nations switched to revision 3 ISIC coding. To compare results to previous literature, I convert revision 3 data back to revision 2 coding.[2]

The Bankscope database provided by Bureau van Dijk (BvD) is used to calculate bank concentration measures. BvD provides detailed micro-level bank data that are aggregated by country over total assets to retrieve an asset concentration ratio for the top 3 banks, CR_3. Bank concentration is the average CR_3 from

[1]Some countries do not have data in 1993 so 1994 is used as the starting year. Also 4 countries do not have data going to 2005. 2004 is then used as the ending year.

[2]See Appendix C.1. for more information on coding conversions.

1993-2006. Moreover, for robustness measures, a CR_5 and a Herfindahl-Hirschman index (HHI) are also calculated. Several authors have used Bankscope data for concentration measures, including Corvoisier and Gropp (2001) and CG2001. The Bankscope data are survey based and, therefore, concentration measures may not be representative of the banking population. Bhattacharya (2003) examines Bankscope data in further detail by comparing it to other banking data for India in 1999. The author shows that the Bankscope data for concentration measures do have an upward selection bias. But this bias can be fixed or ignored for two reasons. First, the coverage ratio (sample asset size to total asset size in a country) for Bankscope is in the 90% range; concentration measures from surveyed banks will not be largely upward biased since most banks not surveyed tend to be small, rural banks. Second, the author believes that there is more of a selection bias in emerging economies and states that the bias will be less apparent in developed nations due to better survey coverage in these countries. Since the data used in this paper is for OECD nations, this bias is mitigated to some degree.

The measure of monetary policy can take several forms, but short-term interest rates are the most common since central banks of the majority of developed nations target short-term interest rates as the primary mechanism for conducting monetary policy. For the U.S., the most common measure is the first difference in the federal funds rate.[3] Mihov and Scott (2001) use the money market rate from the IFS CD

[3] See Bernanke and Blinder (1992) and Bernanke and Mihov (1998) for a more thorough analysis.

published by the International Monetary Fund (IMF). It includes short term interest rates for various countries (i.e. federal funds rate for the U.S., call money rates for Denmark, and money market rates for Austria). Kuttner (2001) gives evidence that short-term interest rates are a reliable measure of the monetary policy stance. Using federal funds market data, he shows that short-term and long-term yields only respond to 'surprise' changes of the target rate, not anticipated changes. If countries' central banks follow some version of the Taylor rule to target interest rates, changes in the target to follow a Taylor rule (keep the economy on track and, therefore, not a change in the monetary policy stance) would be anticipated and not affect short-term or long-term bond yields.

For example, Canada is an explicit inflation targeter. If inflation is lower than the target rate, the Bank of Canada would lower target interest rates to keep the economy on the target path. This change in the target would be anticipated, however, and not affect interest rates on bonds. Bond rates would only change if Canada changed it monetary policy stance such as change its inflation target. Therefore, bond rates should be an adequate measure of monetary policy and will not pick up variations of target rates that would not be considered a true change in monetary policy. To keep in line with other research, the money market rate from the IFS CD is the primary measure of monetary policy, but short-term bond yields, long-term bond yields and lending rates (such as clearing bank lending rates, prime lending rates, and advances to households) are used for robustness measures.

Other control variables include the log of per capita GDP in 1993, industry share of value-added, bank development, and stock market capitalization. Bank development is the ratio of total domestic credit (the sum of lines 32a-32f, excluding 32e on the IFS CD) to GDP in 1993. Stock market capitalization comes from Standard and Poor's Global Stock Market Factbook (1997-2007), which was previously the World Bank's Emerging Stock Market Factbook (1991-1996). The stock market capitalization to GDP ratio in 1993 is used as a control variable. The data statistics for these data are in Table 8 and Table 10 is the correlation table.

Due to a very high correlation of monetary policy and the interaction of monetary policy and bank concentration, the estimation of equation (4.1) may not capture the independent effects of these two important variables. Since these two coefficients are the central contribution of the paper, another estimation technique is used that takes the same form as (4.1), but uses panel data. It takes the form of:

$$\begin{aligned} Growth_{j,k,t} = \quad & cons + \alpha Growth_{j,k,t-1} + \textstyle\sum_J \beta_j D_j + \sum_K \beta_k D_k + \gamma_2 MP_{k,t} \\ & + \gamma_3 BankCons_{k,t} + \gamma_4 MP_{k,t} * BankCons_{k,t} + \textstyle\sum_I \gamma_i X^i_{j,k,t} + \epsilon_{j,k,t} \end{aligned} \tag{4.2}$$

where the data are now in panel form to capture time variation as well. This estimation allows me to jointly estimate how monetary policy and the interaction of monetary policy and bank concentration, γ_2 and γ_4 affect growth. This only estimates how each variable affects growth for that year, however. To calculate the effect of a variable on the long-run (steady state) growth rate, $Growth^{*}_{j,k}$, then all coefficients can be multiplied by $(1-\alpha)^{-1}$. γ_2, γ_3, and γ_4 all have the same expected signs as outlined in equation (4.1).

The same data are used for the estimation of equation (4.2) except it is now in panel form instead of averaged. Since equation (4.2) utilizes yearly data, tests to ensure the dependent variable is stationary are necessary to avoid estimating spurious regressions. Using a Fisher panel data unit root test, I find that the null hypothesis of a unit root is consistently rejected and the data are stationary using one and two lags (years in this case) *and* after removing the cross-sectional means. Thus no differencing of the data is necessary when estimating equation (4.2).

Table 9 contains the summary statistics for the panel data and Table 11 is the correlation table.

4.4. Replication of Cetorelli and Gambera (2001)

First, I replicate the empirics of CG2001 to make sure my conversion of ISIC coding of the dependent variable has been done correctly. CG2001 estimate equation (4.1) above, but without monetary policy or the interaction of monetary policy and bank concentration. Interestingly, initial results of my replication regressions find the coefficient on the level of bank concentration to be positive, while CG2001 have a negative coefficient. Since the data are averaged over the sample period, only industry fixed-effects can be used so I cannot control for country fixed-effects.

Proceeding, I run the same specification as CG2001, but drop one country from my dataset at a time with replacement.

Examining the coefficient on bank concentration, I find countries, that when dropped from the regression, significantly alter the t-statistic on the bank concentration coefficient. Also, some countries that, when dropped, cause this coefficient to reverse signs. This technique allows me to collect a sample of countries that might be skewing the results on the banking coefficient, causing it to be positive. Closer examination of the countries that significantly lowered the positive t-stat on banking concentration when dropped (meaning these countries caused banking concentration to be positive and highly significant) show that four out of six total were countries that joined the OECD during the sample period; the other two do not have many observations of the dependent variable. Since these countries significantly raise the positive t-statistic on the banking concentration coefficient, the six countries that joined during the sample period need to be controlled for in estimations. As explained throughout this section, when adding a dummy variable for OECD countries that joined during the sample period, or dropping them from regressions, I fully recover the negative and significant coefficient on banking concentration as in CG2001 even though my data come from a later sample period.

Table 12 contains replication tables for Cetorelli and Gambera (2001) using newer data and a different selection of countries. Columns 1 has the results from Table IV of CG2001. The dependent variable is the average compounded growth of value added of industry j in country k from 1980 to 1990. Due to limitations of the Bankscope database, banking concentration numbers are no longer obtainable on a year-to-year basis from the 1980s and are only available from 1993 onwards. Column 2 shows the estimation results when using the CG2001 dependent variable (average compounded growth from 1980-1990) but with my newer independent variables. This effort helps to ensure that my dependent variable was correctly recoded from ISIC rev3 back to rev2. Column 3 replicates CG2001 using all new data from 1993-2005 on OECD countries that did not join the OECD during the sample period.[4]

Table 13 contains regression results using data from 1993-2005, but accounts for different groupings of OECD countries. The first column is the same as column 3 of Table 12. The second column adds in the six countries that joined the OECD during the sample period: Mexico, Czech Republic, Hungary, Poland, Korea, and Slovakia in a pooled OLS regression. Significance for all control variables disappears. The last column adds a dummy variable for the six countries mentioned above and also includes the interaction of this dummy variable with banking concentration; all results from the first column reappear. The OECD dummy variable and its interaction with banking concentration offer insight into why significance is diminished when unaccounted for in column 2; these countries' manufacturing sectors do not act like their counterparts in countries that are seasoned members of the OECD. First, controlling for country and industry differences, the average growth in

[4]The regressions also contain a dummy variable for Greece.

manufacturing is 16.4% lower per year in these six countries. This can partially be explained by the fact that these six countries were still developing during the sample period and transitioning from manufacturing economies to service-based economies after joining the OECD. Also, the interaction term of the OECD dummy with bank concentration is positive and significant meaning that higher banking concentration in these six countries boosted the average growth in across manufacturing industries. It should also be noted that out of the 20 OECD countries used in CG2001, all but two (Korea and Mexico) were countries that joined the OECD before their dataset from the 1980s.[5]

4.5. Empirical Results

4.5.1 Main Results from Estimation of Equations (4.1) and (4.2)

After replicating the results from CG2001, equation (4.1) is estimated in its entirety by including monetary policy and the interaction of monetary policy and bank concentration. Table 14 contains the regression results when the money market rate in 1994 is added (columns 1 and 3), as well as the interaction term of the money market rate in 1994 and bank concentration (columns 2 and 4). The first two columns take data of CG2001 (1980-1990) and add in my data on monetary policy. The last

[5]Interestingly, it should be noted that all significance for all variables drops away in all three regressions with the exclusion of the dummy variable for Greece, but the results *do not* change if Greece is excluded from the regressions. This may be due to unreliable value-added data in Greece since it was not collected from 1999 and 2003. Because growth is from 1994-2004 I do not need the missing years to calculate compounded average real growth of value added.

two columns use my dataset (1993-2005), and only include OECD nations the joined before the sample period. The first two columns that use CG2001 data with my monetary policy measure are for comparison for the last two columns.

Column 3 shows that the money market rate does not influence long-run growth since it is insignificant, but the coefficient is positive like in column 1. However, as is seen in column 4, significance does appear with the inclusion of the interaction term of the money market rate with bank concentration. The money market rate is positive and significant and the interaction term is negative and significant, like in column 2. The coefficients of monetary policy and the interaction term in column 4 is not surprising because of the high correlation between the two variables (0.998). This can simply be due to high colinearity of the two terms. Furthermore, an F-test fails to reject the null hypothesis that both coefficients on monetary policy and the interaction term are jointly zero; it has a p-value of 0.165 ($F(2,435)=1.81$). Since the interaction term is of high importance for this paper, Table 14 is as far as I can go for data on average compounded growth in value added. The next estimation technique must now be used; equation (4.2).

Estimation coefficients from equation (4.2) are presented in Table 15. Again, the data are now yearly data, not averaged across time. All three columns have industry fixed effects and country fixed effects. The first column includes industry-by-country fixed effects (essentially the interaction of industry fixed effects with country fixed effects), the second column has only industry fixed effects and country fixed effects, the third column adds a time trend into the regression, and the last column also adds time fixed effects over column 2. As with the averaged data, the coefficient on bank concentration is negative; suggesting higher bank concentration lowers economic growth. Interestingly, the coefficient on the share of manufacturing is significant after being insignificant in all the previous tables. The coefficient on monetary policy (aka the money market interest rate) is negative which signifies that higher interest rates impede growth. This also supports previous empirical work that monetary policy may not be neutral in the long-run. Lastly, the interaction term of bank concentration and monetary policy is positive in all four columns, and is significant in all except when including yearly fixed effects..

Column 2 should be viewed as the base column for estimation of equation (4.2). An F test supports industry-by-country fixed effects jointly equaling zero ($F(626,4760)=0.899$) in column 1. Also the time trend from column 3 is significant but this is more of a sensitivity check than an actual theoretically supported variable. Lastly, it is not surprising that adding time fixed effect reduces significance of both bank concentration and the interaction term since bank concentration is surprisingly stationary over time. Also, time fixed effects is typically not used in panel data models. With the test supporting industry-by-country fixed effects jointly equaling zero, and the coefficients roughly the same sign and magnitude when including a time trend, column 2, with only industry fixed effects and country fixed effects appears to be the most appropriate. Lastly, an F-test rejects the null hypothesis for the coefficients on monetary policy and the interaction term jointly equaling zero with a p-value of 0.000 ($F(2,5385)=21.33$) in column 2 (this was the problem from Table 14).

The coefficients on monetary policy and the interaction term are of the same sign as Adams and Amel (2005) and Chapter II, which focus on bank loans instead of value added growth. That work shows that monetary policy becomes less effective on lending over the business cycle in markets with higher banking concentration. The signs of their work carry over when analyzing growth of value added for manufacturing industries instead of focusing on bank loans; changes in lending due to monetary policy changes carry over to the real economy and also persist in the long-run. Steady-state growth depends upon the lending level in the economy. If all banks transmitted monetary policy changes into lending activity equally (independent of concentration), then the interaction term of monetary policy and bank concentration would be zero.

Overall, these findings are consistent with the theory proposed above in that lending levels do influence growth rates, and that due to concentration differences across countries, monetary policy influences lending levels, and therefore, steady-state growth rates differently across countries as well. Higher banking concentration, either by larger banks or less banks, has a two-fold negative effect on growth; diminishing growth itself and partially canceling monetary policy's effect on long run growth via lending levels. Using coefficient estimates from the second column of Table 15, a 1% reduction (100 basis points) in the money market rate from the sample average increases steady state growth of manufacturing value added by 0.0058% if the bank concentration of the three largest banks is at the country average of 49.7%. If bank concentration decreases by only 1%, the same change in the money market rate increases long-run growth now by 0.0070%.[6] While this effect may appear small, it can make a large difference over the long-run with compounding, or if bank concentration were to change more drastically.

4.5.2 Sensitivity and Robustness Analysis

To ensure that the estimates from the previous tables are accurate, I test for robustness of the estimates coefficients using several methods. First, I use different measures of bank concentration, and I also use several different measures of the monetary policy variable. Next, I include several time lags of the important variables, notedly bank concentration, monetary policy, and the interaction term. Lastly, I allow for serial correlation and do several checks for heteroskedasticity.

The results presented in Table 15 may hinge on two variables: bank concentration and monetary policy. To see how robust these results are, I use different measures of bank concentration and monetary policy. Table 16 contains the estimated coefficients of equation (2) across different bank concentration measures. The first column uses a three-bank concentration ratio. It is identical to the second column of Table 15. The second column uses a five-bank concentration ratio as the

[6]See Appendix C.2. for the equations used for these calculations.

measure of bank concentration, while the last column uses a Herfindahl-Hirschman Index (HHI) instead. When using a five-bank concentration ratio (CR_5) in the estimation, all signs and significance levels remain the same as when using a CR_3. The point estimates are also nearly identical, but this could be due to the high correlation between the CR_3 and CR_5 (0.946).

A better measure for bank concentration suggested by Bhattacharya (2003) and explained in greater detail in Section 4.3 is the Herfindahl-Hirschman Index, or sum of all squared market shares. As explained in Bhattacharya (2003), the HHI tends to decrease the selection bias due to the survey study from BvD. Column 3 of Table 16 presents the estimated coefficients for Equation (4.2) using the HHI as the bank concentration measure. Surprisingly the HHI is estimated to have no significant impact on long-run growth, but the coefficients on monetary policy and the interaction term still maintain their signs and significance from the first two columns. Table 16 estimates show that monetary policy influences steady-state growth rates in countries that have lower bank concentration. It also suggests that this finding does not depend upon the measure of bank concentration used.

Different measures of monetary policy may also change the results from Table 15. Therefore, the estimated coefficients should be robust across several measures of monetary policy. Table 17 estimates equation (4.2) but using a different monetary policy variable. The first column uses short-term interest rates on government securities, the second column uses long-term government security yields while the last column uses lending rates (lending rates from clearing banks, prime lending rates, average lending rates, etc). Again, the data are from the IFS CD. Column 1 shows no significance on either monetary policy or the interaction term, but there is a lack of monetary policy data; only 3547 observations as compared to 5448 using the money market rate (7 more countries are dropped due to lack of data). The second and third columns, however, contain more observations on the monetary policy variable, and subsequently are robust across different interest rates. The last column uses money market rates minus inflation as the monetary policy measure. Different monetary policy measures help to support the theory that higher bank concentration and higher monetary policy interest rates both hinder economic growth, while higher concentration in the banking sector makes monetary policy tools less effective. Both Table 16 and Table 17 show that these results remain consistent while varying measures of banking concentration and monetary policy.

Another way to check the robustness of results found so far is to include one or several lags of the variables of interest: bank concentration, and the interaction term. The first column adds one time lag of the three variables mentioned above beyond equation (4.2). The second column controls for two lags and the third column adds in a second time lag of growth beyond column 2. Bank concentration is significantly negative across all lag-structure estimations, but the lags of concentration is positive and significant. Current monetary policy is significantly negative while the second lag is positive. The interaction term is positive in the first column and the first lag is non-significant. In the second column, only the second lag of the interaction term is significant, but with a negative sign. The third column has the first lag being positive and significant while the second lag is significantly negative; the current interaction is non-significant.

4.6. Conclusion

This chapter is important for several reasons. First, while Chapter II finds monetary policy is less effective on lending levels in markets with higher bank concentration, Chapter III hypothesizes lending should affect capital investment and growth. Since this chapter finds the same affects at work on growth as found on lending in Chapter II, it also helps affirm the theory developed in Chapter III. Specifically, the empirical results discussed in this chapter helps to support a bank lending channel for monetary policy, or that monetary policy affects the real economy via bank lending.

The second contribution this chapter makes is to test how monetary policy affects growth, and how bank concentration can alter that transmission. The empirical findings support the theory developed in Chapter III; higher banking concentration and higher interest rates both impede steady-state growth rates, and that a lowering of interest rates is more effective on raising growth rates in countries with lower levels of bank concentration. The overall effect is quite large as a lowering of interest rates from the sample average suggests to increase steady-state growth rates by 0.58% when a 3-bank concentration ratio is equal to the sample average, while the same change in interest rates increases steady-state growth rates by 0.70% if bank concentration falls by only 1% below the sample average.

Since this chapter is among the first endeavors to examine how bank concentration alters monetary policy, there is a wide array of issues that need to be examined further. Such topics must include theoretical background of the mechanism that drives monetary policy differences. Further investigation should also delve into country income differences discovered in this paper, and examine why later joining OECD countries appear to have a different mechanism than veteran OECD countries. Finally, further research should examine whether those differences appear in developing nations as well.

TABLE 8. Data Statistics for Averaged Data 1993-2005

All Countries	Observations	Mean	Standard Deviation	Minimum	Maximum
$Average\ Growth\ (Compounded)_{j,k}$	621	0.007	0.074	-0.332	0.425
$Fraction\ of\ value\ added_{j,k}$	755	0.034	0.040	0.000009	0.328
$Bank\ development_k$	792	0.892	0.444	0.272	2.463
$Bank\ concentration_k$	792	0.487	0.125	0.248	0.761
$Monetary\ Policy_k$	792	13.43	26.37	0	136.5
$Log\ of\ per\ capita\ GDP_k$	792	2.471	0.855	0.812	3.607
$Stock\ market\ capitalization/GDP_k$	693	0.434	0.348	0.022	1.374
Number of Countries	24				

Pre-Data Set OECD Countries	Observations	Mean	Standard Deviation	Minimum	Maximum
$Average\ Growth\ (Compounded)_{j,k}$	476	0.004	0.072	-0.332	0.425
$Fraction\ of\ value\ added_{j,k}$	567	0.034	0.040	0.000009	0.328
$Bank\ development_k$	594	0.979	0.468	0.272	2.463
$Bank\ concentration_k$	594	0.477	0.126	0.248	0.761
$Monetary\ Policy_k$	594	14.31	30.01	2.2	136.5
$Log\ of\ per\ capita\ GDP_k$	594	2.864	0.540	1.112	3.607
$Stock\ market\ capitalization/GDP_k$	561	0.366	0.269	0.114	1.374
Number of Countries	18				

Late Joining OECD Countries	Observations	Mean	Standard Deviation	Minimum	Maximum
$Average\ Growth\ (Compounded)_{j,k}$	145	0.014	0.081	-0.176	0.325
$Fraction\ of\ value\ added_{j,k}$	188	0.034	0.038	0.00003	0.201
$Bank\ development_k$	198	0.629	0.200	0.405	0.970
$Bank\ concentration_k$	198	0.517	0.117	0.307	0.647
$Monetary\ Policy_k$	198	10.82	8.471	0	23.32
$Log\ of\ per\ capita\ GDP_k$	198	1.291	0.434	0.812	2.104
$Stock\ market\ capitalization/GDP_k$	132	0.233	0.211	0.022	0.499
Number of Countries	6				

TABLE 9. Data Statistics for Annual Data 1993-2005

All Countries	Observations	Mean	Standard Deviation	Minimum	Maximum
$Growth\ of\ value\ added_{j,k,t}$	7046	-0.001	0.342	-5.598	4.802
$Fraction\ of\ value\ added_{j,k,t}$	7699	0.035	0.043	0.00006	1
$Bank\ development_{k,t}$	10404	0.779	0.599	0.0005	3.135
$Bank\ concentration_{k,t}$	10506	0.497	0.149	0.191	0.919
$Monetary\ Policy_{k,t}$	9690	8.897	14.980	0.01	136.47
$Log\ of\ per\ capita\ GDP_{k,t}$	10608	3.598	1.975	0.192	10.838
$Stock\ market\ capitalization/GDP_{k,t}$	10608	0.408	0.387	0	1.990
Number of Countries	24				

Pre-Data Set OECD Countries	Observations	Mean	Standard Deviation	Minimum	Maximum
$Growth\ of\ value\ added_{j,k}$	5253	-0.008	0.324	-5.598	4.802
$Fraction\ of\ value\ added_{j,k}$	5755	0.035	0.044	0.00006	1
$Bank\ development_{k}$	7752	0.856	0.669	0.0005	3.135
$Bank\ concentration_{k}$	7854	0.487	0.150	0.191	0.919
$Monetary\ Policy_{k,t}$	7718	8.017	15.909	0	136.47
$Log\ of\ per\ capita\ GDP_{k}$	7956	4.168	1.972	0.192	10.838
$Stock\ market\ capitalization/GDP_{k}$	7956	0.469	0.417	0	1.990
Number of Countries	18				

Late Joining OECD Countries	Observations	Mean	Standard Deviation	Minimum	Maximum
$Growth\ of\ value\ added_{j,k}$	1793	0.020	0.390	-3.900	3.322
$Fraction\ of\ value\ added_{j,k}$	1944	0.036	0.041	0.008	0.252
$Bank\ development_{k}$	2652	0.553	0.178	0.292	0.976
$Bank\ concentration_{k}$	2652	0.527	0.144	0.225	0.858
$Monetary\ Policy_{k,t}$	1972	12.338	9.866	2.08	60.92
$Log\ of\ per\ capita\ GDP_{k}$	2652	1.908	0.365	1.289	2.743
$Stock\ market\ capitalization/GDP_{k}$	2652	0.223	0.178	0	0.907
Number of Countries	6				

TABLE 10. Correlation Table for Averaged Data 1993-2005

	$Fraction$	$Bank$	CR_3	MP	$MP * CR_3$	GDP	$Stock$
$Fraction\ of\ value\ added_{j,k}$	1.000						
$Bank\ development_k$	-0.022	1.000					
$Bank\ concentration_k$	0.033	-0.358*	1.000				
$Monetary\ policy_k$	0.007	-0.353*	0.056	1.000			
$Monetary\ policy_k *\ Bankconcentration_k$	0.009	-0.351*	0.108	**0.998***	1.000		
$Log\ of\ GDP\ per\ capita_k$	-0.018	0.505*	-0.358*	-0.410*	-0.413	1.000	
$Stock\ market\ capitalization/\ GDP_k$	-0.038	0.337*	-0.437*	-0.103*	-0.122*	0.442*	1.000

*indicates that the correlation is different than zero at the 1% level

TABLE 11. Correlation Table for Annual Data 1993-2005

	$Fraction$	$Bank$	CR_3	MP	$MP * CR3$	GDP	$Stock$
$Fraction\ of\ value\ added_{j,k,t}$	1.000						
$Bank\ development_{k,t}$	0.025	1.000					
$Bank\ concentration_{k,t}$	0.049*	-0.135*	1.000				
$Monetarypolicy_{,t}k$	-0.001	-0.170*	0.126*	1.000			
$Monetay\ policy_{k,t} *\ Bank\ concentration_{k,t}$	0.005	-0.172*	0.225*	0.974*	1.000		
$Log\ of\ GDP\ per\ capita_{k,t}$	-0.011	-0.343*	-0.032*	-0.275*	-0.207*	1.000	
$Stock\ market\ capitalization/\ GDP_k$	0.056*	0.576*	-0.037*	-0.142*	-0.150*	-0.181*	1.000

*indicates that the correlation is different than zero at the 1% level

TABLE 12. Cetorelli and Gambera (2001) Replication Tables

(Industry Fixed-Effects Included)

	CG2001 Table IV	New Data Table IV	New Data Table IV
Dependent Variable	Compounded Growth of Value-Added		
	1980-1990	1980-1990	1993-2005
Bank concentration$_k$	-0.048***	-0.125***	-0.047**
	(0.017)	(0.032)	(0.022)
Fraction of value added$_{j,k}$	-0.876***	0.131	0.001
	(0.260)	(0.135)	(0.097)
Bank development$_k$	0.066***	-0.012***	-0.030***
	(0.016)	(0.006)	(0.007)
Log of per capita GDP$_k$	-0.016***	-0.023**	0.017*
	(0.003)	(0.005)	(0.010)
Stock market capitalization/GDP$_k$	0.031***	-0.020	0.021*
	(0.006)	(0.015)	(0.011)
R^2	0.137	0.189	0.188
Observations	1150	446	476

Heteroskedasticity-consistent standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 13. Adding Interactions for Late OECD Countries

	Early OECD Only	All Data	All Data With Dummies
Dependent Variable	Compounded Growth of Value-Added		
	1993-2005	1993-2005	1993-2005
Dummy for Late Joining OECD Countries			-0.164***
			(0.022)
$Bank\ concentration_k$	-0.047**	0.031	-0.046**
	(0.022)	(0.021)	(0.022)
$OECD\ Dummy * Bank\ Concentration$			0.397***
			(0.053)
$Fraction\ of\ value\ added_{j,k}$	0.011	0.047	0.037
	(0.097)	(0.091)	(0.086)
$Bank\ development_k$	-0.030***	0.004	-0.027***
	(0.007)	(0.007)	(0.007)
$Log\ of\ per\ capita\ GDP_k$	0.017*	-0.008	0.017*
	(0.010)	(0.005)	(0.009)
$Stock\ market\ capitalization/GDP_k$	0.022*	0.004	0.019*
	(0.011)	(0.011)	(0.011)
Dummy For Greece	0.145***	0.109***	0.142***
	(0.026)	(0.026)	(0.027)
R^2	0.248	0.194	0.254
Observations	476	621	621
Industry Fixed Effects?	Yes	Yes	Yes

Heteroskedasticity-consistent standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 14. Estimation of Equation (4.1)

(Industry Fixed Effects Included)

	(1)	(2)	(3)	(4)
Dependent Variable	Compounded Growth of Value-Added			
Dataset	CG2001	CG2001	1993-2005	1993-2005
$Bank\ concentration_k$	-0.033***	0.042**	-0.047**	0.179
	(0.011)	(0.018)	(0.023)	(0.130)
$Monetary\ policy_{k,1994}$	0.001***	0.003***	0.00002	0.020*
	(0.0001)	(0.001)	(0.0002)	(0.011)
$Monetary\ policy_{k,1994} * Bank\ concentration_k$	-	-0.007***	-	-0.038*
		(0.001)		(0.021)
$Fraction\ of\ value\ added_{j,k}$	-0.305***	-0.382***	0.011	0.010
	(0.110)	(0.108)	(0.097)	(0.095)
$Bank\ development_k$	0.078***	0.097***	-0.030***	-0.017
	(0.017)	(0.019)	(0.007)	(0.011)
$Log\ of\ per\ capita\ GDP_k$	-0.022***	-0.027***	0.018	0.029*
	(0.005)	(0.005)	(0.013)	(0.015)
$Stock\ market\ capitalization/GDP_k$	0.068***	0.071***	0.021*	0.027**
	(0.014)	(0.014)	(0.011)	(0.012)
Dummy For Greece	-	-	0.146***	0.191***
			(0.026)	(0.038)
Constant	0.219***	0.227***	-0.021	-0.015
	(0.059)	(0.057)	(0.032)	(0.048)
R^2	0.338	0.360	0.248	0.254
Observations	621	621	476	476

Heteroskedasticity-consistent standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 15. Estimation of Equation (4.2)

(Obs=5448, Industry Fixed Effects and Country Fixed Effects Included)

	(1)	(2)	(3)	(4)
Dependent Variable	Growth of Real Value Added$_{j,k,t}$			
$Growth_{j,k,t-1}$	-0.349***	-0.279***	-0.302***	-0.317***
	(0.037)	(0.035)	(0.035)	(0.035)
$Bank\ concentration_{k,t}$	-0.249***	-0.213***	-0.170***	-0.173**
	(0.068)	(0.065)	(0.064)	(0.077)
$Monetary\ policy_{k,t}$	-0.010***	-0.011***	-0.010***	-0.006***
	(0.002)	(0.002)	(0.001)	(0.002)
$MP_{k,t} * CR3_{k,t}$	0.006**	0.007***	0.007***	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
$Fraction\ of\ value\ added_{j,k,t}$	6.138***	1.151***	1.165***	1.148***
	(0.771)	(0.151)	(0.154)	(0.151)
$Bank\ development_{k,t}$	0.072***	0.082***	0.050	0.013
	(0.031)	(0.029)	(0.031)	(0.032)
$Log\ of\ per\ capita\ GDP_{k,t}$	0.011*	0.012**	-0.002	0.001
	(0.006)	(0.006)	(0.006)	(0.007)
$Capitalization/GDP_{k,t}$	-0.124***	-0.120***	-0.122***	0.031
	(0.024)	(0.024)	(0.024)	(0.025)
$TimeTrend$	-	-	0.008***	-
			(0.002)	
$Constant$	-0.070	0.504***	0.0376***	0.431***
	(0.137)	(0.100)	(0.105)	(0.107)
R^2	0.219	0.127	0.129	0.170
Industry-by-Country Fixed Effects?	Yes	No	No	No
Time Fixed Effects?	No	No	No	Yes

Heteroskedasticity-consistent standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 16. Estimation of Equation (4.2) With Different Measures of Bank Concentration

(Obs=5448, Industry and Country Fixed Effects Included)

	(1)	(2)	(3)
Dependent Variable	Growth of Real Value $Added_{j,k,t}$		
Concentration Measure	CR_3	CR_5	HHI
$Growth_{j,k,t-1}$	-0.279***	-0.297***	-0.295***
	(0.035)	(0.035)	(0.035)
$Bank\ concentration_{k,t}$	-0.213***	-0.226***	-0.023
	(0.065)	(0.066)	(0.053)
$Monetary\ policy_{k,t}$	-0.011***	-0.013***	-0.009***
	(0.002)	(0.003)	(0.001)
$MP_{k,t} * Bank\ concentration_{k,t}$	0.007***	0.009***	0.011**
	(0.002)	(0.003)	(0.005)
$Fraction\ of\ value\ added_{j,k,t}$	1.151***	1.148***	1.140***
	(0.155)	(0.154)	(0.154)
$Bank\ development_{k,t}$	0.082***	0.084***	0.078**
	(0.029)	(0.029)	(0.028)
$Log\ of\ per\ capita\ GDP_{k,t}$	0.012**	0.011*	0.009
	(0.006)	(0.006)	(0.006)
$Capitalization/GDP_{k,t}$	-0.120***	-0.123***	-0.114***
	(0.024)	(0.024)	(0.024)
$Constant$	0.504***	0.551***	0.397***
	(0.100)	(0.108)	(0.097)
R^2	0.127	0.127	0.125

Heteroskedasticity-consistent standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 17. Estimation of Equation (4.2) With Different Measures of Monetary Policy

(Industry and Country Fixed Effects Included)

	(1)	(2)	(3)	(4)
Dependent Variable	Growth of Real Value Added$_{j,k,t}$			
Policy Measure	T-Bill Rate	T-Bond Rate	Lending Rate	Money Rate Minus Inflation
$Growth_{j,k,t-1}$	-0.284***	-0.278***	-0.288***	-0.294***
	(0.049)	(0.033)	(0.037)	(0.036)
$Bank\ concentration_{k,t}$	-0.145**	-0.412***	-0.384***	-0.132**
	(0.058)	(0.084)	(0.090)	(0.061)
$Monetary\ policy_{k,t}$	-0.001	-0.012**	-0.023***	-0.006***
	(0.004)	(0.006)	(0.006)	(0.001)
$MP_{k,t} * Bank\ concentration_{k,t}$	-0.006	0.040***	0.018**	0.001
	(0.006)	(0.012)	(0.009)	(0.001)
$Fraction\ of\ value\ added_{j,k,t}$	1.333***	1.198***	1.237***	1.151***
	(0.227)	(0.153)	(0.169)	(0.156)
$Bank\ development_{k,t}$	-0.015	0.103***	0.045	0.087***
	(0.024)	(0.027)	(0.030)	(0.029)
$Log\ of\ per\ capita\ GDP_{k,t}$	-0.05	0.028***	0.001	0.015**
	(0.005)	(0.005)	(0.006)	(0.006)
$Capitalization/GDP_{k,t}$	-0.128***	-0.083***	-0.107***	-0.118***
	(0.031)	(0.023)	(0.023)	(0.024)
$Constant$	0.153	-0.216***	0.208**	-0.350***
	(0.111)	(0.067)	(0.087)	(0.090)
R^2	0.132	0.108	0.122	0.122
Observations	3547	6058	5127	5401

Heteroskedasticity-consistent standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 18. Estimation of Equation (4.2) With Differing Lag Structures

(Industry and Country Fixed Effects Included)

	(1)	(2)	(3)
Dependent Variable	Growth of Real Value Added$_{j,k,t}$		
$Growth_{j,k,t-1}$	-0.295***	-0.296***	-0.335***
	(0.036)	(0.037)	(0.039)
$Growth_{j,k,t-2}$	-	-	-0.133**
			(0.043)
$Bank\ concentration_{k,t}$	-0.315***	-0.211***	-0.264***
	(0.061)	(0.058)	(0.062)
$Bank\ concentration_{k,t-1}$	0.186**	0.223***	0.212***
	(0.084)	(0.055)	(0.059)
$Bank\ concentration_{k,t-2}$	-	0.216***	0.312***
		(0.073)	(0.074)
$Monetary\ policy_{k,t}$	-0.011***	-0.014***	-0.015***
	(0.003)	(0.003)	(0.003)
$Monetary\ policy_{k,t-1}$	-0.0004	-0.005	-0.009***
	(0.002)	(0.003)	(0.004)
$Monetary\ policy_{k,t-2}$	-	0.005***	0.009***
		(0.002)	(0.003)
$MP_{k,t} * CR3_{k,t}$	0.007**	0.004	0.001
	(0.004)	(0.005)	(0.003)
$MP_{k,t-1} * CR3_{k,t-1}$	-0.0006	0.007	0.013**
	(0.004)	(0.005)	(0.006)
$MP_{k,t-2} * CR3_{k,t-2}$	-	-0.010***	-0.015***
		(0.003)	(0.004)
$Fraction\ of\ value\ added_{j,k,t}$	1.60***	1.061***	1.146***
	(0.158)	(0.162)	(0.164)
$Bank\ development_{k,t}$	0.095***	0.007	0.056*
	(0.037)	(0.029)	(0.031)
$Log\ of\ per\ capita\ GDP_{k,t}$	0.013	-0.015**	-0.015**
	(0.008)	(0.006)	(0.007)
$Capitalization/GDP_{k,t}$	-0.108***	-0.163***	-0.151***
	(0.025)	(0.025)	(0.026)
$Constant$	0.509***	-0.112	0.982***
	(0.124)	(0.091)	(0.196)
R^2	0.126	0.147	0.166
Observations	5349	4981	4582

Heteroskedasticity-consistent standard errors in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

CHAPTER V

CONCLUSION

This dissertation details one method in which the financial system helps or hinders an economy. By making the assumption that banks maximize profits in competition, these banks now play a large role in the market in which they operate. Specifically, this dissertation outlines how bank competition impedes or enhances the transmission of monetary policy. The overall findings are two-fold. First, a lack of competitors hinders an economy in terms of growth. Second, this higher concentration also dampens the effectiveness of monetary policy on an economy.

Chapter II first builds a model of a profit maximizing bank, aggregates to the market level, and shows that bank concentration dampens monetary policy effectiveness on market lending. Since monopoly banks have steeper marginal revenue curves than the market demand curve, monetary policy changes affect market lending less in monopoly markets than in perfectly competitive markets. The theory is then tested empirically using lending data over U.S. metropolitan statistical areas (MSAs) The data support the theory and find that monetary policy is indeed dampened on lending levels by the presence of bank concentration.

The next chapter, chapter III, incorporates the banking set-up from the previous chapter into an endogenous growth model. The model developed in this chapter has several advantages beyond those in chapter II. First, agents and the economy are no longer static. The sectors of the economy now interact and give feedback between each other. Second, the model specifies how bank lending can be intermediated into an economic variable; capital investment. Last, the model shows one channel in which monetary policy transmits to capital investment. Overall, higher inflation increases the nominal return on capital and, therefore capital investment. But the increase in lending is less in concentrated markets than in non-concentrated markets. The model also has an additional finding that too high of inflation may in fact decrease growth. Overall, the findings show that concentration hinders growth by itself, and that concentration also dampens inflationary effects on growth as well.

Finally, chapter IV empirically tests the theory provided in chapter III that concentration adversely affects growth and dampens the effectiveness of monetary policy on growth. Using country-level data on the growth of real value-added in manufacturing sectors, the data support the theory that higher bank concentration does inversely affect growth by itself, and that monetary policy is less effective adjusting the growth of value-added in countries with higher concentration. The results are quite robust across various measures of concentration, monetary policy, and varying lag structures.

The ideas outlined in this dissertation also have several extensions for future research. First, defining the market both theoretically and empirically is important.

A banking market in the U.S. is defined on political boundaries based on counties and MSAs. The way banks actually compete may be based on more geographical or industrial boundaries. Banks may offer a product to a certain industry, such as the industry for solar energy. Banks that offer funding to this industry may compete over county borders or state borders because the firms in solar energy compete across these boundaries as well. The market may be better defined by the data.

A second extension is to look at other theoretical forms of competition. This dissertation focuses on one specific type of competition; Nash in quantity Cournot competition. Other forms such as pricing competition may offer several insights into how banks compete beyond lending volume. These insights could offer a different or more intuitive view of how monetary policy flows through banks and how competition alters that transmission. On this extension, benefit relationships should also be introduced. This dissertation relies solely on period-by-period profit maximization, while benefit relationships focuses on profit maximization through long-term relationships. Lack of competition impedes growth on a period-by-period analysis, but this effect might be somewhat mitigated when accounting for benefit relationships.

Another possible extension is to use the framework provided in this dissertation to analyze how developing nations respond to bank concentration. The country level empirical analysis from chapter IV only examines how concentration affects monetary policy and growth in OECD nations. The findings in that chapter have nothing to say about developing nations. Since developing nations are a major source of concern in the growth literature, how banks interact with the economies in these nations is a fundamental concern as well. Bank concentration may not impede the growth of these nations, but may in fact support growth. Larger banks in developing nations could have better ways of screening borrowers for example. Larger banks would then have lower default rates and these economies would grow faster compared to an identical nation with many small banks.

Hopefully, these extensions can lead to more of an understanding of exactly how the financial system affects an economy and to a more thorough understanding to the transmission mechanism of monetary policy.

APPENDIX A

APPENDIX FOR CHAPTER II

A.1. Calculations for Chapter II

Let $\sum_j x_{jL} \equiv X_L$, or total market quantity of loans. Equation (8) shows

$$h(X_L, \beta, \sigma_{iL}) - E_R = -x_{iL} h_1'(X_L, \beta, \sigma_{iL})$$

Multiplying the right hand side by $\frac{X_L}{X_L}$, then

$$h(X_L, \beta, \sigma_{iL}) - E_R = -\frac{x_{iL}}{X_L} X_L h_1'(X_L, \beta, \sigma_{iL})$$

where $\frac{x_{iL}}{X_L} = s_i$ or market share for bank i. Multiplying both sides by market share, s_i, then

$$s_i[h(X_L, \beta, \sigma_{iL}) - E_R] = -s_i^2 X_L h_1'(X_L, \beta, \sigma_{iL})$$

Aggregating for all i banks in the market then shows that

$$h(X_L, \beta, \bar{\sigma_L}) - E_R = -HHI h_1'(X_L, \beta, \bar{\sigma_L})$$

where $\bar{\sigma_L}$ is the weighted average loan default probability for the market and the left hand side represents the market weighted average markup of loan interest rates over the federal funds rate. Relabeling $h(X_L, \beta, \bar{\sigma_L}) = h(X_L)$ and $h_1'(X_L, \beta, \bar{\sigma_L}) = h'(X_L)$,and taking a total derivative, then:

$$h'(X_L)dX_L - dE_R = -h'(X_L)X_L dHHI - HHI[h'(X_L) + h''(X_L)X_L]dX_L$$

Assuming $dHHI = 0$ and rearranging this to put all the terms with dX_L on the left-hand side is

$$\{h'(X_L) + HHI[h'(X_L) + h''(X_L)X_L]\}\, dX_L = dE_R$$

then solving for $\frac{dX_L}{dE_R}$ shows

$$\frac{dX_L}{dE_R} = \frac{1}{h'(X_L) + HHI[h'(X_L) + h''(X_L)X_L]}$$

A.2. Additional Robustness Tables for Chapter II

TABLE 19. Regression Results Excluding Lagged Loans and Assets

	(1)	(2)
Dependent Variable	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$
$\Delta\ln(Loans)_{t-1}$	-	-0.328***
	-	(-56.5)
ΔFFR_t	-0.057***	-0.0715***
	(-18.13)	(-24.9)
$\Delta\ln(HHI)_t$	0.026	0.0300
	(0.99)	(1.26)
$\Delta FFR_t * \Delta\ln(HHI)_t$	0.114***	0.0917***
	(6.22)	(5.56)
$\Delta\ln(Population)_t$	1.613***	1.681***
	(4.91)	(5.37)
$Inflation_t$	-1.053	-1.919***
	(-1.54)	(-3.03)
$\Delta Number\ of\ Loans_t$ (100,000s)	0.421***	0.403***
	(4.40)	(4.66)
$\Delta\ln(Assets)_t$	0.004	-
	(0.99)	-
$Constant$	0.107***	0.152***
	(7.20)	(10.90)
Observations	26437	24029
Number of Markets	2412	2409
Fixed Effects?	Yes	Yes

t statistics in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 20. Results Using Real Loan Value (Loans/PCE)

(n=24029, No. of Markets is 2409)

	Fixed-Effects	Random Effects
Dependent Variable	$\Delta \ln(Loans)_t$	$\Delta \ln(Loans)_t$
$\Delta \ln(Loans)_{t-1}$	-0.326***	-0.296***
	(-56.34)	(-53.05)
ΔFFR_t	-0.080***	-0.078***
	(-34.95)	(-34.72)
$\Delta \ln(HHI)_t$	0.042*	0.037
	(1.72)	(1.62)
$\Delta FFR_t * \Delta \ln(HHI)_t$	0.096***	0.101***
	(5.81)	(6.62)
$\Delta \ln(Population)_t$	1.907***	0.974***
	(6.16)	(4.83)
$\Delta Number\ of\ Loans_t$ (100,000s)	0.394***	0.253***
	(4.56)	(3.61)
$\Delta \ln(Assets)_t$	0.014***	0.009**
	(3.20)	(2.15)
Constant	0.080***	0.081***
	(23.96)	(25.34)

t statistics in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 21. Robustness Checks 1: Time Lags of Variables

Dependent Variable	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$	$\Delta\ln(Loans)_t$
$\Delta\ln(Loans)_{t-1}$	-0.298***	-0.297***	-0.297***	-0.297***	-0.296***	-0.295***	-0.295***
	(-53.3)	(-50.2)	(-53.2)	(-53.2)	(-52.7)	(-52.5)	(-52.5)
ΔFFR_t	-0.069***	-0.068***	-0.069***	-0.069***	-0.070***	-0.070***	-0.070***
	(-24.8)	(-24.5)	(-24.6)	(-24.5)	(-25.0)	(-24.8)	(-24.8)
ΔFFR_{t-1}	-	-	-	-	0.006**	0.005**	0.006**
	-	-	-	-	(2.45)	(2.20)	(2.23)
$\Delta\ln(HHI)_t$	0.037	0.029	0.036	0.036	0.041*	0.029	0.023
	(1.61)	(1.29)	(1.54)	(1.54)	(1.79)	(1.22)	(0.97)
$\Delta\ln(HHI)_{t-1}$	-	-	-	-	-	-0.052**	-0.052**
	-	-	-	-	-	(2.11)	(2.10)
$\Delta FFR_t * \Delta\ln(HHI)_t$	0.097***	0.100***	0.100***	0.100***	0.092***	0.084***	0.084***
	(6.34)	(6.44)	(6.42)	(6.43)	(5.96)	(5.26)	(5.28)
$\Delta FFR_{t-1} * \Delta\ln(HHI)_{t-1}$	-	-	-	-	-	-0.021	-0.020
	-	-	-	-	-	(1.37)	(1.31)
$\Delta\ln(Population)_t$	0.920***	0.917***	0.905***	0.913***	0.844***	0.867***	0.880***
	(4.55)	(4.52)	(4.46)	(4.49)	(4.16)	(4.27)	(4.33)
$Inflation_t$	-1.89***	-2.15***	-2.10***	-2.07***	-2.39***	-2.59***	-2.64***
	(-3.06)	(-3.47)	(-3.39)	(-3.34)	(-3.72)	(-4.00)	(-4.09)
$\Delta Number\ of\ Loans_t$ (100,000s)	-	0.266***	0.268***	0.277***	0.259***	0.236***	0.235***
	-	(3.80)	(3.82)	(3.86)	(3.69)	(3.33)	(3.32)
$\Delta Number\ of\ Loans_{t-1}$ (100,000s)	-	-	-	-0.045	-	-	-
	-	-	-	(-0.62)	-	-	-
$\Delta\ln(Assets)_t$	0.007*	-	0.007*	0.007*	0.008*	0.007*	-
	(1.84)	-	(1.69)	(1.69)	(1.88)	(1.75)	-
$\Delta\ln(Assets)_{t-1}$	-	-0.010**	-0.010**	-0.010**	-	-0.012***	-0.012***
	-	(-2.52)	(-2.40)	(-2.41)	-	(-2.99)	(-3.11)
$Constant$	0.150***	0.159***	0.156***	0.156***	0.160***	0.166***	0.169***
	(11.0)	(11.6)	(11.3)	(11.3)	(11.3)	(11.5)	(11.8)
Observations	24029	24016	24016	24016	24029	24015	24015
Number of Entities	2409	2409	2409	2409	2409	2409	2409

t statistics in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

TABLE 22. Robustness Checks 2: Difference in HHI, not % Change

Dependent Variable	$\Delta \ln(Loans)_t$	$\Delta \ln(Loans)_t$	$\Delta \ln(Loans)_t$	$\Delta \ln(Loans)_t$	$\Delta \ln(Loans)_t$	$\Delta \ln(Loans)_t$	$\Delta \ln(Loans)_t$
$\Delta \ln(Loans)_{t-1}$	-0.298***	-0.298***	-0.298***	-0.298***	-0.296***	-0.295***	-0.295***
	(-53.3)	(-53.3)	(-53.3)	(-53.3)	(-52.7)	(-52.5)	(-52.5)
ΔFFR_t	-0.070***	-0.069***	-0.070***	-0.070***	-0.071***	-0.071***	-0.070***
	(-25.2)	(-24.8)	(-24.9)	(-24.9)	(-25.3)	(-24.1)	(-25.1)
ΔFFR_{t-1}	-	-	-	-	0.006**	0.006**	0.006**
	-	-	-	-	(2.53)	(2.36)	(2.38)
$\Delta(HHI)_t(1,000s)$	0.041	0.023	0.040	0.040	0.052	0.019	0.002
	(0.69)	(0.39)	(0.67)	(0.66)	(0.85)	(0.31)	(0.04)
$\Delta(HHI)_{t-1}(1,000s)$	-	-	-	-	-	-0.016**	-0.016**
	-	-	-	-	-	(2.54)	(2.55)
$\Delta FFR_t * \Delta(HHI)_t(1,000s)$	0.025***	0.025***	0.25***	0.025***	0.024***	0.021***	0.021***
	(6.11)	(6.21)	(6.17)	(6.18)	(5.77)	(5.00)	(5.03)
$\Delta FFR_{t-1} * \Delta(HHI)_{t-1}(1,000s)$	-	-	-	-	-	-0.004	-0.004
	-	-	-	-	-	(0.94)	(0.88)
$\Delta \ln(Population)_t$	0.894***	0.890***	0.879***	0.887***	0.820***	0.852***	0.863***
	(4.42)	(4.39)	(4.33)	(4.36)	(4.05)	(4.20)	(4.26)
$Inflation_t$	-1.91***	-2.16***	-2.12***	-2.09***	-2.42***	-2.61***	-2.66***
	(-3.10)	(-3.50)	(-3.42)	(-3.38)	(-3.77)	(-4.04)	(-4.26)
$\Delta Number\ of\ Loans_t$ (100,000s)	-	0.263***	0.264***	0.274***	0.256***	0.251***	0.250***
	-	(3.75)	(3.77)	(3.82)	(3.65)	(3.57)	(3.56)
$\Delta Number\ of\ Loans_{t-1}$ (100,000s)	-	-	-	-0.046	-	-	-
	-	-	-	(-0.63)	-	-	-
$\Delta \ln(Assets)_t$	0.007*	-	0.006	0.006	0.007*	0.006	-
	(1.71)	-	(1.56)	(1.56)	(1.74)	(1.58)	-
$\Delta \ln(Assets)_{t-1}$	-	-0.010**	-0.009**	-0.009**	-	-0.012***	-0.013***
	-	(-2.51)	(-2.40)	(-2.41)	-	(-3.10)	(-3.21)
$Constant$	0.150***	0.159***	0.156***	0.156***	0.160***	0.166***	0.169***
	(11.0)	(11.5)	(11.3)	(11.2)	(11.3)	(11.6)	(11.8)
Observations	24030	24017	24017	24017	24030	24017	24017
Number of Entities	2409	2409	2409	2409	2409	2409	2409

t statistics in parentheses

$***p < 0.01,\ **p < 0.05,\ *p < 0.10$

APPENDIX B

DERIVATIONS OF EQUATIONS FOR CHAPTER III

B.1. The Savings/Deposit Function

In nominal terms, the budget constraints are:

$$p_t c_t = W_t - M_t - D_t$$

$$p_{t+1} c_{t+1} = i_{d,t+1} D_t + M_t + T_t$$

Using lower case lettering to denote real holdings and dividing each side by prices gives:

$$c_t = w_t - m_t - d_t$$

$$c_{t+1} = \frac{i_{d,t+1} D_t + M_t + T_t}{p_{t+1}}$$

Finally, multiplying the right hand side of the second equation by p_t/p_t and using $p_t/p_{t+1} = \Pi_{t+1}^{-1}$ or the inverse of the inflation factor, gives

$$c_{t+1} = \frac{i_{d,t+1} d_t + m_t + \tau_t}{\Pi_{t+1}}$$

which are the two constraints found in problem (3.1).

Substituting the constraints into equation 3.1, then the problem becomes:

$$\max_{m_t, d_t} U(m_t, d_t) = \ln(w_t - m_t - d_t) + \ln(m_t) + \beta \ln\left(\frac{m_t + i_{d,t+1}d_t + \tau_t}{\Pi_{t+1}}\right)$$

Solving yields the following two FOC:

$$\frac{\partial U}{\partial m_t} : \frac{1}{c_t} = \beta \frac{1}{c_{t+1}\Pi_{t+1}} + \frac{1}{m_t}$$

$$\frac{\partial U}{\partial d_t} : \frac{1}{c_t} = \beta \frac{i_{d,t+1}}{c_{t+1}\Pi_{t+1}}$$

Substituting the second FOC into the first using c_t, then

$$c_{t+1} = \beta \frac{i_{d,t+1}}{\Pi_{t+1}} c_t = \beta \frac{i_{d,t+1} - 1}{\Pi_{t+1}} m_t$$

Creating a lifetime budget constraint from the two budget constraints yields

$$w_t - c_t - m_t = d_t = \frac{\Pi_{t+1}c_{t+1} - m_t - \tau_t}{i_{d,t+1}}$$

Plugging the FOC's into the lifetime budget constraint to substitute out c_t and

c_{t+1} for m_t and rearranging give the money demand equation

$$m_t = \frac{i_{d,t+1}}{(2+\beta)(i_{d,t+1}-1)}\left[w_t + \frac{\tau_t}{i_{d,t+1}}\right]$$

Using the right-hand side of the lifetime budget constraint for d_t and using the FOCs to substitute out c_{t+1} for m_t gives

$$d_t = \left[\beta\left(\frac{i_{d,t+1}-1}{i_{d,t+1}}\right) - \frac{1}{i_{d,t+1}}\right] m_t - \frac{\tau_t}{i_{d,t+1}}$$

Lastly, using the money demand equation into the one above gives:

$$d_t = \frac{\beta(i_{d,t+1}-1)-1}{(2+\beta)(i_{d,t+1}-1)} w_t + \left[\frac{\beta(i_{d,t+1})-1}{(2+\beta)(i_{d,t+1}-1)} - 1\right]\frac{\tau_t}{i_{d,t+1}}$$

or the demand equation (3.3)

$$d_t = \frac{\beta(i_{d,t+1}-1)-1}{(2+\beta)(i_{d,t+1}-1)} w_t - \frac{2i_{d,t+1}-1}{(2+\beta)(i_{d,t+1}-1)}\frac{\tau_t}{i_{d,t+1}}$$

B.2. Deposit Interest Rate and Bank Profits

Taking (3.5) into (3.9), we can solve for i_d:

$$i_{d,t+1} = i_{l,t+1} + i'_{l,t+1} D_t H$$

Using (3.5), then:

$$i_{L,t+1} = \Pi_{t+1} \alpha B A_{t+1}^{1-\alpha} k_{t+1}^{\alpha-1}$$

$$i'_{L,t+1} = -\Pi_{t+1} \alpha (1-\alpha) B A_{t+1}^{1-\alpha} k_{t+1}^{\alpha-2}$$

Finally, Using the fact that $A_t = k_t$, and $D_t/p_t = d_t = \Pi_{t+1} k_{t+1}$, then

$$i_{d,t+1} = \Pi_{t+1}(\alpha B - \Pi_{t+1} \alpha B (1-\alpha) H)$$

and nominal bank profits are equal to the interest earned on loans minus the interest paid on deposits times total deposits, or

$$T_{t+1} = (i_L - i_d) D_t = \Pi_{t+1} \alpha (1-\alpha) BHD_t = p_{t+1} \alpha (1-\alpha) BHd_t$$

Since real bank profits are nominal profits divided by the price level, then:

$$\tau_{t+1} = \alpha (1-\alpha) BHd_t = \Pi_{t+1} \alpha (1-\alpha) BHk_{t+1}$$

B.3. The Capital Accumulation Equation and Growth Equation

Taking the fact that $d_t = \Pi_{t+1}k_{t+1}$ and using the deposit function (3.3), and (3.6), then

$$\Pi_{t+1}k_{t+1} = \frac{\beta(i_{d,t+1}-1)-1}{(2+\beta)(i_{d,t+1}-1)}(1-\alpha)Bk_t - \frac{2i_{d,t+1}-1}{(2+\beta)(i_{d,t+1}-1)}\frac{\Pi_t\alpha(1-\alpha)BHk_t}{i_{d,t+1}}$$

taking the growth factor $\Gamma = k_{t+1}/k_t$;

$$\Gamma = \frac{(1-\alpha)B}{\Pi^e_{t+1}(2+\beta)(i^e_{d,t+1}-1)}\left[\beta(i^e_{d,t+1}-1)-1-\frac{\Pi_t(2i^e_{d,t+1}-1)}{i^e_{d,t+1}}\right]$$

where $i^e_{d,t+1} = \Pi^e_{t+1}(\alpha B - \Pi^e_{t+1}\alpha(1-\alpha)BH)$.

APPENDIX C

APPENDIX FOR CHAPTER IV

C.1. Data Conversion

Since the data are only in 4-digit format from the UN, the conversion from Revision 3 back to Revision 2 is imperfect because one revision 3 code may feed into several revision 2 codes. An example of this is rev.3 code 1549, the manufacturing of other food products. This code feeds into both rev.2 3111, slaughtering, preparing and preserving meat and also into rev.2 3113, canning and preserving of fruits and vegetables. To overcome this problem, I did an initial conversion where one rev.3 code converted directly into one rev.2 code. Then is reverted rev.3 codes that went into several rev.2 codes into the largest share of value-added rev.2 code. For example, if 3111 had a larger share of manufacturing than 3113, I converted rev.3 code 1549 into rev.2 code 3111. While there is some possible bias in the data because of imperfect reversions, most of the time overlaps had very small shares of value-added. Typically, using the example above, rev.2 3111 would already have over 4-5 times more in value-added than in 3113, so one would expect that the part of rev.3 1549 that streamed into rev.2 3113 would be much smaller than what went into rev.2 3111. Also, many times rev.2 code 3110 (3 digit) would be used in Rajan and Zingales (1998) and all of rev.3 1549 would feed directly into rev.2 3110. To check against possible biases, I also have the raw value-added data in rev.3 coding in which to run the regressions. I also have the one-to-one conversion coding that I used in .xls format that is available.

C.2. Equations used to Calculated Growth Rate Changes

$$g_y^* = \frac{\alpha_4}{1-\alpha_1} CR3 + \frac{\alpha_5}{1-\alpha_1} MP + \frac{\alpha_6}{1-\alpha_1} CR3 * MP \tag{C.1}$$

$$\partial g_y^* = \frac{\alpha_4}{1-\alpha_1} \partial CR3 + \frac{\alpha_5}{1-\alpha_1} \partial MP + \frac{\alpha_6}{1-\alpha_1} \left[\overline{CR3} * \partial MP + \partial CR3 * \overline{MP} \right] \tag{C.2}$$

$\overline{CR3} = 0.497$ and $\overline{MP} = 8.897$. $\alpha_1 = -0.279 \alpha_4 = -0.213 \alpha_5 = -0.011 \alpha_6 = 0.007$

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