IS A LOAN TAX OPTIMAL IN THE PRESENCE OF LEANING AGAINST THE LOAN WIND POLICY?

A Master's Thesis

by
Şiva Çelik

Department of
Economics
İhsan Doğramacı Bilkent University
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Graduate School of Economics and Social Sciences
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Şiva Çelik

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of
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September 2013

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Assoc.Prof.Dr.Refet S. Gürkaynak

Supervisor

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Assoc. Prof. Dr.Bilin Neyaptı

Examining Committee Member

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Assoc. Prof. Dr.Süheyla Özyıldırım

Examining Committee Member

Approval of the Graduate School of Economics and Social Sciences

---

Prof. Dr. Erdal Erel

Director

ABSTRACT

IS A LOAN TAX OPTIMAL IN THE PRESENCE OF LEANING AGAINST THE LOAN WIND POLICY?

ÇELİK, Şiva

M.A., Department of Economics

Supervisor: Assoc.Prof.Dr.Refet S. Gürkaynak

September 2013

This thesis aims to figure out an optimal combination of monetary policy tools and macroprudential tools in order to maintain both financial stability and price stability. In particular, given that monetary policy authority already considers loan growth in its objective function, it asks whether an additional macroprudential tool, a loan tax, is welfare-improving. For this purpose, it constructs a simple New Keynesian Model with capital and banking sector. By incorporating loan growth in a loss function, monetary policy authority chooses the optimum weights and derives a Taylor-type interest rate rule, which could be also called as leaning against the credit winds. Then, it adds an endogenous tax rule and compares the minimum mean values of loss function. The result of simulations suggest that a tax rule that responses to deviations from steady state value of growth, inflation and loan growth leads lower loss values, thus, the inclusion of tax in the policy rule set is welfare-improving.

Keywords: Financial Stability, Macroprudential Policy, Taylor-Type Interest Rate Rule, Optimal Monetary Policy, Loan Tax ,Credit Boom

ÖZET

KREDİ RÜZGARLARINA KARŞI DURUŞ POLİTİKASI VARLIĞINDA KREDİ VERGİSİ İDEAL MİDİR?

ÇELİK, Şiva

Yüksek Lisans, Ekonomi Bölümü

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Bu tez çalışması, finansal istikrar ve fiyat istikrarını birlikte sağlayabilmek amacıyla, optimal bir para politikası ve makro-ihtiyari politika birleşime ulaşmayı amaçlamaktadır. Daha spesifik olarak, bu çalışma, para politikası yetkililerinin kredi büyümesini göz önünde tuttuğu bir durumda, ilave bir makro-ihtiyari politika aracı olarak kredi vergisinin refahı arttırıp arttırmayacağını araştırmaktadır. Bu amaçla, sermaye ve banka içeren basit bir Yeni Keynezyen Model oluşturulmuştur. Modelde, para politikası yetkilileri, kredi büyümesini içeren bir kayıp fonksiyonun minimizasyonu yoluyla , bir çeşit Taylor nominal faiz kuralını oluşturmaktadır. Bu geliştirilmiş Taylor kuralı ile kredi büyümesine faiz kuralıyla müdahele etmek, kredi rüzgarlarına karşı duruş politikası olarak da adlandırılmaktadır. Daha sonra, gelir,enflasyon ve kredi büyümesine göre değişen bir vergi kuralının da politika setine eklenmesi ve kayıp fonksiyonundaki değerlerinin karşılaştırılması yoluyla, refah artışı sağlandığı sonucuna ulaşılmıştır.

Anahtar Kelimeler: Finanal İstikrar, Makro-ihtiyari politikalar, Taylor Faiz kuralı, Optimal Para Politikası, Kredi Vergisi ,Kredi Büyümesi

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CHAPTER 1

INTRODUCTION

This paper aims to figure out optimal monetary policy when loans are also considered as a component of policy rule. In particular, central bank includes a loan growth component in its loss function, then, it accordingly drives a Taylor-type interest rate rule with optimum weights. This augmented Taylor rule presents *a leaning against the financial winds (credit winds)* stance. Moreover, by comparing the values of loss function, it attempts to answer whether a loan tax is welfare improving or not. This also implies a question that asks whether financial stability could be enhanced through loan taxes. For this purpose, I develop a simple New Keynesian Model with capital and loan.

Adding capital accumulation into a New Keynesian Model creates a new channel for monetary policy via no arbitrage condition between real returns on deposits and capital. That is, an increase in interest rates in response to increase in inflation raises the renting cost of capital, giving rise to *cost-push inflation*. This addition creates changes in stability properties and model dynamics.[1] Apart from this, another channel for monetary policy and macro-prudential policy is created by introducing a financial intermediary -bank-

[1] See Calstrom and Fuerst (2005)

and a loan tax. Under zero profit assumption, banks take deposits and after tax payment, they provide all remained deposits as loan to firms. This implies that a change in tax rate affects loan available to firms, thereby it changes the total investment. This second channel allows to study impacts of a loan tax (as a macroprudential tool) on investment, in particular, on loss values.

The motivation for the paper comes from different arguments: Firstly, the recent financial crisis of 2007-2008 has forced economists and politicians to rethink monetary policies. In the wake of the crisis, price stability oriented monetary policies have been generated much doubt about sustaining healthy macroeconomic conditions. Since price stability could not guarantee financial stability, and the financial distress adversely affects the real economy, the need for policies regarding both financial stability and price stability have emerged. Secondly, credit booms and asset price bubble pose high potential risks to macroeconomic stability as seen in experienced crisis, i.e. 1929 Great Depression, 1989 Japanese asset price bubble, 1990s Nordic Countries 'Experiences. In the light of leaning against the wind policies, it would be worth questioning the need for additional macroprudential policies in an economy with asset price increases due to increased credit. Japanese boom-bust cycle emerged in the mid 1980 with a run-up of real estate prices fueled by an increase in bank lending and easy monetary policy. The property price boom caused a stock market boom since future profits increased due to the fact that asset values of the firms increased. Consequently, firms increased collateral stimulated further bank loans. Bank of Japans response to asset price boom was the adoption of tighter monetary policies, which led asset price collapse in the next 5 years. It followed by a collapse in bank lending with a decline in collateral based loans. Banks became insolvent as the decline in asset prices impaired the capital stock of banking system. After the burst of the bubble, banks still provided loans to inefficient, highly leveraged firms. Even after

a decade, Japanese economy still faced stagnation and deflation due to the tight monetary policy and the slow recovery of banks. Therefore, Japans experience has brought attention to regulatory policies and created doubt on efficiency of leaning against the wind policies.

Moreover, the current financial crisis of 2007-2009 has also highlighted the importance of monetary policies toward asset price booms and credit booms. Accordingly, there has been a growing debate over macroprudential tools, which mainly aim to mitigate financial sector imperfections to maintain financial stability and their possible combinations with traditional monetary policy.[2]

In this paper, I construct a simple New Keynesian Model with capital and a financial intermediary in an economy with financial imperfections which could bring about excessive credit levels and asset price booms. A highly leveraged economy could pose such potential risks: a negative shock to prices changes net worth of firms, causing the cost of capital to increase. Consequently, it limits the available amount of loans ,thereby it reduces total investment and output, which gives rise to further decreases in asset prices and net worth and these feedback effects could cause persistent and undesired economic conditions. This mechanism is the well-known financial accelerator (BGG,1999) mechanism (in a negative way) as it also refers to debt-deflation (Fisher,1933). In this case, traditional rules might not be able to sustain financial stability. In this paper, however, I do not study reasons behind loan booms explicitly. Instead, I assume that central bank takes loan growth into account due to risks posed by highly-leveraged economy[3]; hence it incorporates a loan growth component in the loss function in addition to deviations

[2]see Galati and Monessner(2010) and Borio and Lowe(2002) for a literature review on macroprudential policies and a general discussion over macroprudential tools

[3]see Adrian and Shin (2008) and BIS research(2001)

from output and inflation and generates a Taylor-type interest rate rule via calibration studies.

The main contribution of the paper to the literature is that inclusion of loan growth into loss function and optimizing the Taylor-type interest rate rule and discuss whether using loan tax as an additional component of the policy rule is welfare-improving.

CHAPTER 2

LITERATURE SURVEY

This paper mainly belongs to a newly growing macroprudential policy and financial stability literature. Specifically, it is related to papers that monetary and macroprudential policies are examined in order to sustain both financial and price stability.

Kannan, Rabanal and Scott (2012), Lamberteni, Mendicino and Punzi (2011), Angelini, Panette and Neli (2012), Beau, Clerc and Mojon (2012) work on potential gains of monetary and macroprudential policies. By using DSGE models with financial frictions, they compare different combinations of Taylor type interest rate rule that leans against financial winds as well as a standard Taylor rule and macroprudential tools under different shocks. They all show that a Taylor rule that responds to loan growth is more efficient than using a standard Taylor rule. Moreover, in these papers, it is suggested that loan to value ratios that respond to loan growth could be used to reduce the amplitude of boom-bust cycles in credit and asset prices, particularly, in the presence of financial shocks. Similar to these papers, I examine the optimality of an additional macroprudential tool, which is a loan tax, by comparing the efficiency results with the case in which only a Taylor type interest rate that leans against loan growth is adopted. Different from these

papers, in this study, by adding capital, investment and loan dynamics, it allows to generate an additional channel that policy makers can affect the model dynamics via no-arbitrage condition between real returns on deposits and capital. This channel affects financial decisions and the availability of credit to firms. Accordingly, even in the presence of supply shocks, using an additional macroprudentional tool could become much more efficient, which is opposed to the results in these papers. Moreover, neither of these papers compare the efficiency results of a loan tax that responds to deviations from steady state values of output, inflation and loan growth in the presence of a Taylor rule that leans against loan growth. However, monetary policy authority could utilize both an augmented Taylor rule that respond to loan growth and an endogenous loan tax. Therefore, there is still a question that ask whether there exists an optimum loan tax such that it results in lower loss values.

This paper is also related to the studies that examine (in)determinacy of interest rate rule and optimal monetary policy. Bernanke and Woodford (1997), Clarida, Gali and Gertler (1999), Kerr and King (1996) discuss the existence and uniqueness of rational equilibrium in three-equation New Keynesian Models, which have been commonly used in examining the optimality of monetary policies. While Clarida, Gali and Gertler (1999) analyze and compare a various of alternative monetary policies such as commitment vs. discretion, certainty vs. uncertainty. Bernanke and Woodford (1997) highlight the forecast-based inflation targeting, its properties and the need for internal forecast-with structural models along with the private sector forecasts. In these papers, a standard result is that in order to avoid indeterminacy, monetary policy ought to respond aggressively to either expected inflation (see Bernanke and Woodford (1997)) and Clarida, Gali and Gertler (1999))or current inflation (see Kerr and King(1996)). Apart from these pa-

pers, Calstrom and Fuerst (2005) adds capital into a New Keynesian Model, then search for the necessary conditions to avoid indeterminacy of interest rate rule. They conclude that inclusion of capital makes the determinacy harder and shrinks the determinacy range. As opposed to previous papers, they find that forward looking rules are more subject to local indeterminacy. Similar to all these papers, I examine the existence and uniqueness of an interest rate. However, differently, the interest rate is an augmented Taylor rule that responds to loan growth in the presence of flexible inflation targeting, committing to the loss function. Similar to Calstrom and Fuerst (2005), I use a capital included New Keynesian model. Moreover, I also include loan dynamics into model as well as an endogenous tax rule. Different from this studies, instead of focusing on determinacy cases for different timing conventions in the interest rule, I examine determinacy of interest rate rule that leans against loan winds in the presence of an additional macroprudential tool- an endogenous loan tax over deposits.

This paper is also related to DSGE models with financial frictions. Due to departures of Modigliani- Miller theorem (1958), firms borrow in the presence of a variety of financial market imperfections (agency costs, moral hazard problems, herd behavior, over-optimism). In this literature, Bernanke, Gertler and Gilchrist (1999, B.G.G. henceforth) financial accelerator mechanism framework demonstrates that borrowers face an external finance premium, which reflects the different costs of internally and externally raised funds. The finance premium inversely depends on borrowers net worth, which is pro-cyclical due to the pro-cyclicality of profits and asset prices. This implies that the external finance premium is countercyclical, enhancing the swings in borrowing and hence investment and aggregate demand. Accordingly, the external finance premium propagates shocks to the real economy and amplifies business cycle fluctuations. Apart from BGG, in Kyotaki and

Moore (1997), firms borrow according to their collateral value and a positive shock to prices improves the ability borrowing and this further increase the prices, thereby it might lead a credit boom and asset price bubble, which could carry systematic risks on macroeconomic stability. Moreover, this paper is related to empirical papers that investigate relations between credit booms and financial crises. Mendoza and Terrones (2008), Eichengreen and Arteta (2002) show that credit booms are associated with the periods of economic expansions, rising prices and most of these credit booms result in financial crisis, especially in emerging countries. Similarly, by examining 20 crises including 20 countries, Kaminsky and Reinhart (1996) illustrate that financial liberation and credit expansion could be a leading warning indicator. Borgy, Clerc and Penne (2009) show that not all asset price booms are bad, however, credit driven asset price boom are especially likely to burst ,resulting in financial crises.

CHAPTER 3

MODEL

3.1 Households

Following Calstrom and Fuerst(2005) and Yun (1998), I construct a New Keynesian Model with capital accumulation and sticky prices: Households are identical and infinitely-lived with preferences over consumption, real money balances and leisure are given by

$$E\sum_{t=0}^{\infty}\beta u(C_t, M_{t+1}, 1-L_t) \tag{3.1}$$

where β is the discount factor, C_t is consumption at time t, M_{t+1} is nominal money holdings at the beginning of the period $(t+1)$, $1-L_t$ is leisure, P_t is the price level and M_{t+1}/P_t is real money balances.

Households utility function is separable in leisure and forms as:

$$U(C_t, M_{t+1}, 1-L_t) = C_t^{1-\sigma}/1-\sigma + \Phi ln(M_{t+1}/P_t) + \mu L_t \tag{3.2}$$

Different from Calstrom and Fuerst(2005) and Yun (1998), a representative household holds D_{t-1} deposits and M_t cash balances. A household gains interest payments on deposits D_{t-1} with nominal interest rate R_{t-1} and keep

deposits again in the next period, D_t . Moreover, a household receives real factor payments from the labor market $w_t L_t$ and capital market $(r_t + (1-\delta))K_t$. Households also take firms profits Π and spend money on capital K_{t+1} and C_t . According to the intertemporal budget constraints below , a household chooses $M_{t+1}, C_t, 1 - L_t$ and solves maximization problem:

$$M_{t+1} + D_t + P_t C_t + P_t K_{t+1} = M_t + D_{t-1} R_{t-1} + P_t(w_t L_t + (r_t + 1 - \delta)K_t) + \Pi \tag{3.3}$$

First order conditions of the households maximization problem:

$$U_c/U_l = -1/w \tag{3.4}$$

$$U_c(t) = \beta E(U_c(t+1)(r_{t+1} + 1 - \delta)) \tag{3.5}$$

$$U_c(t) = \beta R_t E(U_c(t+1)/P_{t+1}) \tag{3.6}$$

$$U_m(t)/U_c(t) = R_{t-1}/R_t \tag{3.7}$$

where equation(4) is consumption-labor condition, equation(5) is the Euler equation, equation(6) is the Fisherian interest rate determination in which the nominal interest rate varies with expected inflation and the real rate of interest on deposits and equation(7) is the models money demand equation.

3.2 Firms

Following Calstrom and Fuerst(2005) and Yun (1998), I adopt the firm behavior as the following: Firms monopolistically compete in the intermediate goods market $y_t(i)$ with Dixit-Stiglitz (1977) technology. The CES production

function is given by

$$Y_t = (\int_0^1 y_t(i)^{\eta-1/\eta} di))^{\eta/\eta-1} \tag{3.8}$$

where Y_t is the final good , $y_t(i)$ is the continuum of intermediate goods each indexed by $i \in [0, 1]$. The corresponding demand function is then given by

$$Y_t(i) = Y_t(P_t(i)/P_t)^{\eta} \tag{3.9}$$

where $P_t(i)$ is price of good i, and P_t is price of the final goods and η is the constant price elasticity. Perfect competition in the final goods market implies that the final goods price is given by

$$P_t = (\int_0^1 p_t(i)^{1-\eta} di))^{1/1-\eta} \tag{3.10}$$

Firms rent capital and labor and produces with constant returns to scale technology (CRS):

$$Y = F(K, L) = K^{\alpha} L^{1-\alpha} \tag{3.11}$$

Due to imperfect competition, the factor prices are distorted and the first order conditions of cost minimization yield:

$$r_t = z_t f_k(k, l) \tag{3.12}$$

$$w_t = z_t f_l(k, l) \tag{3.13}$$

where z_t is the marginal cost of production. Rearranging the conditions with the Cobb-Douglas production function gives that:

$$r_t = \alpha z_t . Y_t / K_t \tag{3.14}$$

$$w_t = (1-\alpha) z_t (Y_t / K_t)^{-\alpha/1-\alpha} \tag{3.15}$$

According to Calvo staggered pricing, a fraction $(1-v)$ firms receives a signal to reset its price. Thereby, firms maximize the sum of discounted profits regarding the probability of resetting its price. Then, Calvo Pricing and the firms maximization problem is as the following:

$$\max_{P_t(i)} E \sum_{j=t}^{\infty} (v / \prod_{i=0}^{j} R_i)^j ((P_t(i)/P_t)^{\eta} Y_t (P_t(i)/P_t - z_t)) \tag{3.16}$$

(16) Log-linearized form of the profit maximization conditions give a log-linearized New Keynesian Phillips Curve:

$$\tilde{\pi} = \beta E(\tilde{\pi}(t+1)) + \Lambda \tilde{z}_t \tag{3.17}$$

where $\Lambda = (1-v)(1-\beta v)/v$ is the real marginal cost elasticity of inflation.

3.3 Banks

Banks operate in a perfectly competitive market and make zero profit. It takes deposits from households and gives loans to firms by an amount equal to residual deposits after tax payment. The relationship between deposits and loan supply is given by

$$Loan_t = (1-\gamma) D_t \tag{3.18}$$

where γ is loan tax rate and D_t is deposits.

A loan tax could be in form of a compulsory reserve requirement which is adopted by central bank that aims to affect the total amount of loan provided to firms via banking channel. Central bank imposes such regulatory policy in two cases : First, in case of excessive loan supply, central bank wants to curb the supply of loans in order to cool the overheated economy. Therefore, holding the deposits constant, the supply of loan is lowered by increasing reserve requirements, which is the form of a loan tax. Apart from this, when central bank regards excessive loan supply as a threat to macroeconomic stability, it also intervenes the supply of loans. In this case, this loan tax more resembles loan loss provision, which banks are required to set aside allowance for bad loans. In both cases, a loan tax is adopted and collected by central bank. Moreover, the revenues are not spent on anything, instead , tax revenues are kept owing to cautionary behavior of central bank and this unexpended tax revenues could be provided as liquidity throughout a financial distress similar to what has happened in the recent financial crisis 2007-2008.

For simplicity, I ignore the interest rate spread between deposits and loan. By explicitly assuming that banks are hold by households and bank profits are transferred to households budget, this simplification does not harm the specification and impacts of channels on model dynamics. Therefore, I assume that banks make zero profit and face the loan tax as the only source of expenses.

3.4 Monetary Policy

Monetary policy makers use a loss function over three variables: deviations from steady state values of output, deviations from steady state values

of inflation and loan growth. Different from a standard loss function, it incorporates loan growth into loss function and similarly takes the linear-quadratic form as such:

$$Loss_t = \tau_y(y - \tilde{y_t})^2 + \tau_{inf}(\pi - \tilde{\pi})^2 + \tau_{loan}(Loan_{t+1} - Loan_t)^2 \tag{3.19}$$

where τ_y is the weight of output deviations from steady state, τ_{inf} the weight of inflation deviations from steady state and τ_{loan} is the weight of loan growth in the loss function.

Under commitment, policy decision makers seek the optimum weights that minimize the value of loss function and it accordingly drives a Taylor-type interest rate rule with these optimal values as such:

$$R_t = i_t + \tau *_y (y - \tilde{y_t}) + \tau *_{inf} (\pi - \tilde{\pi}) + \tau *_{loan} (Loan_{t+1} - Loan_t) \tag{3.20}$$

where R_t is the nominal interest rate ,i_t is the real interest rate and $\tau *_y$,$\tau *_{inf}$,$\tau *_{loan}$ are the optimum weights derived from loss minimization.

3.5 Dynamics of The Model

The dynamics of the model are defined a system of first order conditions log-linearized around the steady state for households and firms, monetary policy and shock of preferences and marginal cost with combining aggregate resource constraint:

$$Y = C + I + \gamma S \tag{3.21}$$

$$K_t = (1 - \delta)K_{t-1} + I_{t-1} \tag{3.22}$$

$$Loan_t = I_{t-1} \tag{3.23}$$

Equation (21) suggests that a proportion of savings (deposits) is non-performing savings due to taxation. However, the residual of deposits is turned into loan, and all loans are converted into investment without any additional costs as Equation (23) implies. Hence, Equation(22) gives the corresponding law of motion for capital.

$$\tilde{C}_t = E(\tilde{C_{t+1}}) - \frac{1}{\sigma}(\tilde{R}_t - E(\tilde{\pi_{t+1}}) + \varepsilon_{g,t} \tag{3.24}$$

$$\tilde{R}_t - E(\tilde{\pi_{t+1}}) = (1 - \beta(1-\delta))(E(\tilde{z_{t+1}}) + E(\tilde{Y_{t+1}})) - \tilde{K_{t-1}} \tag{3.25}$$

$$\sigma\tilde{C}_t = \tilde{z}_t + \frac{\alpha}{1-\alpha}(\tilde{K}_t - \tilde{Y}_t) \tag{3.26}$$

$$\tilde{\pi}_t = \beta E(\tilde{\pi_{t+1}}) + \Lambda\tilde{z}_t + \varepsilon_{z,t} \tag{3.27}$$

$$\tilde{K}_t = (I/Y)\tilde{I_{t-1}} + (1-\delta)\tilde{K_{t-1}} \tag{3.28}$$

$$\tilde{I_{t-1}} = \tilde{Loan}_t \tag{3.29}$$

$$\tilde{Loan}_t = (1-\gamma)\tilde{D}_t \tag{3.30}$$

$$\tilde{Y}_t = (C/Y)\tilde{C}_t + (I/Y)\tilde{I}_t + \gamma(S/Y)\tilde{S}_t \tag{3.31}$$

$$\varepsilon_{z,t} = \rho_z\varepsilon_{z,t-1} + u_{z_t} \tag{3.32}$$

$$\varepsilon_{g,t} = \rho_g\varepsilon_{g,t-1} + u_{g_t} \tag{3.33}$$

$$R_t = i_t + \tau_y^*(y - \tilde{y}_t) + \tau_{inf}^*(\pi - \tilde{\pi}) + \tau_{loan}^*(Loan_{t+1} - Loan_t) \tag{3.34}$$

$$Loss_t = \tau_y(y - \tilde{y}_t) + \tau_{inf}(\pi - \tilde{\pi}) + \tau_{loan}(Loan_{t+1} - Loan_t) \tag{3.35}$$

in the second case, the additional equation:

$$\tilde{\gamma}_t = m\tilde{\pi}_t + n\tilde{Y}_t + g(Loan_{t+1} - Loan_t) \tag{3.36}$$

Equation(24) is the Euler equation for the households optimization problem with demand (preference) shock $\varepsilon_{g,t}$ that follows AR(1) process. Equation(25) is the Fisherian equation . Equation(26) comes from the labor market equilibrium conditions (4,14). Moreover, deposits and savings are equal.

Substituting $\tilde{y}_t$ into the the equations gives a system of variables $\tilde{Y}_t, \tilde{C}_t, \tilde{Loan}_t$

$\tilde{\pi_t}, \tilde{L_t}, \tilde{K_t}, \tilde{R_t}, \varepsilon_{g,t}, \varepsilon_{z,t}$:

$$\tilde{C_t} = E(\tilde{C_{t+1}}) - \frac{1}{\sigma}(\tilde{R_t} - E(\tilde{\pi_{t+1}}) + \varepsilon_{g,t} \tag{3.37}$$

$$\tilde{R_t} - E(\tilde{\pi_{t+1}}) = (1 - \beta(1-\delta))(\sigma E(\tilde{C_{t+1}}) + \frac{1}{1-\alpha}(E(\tilde{Y_{t+1}}) - E(\tilde{K_{t+1}}) \tag{3.38}$$

$$\tilde{\pi_t} = \beta E(\tilde{\pi_{t+1}}) + \Lambda(\sigma \tilde{C_t} \frac{\alpha}{1-\alpha}(\tilde{K_t} - \tilde{Y_t} + \varepsilon_{z,t} \tag{3.39}$$

$$\tilde{K_t} = (I/Y)\tilde{I_{t-1}} + (1-\delta)\tilde{K_{t-1}} \tag{3.40}$$

$$\tilde{I_{t-1}} = \tilde{Loan_t} \tag{3.41}$$

$$\tilde{Loan_t} = (1-\gamma)\tilde{D_t} \tag{3.42}$$

$$\tilde{Y_t} = (C/Y)\tilde{C_t} + (I/Y)\tilde{I_t} + \gamma(S/Y)\tilde{S_t} \tag{3.43}$$

$$R_t = i_t + \tau_y^*(y - \tilde{y_t}) + \tau_{inf}^*(\pi - \tilde{\pi}) + \tau *_{loan} (Loan_{t+1} - -Loan_t) \tag{3.44}$$

$$Loss_t = \tau_y(y - \tilde{y_t}) + \tau_{inf}(\pi - \tilde{\pi}) + \tau_{loan}(Loan_{t+1} - Loan_t) \tag{3.45}$$

$$\varepsilon_{z,t} = \rho_z \varepsilon_{z,t-1} + u_{z_t} \tag{3.46}$$

$$\varepsilon_{g,t} = \rho_g \varepsilon_{g,t-1} + u_{g_t} \tag{3.47}$$

where u_{z_t}, u_{g_t} are iid.

In the second case, the additional equation:

$$\tilde{\gamma_t} = m\tilde{\pi_t} + n\tilde{Y_t} + g(Loan_{t+1} - Loan_t) \tag{3.48}$$

Different from a standard three equation New Keynesian Model, which is composed of Phillips Curve(39), Dynamic IS Curve(37) and monetary policy rule (44), this system includes more dynamics due to addition of capital into a simple New Keynesian Model. Inclusion of capital mainly creates such differences in the dynamics of model:

- Marginal product of capital is related with the real interest rate in Fisher equation (38)
- New Keynesian Phillips Curve (39)also includes capital

Moreover, interest rate also affects output via production sector in addition to consumption channel in models without capital.

3.6 Model Simulation

As expressed before, different from the standard loss function, which composes only deviations from steady state of output and inflation, the loss function in this model also incorporates loan growth. The methodology I use here is that calibrating the parameters over loops in the loss function and find optimum combinations that minimize the value of loss. Then, I consider the tax as an endogenous variable that is calculated due to economic conditions , as the same variables in the loss function with different weights. Therefore, firstly, I define parameter spaces and run loop over policy rule parameters.

In the literature, elasticity of nominal interest rate with respect to inflation τ_{inf}, is assumed to be greater than one for determinacy purposes and in the original paper Taylor(1993), it is around 1.5 and elasticity of nominal interest rate with respect to output τ_y is 0.5.

However, I define the parameters range as the following : Elasticity of nominal interest rate with respect to inflation, τ_{inf}, and elasticity of nominal interest rate with respect loan growth, τ_{loan},vary between 1 to 3 by increasing 0.10 each time. On the other hand, I consider the parameter range for elasticity of nominal interest rate with respect to nominal output, τ_y, is between 0 and 2. Other parameter values are adopted from Calstrom and Fuerst(2005).

Table 3.1: Calibration of Parameters

α : share of capital income	0,33
β : discount factor	0,99
σ: inverse elasticity of intertemporal substitution of consumption	2
δ: depreciation	0,02
Λ: real marginal cost elasticity of inflation in Calvo Model	0,3
ρ_g: persistence of preference shock	0,7
ρ_z: persistence of marginal cost shock	0,7
standard deviation of marginal cost shock	0,38
standard deviation of preference shock	1
S/Y: share of investment in output	0,33
C/Y: share of investment in output	0,69
τ_{inf}:response of monetary policy rule to inflation	[1,3]
τ_y:response of monetary policy rule to output	[0,2]
τ_{loan}:response of monetary policy rule to loan	[1,3]

Table 3.2: Indeterminate and Some Determinate Combinations

Indeterminate	**Determinate**
$(\tau_{inf} = 0, \tau_y = 1, \tau_{loan} = 1)$	$(\tau_{inf} = 1.10, \tau_y = 1, \tau_{loan} = 1)$
$(\tau_{inf} = 0, \tau_y = 1, \tau_{loan} = 0)$	$(\tau_{inf} = 1.10, \tau_y = 1, \tau_{loan} = 0)$
$(\tau_{inf} = 0, \tau_y = 0, \tau_{loan} = 1)$	$(\tau_{inf} = 1.10, \tau_y = 0, \tau_{loan} = 1)$
$(\tau_{inf} = 1, \tau_y = 1, \tau_{loan} = 0)$	$(\tau_{inf} = 1.10, \tau_y = 1, \tau_{loan} = 0)$
$(\tau_{inf} = 1, \tau_y = 0, \tau_{loan} = 0)$	$(\tau_{inf} = 1.10, \tau_y = 0, \tau_{loan} = 0)$
$(\tau_{inf} = 1, \tau_y = 1, \tau_{loan} = 1)$	$(\tau_{inf} = 1.10, \tau_y = 1, \tau_{loan} = 1)$

Calibration of other parameters

3.7 Simulation Results

Result 1 : Determinacy of the model

The model is only determinant when τ_{inf} is equal or greater than 1.10. Otherwise, it gives indeterminate solutions, which is consistent with the related literature. Then, I can conclude that the model is only determinate with active monetary policy, which requires that nominal interest rate responds to inflation more than one-to-one. Moreover, I list indeterminate and some determinate combinations in the Table2.

The model gives determinate solutions even when τ_{loan}=0 either $\tau_y = 0$. However, I dont consider the cases when $\tau_{loan} = 0$ is between 0 and 1 since I

assume that central bank responds actively to loan growth.

These results are consistent under a fixed tax rate changing between 0 and 0.50. The model is not determinate when tax rate is higher than 0.50.

Result 2: At each combination of parameters out of 8000 combinations, which comes from the ranges of parameters in which each takes 20 values, Loss is lower when central bank puts a loan tax as a policy rule.

I make the analysis with two ways : In the first way, the methodology I use is that I start from the calibration in which tax is zero as running the loop as described before. Then, I replicate the simulations for increasing tax values. Up to the point that tax is equal or greater than 0.50, the model is determinate and the value of loss function is lower at each simulation for different calibrations in which tax rate varies.

1. When tax is zero, the optimum policy rule parameters are as the following:

   $(\tau_{inf}, \tau_y, \tau_{loan})$=(1.2,1.9,1.10)

   tax=0 and minimum mean Loss=0.0510, (in terms of real numbers Loss=1.0523)

2. With this optimum combination of parameters , I further simulate the model with different tax values. The results of the simulation are as the following:$(\tau_{inf}, \tau_y, \tau_{loan})$ =(1.2,1.9,1.10)

   (a) tax =0.10 minimum mean Loss=0.0471 (in terms of real numbers Loss=1. 0482)

   (b) tax=0.20 minimum mean Loss=0.0423 (in terms of real numbers Loss=1. 0442)

(c) tax=0.30 minimum mean Loss=0.0401 (in terms of real numbers Loss=1. 0440)

According to the simulation results, we see that there must be an optimum tax rate (greater than zero) to gain lower loss values. In this case , it must be between 0.30-0.50 since loss is decreasing in tax rate up to the point where tax rate is 0.50.

Result 2 with different methodology: After optimization over policy rule parameters in which tax rate is zero, I take this parameters as given. Next, I define tax rate as an endogenous variable which depends on deviations from steady state from output and inflation, and loan growth, implying that central bank changes the tax rate according to the economic conditions. Then, I write a loop over the new parameters of tax rate equation and simulate for this loop. Consequently, simulation results show that inclusion of tax rate leads lower loss values.

$$\tilde{\gamma}_t = m\tilde{\pi}_t + n\tilde{Y}_t + g(Loan_{t+1} - Loan_t) \tag{3.49}$$

where m, n, g are the elasticities of tax rate with respect to deviations from steady state from output and inflation, and loan growth respectively. I constrain each of them as between 0 and 1 and consider the simulation results in which tax is greater than zero.

1. When tax is zero , the optimum policy rule parameters are as the following:$(\tau_{inf}, \tau_y, \tau_{loan}$)=(1.2,1.9,1.10)

   tax=0 and minimum mean Loss=0.0510,(in terms of real numbers Loss=1.0523)

2. Running simulation again for a loop over taxation gives such a result: Minimum mean Loss is 0.0176 (in terms of real numbers, min.mean

Loss=1.0177)

3.8 Graphics of Simulation

a) In two cases, when tax is zero, impulse responses to a marginal cost shock and losses are given as such:

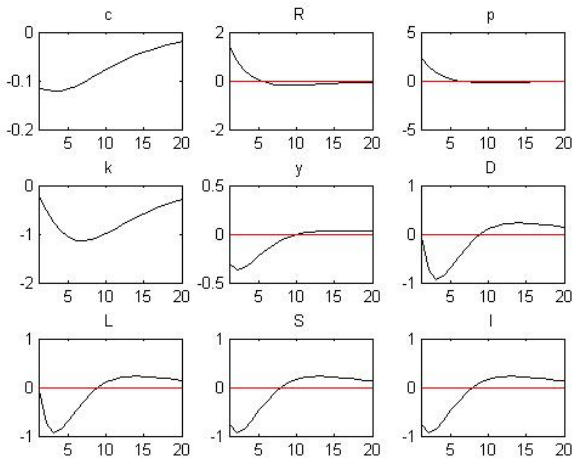

Figure 3.1: Impulse responses to a marginal cost shock when tax=0

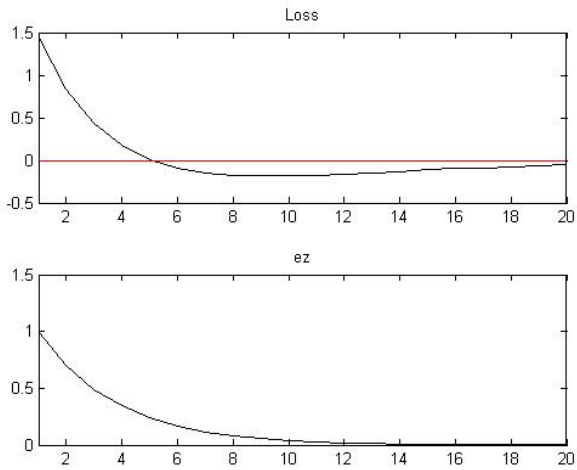

Figure 3.2: Changes in mean of loss values responding to a marginal cost shock when tax=0

b) when tax=0,20;

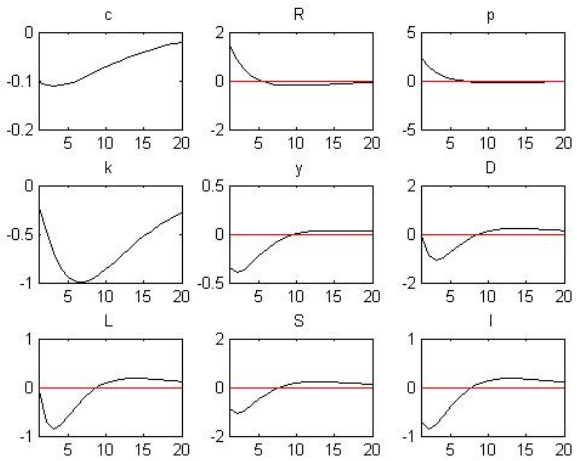

Figure 3.3: Impulse responses to a marginal cost shock when tax=0.20

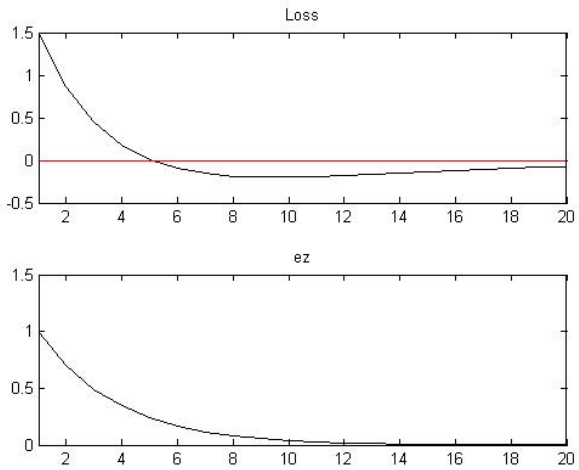

Figure 3.4: Changes in mean of loss values responding to a marginal cost shock when tax=0.20

c) tax=0,30;

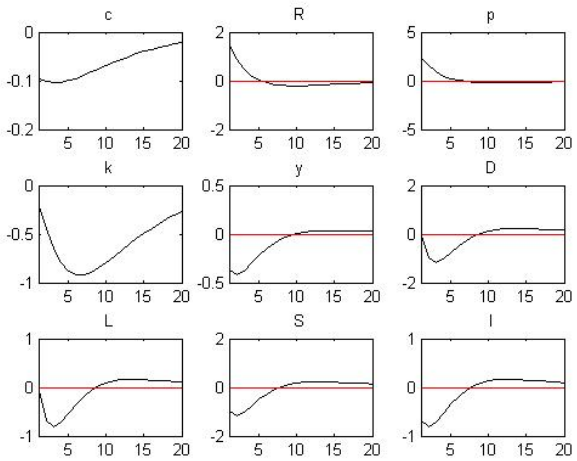

Figure 3.5: Impulse responses to a marginal cost shock when tax=0.30

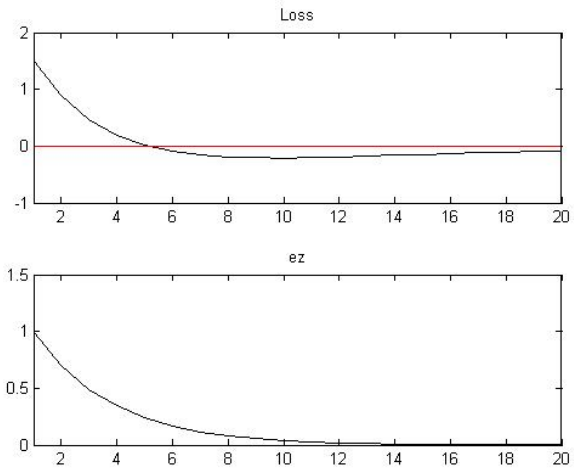

Figure 3.6: Changes in mean of loss values responding to a marginal cost shock when tax=0.30

d) An endogenous taxation equation, tax is between zero and unity,

Loss

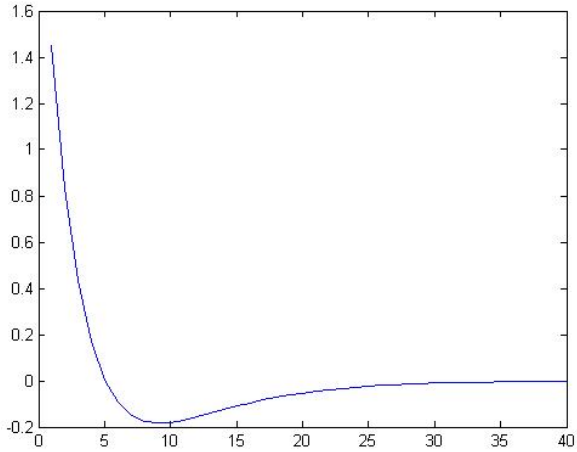

Figure 3.7: Loss

Tax

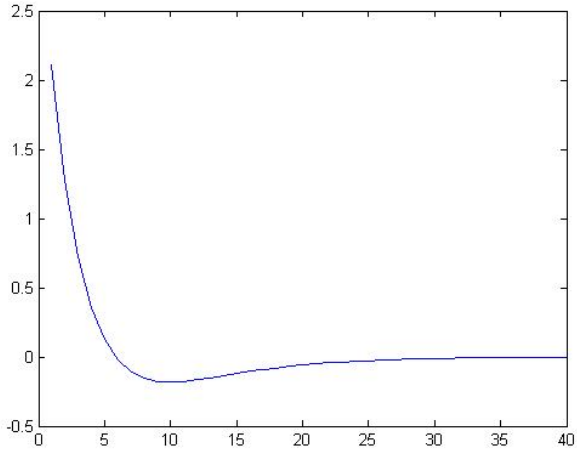

Figure 3.8: Tax

CHAPTER 4

CONCLUSION

In the case that monetary policy authority considers excessive loan growth as a potential threat to financial stability, an alternative way to take it into account is to make the loan growth be a component of the loss function. Then, under commitment, it seeks for the interest rate rule via optimizing the weights in the loss function. In this set up, the simulation results suggest that an endogenous taxation provides lower mean values of loss function since there exists an optimum tax rate for any optimum combinations of policy rule parameters. On the other hand, trying to achieve both financial stability and price stability by penalizing excessive loan growth only in a Taylor-type interest rate rule causes higher mean values function since there exist trade-off issues among components of the interest rate rule. That is, an increase in interest rates in response to loan growth raises the renting cost of capital, leading to *cost-push inflation*. Therefore, it creates a conflict of stability purposes. Moreover, giving more weights than optimal values in the interest rate rule increases mean values of loss function. However, incorporating a loan tax that responds to output, inflation and loan growth allows to further penalize excessive loan growth instead of giving more weights on loan growth in the interest rate rule. Accordingly, a loan tax that responds to output,inflation and loan growth is welfare-improving in the presence of

leaning against financial winds policy. In other words, in order to sustain both financial stability and price stability, a loan tax and and an augmented Taylor that respond to output, inflation and loan growth form the optimal monetary policy combination.

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APPENDIX

In this part, I figure two alternative calibration studies at certain tax levels, and then seek for a more efficient tax rate via the same methodology I have employed before.

A)

1. When tax rate is 0.20, the optimum policy rule parameters are as the following:$(\tau_{inf}, \tau_y, \tau_{loan})$=(1.3,1.9,1.10)
   when tax rate=0.20 and minimum mean Loss=0.0394, (in terms of real numbers Loss=1.0401)

2. With this optimum combination of parameters , I further simulate the model with different tax values. The results of the simulation are as the following:

   (a) when tax rate =0.30 minimum mean Loss=0.0365 (in terms of real numbers Loss=1.0371)

   (b) when tax rate is in between (0.30,0.50) minimum mean Loss=0.0186 (in terms of real numbers Loss=1.0119)

B)

1. When tax rate is 0.30, the optimum policy rule parameters are as the following:$(\tau_{inf}, \tau_y, \tau_{loan})$=(1.4,1.9,1.10)
   when tax rate=0.30 and minimum mean Loss=0.0330, (in terms of real numbers Loss=1.0335)

2. With this optimum combination of parameters, I further simulate the model with different tax values. The results of the simulation are as the following:

   when tax rate is in between (0.30,0.50) minimum mean Loss=0.0180 (in terms of real numbers Loss=1.0181)