The interaction between fiscal and macroprudential policy in emerging countries

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Contents

Abstract

A continuously increasing credit growth in these recent decades urges emerging countries to pay more attention on financial stability besides economic growth. According to some academic literature and countries' examples, one of the factors that accelerate credit growth is fiscal policy. However, fiscal policy is an important economic stimulus tool that every emerging country needs and cannot refrain from using it. This paper focuses on the interaction between fiscal and macroprudential policy from the financial stability viewpoint. It, first, investigates the negative effect of fiscal policy on financial stability in emerging countries. Next, it examines whether macroprudential policy can mitigate the negative effect from fiscal policy or not. Finally, the paper proposes some policy suggestions that help emerging countries maintain financial stability without restricting the implementation of fiscal policy. The paper is a theoretical study and uses DSGE framework in the analysis. Three main results are found. First, fiscal policy can induce financial instability through the credit market. Second, macroprudential policy can help stabilizing the volatilities in the economy including households and corporates credit. Lastly, implementing the policy combination between fiscal and macroprudential policy can enable emerging countries to achieve financial stability besides economic growth, and it also improves the social welfare.

1 Introduction

In these recent decades, emerging countries have experienced a continuously increasing economic and credit growth. The world GDP share of emerging countries has been increasing since 1990s and finally exceeded the share of developed countries in 2007. In 2018, the world GDP share of emerging and developing countries is 59.24%. One of the factors that contributes to emerging countries' economic growth is the implementation of fiscal policies such as public spending and tax policy. Along with the economic growth, emerging countries are also facing an increasing credit growth. Especially, corporate credit contributes the most to the overall credit growth in every country. The increasing credit growth can be either a good or a bad situation. In good case, it implies the development of the country. We can observe a positive correlation between economic growth and credit growth in emerging countries. Economic and credit growth has a positive influence on each other (Townsend and Ueda (2010), Garcia et al. (2015)). However, at the same time, credit growth is an index used to measure financial instability, and it is the best predictor of financial crises (Freixas et al. (2015)).

Many international institutions and central banks in emerging countries start to be aware of the increasing credit growth issue. For example, Bank of Thailand (BOT) 2017 financial report states that loans to corporate, especially to small and medium enterprises (SMEs), account the biggest share of the total loan in Thailand. However, loans to SMEs are likely to become the non-performing loans (NPL). It is difficult to restrict the amount of loans to SMEs because SMEs performances account a large part of Thailand GDP. In 2017, 42.4% of Thailand GDP comes from SMEs. Therefore, BOT instead monitors the loan quality in order to control NPL ratio. Another example is China. Chen and Kang (2018) explains that China has been experiencing a rapid credit growth since 2008 (after the Global Financial Crisis). This credit growth has supported China economy, but many international institutions believe that this credit growth is not sustainable. Most of the credit goes to industrial and service sectors, but it is ineffectively used. The reliance on infrastructure investment is also another factor that accelerates credit growth. A rapid increase in debt raises the concerns about financial stability in China. Emerging countries are more exposed to domestic and foreign shocks than developed countries. When bad situations happen, for example, currency depreciation, foreign interest rate cut, or changes in demand, it is difficult to repay the high level of debt. As a response to the increasing credit growth in emerging countries, AMRO (2018) suggests that emerging countries' policymakers should prioritize financial stability over economic growth in the near future. In addition, the combination of fiscal, monetary, and

macroprudential policy should be well organized depending on the current business and credit cycle of each country. One cannot deny that besides economic growth, financial stability is an upcoming issue that policymakers in emerging countries should consider.

This paper aims to find a policy solution that can maintain financial stability without restricting the economic growth promoting policy, and helps emerging countries achieve a sustainable development. It focuses on the interaction between fiscal and macroprudential policy because the objective of fiscal policy is economic growth, and the objective of macroprudential policy is financial stability. Previous studies about financial policies focus on macroprudential policy itself or its interaction with monetary policy. The study about fiscal and macroprudential policy is relatively scare. There exist some empirical studies that show the negative effect of fiscal policy on financial stability (Afonso & Sousa (2012), Hodula (2018)). Some confirm that macroprudential policy, tightening LTV rate, can cool down the credit growth (Alpanda & Zubairy (2017), Erlend & Heedon (2016)). As far as I know, the theoretical studies about fiscal and macroprudential policy define fiscal policy as tax system such as mortgage tax deduction regime. This paper is new to the extent that it is a theoretical paper that defines fiscal policy as government spending. The paper also explains the mechanism that fiscal policy negatively affects financial stability and the policy solution to this problem. I hope the implications from the results of this paper will contribute to the limited study about fiscal and macroprudential policy in emerging countries and help the policymakers figure out the way to maintain financial stability and achieve economic growth at the same time.

We can see the example of government spending affecting credit growth in the real world. Thailand, which is a trade partner of many developed countries and attracts many foreign investors, is carrying out a train construction project supported by the government. The government spends a huge amount of expenditure on the construction and operation. As the construction proceeds, the demand for land and houses, mainly condominiums, along the railways increases because people expect a higher value of the condominiums. Same as land and houses, people use condominiums as collateral. An increase in condominium price allows people to borrow more. As a consequence, household credit of Thailand increases. At the same time, construction firms borrow and build a massive number of condominiums to meet the demand. However, the supply seems to be too much and has low quality. Now, there are many condominiums left unsold and many construction plans are called off. The price of condominium falls and creates a serious situation for both households and firms. Households who carry a large amount of debt have lower ability to repay because of the fall in asset value. Firms also face

the difficulty to repay the debt because they cannot sale the condominiums. As a result, the non-performing loans of Thailand increases and becomes a serious issue for BOT. From Thailand case, we can conclude that an increase in government expenditure on infrastructure can increase household and corporate loans. With a bad situation, the loans can turn to the non-performing loans, which accelerate the fragility in credit market and financial system. For empirical evidence, Afonso & Sousa (2012) confirms that government expenditure can increase house price. In addition, according to the literature about credit friction, a rise in house price can be interpreted as an increase in collateral value, which finally increases the amount of credit.

Even though government spending on infrastructure has a side effect on financial stability, it is still an important fiscal policy tool that every emerging country needs to promote the economic growth. Infrastructure investment has been an economic stimulus tool since the beginning of the Global Financial Crisis. Even now, Infrastructure demand in emerging countries, especially the demand for transportation infrastructure, continues to increase. The infrastructure spending, mostly supported by the government, also has an upward trend. According to UBS (2018), emerging countries' infrastructure spending share will become two-third of the world in 2025. Infrastructure can increase not only the output and productivity of the country, but it also attracts foreign businesses. Many developed countries' multinational companies suggest that the current infrastructure in emerging countries are still insufficient, which lessen their incentives to start the businesses despite the low labor cost. Emerging countries' governments are aware of this insight. Therefore, they tend to launch many infrastructure construction projects and are likely to ignore the side effects such as fiscal deficit and rapid credit growth.

To maintain the stability in credit market and financial system, macroprudential policy is needed. Macroprudential policy has financial stability as a prior objective, while fiscal policy's target is to promote economic growth. When there are some trade-offs between economic growth and financial stability, there is no guarantee that the fiscal policymakers will take financial stability into account. In addition, fiscal policy, especially in emerging country, is influenced by some political factors and may not be optimally used. Dumicic (2019) claims that the optimal fiscal policy is difficult to achieve due to election cycle. Hence, we need another policy that has an objective to contain the risks and stabilize the financial system. Macroprudential policy is the policy that aims to achieve financial stability and has gathered the interest since the Global Financial Crisis. Many emerging countries have already introduced macroprudential policy. According to Cerutti et al. (2017), the use of macroprudential policy in emerging country is the highest among

other country groups, but the studies about its effects and the interaction with other policies is still limited.

Some emerging countries have succeeded in curbing financial instability by using macroprudential policy. Turkey has faced a rapid credit growth since the early 2000s, it finally experiences the highest credit growth among emerging countries during 2010 to 2012 (Garcia et al. (2015)). As a consequence, Turkey has implemented a sequence of macroprudential policies since 2011. Turkey establishes Financial Stability Committee (FSC) as a formal authority that is responsible for macroprudential policy. The FSC uses various packages of policies to contain credit growth and household debt. Concretely, the FSC puts higher risk weights for consumer loan, higher minimum payments for credit card debt, and introduces loan-to-value (LTV) caps for housing loans. After implementing the policies, consumer loans vividly decrease. However, corporate loans do not change much because the introduced policy tools target only household indebtness. To conclude, macroprudential policy helps Turkey contain the risks in credit market. A well study about the effect of each policy tool and choosing the right policy at the right time is important.

This paper explores the effect of fiscal policy and macroprudential policy on emerging market economy, focusing especially on the financial stability viewpoint, and provides some policy suggestions. In this paper, fiscal policy refers to government spending on infrastructure, macroprudential policy refers to loan-to-value (LTV) ratio, and financial instability refers to the increase in household and corporate credit-to-GDP from steady state level. The paper is a theoretical study and uses DSGE framework. It, first, examines whether fiscal policy can induce financial instability or not. Next, it investigates whether macroprudential policy can help mitigate the negative effect of fiscal policy. Finally, the paper does the welfare analysis of the policies in order to find out what kind of policy combination benefits the economy.

In order to study the above 3 research questions, I construct a model that has infrastructure as a factor of production and the credit market where agents in the economy can directly lend and borrow the money subject to some borrowing constraints. There is no bank in this model. The lender is patient households, and the borrowers are impatient households and entrepreneurs. Household credit is the amount of borrowing impatient households borrow from patient households. Corporate credit is the amount of borrowing entrepreneurs borrow from patient households. I use DSGE framework to capture the effect of fiscal policy shock, which is a positive infrastructure spending shock. I call the situation when there exists a fiscal policy shock, but the LTV rates are fixed at a certain value as a benchmark

case. After that, I study the effect of macroprudential policy by adding the macroprudential policy rules to the simulation and compare the result with the benchmark case. Under macroprudential policy rules, the LTV rates are allowed to change responding to the changes in household and corporate borrowings. Since there are 2 kinds of credit (household and corporate), there are 2 kinds of macroprudential policy tools; household LTV rate and corporate LTV rate. Each tool targets different agents. Lastly, I compute the steady state value of the social welfare and the welfare of each agent. Then I observe how the values change when I tighten the LTV rates. With this method, I can capture the welfare effect of macroprudential policy.

Three main findings are found. First, fiscal policy can induce financial instability. An increase in government spending on infrastructure increases both household and corporate credit. Second, macroprudential policy can help stabilizing the volatilities of the variables in the economy including household and corporate credit. The introduction of household LTV rate rule decreases the volatility of impatient households' borrowing. Corporate LTV rate rule has a wider effect. It decreases not only the volatility of entrepreneurs' borrowing but also the volatilities of all variables in the economy. Lastly, using fiscal and macroprudential policy together can improve the social welfare, which is defined as a weighted average welfare of the agents in the economy. However, there are welfare trade-offs between agents.

This paper is most related to Iacoviello (2005) to the extent that it models the economy with credit market, and the agents are subject to the borrowing constraints. The difference is that this paper does not consider inflation because it wants to focus on fiscal and macroprudential policy. Iacoviello (2005), on the other hand, focuses on monetary policy, and incorporate inflation and nominal interest rate into the model. This paper also related to Mendicino and Punzi (2014) in the sense that it introduces LTV rate as the macroprudential policy tool. However, the paper defines financial instability as the fragility in domestic credit market, while Mendizino and Punzi (2014) takes current account as the financial instability index.

In the next section, I introduce some related literature to prepare some background information relevant to this study and support the arguments in this paper. Section 3 presents the model. Section 4 discusses about the parameters used in the numerical experiment and shows the results. Section 5 analyzes the welfare effect of the policies introduced in the model. Section 6 concludes.

2 Related Literature

International institutions and central banks in emerging countries start to worry about an increasing credit growth because credit growth is a sign of financial crises and can cause some risks in financial system. According to Freixas et al. (2015), a rapid credit growth, or in other words, credit boom in emerging markets increases the interest rate, which attracts the foreign capital. The inflow of foreign capital, then, accelerates the domestic credit growth and asset bubbles. The situation can develop to a systemic risk and threaten the stability of the financial system. The rises in credit and asset price, as we can see in many emerging countries, are signs of credit booms and asset price bubbles, and sequentially the crises. Monitoring credit growth is one way to maintain financial stability and prevent the country from the crises. (Jordà et al. (2011), (2013))

There are several factors that can accelerate the credit cycle in an unhealthy way, for example, monetary policy and fiscal policy. Claessens (2014) summarizes 6 channels that monetary policy can affect financial stability. Among these 6 channels, there are both positive and negative relationship between interest rate and financial stability. A rise in interest rate may improve financial stability in some channels but deteriorate in the others. The paper also proposes some macroprudential policy tools that can reduce the side effects of monetary policy and suggests that the combination between these two policies can enhance the economy.

Fiscal policy such as tax system can increase the risk in credit cycle. According to IMF (2013), corporate tax system can create debt bias. The system makes the corporates choose debt rather than equity as a funding method. Since debt interest payment is deductible in the taxable profit calculation, while equity dividend is not, the corporates prefer to issue debt and pay more interest, so that they can pay less corporate tax. This results in a high level of corporate credit, which is a source of fragility in financial system. In addition, housing-related tax policy such as mortgage interest deduction can increase household debt and lead to output losses of the economy (Alpanda & Zubairy (2016)). In order to decrease household credit, tightening LTV rate and reducing mortgage interest deduction are the effective and less costly tools (Alpanda & Zubairy (2017)).

Government expenditure, another fiscal policy tool, also affects financial stability. According to the empirical work of Hodula (2018), an increase in government expenditure raises the demand for credit. The paper argues that the credit increases through the housing market because house price has an upward response to the government expenditure shock. Because people use houses as collateral, the credit demand leads to an increase in housing

demand and, hence, the rise in house price.

A tool that can stabilize financial system and has gained attentions after Asian financial crisis is macroprudential policy. Some empirical studies share the same view that borrower-based macroprudential policy tools such as LTV rate can significantly reduce household credit growth and improve the social welfare (Morgan et al. (2019), Cerutti et al. (2015), Kuttner and Shim (2013)). Theoretical study has also been done. Garbers and Liu (2018) generates a model of small open economy to investigate the effect of macroprudential policy on the economy when there is a positive foreign interest rate shock, which decreases the supply of foreign funds. They use 2 macroprudential policy tools, namely caps on LTV rate and capital requirement. They conclude that both macroprudential policy tools benefit the stability of financial sector and the economy.

Another strand of literature about macroprudential policy is the study about its interaction with other policies. Most of the studies mainly focus on the interaction between monetary and macroprudential policy. Erlend & Heedon (2016) empirically tests whether the effect of macroprudential policy is enhanced when altogether used with monetary policy, but the result is insignificant. For theoretical study, Aoki et al. (2018) constructs a small open economy model with international financial market to explore the effect of macroprudential policy when there is an external shock and its interaction with monetary policy. They define the external financial shock as a positive foreign interest rate shock, which leads to local currency depreciation and, then, results in high inflation and high nominal value of foreign debt. The macroprudential policy tool used in their paper is tax on foreign currency. The result states that the combination of both monetary and macroprudential policy is effective to mitigate the effect of foreign shock, while using monetary policy solely decreases the welfare. Mendicino and Punzi (2014) builds a 2-country DSGE model with foreign and domestic shocks. For example, risk premium shock and housing preference shock are incorporated in the model. They investigate the shock transmission toward house price and household credit. Then, they examine the effect of macroprudential policy, defined as LTV rate, and its interaction with monetary policy. The result says that using 2 policies altogether can reduce macroeconomic and financial fluctuation and is Pareto-improving.

There is also a literature that studies the interaction between fiscal policy and macroprudential policy. Carvalho and Castro (2017) constructs a model to examine the effect of macroprudential policy and the optimal combination of macroprudential, fiscal, and monetary policy in Brazilian economy when there are external shocks. One of their results suggests that fiscal policy is effective if the implementation of macroprudential policy is allowed.

3 The Model

The model in this paper is a small open economy with 4 agents: patient households, impatient households, entrepreneurs, and government. Patient households have high discount rate, which means they do not discount the utility in the future that much. Therefore, they invest and lend to other agents. Impatient households have lower discount rate than patient households, hence, they do not save but borrow from patient households to finance the livings. Entrepreneurs produce final good and finance their livings by the profit from selling final goods and the borrowing from patient households. The discount rate of entrepreneurs is less than that of the patient households. The economy has both domestic and international financial activities. The domestic financial activity is the direct credit transaction between agents. Impatient households and entrepreneurs can directly borrow from patient households under some borrowing constraints. The domestic interest rate is endogenously determined by the credit market clearing condition. The international financial activity is carried out by government. The government can borrow from foreign countries with a fixed exogenous world interest rate. The exchange rate is also fixed and exogenously determined. There is no inflation and monetary policy in this model. All variables are real term. I abstract from bank for simplicity. Figure 1 shows the flow of fund of this model.

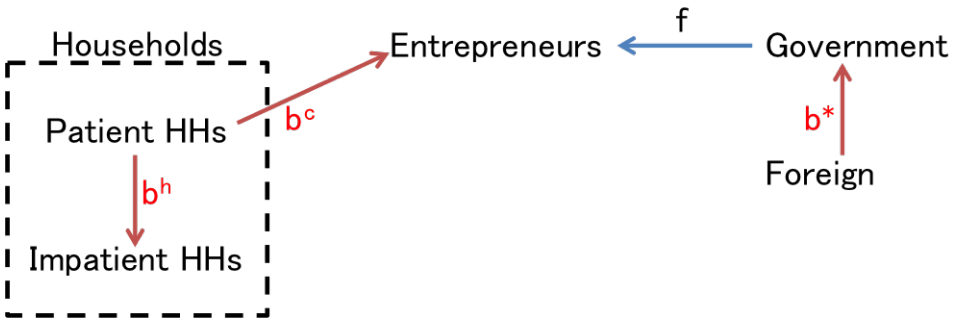

Figure 1: Flow of Fund

The assumption that households and entrepreneurs do not have an access to international financial activity may not be a familiar assumption in developed countries, but it is rationable in emerging countries. Haruhiko Kuroda, Governor of the Bank of Japan, states in his speech at the 2019 Global Meeting of the Emerging Markets Forum that, one of the important challenges for mid- and long-term development in emerging countries is financial inclusion. He defines financial inclusion as the circumstance where

"households and businesses have access to appropriate financial services and are able to use them effectively". By promoting financial inclusion, it can help improve poverty, inequality, and also support economic growth. However, according to the World Bank, about 40% of the adult population in emerging countries does not have a bank account. Based on his speech, one may conclude that the access to financial activities even the domestic one is still limited in emerging countries. Therefore, the access to international financial activities, such as foreign borrowing, is a difficult issue.

The assumption that government cannot borrow from households is also a doubtful assumption in developed countries, but it is a reasonable one in emerging countries. In developed countries such as Japan, the government borrows the money by issuing government bond, and the government bond holders are the households in that country. On the other hand, in emerging countries, the domestic agents have little opportunity to buy government bond due to the lack of financial inclusion mentioned in the previous paragraph. In order to buy government bond, an agent needs a bank account or an access to a brokerage. Considering the current level of financial inclusion in emerging countries, issuing government bond toward the domestic market is still difficult. In addition, the data from IMF says that in most emerging countries, a large proportion of government debt is held by foreign agents such as foreign official sector, foreign bank, and foreign non-bank. This data supports the argument that domestic agents in emerging countries do not hold government bond. Hence, the assumption that there is no government bond in this model is a justified assumption for emerging countries.

3.1 Patient Households

Patient households choose consumption $c_{s,t}$, house buying $h_{s,t}$, labor supply $n_{s,t}$, capital $k_{s,t}$, the amount of lending to impatient household b_t^h, and the amount of lending to entrepreneur b_t^c in order to maximize the lifetime expected utility

$$E_0 \sum_{t=o}^{\infty} (\beta^s)^t [log(c_{s,t}) + \gamma_h log(h_{s,t}) - \chi \frac{n_{s,t}^{\eta}}{\eta}]$$

subject to the budget constraint

$$\begin{aligned}(1-\tau)w_{s,t}n_{s,t} + R_{t-1}^h b_{t-1}^h + R_{t-1}^c b_{t-1}^c + R_t^k k_{s,t-1} \\ = c_{s,t} + q_{h,t}(h_{s,t} - (1-\delta_h)h_{s,t-1}) + q_{k,t}(k_{s,t} - (1-\delta_k)k_{s,t-1}) + b_t^h + b_t^c\end{aligned}$$

where the subscript s comes from the word "savers", which represents patient households and t refers to time.

β^s is patient households' discount rate, γ_h is house preference, χ is labor preference, η is labor inverse, τ is labor income tax rate, $w_{s,t}$ is patient households' wage, R^h_{t-1} is the return from lending to impatient households, R^c_{t-1} is the return from lending to entrepreneurs, R^k_{t-1} is the return from capital investment, δ_h is the depreciation rate of house, δ_k is the depreciation rate of capital, $q_{h,t}$ is house price, and $q_{k,t}$ is capital price. House price and capital price are endogenously determined by the house and capital market conditions, respectively.

Patient households earn income from after-taxed income, return from lending to impatient households and entrepreneurs, and return from capital. Patient households, then, spend the income on consumption, house buying, capital investment, and lending to impatient households and entrepreneurs.

3.2 Impatient Households

Impatient households choose consumption $c_{b,t}$, house buying $h_{b,t}$, labor supply $n_{b,t}$, and the amount of borrowing b^h_t to maximize the lifetime expected utility

$$E_0 \sum_{t=o}^{\infty} (\beta^b)^t [log(c_{b,t}) + \gamma_h log(h_{b,t}) - \chi \frac{n^\eta_{b,t}}{\eta}]$$

subject to the budget constraint

$$(1-\tau) w_{b,t} n_{b,t} + b^h_t = c_{b,t} + q_{h,t}(h_{b,t} - (1-\delta_h) h_{b,t-1}) + R^h_{t-1} b^h_{t-1}$$

and the borrowing constraint

$$R^h_t b^h_t \leq m^h q_{h,t+1} h_{b,t}$$

The subscript b refers to the word "borrowers", which represents impatient households.
β^b is impatient households' discount rate where $\beta^b < \beta^s$, m_h is household LTV rate, and $w_{b,t}$ is impatient households' wage.

Impatient households use after-taxed income and the borrowing from patient households to finance their consumption, house buying, and debt repayment. Impatient households use houses as collateral, and they can borrow up to a fraction of their houses value in the next period.

I model the borrowing constraint following Kiyotaki and Moore (1997), but I add the loan-to-value limit feature from Iacoviello (2005), and Mendizino and Punzi (2014). There is no uncertainty in this model. Therefore, there is no expectation term E_t in the borrowing constraint. In Kiyotaki and Moore (1997), there is no LTV rate, hence, impatient households can borrow

up to a level that the repayment does not exceed the market value of the houses in the next period. With m^h $(0 < m^h < 1)$ in the borrowing constraint, impatient households can borrow only a fraction of their collateral value. In reality, central banks use LTV rate as a macroprudential policy tool to control the amount of borrowing. At steady state, the borrowing constraint is always binding. [1]

3.3 Entrepreneurs

Entrepreneurs choose consumption $c_{c,t}$, the amount of borrowing b^c_t, labor demand from patient and impatient households $n_{s,t}$ and $n_{b,t}$, capital investment by retained profit $k_{c,t}$, and capital rent from patient household $k_{s,t}$ to maximize the lifetime expected utility

$$E_0 \sum_{t=o}^{\infty} (\beta^c)^t log(c_{c,t})$$

subject to the budget constraint

$$Y_t - w_{s,t}n_{s,t} - w_{b,t}n_{b,t} - R^k_t k_{s,t-1} + b^c_t = R^c_{t-1}b^c_{t-1} + c_{c,t} + q_{k,t}(k_{c,t} - (1-\delta_k)k_{c,t-1})$$

and the borrowing constraint

$$R^c_t b^c_t \leq m^c q_{k,t+1} k_{c,t}$$

Y_t is the final goods that entrepreneurs produce under the production function

$$Y_t = A N_t^{1-\alpha_k-\alpha_f} K_t^{\alpha_k} f_t^{\alpha_f}$$

where aggregate labor $N_t = n^{0.5}_{s,t} n^{0.5}_{b,t}$, aggregate capital $K_t = k^{0.5}_{s,t} k^{0.5}_{c,t}$, and f_t is the infrastructure supplied by the government for free. To avoid distortion

[1] Proof: From impatient households' first order conditions, the Lagrange multiplier on borrowing constraint can be expressed as

$$\lambda'_t = \frac{(\beta^b)^t}{R_t}\{\frac{1}{c_{b,t}} - \beta^b \frac{1}{c_{b,t+1}} R_t\}$$

At steady state, the equation becomes

$$\lambda'^{ss} = \frac{(\beta^b)^t}{c^{ss}_b}\{\beta^s - \beta^b\}$$

From the assumption $\beta^s > \beta^b$, λ'^{ss} is always more than zero. Therefore, the household borrowing constraint is always binding at steady state.

within labor and capital market, and for simplicity, I assume the share of patient and impatient households labor, and also the share of entrepreneurs owned-capital and rent capital are 0.5 equally.
The subscript c comes from the word "corporates", which represents entrepreneurs. β^c is entrepreneurs' discount rate where $\beta^c < \beta^s$, and m^c is corporate LTV rate.

Entrepreneurs use the profit from selling final goods and the borrowing from patient households to repay the debt, consume, and invest in capital. The borrowing constraint is the same as impatient households but entrepreneurs use owned-capital instead of houses as collateral. Same as impatient households, the entrepreneurs borrowing constraint is always binding at steady state. [2]

3.4 Government

Government gains labor income tax revenue and borrows from abroad in order to produce infrastructure and repay the debt. Infrastructure production process is simple. Government buys final goods and converts them into infrastructure with no cost.[3] Government exogenously chooses the amount of infrastructure supply without maximizing objective function. However, government follows the budget constraint

$$\tau(w_{s,t}n_{s,t} + w_{b,t}n_{b,t}) + eb_t^* = f_t + eR^*b_{t-1}^*$$

b_t^* is the amount of foreign borrowing, e is exchange rate, and R^* is world interest rate. The latter two are exogenous fixed variables. b_t^* is endogenously determined by f_t and the government budget constraint.

The government will borrow ($b_t^* > 0$) when the total amount of infrastructure supply cost and debt repayment exceeds the labor income tax revenue in that period. Otherwise, the government does not borrow or lend to other countries ($b_t^* \leq 0$). In this paper, I exclude the situation where government runs a huge deficit in every period, and the level of foreign debt explodes from the analysis.

[2]Proof: Same as household borrowing constraint, the Lagrange multiplier of entrepreneur borrowing constraint at steady state can be written as followed

$$\lambda'^{ss} = \frac{(\beta^c)^t}{c_c^{ss}}\{\beta^s - \beta^c\}$$

Hence, from the assumption $\beta^s > \beta^c$, the entrepreneur borrowing constraint is always binding at steady state.

[3]I also consider the case with adjustment cost but the result is the same.

The supply of infrastructure in this model is a fiscal policy tool, by which the government can directly control output and indirectly control the agents' income. I model the change in infrastructure supply as a fiscal policy shock in the economy. Details about the fiscal policy shock will be explained in section 3.6.

3.5 Market Equilibrium

The final goods are used for consumption, infrastructure production, and export. Export is the amount of period $t-1$ foreign debt repayment minus the amount of new foreign borrowing in period t. The good market clearing condition is as follows.

$$Y_t = c_{s,t} + c_{b,t} + c_{c,t} + f_t + e(R^* b^*_{t-1} - b^*_t)$$

Following Iacoviello (2005), the total amount of house and capital is fixed. Hence, the house and capital market clearing conditions are

$$h_{s,t} + h_{b,t} = H$$

$$k_{s,t} + k_{c,t} = K$$

H and K are, respectively, the total amount of house and capital.

I derive the first order conditions of each agent and substitute the labor market clearing conditions into other equations to get the reduced form version of the model. The competitive equilibrium is a sequence of 11 endogenous quantity variables $\{c_{s,t}, h_{s,t}, c_{b,t}, h_{b,t}, c_{c,t}, Y_t, b^h_t, b^c_t, b^*_t, k_{s,t}, k_{c,t}\}$, 4 endogenous price variables $\{q_{h,t}, q_{k,t}, R_t, R^k_t\}$, and 14 parameters $\{\beta^s, \beta^b, \beta^c, \chi, \eta, \gamma^h, m^h, m^c, \delta_h, \delta_k, \alpha_k, \alpha_f, e, R^*\}$ which satisfies the following 15 equations.

$$\frac{1}{c_{s,t}} = \beta^s \frac{1}{c_{s,t+1}} R_t \tag{1}$$

where $R_t \equiv R^h_t = R^c_t$

$$\frac{q_{h,t}}{c_{s,t}} = \frac{\gamma^h}{h_{s,t}} + \beta^s \frac{q_{h,t+1}}{c_{s,t+1}}(1-\delta_h) \tag{2}$$

$$R_t = \frac{1}{q_{k,t}} E_t[R^k_{t+1} + q_{k,t+1}(1-\delta_k)] \tag{3}$$

$$c_{b_t} + q_{h,t}(h_{b,t} - (1-\delta_h)h_{b,t-1}) + R_{t-1}b^h_{t-1} = (1-\tau)(0.5)(1-\alpha_k-\alpha_f)Y_t + b^h_t \tag{4}$$

$$R_t b_t^h = m^h q_{h,t+1} h_{b,t} \tag{5}$$

$$\frac{q_{h,t}}{c_{b,t}} = \frac{\gamma^h}{h_{b,t}} + \beta^b \frac{q_{h,t+1}}{c_{b,t+1}}(1-\delta_h) + \frac{m_h q_{h,t+1}}{R_t}\{\frac{1}{c_{b,t}} - \beta^b \frac{R_t}{c_{b,t+1}}\} \tag{6}$$

$$Y_t = A_t[(n_{s,t})^{0.5}(n_{b,t})^{0.5}]^{1-\alpha_k-\alpha_f}[(k_{c,t-1})^{0.5}(k_{s,t-1})^{0.5}]^{\alpha_k} f_t^{\alpha_f} \tag{7}$$

where $n_{i,t} = \{\frac{Y_t}{c_{i.t}} \frac{0.5(1-\alpha_k-\alpha_f)(1-\tau)}{\chi}\}^{\frac{1}{\eta}} \qquad i = s, b$

$$R_t^c b_t^c = m^c q_{k,t+1} k_{c,t} \tag{8}$$

$$\beta^c \frac{1}{c_{c,t+1}}\{(0.5)\alpha_k \frac{Y_{t+1}}{k_{c,t}} + q_{k,t+1}(1-\delta_k)\} + \frac{1}{R_t}(\frac{1}{c_{c,t}} - \beta^c \frac{R_t}{c_{c,t+1}}) m^c q_{k,t+1} = \frac{q_{k,t}}{c_{c,t}} \tag{9}$$

$$(0.5)\alpha_k \frac{Y_{t+1}}{k_{s,t}} = R_{t+1}^k \tag{10}$$

$$R_{t-1}^c b_{t-1}^c + c_{c,t} = Y_t - w_{s,t} n_{s,t} - w_{b,t} n_{b,t} - q_{k,t}(k_{c,t} - (1-\delta_k)k_{c,t-1}) - R_t^k k_{s,t-1} + b_t^c \tag{11}$$

$$\tau(w_{s,t} n_{s,t} + w_{b,t} n_{b,t}) + e b_t^* = f_t + e R^* b_{t-1}^* \tag{12}$$

where $w_{s,t} n_{s,t} = w_{b,t} n_{b,t} = 0.5(1-\alpha_k-\alpha_f) Y_t$

$$Y_t = c_{s,t} + c_{b,t} + c_{c,t} + f_t + e(R^* b_{t-1}^* - b_t^*) \tag{13}$$

$$h_{s,t} + h_{b,t} = H \tag{14}$$

$$k_{s,t} + k_{c,t} = K \tag{15}$$

The equations derived from patient households' first order conditions are (1) Euler equation, (2) housing demand, and (3) capital demand. The equations from impatient households are (4) budget constraint, (5) borrowing constraint, and (6) housing demand. The equations relevant to entrepreneurs are (7) production function, (8) borrowing constraint, (9) capital investment, (10) the return of rent capital, and (11) budget constraint. (12) is the government budget constraints. (13)-(15) are, respectively, goods, house, and capital market clearing conditions.

3.6 Shock and Policy rule

The shock in this model is a fiscal policy shock that follows an AR(1) process with coefficient 0.9. A positive fiscal shock occurs when the government arbitrarily increases the supply of infrastructure for some reasons. In reality, the governments in emerging countries usually use fiscal policy as a tool to gain the approval rating from the people, especially before the election.

The macroprudential policy rules to stabilize the credit market are as follows.

$$m_t^h = m^{h^{ss}}(\frac{b_t^h}{b^{h^{ss}}})^{-\phi_h}$$

$$m_t^c = m^{c^{ss}}(\frac{b_t^c}{b^{c^{ss}}})^{-\phi_c}$$

where superscript ss means the steady state value of each variable. ϕ_h and ϕ_c are the parameters that show how strongly the policymakers will response to the volatility in household and entrepreneur borrowing respectively. The LTV rates are tightened when the amount of borrowing deviate from the steady state value. In the next section, I report the simulation result of the positive fiscal policy shock.

4 Numerical Experiment

Table 1 reports the parameter values. Most of them follow the previous studies and the values are standard in macroeconomics. I set the steady state value of household and entrepreneur LTV rates based on the actual rates data of emerging countries. Between 2 types of LTV rate, corporate LTV rate is relatively higher than household LTV rate because entrepreneurs are one of the main sources of economy growth and many emerging countries' governments have the policies that encourage entrepreneurs to produce. In addition to high LTV rate, entrepreneurs also have other credit privileges such as loose borrowing conditions and an extension of debt repayment. The value of infrastructure share in this model is lower than the value in previous literature because the previous literature uses the data of developed country in the computation. However, according to UNECE (2016), the contribution of infrastructure on output is different because of the deficiency in public investment. Calderón et al. (2014) uses the data of 88 industrial and developing countries to estimate the contribution of infrastructure on output. They conclude that 10% increase in infrastructure may raise output per worker by 0.7% to 1%. Macroprudential policy response is difficult to choose because of the lack of literature about this topic. I leave the realistic value of

parameter	description	value
β^s	saver discount rate	0.99
β^b	borrower discount rate	0.85
γ_h	house preference	0.1
δ_h	house depreciation rate	0.03
δ_k	capital depreciation rate	0.03
η	labor inverse	2
χ	labor preference	1
α_k	capital share	0.3
α_f	infrastructure share	0.1
m^h	steady state household LTV rate	0.8
m^c	steady state corporate LTV rate	0.9
e	exchange rate	30
R^*	foreign interest rate	1.03
τ	labor income tax	0.2
$\frac{f}{y}$	steady state infrastructure/GDP	0.1
ϕ_h	household LTV rate response	0.5
ϕ_c	corporate LTV rate response	0.5

Table 1: Parameters values

policy response parameter for further study. For now, I can conclude that the change in policy response parameter only change the magnitude of variables' impulse response, but it does not change the movement. The exchange rate is also difficult to pick because each country has different exchange rate. Here, I use the exchange rate of Thai baht to U.S. dollar. However, the value of exchange rate does not have any effect on the results. The variables' steady state equations and values are reported in Appendix.

4.1 The effect of fiscal policy shock without macroprudential policy rules

Figure 2 shows the impulse response of macroeconomic variables to the positive fiscal policy shock. In this case, LTV rates are fixed at their steady state values reported in Table 1. Since I use the log-linearized model in the simulation, the graphs in the following figures show the deviation from the steady state of each variable. The main result from this exercise is that fiscal policy can increase both household and entrepreneur borrowings, especially the latter is more affected. This result is consistent with the real data of emerging countries to the extent that the level of corporate credit, or entrepreneur

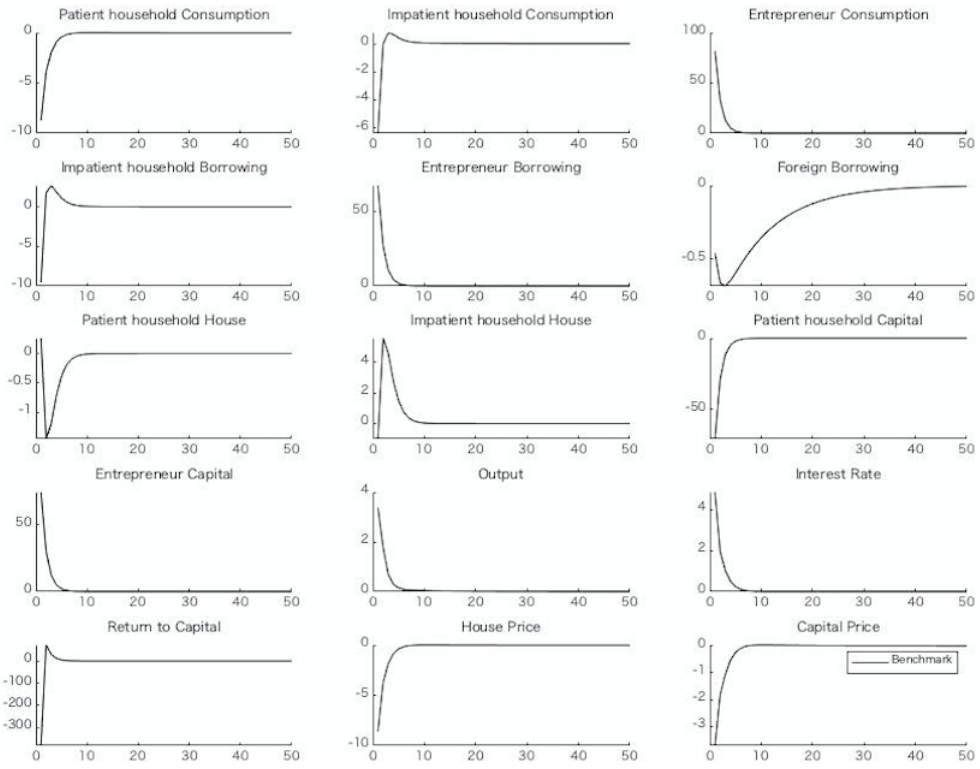

Figure 2: Benchmark case impulse response

borrowing in this model, is higher than that of the household credit. The supply of infrastructure increases output Y and, hence, households and entrepreneurs income. A rise in output directly increases entrepreneurs' profit. At the same time, it increases the marginal product of labor and, then, the wages of both households. As a consequence, entrepreneurs spend more on consumption c_c and capital investment k_c, so they can further borrow more from patient households b_c. Impatient households, on the other hand, decrease consumption c_b in order to buy more houses h_b to increase the borrowing b_h. Eventhough fiscal policy shock can increase output, but it also increases household credit-to-GDP b_h/y and corporate credit-to-GDP b_c/y (Figure 3). Therefore, we can conclude that fiscal policy induce financial instability.

The explanation about other variables is as follows. An increasing borrowing demand from impatient households and entrepreneurs leads to a hike in domestic interest rate R. High domestic interest rate, which means high return from lending, encourages patient households to spend less and lend more. As we can see, patient households' consumption c_s, house buying

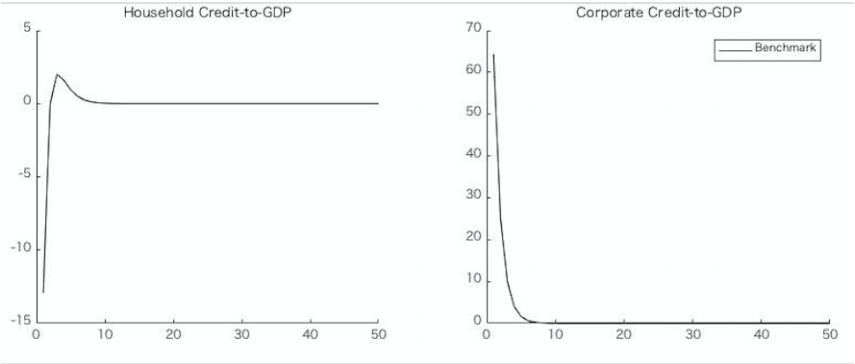

Figure 3: Benchmark case Credit-to-GDP

h_s, and capital investment k_s fall. The falls in patient households' house and capital demand seem to be big because despite an increase in impatient households' housing demand and entrepreneurs' capital demand, house price q_h, capital price q_k, and capital rent R_k still decrease. The decrease in house and capital price in this model is not consistent with the related literature who say that fiscal policy increases the amount of credit through asset price channel. My guess is that the difference deviates from the lack of monetary policy in this model. If the domestic interest rate R is kept at low level to target inflation, the incentive for patient households to save the money and lend will be lower. Hence, patient households' demand for goods, houses, and capital will be higher. The higher demands will mitigate the falls in house price and capital price.

The fiscal policy shock in this model does not seem to have a negative effect on foreign borrowing b_f. Instead, foreign borrowing slightly decreases because 1 unit increase in infrastructure can lead to about 3 units increase in output. This effect is consistent with the conventional macroeconomic theory about fiscal multiplier.

4.2 The effect of fiscal policy shock with macroprudential policy rules

Figure 4, 5, and 6 show the impulse response to the fiscal policy shock with macroprudential policy rules. Figure 4 is the case when central bank or responsible authority allows household LTV rate to respond to an increasing households borrowing according to the policy rule. The main result of this simulation is that the implementation of household LTV rate rule can decrease the amount of household borrowing and also impatient households' houses.

Figure 5 shows the case when corporate LTV rate is allowed to change as a response to the change in entrepreneurs borrowing. Corporate LTV rate rule can decrease the volatility of entrepreneurs borrowing and entrepreneurs capital investment. However, unlike household LTV rate case, the change in corporate LTV rate has a more vivid effect on other variables in the economy. Tightening corporate LTV rate decreases entrepreneurs borrowing and the investment in capital. The effect widely spreads out because entrepreneurs are the producers who control the output of the economy.

Figure 6 combines the effect of implementing both household and corporate LTV rate rules. We can see that all variables in the economy still have the same movement as the benchmark case, but the volatility of each variable decreases. Fiscal multiplier effect still can be seen because output still increases more than 1 unit. The deviation from steady state of household credit-to-GDP and corporate credit-to-GDP also decreases (Figure 7). Therefore, we can conclude that macroprudential policy can mitigate the negative effect of fiscal policy on credit market.

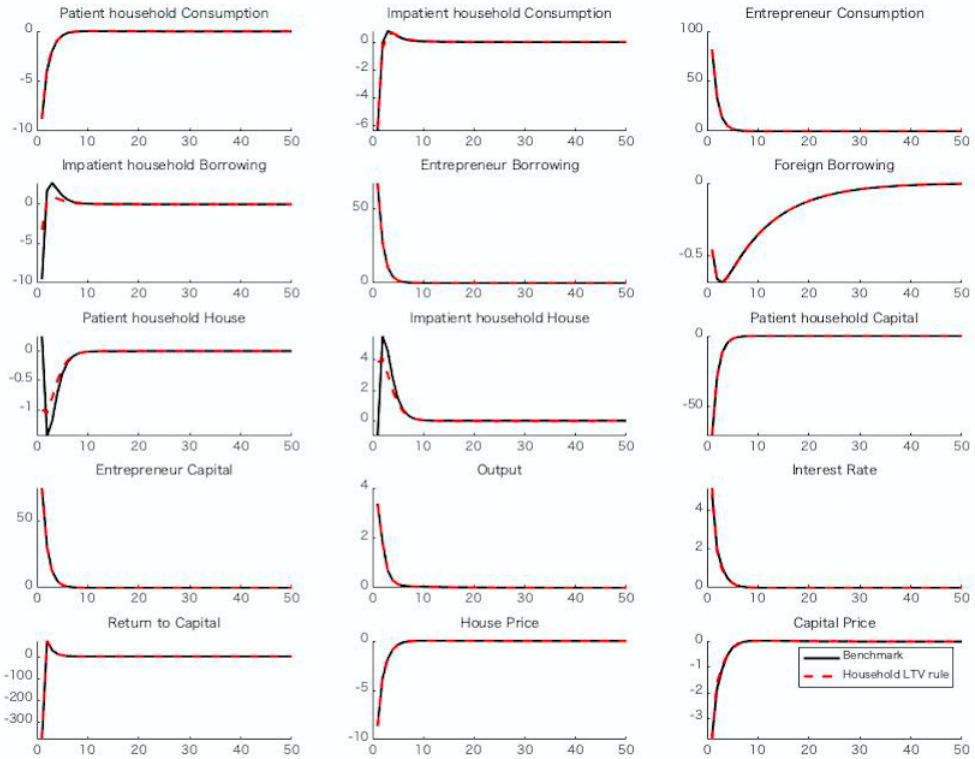

Figure 4: Household LTV rate rule

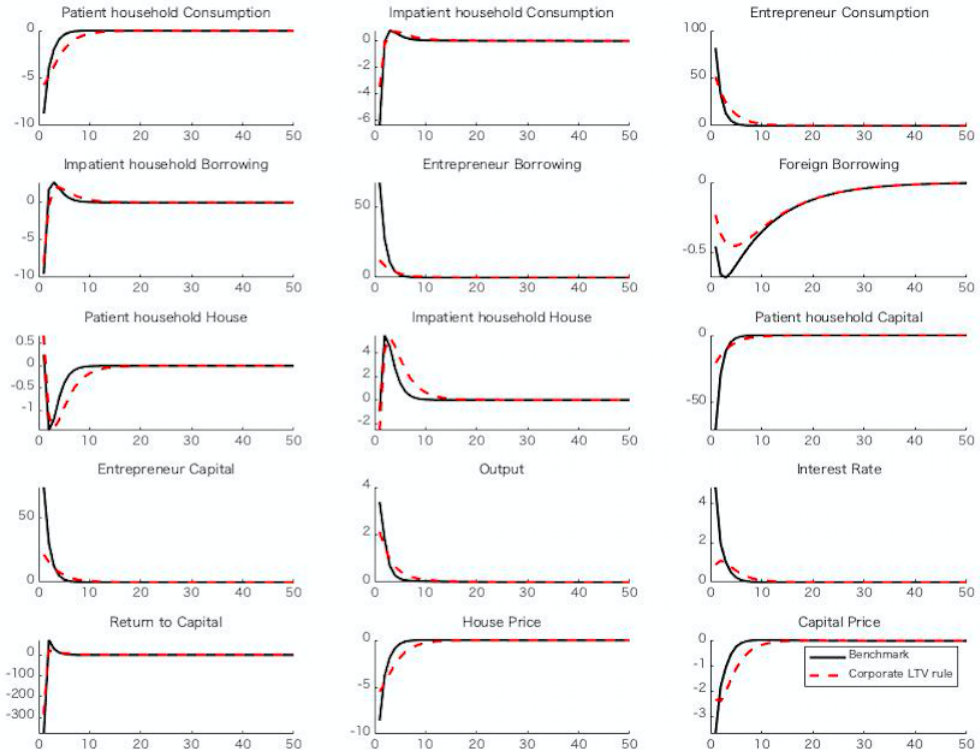

Figure 5: Corporate LTV rate rule

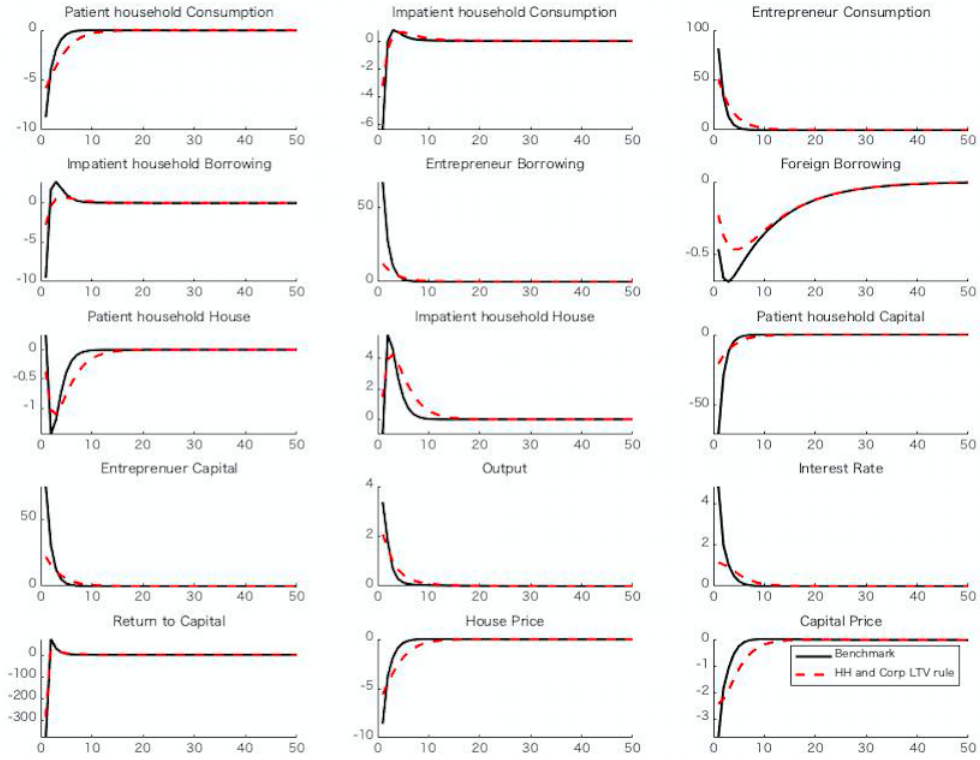

Figure 6: Household and Corporate LTV rate rules

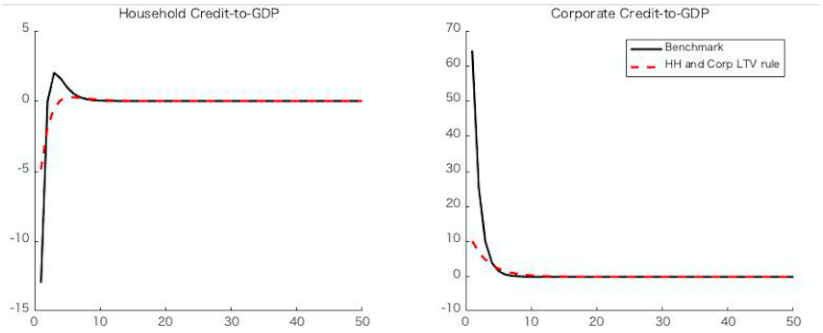

Figure 7: Both LTV rate rules Credit-to-GDP

5 Welfare Analysis

From the above results, we can say that macroprudential policy can decrease the volatilities in the economy, especially in credit market. However, we cannot conclude that macroprudential policy is desirable and better to implement. Therefore, I do the welfare analysis of macroprudential policy, testing whether macroprudential policy can improve social welfare or not. To do this, I define social welfare following Mendizino and Punzi (2014), which is the weighted average of the welfare of 3 agents: patient households, impatient households, and entrepreneurs. Then I compare the steady state value of social welfare under some certain LTV rates and compute the percentage change in welfare when the LTV rates are tightened. Each agent's welfare is defined as the expected lifetime utility, and the weight is inversely proportional to the discount rate. Hence, the social welfare is

$$\overline{V_t} = \omega^s V_{s,t} + \omega^b V_{b,t} + \omega^c V_{c,t}$$

where

$$V_{s,t} = \{logc_{s,t} + \gamma^h logh_{s,t} - \chi\frac{n_{s,t}^{\eta}}{\eta}\} + \beta^s V_{s,t+1}$$

$$V_{b,t} = \{logc_{b,t} + \gamma^h logh_{b,t} - \chi\frac{n_{b,t}^{\eta}}{\eta}\} + \beta^b V_{b,t+1}$$

$$V_{c,t} = \{logc_{c,t}\} + \beta^c V_{c,t+1}$$

and the weight of each agent $\omega^i = 1 - \beta^i \qquad (i = s, b, c)$
Use dynamic programming and rewrite the equations, the steady state value of social welfare will be

$$\overline{V^{ss}} = \omega^s V_s^{ss} + \omega^b V_b^{ss} + \omega^c V_c^{ss}$$

where

$$V_s^{ss} = \{logc_s^{ss} + \gamma^h logh_s^{ss} - \chi\frac{n_s^{ss\eta}}{\eta}\} + \beta^s V_s^{ss}$$

$$V_b^{ss} = \{logc_b^{ss} + \gamma^h logh_b^{ss} - \chi\frac{n_b^{ss\eta}}{\eta}\} + \beta^b V_b^{ss}$$

$$V_c^{ss} = \{logc_c^{ss}\} + \beta^c V_c^{ss}.$$

Table 2 reports the percentage change in social welfare when the LTV rates are tightened. In benchmark case, household LTV rate and corporate LTV rate are first set as 80 and 90 respectively. When I tighten corporate LTV rate m^c from 90 to 85, the social welfare increases by 1.2%. If I further tighten the rate to 60, the social welfare will improve by 5.74%. On the other hand, when household LTV rate m^h is tightened from 80 to 75, the social welfare decreases by 0.03%. Furthermore, when it is tightened from 80 to 50, the social welfare losses by 0.4%. The welfare gain from tightening corporate LTV rate is larger than the welfare loss from tightening household LTV rate. Hence, tightening both rates results in an increase in social welfare.

social welfare (%change)		m^c			
		90	85	80	60
m^h	80	0	1.2	2.29	5.74
	75	-0.03	1.17	2.25	5.71
	70	-0.09	1.11	2.2	5.66
	50	-0.4	0.8	1.89	5.35

Table 2: Social Welfare Percentage Change

The next question is who loss and who gain. To answer this question, I look into the steady state value of each agent welfare. Table 3, 4, 5, respectively, reports the percentage change in patient households, impatient households, and entrepreneurs welfare.

From table 3, we can say that tightening either household or corporate LTV rate decreases the patient households welfare. Intuitively, when LTV rates are tightened, impatient households and entrepreneurs can borrow less, which means patient households' lending will decrease. The domestic interest rate also falls too because of the lower credit demand. According to figure 6, the fall in interest rate is much bigger than the improvement of house price and capital return. Therefore, the income loss from the domestic interest rate change is more than the income gain from the asset price change. Hence, patient households earn less return from lending, which results in less consumption and lower welfare.

patient households welfare (%change)		m^c			
		90	85	80	60
m^h	80	0	-0.47	-0.93	-2.64
	75	-0.09	-0.51	-1.02	-2.73
	70	-0.16	-0.64	-1.1	-2.81
	50	-0.35	-0.82	-1.29	-3.01

Table 3: Patient Households Welfare Percentage Change

Table 4 displays the percentage change in welfare of impatient households. It shows that tightening corporate LTV rate increases impatient households welfare, but the effect of household LTV on the impatient households welfare depends on the level of household LTV rate. Until a certain level of household LTV rate, tightening the rate improves impatient households welfare. However, after that certain level, the welfare falls. I leave the analysis about the turning point for further study.

The intuitive explanation about the effect of corporate LTV rate is as follows. Tightening corporate LTV rate decreases entrepreneurs borrowing demand and, hence, lowers the domestic interest rate. Then, patient households have less incentive to lend the money and, instead, use the money to consume, buy house and capital. As a consequence, the demand for house increases, which leads to an increase in house price. This can be interpreted as an increase in impatient households' collateral value. As a result, impatient households can borrow more to consume and buy houses.

In the case of household LTV rate, tightening the rate when it is still higher than a certain level makes impatient households shift their spending on houses to consumption. In other words, an excessive house buying is amended. This change in impatient households' behavior improves the welfare. However, when the rate is tightened too much and goes below a certain level, it excessively restricts impatient households' borrowing. As a result, impatient households have to decrease both consumption and house buying. Finally, the welfare falls. The welfare result of household LTV rate case is consistent with Alam et al. (2019) who states that tightening LTV rate when the initial rate is already tight will reduce consumption more than when the initial rate is relatively loose. In addition, the effect on household credit growth is also weaker when the initial LTV rate is tight. They further suggest that when the initial LTV rate is already tight, macroprudential authorities should consider other macroprudential tools to complement the current policy package.

Table 5 shows the change in entrepreneurs welfare. Based on table 5, tightening corporate LTV rate improves entrepreneurs welfare, while tight-

impatient households welfare (%change)		m^c			
		90	85	80	60
m^h	80	0	0.25	0.48	1.28
	75	0.18	0.43	0.66	1.47
	70	0.22	0.47	0.71	1.53
	50	-0.3	-0.05	0.2	1.04

Table 4: Impatient Household Welfare Percentage Change

ening household LTV rate decreases entrepreneurs welfare. High corporate LTV rate encourages entrepreneurs to invest in their own capital to get more loans, which may cause an excessive investment. Tightening the rate makes entrepreneurs shift the spending from capital investment to consumption. As a result, the welfare increases. On the other hand, household LTV rate has an impact on households' goods demand. Tightening household LTV rate decreases the final goods demand and, hence, entrepreneurs' profit. Entrepreneurs have to cut their spending due to the lower income. This leads to the fall in entrepreneurs welfare.

entrepreneurs welfare (%change)		m^c			
		90	85	80	60
m^h	80	0	50.19	96.23	248.18
	75	-0.62	49.57	95.62	247.58
	70	-1.13	49.06	95.12	247.09
	50	-2.5	47.71	93.77	245.78

Table 5: Entrepreneurs Welfare Percentage Change

Although the fiscal policy shock has a negative effect on financial stability, but one cannot deny that it increases GDP and also the social welfare. Doing the same exercise as above, I found that a 10% rise in infrastructure supply can increase the social welfare by about 1% and all agents in the economy experience the welfare gains.

The policy implication from the results in section 4 and 5 is that, given fiscal policy shock, macroprudential policy should be used to maintain financial stability, and it can improve the welfare. However, a well consideration of which sector should be targeted by the macroprudential policy is needed. The sector that has high financial volatility and wide impact on the economy (entrepreneurs in the model) should be targeted by the macroprudential policymakers. Targeting a relatively low financial volatility sector may lessen the social welfare. The combination of both fiscal and macroprudential policy

makes it possible to maintain financial stability without restricting economic growth. In addition, it also improves the social welfare.

6 Conclusion

Along with economic growth, emerging countries are facing a rapid credit growth. Many international institutions and central banks start to be aware of the financial instability diverting from the increasing credit. It is time for emerging countries to give more importance to financial stability besides economic growth and reconsider the policy packages.

This paper argues that fiscal policy, which is a famous economic stimulus policy, can induce financial instability. Concretely, the paper shows that an increase in government spending on infrastructure, or the fiscal policy shock in the model, can lead to an increase in households and entrepreneurs borrowing from the steady state. The infrastructure contributes to an increase in output of the economy, and also the households' and entrepreneurs' incomes. Households and entrepreneurs, then, buy more houses and capital, which are the assets that can be used as collateral, to get more loans. As a result, households and entrepreneurs borrowings rise.

Even though the government spending on infrastructure has a side effect, the government cannot refrain from using this fiscal tool because infrastructure is a main source of economic growth, and the infrastructure demand is continuously high in emerging countries. To solve this problem, I propose the use of macroprudential policy. The macroprudential policy tools used in this paper are rules on household LTV rate and corporate LTV rate. When the LTV rates are allowed to respond to the change in households and entrepreneurs borrowings, the rise in borrowings after the fiscal policy shock decreases. In addition, tightening corporate LTV rate has a wider effect than tightening household LTV rate to the extent that it can reduce the volatility of all variables in the economy. Even though macroprudential policy lessens the effect of fiscal policy on output, we can still see a more-than-one fiscal multiplier effect. The use of macroprudential policy under a given fiscal policy improves the social welfare because it gives the incentives for households and entrepreneurs to shift their spending from houses and capital buying to consumption. Tightening LTV rates prevent the excess collateral assets' buying behavior of households and entrepreneurs.

Based on the results, I suggest that macroprudential policy should be used together with fiscal policy. The combination of fiscal and macroprudential policy helps emerging countries to maintain financial stability and achieve economic growth at the same time, and it also improves the social welfare.

7 Appendix

After I derive the first order conditions of each agent, I substitute the labor market conditions to get the reduced form equilibrium equations. When there is a fiscal policy shock but no active macroprudential policy rules, the log-linearized model is as followed.

$$\hat{c}_{s,t} = \hat{c}_{s,t+1} - \hat{R}_t \tag{1A}$$

$$\hat{h}_{s,t} = \frac{1}{\gamma_h}\frac{q_h h_s}{c_s}\{(\hat{c}_{s,t} - \hat{q}_{h,t}) + \beta^s(1-\delta_h)(\hat{q}_{h,t+1} - \hat{c}_{s,t+1})\} \tag{2A}$$

$$\hat{R}_t = \beta^s\{\frac{R^k}{q_k}(\hat{R}^k_{t+1} - \hat{q}_{k,t}) + (1-\delta_k)(\hat{q}_{k,t+1} - \hat{q}_{k,t})\} \tag{3A}$$

$$\begin{aligned}\hat{c}_{b,t} =& \frac{Y}{c_b}\{0.5(1-\tau)(1-\alpha_k-\alpha_f)\hat{Y}_t - \\ & \frac{q_h h_b}{Y}(\delta_h\hat{q}_{h,t} + \hat{h}_{b,t} - (1-\delta_h)\hat{h}_{b,t-1}) - \frac{b^h}{Y}(R(\hat{R}_{t-1} + \hat{b}^h_{t-1}) - \hat{b}^h_t)\}\end{aligned} \tag{4A}$$

$$\hat{b}^h_t = \hat{q}_{h,t+1} + \hat{h}_{b,t} - \hat{R}_t \tag{5A}$$

$$\begin{aligned}\hat{h}_{b,t} = & \frac{1}{\gamma_h}\frac{q_h h_b}{c_b}\{(\hat{c}_{b,t} - \hat{q}_{h,t}) + \beta^b(1-\delta_h)(\hat{q}_{h,t+1} - \hat{c}_{b,t+1}) \\ & + m^h((\beta^s - \beta^b)\hat{q}_{h,t+1} - \beta^s(\hat{R}_t + \hat{c}_{b,t}) + \beta^b\hat{c}_{b,t+1})\}\end{aligned} \tag{6A}$$

$$\hat{Y}_t = -0.5(\hat{c}_{s,t} + \hat{c}_{b,t}) + \frac{\eta}{\eta - (1-\alpha_k-\alpha_f)}(\alpha_f\hat{f}_t + 0.5\alpha_k(\hat{k}_{c,t-1} + \hat{k}_{s,t-1})) \tag{7A}$$

$$\hat{b}^c_t = \hat{q}_{k,t+1} + \hat{k}_{c,t} - \hat{R}_t \tag{8A}$$

$$\begin{aligned}\hat{q}_{k,t} = & 0.5\beta^c\alpha_k\frac{Y}{q_k k_c}(\hat{Y}_{t+1} - \hat{c}_{c,t+1} - \hat{k}_{c,t}) + \beta^c(1-\delta_k)(\hat{q}_{k,t+1} - \hat{c}_{c,t+1}) \\ & + m^c\{(\beta^s - \beta^c)\hat{q}_{k,t+1} - \beta^s(\hat{c}_{c,t} + \hat{R}_t) + \beta^c\hat{c}_{c,t+1}\} + \hat{c}_{c,t}\end{aligned} \tag{9A}$$

$$\hat{R}^k_{t+1} = \hat{Y}_{t+1} - \hat{k}_{s,t} \tag{10A}$$

$$\hat{c}_{c,t} = \frac{Y}{c_c}\{(\alpha_k+\alpha_f)\hat{Y}_t - \frac{q_k k_c}{Y}(\delta_k \hat{q}_{k,t} + \hat{k}_{c,t} - (1-\delta_k)\hat{k}_{c,t+1}) \\ -\frac{R^k k_s}{Y}(\hat{R}^k_t + \hat{k}_{s,t-1}) + \frac{b^c}{Y}(\hat{b}^c_t - R(\hat{R}^c_{t-1} + \hat{b}^c_{t-1}))\} \tag{11A}$$

$$\hat{b}^*_t = \frac{Y}{eb^*}\{\frac{f}{Y}\hat{f}_t - \tau(1-\alpha_k-\alpha_f)\hat{Y}_t\} + R^*\hat{b}^*_{t-1} \tag{12A}$$

$$\hat{Y}_t = \frac{c_s}{Y}\hat{c}_{s,t} + \frac{c_b}{Y}\hat{c}_{b,t} + \frac{f}{Y}\hat{f}_t + \frac{eb^*}{Y}(R^*\hat{b}^*_{t-1} - \hat{b}^*_t) \tag{13A}$$

$$\hat{h}_{s,t} = -\frac{h_b}{h_s}\hat{h}_{b,t} \tag{14A}$$

$$\hat{k}_{s,t} = -\frac{k_c}{k_s}\hat{k}_{c,t} \tag{15A}$$

$$\hat{f}_t = \rho_f \hat{f}_{t-1} + \epsilon_f \tag{16A}$$

Equation (1A)-(15A) are the log-linearized form of equation (1)-(15). Equation (16A) is the fiscal policy shock.

When macroprudential policy rules are implemented, the LTV rates can change over time in order to respond to the volatility of the borrowings. Macroprudential policy rules for impatient households and entrepreneurs follow equation (17A) and (18A) respectively.

$$\hat{m}^h_t = -\phi_h \hat{b}^h_t \tag{17A}$$

$$\hat{m}^c_t = -\phi_c \hat{b}^c_t \tag{18A}$$

In addition, when macroprudential policy rules are active, the log-linearized equations of impatient households borrowing constraint, impatient households housing demand, entrepreneurs borrowing constraint, and entrepreneurs capital demand change. Hence, we can rewrite equation (5A), (6A), (8A), and (9A) as follows.

$$\hat{b}^h_t = \hat{m}^h_t + \hat{q}_{h,t+1} + \hat{h}_{b,t} - \hat{R}_t \tag{5A'}$$

$$\hat{h}_{b,t} = \frac{1}{\gamma_h}\frac{q_h h_b}{c_b}\{(\hat{c}_{b,t} - \hat{q}_{h,t}) + \beta^b(1-\delta_h)(\hat{q}_{h,t+1} - \hat{c}_{b,t+1}) \\ +m^h((\beta^s-\beta^b)(\hat{m}^h_t + \hat{q}_{h,t+1}) - \beta^s(\hat{R}_t + \hat{c}_{b,t}) + \beta^b \hat{c}_{b,t+1})\} \tag{6A'}$$

$$\hat{b}_t^c = \hat{m}_t^c + \hat{q}_{k,t+1} + \hat{k}_{c,t} - \hat{R}_t \tag{8A'}$$

$$\begin{aligned}\hat{q}_{k,t} = 0.5\beta^c\alpha_k\frac{Y}{q_k k_c}(\hat{Y}_{t+1} - \hat{c}_{c,t+1} - \hat{k}_{c,t}) + \beta^c(1-\delta_k)(\hat{q}_{k,t+1} - \hat{c}_{c,t+1}) \\ +m^c\{(\beta^s - \beta^c)(\hat{m}_t^c + \hat{q}_{k,t+1}) - \beta^s(\hat{c}_{c,t} + \hat{R}_t) + \beta^c\hat{c}_{c,t+1}\} + \hat{c}_{c,t}\end{aligned} \tag{9A'}$$

The steady state equations of the variables are reported below.

$$R = \frac{1}{\beta^s}$$

$$\frac{q_h h_s}{c_s} = \frac{\gamma^h}{1-\beta^s(1-\delta_h)}$$

$$\frac{q_h h_b}{c_b} = \frac{\gamma^h}{1-\beta^b(1-\delta_h) - m^h(\beta^s - \beta^b)}$$

$$\frac{c_b}{Y} = \frac{0.5(1-\tau)(1-\alpha_k-\alpha_f)}{1+\frac{q_h h_b}{c_b}(\delta_h + (1-\beta^s)m^h)}$$

$$\frac{q_h h_b}{Y} = \frac{q_h h_b}{c_b}\frac{c_b}{Y}$$

$$\frac{b^h}{Y} = \beta^s m^h \frac{q_h h_b}{Y}$$

$$\frac{R^k}{q_k} = R - (1-\delta_k)$$

$$\frac{Y}{q_k k_c} = \frac{1}{0.5\beta^c\alpha_k}(1-\beta^c(1-\delta_k) - (\beta^s - \beta^c)m^c)$$

$$\frac{R^k k_s}{Y} = 0.5\alpha_k$$

$$\frac{b^c}{Y} = \beta^s m^c \frac{q_k k_c}{Y}$$

$$\frac{c_c}{Y} = (\alpha_k + \alpha_f) - \delta_k\frac{q_k k_c}{Y} - \frac{R^k k_s}{Y} + (1-R)\frac{b^c}{Y}$$

$$\frac{b^*}{Y} = \frac{1}{e(R^*-1)}(\tau(1-\alpha_k-\alpha_f) - \frac{f}{Y})$$

$$\frac{c_s}{Y} = 1 - \frac{c_b}{Y} - \frac{c_c}{Y} - \frac{f}{Y} - e(R^* - 1)\frac{b^*}{Y}$$

$$\frac{h_b}{h_s} = \frac{q_h h_b}{Y} / (\frac{q_h h_s}{c_s}\frac{c_s}{Y})$$

$$\frac{k_c}{k_s} = (\frac{q_k k_c}{Y}\frac{R^k}{q_k}) / \frac{R^k k_s}{Y}$$

Table 6 shows the steady state value of the variables calibrated by the above equations.

variable	steady state value
R	1.01
$\frac{q_h h_s}{c_s}$	2.52
$\frac{q_h h_b}{c_b}$	1.57
$\frac{c_b}{Y}$	0.23
$\frac{q_h h_b}{Y}$	0.36
$\frac{b^h}{Y}$	0.28
$\frac{R^k}{q_k}$	0.04
$\frac{Y}{q_k k_c}$	0.28
$\frac{R^k k_s}{Y}$	0.15
$\frac{b^c}{Y}$	3.16
$\frac{c_c}{Y}$	0.11
$\frac{b^*}{Y}$	0.02
$\frac{c_s}{Y}$	0.54
$\frac{h_b}{h_s}$	0.26
$\frac{k_c}{k_s}$	0.95

Table 6: Variables steady state values

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