Effect of Wage Support by Government on Economic Volatility and Optimal Stabilization Policy

Jongheuk Kim*

Financial Supervisory Service

April 30, 2015

Abstract

This paper investigates the role of real wage changes in the dynamic responses of the optimal macroeconomic policy to the negative foreign demand shocks, where the wage structure is partly affected by a manually operated by a government. To do this, I build a small open economy (SOE) dynamic stochastic general equilibrium (DSGE) model with a sticky price and a monopolistically competitive nontradable sector assumptions. If a government manually supports the domestic consumers by a binding minimum wage which is financed by a lump sum taxation, the optimally determined the real marginal cost in the New Keynesian Phillips Curve (NKPC) is decreased, and thus the economy experiences less exacerbated trade-off between output gap and inflation stabilization faced by a policy maker. Therefore, with the higher level of the real wage support, an economic volatility in key macroeconomic variables from the optimal Ramsey policy problem is more mitigated, and the economy accomplishes more efficient stabilization goal.

Keywords: Government Wage Support; New Keynesian Phillips Curve; Ramsey Policy Problem; Stabilization Policy; Central Banking

JEL Classification Numbers: E12, E61, F41

*Corresponding address: Financial Supervisory Service, Macro-prudential Supervision Department, 38, Yeoui-Daero, Youngdeungpo-Gu, Seoul, 150-743, South Korea; Tel: +82 2 3145 8890; Fax: +82 2 3145 8894; e-mail: *jongheuk.kim@fss.or.kr.*

1 Introduction

A sudden stop is defined, by related notable studies such as Calvo & Reinhart (1999), as a sudden decrease in foreign capital inflows. Since a capital inflow is calculated by a sum of current account deficit and foreign reserves, the sudden reversal of foreign capital flows damages both an output and a financial vulnerability, and it also exacerbates an unemployment rate and a relative price volatility. This phenomenon has been a main topic in the related literature since many emerging market or developing countries have experienced the similar pattern of economic shifts during economic crises in various times. A notable example of the phenomenon observed in those regions would be Mexican financial crisis in 1994 or Asian and Latin American financial crisis in 1998 and 1999. While significant academic achievement on the possible causality of the historic economic turmoils has been done in the literature, there has been still an ongoing debate on a policy implication of the aftermath of the economic crisis in devleoping countries. Braggion et al. (2009) is a milestone study for the monetary policy implication which is aimed to stabilize the economic volatility after a sudden stop comes. Another important stabilization policy discussion regarding the phenomenon is Caballero & Krishnamurthy (2004b), which considers an inflation targeting as a possible remedy for the consequential event of the financial crisis. While these papers efficiently argue that the main monetary policy tool has been made an enough effect on the business cycles in some countries, an effect of a structural changes in real wages on the consequence of the sudden stops, or similar pattern of economic crisis has been a little ignored because of its minor role as a macroeconomic policy tool. In fact, there are strong statistical motivations to be interested in the role of a wage support by a government such as a increasing minimum wages in a specific period with a specific regional conditions. First, there is an intriguing linkage between an inflation volatility and a real minimum wage level, which suggests that an increasing minimum wage level maybe helpful in stabilizing price volatility after sudden stops or similar crisis caused by a sudden external changes. Figure 1 shows a different path of inflation volatility of two countries which kept dramatically different minimum wage regimes. South Korea, which experienced a financial crisis in 1998 and has consistently increased its real minimum wage level for the last 25 years, was able to avoid a high volatile price changes after the crisis. On the other hand, Mexico, which had the similar crisis during 1994, never increased its real minimum wage level for the same span of period, and it experienced relatively high volatile inflation fluctuations after the crisis. While the minimum wage controlling would not be the most favorable main fiscal policy tool to stabilize the economic volatility during and after the economic crisis, it must be studied further to recognize to what extent this wage controlling method can help the main macroeconomic stabilization policies in the special situation of crisis. Second, there is an ongoing question of what should be the optimal level of minimum wage to fully stabilize an inflation volatility after severe fluctuation of macroeconomic variables is experienced. Figure 2 compares different level of real minimum wage changes and their linkage to the macroeconomic variables. Chile has kept the lower growth rate of the real minimum wage than South Korea for the last 25 years and the country was successful in suppressing the price fluctuations after the sudden stops in 1999, but it failed to stabilize the higher inflation volatility around the new financial crisis in 2008. International and domestic economic environments should be different between those two different times, but it is still interesting to wonder if there is any specific level of optimal minimum wage level to fully stabilize the volatility of some key macroeconomic variables after the crisis. Third, if there is a specific link between minimum wage control and price volatility, it is also worth to question if the relationship only matters for emerging market or developing countries. Figure 3 tells that the possible effect of the minimum wage on the economic dynamics is limited to the developed economies, by showing that US data has no seemingly correlated linkage between the special fiscal regime and the business cycles. US never experienced any type of economic crisis similar to a sudden stop or the other pattern of crisis caused by a sudden foreign shocks during the past 25 years, and the data never shows any meaningful effect of the minimum wage levels on the economic dynamics during any type of external crisis. It is still unknown and very difficult to sort out an independent effect of the minimum wage on the business cycles because the regime has never been considered as a main macroeconomic stabilization policy tool in those developing countries during the crisis, and it only has been used for a supplemental purpose as a part of social security system. But it is important to investigate the effect of the minimum wage on the inflation stabilization process after the economy experiences a dramatic foreign demand changes such as a sudden stop, and to figure out how much it is helpful to support the monetary policy to accomplish its major goal of price and output stabilization in the uniquely characterized economic downturn.

To answer those questions, I build a Small Open Economy (SOE) Dynamic Stochastic General

Equilibrium (DSGE) model with New Keynesian fashion. In addition to assumptions of a price rigidity and a monopolistically competitive nontradable sector, I add a partially supported wage structure by a government. A government sets a fixed level of a portion of the wage level that positively affects the labor income and finances it by a lump sum fashioned taxation. This simple wage structure cannot fully capture a realistic model of the minimum wage, but it still successfully illustrates the effect of the minimum wage on the overall wage level and the economy wide marginal cost structure. In this structure, the fixed part of the wage directly changes the overall income of the domestic households, but it does not affect the optimal labor demand and wage determined in a production sector. Minimizing a distorting effect of the government operation on the economic equilibrium, the model shows the effect of the changing government wage support on the economic dynamics of macroeconomic variables in a Ramsey policy equilibrium. I build a linear-quadratic (LQ) social welfare loss measurement and use it as an objective function of the Ramsey policy problem. The LQ form of the welfare loss function has a merit in terms of tractability. As a result, I find that the increasing government wage support in the form of minimum wages can reduce the economic volatility of key macroeconomic variables, by ameliorating the trade-off between output gap and inflation stabilizations faced by a policy maker. With this reduced trade-off in New Keynesian Phillips Curve (NKPC) the economy can achieve the goal of stabilization more successfully. The economic intuition behind this result is that, a permanent increase in a certain portion of the labor income preserves higher level of real purchasing power of the domestic agents and it gives them a more room to keep their original level of consumption and production even if there comes a sudden, unexpected negative foreign demand shock. This positive preservation effect overcomes a negative effect of the increasing lump sum taxation in this model, and thus the overall stabilization effect of the economy is improved. This model lacks an ability to answer the second question drawn in the previous paragraph, so that it cannot find the optimal level of minimum wage to fully stabilize the economy since the minimum wage level is fixed and given in the problem. It also fails to answer the question of what should be the main difference between developed and developing countries if the same level of the government wage support program is introduced. Those two questions should be sought in the future development of the paper.

One main contribution of the paper is that, it introduces a kind of wage manipulation by government in DSGE literature and tries to find the optimal policy regime in that environment. Benassy (1995) brings the minimum wage discussion into the macroeconomics context and Gali (1996) briefly discusses the role of it in Real Business Cycle fashion, but there has not been an any other notable works studying the role of government-lead wage structural changes in the consequences of the foreign-originated crisis in developing countries. The importance of the minimum wage has never been ignored in labor economics literature with microeconomic scope, but it is also important in the context of business cycle and sudden stops literature. This paper shows that, while the statistical background is remained as a weak part, the aggressive wage support program by the government possibly reduces the macroeconomic volatility by a significant level.

2 Literature Review

There has been a rich volume of literature on a sudden stop. Majority of the research has been focused on the causality of the sudden foreign capital inflows decrease motivated by Mexican crisis in 1994 and the financial crisis in Asia and Latin America in 1998 and 1999. The international dimensions of the developing countries naturally became strong candidates for the main driver of the macroeconomic collapse. While Cavallo & Frankel (2008) focus on the negative effect of an openness to trade on the severity of the sudden stop, Joyce & Nabar (2009) look the history of emerging markets from 1976 to 2002 to find out that the financial openness made those countries more vulnerable to the sudden capital reversals. Similarly, Mendoza & Smith (2006) points out that financial friction such as collateral constraint in those countries could be a possible trigger. Another potential reasons for the sudden stops are liability dollarization argued by Chue & Cook (2008), Calvo (2006) and Calvo (2002), fiscal institutional problem argued by Calvo (2003), and asymmetric information problem pointed out by Rothenberg & Warnock (2011).

The result of the sudden stop is characterized by sudden decrease in output, severe depreciation in real exchange rate, and high volatile price fluctuations. Kehoe & Ruhl (2009) tries to replicate the observed movement of the macroeconomic variables by inviting several restrictions in their growth model, such as labor sectoral reallocation or various types of intermediate goods production process. Relative price volatility is studied by Calvo et al. (2006), which empirically confirms the relevance of sudden stops and price volatility.

Study on policy implications of the aftermath of the sudden stops has been relatively little considered in the literature, due to the difficulty of the empirical analysis on the identification of the effect of macroeconomic policies on the consequences of the sudden stops. Several theoretical works on a monetary policy after sudden stops are notable, such as Braggion et al. (2009) which points out that the increasing interest rate in South Korea during the crisis was logically appropriate by showing the procyclical policy mitigated the distortions created by a binding collateral constraint, and thus it was a welfare improving. On the other hand, Caballero & Krishnamurthy (2004a) suggests that the countercyclical time-contingent inflation targeting monetary policy is optimal in the dimension of sudden stops where time inconsistency problem is relatively more significant.

Role of minimum wage on the business cycles are rarely studied in the recent New Keynesian literature, since the body of school mainly focuses on the role of interest rate controlling in which a money non-neutrality is a strong feature as an economic environment. But in Real Business Cycle (RBC) literature, the supplemental policy regime is considered a positive rather than negative supporting tool for the economic dynamics. Cahuc & Michel (1996) argues that setting minimum wage above the steady state wage level of an unskilled labor would increase demands for a skilled labor, giving the unskilled labor a motivation to improve its labor efficiency, and thus the economy shifts to the trade-friendly labor market structure and it finally induces higher level of economic growth. Flug & Galor (1986) also points out that in the unique environment of developing countries where the real wage of unskilled labor is sticky downwards, the effective minimum wage control roles as a distortion that changes a composition between unskilled and skilled labor forces and thus it affects the trade pattern in an open economy and economic dynamics.

In sum, the effect of the minimum wage on the economic dynamics in an environment where the sudden stops come or the money neutrality assumption is broken has not been clearly investigated, and there is a room for this paper to have a potential contribution to the related literature.

3 Model

To see the effect of an increase in minimum wages on business cycles in an open economy, I build a small open economy DSGE model with nominal price rigidity in a nontradable sector. A small open economy, called domestic country, is assumed to be enough small to be ignored by the world economy, which is the other side of the model. Therefore, the domestic country is given world price and output as an exogenous variables. The world economy ignores an economic activity of the domestic country because it is too small to make any worldwide change. Each part of the economy consists of three parts: Households, firms, and a government. A representative household consumes tradable and nontradable final goods and a firm uses a labor as an input. The nontradable sector is monopolistically competitive, which gives an each firm in the sector a small price power at each period. The tradable sector is assumed to be perfectly competitive and the price is totally flexible. The model includes a structure of binding minimum wage. The wage level is the same across sectors, so that if the government sets the binding minimum wage which is manually determined such as a parameter, it increases the overall wage level directly. By changing the binding minimum wage level, the wage and price level of the economy are affected and the change finally makes a different transmission process of foreign exogenous demand shocks to the domestic economy. I solve Ramsey policy problem from the competitive equilibrium conditions, and find an optimal policy values which are used to determine the effect of the binding minimum wage on the equilibrium of the economy.

3.1 Households

There are two types of goods produced in each country: Tradable and nontradable goods. Composite final goods are aggregated by Cobb-Douglass fashion:

$$C_t = \frac{(C_{T,t})^{\gamma}(C_{N,t})^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}} \tag{1}$$

where C_t is a final goods consumption, $C_{T,t}$ is an amount of consumption for the tradable goods and $C_{N,t}$ is an amount of consumption for the nontradable goods. In the similar way, an overall price level (CPI) is defined by prices of tradable and nontradable goods.

$$P_t = (P_{T,t})^{\gamma}(P_{N,t})^{1-\gamma} \tag{2}$$

where P_t is an overall price level, $P_{T,t}$ is a price level of tradable goods and $P_{N,t}$ is a price level of nontradable goods. $P_{T,t}$ is directly linked to the world tradable goods price level and a nominal exchange rate:

$$P_{T,t} = P^*_{T,t}\mathcal{E}_t \tag{3}$$

where $P^*_{T,t}$ denotes the foreign (world) price level of tradable goods and $\mathcal{E}_t$ stands for a nominal exchange rate. Hereafter, any variable with asterisk mark is defined by a foreign variable. By normalizing $P^*_{T,t}$ by unity, the domestic price level of tradable goods is simply the same with the level of nominal exchange rate.

The demand functions for tradable and nontradable goods are then calculated:

$$C_{T,t} = \gamma\left(\frac{P_{T,t}}{P_t}\right)^{-1} C_t \tag{4}$$

$$C_{N,t} = (1-\gamma)\left(\frac{P_{N,t}}{P_t}\right)^{-1} C_t \tag{5}$$

The foreign country's composite consumption, price level, and the demand functions are similarly defined and calculated with asterisk mark. The demand function for each differentiated nontradable good is derived by

$$C_{N,t}(j) = \left(\frac{P_{N,t}(j)}{P_{N,t}}\right)^{-\varepsilon} C_{N,t}$$

where $j \in (0,1)$ is an index for single firm in the nontradable sector, ε denotes a substitution of elasticity between the differentiated goods in the sector. The domestic households are assumed to access to both domestic and foreign currencies denominated nominal bonds, $B_{H,t}$ and $B_{F,t}$, respectively, with fixed returns of interest, R_t and R^*_t, respectively. They are also assumed to receive a wage by providing an inelastic labor from one of tradable and nontradable sectors, and own firms in both tradable and nontradable sectors. Therefore, a budget constraint for the represent household is given by

$$P_tC_t + B_{H,t} + \mathcal{E}_tB_{F,t} \leq R_{t-1}B_{H,t-1} + \mathcal{E}_tR^*_{t-1}B_{F,t-1} + (W_t \cdot \bar{W})(L_{T,t} + L_{N,t}) - T_t + \Gamma_{T,t} + \int_0^1 \Gamma_{N,t}(j)dj \tag{6}$$

where W_t is a nominal wage in both sectors sectors, $\bar{W}$ is a fixed minimum wage supported by a government, $L_{T,t}$ and $L_{N,t}$ are an amount of labor supplied to tradable and nontradable sectors, respectively, T_t is a lump sum transfer from a government, and $\Gamma_{T,t}$ and $\int_0^1 \Gamma_{N,t}(j)dj$ are total profits of tradable and nontradable firms. Note that, a consumer receives a total wage $W_t \cdot \bar{W}$ at each period t, which consists of two margins, W_t, paid by a firm, and $\bar{W}$, paid by a government. This simple wage structure illustrates a reality that a strictly set minimum wage by government increases overall wage level, while that forced part of the wage structure is partly subsidized by the government spending. The government finances the total minimum wage spending $\bar{W}(L_{T,t} + L_{N,t})$ by levying a lump sum tax T_t. According to the constraint, the baseline value of the minimum wage is 1, which means that the minimum wage does not increase or decrease the wage level paid to the consumers. If the minimum wage level is 1.1, the overall wage level is increased by 10%. If the minimum wage level is set to be 0.9, the overall wage level is decreased by 10%. Therefore, by controlling the minimum wage level, the government can directly change the overall wage level finally paid to the domestic consumers. It is weird to see that the minimum wage is expressed by a proportional value, but this type of modeling is designed for the tractability, and this does not harm the original intuition of the role of the minimum wage on the wage structure and the effect of it on the entire model of this paper. If a government understands the fact that the increasing minimum wage directly affects the increasing overall wage level and wants to do it, the government precisely determine the increasing amount of wage level and manually control it.

The utility function of the domestic households is defined by

$$U(C_t, L_{T,t}, L_{N,t}) = E_0 \sum_{t=0}^{\infty} \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{(L_{T,t} + L_{N,t})^{(1+\phi)}}{1+\phi} \right) \tag{7}$$

where β is a time discounting factor, $\sigma \geq$ is an intertemporal elasticity of substitution in private consumption, and $\phi \geq 0$ denotes a reverse elasticity of labor supply. The utility function of the foreign agent is defined identically with asterisk mark to the endogenous variables. The budget constraint of the foreign agent is defined by

$$P_t^* C_t^* + B_{F,t}^* \leq R_{t-1}^* B_{F,t-1}^* + W_t^* L_t^* + T_t^* + \Gamma_t^* \tag{8}$$

Note that for the small open economy assumption, the foreign (world) economy ignores the domestic financial market activity and thus it does not consume the domestic nominal bond holdings.

The first order conditions of consumers' problems are calculated as following:

$$\frac{(W_t \cdot \bar{W})}{P_t} = (L_{T,t} + L_{N,t})^{\phi} C_t^{\sigma} \tag{9}$$

$$1 = \beta R_t \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} (\Pi_{t+1})^{-1} \tag{10}$$

$$1 = \beta R_t^* \left(\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right) \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} (\Pi_{t+1})^{-1} \tag{11}$$

$$1 = \beta R_t^* \left(\frac{C_{t+1}^*}{C_t^*} \right)^{-\sigma} \left(\Pi_{t+1}^*\right)^{-1} \tag{12}$$

where $\Pi_t = \frac{P_t}{P_{t-1}}$ and $\Pi_t^* = \frac{P_t^*}{P_{t-1}^*}$. (9) is a real wage determination or labor supply equation, (10) and (11) are an Euler equation for home country. (11) is affected by a foreign interest rate, which is assumed to be exogenous and stochastic to be defined later. (12) is an Euler equation for the foreign economy, and both foreign consumption and inflation rate are assumed to be exogenous to the domestic economy. Therefore, (13) describes the relation between those exogenous stochastic processes.

3.2 Firms

There are two types of firms in the domestic country: Tradable and nontradable firms. While the nontradable sector is monopolistically competitive with differentiated goods produced, the tradable sector is supposed to be perfectly competitive.

Tradable Sector A single tradable sector firm produces goods by using labor with linear technology,

$$Y_{T,t} = A_{T,t} N_{T,t} \tag{13}$$

where $Y_{T,t}$ is a non-differentiated final tradable good, $A_{T,t}$ is a productivity shock which follows the stochastic process,

$$\log A_{T,t} = \rho_T \log A_{T,t-1} + \mu_{T,t} \tag{14}$$

where $0 \leq \rho_T < 1$ and $\mu_{T,t} \sim N(0, \sigma_T^2)$, and $N_{T,t}$ is a labor demand for tradable goods production. A single tradable sector firm faces a profit maximization problem,

$$Max_{N_{T,t}} \sum_{t=s}^{\infty} \Lambda_{t,s} \left(P_{T,t} Y_{T,t} - W_{T,t} N_{T,t} \right) \tag{15}$$

subject to (15), where $\Lambda_{t,s} = \beta^{t-s} \left(\frac{C_t}{C_s} \right)^{-\sigma} \left(\frac{P_t}{P_s} \right)^{-1}$, a stochastic discount factor. The first order condition is calculated by

$$\frac{W_t}{P_{T,t}} = A_{T,t} \tag{16}$$

Nontradable Sector A single nontradable sector firm faces the similar production technology and the profit maximization problem. The production technology is linear:

$$Y_{N,t}(j) = A_{N,t} N_{N,t}(j) \tag{17}$$

where $Y_{N,t}(j)$ is a differentiated final nontradable good of firm j, $A_{N,t}$ is a generally influential productivity shock which follows the stochastic process,

$$\log A_{N,t} = \rho_N \log A_{N,t-1} + \mu_{N,t} \tag{18}$$

where $0 \leq \rho_N < 1$ and $\mu_{N,t} \sim N(0, \sigma_N^2)$, and $N_{N,t}$ is a labor demand for nontradable goods production. A marginal cost for a typical nontradable sector j, $MC_{N,t}(j)$, is derived by

$$MC_{N,t}(j) = \frac{W_t}{A_{N,t}} \tag{19}$$

A price rigidity assumption is invited in this sector, following Calvo (1983) and Yun (1996) type staggered price setting. A randomly selected portion of producers $(1 - \theta)$ freshly sets a new price level at each period, while θ of firms keep their old price level at the same level with the last period. Therefore, θ captures a degree of price rigidity. Let $\overline{P_{N,t}(j)}$ be a price set optimally by a firm j at time t. With the staggered price setting described above, $P_{N,t+k}(j) = \overline{P_{N,t}(j)}$. Then, a typical firm j's problem is given by

$$Max_{\overline{P_{N,t}(j)}} E_t \sum_{k=0}^{\infty} \theta^k E_t \left[\Lambda_{N,t}^k \{ Y_{N,t}^k(j) \left(\overline{P_{N,t}(j)} - MC_{N,t+k}(j) \right) \} \right]$$

subject to the international demand constraints

$$Y_{N,t}^k(j) \leq \left(\frac{\overline{P_{N,t}}}{P_{N,t+k}} \right)^{-\varepsilon} \left(Y_{N,t}^k \right) \tag{20}$$

$$MC_{N,t+k} = \frac{W_{N,t+k}}{A_{N,t+k}} \tag{21}$$

where $\Lambda_{N,t}^k \equiv \beta^k \left(\frac{C_{t+k}}{C_t}\right)^{-\sigma} \left(\frac{P_t}{P_{t+l}}\right)$ and $MC_{N,t+k}$ denote a stochastic discounting factor and a nominal marginal cost at period $t+k$ with respect to the staggered price setting $\overline{P_{H,t}}$, respectively. Note that a firm specific index j can be dropped in this problem as well, because every single firm uses the same price setting subject to the same marginal cost and the same resource constraint. First order condition yields

$$\sum_{k=0}^{\infty} \theta^k E_t \left[\Lambda_{N,t}^k Y_{N,t}^k \left(\overline{P_{N,t}} - \frac{\varepsilon}{\varepsilon - 1} MC_{N,t+k} \right) \right] = 0 \tag{22}$$

Note that in the perfect flexible price setting, $\theta = 0$, above equation reproduces $P_{N,t} = \frac{\varepsilon}{\varepsilon-1} MC_t$. It can be rearranged with stationary variables,

$$\sum_{k=0}^{\infty} (\theta\beta)^k E_t \left[C_{N,t+k}{}^{-\sigma} Y_{N,t}^k \frac{\overline{P_{N,t}}}{P_{N,t+k}} \left(\frac{\overline{P_{N,t}}}{P_{N,t-1}} - \frac{\varepsilon}{\varepsilon - 1} \frac{P_{N,t+k}}{P_{N,t-1}} \frac{MC_{t+k}}{P_{N,t+k}} \right) \right] = 0 \tag{23}$$

One can now define the new price index of domestically produced goods under the staggered price setting,

$$P_{N,t} = \left[\theta P_{N,t-1}{}^{1-\varepsilon} + (1-\theta)(\overline{P_{N,t}})^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \tag{24}$$

$$\leftrightarrow \Pi_{N,t} \equiv \frac{P_{N,t}}{P_{N,t-1}} = \left[\theta + (1-\theta) \left(\frac{\overline{P_{N,t}}}{P_{N,t-1}} \right)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \tag{25}$$

3.3 Competitive Equilibrium

Remaining part of this section is describing market clearing conditions, undefined exogenous processes, and defining competitive equilibrium. First of all, the nontradable goods market clearing condition is given by

$$
\begin{aligned}
Y_{N,t} &= (1-\gamma)\left(\frac{\mathcal{E}_t}{P_{N,t}}\right)^{\gamma} C_t && (26)\\
&= A_{N,t}N_t && (27)
\end{aligned}
$$

Domestic and foreign bonds markets are cleared every period,

$$B_{H,t} = 0 \tag{28}$$

$$B_{F,t} + B^*_{F,t} = 0 \tag{29}$$

and both productions sectors has matched labor supply and demand at each term,

$$
\begin{aligned}
L_{T,t} &= N_{T,t} && (30)\\
L_{N,t} &= N_{N,t} = \int_0^1 N_{N,t}(j)dj && (31)
\end{aligned}
$$

Balance of payment constraint is calculated by

$$\gamma C_t = \left(\frac{\mathcal{E}_t}{P_{N,t}}\right)^{(1-\gamma)} (R^*_{t-1}B_{F,t-1} - B_{F,t} + Y_{T,t}) \tag{32}$$

Next, I specify two types of external shocks to the domestic economy, R^*_t and C^*_t. The foreign price changes, the other exogenous variables to the domestic market, is automatically determined by (14). The foreign interest rate shock is defined by

$$\log R^*_t = \rho_R \log R^*_{t-1} + \mu_{R,t} \tag{33}$$

where $0 \leq \rho_R < 1$ and $\mu_{R,t} \sim N(0, \sigma^2_R)$ and the foreign consumption (production) shock is defined by

$$\log C^*_t = \rho_C \log C^*_{t-1} + \mu_{C,t} \tag{34}$$

where $0 \leq \rho_C < 1$ and $\mu_{C,t} \sim N(0, \sigma_C^2)$. The reduced form of competitive equilibrium is defined by a set of endogenous variables, $\{C_t, L_{T,t}, L_{N,t}, N_{T,t}, N_{N,t}, Y_{T,t}, Y_{N,t}, B_{H,t}, B_{F,t}, MC_{N,t}\}_{t=0}^{\infty}$ with a set of prices, $\{\mathcal{E}_t, W_t, P_t, P_{N,t}, \overline{P_{N,t}}, \Pi_{N,t},\}_{t=0}^{\infty}$, and a set of exogenous variables, $\{A_{T,t}, A_{N,t}, R_t^*, C_t^*, \Pi_{N,t}^*\}_{t=0}^{\infty}$, which solves equations (9) to (12), (13), (14), (16), (18), (19), (20), (22), (24) to (32), (33) and (34).

4 Qualitative Analysis

In this section, I derive a log-linearized system of equations that characterizes the competitive equilibrium, which is reduced to several important relations such as New Keynesian Phillips Curve (NKPC) or IS relation. To solve an optimal policy problem, I derive a linear-quadratic (LQ) welfare loss function from the domestic household's utility function and the other equations. Then I derive first order conditions from the well defined Ramsey policy problem.

4.1 Log-linearized System of Equations

First of all, let us define a relative price of tradable goods price $P_{T,t}$ to the price of nontradable goods, $P_{N,t}$, by $Q_t \equiv \frac{P_{T,t}}{P_{N,t}}$. Then the CPI price index can be expressed by

$$P_t = Q_t^{\gamma} P_{N,t} \tag{35}$$

The total production of tradable and nontradable goods can be log-linearized by

$$y_{T,t} = a_{T,t} + n_{T,t} \tag{36}$$

$$y_{N,t} = a_{N,t} + n_{N,t} \tag{37}$$

where $x_t = \frac{X_t - X}{X}$ for any arbitrary endogenous variable X_t, and X means a zero inflation steady state value of X_t. The market clearing conditions of the nontradable and tradable sectors, (26) and (32), are also log-linearized to find the relationship between two outputs in the domestic country.

$$y_{T,t} = -q_t + y_{N,t} \tag{38}$$

where I use the market clearing conditions of home and foreign asset holdings and $\frac{Y_T}{(R-1)}B_F + Y_T$ approximates to unity. Next, the real marginal cost in the nontradable sector is expressed by

$$\begin{aligned}\frac{MC_{N,t}}{P_{N,t}} &= \frac{W_t}{P_{N,t}A_{N,t}} \\ &= \left(\frac{(N_{T,t}+N_{N,t})^{\phi}C_t^{\sigma}}{\bar{W}}\right)\frac{Q_t^{\gamma}}{A_{N,t}} \qquad (39)\end{aligned}$$

Combining (36), (37), (38), and (39), the log-linearized version of the real marginal cost in the nontradable sector is calculated by

$$\begin{aligned}\widehat{mc_{N,t}} &\equiv mc_{N,t} - p_{N,t} - \log\mu \\ &= \phi\gamma n_{T,t} + \phi(1-\gamma)n_{N,t} + \sigma c_t + \gamma q_t - \bar{w} - a_{N,t} \\ &= \phi\gamma y_{T,t} + (\phi(1-\gamma)+\sigma)y_{N,t} + \gamma(1-\sigma)q_N - \bar{w} - \sigma\gamma a_{T,t} - (\phi(1-\gamma)+1)a_{N,t} \\ &= (\phi+\sigma)\,y_{N,t} + \gamma(1-\sigma)(1-\phi)q_t - \bar{w} - \sigma\gamma a_{T,t} - (\phi(1-\gamma)+1)a_{N,t} \qquad (40)\end{aligned}$$

where $\mu = \frac{\varepsilon}{\varepsilon-1}$, $\bar{w} = \log\bar{W}$, and I use an estimation $\frac{N_t}{N_t+N_n} = \gamma$. The price decision equation in the nontradable sector (23) can be solve forward and log-linearized by

$$\pi_{N,t} = \kappa\widehat{mc_{N,t}} + \beta E_t\pi_{N,t+1} \qquad (41)$$

where $\kappa = \frac{(1-\theta)(1-\beta\theta)}{\theta}$. Next equations explain natural rates of three endogenous variables which will be helpful in deriving NKPC and IS relation with a "gap" variable, which is defined by $\widehat{x_t} = x_t - x_t^n$, where x_t^n is a natural rate of x_t. "Natural rate" means an equilibrium variable in an economy where no economic friction exists.

$$\begin{aligned}q_t^n &= a_{T,t} - a_{N,t} \qquad (42)\\ y_{N,t}^n &= \left(\frac{1+\gamma(1-\sigma)}{\sigma}\right)q_t^n \qquad (43)\\ y_{T,t}^n &= (1-\gamma)q_t^n \qquad (44)\end{aligned}$$

The detailed derivations are provided in the appendix. By combining (41) with (40), (42), and (43), the baseline NKPC is derived by

$$\pi_{N,t} = \kappa \left(\Omega_y \widehat{y_{N,t}} + \Omega_q \widehat{q_t} - \bar{w} - \Omega_t a_{T,t} - \Omega_n a_{N,t}\right) + \beta E_t \pi_{N,t+1} \tag{45}$$

where $\Omega_y = \phi + \sigma$, $\Omega_q = \gamma(1-\sigma)(1-\phi)$, $\Omega_t = \Omega_y \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right) - \gamma(1+\phi)$, and $\Omega_n = (\phi(1-\gamma)+1) - \gamma - \Omega_y(\frac{1-\gamma(1-\sigma)}{\sigma})$. Note that as γ goes to zero, the equation replicates a closed economy version of the NKPC. Also note that, $\bar{w}$ diminishes the trade-off between nontradable inflation and output gap stabilization as long as Ω_y is positive value, and it also softens the trade-off between nontradable inflation and the relative price changes, $\widehat{q_t}$, as long as Ω_q is positive value. Therefore, if Ω_y and Ω_q are positive, $\bar{w}$ behaves an economic volatility ameliorating role and thus the trade-off faced by a policy maker is also mitigated. The demand side of the economy can be summarized by so called IS relation, which can be started by a log-linearization of the household's Euler equations, (10) and (11), combining with (12):

$$\begin{aligned}
0 &= \log\beta + r_t - \sigma(c_{t+1} - c_t) - \pi_{t+1} \\
&= \log\beta + r_t^* + (1-\sigma\gamma)(q_{t+1} - q_t) - \sigma(y_{t+1} - y_t) \\
&= \log\beta + \sigma(y_{t+1}^* - y_t^*) + \pi_{t+1}^* + (1-\sigma\gamma)(q_{t+1} - q_t) - \sigma(y_{N,t+1} - y_{N,t}) \\
&= \log\beta + r_t - \sigma\left(1 + \frac{\gamma(1+\sigma)}{1-\sigma\gamma}\right)(\Delta y_{N,t+1}) + \frac{\sigma\gamma(1+\sigma)}{1-\sigma\gamma}(\Delta y_{t+1}^*) - \pi_{N,t+1} + \frac{\sigma\gamma}{1-\sigma\gamma}\pi_{t+1}^*
\end{aligned} \tag{46}$$

where $\Delta x_{t+1} \equiv x_{t+1} - x_t$. By combining with (42) and (43), the above equation can be expressed with "gap" variables:

$$0 = \log\beta + r_t - \Omega_{yy}(\Delta\widehat{y_{N,t+1}}) + \frac{\sigma\gamma(1+\sigma)}{1-\sigma\gamma}(\Delta y_{t+1}^*) - \pi_{N,t+1} + \frac{\sigma\gamma}{1-\sigma\gamma}\pi_{t+1}^* - \Omega_{y^*}(\Delta a_{T,t+1} - \Delta a_{N,t+1}) \tag{47}$$

where $\Omega_{yy} = \sigma\left(1 + \frac{\gamma(1+\sigma)}{1-\sigma\gamma}\right)$, $\Omega_{y^*} = \Omega_{yy}\left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)$. Note that, as tradable sector weigh parameter γ goes zero, the IS relation replicates a typical closed economy IS curve. Also note that, the output gap in nontradable sector is positively affected by the interest rate, foreign demands, but it is negatively affected by domestic inflation rate and combined negative productive shocks. The other two important equations which consist of the log-linearized equilibrium conditions are a relation between home and foreign output changes and a relation between tradable and nontradalbe output gaps.

$$\widehat{y_{N,t}} = y_t^* + \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)\widehat{q}_t - \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)(1-\gamma)(a_{T,t}-a_{N,t}) \quad (48)$$

$$\widehat{y_{T,t}} = (-\widehat{q}_t + \widehat{y_{N,t}} + \frac{1-\gamma}{\sigma}(a_{T,t}-a_{N,t})) \quad (49)$$

4.2 Linear Quadratic Welfare Loss Function

Following Benigno & Woodford (2012) and Woodford (2003), I build a linear-quadratic social welfare loss measurement. This LQ type welfare loss function has a merit in two dimensions. First, by using LQ welfare loss function, it is convenient to find a guaranteed locally maximized unique solution. Second, it is also convenient to use for comparing different types of policy tool alternatives. The welfare loss function in this economy is derived by

$$\begin{aligned}\mathbb{W} = -\frac{1}{2}\{&\pi_{N,t}^2 + \Sigma_q\widehat{q}_t^2 + \Sigma_n\widehat{y_{N,t}}^2 + \Sigma_t\widehat{y_{T,t}}^2 + (1-\gamma)\gamma\widehat{y_{N,t}}\widehat{y_{T,t}} + \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)\widehat{y_{N,t}}y_{N,t}^n \\ &+ (1-\gamma)\widehat{y_{N,t}}a_{N,t} + \gamma\widehat{y_{T,t}}a_{T,t} + 2\gamma\Sigma_q\widehat{q}_t(a_{N,t}-a_{T,t}) + \gamma\left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)\Sigma_n\widehat{y_{N,t}}(a_{N,t}-a_{T,t}) \\ &+ \gamma\left(\frac{1-\gamma}{\sigma}\right)\Sigma_t\widehat{y_{T,t}}(a_{N,t}-a_{T,t})\} + O(\parallel\xi\parallel^3) + t.i.p.\end{aligned} \quad (50)$$

where $\Sigma_n = (1-\gamma)((1-\gamma)+2)$, $\Sigma_q = \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)^2 + \gamma(1-\gamma)$, $\Sigma_t = \gamma(\gamma+2)$, $O(\parallel\xi\parallel^3)$ denotes terms that are of order higher than third, in the bound $\parallel\xi\parallel$ on the magnitude of the relevant shocks, and $t.i.p.$ represents terms independent of policy variables. A detailed derivation is given in the appendix. Note that every coefficient on each part of (50) is positive, and thus the social welfare loss is increased by increasing variance or covariance of the policy variables.

4.3 Ramsey Policy Problem

A Ramsey policy problem is defined by a maximization of the welfare loss function, (50), with respect to the policy variables $\{\pi_{N,t}, \widehat{q}_t, \widehat{y_{N,t}}, \widehat{y_{T,t}}, r_t\}$, subject to the NKPC, (45), IS relation, (47), and two other relations, (48) and (49). Lagrangian equation for the policy problem is given by

$$\begin{aligned}\mathcal{L}_t &= \Sigma_{t=0}^{\infty}\beta^t[\mathbb{W} + \chi_{1,t}\left[\kappa\left(\Omega_y\widehat{y_{N,t}} + \Omega_q\widehat{q}_t - \bar{w} - \Omega_t a_{T,t} - \Omega_n a_{N,t}\right) + \beta E_t\pi_{N,t+1} - \pi_{N,t}\right] \\ &+ \chi_{2,t}\left[\log\beta + r_t - \Omega_{yy}(\Delta\widehat{y_{N,t+1}}) + \frac{\sigma\gamma(1+\sigma)}{1-\sigma\gamma}(\Delta y^*_{t+1}) - \pi_{N,t+1} + \frac{\sigma\gamma}{1-\sigma\gamma}\pi^*_{t+1} - \Omega_{y^*}(\Delta a_{T,t+1} - \Delta a_{N,t+1})\right] \\ &+ \chi_{3,t}\left[y^*_t + \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)\widehat{q}_t - \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)(1-\gamma)(a_{T,t} - a_{N,t}) - \widehat{y_{N,t}}\right] \\ &+ \chi_{4,t}\left[(-\widehat{q}_t + \widehat{y_{N,t}} + \frac{1-\gamma}{\sigma}(a_{T,t} - a_{N,t})) - \widehat{y_{T,t}}\right]]\end{aligned} \tag{51}$$

where $\chi_{1,t}$, $\chi_{2,t}$, $\chi_{3,t}$ and $\chi_{4,t}$ are the shadow prices for NKPC, IS relation, the foreign-home outputs relation, and tradable-nontradable outputs relation, respectively. The first order conditions of the Ramsey policy problem is derived by

$$-\pi_{N,t} - \chi_{1,t} + \beta\chi_{1,t+1} - \chi_{2,t} = 0 \tag{52}$$

$$\Sigma_t\widehat{y_{T,t}} - \frac{\gamma(1-\gamma)}{2}\widehat{y_{N,t}} - \frac{\gamma}{2}a_{T,t} - (\frac{1-\gamma}{\sigma})\Sigma_t(a_{N,t} - a_{T,t}) - \chi_{4,t} = 0 \tag{53}$$

$$-\Sigma_q\widehat{q}_t\gamma\Sigma_q(a_{N,t} - a_{T,t}) + \kappa\Omega_q\chi_{1,t} + \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)\chi_{3,t} - \chi_{4,t} = 0 \tag{54}$$

$$\chi_{2,t} = 0 \tag{55}$$

$$\begin{aligned}&-\Sigma_n\widehat{y_{N,t}} - \frac{(1-\gamma)\gamma}{2}\widehat{y_{T,t}} - \frac{1}{2}\left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)y^*_t - \frac{(1-\gamma)}{2}a_{N,t} - \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right)\Sigma_n(a_{N,t} - a_{T,t}) \\ &+ \kappa\Omega_y + \sigma\left(1 + \frac{\gamma(1+\sigma)}{1-\sigma\gamma}\right)\chi_{2,t} - \beta\sigma\left(1 + \frac{\gamma(1+\sigma)}{1-\sigma\gamma}\right)\chi_{2,t+1} - \chi_{3,t} + \chi_{4,5} = 0\end{aligned} \tag{56}$$

(45), (47), (48), (49), and (52) to (56) consist of the complete system of equations of the Ramsey policy problem.

5 Quantitative Analysis

In this section, I observe impulse responses of some important macroeconomic variables at the competitive equilibrium to the previously defined exogenous shocks. The purpose of this work is that, by changing the binding minimum wage in the model, one can clearly and numerically observe how the transmission of the external shock is varied. In the model, the baseline value of the minimum wage is 1, which means that the minimum wage does not increase or decrease the wage level paid to the consumers. If the minimum wage level is 1.1, the overall wage level is increased by 10%. If the minimum wage level is set to be 0.9, the overall wage level is decreased by 10%. Therefore, by controlling the minimum wage level, the government can directly change the overall wage level finally paid to the domestic consumers.

5.1 Parameterization

Table 1 shows the list of baseline parameter values. Time discounting factor is set to be 0.99 as normal in the literature, elasticity of labor supply and intertemporal elasticity of substitution in composite consumption are set to be unity and two, respectively, by following Demirel (2010). I also follow the same paper to set the share of tradable goods in composite consumption to be 0.45. Price stickiness parameter θ is set to be 0.66. There are two types of domestic productivity shocks, and they are separately defined. I follow Demirel (2010) to define the specifications of the both productivity shocks in different sectors. I follow Galí (2008) and Galí & Monacelli (2005) to define two international dimensions of shocks, foreign interest rate shocks and foreign demand shocks.

5.2 Role of Minimum Wage on Business Cycles

Figure 4 shows the changes in standard deviations of the key variables as the value of $\bar{w}$ changes from 0.5 to 1.5. The benchmark value of $\bar{w}$ is set to be unity. If $\bar{w}$ is 1.1, the wage is increased by 10% by the minimum wage increment forced by the government. Figure 4 clearly shows that, for all five variables, economic volatility is decreased by the increasing real wage, supported by the minimum wage raises. CPI inflation rate and the output gap in tradable sector show a relatively higher volatility which is reasonable since the observed result is gathered from the exogenous foreign output (demand) shock, and thus the terms including tradable goods react more sensitively. Figure 5 shows the impulse responses of key macroeconomic variables to the 1% foreign negative demand shock. These five graphs also support the argument that the increasing minimum wage can reduce the volatility of the economy when sudden decrease in foreign demand for the domestic tradable goods. It is interesting to see that when minimum wage is increased by 50%, the relative price of tradable sector to the one of nontradable sector positively reacts to the negative shock while the nontradable sector is decreased. CPI inflation still negatively reacts to the shock, but the volatility is much reduced in the case of positive minimum wage increasing.

6 Conclusion

This paper investigates the role of change in real wages on the economic dynamics and optimal policy decision making where a portion of the wage structure is forced to operated manually by a government. This model structure is designed to illustrate the effect of a fixed level of minimum wage on the overall wage level and the marginal cost that permanently change the reaction of the economy to the unexpected external foreign demand changes. Increasing minimum wage reduces the real marginal cost by amount of changes in the overall wage increment, and thus it ameliorates the trade-off between output gap and inflation stabilization faced by a policy maker. This alleviated trade-off problem can lower the level of volatilities in key macroeconomic variables in the Ramsey policy equilibrium. Economic intuition of this simulation result is that, the increasing minimum wage can preserve a certain (more) amount of real purchasing power of the domestic agents even if the public support is governed by a lump sum taxation, and this increasing purchasing power enables the domestic economy to persist with the original pattern of economic activities more consistently.

There are several significant limitation in this paper. First, wage structure should be considered more seriously. It must show the effect of the minimum wage on the overall wage level and the marginal cost structure more clearly, and it also must explain more clearly about the role of the minimum wage on the business cycles. Second, staggered wage assumption would be helpful to explain the puzzled part of the paper. In many developing countries, a nominal wage rigidity has been found as a major economic characteristics and this phenomenon could help the role of minimum wage in a clearer view.

A Derivation of Natural Rates of q_t, $y_{N,t}$, $y_{T,t}$

A "natural" variable is defined by a variable at a state where no friction exists in the economy. In the case of this paper, since the only economic friction is a price rigidity in the nontradable sector, the fully flexible prices in both sectors are assumed to derive natural rates of log-linearized version of key variables. First of all, in the frictionless economy, the marginal cost of firm j in the nontradable sector equals to the price of a perfectly competitive sector:

$$MC_{N,t}(j) = P_{N,t} = \frac{W_t}{A_{N,t}}$$

The price of the tradable sector is the same in the previous sector:

$$P_{T,t} = \frac{W_t}{A_{T,t}} = \mathcal{E}_t$$

Equalizing the above two equations, a natural rate of the relative price of tradable goods to the nontradable goods is derived by

$$Q_t^n = \frac{P_{T,t}}{P_{N,t}} = \frac{A_{T,t}}{A_{N,t}} \tag{57}$$

Log-linearizing (57) gives a natural rate of q_t:

$$q_t^n = a_{T,t} - a_{N,t} \tag{58}$$

Next, combining (11) and (12), and substituting (57) into it, a natural rate of private consumption has a relation with foreign consumption and the relative price:

$$C_t^n = \xi C_t^* (Q_t^n)^{\frac{1-\gamma}{\sigma}} \tag{59}$$

Log-linearizing (59) gives

$$c_t^n = y_t^* + (\frac{1-\gamma}{\sigma}) q_t^n \tag{60}$$

Log-linearizing the nontradable goods market clearing condition (26) and combining it with (60) gives a natural rate of $y_{N,t}$:

$$\begin{aligned} y^n_{N,t} &= \gamma q^n_t + c^n_t \\ &= \gamma q^n_t + \left(\frac{1-\gamma}{\sigma}\right) q^n_t \\ &= \left(\frac{1-\gamma(1-\sigma)}{\sigma}\right) q^n_t \end{aligned} \tag{61}$$

Latly, the market clearing condition (32) and substituting (29), (60), and (61) into it gives a natural rate of $y_{T,t}$:

$$\begin{aligned} y^n_{T,t} &= (-q^n_t + y_{N,t}) \\ &= (1-\gamma) q^n_t \end{aligned} \tag{62}$$

B Derivation of Linear-Quadratic Welfare Loss Fuction $\mathbb{W}$

In this appendix, I derive a linear-quadratic welfare loss function by doing a second-order approximation to the representative home consumer's utility function and the other important equations. This loss function is used as an objective function in the Ramsey policy problem in section 4. To begin with, I use the following simple rule in this entire appendix:

$$\frac{X_t - X}{X} \simeq x_t + \frac{1}{2} x^2_t + O(\parallel \xi \parallel^3) \tag{63}$$

It is also useful to know the following knowledge:

$$\sigma = -\frac{U_{CC}}{U_C} C \tag{64}$$

$$\phi = \frac{U_{LL}}{U_L} L \tag{65}$$

where $U_X \equiv \frac{\partial U(.)}{\partial X}$ and $U_{XX} \equiv \frac{\partial^2 U(.)}{\partial X^2}$ for any arbitrary variable X. The domestic consumer's utility function is approximated by

$$\frac{U_C - U}{U_{CC}} = \left(c_t + l_{N,t} + l_{T,t} + \frac{1}{2}(1-\sigma)c_t^2 + \frac{1}{2}(1+\phi)(l_{N,t} + l_{T,t})^2 \right) \tag{66}$$

To eliminate the first-order terms in (66), I use the following identities:

$$c_t + \frac{1}{2}c_t^2 = y_{N,t} + \frac{1}{2}y_{N,t}^2 - \gamma(q_t + \frac{1}{2}q_t^2) \tag{67}$$

$$l_t = (1-\gamma)y_{N,t} + \gamma y_{T,t} - \frac{1}{2}l_t^2 + (\frac{\gamma}{2})y_{T,t}^2 + (\frac{1-\gamma}{2})y_{N,t}^2 - (1-\gamma)y_{N,t}a_{N,t} - \gamma y_{T,t}a_{T,t} \tag{68}$$

Substituting (67) and (68) into (66) gives an identical equation with (50).

References

Benassy, J.-P. (1995). Money and wage contracts in an optimizing model of the business cycle. *Journal of Monetary Economics*, *35*, 303–315.

Benigno, P. & Woodford, M. (2012). Linear-quadratic approximation of optimal policy problems. *Journal of Economic Theory*, *147*, 1–42.

Braggion, F., Christiano, L. J., & Roldos, J. (2009). Optimal monetary policy in a 'sudden stop'. *Journal of Monetary Economics*, *56*, 582–595.

Caballero, R. & Krishnamurthy, A. (2004a). Exchange rate volatility and the credit channel in emerging markets: A vertical perspective. Working Paper 10517, National Bureau of Economic Research.

Caballero, R. J. & Krishnamurthy, A. (2004b). *Inflation Targeting and Sudden Stops*, chapter 10, (pp. 423–445). The Inflation-Targeting Debate. University of Chicago Press.

Cahuc, P. & Michel, P. (1996). Minimum wage unemployment and growth. *European Economic Review*, *40*, 1463–1482.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, *12*, 383–398.

Calvo, G. A. (2002). On dollarization. *Economics of Transition*, *10*(2), 393–403.

Calvo, G. A. (2003). Explaining sudden stops, growth collapse and BOP crises: The case of distortionary output taxes. *NBER Working Paper Series*, *9864*, 1–35.

Calvo, G. A. (2006). Monetary policy challenges in emerging markets: Sudden stop, liability dollarization, and lender of last resort. *NBER Working Paper Series*, *12788*, 1–29.

Calvo, G. A., Izquierdo, A., & Loo-Kung, R. (2006). Relative price volatility under sudden stops: The relevance of balance sheet effects. *Journal of International Economics*, *69*, 231–254.

Calvo, G. A. & Reinhart, C. M. (1999). When capital inflows come to a sudden stop: Consequences and policy options. Mimeo.

Cavallo, E. A. & Frankel, J. A. (2008). Does openness to trade make countries more vulnerable to sudden stops, or less? using gravity to establish causality. *Journal of International Money and Finance*, *27*, 1430–1452.

Chue, T. K. & Cook, D. (2008). Sudden stops and liability dollarization: Evidence from asia's financial intermediaries. *Pacific-Basin Finance Journal*, *16*, 436–452.

Demirel, U. D. (2010). Macroeconomic stabilization in developing economies: Are potimal policies procyclical? *European Economic Review*, *54*, 409–428.

Flug, K. & Galor, O. (1986). Minimum wage in a general equilibrium model of international trade and human capital. *International Economic Review*, *27*(1), 149–164.

Gali, J. (1996). Unemployment in dynamic general equilibrium economies. *European Economic Review*, *40), pages = 839–845*.

Galí, J. (2008). *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework*. Princeton University Press.

Galí, J. & Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *Review of Economic Studies*, *72*, 707–734.

Joyce, J. P. & Nabar, M. (2009). Sudden stops, banking crises and investment collapses in emerging markets. *Journal of Development Economics*, *90*, 314–322.

Kehoe, T. J. & Ruhl, K. J. (2009). Sudden stops, sectoral reallocations, and the real exchange rate. *Journal of Development Economics*, *89*, 235–249.

Mendoza, E. G. & Smith, K. A. (2006). Quantitative implications of a debt-deflation theory of sudden stops and asset prices. *Journal of International Economics*, *70*, 82–114.

Rothenberg, A. D. & Warnock, F. E. (2011). Sudden flight and true sudden stops. *Review of International Economics*, *19*(3), 509–524.

Woodford, M. (2003). *Interest and Prices*. Princeton University Press.

Yun, T. (1996). Nominal price rigidity, money supply endogeneity, and business cycles. *Journal of Monetary Economics*, *37*, 345–370.

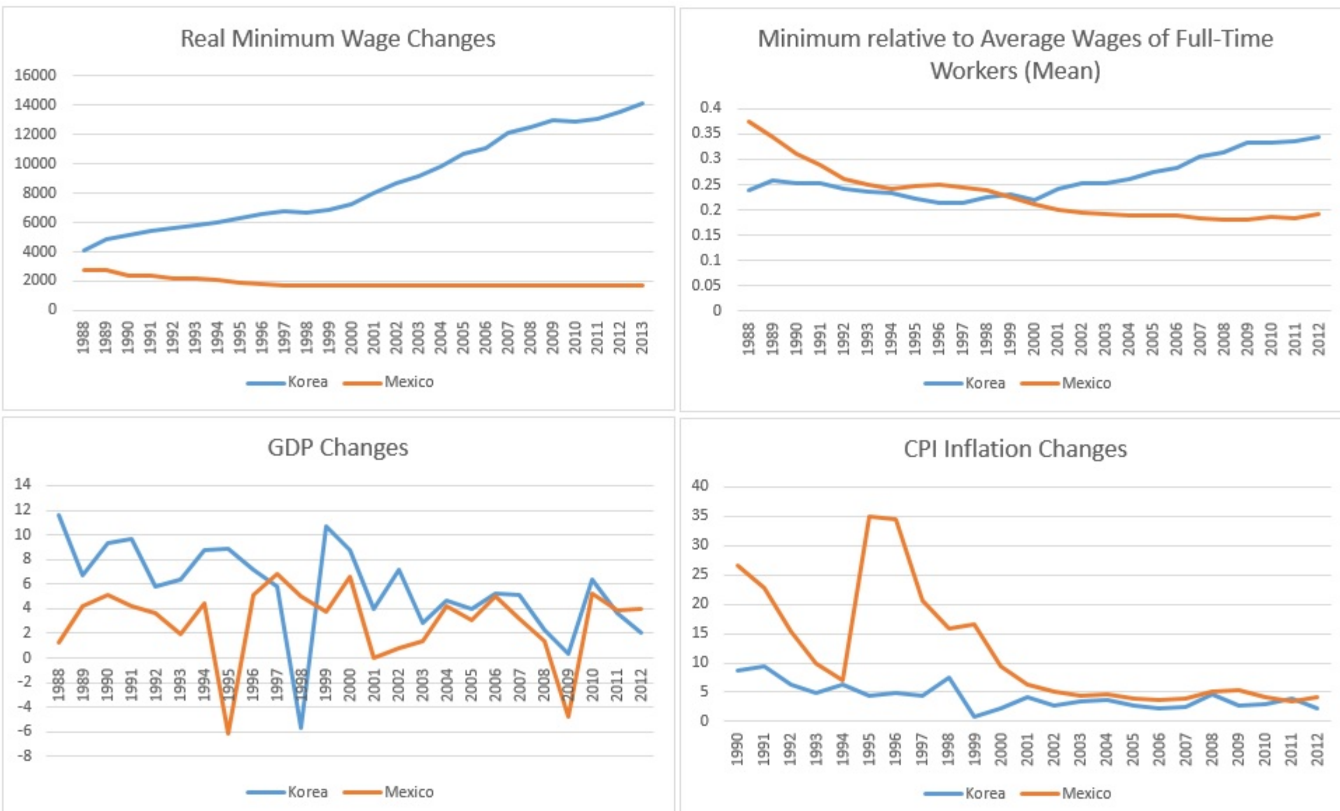

Figure 1: Statistical Comparison between South Korea and Mexico during the Different Time of Crisis

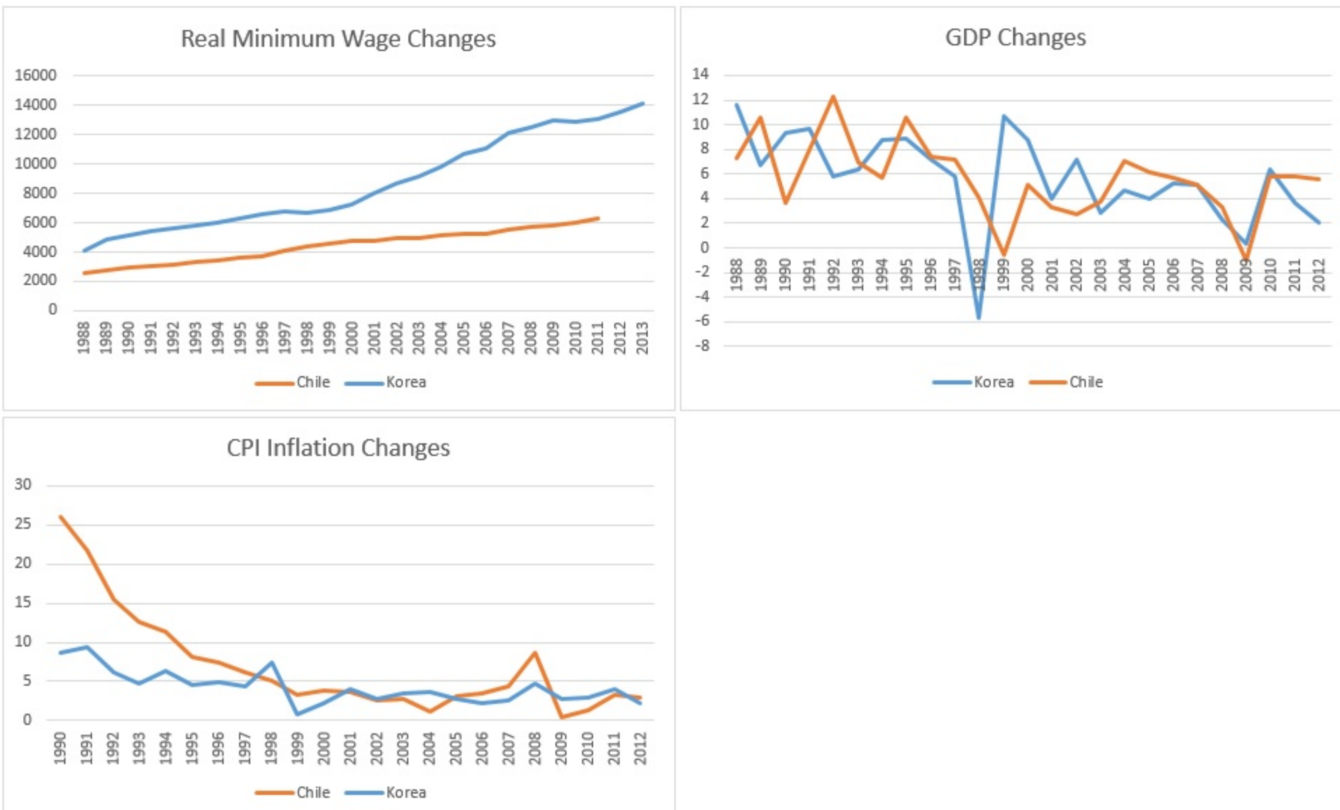

Figure 2: Statistical Comparison between South Korea and Chile during the Different Time of Crisis

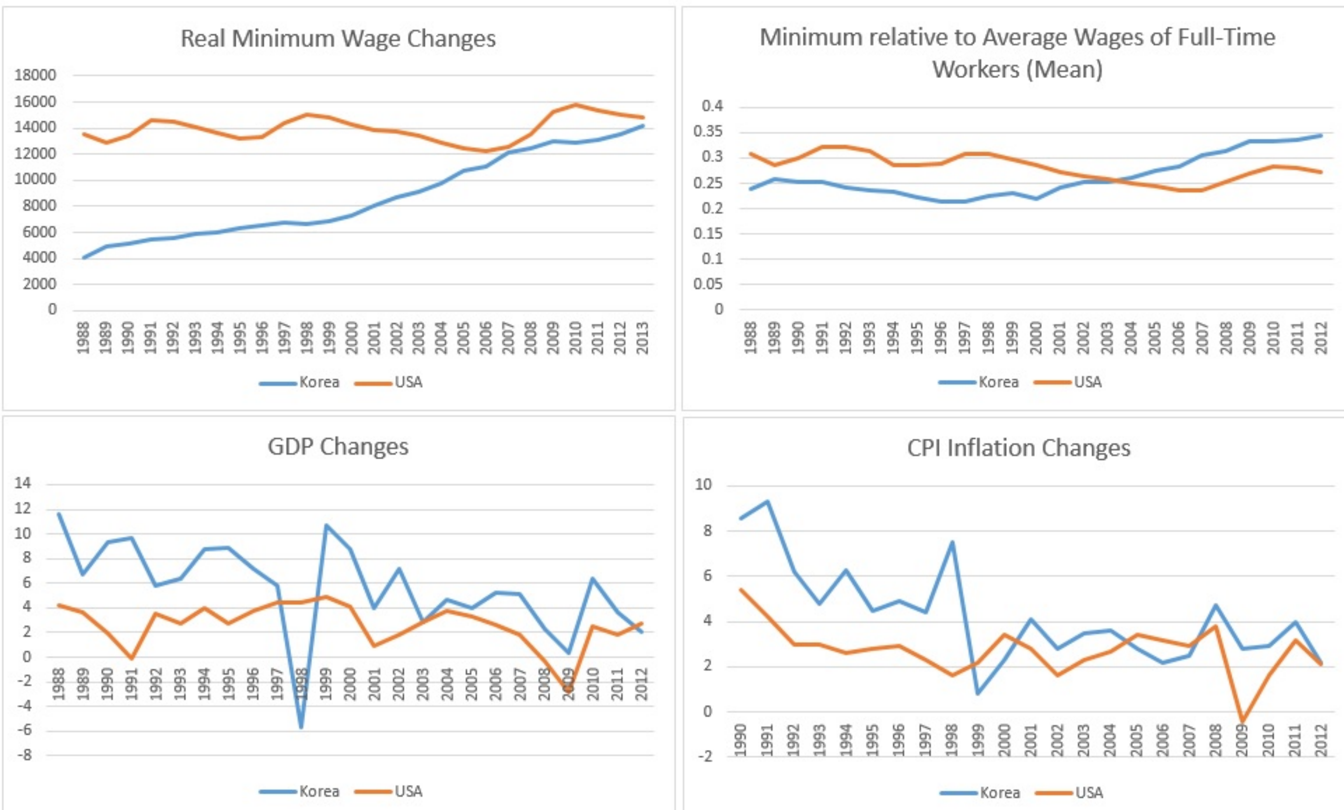

Figure 3: Statistical Comparison between South Korea and US

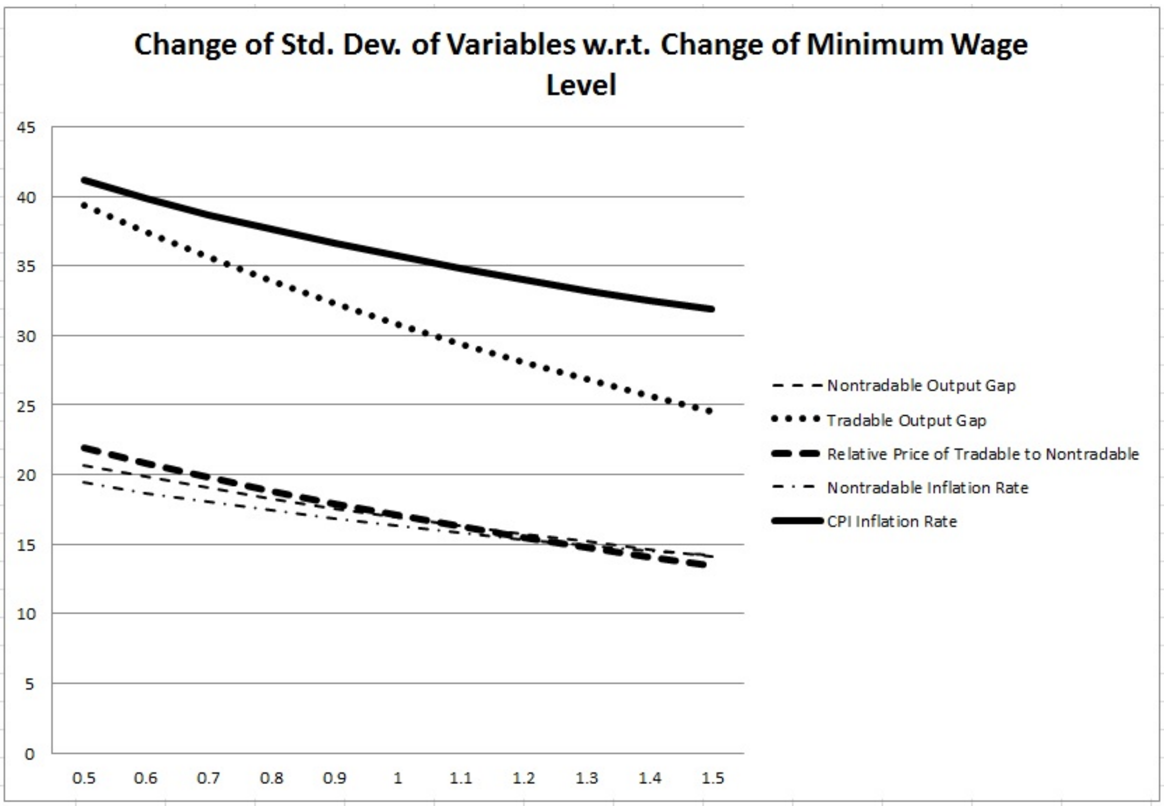

Figure 4: Changes in Standard Deviations of Key Variables with respect to the Change in $\bar{w}$

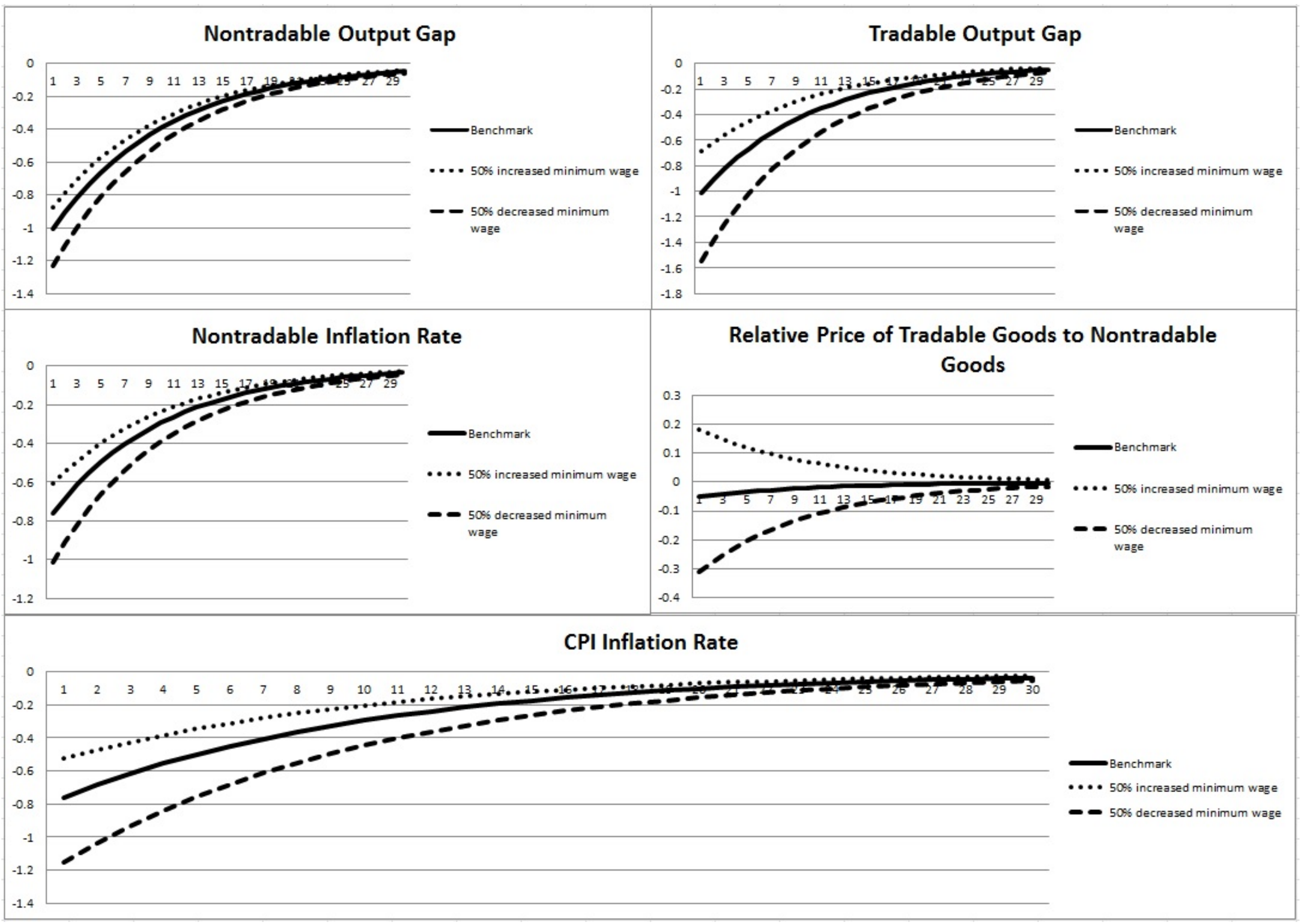

Figure 5: Impulse Responses of Key Variables to Foreign Demand Shock

Table 1: Baseline Parameter Values

Symbol	Name	Estimated Value
ϕ	Reverse of Elasticity of Labor Supply	1
σ	Intertemporal Elasticity of Substitution in Private Consumption	2
γ	Share of Tradable Goods in Composite Consumption	0.45
β	Time Discounting Factor	0.99
θ	Degree of Price Stickiness	0.66
ρ_T	Autoregressive Parameter of Domestic Tradable Sector Productivity Shock	0.69
ρ_N	Autoregressive Parameter of Domestic Nontradable Sector Productivity Shock	0.94
ρ_R	Autoregressive Parameter of Foreign Interest Rate Shock	0.9
ρ_C	Autoregressive Parameter of Foreign Demand Shock	0.86
σ_T	Standard Deviation of Domestic Tradable Sector Shock	0.071
σ_N	Standard Deviation of Domestic Nontradable Shock	0.039
σ_R	Standard Deviation of Foreign Interest Rate Shock	0.007
σ_C	Standard Deviation of Foreign Demand Shock	0.007