RESEARCH ARTICLE

Inflation and Public Debt Dynamics in ASEAN

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Abstract: This paper studies how inflation affects the debt dynamics focusing on six ASEAN countries: Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. Using projection data, we perform simulations of debt dynamics under various inflation policies. It results that Vietnam has the highest ability of inflating debt, while the Philippines is lastly ranked. Moreover, the optimal inflation rate for each member country and also the common policy rate for ASEAN integration are calculated under additional debt management motive. We found that if the ASEAN happened to use the common inflation policy rate, Malaysia and the Philippines would not be much affected as their individual optimal rates are close to the common rate, while Indonesia and Singapore would suffer from withstanding the common inflation rate far from their own optimal levels.

Keywords Public debt, Inflation, Optimal monetary policy, Integration.

JEL Classification: C32, C63, E31, E52, F02, H63

This paper studies the inflation-debt dynamics with the focus on ASEAN countries. We aim to explain theoretically and numerically the exact mechanism for inflation to reduce public debt. Moreover, with additional regard in debt management, we want to specifically calculate the debt dynamics, optimal individual inflation policy, and most importantly the optimal common inflation policy rate of ASEAN integration, if there will be any, to see who will gain and lose.

In the early 21st century, sovereign debt and inflation issues caught the substantial attention of economists. The subprime crisis of the US led to an enormous quantitative easing (QE) policy with the aim to inflate the economy to cause the dollar to depreciate and boost up GDP. Later on, the groundbreaking debt crisis occurred in many countries in the eurozone. Greece has accumulated debt to the level that exceeds the credible debt ceiling. Consequently, the Greek debt crisis burst out. This crisis signaled to the entire world that one cannot be careless about fiscal sustainability. This crisis affected the eurozone greatly and eventually ended up with another enormous QE policy. Inflating an economy to lessen the debt problem is not theoretically new. However, debt management is not in a mandate of the central bank in conducting monetary policy. This paper brings the debt management into the picture.

This paper simulates the debt dynamics of each ASEAN country given various degrees of Fisher's effect. We highlight the new role of the central bank over the public debt management, which becomes more evident in both advanced and emerging economies. At the end of the year 2015, the ASEAN Economic Community was established. To avoid the history of the EU repeating in the ASEAN, we study carefully through policy simulation for the optimal inflation rate in terms of individual countries and overall the ASEAN. As a result, we find that Malaysia and the Philippines gain the most benefit from the regional

integration while Indonesia and Singapore relatively suffer in terms of losing monetary authority.

One of our main contributions is to propose the methodology to endogenously calculate the implicit desirable debt level in the debt-augmented loss function. We assume that the central bank simultaneously chooses this desirable debt level to minimize its loss function. Hence, we can recover the desirable debt level from the first-order condition with respect to the desirable debt level itself. This method proves to give more plausible value of optimal inflation rates than simply using the averaged-debt-level proxy.

The paper is organized as follows. Section 2 reviews the related literature. Section 3 discusses the theoretical relationship between inflation and debt as well as the determination of optimal inflation target. Section 4 provides the empirical results of the relationship between public debt and monetary policy in ASEAN. Section 5 presents simulation results and the optimal inflation policy rate for each individual country and ASEAN monetary integration. Section 6 concludes the paper.

Review of Literature

The literature on the relationship between sovereign debt, inflation, monetary integration, and optimal monetary policy is substantial. Cherif and Hasanov (2012) have shown that US debt dynamics react to shocks in inflation only temporarily. Moreover, the austerity shock reduces debt accumulation only in a short period of time especially with a weak economic environment. Chudik, Mohaddes, Pesaran, and Raissi (2013) have found that debt and inflation have a negative effect on economic growth. However, if the change in debt is temporary, there is no long-term effect on growth. Elisa, Albert, Rigas, and Andrew (2013) have used the dynamic stochastic general equilibrium model under different economic environments to examine how debt and debt maturity affect inflation. Krause and Moyen (2013) have simulated the calibrated model of US economy during the crisis and found that a temporary increase in inflation target has a minor effect on real public debt. Aguiar, Amador, Farhi, and Gopinath (2014) have argued that by backward induction, creditors charge different levels of interest rate based on difference ex-post incentive of debtors to inflate debt away. Thereby, an impatient economy,

which would like to accumulate more debt, has the other incentive to reduce debt level to gain more inflation credibility and then bear less interest rate cost.

Mason and Jayadev (2014) have investigated US data and found that household debt is negatively related to inflation and output growth, while it is positively related to nominal interest rate. Thereby, the result confirms the seigniorage effect and interest rate effect in the present paper. Hilscher and Raviv (2014) have tested the significance of seigniorage effect in the US economy and found that the effect is modest. On the other hand, the more promising tool to inflate away public debt is financial repression.

Akitoby, Komatsuzaki, and Binder (2014) have studied the inflation-debt dynamics in G7 countries by simulating the dynamic of public debt-to-GDP through detailed debt dynamic equation using the projection data. They emphasized the importance of decomposing of public debt according to its maturity and currency-denomination and of specifying the degree of Fisher's effect. The first part of our paper follows their methodology. Goodhart and Lim (2011) have suggested the best methodology to forecast interest rate using US, New Zealand, and UK data. We use their methodology to obtain projection of interest rate. Ueda and Valencia (2014) have theoretically studied the uses of macroprudential regulation, which cannot be adjusted according to shock, and monetary policy, which has a time-inconsistency problem. Given the ex-ante optimal policy, the central bank has incentive to further inflate the economy ex-post to improve the private balance sheet. Mandilaras and Levine (2001) have extended the model of Missale and Blanchard (1994) and have shown that due to the time-inconsistency problem, it is not possible to have inflation and the structure of debt that maintain tax-smoothing ex-ante and ex post, over time and across states of nature. Again, the debt-augmented loss function is similar to the one of Ueda and Valencia (2014). This debt-augmented loss function is then used in our paper to analyze the optimal common inflation rate policy in the ASEAN.

Do the central banks of emerging countries like those in the ASEAN really care about debt management? According to the Bank for International Settlement (2012), the problem of fiscal dominance has recently been alleviated among emerging economies, unlike many of advanced economies. Since 2000, most emerging economies have improved their fiscal

disciplines toward a more balanced budget. This results in the public debt-to-GDP ratio level, which does not constrain the conduct of central banks' monetary policies. In the ASEAN, the debt-to-GDP ratio accumulation is evidently slowed down as compared to what happened in the late 1900s.

However, BIS (2012) also highlighted the new role of the central bank over public debt management, which becomes more evident in both advanced and emerging economies. Many central banks around the world have become more active domestic debt issuers compared to governments. There are various objectives such as to keep the interest rate costs and refinancing risks at the minimum, to ensure the sufficient supply of risk-free assets, and to gain more control over the long-term interest rate or exchange rate. Mostly, the intervention of central banks so far has focused on restructuring public debt.

In African economies where governments have limited resources to finance their budget deficit, the issue on seigniorage is well established. Veiga, Ferreira-Lopes, and Sequeira (2015) have investigated 52 African economies and found that public debt affects economic growth in an inverted U-shaped relationship. Moreover, the higher debt leads to higher inflation.

In the ASEAN, the averaged debt-to-GDP ratio is about 44%, which is indeed relatively low compared to the world's standard. Yet, Ferrarini, Jha, and Ramayandi (2012) have compared the evolution of debt-to-GDP ratio of each region in Asia from 1994 to 2010. They found that, apart from the South Asian region, which initially possesses a high level of debt, the ASEAN debt-to-GDP ratio has grown about 5% over 1997–2015, which is relatively fast and eventually surpasses other regions. This may somewhat bring the public debt tension toward the region.

Bhattachaya (2014) has empirically investigated inflation determinants of Vietnam, where the central bank's mandate does not clearly focus on price stability. As a result, key drivers are the movement in the nominal effective exchange rate and the credit growth. However, interest rates in Vietnam do not seem to have a significant impact on headline inflation.

Although there is no explicit evidence in the related literature that the central bank intends to inflate the public debt away, the central bank's objective on debt management becomes more convincing. Hence, our counterfactual analysis on optimal unified monetary policy under debt management objective would shed a new light of understanding over the ongoing ASEAN integration.

Theoretical revision

Debt Dynamic Equation

The relationship between inflation and debt is simply through seigniorage, that is, printing more money in order to raise the inflation tax income to repay the real value of debt. This "debt-erosion channel" is theoretically well understood through the standard debt dynamics equation. Following Akitoby, Komatsuzaki, and Binder (2014), we consider the economy that is in the neighborhood of steady state where the real money balance is assumed to be constant and thereby the seigniorage revenue depends solely on inflation rate. The debt dynamics equation is given below[1]:

$$b_t = -pb_t + b_{t-1}^{ST} \frac{(1+r_t^{ST})(1+\pi_t^{base}+\alpha\pi_t^{sur})}{(1+g_t)(1+\pi_t^{base}+\pi_t^{sur})} \quad (1)$$

$$+b_{t-1}^{LT,old} \frac{1+i_t^{imp}}{(1+g_t)(1+\pi_t^{base}+\pi_t^{sur})} + b_{t-1}^{LT,new} \frac{1+i_t^{imp}+\alpha\pi_t^{sur}}{(1+g_t)(1+\pi_t^{base}+\pi_t^{sur})}$$

where b is real debt-to-GDP ratio, pb is real primary balance, b^{ST} is short-term real debt-to-GDP ratio, $b^{LT,old}$ is long-term previously issued real debt-to-GDP ratio, $b^{LT,new}$ is long-term newly issued real debt-to-GDP ratio, r^{ST} is short-term real interest rate, π^{base} is baseline inflation (inflation target), π^{sur} is inflation shock (surprise inflation), g is real output growth, and i^{imp} is the implied nominal interest rate on long-term debt. Notably, (1) has already incorporated a general partial Fisher effect where 1% increase in inflation rate leads to α percent increase in nominal interest rate where $\alpha \in [0,1]$. Additionally, π_t is denoted as a prevailing inflation rate where $\pi_t = \pi^{base} + \pi_t^{sur}$.

How inflation policy can affect public debt is the main concern of this paper. It is important to highlight that change in inflation target (change in baseline inflation) cannot affect public debt dynamic. This is because the inflation targeting policy announces the target rate in advance for the economy to form the expected inflation rate, which in turn determines the nominal interest rate. Given $\pi_t^{sur} = 0$, (1) implies that an increase in π_t^{base} would be offset by an increase in i_t^{imp}, so b_t is unchanged.

Therefore, the only channel for the inflation rate to affect public debt is through inflation shock (π_t^{sur}). That is, given π_t^{base}, unanticipated action from the central bank results in π_t^{sur} which determines π_t- the prevailing inflation rate. Rewriting (1) gives

$$b_t = C_t + (SE_t - IE_t)/(1 + \pi_t) \qquad 2$$

where

$$C_t = -pb_t + \frac{\alpha}{(1+g_t)}\left[b_{t-1}^{ST}(1 + r_t^{ST}) + b_{t-1}^{LT,new}\right], \; IE_t = \frac{\alpha b_{t-1}^{LT,new}\pi_t^{base}}{1+g_t}$$

$$SE_t = \frac{(1-\alpha)b_{t-1}^{ST}(1+r_t^{ST})(1+\pi_t^{base})+b_{t-1}^{LT,old}\left(1+i_t^{imp}\right)+b_{t-1}^{LT,new}\left[(1-\alpha)+i_t^{imp}\right]}{1+g_t}.$$

According to (2), an increase in inflation rate (π_t) has two effects on public debt. First, it helps reduce the real interest rate of all debts for any given nominal interest rate. This is evident especially in the case of long-term previously issued debt of which nominal interest rate is fixed by the past contract. The debt is repaid by inflationary tax income, which is earned from seigniorage. That is, higher inflation is negatively related to debt. We refer to this effect as the seigniorage effect. Second, inflation at the same time, however, directly raises the cost of long-term newly issued debt. In particular, creditors recognize the current inflation shock and hence increase nominal interest rate instantaneously. In this regard, higher inflation is positively related to debt. We refer to this effect as the interest rate effect. Notably, the seigniorage effect tends to dominate the interest rate effect, especially when is low. In fact, as will be shown in the simulation section later, the seigniorage effect totally dominates in all cases.

Optimal Inflation Rate Policy

What level of inflation rate is desirable is a crucial question to policymakers. The literature on optimal monetary policy is substantially vast and well developed. For this paper, we investigate this issue specifically with the main focus on the public debt aspect.

Our idea is that the announced inflation target (π_t^{base}) is conventionally determined by the loss function trading off between output and inflation rate.[2] Once the target is determined, the central bank is always tempted to break a promise traditionally due to the desire to boost the output level in the short-term. This is a well-established time-inconsistency argument. Now, we assume that the central bank has the other hidden agenda for breaking the promise: managing public debt level. There are many reasons why the central bank wants to do so; for example, public debt management is not in the standard mandate of the central bank, the central bank may try to avoid any controversy about why the current generation should be levied inflation tax to pay for accumulated debt from previous generations, and so forth. From this point, we proceed in two methodologies: debt minimization and loss-function minimization.

Firstly, we assume that the central bank inconsistently cares solely on debt level given the announced inflation target. From (2), in each period, the central bank is tempted by the seigniorage effect to inflate (or deflate) the economy apart from the announced target. However, the seigniorage effect may not always dominate. The existence of the interest rate effect creates the possibility to have the debt-minimizing inflation rate. Notably, this methodology is not so rigorous and only aims to highlight the seigniorage effect and interest rate effect over public debt in inflating the economy.

The more rigorous methodology is for the central bank to minimize the new loss function, which now includes the debt element. Following Ueda and Valencia (2014), the new loss function is as follows:

$$L = (\bar{y} + \mu\delta - y^*)^2 + a(\pi - \pi^*)^2 + b(\bar{b} + \delta - b^*)^2$$

where y is output, δ is the rate of change in the stock of debt, the barred variable is denoted as the level that would prevail in the absence of debt distortions, the starred variable is denoted as the socially optimal levels of each variable, and μ, a, $b > 0$ is arbitrarily constant.

Since the output and debt elements are both positively related only to and our focus is on the linkage between debt and inflation, apart from Ueda and Valencia (2014), we modify the above loss function by assuming away the output element because our focus is on the linkage between debt and inflation. Using such simplification, we trade off the theoretical accuracy with the reduction in a number of unknown variables such as $\bar{y}$ and y^*. This is beneficial in our policy simulation later on. Since the output and debt elements are both positively related only to δ, one may equivalently say that we assume $\mu \to 0$. The modified loss function is given below:

$$\tilde{L} = (\pi - \pi^*)^2 + \gamma(\bar{b} + \delta - b^*)^2 \qquad\qquad 3$$

where $\gamma > 0$ is a constant weight of debt element in relation to inflation.

The Relationship Between Inflation and Public Debt in the ASEAN

Regarding our methodology to analyze the inflation policy of the ASEAN, we choose to extend the classic loss function minimization subject to the aggregate supply function of Kydland and Prescott (1977) by embedding the debt dynamic equation into the model, though we assume that output is at the full potential level. The model is indeed not micro-founded and lacks the general equilibrium structure especially over the demand side. Moreover, the analysis emphasizes inflation-debt interaction and abstracts away the endogenous fiscal policy, which is already substantially studied in the literature (see Gervais & Mennuni, 2015, and Jorda & Taylor, 2016). These are limitations of the model that can be the task for the future research.[3]

However, our methodology is still solid among the existing alternatives in the literature. For example, Pesaran, Smith, and Smith (2007) construct the global vector-autoregressive model to analyze the effect of common monetary policy in the hypothetical event of Britain joining the eurozone. In details, they use the historical data to create the interaction between macroeconomic variables of each country and forecasts based on such interaction but given the restriction of common nominal exchange rate and common interest rate. This characteristic of the model where the change in policy regime does not affect the macroeconomic foundation of each country is the same as ours.[4]

Our methodology is more favorable in two aspects. Firstly, we can endogenously determine the latent desirable debt level which in turn helps to analyze the common policy coordination. Secondly, the analysis is applicable even under the limited data availability. In our case, the fiscal data of Indonesia and Vietnam are scarce.

To see whether the link between inflation and public debt is valid in the ASEAN, we estimate the relationship between public debt and inflation in the case of the ASEAN. The quarterly data of four ASEAN countries are collected.[5] The government balances are also included in the regression as the control variable. Table 1 shows the empirical results from the time-series regression for Malaysia, the Philippines, Singapore, and Thailand. Furthermore, we estimate the panel data regression of these four ASEAN countries (ASEAN4) to look for the regional linkage. Empirical results are summarized as follows.

Except the case of the Philippines, the sign of inflation's coefficient is expectedly negative. Although only Malaysia has a statistically significant (implicit) role of monetary policy in inflating away public debt, the overall ASEAN4 panel analysis confirms the result.

Even though there is still lack of evidence that central banks in Asia apply the monetary policy to manage public debt, our empirical results show the implicit relationship between the public debt and inflation in the ASEAN. Hence, these results support the argument of using monetary policy on the public debt management mentioned in the BIS (2012). This rationalizes our methodology outlined in previous sections.

Inflation Policy Simulations

In this section, we work on various simulations over inflation policies. We begin with the simple recursive calculation using the debt dynamics equation in (2) to find how the time path of debt changes with

Table 1. *Empirical Evidences on Inflation–Debt Linkage in ASEAN*

Dependent Variable	Change in Debt-to-GDP Ratio				
Independent Variables	Malaysia	Philippines	Singapore	Thailand	ASEAN4
Constant	0.0042*	−0.0041	0.0125**	−0.0018	0.0017
Primary balance	-6.13×10^{-5}*	-7.96×10^{-6}	−0.0001**	-3.60×10^{-8}	7.43×10^{-7}
Inflation	−0.6379***	0.0958	−0.3824	−0.0233	−0.2760*

*, **, and *** represent statistical significance at 10%, 5%, and 1% respectively.
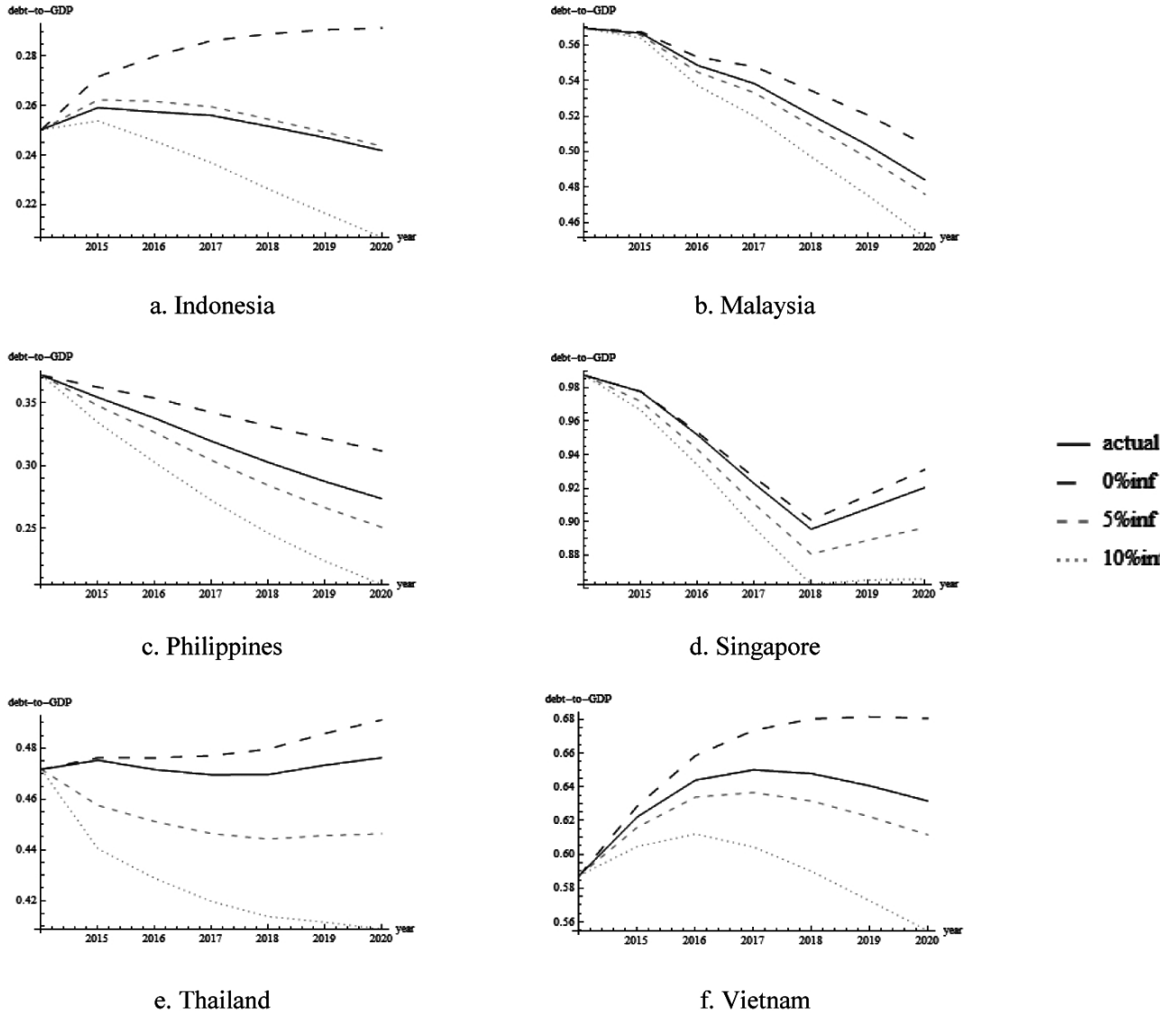
**Figure 1.** Constant-interest-rate policy for full Fisher effect .

the change in inflation. Again, following Akitoby, Komatsuzaki, and Binder (2014), we assume that the debt composition is time invariant. The projection data are applied to endogenously calculate the series of i_t^{imp}. These assumptions are used throughout the paper.

Apart from Akitoby, Komatsuzaki, and Binder (2014), this paper focuses on only ASEAN countries. Due to the data availability, we only include six main countries, which are Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. We use the IMF annual projection data from 2014 to 2020. For b, pb, π, and g, we also use the IMF forecast from the CEIC database. For r^{ST}, we use the IMF historical annual data from the CEIC database to forecast using

the methodology of Goodhart and Lim (2011). For the debt composition, the fixed proportion among short-term, previously issued long-term, and newly issued long-term debts of the year 2014 is applied. For π^{base}, we fix the target equal to the announced target of the year 2015.[6] Subsequently, i^{imp} is endogenously calculated from (1).

Debt Dynamics Simulation Over Constant-Inflation-Rate Policy

We suppose that the central bank conducts the constant-inflation-rate policy by having the fixed desirable inflation rate ($\pi_t = \pi$ for $t = 0,1,... T$,
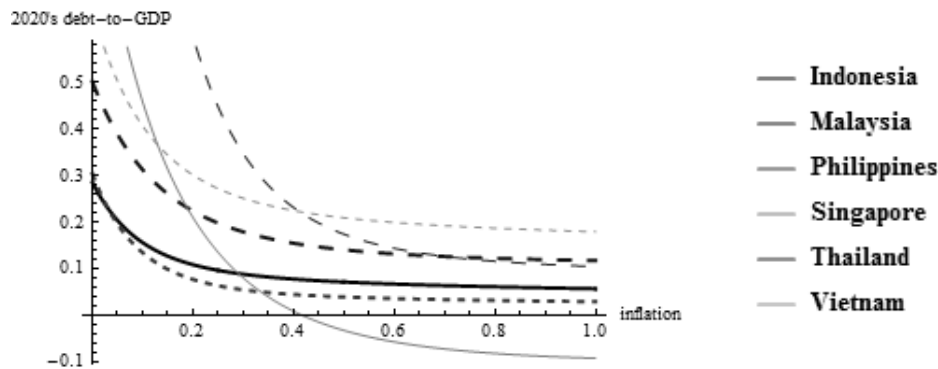
Figure 2. Seigniorage effect of each country with full Fisher effect.

Table 2. *Average Debt-to-GDP Reduction per 0.01 Increase in Inflation*

| Country	0.0	0.5	1
Indonesia	0.00252	0.00241	0.00230
Malaysia	0.00498	0.00441	0.00383
Philippines	0.00285	0.00280	0.00275
Singapore	0.01140	0.01084	0.01058
Thailand	0.00469	0.00433	0.00398
Vietnam	0.00621	0.00549	0.00498

where $t = 0$ is the present date and $t = T$ is the future terminal date). This inflation rate level is not publicly announced as argued in the previous section. We use (2) to recursively iterate forward, while we have $\pi_t = \pi$ fixed for $t = 2015, 2016, ..., 2020$.

Figure 1 shows simulated dynamics of each ASEAN country assuming full Fisher effect ($\alpha = 1$). The figure also suggests that the impact of the constant-inflation-rate policy is qualitatively similar throughout ASEAN countries. For every country, the higher π dynamically lowers the debt-to-GDP ratio. For example, in Thailand's case, if π is set equal to 0 (5%), the debt-to-GDP ratio of year 2020 would increase (decrease) by about 1.5 (3%) from the projection level. However, the effectiveness of such policy for each country differently depends on how dominant the seigniorage effect is over the interest rate effect.[7]

According to many simulation results, we broadly conclude that the rate of debt reduction as inflation rate rises is decreasing. For example, Figure 2 compares the simulated debt-to-GDP ratio of the year 2020 of each country with respect to the constant-inflation-rate policy in the case of a full Fisher effect. In particular, future debt is decreasing in the policy inflation rate, which shows that the seigniorage effect dominates in all ASEAN countries. Since the slope of each curve is decreasing and approaching 0, the net seigniorage effect is weaker as inflation rises. Table 2 calculates the average of the debt reduction rate of each country at a given Fisher effect. We find that the strongest net seigniorage effect belongs to Singapore, which is then followed by Vietnam, Malaysia, Thailand, the Philippines, and Indonesia.

An increase in policy inflation rate is more effective on an economy with low Fisher effect. From (2), the lower the Fisher effect is, the stronger the seigniorage effect becomes in relation to the interest rate effect. Intuitively, inflation acts like the implicit tax for the central bank to earn more income and repay the debt. If inflation does not fully raise the nominal interest rate, the rise in interest payment of the new long-term debt is thus relatively insignificant. Consequently, the central bank with a lower Fisher effect has higher incentive to inflate the economy.

a. Indonesia

b. Malaysia

c. Philippines

d. Singapore

full–FE
half–FE
no–FE

e. Thailand

f. Vietnam
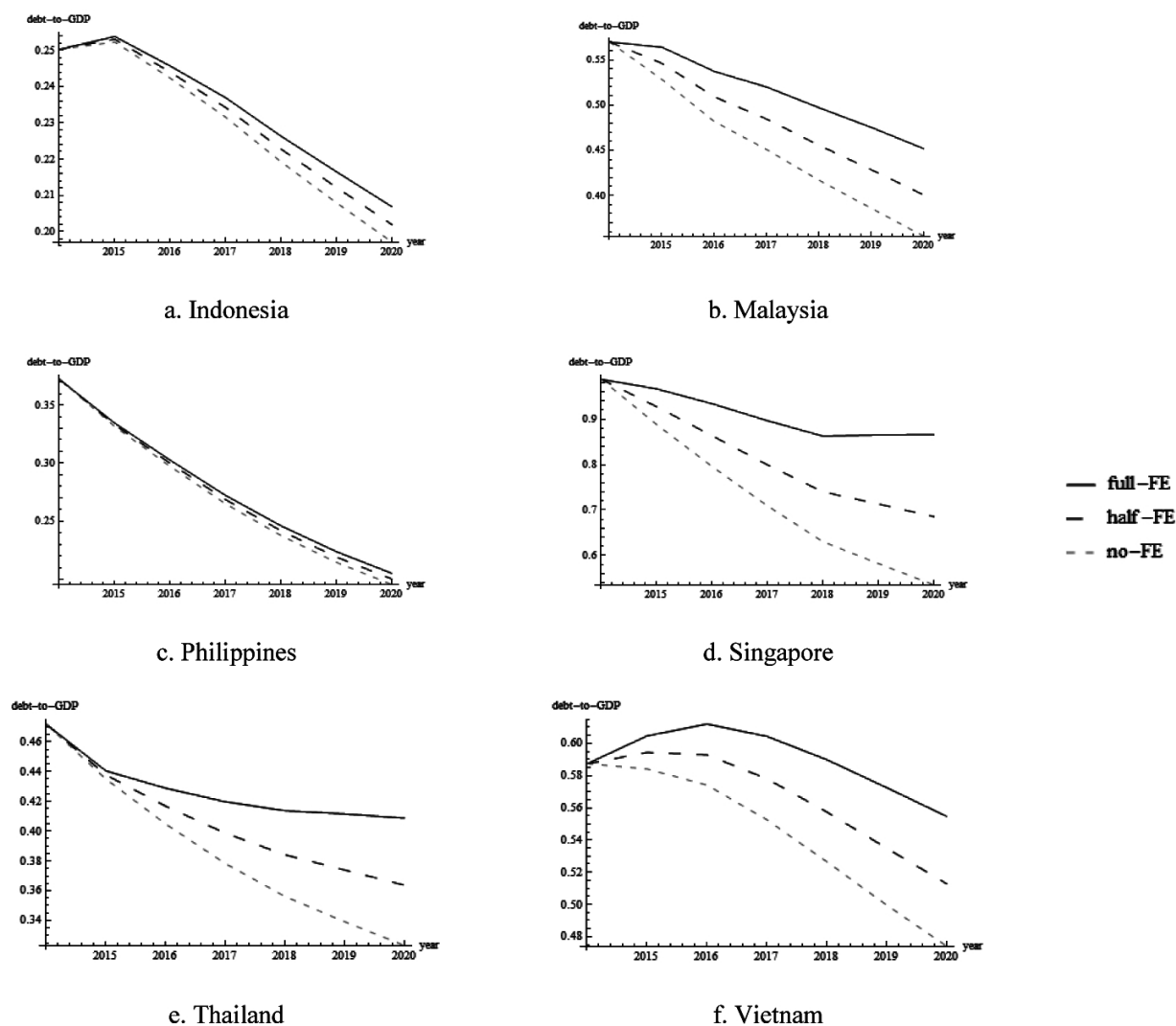
Figure 3. Varying Fisher effect with $\pi = 0.1$.

Figure 3 illustrates this point. The change in Fisher effect in each country influences the policy effectiveness in different degrees. In some countries like Indonesia and the Philippines, the difference in Fisher effect almost plays no role in inflation-debt dynamics, but in other countries, it significantly does. Table 3 gives the average change in average debt-to-GDP reduction per 0.1 decrease in Fisher effect. In other words, it shows how much the low Fisher effect can enhance the inflation policy in reducing debt. Again, Vietnam is most willing to inflate the economy more when the Fisher effect falls. Then, Malaysian, Thailand, Singapore, Indonesia, and the Philippines follow in order.

In the next subsection, we use this negative relationship between debt and inflation to find the optimal inflation rate policy for each ASEAN country. We also investigate further the possibility of a unified inflation rate policy for ASEAN integration.

Loss Function Minimization

To search for the optimal constant-inflation-rate policy from 2015–2020, the sum of discounted loss function of the form (3) is used as an objective function. The loss function minimization setup for each country is as follows:

$$\min_{\pi} \hat{L} = \sum_{t=1}^{6} \beta^t \left[(\pi - \pi^*)^2 + \right.$$

$$\left. \gamma \left(\bar{b} + \frac{b_{2014+t} - b_{2014+t-1}}{b_{2014+t-1}} - b^* \right)^2 \right] \qquad (4)$$

subject to backward recursive iterations of (2) for b_{2014+t} for all t and given b_i, where is discount factor and all the simulation assumptions hold.

Parameterizing the model, we set $\beta = 0.99$, $\bar{b} = b_{2014}$, and $\pi^* = \pi^{base}$.[8] The most problematic parameter is b^*: what the desired level of debt should be is controversial. In the literature, a country seems to have the maximum debt level where the country exceeding this level loses its credibility. Intuitively, should be the value in between 0 and the maximum debt level. We proceed from here by varying b^* from 0 to 2.[9] We also consider the case where b^* is the average of projection data.

Alternatively, according to the time inconsistency argument, we assume that the projected inflation data we have is the projection of inflation resulting from the loss function minimization given the announced baseline inflation. In this way, we can recover the implied desired debt-to-GDP level in that loss function and then use this implied level to reminimize the loss function choosing the optimal constant-inflation-rate policy. Assuming that the projection data is generated from the loss-function minimization (4), we propose two methods in recovering b^* as follows:

- Method 1: Recovery from the first-order conditions (FOCs) with respect to π_t: $\{\pi_t\}_{t=2015}^{2020}$ should be derived from FOCs of (4) which are $\left\{ \frac{\partial L}{\partial \pi_t} = 0 \right\}_{t=2015}^{2020}$. Since we have 4 unknown parameters that are β, γ, α, and b^*, we choose the first 4 FOCs to form the system of nonlinear equations and solve for parameter values of each country.

- Method 2: Recovery from the FOC with respect to b^*: Since b^* is the desired level of debt, we further assume in this method that the central bank also chooses b^* to minimize the loss function given other primitive parameter values.

Indeed, Method 1 is theoretically preferred to Method 2 because it relies on less assumption and can determine all country-specific characteristic parameters. However, the solution of such huge system of nonlinear equations is very sensitive to noises in our projection data resulting in the parameter value that is out of sensible range.[10] To use Method 1, further methodological improvement is required, which is out of this paper's scope.

For Method 2, although it is theoretically less rigorous than Method 1, it greatly reduces a calculating complication and gives more sensible parameter values. Thereby, we adopt Method 2 to calculate b^* as function of α, given $\beta \in 0.99$. We call it the implied

Table 3. *Average Change in Debt-to-GDP Reduction per 0.1 Decrease in Fisher Effect*

Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
0.00216	0.01149	0.00101	0.00462	0.00711	0.01412

Table 4. *Implied Desired Debt-to-GDP Ratio*

	Country	0	0.5	1
Implied	Indonesia	0.24399	0.24504	0.24608
	Malaysia	0.54344	0.54299	0.54255
	Philippines	0.32235	0.32232	0.32230
	Singapore	0.97562	0.97582	0.97602
	Thailand	0.47503	0.47416	0.47329
	Vietnam	0.60368	0.60029	0.59692

b^*, which is showed in Table 4. Note that since these implied b^* is recovered from data, the resulting values are certainly within the range of debt projection data of each country.

Table 5 summarizes outcomes of optimal constant inflation rate policy.[11] Intuitively, the loss-function-minimizing inflation rate is a decreasing function of the desired level of debt (b^*) since low inflation rate helps

raise the debt level towards b^*. Two remarks are worth highlighting. Firstly, the economy with low Fisher effect has stronger seigniorage effect. Therefore, there is more incentive to deviate inflation away from π^* for the debt to approach b^*. Secondly, all resulting figures are sensitive to the inflation-debt weighting parameter γ. So, the absolute figures are less meaningful but still useful in the relative sense.

Table 5: *Loss-Function-Minimizing Constant Inflation Policy Rate*

b^*	Country	γ					
		0.01			0.5		
		α			α		
		0	0.5	1	0	0.5	1
0	Indonesia	0.04193	0.04174	0.04149	0.10726	0.10280	0.09755
	Malaysia	0.03839	0.03677	0.03512	0.16590	0.13286	0.07824
	Philippines	0.03254	0.03236	0.03219	0.11465	0.11148	0.10794
	Singapore	0.02454	0.02015	0.01563	0.29804	0.20760	0.07027
	Thailand	0.02891	0.02771	0.02649	0.14592	0.12244	0.08666
	Vietnam	0.05443	0.05323	0.05201	0.18733	0.16456	0.13147
0.6	Indonesia	0.03738	0.03768	0.03799	−0.08216	−0.07419	−0.06354
	Malaysia	0.03370	0.03387	0.03404	0.01654	0.02138	0.02885
	Philippines	0.02778	0.02794	0.02809	−0.06626	−0.06297	−0.05887
	Singapore	0.01834	0.01662	0.01486	0.13241	0.09975	0.03738
	Thailand	0.02390	0.02424	0.02457	−0.01796	−0.00940	0.00434
	Vietnam	0.04995	0.04997	0.04998	0.04814	0.04849	0.04897
2	Indonesia	0.02633	0.02795	0.02957	−0.61665	−0.64540	−0.67710
	Malaysia	0.02232	0.02694	0.03150	−0.56042	−0.67425	−0.16506
	Philippines	0.01624	0.01724	0.01824	−0.60952	−0.62681	−0.64524
	Singapore	0.00338	0.00822	0.01307	−0.40713	−0.48593	−0.06066
	Thailand	0.01175	0.01592	0.02004	−0.57183	−0.65050	−0.71029
	Vietnam	0.03910	0.04216	0.04518	−0.54140	−0.61812	−0.72791
average	Indonesia	0.04154	0.04136	0.04119	0.09463	0.09096	0.08665
	Malaysia	0.03814	0.03661	0.03506	0.15937	0.12774	0.07576
	Philippines	0.03231	0.03215	0.03199	0.29390	0.10487	0.10159
	Singapore	0.02438	0.02006	0.01561	0.29390	0.20517	0.06949
	Thailand	0.02875	0.02760	0.02643	0.14180	0.11904	0.08440
	Vietnam	0.05418	0.05304	0.05189	0.18103	0.15911	0.12741
Implied	Indonesia	0.04009	0.04008	0.04006	0.04363	0.04313	0.04264
	Malaysia	0.03414	0.03414	0.03414	0.03407	0.03410	0.03401
	Philippines	0.03000	0.03000	0.03000	0.02988	0.02989	0.02990
	Singapore	0.01440	0.01439	0.01438	0.01493	0.01479	0.01458
	Thailand	0.02496	0.02497	0.02498	0.02337	0.02372	0.02405
	Vietnam	0.04992	0.04996	0.04999	0.04705	0.04842	0.04947

Intuitively, using the implied b^* should give more credible results. As in Table 5, the inflation policy rates resulted from implied b^* fall in the reasonable rage and are robust with respect to α and γ. For $\gamma = 0.5$, all other results are either negative or two-digit inflation rates, which seem unrealistic.

However, readers should be aware that this implied $b^{\wedge*}$ can also be easily overestimated or underestimated, especially if the projection data exhibits time trend. In particular, the projection data may be only a part of the long inflation-debt-smoothing path. Since our projection period is too short (only 6 years), we accept this point as the limitation of our work.

Unified Inflation Policy for Integrated Economy

One of the key motivations of this paper is to study how to perform a common monetary policy of the integrated economic zone like the ASEAN Economic Community (AEC). To smoothly unite the economy together, it may come to the point where the common inflation rate is needed. The importance of monetary policy synchronization has been notified in the economic integration literature. In the ASEAN, Basnet, Sharma, and Vatsa (2015) pinpoints that the rapid growth of ASEAN intraregional trade encourages the need for more stable exchange rate comovement within the region. Their finding is that Malaysia, the Philippines, Singapore, and Thailand share a common exchange rate cycle both in short term and long term. Although their policy target is on exchange rate, we all know that there is close connection among monetary variables such as money supply, interest rate, inflation, and exchange rate. The comovement in one variable implies comovement of the others as well.

Empirical studies, so far, show that the monetary policy linkage in ASEAN is still lagging behind the synchronization of business cycle. Kim et al. (2003) illustrates that the monetary policy variables in East Asian countries still significantly differ across countries but the fluctuations in macroeconomic variables are similar. Recently, Sethapramote (2015) also finds similar results that the interest rates in ASEAN have low static and dynamic correlations with each other but the output growths are highly correlated. However, these results are based on the past development of the ASEAN. The tighter economic integration like the ASEAN Economic Community (AEC) established

in 2016 is the evidence that the ASEAN community will continue to unite and the level of monetary policy synchronization must be much higher in the future.

Therefore, the counterfactual scenario on the common monetary policy is important to provide the crucial information for policymakers in ASEAN to evaluate the effect of enhancing collaboration in the economic policy to take care of the increasing degree of business cycle synchronization among the ASEAN countries.

From our analysis so far, it is straightforward to think that the common inflation rate policy $\tilde{\pi}$ is set by minimized the weighted sum of (4) of all member countries. Denote i as an index for AEC countries and w_i as the country i weight. The aggregate loss function minimization is defined below:

$$\min_{\pi^{com}} \sum_{i=1}^{6} w_i \sum_{t=1}^{6} \beta^t \left[\left(\tilde{\pi} - \pi_i^{base} \right)^2 + \right.$$

$$\left. \gamma_i \left(\bar{b}_i + \frac{b_{i,2014+t} - b_{i,2014+t-1}}{b_{i,2014+t-1}} - b_i^* \right)^2 \right] \tag{5}$$

subject to backward iterations of (2) for $b_{i,2014+t}$ and given $b_{i,2014}$ for all t and i.

Since the member countries should have equal political power in the union, we assume $w_i = 1$ for all i. For simplicity, we assume common debt element weight across countries ($\gamma_i = \gamma$). For b_i^*, we only use the implied b_i^* from Table 3 because we have shown in the previous subsection that it gives the most credible result.

From (5), we can also calculate for both the ASEAN baseline inflation policy rate $\tilde{\pi}^{base}$ (common ex ante optimal inflation target), which is equal to $\tilde{\pi}$ when $\tilde{\pi}_i^{sur} = 0$ for all i. We present $\tilde{\pi}^{base}$ and $\tilde{\pi}$ in Tables 6 and 7, respectively. The results are very robust. Especially in the case of $\gamma = 0.01$, the inflation target almost coincides with the desired inflation policy rate. This intuitively implies that when the policymaker cares relatively less about public debt, the time inconsistency problem is lessened.

Being aware of the shortcoming of using implied b_i^*, we recognize that the results in Tables 6 and 7 are not so meaningful in the absolute sense. Instead, we emphasize our result more on the percentage change between the individual desired rate and the common policy rate ($\left(\pi_i^{base} - \tilde{\pi}^{base} \right) / \tilde{\pi}^{base}$ and

Table 6. *ASEAN Common Inflation Target*

	γ	
	0.01	0.5
$\tilde{\pi}^{\text{base}}$	0.03226	0.03258

Table 7. *ASEAN Common Inflation Policy Rate*

	γ					
	0.01			0.5		
	α			α		
	0	0.5	1	0	0.5	1
$\tilde{\pi}$	0.03224	0.03226	0.03226	0.03159	0.03236	0.03268

$(\pi_i - \tilde{\pi})/\tilde{\pi})$, which measures each country's loss from abandoning monetary flexibility due to the regional integration.

Table 8 informs that Malaysia and the Philippines are the most satisfactory member of all since their desired rate almost coincides with the AEC common policy rate—the figures are close to 0. On the other hand, Singapore and Vietnam suffer the most. In the case of Vietnam, joining AEC with common inflation policy induces a loss from deflation: it would have to increase its inflation rate by about 1.5% if no integration takes place. Singapore encounters the exact opposite as its economy has to endure extra cost of living under integration.

Finally, one should keep in mind that we assume that the benefit from having a common inflation policy rate within a union is fixed. In other words, it is not a function of the common policy rate itself. If this assumption is relaxed, the loss function of each country needs to be modified accordingly.

Conclusion

The paper investigates the impact of inflation on debt dynamics of ASEAN countries. Raising the inflation rate helps reduce public debt through seigniorage income, even though an increase in nominal interest rate makes newly issued debt more costly. From various simulations, it results that ASEAN

countries have different abilities to inflate away public debt. In particular, Vietnam, Malaysian, Thailand, Singapore, Indonesia, and the Philippines are ranked from high to low abilities.

Optimal inflation policy rates are calculated through the projection data together with the optimal common inflation target and common desired inflation policy rate among ASEAN countries. As a result, we find that such common monetary policy would be favorable for Malaysia and the Philippines. On the other hand, Indonesia and Singapore would suffer the most.

Notes

[1] For this debt dynamics formula, we assume no indexed bond in the debt composition. This is because later on we focus on the ASEAN context where the portion of indexed bond is insignificant.

[2] The incorporation of public debt into the loss function does not affect the determination of π_t^{base} as we already argued that the change in π_t^{base} cannot affect b_t.

[3] As the Bank for International Settlement (2012) states, countries learned from the historical experience over 1900s and now have well-disciplined fiscal performance. This may imply that given the economic condition, there is a little room left for fiscal policy over debt management. We think that it is justifiable to assume the fiscal balance to be exogenous.

[4] In the same spirit as Pasaran, Smith, and Smith (2007), we argue against "the Lucas Critique" in our model. In

Table 8. *Percentage Change in Individual Desired Inflation Rate*

Country	γ							
	0.01				0.5			
	$\tilde{\pi}^{base}$	$\tilde{\pi}$			$\tilde{\pi}^{base}$	$\tilde{\pi}$		
		α				α		
		0	0.5	1		0	0.5	1
Indonesia	0.23993	0.24364	0.24241	0.24179	0.22775	0.38113	0.33282	0.30477
Malaysia	0.05845	0.05906	0.05828	0.05828	0.04806	0.07851	0.05377	0.04070
Philippines	−0.07006	−0.06936	−0.07006	−0.07006	−0.07919	−0.05413	−0.07633	−0.08507
Singapore	−0.55429	−0.55329	−0.55394	−0.55425	−0.55867	−0.52738	−0.54295	−0.55386
Thailand	−0.22505	−0.22571	−0.22598	−0.22567	−0.23266	−0.26021	−0.26700	−0.26408
Vietnam	0.54991	0.54858	0.55394	0.54960	0.53468	0.48940	0.49629	0.51377

particular, the inflation and debt dynamic relationship is invariant over any monetary coordination restriction. There are two main reasons. First, policy changes are constantly observed in reality, and hence, it is natural for any decision maker to think of policy changes as realizations of a random variable with a fixed parameter. Second, it is evident that the learning process over the new policy restriction takes time, and hence, the analysis over the short forecast time horizon over the old economic structure is still valid. In addition, our debt and inflation dynamic is constituted from the government budget constraint with a given fiscal behavior, not from the representative agent's utility maximization problem. Therefore, there is absolutely no reason to think that any monetary restriction will change the debt and inflation dynamic in each country.

[5] The data are ranged from 1991Q4 to 2016Q2 for Malaysia, from 1993Q1 to 2016Q2 for the Philippines, from 1998Q1 to 2013Q2 for Singapore, and from 2001Q4 to 2016Q2 for Thailand. All data is obtained from CEIC database. For Indonesia and Vietnam, the quarter data on the debt are unavailable.

[6] From http://www.centralbanknes.info, the 2015 inflation targets of Indonesia, the Philippines, and Thailand are 0.04, 0.03, and 0.025, respectively. For Vietnam, we use the 0.05 inflation target cited from Resolution No. 77/2014/QH13 dated October 11, 2014, issued by Vietnam's National Assembly at Legislature XIII, section VIII. Malaysia and Singapore do not use inflation targeting, so the average of projected inflation data is instead applied.

[7] According to (2), the effect of inflation on debt-to-GDP ratio is amplified by the net effect between seigniorage effect and interest rate effect. In particular, the 1% increase in inflation rate reduces the real cost of borrowing more in the country with a high implied interest rate of the old debt than one with a low rate.

[8] In the calibration literature, $\beta \in [0.96, 0.99]$ is standard. Since $\bar{b}$ is the debt level without the policy distortion, we simply set it at the current-year value which is of year 2014. For π^*, since the specification of (3) is under the assumption of negligible output element ($\mu \to 0$) and the inflation target is set from the loss function, it consistently results in π^{base} being equal to π^*.

[9] Notably, 200% approximately represents the highest number debt-to-GDP ratio of Japan, and 60% is the usual figure economists usually refer as common debt ceiling.

[10] For example, in the case of Singapore, Method 1 gives $\beta=1.456 \notin [0,1]$, $\gamma=0.02667$, $\alpha=-44.5203 \notin [0,1]$, and $b^*=0.96942$.

[11] The traditional insight of monetary policy suggests that low γ should be applied: the debt element of loss function should be secondary compared to inflation element. Hence, we present only the results when $\gamma \in \{0.01, 0.5\}$.

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