

Very preliminary

Uncertainty of the Keynesian Multiplier:

Monte Carlo Simulation Evidence from Malaysia

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Abstract

From the fourth quarter of 2008, the world economy experienced a deep recession and many governments of both developed and developing countries took fiscal measures to stimulate the economy. Among these, the Government of Malaysia employed a sizable fiscal expansionary policy ahead of other developing countries. It is however absolutely essential to understand the size of the Keynesian multiplier as well as the gross domestic product (GDP) gap when adopting fiscal measures to stabilize or boost the economy. Therefore, this paper focuses on Malaysia's expansionary fiscal policy implemented in 2008 and 2009 adopting concepts of the Keynesian multiplier and its uncertainty. Both deterministic and stochastic simulations based on a small-sized IS-LM model are performed in this study. The results of the former reveal the essence of the multiplier and those of the latter based on Monte Carlo simulations indicate the uncertainty of the size of multipliers; this finding supports the Lucas critique and requires a more precisely designed fiscal policy.

Key Words: Econometric Model, IS-LM Analysis, Fiscal Policy, Keynesian
Multiplier, Monte Carlo Simulation, Lucas Critique

JEL Classification: C32, E17, O41

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1. An Introduction

After late 2008, the world economy experienced a deep recession caused by the US subprime bubble collapse and a financial crisis as its aftermath. In both developed and developing countries, strong fiscal measures were taken to boost the economy and to cover the large negative gross domestic product (GDP) gap to a sizable extent. For example, IMF (2009a) estimates that the GDP gap in Asia will increase to around two percent in 2010.¹ From the fourth quarter of 2008, fiscal measures aimed at economic stabilization and stimulation were taken. According to the Budget Speech for the Lower House by the Minister of Finance of Malaysia on November 4, 2008, the Government of Malaysia provided a package amounting to nearly US\$ 2 billion² to boost the country's economy.

- 1) Upgrade of repair and maintenance for public amenities, including schools, hospitals, roads, etc. (RM 1,500 million)
- 2) Upgrade and maintenance of public transportation, including the extension of two existing LRT lines and the construction of one new line (RM 500 million)
- 3) Construction of additional low- and medium-cost houses and improvement of housing programs (RM 1,200 million)
- 4) Establishment of an investment fund to attract private investment (RM 1,200 million)
- 5) Provision of additional business premises for small and medium entrepreneurs (RM 100 million)
- 6) Micro-financing to provide support such as additional soft loans to commercial banks (RM 200 million)

As described by Vijayaedchumy (2003), the Malaysian fiscal policy played a direct and active role in the country's overall social and economic development process during the 1970s and expanded further in 1980–82 to pursue a countercyclical purpose and stimulate economic activity in order to tackle the negative effects of the global recession. Subsequently, since the Government of Malaysia shifted its policy to private-sector-driven growth and the fiscal policy receded into the background, the share of public expenditure in the GDP declined to 21% in 1997 from a peak of 44% in 1982. As Baharumshah and Lau (2007) points out, however, Malaysia's fiscal policy has begun to play a bigger role in smoothing the business cycle after the 1997 Asian financial crisis, which appears to be natural. Furthermore, Mahani et al. (2003) stresses that the expansionary policy facilitated the quick recovery in Malaysia. Thanoon et al. (2006) reveals that fiscal constraint in Malaysia is considerably larger than the savings and foreign gaps, according to their three-gap model,³ which may possibly suggest that fiscal resources are one of the scarcest in Malaysia. The measurement of the effects of fiscal policy is therefore very important, and it is absolutely essential to assess the size of the multiplier, as well as the GDP gap, when a fiscal policy aimed at boosting the economy is adopted. For example, Romer and Bernstein (2009) suggests that the size of the fiscal multiplier is around 1.5–1.6⁴. However, the stability or certainty of this figure is unknown. Hence, this paper explores the Malaysian fiscal policy by estimating the size of the Keynesian multiplier, employing small-sized IS-LM model simulations. In particular, the paper focuses on the consumption

function, which is a key factor for the multiplier. Both deterministic and stochastic simulations are completed to unveil the uncertainty of the size of the multipliers.

Initially, it seems helpful to confirm that simple and textbook-style Keynesian multipliers are differently calculated for the three types, regardless of whether it is a closed or open economy, or whether the government sector that does or does not collect taxes is included. The model is described as follows:

(EQ-1) Closed economy excluding the government sector (both tax revenue and imports are exogenous)

$$MULT = \frac{1}{1-c}$$

(EQ-2) Closed economy including the government sector (tax revenue is endogenous)

$$MULT = \frac{1}{1-(1-t)c}$$

(EQ-3) Open economy including the government sector (both tax revenue and imports are endogenous)

$$MULT = \frac{1}{1-(1-t)c+m}$$

where *MULT* multiplier
c marginal propensity to consume
t marginal tax rate
m marginal propensity to import

The multiplier in a closed and government-excluded⁵ economy seems to be the largest among the three and its size declines as the model assumption is expanded to include the government sector and to open the economy that introduces the foreign sector, particularly, imports. This paper then estimates the size of the Malaysian multiplier by simulating three types of models based on (EQ-1), (EQ-2), and (EQ-3). Finally, to reveal the uncertainty of the size of the Keynesian multiplier, three types of stochastic simulations are performed on the basis of a Monte Carlo methodology.

The contents of the paper are as follows. The introduction overviews the main fiscal policy adopted by the Malaysian government in late 2008 and some existing literature on the Malaysian fiscal policy, and presents basic concepts of the Keynesian multiplier. The next chapter reveals the structure of a small-sized IS-LM model of Malaysia, which includes five structural equations and a definition. The third chapter reports the deterministic, i.e., non-stochastic, simulation results of the model, which indicate a tendency to decline the size of multipliers according to the expanding model sectors such as the government and the foreign sectors. The fourth chapter shows the stochastic, i.e., Monte Carlo, simulation results, including the uncertainty of the consumption function on both the disturbance term and the estimated parameter. The final chapter briefly concludes the paper and presents some remaining issues. Further, EViews V6 is employed for estimations and simulations.

2. Structure of the Small-Sized IS-LM Model

This paper employs a small-sized IS-LM Keynesian model where demand factors determine the output level. The following equations in (EQ-4) depict the structural functions, while (EQ-5) reports the definitions. All structural functions are estimated for the period 1983–2008 and the GMM is employed in order to minimize the coincident equation bias, which is one of the most remarkable features of the model. The data adopted in the model are at current prices on an annual basis, and are taken from IMF (2009b), except for tax revenue, which is referred from ABD (2009). R^2 , SE, and J-stat denote the adjusted R-square, standard error of the equation, and p-value of overidentification tests, respectively. The numbers within parentheses under the equations indicate the standard errors of each parameter. Moreover, Table1 reports the list of model variables.

(EQ-4) Structural equations

(1) Consumption function

$$C = 12.335 + 0.199 (GDP - TAX) - 1.415 R + 0.654 C_{-1} + ERROR$$

(6.707) (0.186) (1.391) (0.386)

$$R^2 = 0.995, SE = 5.977, J\text{-stat} = 0.151$$

(2) Investment function

$$I = 18.581 + 0.627 GDP_{-1} - 0.621 GDP_{-2} - 1.627 R + 0.663 I_{-1} + ERROR$$

(8.892) (0.143) (0.190) (1.054) (0.178)

$$R^2 = 0.890, SE = 14.120, J\text{-stat} = 0.104$$

(3) Import function

$$M = -39.570 + 0.439 GDP + 12.336 TT + ERROR$$

(12.724) (0.049) (1.441)

$$R^2 = 0.984, SE = 23.830, J\text{-stat} = 0.119$$

(4) Tax function

$$TAX = 3.972 + 0.146 GDP + ERROR$$

(0.800) (0.0016)

$$R^2 = 0.980, SE = 4.069, J\text{-stat} = 0.143$$

(5) Money demand function

$$R = 11.939 + 0.809 \log(GDP) - 2.049 \log(M3) + ERROR$$

(8.637) (6.349) (4.880)

$$R^2 = 0.131, SE = 2.032, J\text{-stat} = 0.195$$

(EQ-5) Definition

(6) Gross domestic product

$$GDP = C + I + II + G + X - M$$

Before proceeding to the model's final test results, we must focus on the following three points:

- 1) The money demand function of equation (5) in (EQ-4) is set to be solved for the interest rate as an inverse function.
- 2) Imports and money demand functions are estimated on the basis of a normal and well-known assumption, while Yoshioka (2001) provides some background information for estimating the consumption and investment function.
- 3) Since the Keynesian multiplier is defined in a short run, which means that the prices are constant, all variables in the model are denoted as nominal.

A final test is completed, which reports that the RMSPE of the GDP is 2.67 percent. Fig. 1 depicts the both actual and the simulated GDP. Considering the RMSPE, the GDP traceability of the model does not seem bad.

3. Deterministic or Non-Stochastic Simulation Results

Before proceeding to stochastic simulations, some deterministic simulations are performed. Here, "deterministic" means that neither the elements of uncertainty, nor, those of stochasticity are included in equations or parameters. According to (EQ-1), (EQ-2), and (EQ-3), three types of simulations are performed to confirm the decline of multipliers when the sectors are included in a model. The model is simulated through its estimation period during 1983–2008 with constant terms adjusting to the actual values of each variable for baseline simulations. The sustainable shock of 1 percent of the GDP is added to government consumption for the final three years from 2006 to 2008 for an impact simulation. Evidently, the multipliers are derived with the deviation between baseline and impact simulations. Table 2 reports the details of the model assumptions for estimated functions. Therefore, the smaller the number of cases the larger is the size of the multipliers in a macroeconomics textbook.

While the imports function is not included in the model for Cases 1 and 2, it is included for Case 3. On the other hand, tax revenue is treated as exogenous at its value for Case 1 and endogenous for Cases 2 and 3. For all simulation cases, the money demand function⁶ is always treated as endogenous, which means that the LM curve is not flat. According to Friedman (1973), the slope of the LM curve determines the size of the multiplier, while Romer (2000) discusses the requirement of the LM curve in a Keynesian framework. Apparently, Case 1 corresponds to (EQ-1), which excludes the government tax revenue function and assumes a closed economy, while Case 2 is equivalent to (EQ-2), where the closed economy leaks some expanding fiscal policy effect to taxes. Case 3 of the open economy spills the stimulus to both taxes and the foreign sector through imports. Most economists seem to regard that the multiplier of Case 1 is the largest among three cases and that of Case 3 is the smallest, whereas that of Case 2 lies midway between Cases 1 and 3. This argument is empirically proven in this paper. Figure 2 depicts the Malaysian fiscal multipliers of three cases at Table 2.

According to the tax and imports functions reported in (EQ-4), the marginal propensity to import of 0.44 is far larger than the marginal tax rate of 0.15. Hence, the leakage of fiscal stimulus to the foreign is much larger than that of government tax revenue. Thus, the degree of decline of the multiplier including

government tax revenue function is smaller than that including the foreign sector, as reported by Figure 2. This is partly owing to data definition, since this model considers only central government tax revenue,⁷ and the local government is excluded because of data availability. The inclusion of the local government, however, does not seem to raise the marginal tax rate significantly, since the decentralization of government power does not proceed in many developing countries and Malaysia⁸ is not an exception. Moreover, in general, the trade dependency is sizably high in a small country. Figure 2 reports the imports, exports, and central tax revenue in Malaysia during the estimation period. In particular, Tang and Nair (2002) reveals that import volume, income, and relative prices are cointegrated by adopting the bounds test of unrestricted error correction model. The estimated long-run elasticity of import demand with respect to income is around 1.5, and is larger than that to relative prices, i.e., 1.3. During the estimation period of the paper, tax revenue roughly indicates a tendency to decline, which is consistent with the affirmation of Vijayaledchumy (2003). In contrast, the share of imports to the GDP has increased according to the extent of globalization across the world, including Malaysia. Therefore, the inclusion of the imports function therefore causes further decline to the multipliers than the tax revenue function does.

4. Stochastic Simulation Results

In addition to the previous deterministic, i.e., non-stochastic, simulations of the model, a few Monte Carlo simulations are performed for Case 3 at Table 2, where both imports and taxes are treated as endogenous. As mentioned before, this paper focuses on the uncertainty of consumption function, so that two types of stochastic elements are employed and three types of Monte Carlo simulations are executed as follows:

- 1) Case A includes uncertainty in the entire consumption function, i.e., a disturbance term that is the product of the equation standard error and a normal random number is added at the equation's error term.
- 2) Case B includes uncertainty in the parameter for the disposable income at the consumption function, i.e., a disturbance term that is the product of the parameter's standard error that is given as *SE2* in the following equation in (EQ-6), and a normal random number is added at the parameter for the disposable income.
- 3) Case C includes both uncertainties of the above simulations, i.e.,

(EQ-6) Consumption function including uncertainty

$$C = 12.335 + 0.199(1 + SE2 \times RAND2) * (GDP - TAX) - 1.415R + 0.654C_{-1} + SE1 \times RAND1$$

where *SE1* standard error for whole consumption function
SE2 standard error for parameter of disposable income

Here, normal random numbers are calculated from uniform random numbers according to Box-Müller transformation indicated in Box and Müller (1958), which generates two sets containing 1000 random

numbers that follow $N.I.D.(0,1)$.⁹ These two sets of normal random numbers for the equation of the consumption function and the parameter of disposable income are stored, and identical random numbers are employed for all three cases, which is one of the most remarkable features of the Monte Carlo simulations in the paper.¹⁰ Figure 4 depicts the histograms of these two sets of normal random numbers. The sample means are almost equal to zero, and the sample standard deviations are practically identical to 1.

After performing 1000 Monte Carlo simulations for each case, the values of standard deviations for the last three years for each simulation case are derived from the results and are compared with deterministic simulation results of Case 3 at Table 2 and Figure 2. Figure 5 reports the multipliers according to each case. The center bars of each year depict the multiplier derived from deterministic simulation results of Case 3 at Table 2 and Figure 2, while the left-side and the right-side bars indicate those that added and reduced a value of one unit of standard deviation derived from each Monte Carlo simulation case respectively.

At a glance, it is not difficult to detect that multiplier deviations of stochastic simulation from the deterministic case increase over the time, i.e., from 2006 through 2008. Moreover, the deviations of Cases A, B, and C increase in this order according to the amount of uncertainty included in the consumption equation. One of the most impressive results should be that the deviation of the parameter uncertainty case is far larger than that of the equation uncertainty case. This is partly owing to a small significance or large standard error of the parameter, but is reminiscent of the also reminds Lucas critique presented in Lucas (1976), which emphasizes that the estimated parameters of the models are not necessarily structural, i.e., not policy-invariant or policy-variant, such that they may change whenever the policy is changed. Further, it reveals that policy conclusions based on those models would therefore be potentially misleading. Since the model system of the paper reported at (EQ-4) does not adapt to the Lucas critique, the Monte Carlo simulation is employed for approximation. According to the estimation results reported in Figure 5, it is revealed that the Keynesian fiscal multiplier may possibly decline largely in the negative for the case including uncertainty in a consumption function, specifically, for the parameter with its standard error.

5. Conclusion and Remaining Issues

Numerous economists regard that Romer and Bernstein (2009) was unveiled to provide an empirical basis to promote fiscal stimulus not only in the US, but also across the world, including Malaysia. In contrast, some critical literature, including Cogan et al. (2009) and Davig and Leeper (2009), is also presented, while Smets and Wouters (2007) asserts that the multiplier is around 1.0–0.4 and is far smaller than that of Romer and Bernstein (2009), adopting the Bayesian DSGE approach.

This paper is also inspired by Romer and Bernstein (2009), but it employs a different approach from other literature adopting the stochastic Monte Carlo Simulation, which reveals that the Keynesian fiscal multiplier may possibly become negative if a sizable uncertainty is included in the consumer's behavior, specifically, in the marginal propensity to consume. The uncertainty of the Keynesian multiplier emerges

both in deterministic and stochastic simulations. Even in deterministic simulations, the Keynesian multiplier differs, regardless of whether the government and the foreign sectors are involved in a model or not. Clearly, the stochastic simulation results reveal a large uncertainty of the size of multipliers. From another perspective, the results of the paper support the Lucas critique and suggest that a more precise design of the fiscal policy would be required in both developed and developing countries, since developing countries also utilize fiscal policy as an autonomous tool for stabilizing the national economy after the recent recession. Further, this is very important for the development economics.

Furthermore, it is essential to present a few remaining issues. First, greater accuracy of equation estimations is necessary. Partly because of data availability of the general government's tax revenue, the parameter for disposable income in the consumption function that defines the marginal propensity to consume may contain a bias. Second, a more comprehensive model is required. The model constructed in the paper comprises only six structural functions and a definition. On the other hand, a more comprehensive model does not necessarily provide more precise simulation results. Third, including Romer and Bernstein (2009), quarterly models are employed in most developed countries. In developing economies, however, it is difficult to obtain seasonally adjusted quarterly data, while it is not easy to resolve these remaining issues promptly but further investigation efforts will certainly be made for the development economics.

(Endnote)

¹ See Figure 1.9 on p.16 in IMF (2009a).

² This was equivalent to around RM 7 billion. After this package, an additional fiscal plan was also announced.

³ See Figure 2 on p.307 in Thanoon et al. (2006), which indicates that the fiscal gap curve is the steepest among the three against capacity utilization.

⁴ This figure is reported in Appendix 1 on p.12 in Romer and Bernstein (2009). However, some literature raises important questions. The conclusion of this paper will address this point.

⁵ In the government-excluded economy here, both government expenditure and tax revenue are treated as exogenous, and the word 'government-excluded' does not mean the absence of the government with regard to its expenditure.

⁶ The money demand function in the model is solved for an interest rate function as a reverse function. This seems to be the usual manner for econometric models.

⁷ Usually, the tax revenue of the central government is smaller than that of the general government, but it is unclear as to which marginal tax rate of these two types of government is larger.

⁸ Jalil and Karim (2008) provides useful information on local government fiscal constraints based on Article 111(2) of the Constitution of Malaysia.

⁹ EXCEL is employed for this calculation.

¹⁰ Hence, the Monte Carlo simulations performed in the paper are reproducible.

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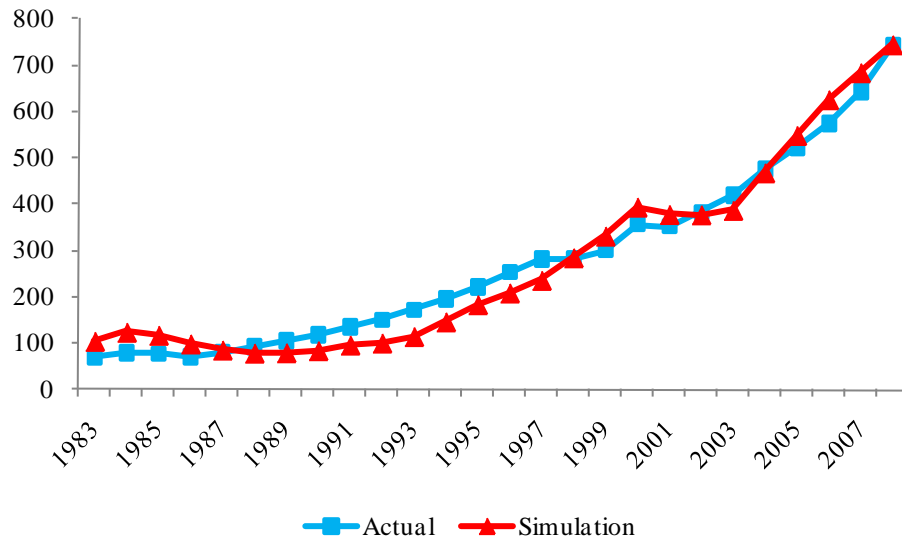
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Table1: List of Model Variables in Alphabetical Order

Notations	Types	Definitions	Unit	Sources
<i>C</i>	endogenous	household consumption	billion ringgit	IMF (2009b)
<i>I</i>	endogenous	gross fixed capital formation	billion ringgit	IMF (2009b)
<i>II</i>	exogenous	changes in inventories	billion ringgit	IMF (2009b)
<i>G</i>	exogenous	government consumption	billion ringgit	IMF (2009b)
<i>X</i>	exogenous	exports of goods and services	billion ringgit	IMF (2009b)
<i>M</i>	endogenous	imports of goods and services	billion ringgit	IMF (2009b)
<i>GDP</i>	endogenous	gross domestic product	billion ringgit	IMF (2009b)
<i>TAX</i>	endogenous	central government tax revenue	billion pesos	ADB (2009)
<i>R</i>	endogenous	treasury bill rate	percent per annum	IMF (2009b)
<i>M2</i>	exogenous	money supply, M2	billion ringgit	IMF (2009b)
<i>TT</i>	exogenous	linear time trend	none	dummy

Sources: IMF (2009b), ADB (2009), and author

Fig. 1: Actual and simulated GDP at the final test of the model



Note: The unit of the vertical axis is RM billion.

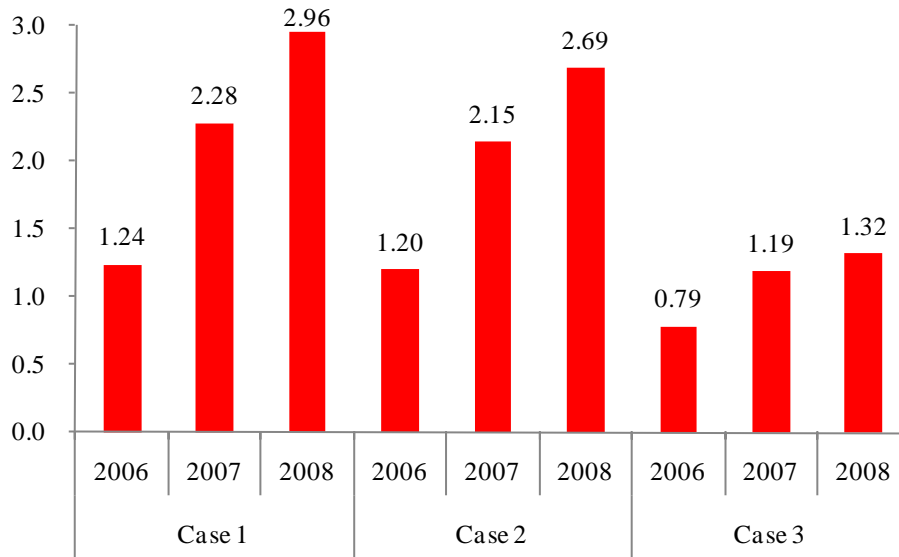
Sources: IMF (2009b) and Author's estimation

Table 2: Model Assumptions

Functions	Case 1	Case 2	Case 3
Consumption function	endogenous	endogenous	endogenous
Investment function	endogenous	endogenous	endogenous
Import function	exogenous	exogenous	endogenous
Tax revenue function	exogenous	endogenous	endogenous

Source: Author

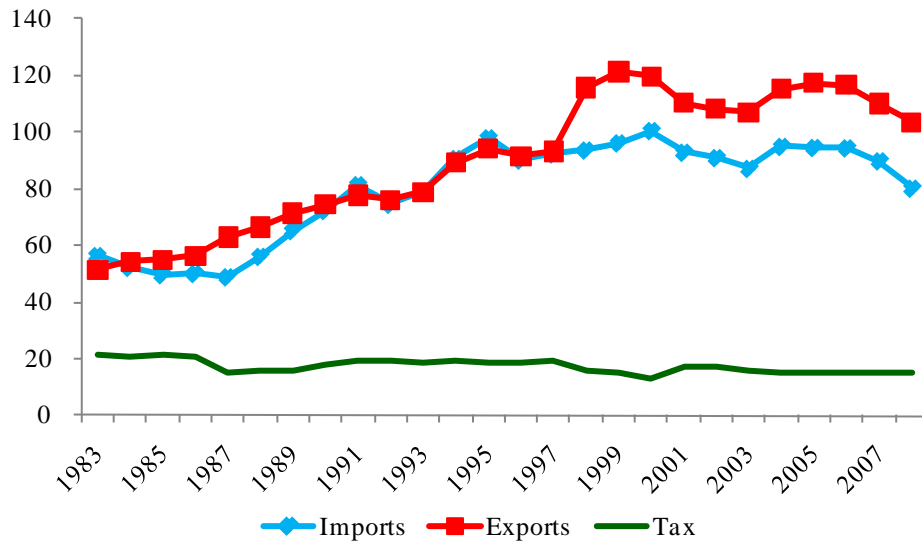
Fig. 2: Sizes of Multipliers for Cases 1–3



Note: The unit of vertical axis is an absolute number, since the values shown are of multipliers.

Source: Author's estimation

Fig. 3: Imports, Exports, and Central Government Tax Revenue in Malaysia

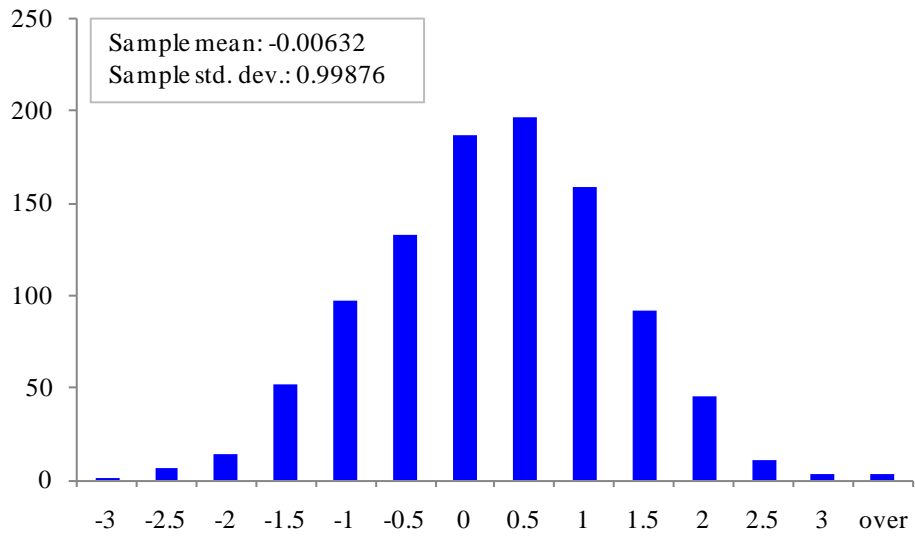


Note: The unit of vertical axis is the percent to GDP.

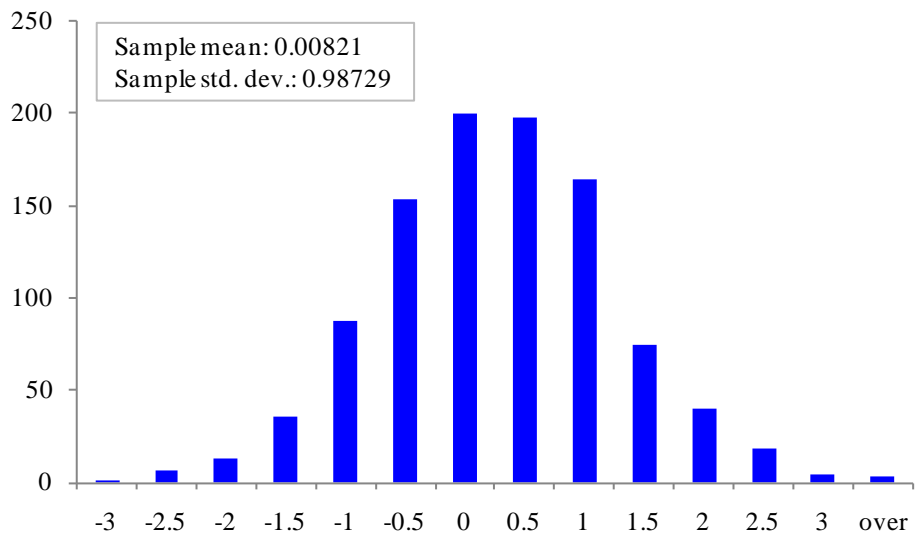
Sources: ADB (2009) and IMF (2009b)

Fig. 4: Histograms of Normal Random Numbers

(1) *RAND1*: Random Numbers for Entire Consumption Function



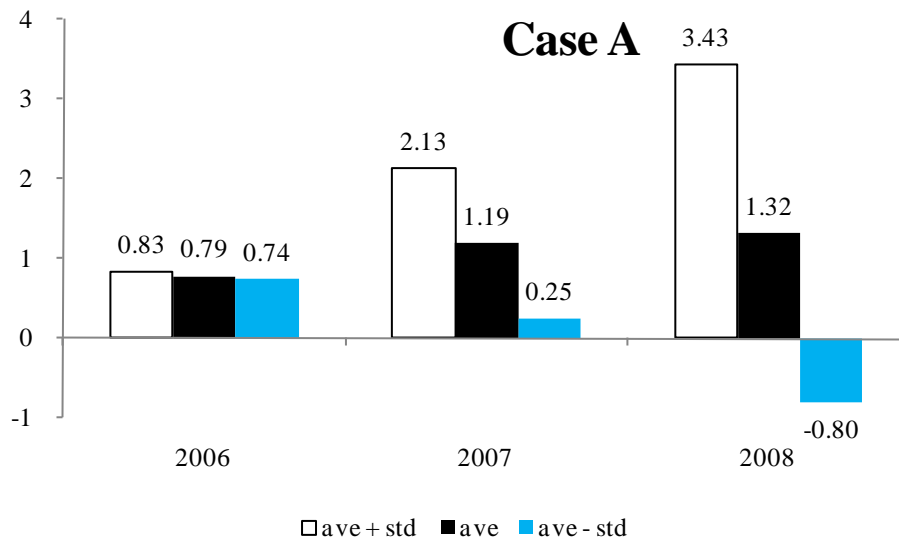
(2) RAND2: Random Numbers for Parameter of Disposable Income



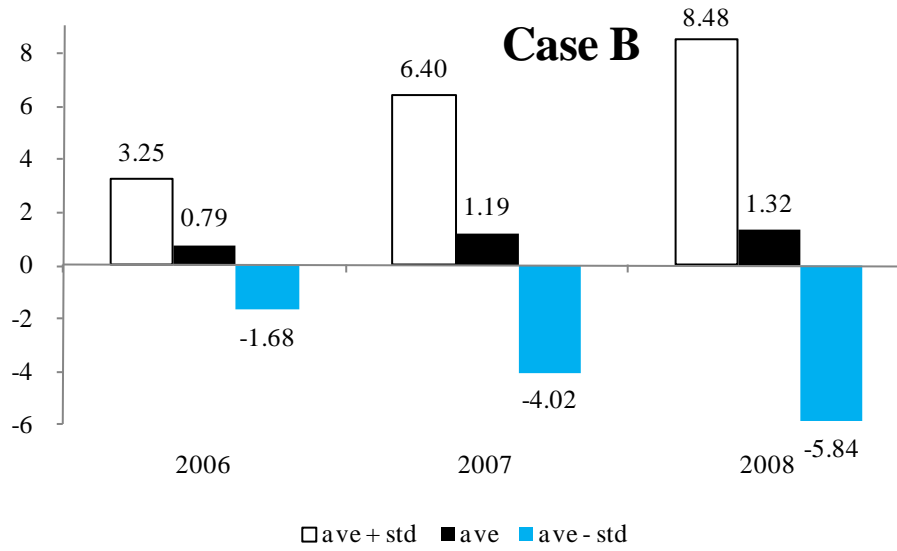
Source: Author's transformation

Figure 5: Multipliers Derived from Monte Carlo Simulations

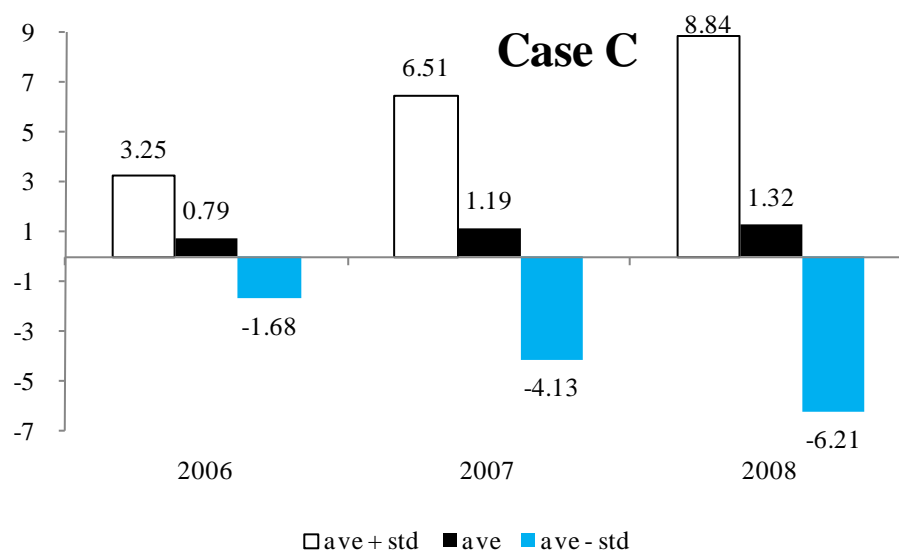
(1) Case A: Including uncertainty in whole consumption function



(2) Case B: Including uncertainty in coefficient of disposable income at consumption function



(3) Case C: Including uncertainty both in whole consumption function and in coefficient of disposable income at consumption function



Source: Author's estimation