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# Existence of J-Curve between Thailand and ASEAN: A Real Business Cycle Perspective

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**Abstract.** Could the IRBC model repricate J-curve effect in case of Thailand with ASEAN? In order to receive the state space representation: transition and observation equation, the stochastic optimal linear regulator problem is solved. According to the main simulation results, the dynamic responses of macroeconomic cycles toward one-standard-deviation innovation indicate that in the long run the cycles converge to the steady state obviously. When the simulated value with stylized fact is compared, the overall simulation results on standard deviation statistical property are rather good. At the same time, the cross correlation between trade balance and terms of trade replicates quite well a J-curve pattern. It is, nonetheless, sensitive to variations on the parameter of elasticity of substitution between domestic and imported product. The parameterization should be developed for the future research direction. It should be country-specific for some parameters, as for instant the elasticity of substitution.

**Keywords:** J-Curve, Trade Balance, Terms of Trade, Real business Cycle Model.

## 1. Introduction

The international real business cycle (IRBC) has been studied [9], [12] and extended to simulation of dynamic correlation between trade balance and terms of trade [6], [7], also known as J curve. It assumes that the productivity shock is the origin of such correlation. In Thailand, this was discussed in the work of Rungreangsumrit [19] which used model of the 2 countries of the same size developed by Backus et. al. [2]-[4] to simulate the situation. However, Zimmermann [25] extended the idea to IRBC model between countries of different size [13] which may be suitable for the case of Thailand as a small country and trading parties as a large country. The next question is that which country should be selected as trading party under the model and whether it should still be USA? According to the review on Thailand's international trade for the past 5 years, it appeared that ASEAN countries are more significant export market of Thailand than that of EU, USA and Japan and it also showed expansion trend. In 2009, Thailand's export value was 34,577.88 Millions of USD. It rose to 54,531.19 Millions of USD in 2012. At the same time, if taking a closer look at ASEAN countries, it can be said that Malaysia, Singapore and Indonesia are the most significant trading party of Thailand. After first 11 months of 2013, the export value shared the proportion about 5.7%, 5.0% and 4.9% of total value, respectively. In addition, due to limited amount of data of other countries in ASEAN, we therefore limit scope of the term ASEAN to only those trading parties of Thailand including Singapore, Malaysia, Indonesia and the Philippines. From the above, it brings about the question that can the IRBC model developed by Zimmermann [25] simulate J-curve effect in case of Thailand with ASEAN as trading parties?

## 2. Concept and Theory

### 2.1. Literature Review

From the above question, the literature review has conducted and revealed that whether scope for analyzing correlation between trade balance and real exchange rate features J-Curve or not can be classified into 2 types. The first type is based on econometrical tools used for analyzing dynamic time series data called error correction model and co-integration. The second type refers to IRBC model to simulate situation. It can

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be said that the first research group is based on international trade theories and then applies statistical tools to affirm J curve hypothesis. The second research group, meanwhile, refers to theory of IRBC with belief that such relation is the result of productivity shock and simulation. Over the past decade, most research papers belonging to the first group in Asian countries confirmed the existence of dynamic correlation between trade balance and real exchange rate including Bahmani-Oskooee and Kantipong [5] which analyzed data of Thailand and 5 significant trading parties. At the same time, Yuen-Ling et. al. [24] and Hameed [11] also confirmed such results based on data analysis of Malaysia and Pakistan, respectively. However, Wilson [22] found no obvious statistical evidence in case of Singapore, USA and Japan. Similarly, according to Akbostanci [1], J Curve was not expressly found in Turkey's international trade. In addition, some European works such as that of Jorlén [17] prominently analyzed details of each of 149 products. The econometrical analysis did not confirm correlation in J Curve between Sweden and its trading party. On the other hand, there is limited number of research papers belonging to the second group. IRBC model to replicate J Curve was inspired by Backus *et. al.* [4] and then Zimmermann [25] expanded models to 3 countries of different sizes covering Switzerland and Canada. Rungreangsumrit [19] then applied Backus *et. al.* [2]-[4] for experiment in Thailand. It would be said that the result of that experiment was not complete. Findings from this paper will expand knowledge frontier about IRBC in Thailand.

## 2.2. Model

The model is based on Zimmermann [25]. According to the school of real business cycle, social planner will allocate limited resources at the maximum utility of representative consumer. This optimum point or maximum satisfaction is the same point where resources are allocated under perfect competition market. This implies that the model under this concept has no monetary price variable. Therefore, marginal rate of transformation between domestic supply and import will reflect terms of trade or real exchange rate which is presented in equation (1). International trade balance variable is presented in equation (2).

$$P_{Tt} = \frac{\partial G(Y_{TTt}, Y_{ATt})/\partial Y_{ATt}}{\partial G(Y_{TTt}, Y_{ATt})/\partial Y_{TTt}} = \left(\frac{\omega_{AT}}{\omega_{TT}}\right)\left(\frac{Y_{TTt}}{Y_{ATt}}\right)^{\rho+1} \quad \ldots \quad (1)$$

$$NX_{Tt} = \frac{\alpha_A}{\alpha_T} Y_{TAt} - P_{Tt} Y_{ATt} \quad (2)$$

From equation (1), products produced and consumed in Thailand $(\alpha_T Y_{TTt})$ and imported from ASEAN countries $(\alpha_A Y_{ATt})$ are mixed in function Armington aggregator $(G(\cdot))$ and show quality of homogeneous of degree one as in equation (3). Whereas substitution elasticity between domestic supply and imported item is $\sigma = 1/(1+\rho)$ and $\rho \geq -1$. Products mixed under equation (3) are used for consumption $(C_{Tt})$ and investment in Thailand $(X_{Tt})$ can be shown in equation (4).

$$G(Y_{TTt}, Y_{ATt}) = \left(\omega_{TT} Y_{TTt}^{-\rho} + \omega_{AT} Y_{ATt}^{-\rho}\right)^{-\frac{1}{\rho}} \quad \ldots(3)$$

$$C_{Tt} + X_{Tt} = G(Y_{TTt}, Y_{ATt}) \quad \ldots(4)$$

According to equation (4), considering investment in Thailand at the present time $(X_{Tt})$ will have effect of capital accumulation combining with capital stock in Thailand at the present time $(K_{Tt})$ and being deducted by depreciation of existing capital stock $(\delta K_{Tt})$, we will receive future capital stock $(K_{i,t+1})$ as a motion in equation (5). Capital stock will be used for production of GDP. Nonetheless, apart from existing production factors, the model also determines that the production will be influenced by Total Factor Productivity (TFP, $Z_t$), that is, when TFP increases, it will reflect that technology progress can increase national product even when existing factors are still the same. Definition of technology matrix is

intervened by matrix $Z_t \equiv \begin{pmatrix} Z_{Tt} \\ Z_{At} \end{pmatrix}$ intervened by matrix $\varepsilon_t \equiv \begin{pmatrix} \varepsilon_{Tt} \\ \varepsilon_{At} \end{pmatrix}$ called productivity shock but this shock shows good behavior where $\varepsilon_t \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \upsilon_{TT} & \upsilon_{TA} \\ \upsilon_{AT} & \upsilon_{AA} \end{pmatrix}\right)$.Law of motion of technology manifests dynamic pattern called first-order autoregressive as in equation (6).

$$K_{T,t+1} = (1-\delta)K_{Tt} + X_{Tt} \tag{5}$$

$$Z_{t+1} = \overline{Z} + AZ_t + \varepsilon_{t+1} \ldots \tag{6}$$

$$\text{Matrix } A = \begin{pmatrix} a_{TT} & a_{TA} \\ a_{AT} & a_{AA} \end{pmatrix}$$

where

$a_{ij}, i \in \{T,A\}$ suggesting spillover effect between Thailand and ASEAN. Therefore, Thailand production will be affected from productivity shock both in Thailand and ASEAN provided that production refers to return against constant scale as in equation (7).

$$\mathbf{Y_{Tt} = Z_{Tt} F(K_{Tt}, N_{Tt}) = Z_{Tt} K_{Tt}^{\theta} N_{Tt}^{1-\theta}} \tag{7}$$

where

$N_{Tt}$ refers to Thai labor during t period under the model of neoclassic school, real business cycle. Assuming that labour is identical in all respects which can be analyzed by Representative agent therefore $N_{Tt}$ may reflect working hours of representative agent as well. Parameter $\theta$ refers to return ratio earned by capital stock against total return where $0 < \theta < 1$ . Additionally, labor is the consumer under the model and also representative consumer. The model is fixed to have indefinite life where representative consumer's utility is explained by consumption $(C_{Tt})$and leisure $(1-N_{Tt})$.Therefore, overall utility of Thai representative consumer gained for the entire life is equal to $\sum_{t=0}^{\infty} \beta^t U(C_{Tt}, 1-N_{Tt})$ where $\beta$ refers to utility discount factor where utility is presented by $U(C_{Tt}, 1-N_{Tt}) = \left[C_{Tt}^{\mu}(1-N_{Tt})^{1-\mu}\right]^{\gamma} \Big/ \gamma$ where $\mu$ means proportion between consumption and utility working hours $0 < \mu < 1$ and $\gamma$ represent curve of utility function which will signify level of risk aversion and be less than 1. Nonetheless, in this model, $\gamma = 0$ utility function pattern then changes to:

$$U(C_{Tt}, 1-N_{Tt}) = \mu \log(C_{Tt}) + (1-\mu)\log(1-N_{Tt}) \quad \ldots(8)$$

According to second welfare theorem under economic environment above, resources allocation between Thailand and ASEAN to maximize social welfare will result from decision to be made by social planner that chooses $\{C_{Tt}, C_{At}, N_{Tt}, N_{Tt}\}_{t=0}^{\infty}$ to achieve optimum utility which can be presented in mathematical format as follows:

$$\text{Max} E_0\left(\sum_{t=0}^{\infty} \beta^t \left(\mu \log(C_{Tt}) + (1-\mu)\log(1-N_{Tt}) + \mu \log(C_{At}) + (1-\mu)\log(1-N_{At})\right)\right)$$

Under the constraints according to equation (3) to (7) which are intervened by productivity shock for all periods of time, solving such problems by stochastic dynamic programming method will get state space representation: transition and observation equation. Moreover, we can find dynamic correlation between

terms of trade and trade balance per national product from the correlation as follows: $Cor(NX_{Tt}, P_{Tt+s})$ where $s=-5,-4,-3,-2,-1,0,1,2$ .

# 3. Method and Procedure

## 3.1. Calibration

This paper will divide parameters into 3 groups. The first group is borrowed from the USA case [25], that is, β, μ in utility function, δ in production function and σ in Armington aggregator. The second group is adopted from the average of time series of Thailand and ASEAN including Singapore, Malaysia, Indonesia and the Philippines, i.e. $\theta_T$, $\theta_A$ [10], [20], [23], $\alpha_T$ and $\alpha_A$ for production, $\omega_{TT}$, $\omega_{AT}$, $\omega_{AA}$ and $\omega_{TA}$ for Armington aggregator (Table 1). The third group is derived from estimation by ordinary least square method i.e. matrix A and variance-covariance matrix of ε in technological variables as in equation (9) and (10) [15], [16], respectively. The calculation of technological variables ($Z_T$ and $Z_A$) will be based on data about production, labour and capital stock of Thailand, Singapore, Malaysia, Indonesia and the Philippines from Penn World Table of Feenstra et. al. [8], [21] except capital stock of Indonesia which is derived from Yudanto et al. [23].

Table 1: Parameterization

| **Thailand** | | **ASEAN** | |
|---|---|---|---|
| **Parameter** | **Parameter** | **Parameter** | **Parameter** |
| β = 0.96 | θ = 0.73 | β = 0.96 | θ = 0.58 |
| μ = 0.33 | $\alpha_T$ = 59.20309 | μ = 0.33 | $\alpha_T$ = 292.1343 |
| δ = 0.10 | $\omega_{AT}$ = 0.000835 | δ = 0.10 | $\omega_{TA}$ = 0.001830 |
| σ = 1.5 | $\omega_{TT}$ = 0.41 | σ = 1.5 | $\omega_{AA}$ = 2.46 |

$$A = \begin{bmatrix} 0.968882 & 0.040104 \\ -0.119924 & 0.873337 \end{bmatrix} \tag{9}$$

$$\varepsilon = \begin{bmatrix} 0.002121 & -6.53E\text{-}05 \\ -6.53E\text{-}05 & 0.000659 \end{bmatrix} \cdots \tag{10}$$

## 3.2. Calculation under Steady State

Technological variable is not further intervened in the long term and equal to 1, that is, $Z_T = Z_A = 1$ and average working hour is equal to 8 hours per day. Therefore $N_T = N_A = 0.3$. After that when maximum profit is solved, we will get variables for capital stock and investment at steady state as in equation (10) and (11), respectively, where $Y_T = 3.0815$ and $Y_A = 2.3244$ provided that the real interest rate in the long term (r) is assumed to be equal to 4% p.a. and also assumes that terms of trade and trade balance is equal to 1 and 0, respectively.

$$K_i = \left( \frac{\theta_i N_i^{1-\theta_i}}{r+\delta} \right)^{1/1-\theta_i}; \quad i \in \{T,A\} \tag{10}$$

$$X_i = \frac{\delta \theta Y_i}{(r+\delta)}; \tag{11}$$

## 3.3. Simulation

We will begin with adjustment of problem on seeking for optimum utility under fluctuating economic resources due to productivity shock which is presented in Section 2 by Second – order Taylor series expansion around the steady state. In this regard, Mathematica software is applied to calculate part of

derivatives at steady state of Jacobian matrix $U'(\bullet)$ and Hessian matrix $U''(\bullet)$, respectively. Afterward, the code in Matlab software to lead to solution of stochastic optimal linear regulator problem [18] which can be demonstrated in mathematic format as follow:

$$\underset{\{\tilde{u}_t\}_{t=0}^{\infty}}{\text{Max}} \; E_0 \sum_{t=0}^{\infty} \beta^t \left( \tilde{x}'_t R \tilde{x}_t + 2\tilde{u}'_t W \tilde{x}_t + \tilde{u}'_t Q \tilde{u}_t \right)$$

$$\tilde{x}_{t+1} = A\tilde{x}_t + B\tilde{u}_t + C\varepsilon_{t+1},$$

where

Matrix **R**, **W**,and **Q** is consistent with Jacobian matrix and Hessian matrix, respectively. Matrix **A**, **B**, and **C**, and then followed by Code simulating productivity shock of Thailand and ASEAN. In the first case, shock will intervene with simulation for 1 period of time to see the response to fluctuation of variables in macroeconomic called dynamic responses toward one-standard-deviation innovation. In the second case, 30 simulations will be carried out to find the average where in each simulation, shock is assumed to intervene with simulation 100 periods of time to replicate stylized fact in terms of fluctuation of business cycle of Thailand and ASEAN. Analysis is made based on standard deviation and discounting the trend by Hodrick-Prescott Filter [14]. Time series applied ranges between 1960 – 2010 of national product, consumption, investment and employment in Thailand and in ASEAN which is the total figures of Singapore, Malaysia, Indonesia and the Philippines. The first three variables are received from Penn World Table 7.1. Employment variable is derived from Penn World Table 8.0 of Feenstra et. al. [8], [21] and dynamic correlation between trade balance and terms of trade is analyzed by referring to correlation. The last case, sensitivity analysis is tested by changing elasticity of substitution between domestic product and imported items $(\sigma)$ which is adjusted to 1.48, 1.75 and 1.86, respectively, to see the change to J shape.

## 4. Results and Discussion

Once one-standard-deviation innovation has occurred in Thailand, it will have direct effect on TFP cycle of Thailand which will be the driving force for cycles of all macroeconomic variables including consumption, investment, trade balance, terms of trade and GDP to increase, respectively. Later, TFP cycle will converge to steady state and all macroeconomic variables will also converge to steady state (Figure 1). Please be noted that consumption variable will adjust in lesser increasing direction due to behavior of the consumption smoothing. When income increases in the second period, representative consumer will save part of it for later consumption. During the third phase, consumption will therefore not decrease immediately, that is, representative consumer can divide increased income resulted from positive productivity shock in one period of time for consumption in several other periods. Investment shows more fluctuation than gross domestic product as investment relates to alteration of GDP through accelerator of investment. Increase of investment in addition to consumption will be higher than increase of product which will result in compensation by importing more from ASEAN while trade balance will increase surplus. Therefore, although the IRBC model may be under economic environment rather far from reality but it is sound in terms of economic theory.

If we compare between stylized fact and simulation results of IRBC model where productivity shock occurs 100 periods of time, it shows that standard deviation is more likely to be in line with stylized fact (Table 2). In case of Thailand, the standard deviation of product and consumption under simulation is similar to those from empirical data. With respect to investment, although simulation result is quite lower than empirical data, pattern of fluctuation of simulation as opposed to product cycle is quite in line with empirical data. Investment cycle shows more fluctuation than that of product cycle about 1.06%. At the same time, in respect of ASEAN, its statistical parameters for product, consumption and investment from the simulation are in consistent with empirical data. In summary, consumption cycle varies at similar degree with gross domestic product cycle while investment cycle fluctuates about 3 times above the product. This is in line with the research conducted by the previous literatures [2], [3], [9], [12], [13], [25].

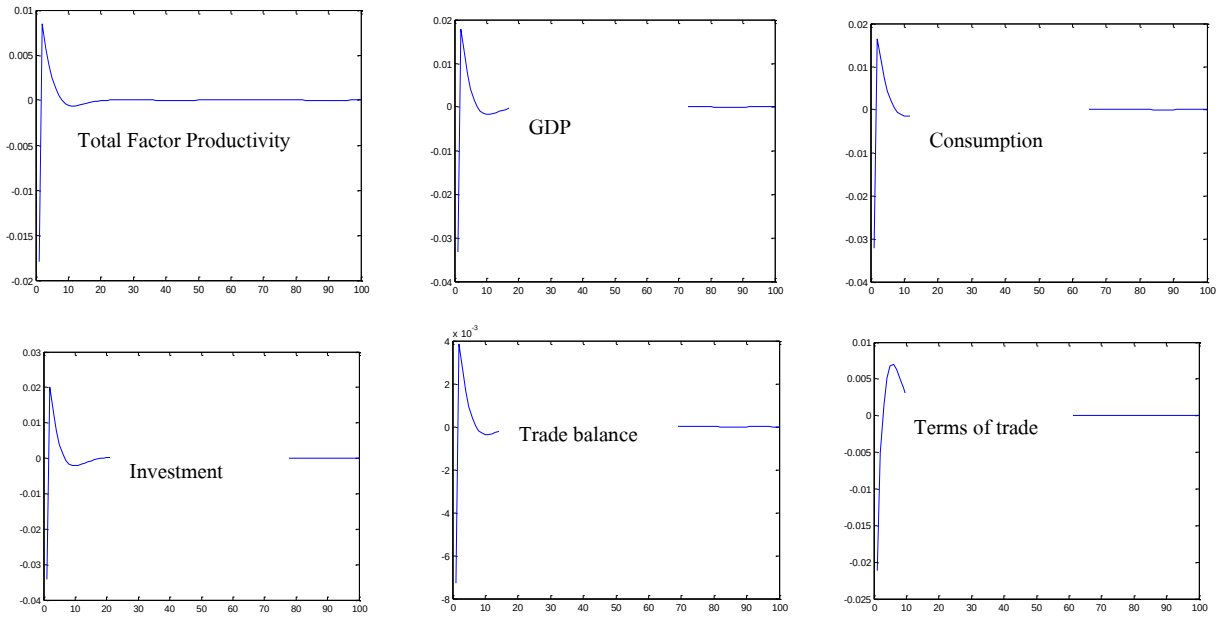


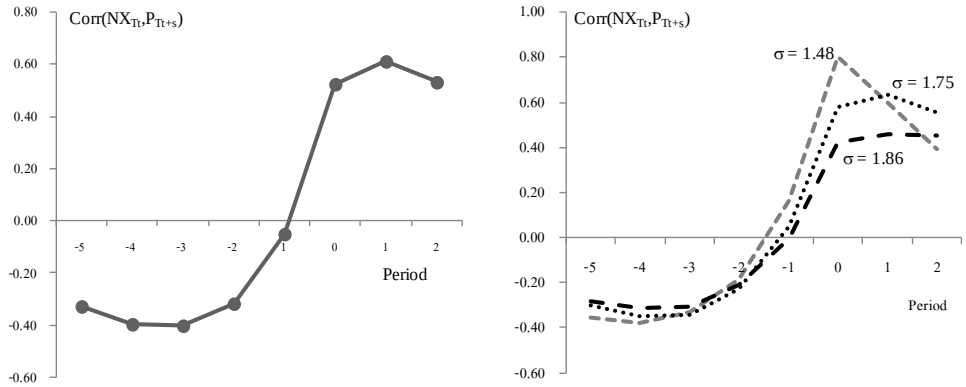

Fig. 1: Dynamic responses of macroeconomic variables toward one-standard-deviation innovation of Thailand in the model.

Table 2: Stylized Fact and Results of Simulation under IRBC Model

| **Standard Deviation (%)** | | | | |
|---|---|---|---|---|
| **Variables** | **Stylized fact (1960-2010)** | | **International Business Cycle Model (100 periods)*** | |
| | **Thailand** | **ASEAN** | **Thailand** | **ASEAN** |
| Production | 4.37 | 3.63 | 4.94 | 3.01 |
| | | | (0.52) | (0.35) |
| Consumption | 4.12 | 3.23 | 4.81 | 3.02 |
| | | | (0.52) | (0.37) |
| Investment | 16.56 | 10.01 | 5.25 | 11.55 |
| | | | (0.55) | (0.98) |
| Employment | 2.74 | 1.22 | 3.62 | 0.18 |
| | | | (0.40) | (0.01) |

Note: *Means of model derived from 30 simulations. Numbers in parentheses refer to standard deviation of 30 simulations.

According to results from simulation of impact from productivity shock on dynamic correlation between trade balance and terms of trade of Thailand, it appears that such correlation manifests in J shape (Fig. 2). Moreover, correlation between trade balance cycle and terms of trade cycle gradually increases from -0.33 to until 0.52. On the other word, it reflects that 5 periods of time with change of terms of trade give benefit for trade balance. This implies that the real exchange rate will not have immediate effect on trade balance of Thailand but it needs time for adaptation. This means that in the very short period, depreciated baht value will still not have benefit for export activity or decrease import volume as it is possible that international trade agreement has been concluded earlier. Therefore, we will not see trade balance having adapted in better direction yet. If comparing with the works of Rungreangsumrit [19], it can be said that our simulation gives more obvious J shape. In addition, if we compare with the results of simulation done in certain developed countries as presented in Backus et. al. [4] analyzing the case of the US and Zimmermann [25] analyzing the case of EC, Switzerland, the US and Canada, it can be said that trade balance of those countries as a large economic scale unit, can adapt more slowly.




a. σ=1.5 b. Sensitivity analysis

Fig. 2: Effects of productivity shock on correlation between trade balance and terms of trade under the model

Furthermore, dynamic correlation is sensitive to parameters of elasticity of substitution between domestic and imported product. It is significant to note that in case this elasticity decreases from 1.86 to 1.48, it will cause Cor($NX_{Tt}$, $P_{Tt-5}$) to decline from -0.28 to -0.35. At the same time, decrease of elasticity will also causes Cor($NX_{Tt}$, $P_{Tt}$) to increase from 0.40 to 0.80. This suggests that depreciation of the real exchange rate will relatively give more benefit for trade balance as negative power to trade balance from imported products should have less effect. In addition, when elasticity decreases to 1.48, it will cause the economic system to adapt over time to only 4 periods. Alternation of terms of trade will hence give benefit for trade balance. However, the head part of J shape seems to be really sensitive where correlation decreases from 0.60 to 0.39. By trying to change such parameter to lesser value, it will cause the simulation to give correlation in complex number.

## 5. Conclusion

The paper attempted to use the IRBC for replicating the correlation between trade balance and terms of trade whether it is in J shape. When applying for simulation of effects from productivity shock toward dynamic correlation between trade balance and terms of trade of Thailand, it shows empirical evidence that such correlation is shown in J shape implying that the real exchange rate will not have immediate effect on trade balance of Thailand but it needs time to adapt. It is, nonetheless, sensitive to variations on the parameter of elasticity of substitution between domestic and imported product. The parameterization should be developed for the future research direction. It should be country-specific for some parameters, as for instant the elasticity of substitution. Apart from this, this paper has quite limited policy implication because the government sector did not plug into the IRBC. According to real business cycle school of thought, cycle fluctuations are all under the optimum utility of representative consumer for the entire life. Therefore, any intervention policy for economic system should not be applied by the government.

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