Original Paper

Exchange Rate and World Currency

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Abstract

This paper explores the derivation of exchange rate and the way of world currency issuing, and some findings are captured as: the world's currency demand is equal to the global export increment, and that every nation's world currency needs should equal to their own export increment. Currently, there are issues with the existing world currency system, which many countries or regions call for change. Because all the existing proposals in the field have their constraints, so this paper suggests that the world central bank issuing a global currency with which each country would take its own share and maintain that the world currency supply to be equal to the global export increments. This will be more sustainable for international business and this theory of world currency does have advantage over existing systems.

Keywords

macroeconomics, world currency, exchange rate, mathematical modeling

1. Introduction

As the international financing and trading expand, more and more world currencies are needed. For the sake of international business developing fairly and sustainably some major challenges need to be addressed, for example, how to calculate exchange rates fairly and reasonably among countries, and another challenge is how to issue world currency fairly. Addressing these two questions together would simplify the discussion of exchange rate and world currency, as the world currency and exchange rate among countries are inseparable topics of discussion. For example, if the exchange rate among two countries for trading is not calculated properly, fairness in the trading could not be achieved; if world currency system is not properly established, there is no fairness in international trading even if the exchange rate is right.

In section II of this paper, the method to calculate fair exchange rate will be discussed. The calculating formula is built upon mathematical logic. It can avoid problems such as statistical errors, short of

variables and logic, which are the common traits among existing exchange rate models. The logic model proposed in this paper can not only calculate the exchange rate between two countries, but also multilateral rates. In the process of the exchange rate discussion, some intermediate conclusions can be used in world currency discussion, such as world currency demand, money supply of a country in a closed and open economy.

In part III of the paper, the existing arguments and proposals on world currency is evaluated. The existing theories share a common point of view, which the mechanisms of world currency should be changed, as existing world currency systems have issues such as economic sovereignty, equity, surplus, poor feeds rich and compare advantage.

By using the conclusion of part 2 to solve the existing problems of current world currency system, the paper calls for a kind of new world currency, which can be issued by world central bank, used for international business and trading only. All the countries and regions would take shares of the world currency, and this share is calculated based on their international trading increment. For trading limited within the country, a domestic currency is still in use.

The proposed world currency has advantages as below:

- The newly proposed world currency is fair and it upholds state economic sovereignty and eliminates poor feeding the rich.

- It reduces the demand of foreign currency reserve and raises world currency efficiency.

- It eliminates surplus and brings comparative advantage into full play.

- It shields inflation among countries and reduces the risk of economic crisis.

- It is a real world currency and sustainable.

2. The Calculation of Exchange Rate

Economists have done a lot of research on the calculation of exchange rate where many mathematical models were built. However, as it seems in the existing models, each model has its own constraints and limitations in its application.

Feenstra, Robert C and Taylor Alan M. presented Interest Rate Parity (IRP) in "International Economics" in 2008. Cassel, Gustav built up Purchasing Power Parity (PPP) in "Abnormal Deviations in International Exchanges" in 1918. Both IRP and PPP take exact same mathematical form, only the determinants differ one from the other. They can be used to examine and judge if the exchange rate between two countries is reasonable or not, however in these models, only three variables are taken into consideration. It is hard to avoid deviations for exchange rate because it is also affected by many other economic variables.

Michael L Mussa's exchange rate model is built according to supply, demand and expected exchange rate change in National Bureau of Economic Research in 1984. It treats currency as goods on the basis of supply and demand to calculate exchange rate. Only a rough one can be reached because the variables such as demand, supply and expected exchange are all estimates. And supply and demand

70

parity shares the same problem with former two models, still short of variables.

Sergio Da Silva published "Class Room Guide to the Equilibrium Exchange Rate Model" on Economic Issues in 2002. On the basis of Douglas Production model, an exchange rate model was built up with mathematical statistics method. As production model already has statistic errors, so on the basis of it the exchange rate model will amplify the statistic errors. More important problem that affects the application of statistical mathematical models is that it is short of the logical relationship among the variables. And another problem of statistical models is that the variables used in building exchange rate models are not enough. Because of the problems above, it is really hard for statistic mathematical models to hold for long term.

There are lots of variables in complicated economy system and they are interdependent upon each other. All the variables changes follow objective laws and logics existing in the system. To find reasonable way to calculate exchange rate, all the related variables should be taken into consideration directly or indirectly in the model and it should be in accordance with mathematical logic.

2.1 Exchange Rate Calculation

In my paper, published in Theoretical and Practical Economy Theory Vol V in 2015, the following exchange rate formula as one of the application of "The Whole Economy Approach of Input and Output Model" is used. The exchange rate between two countries is calculated with formula below:

$$R_e = \frac{M_1^t - \vartheta^t\left(P^o Q^o + Y^o\right)}{\left(1 + \vartheta^t\right) I_m^o - E_x^o + F_o^t - F_i^t}$$

The factors affecting exchange rate are new issued money (M1'), domestic total sale (PQ) and yield (Y) increments, nominal economy growth (ϑ'), import (Im), export (Ex) and inflow (Fi) and outflow (Fo) of foreign currency.

Where superscripts o indicates last period (year), and' the inspecting period (this year).

Formula above is only suit to clear trade off condition, that is, there is no surplus in international trades. In fact the trading surplus and foreign currency reserve (Rf) do exist and they are also the important factors affecting exchange rate among countries. Taking them into consideration, formula above changed into formula 1

$$M_1^t - \vartheta^t\left(P^o Q^o + Y^o\right) - R_e\, R_f^t = R_e\left[\left(1 + \vartheta^t\right) I_m^o - E_x^o + F_o^t - F_i^t + R_f^t\right] \quad (1)$$

Adding term $-R_e\,\vartheta^t\,E_x^o$ on both sides of 1, get the money equality for term T':

$$M_1^t - \vartheta^t\left(P^o Q^o + Y^o\right) - R_e\,\vartheta^t E_x^o - R_e\, R_f^t = R_e\left[\left(1 + \vartheta^t\right)\left(I_m^o - E_x^o\right) + F_o^t - F_i^t + R_f^t\right]$$

$$(2)$$

Checking 2, both side of equality are equal to 0. Left side tells a nation's money demand in open economy.

$$M_1^t = \vartheta^t (P^o Q^o + Y^o) + R_\varepsilon \, \vartheta^t \, E_x^o + R_\varepsilon \, R_f^t$$

In equality above:

$\vartheta^t (P^o Q^o + Y^o)$ — The money demand in closed economy

$R_\varepsilon \, \vartheta^t \, E_x^o$

— To meet the export increment needs, a nation supplies $R_\varepsilon \, \vartheta^t \, E_x^o$

domestic money and uses it to produce export goods sold for $\vartheta^t \, E_x^o$ foreign

currency.

$R_\varepsilon \, R_f^t$

— In order to accumulate foreign currency reserve Rf, a nation needs to pay

equal value of domestic currency to enterprises. $R_\varepsilon \, R_f^t$ will increase domestic

total sales (PQ) mostly by price level increase.

For the countries whose money can't be used as world currency, foreign currency reserve is a big burden. It increases domestic price level and decrease the efficiency of financing resource. It is passive and defensive. So it can be called double burden.

Right side is the country's foreign currency balance sheet:

$$R_f^t = (1 + \vartheta^t)(E_x^o - I_m^o) + F_i^t - F_o^t$$

On the basis of discussion above, new exchange rate formula can be deduced by the left side of F2

$$R_\varepsilon = \frac{M_1^t - \vartheta^t (P^o Q^o + Y^o)}{R_f^t + \vartheta^t E_x^o}$$

For the reason that a country's categories of foreign currency reserve doesn't really reflect its international trading scale, when calculating exchange rate, better to use the formula 3:

$$R_\varepsilon = \frac{M_1^t - \vartheta^t (P^o Q^o + Y^o)}{E_x^t - I_m^t + F_i^t - F_o^t + \vartheta^t E_x^o} \tag{3}$$

2.2 Multi-Countries Exchange Rate

On the basis of two countries exchange rate calculation, three countries formula can be written down. For more countries similar method can be used. Using 3 and adding the corresponding variables to it, a simultaneous equation of three countries exchange rate is shown below:

$$M_{1a}^t - \vartheta_a^t(P_a^o Q_a^o + Y_a^o)$$
$$= (R_{\varepsilon ab} E_{xab}^t + R_{\varepsilon ac} E_{xac}^t) + \vartheta_a^t(R_{\varepsilon ab} E_{xab}^o + R_{\varepsilon ac} E_{xac}^o)$$
$$- (R_{\varepsilon ab} I_{mab}^t + R_{\varepsilon ac} I_{mac}^t) + R_{\varepsilon ab}(F_{iab}^t - F_{oab}^t)$$
$$+ R_{\varepsilon ac}(F_{iac}^t - F_{oac}^t)$$
$$M_{1b}^t - \vartheta_b^t(P_b^o Q_b^o + Y_b^o)$$

$$= (R_{eba}E^t_{xba} + R_{ebc}E^t_{xbc}) + \vartheta^t_b(R_{eba}E^o_{xba} + R_{ebc}E^o_{xbc})$$
$$- (R_{eba}I^t_{mba} + R_{ebc}I^t_{mbc}) + R_{eba}(F^t_{iba} - F^t_{oba})$$
$$+ R_{ebc}(F^t_{ibc} - F^t_{obc})$$
$$M^t_{1c} - \vartheta^t_c(P^o_c Q^o_c + Y^o_c)$$
$$= (R_{eca}E^t_{xca} + R_{ecb}E^t_{xcb}) + \vartheta^t_c(R_{eca}E^o_{xca} + R_{ecb}E^o_{xcb})$$
$$- (R_{eca}I^t_{mca} + R_{ecb}I^t_{mcb}) + R_{eca}(F^t_{ica} - F^t_{oca})$$
$$+ R_{ecb}(F^t_{icb} - F^t_{ocb})$$

In Equation:

Reab - The exchange rate between country a and country b

Imab - Import of country a from country b

Exab - Export of country a to country b

Fiab - Inflow of country b's currency into country a from country b

Foab - outflow of country b's currency into country b from country a

Other variables can be explained similarly.

For every single equality in simultaneous equation, one country's own currency is used for quoting prices and settling accounts. For the equation, there are 6 exchange rates as unknown variables. All others are taken as known. Notice that the exchange rates between two countries exists the relationship:

$$R_{eab} = \frac{1}{R_{eba}}$$

So there are only 3 unknown variables left, and the simultaneous equation is solvable. It can be used to calculate the exchange rate in existing world economy. For simplifying discussion, only 2 related country's currencies were listed. In real application of simultaneous equation, more corresponding used currencies need to be added into equation. It does not change the varieties amount and affect the

solvability of the equation. In addition, a nation's economic growth ϑ^t is assumed to be even in all fields for the same reason.

2.3 World Currency Demand

The world currency demand can be calculated by summing up three countries exchange rate simultaneous equation.

$$M^t_{1a} - \vartheta^t_a(P^o_a + \vartheta^o_a + Y^o_a) + M_{1b} - \vartheta^t_b(P^o_b + \vartheta^o_b + Y^o_b) + M_{1c} - \vartheta^t_c(P^o_c + \vartheta^o_c + Y^o_c)$$
$$= \vartheta^t_a(R_{eab}E^o_{xab} + R_{eac}E^o_{xac}) + \vartheta^t_b(R_{eba}E^o_{xba} + R_{ebc}E^o_{xbc}) + \vartheta^t_c(R_{eca}E^o_{xca}$$
$$+ R_{ecb}E^o_{xcb})$$

In the process of deduction, the export and outflow of country a to country b ($R_{eab}E^t_{xab}$, $R_{eab}F^t_{oab}$)

equal to import and inflow of country b from country a ($R_{eba}I^t_{mba}$, $R_{eba}F^t_{iba}$) respectively, so the

sum of 4 items above is zero. Similarly other exports, imports, outflows and inflows in the

73

simultaneous equation are all canceled out in dual.

The left side of the equality above is the sum of three countries world currency demand and the right side is the sum of three countries export increments. So the total world currency demand is global export increment and every country or region supposed to take its own share.

3. World Currency

As globalization continues to bring international trading opportunities, world currency continues to be a hot topic of discussion. Governments and economists from around the world have been discussing the topic widely and openly, and have made various proposals. The common feature of the proposals is calling for change, because the existing system has vital problems. The issue comes from that only several currencies are acceptable in international business, other countries have to save foreign currency reserve by favor surplus to meet the future needs of international trade and finance safety's sake. That is why surplus exists.

Several rich countries issue world currency is not fair to poor countries. It encroaches on poor countries' economic sovereignty. In following discussion we call the countries who issue more world currency over their share rich, and others poor.

By the mechanism of poor feeding the rich, there formed three economy empires on the world, which is synchronized with that they monopolized world currency. As the surplus is passive and defensive measures taken by poor, there is no clear trade off in international trade, so the compare advantage is out of question.

3.1 Proposals for World Currency

The proposals for world currency roughly go into four categories:

3.1.1 A Global Currency

Journal "The Economist" published "Get Ready for the Phoenix" in 1988, in which they predicted by around 2018, a new global currency "Phoenix" would be in use. Russia president showed off a coin minted with the worlds "Unity in Diversity" at the G8 summit in July 2009, calling for a supra-reserve currency. Robert A. Mundell has suggested creating a world currency for a long time.

3.1.2 Regional Currencies

The European Union created the euro as the regional currency in January, 1999.

In East Asia, North America, South America and Africa there are moves and calls for their own regional currencies.

Ben Steil published "The End of National Currency" in 2007. The author claimed the solution for world currency is regional currency and abandoning monetary nationalism.

3.1.3 Enlarging the List of Reserve Currencies

A UN panel of expert economists proposed a new global reserve currency by greatly expanding SDR on March 26, 2009.

Zhou Xiaochuan, President of People's Bank of China suggested on March 24, 2009, that IMF's SDR

74

could serve as a super-sovereign reserve currency.

3.1.4 A Petro-Currency

At the second South-Arab League Summit on March 30, 2009, Venezuelan President Hugo Chavez proposed the creation of a petro-currency. Petro is only a kind natural resource and could not be used as currency because the distribution of it is not even.

Facing the problem existed in nowadays world currency system, all proposals call for change. Looking at proposals above, all of them has their own flaws to be fixed. A single global currency could never fully replace territorial ones because economic sovereignty. Regional one looks worse because economic sovereignty problem is still there. It also added intermediate link between world currency and national ones, making financing system more complicated and fragile. At same time both of them did not mention how to deal with equity. As a solution, enlarging SDR is moving in right direction. But to equity it is far not enough. A petro-currency is like gold money and out of date.

3.2 Problems

Prior to addressing the world currency issue, it is important to understand the reason for these issues to exist.

3.2.1 Imbalance of Economic Development

Reviewing world currency history briefly, individual country monopolized world currency is in synchronized with the forming of economic empires in different period. It explains clearly that the relationship between unfair world currency issue and imbalance economic development (Table 1).

Table 1. World Currency History Table

Term	World Currency	Economic Empire
17th-19th century	Spanish dollars	Spain
19th-mid 20th century	Pound/Sterling	United Kingdom
mid 20th century-present	US dollar (most of them)	United States

3.2.2 Economic Sovereignty

General accepted macroeconomics definition: Macro-economics is a branch of economics that deals with the performance, structure, behavior and decision-making of the entire economy. Be that a national, regional, or the global economy. Issuing money is one of the most important economic policy decision made by a nation's government. It is one kind of tax and affects the economic performance, structure and behavior of nation's whole economy very badly. The sole legal government can make decisions only within their own country or region. In existing world currency system it is evident that the specific country executed others economic sovereignty in world currency issuing.

3.2.3 Trading Surplus and Foreign Currency Reserve

For future international trading needs and financing safety's sake, poor needs foreign currency reserve, and rich doesn't because their own money are the world currency. The poor have to make it by favorable trading surplus. If no change is made about world currency, the trading surplus will exist forever. This leads to poor feeds the rich.

3.2.4 Poor Feeds Rich

The mechanism of poor feeds the rich can be explained as follows: poor needs favorable surplus as foreign currency reserve, and rich gets adverse one. So rich consumes the total sales is domestic total sales plus adverse surplus by printing world currency. Poor is just in contrary condition. The bigger the surplus, the more poor feeds the rich.

Farther more, almost every identical imported goods price is cheaper in rich than in poor because the fierce export competition among poor and relatively price rigidity of rich's domestic goods and labor cost.

Suppose there are two identical countries, the only difference between them is one issues world currency and the other doesn't. Let TPP means total purchasing power and TPM represents total produced merchandise. There is

$$\frac{(TPM+S)}{TPP} \, rich > \frac{(TPM-S)}{TPP+S} \, poor$$

The inequality above says rich consumes more goods with less money and poor less goods with more money. Because poor needs buying favor surplus from local companies as foreign reserve on the basis of consuming less (S) goods. Let QT and QS represent the good quantity of total produced merchandise and surplus respectively, there is

$$\left(\frac{TPP}{Q_T + Q_S}\right) rich < \left(\frac{TPP+S}{Q_T - Q_S}\right) poor$$

This tells the goods is cheaper in rich than in poor.

3.2.5 Blank Receipt

As international businesses expand, poor needs more reserve. Rich borrows merchandise (surplus) from poor and what rich pays back is their own currency. From the long run, accumulated reserve has no limitation and no schedule to balance due. Even if rich pays back some of them in the future, the reserve's real purchasing power is devalued greatly because the time passes and inflation. So the reserve poor saved by favorable surplus is only a blank receipt (IOU). It means poor provides real wealth to rich and gets blank receipt (reserve) back in return.

3.2.6 Equity

Poor loses some of economic sovereignty, feeds rich and has no limitation and schedule to balance due are all not fair. UN panel pointed out that "the greatly expanded SDR, could contribute to global stability, economic growth and global equity". Sure, equity is most important because no fair, no order, no stability and no peace.

F3 in part II tells something more about fairness. Rich doesn't needs foreign currency reserve, Rf = 0. Since their own money is world currency. Because the adverse surplus (sp) exists, so that:

$$L_m - E_x = sp, \qquad sp > 0$$

Rich's open economy balance sheet is:

$$M_1^t - \vartheta^t (P^o Q^o + Y^o) - R_e R_f^t = R_e [(1 + \vartheta^t)(L_m^o - E_x^o) + F_o^t - F_i^t + R_f^t]$$

If $F_o^t = F_i^t$ then $M_1^t = \vartheta^t (P^o Q^o + Y^o) + R_e \vartheta^t E_x^o + R_e (1 + \vartheta^t) sp$

On the right side of equation, term 1 plus term 2 is domestic money supply, and term 3 is taken as foreign currency reserve by poor. This is similar with poor payed surplus to rich as tax.

If $F_i^t - F_o = \Delta F$ and $\Delta F > 0$ then

$$M_1^t + R_e \Delta F^t = \vartheta^t (P^o Q^o + Y^o) + R_e \vartheta^t E_x^o + R_e (1 + \vartheta^t) sp$$

This equality says rich still taxed poor surplus, but rich reduced the quantity of newly issued money by borrowing from poor like issuing government bonds.

Poor lends ΔF to rich, which is exchanged with real wealth. Rich uses it pay next cycles surplus. No change about "world currency", no end of cycle, and no fair.

3.4 Solutions for World Currency

Strictly speaking, there is no real standard world currency now; the international agreed on currency is still based on powerful countries. For the sake of more efficient global economy, a real world currency and a new world currency system should be created. The world central bank should be in charge of world currency, which is used only in international business and every country and region keeps their own domestic currency. The new issued world currency is shared by all the nations and regions. The new world currency supply is equal to total export (import) increment of the world. Every nation shares it by the sum of their own half export and half import increments for encouraging international trading balance aim. This way the exchange rate calculation between world currency and every domestic money is much easier:

$$R_{eaw} = \frac{M_{1a}^t - \vartheta^t (P_a^o Q_a^o + Y_a^o)}{R_{fa}^t + \vartheta^t E_{xa}^o}$$

And exchange rate between countries:

$$R_{eab} = \frac{R_{eaw}}{R_{ebw}}$$

3.4.1 The Advantage of New World Currency

The proposed world currency has advantages below,

- The fair way of world currency issuing defends all the countries economic sovereignty and eliminates poor feeds rich.

- It reduces the demand of foreign currency reserve and raise world currency efficiency.

77

- It eliminate surplus and brings comparative advantage into full play.

- It shields inflation among regions and reduces the risks of economic crisis.

- It solves the problem of controlling exchange rate.

4. Conclusions

Reasonable exchange rates among the countries can be calculated with classic mathematical method. The existing mechanism of world currency has some fatal problems: economic sovereignty, equity, poor feeds rich, trading surplus and foreign currency reserve, and imbalance of economic development. To resolve this issue, it is important to recognize that the world currency demand is equal to the global export increment. With that in mind, a standardized real world currency controlled by the world bank should be adopted, where every county or region takes its own deserved share. This new proposed system would demonstrate many advantages over the existing system and would be more sustainable in the long run.

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