Redistribution of wealth through cross border financial transactions: A closer look

Nizam, Ahmed Mehedi

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Ahmed Mehedi Nizam
ahmed.mehedi.nizam@gmail.com

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Abstract

Contrary to existing literature, here we consider the foreign exchange reserve balance of a particular country as an indicator of how much goods, services and/or physical asset the country has transferred to the rest of the world in exchange of some fiat foreign currencies. On the other hand, the reserve balances of the rest of the world denominated in the currency of that particular country can be considered as the amount of goods, services and/or physical assets that the particular country has received from the rest of the world in exchange of its own fiat currencies. Hence, if we subtract the second quantity from the first one, we get an estimate of the extent of net non-monetary wealth that the particular country has transferred so far to the rest of the world in exchange of some fiat foreign money. We calculate the amount of net non-monetary wealth (thus defined) transferred to and from some major economies stemming from cross border financial transactions and analyze their long term and short term dynamics using VECM. The main objective of this study is to give a new perspective to what we conventionally mean by foreign exchange reserve of a country: Instead of assuming the reserve balance of a country as an asset we consider it as a measure of gross wealth (i.e., goods, services and physical asset) the country has transferred so far to other countries around the globe in exchange of some *paper* currencies with no intrinsic value.

Keyword

Cross border trade, wealth redistribution, hard currencies

JEL Codes

E01, E21, F14, F41

1 Introduction and the history of US dollar as a hard currency

Nowadays US dollar tends to dominate international foreign exchange market although it has not been so for so long. During the backdrop of the First World War US dollar started to replace pound sterling on its way to becoming the leading international currency of the world discharging a wide array of functionalities for the countries that hold it [10]. Back in 1912 US turned out to be one of the leading trading nations in the world. But to their dismay the exporters back in US found out that the banks in their native land were unable and unwilling to provide for any kind of trade credit

directly to the exporters in US. Rather the banks in US used to seek acceptances through their correspondent relationships with the banks in London and these acceptances were eventually denominated in pound sterling [10]. Acceptances thus obtained were sold in an active secondary market of individuals and institutions in London and in the unusual and unlikely case where no party was intended to purchase the acceptance it was inevitably offloaded to the Bank of England at the existing bank rate [10]. Thus Britain's early start as a trading nation, the existence of an active secondary market for acceptances initiated by the banks in London and the Bank of England backstopping any such unsubscribed acceptances led to the prominence of pound sterling in financing cross border trade credit [10], [26], [28]. Apart from London's proven advantages as a facilitator in international trade credit, banks in US had to come across some regulatory hurdles which resisted them from actively taking part in cross border market of trade credits. National Banking Act prohibited the US banks to open offshore branches while federal legislation stopped them from dealing with trade credit [10]. However, Federal Reserve Act of 1913 gave generous permissions for the US banks to open offshore branches and also allowed them to participate in cross border trade credit [10]. These regulatory reforms along with the advent of First World War in Europe closed the international market of trade credit from London and pound sterling and opened it for New York and US dollar. Since then US dollar starts to dominate international foreign exchange market and nowadays performs a diverse set of roles including but not limited to currency substitution, currency boarding [5], currency pegging [22], trade invoicing [18], bond issuing [31], commodity pricing [6] and so on and so forth. These multifarious roles of US dollar entice countries around the globe to hoard huge amount of US dollars as part of their official reserve. In the process of stockpiling dollars the countries transact real goods and services in exchange of US dollar which is no better than any other fiat currencies with no intrinsic value within. This is also true for all other reserve currencies like euro, Japanese yen, pound sterling, Australian and Canadian dollar, Swiss franc, Chinese renminbi and others. However, the United States, Eurozone, Japan, UK, Australia, Canada, Switzerland, China and any other countries native to any of the hard currencies also maintain foreign exchange reserves which are essentially denominated in currencies other than their own one. So, if we subtract the official foreign exchange reserve of a country from the total amount of global foreign exchange reserve denominated in the currency of that particular country then we will be able to get a cumulative measure of real wealth (goods, services and/or physical assets) that the country has transacted so far with the rest of the world in exchange of its fiat currency. Here, we try to quantify the aforesaid amount of wealth transfer for some major global economies including US, Eurozone, Japan and China and analyze their trends. Main purpose of this study is to rethink the decisions of building up reserve balances in an unreasonable proportion which, according to us, is detrimental to the country itself from consumption, (consumption induced) welfare and ownership point of view. The rest of the article is organized as follows. In Section: 2 we try to investigate why countries tend to accumulate foreign exchange reserve in the first place. Section: 3 elaborates how the official foreign exchange reserve of a country is created gradually through transactions in current and capital account. Section: 4 discusses the role of fiat currency in wealth redistribution and elaborates the scope of the current study. Section: 5 provides a brief description of the official foreign exchange reserve of some major economies and the amount of wealth thus transferred in the process. Section: 6 concentrates the intuitive reasoning presented so far into a mathematical model. Section: 7 compiles the data gathered from different sources and analyzes their long term trends. In Section: 8 we sketch the methodology followed for the empirical measurement. Section: 9 discusses the results of empirical analysis. Section: 10 explains some of the limitations of the current study and its future scope. Finally Section: 11 concludes the article.

2 Why countries choose to stockpile hard currencies like dollar

- **Store of value:** Many countries around the globe often choose US dollar as a safe store of value. It has been estimated that nearly 60% of all US dollars in circulation were held outside the US as on 2005 [35] and these trends are even more noticeable in recent times. For example, at the end of March, 2009 roughly 65% of the US dollar issued or nearly 580 billion in physical US currency outstanding was circulating outside the US [16]. Moreover, as on 2016 nearly 900 billion US dollar in physical form were circulating in countries other than US which comprised 60% of all US dollar issued at that point of time [27]. It has been observed that the demand for US dollar increased steadily during the 1990s and into the early 2000s: A period which witnessed several unprecedented political and economic turmoil including the fall of the Berlin wall, the collapse of the Soviet Union and intermittent crisis in different Latin American countries [27]. The fuss and confusion created thereby, lured countries across the globe to hold physical dollars as a dependable store of value while seeing an extreme volatility in their own domestic currencies. To date Russia and different Latin American countries still hold majority of US dollar circulating beyond the national boundaries [16]. Introduction of euro finally stabilized the demand of dollar although it is highly unlikely for euro to dethrone US dollar from its current role in recent times [16], [27], [30].

- **Medium of exchange in international trade:** US dollar has been predominantly used in international trade as an invoicing currency [18]. Using a sample of some 24 countries, Goldberg and Tille (2008) [15] have shown that US dollar happens to be the currency of choice for both exports from and import to United States. Moreover, drawing on their novel dataset, they have also shown that US dollar has also been extensively used to facilitate international trade as a vehicle currency even when US is not involved in the trade itself. Their second result, i.e., the role of the dollar as a vehicle currency is further analyzed by Gopinath (2015) [17]. Gopinath (2015) [17] has shown that the volume of international trade denominated in US dollar is far more than the US's role as exporter and importer. Gopinath (2015) further finds that the share of dollar as an invoicing currency to facilitate cross border imports is roughly 4.7 times the share of US goods in import while the same is found to be nearly 1.2 for euro. This also happens to be true for export invoicing as observed by Goldberg (2010) [16].

- **Low transaction cost:** In a frictionless ecosystem of international trade there is evidently no reason for cross border transactions between any two arbitrary countries to take place in some vehicle currency [7]. Countries that are involved in such kind of transactions can easily use their own local currencies to facilitate trades between them. However, transaction costs associated with trading in local currencies tempt traders away from using their local currencies and make them more prone to utilize a widely traded and internationally accepted vehicle currency to facilitate such trades [29], [4], [7]. Regardless of the benefits obtained by the traders in the process this eventually provokes an eventual asymmetry in international financial market and thus gives birth to a dominant international currency. Transaction costs associated with the trading in local currencies mainly stem from the fact that now the financial intermediaries have to maintain sufficient balances in a whole spectrum of accounts denominated in different currencies.

- **Sustained liquidity:** Apart from low transaction cost another desirable characteristic for a truly international currency is that it has to maintain sufficient liquidity in the

international market even amidst financial instabilities. It is to be noted in this regard that during the peak of the global financial crisis of 2007-2008 US dollar successfully maintained sufficient liquidity in the trading market which greatly reinforced its role as a truly international currency. Moreover, at the height of the global financial crisis dollar denominated assets performed distinctively well which eventually cemented its position in international currency market [30], [19].

- **Socio-economic stability:** Socio-Economic stability of a region often adds significantly to the choice of the hard currencies. To further investigate the matter we can take a look at the path dollar and euro have traversed on their way to becoming international currencies and also how one surpasses the other significantly in the race. Since the introduction of euro back in 1999 its global usage as an international currency grew steadily and within 2005 it appeared to become one of the leading currencies alongside dollar [30]. However, after that and during the global financial crisis it happens to lose ground to dollar and dollar denominated international corporate bonds see a huge surge in use only at the expense of euro [31]. Moreover, Maggiori, Neiman and Schreger (2019) [30] have also shown that the dominance of US dollar is not confined to the internationally traded bond market. Rather starting roughly around the peak of sub-prime crisis it is equally observed across many other aspects of international currency use. It has been argued that dollar's sustained liquidity during the crisis coupled with sovereign debt crisis in the Eurozone and its subsequent instabilities added greatly to the retreat of euro on its race of becoming the leading international currency [30]. Instability in the Eurozone mainly stemmed from the probable exit of several nations like United Kingdom and others from EU making the investors and lenders alike reluctant to trade on a currency like euro, the existence of which was then merely trembling in the balance.

- **Currency substitution:** Many countries across the globe have chosen to replace their own currencies either completely or partially by the US dollar after declaring the same as legal tenders inside their countries [5]. Within these countries US dollar has been extensively used to transact goods and services in both local and foreign market. To date US dollar has been used to completely replace local currencies in British Virgin Islands, Caribbean Netherlands , El Salvador, Marshall Islands, Federated States of Micronesia, Palau and Turks and Caicos Islands. The list of countries that use US dollar alongside their own currencies is even longer and currently includes Argentina, Barbados, Belize, Cambodia, Iraq and many more. However, US dollar is not the only currency that is used as legal tenders beyond their national boundaries: Australian dollar, euro, Indian rupee, New Zealand dollar, South African rand, Armenian dram, Brunei dollar, Danish kroner, Egyptian pound, Hong Kong dollar, New Israeli shekel, Jordanian dinar, Russian ruble, Swiss franc and Turkish lira enjoy the same status in various proportions. The main benefit the countries reaped in by adopting a hard currency as legal tender is the reduced transaction cost [1] and less volatility in international trade [25] which facilitate economic integration with the rest of the world [3], [34]. Other than trade benefits currency substitution offers greater discipline in monetary and fiscal arena, enhanced macroeconomic stability and financial deepening [25].

- **Pegged exchange rate regime:** Although quite a few countries have either fully or partially replaced their currencies with some hard currencies, other countries with not so strong currencies of their own are more conservative in approach and instead of declaring a foreign currency as legal tenders they tend to peg their currency against some hard currencies. These countries intend to maintain a fixed predefined exchange rate for their currencies against US dollar, euro or some other currencies or currency basket with a view to reduce volatility in foreign exchange market. According to

the de facto classification of exchange rate arrangements around the globe carried out by IMF, currently 43 countries are following some form of pegged exchange rate mechanism [22]. Among these 43 (forty three) countries, 14 (fourteen) countries peg their currencies against US dollar, 18 (eighteen) others use euro as the reference currency, 04 (four) use different currency-mixes as reference while the rest 07 (seven) choose some other currencies as currency anchor. Typically countries that are intended to peg their currency against some other currency must hold sufficient amount of that reference foreign currency in order to stabilize any sharp spike or fall in the currency market through open market operation [11]. Another less used mechanism to maintain currency pegging is to declare currency conversion in any rate other than the prescribed one as illegal. However, it is difficult to implement and may often lead to the creation of black market for foreign exchanges inside the country. Nonetheless some countries like China has been immensely successful in implementing the scheme so far as intended [20].

- **Currency inertia:** Once a currency establishes itself as an international currency it continues to maintain its status due to inertia in currency usage [16]. As the global financial system is adapted to the usage of that particularly strong currency it becomes increasingly difficult to replace it with some other new currencies. In other words the momentum an international currency attains once it establishes itself as a hard currency places it even more firmly in global financial arena. Apart from its essential role of store of value, medium of exchange and currency peg, more and more new roles are created. For example, once the US dollar has solidified its position as a hard currency more and more entities across the world start to issue sovereign and corporate debt securities denominated in US dollar [30]. As on 2017 nearly 70% of all cross border corporate bonds are denominated in US dollar whereas only 20% are denominated in euro [31]. Moreover, share of US dollar in syndicated bank finance reaches as high as 70% during 2017 with a trend pointing even upward [30]. It has been argued that US dollar will continue to hold its position as a leading international currency even if it starts to depreciate considerably [33]. Aside from the empirical investigation of currency inertia Matsuyama et al. (1993) [32] provides a theoretical foundation of currency inertia in the context of a random matching game.

3 How reserves are gradually built up through transactions in current and capital account

Before delving into detail a few preliminary definitions are on the way:

- **Net open foreign exchange position of commercial banks (NOP FX):** NOP FX is defined as the difference between foreign currency assets and foreign currency liabilities of a particular bank and it is often treated to be one of the core financial soundness indicators for banks [23]. If a bank's foreign currency assets are greater than its foreign currency liabilities then it is said to have a long position. On the other hand when the foreign currency liabilities are greater than the foreign currency assets of a bank then the bank's position is termed as short position. Particularly, NOP FX is a measure that indicates how much a bank might gain/lose in the foreign exchange market due to the movements of exchange rate. For example, if a bank has a net long position then an appreciation in domestic currency will lead to less profitability for the bank in its foreign exchange holdings. This is because the bank's net foreign currency asset now means less in terms of local currency. On the other hand if the bank has a net short position in FX market then an appreciation in local currency will add to the profitability of the

bank as the bank's net foreign currency liability now means less in terms of local currency. When the bank's foreign currency asset perfectly matches its foreign currency liability then the bank is said to have a balanced position which shields the bank against exchange rate movements. To limit how much risk a bank may take regulators in many if not all emerging market economies tend to set a specific limit for NOP FX and this limit is often tied to the eligible regulatory capital of the respective bank [21]. Higher the bank's capital higher will be NOP FX limit as capitals are often treated as a cushion against risk [2]. However, many developed jurisdictions often refrain from setting up an explicit limit on NOP FX and in these cases banks' NOP FX limits are ultimately restricted by the risk based capital holding requirements for the banks set out by Basel guideline [2]. We will discuss about it in the next segment.

- **Indirect limit for foreign currency holding:** We have already discussed that many advanced jurisdictions do not set up an explicit limit for NOP FX. However, nowadays central banks in the developed countries are actively advocating the implementation of the recommendations of Basel-III accord [2] in the commercial banks under their respective jurisdictions [9], [12]. According to the first pillar of the Basel-III accord each bank should maintain at least 8% of its total risk weighted asset as capital [2]. Minimum Capital Requirement (MCR) under the applicable provision of Basel-III is calculated by considering risk weighted assets for credit, market and operational risk [2]. If the risk weighted asset associated with any of these 03 (three) risks increases then MCR also increases. If the bank fails to maintain required MCR then it may fall into regulatory treatment. So, banks always try to keep adequate capital by restricting the growth of risk weighted asset in all three buckets. As net uncovered foreign exchange position of the bank or NOP FX is a significant contributor to market risk there is a natural urge from the banks to keep their NOP FX as low as possible. This implicitly prohibits the banks from holding an ever increasing amount of foreign currency assets and/or liabilities.

As we are done with the basic definitions we now discuss how transactions in current and capital account can build or deplete a country's official foreign exchange reserve. Following illustration, i.e., Fig: 1 graphically presents the flow of non-monetary assets and fiat money arising from cross border transactions between any particular country and the rest of the world.

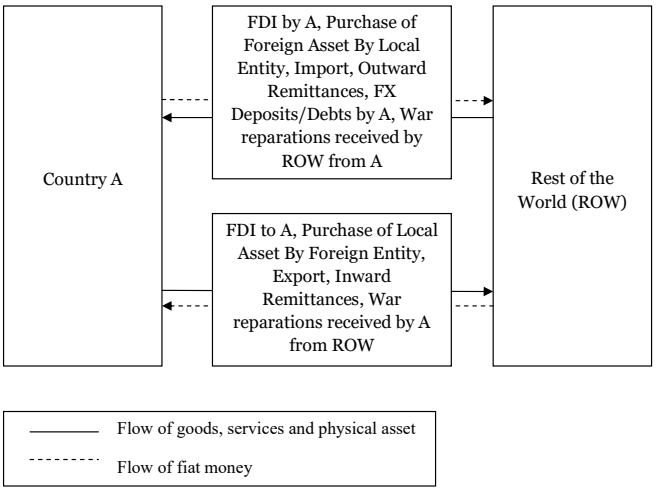

Fig 1. Flow of non-monetary assets and fiat money

- **Import:** When an importer makes payments for his import generally he has two ways. He can either make payment from his own foreign currency account. Or if the applicable law permits he may request his bank to make payment for his behalf either by submitting an equivalent amount of local currencies or by creating a loan account against his name. In either case the bank has to remit the equivalent amount of foreign currencies abroad. If the bank has sufficient foreign currency balance in its respective nostro account then it will not hamper the official foreign currency reserve of the country. If however the bank does not have required foreign currency to make import payment then it may wish to purchase the same from the local central bank. In this case the official foreign currency balance of the importing country reduces by the importing amount.

- **Export:** When an exporter receives his export proceeds in foreign currencies he can do two things with it. Either he retains the foreign currency balance in his account or he may wish to convert it into equivalent local currency from a bank in order to meet his day to day business expenditures. In the later case the foreign currency balance of the exporter's bank increases. Increased foreign currency balance may make the exporter's bank breach its own NOP FX limit. Even if the exporter's bank does not breach its NOP FX limit the above phenomenon must increase the bank's overall market risk and bring it into the realm of enhanced capital requirements according to the applicable provision of the Basel accord. In either case the exporter's bank may choose to sell a portion of its foreign currency holdings to the local central bank. If the central bank agrees to purchase the foreign currencies from the exporter's bank only then the official reserve of the exporting country increases.

- **Inward remittances by domestic factor:** Domestic factor serving abroad may earn foreign currencies and may wish to remit it to its native land. To do so, the factor may wish go to any of the offshore branches of a local bank and gives it the amount in foreign currency to remit it to its native land. In this case the bank purchases the foreign currency and gives an equivalent amount of local currencies to the designated beneficiary in the factor's native land. Again by purchasing foreign currency the bank increases its market risk or even breaches its NOP FX limit. In either case it may wish to sell the foreign currency to the local central bank. If the central bank native to the factor serving abroad purchases the foreign currency then it will add up to the official reserve of the factor's local land.

- **Outward remittances by foreign factor:** Foreign factor serving within a country may wish to remit a portion of its income abroad. This is just the opposite case of what we have discussed in the previous section. In this case the official foreign currency balance of the foreign factor's native land may increase in the process.

- **Purchase of foreign asset by local entity:** If any local entity intends to purchase foreign asset then in the first place he may go to his bank with equivalent amount of local currency (or apply for a credit line from the bank) to initiate a foreign remittance to seller of the foreign asset abroad. If the bank agrees, the local legislation permits and the bank has sufficient foreign currency balance then it may initiate the transaction and local official foreign currency reserve is effectively left unaffected. If however the bank does not have sufficient FX balance then it may wish to purchase it from the local central bank and in this case the local foreign currency balance is depleted by the amount purchased and remitted abroad.

- **Purchase of local asset by foreign entity:** If a foreign entity intends to purchase any local asset then it must remit an equivalent amount of foreign currency through any of the local banks. The bank that receives the inward remittances gives equivalent

local currency to the foreign entity with which the purchase is made. Purchasing foreign currency inevitably increases the local bank's market risk or it may even breach its permissible NOP FX limit. In either case if the bank sells any amount of its foreign currency holding to the local central bank then it will eventually adds to the local country's official foreign exchange balance.

- **Foreign Direct Investment (FDI)**: When a country receives FDI from some other country then the fund can be channeled through two plausible ways: either it transmits through some local commercial banks or it may do so through the local central bank at the receiving end. If the FDI is sponsored by some foreign private sector entity then it is generally transmitted through some of the local commercial banks in the receiving country. In this case, the local commercial banks that receive the foreign currency fund will give away an equivalent amount of local currencies to the foreign entity or its representatives that initiate the remittance. The local bank may choose to sell its foreign currency receipt thus obtained to the local central bank for at least 03 (three) main reasons: 1) in order to meet up its day to day expenditure 2) to maintain its NOP FX limit and 3) to curb market risk and capital charge thereon according to the applicable provision of the risk based capital adequacy guideline issued by the Basel Committee of Banking Supervision. Once the commercial banks sell out their foreign currencies to the local central bank it gets reflected into the country's official foreign exchange reserve balances. On the other hand, with local currency thus received the foreign entity will then acquire local assets i.e., it may buy lands, machineries and other equipments for investment purpose. Instead of direct investment, the foreign entity may also choose to invest in the local stock market and in this case it gets the ownership of some companies' which hold physical assets. In both cases, the foreign entity gets the ownership of real assets in exchange of some fiat foreign currency. However, if the initial foreign investment is sponsored by the foreign government then the fund usually transmits through the central bank and immediately gets reflected into the reserve balance of the receiving country. The rest of the steps are same as above.

- **Foreign currency deposits and debts:** When a country receives foreign currency deposits and/or foreign currency debts then its reserve balance is immediately increased. However, unlike all the transactions discussed above no immediate transfer of ownership of goods, services and/or physical assets takes place in the process. Nonetheless, these foreign currency deposits and debts are supposed to be paid back in foreign currencies and these foreign currencies are in turn earned by the deposit/debt receiving country through any of the aforementioned transactions i.e., export, inward remittances etcetera which involves exchange of physical assets for some fiat currencies. Thus the contribution of foreign currency deposits and debts in the official foreign currency reserve of a country represents the future (deemed) transfer of wealth by the receiving country to its foreign creditors for some paper currencies during the time of settlement.

- **War reparations:** Unlike anything mentioned above a country may receive reparations in foreign currency for damages caused by the war usually from its defeated foes. War reparations add to the receiving country's reserve balances. However, the portion of a country's official reserve balances that are attributed to such compensations does not directly involve any transfer of physical wealth from the receiving to the giving entity. But, if we consider the mechanism inside such reparations then we will be able to reconcile all of its disparities with the other transactions mentioned above. During the war the defeated country inflicted damages in terms of physical assets to the compensation receiving country. Thus we can safely assume that the country that makes such compensation takes possession of the now-destroyed physical

asset (of current book value of zero) previously belonging to the winning country and the winning country receives payment in fiat foreign money which immediately gets reflected into its reserve balances.

4 Role of the fiat currency in wealth redistribution and the scope of the current study

Although the ancient history of the fiat money can be traced back to the 12th century China [37] its modern history began only in the early nineteen seventies when president Nixon of United States unilaterally cancelled the covenants of the Bretton Woods conference and suspended the direct convertibility of US dollar to gold [38]. Since the collapse of the Bretton Woods agreement most (if not all) of the world's currencies are fiat currencies, i.e., they are not backed by any valuables like gold, silver etcetera. The modern fiat money system is in fact incidentally designed to exacerbate global income inequality through at least five main channels namely inflation tax channel, savings redistribution channel, interest rate exposure channel, earning heterogeneity channel and income composition channel [40]. Inflation tax channel stresses that unexpected inflation will disproportionately hurt the households that rely more on cashes to conduct their day to day transactions. It has been argued that the low income households tend to use more cash based transactions as compared to their wealthier counterparts and they are the ones that are most vulnerable to the (negative) redistributive effect of inflation [39]. Thus the welfare cost of inflation is substantially higher for low income households than their wealthier peers and thereby inflation may be treated as regressive taxes on consumption [39]. The second channel namely the savings redistribution channel posits that inflation revalues nominal balance sheet of the households and/or firms where the debtors gain at the expense of the creditors [41]. Using the savings redistribution channel Doepke and Schneider (2006) [42] has shown that the young, middle class households will be benefitted most from moderate inflation episodes as they tend to hold long-term nominally denominated debt in the form of fixed-rate mortgages. On the other hand the main losers will be the rich and elderly households that own majority of government bonds as assets. The third channel of wealth distribution through monetary policy decisions under fiat money system is the interest rate exposure channel which postulates that a decrease in real interest rate will result into an increase in the value of the financial assets. Financial assets appreciates as their future cash flows, i.e., coupon payments, dividends are now discounted with a reduced rate. It has been argued that a decline in real interest rate would redistribute wealth from the short term deposit/bond holders to those who hold long term investments and/or adjustable rate mortgage liabilities [41]. The fourth channel through which monetary policy actions contribute to income and wealth redistribution is known as the earnings heterogeneity channel. According to this channel labor incomes are disproportionately affected by monetary policy shocks, i.e., incomes of high end and low end households may respond differently to monetary policy decisions [43]. Moreover, these responses are not uniform across peoples of different age groups, racial and ethnic categories with different skill sets [44]. The fifth mechanism through which the monetary policy decisions under a fiat currency system may intervene into the income distribution is known as the income composition channel. The idea behind the income composition channel is rather simple: Households at different regions of income distribution may rely upon different means of income generation. For example, the low income households tend to rely upon transfer payments and food stamps whereas the middle income groups depend upon the labor income and high end groups rather rely on business and capital income [40]. As these heterogeneous income sources respond quite differently to incumbent monetary policy shocks so will do the household incomes

at different ends of the income distribution.

Literature cited above tends to describe the distribution of *monetary* wealth inside a country (or a consortium of countries in a monetary union) through monetary policy decision under a fiat currency system. In the above literature wealth indicates monetary or nominal wealth. Here, in the first step, we redefine wealth as the ownership of physical assets, consumable goods and entitlement to certain services instead of some monetary balances that may rest in a bank account. For example, in the context of the current discourse, imports adds to the total wealth of the importing country as it gets ownership of real (non-monetary) assets in exchange of some fiat foreign exchange balances with no intrinsic value. In contrast, export transfers real goods and services from the exporting to the importing country and thereby reduces the total wealth of the exporting country in exchange of some *fiat* monetary gain. Thus, through cross border financial transactions some countries get the ownership of real goods, services and physical assets while the others tend to accumulate balances in their reserve account and these reserve balances are no better than some figures in a table with no consumable value within. Although, the reserve balances can be used to purchase real goods, services and physical assets in the international market, its value can only be realized when such a purchase actually takes place, i.e., unless it is used it does not deliver any value. Here, after redefining wealth in such a (non-monetary) way we analyze the role of cross border transactions in current and capital account in the distribution of non-monetary wealth amongst the participating countries.

5 Official foreign exchange reserves of the whole world

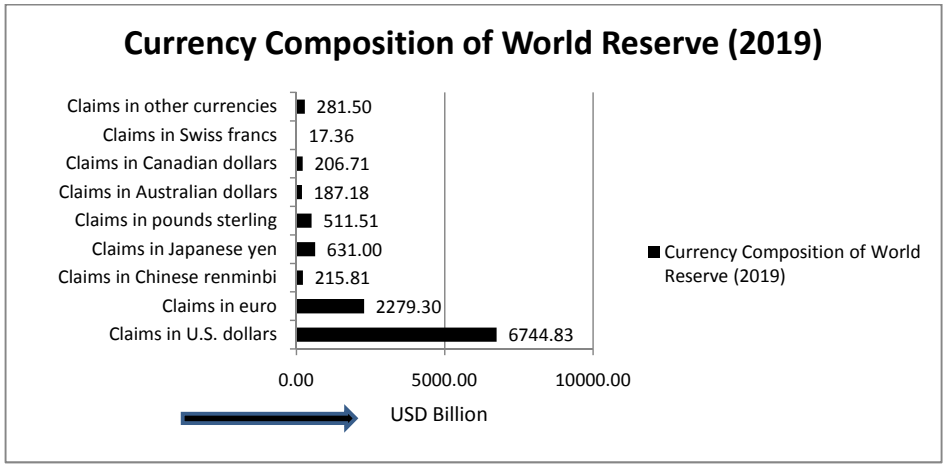

Fig 2. Total allocated foreign currency reserve of the whole world in 2019. Data source: IMF COFER Database [24]

According to the IMF COFER database [24] the total allocated foreign currency reserve of the whole world during 2019 is found to be nearly USD 11.08 trillion. Fig: 2 demonstrates the currency-wise composition of the consolidated foreign exchange reserve of the whole world. Reserve balances maintained in currencies other than US dollar are converted into equivalent US dollar amount by using the year end market exchange rate [24]. From Fig: 2 it is evident that USD 6744.83 billion or 60.90% of the total allocated foreign exchange reserve of the world is maintained in US dollar while USD 2279.30 billion or 20.58% is maintained in euro. Starting as an international reserve currency back in 2016 Chinese renminbi contributes to around 1.95% of the total foreign currency re-

serve of the whole world. However, it is still preceded by Japanese yen and British pound.

So far we have seen that the world's official foreign currency reserve is primarily denominated in US dollar. Now let us have a look at the foreign exchange reserve maintained by the United States itself. According to the data reported in IMF international Financial Statistics (IFS) and World Bank [36] total official reserve balances of US is found to be USD 118 billion in 2019 which is substantially lower than the US dollar denominated official reserve balances of the rest of the world. If we superimpose official foreign exchange reserve of United States with the dollar denominated foreign reserve of the rest of the world in the same figure we get the picture as depicted in Fig: 3.

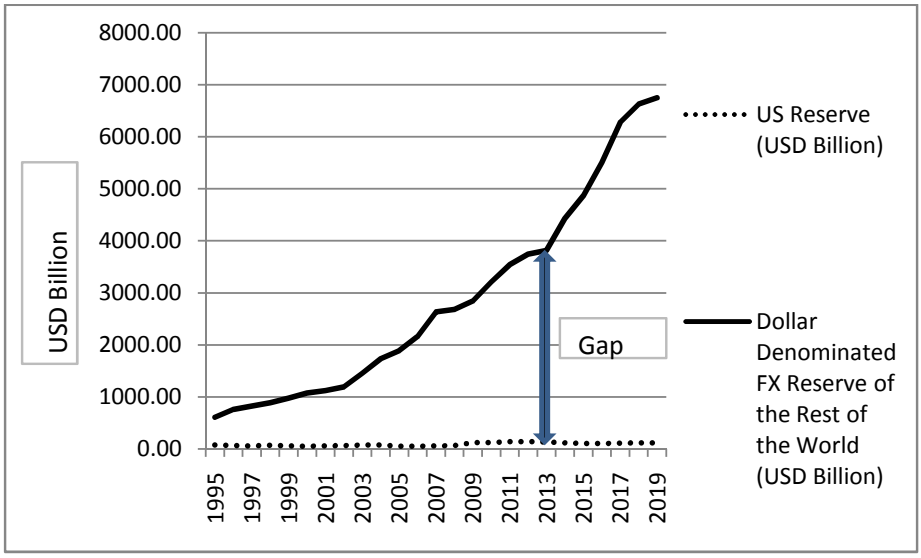

Fig 3. US Reserve VS reserves of the rest of the world in US dollar. Data sources: [36], [24]

From Fig: 3 we see an ever increasing gap between dollar denominated foreign exchange reserve of all countries except United States and the official reserve balance of United States itself. Official reserve balance of United States does not rise much from 1995 to 2019. Rather it is seen to maintain a relatively steady level and in 2019 it reaches nearly USD 118 billion in equivalent amount. However, during the same period US dollar denominated reserve asset across the globe has been soared into a formidable level as can be seen from the snapshot of 1995-2019 and the gap between these two series is steadily increasing ever after. In fact, like other countries the official reserve balances of United States have been accumulated over the course of time from the transactions in current and capital account. It is an indication of cumulative amount of wealth (goods, services and/or physical asset) that US has transacted for some fiat foreign currencies. On the other hand, dollar denominated reserve balances of the rest of world indicate the amount of real goods, services and assets the rest of world has produced and transacted for US dollar which itself is a fiat currency with no intrinsic value. Thus the gap between the two indicates the net amount of real goods, services and/or physical assets that have been either transported to United States physically or some US entities have acquired the ownership of it so far in abroad or some other US entities have consumed an equivalent amount of services in the process in exchange of *fiat* US dollar.

6 Proposed model for cross border non-monetary wealth transfer

To begin with let us assume that R_{AB} denotes the official reserve balance of country A denominated in the currency of country B. Let us also assume R_{BA} denotes the official reserve balance of country B denominated in A's currency. Then the amount of net wealth transferred to country A from country B is given by the following:

$$W_A = R_{BA} - R_{AB}$$

If $R_{BA} > R_{AB}$ then W_A will be positive. It implies that country A has gained net wealth (in goods, services or physical assets) from country B in exchange of its own fiat currency. However, if $R_{BA} < R_{AB}$ then it means country A instead has transferred net wealth to country B and has received payment in fiat currency of country B. When $R_{BA} = R_{AB}$ then it means no net transfer of wealth between the two countries has occurred and the system is in the balance. The above idea can be extended for multiple countries as well and to do so let us assume there are n different countries in the world which are designated by the number 1 to n. Then for any country $i, 1 \leq i \leq n$, W_i indicates the amount of net wealth that has been transferred to country i from the rest of the world for which country i has paid in its fiat money and it is given by the following construct:

$$W_i = \sum_{\substack{j=1 \\ j \neq i}}^{n} R_{ji} - \sum_{\substack{j=1 \\ j \neq i}}^{n} R_{ij}$$

The first operand on the right hand side indicates the total amount of reserve balances of all the countries denominated in the currency of country i whereas the second operand namely $\sum_{\substack{j=1 \\ j \neq i}}^{n} R_{ij}$ denotes the total reserve balances maintained by country i in all the currencies other than its own. Thus W_i estimates the net amount of wealth that has been transferred to country i in exchange of the intrinsically valueless fiat currency of country i.

7 Compiled data

To start with we collect time series data of total official foreign currency reserves without gold for USA, Eurozone, Japan and China from World Bank Open Data [36]. We also collect currency composition as well as the volume of the total allocated foreign currency reserve of the whole world from IMF COFER database [24]. In the next step we subtract the official foreign currency reserve of a country/region from the total official foreign reserve of the whole world denominated in the currency of that particular country/region in order to calculate the value of W. We calculate W for USA, Eurozone [1], Japan and China. Choice of countries/regions stems from the facts that nearly 80.48% of the world's reserves are maintained in US dollar and euro while China and Japan jointly hold 39.80% of the total allocated foreign currency reserves of the whole world [36], [24]. The timeframe we use for our empirical analysis extends from 1999Q1 to 2019Q1. We start from 1999 because it is when euro was introduced as a regional currency intended for circulation inside the European Union replacing some of the dominant international currencies of the world including Deutsche mark, French franc, Italian lira and many more. Descriptive statistics of the time series values of W for China, Japan, Eurozone and USA are presented in Table: 1.

[1] Eurozone is officially the set of countries inside the European Union that use euro as legal tenders and currently includes Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain [13].

Table 1. Statistical characteristics of W (in USD Billion) for China, Japan, Eurozone and USA. Data sources: [36], [24]

Particular	W (China)	W (Eurozone)	W (Japan)	W (USA)
Mean	-2019.52	820.06	-757.91	2953.87
Median	-2416.04	963.40	-831.48	2693.45
Maximum	-157.73	1890.47	-212.14	6608.65
Minimum	-3859.17	-20.86	-1064.62	821.83
Std. Dev.	1316.35	540.10	243.22	1702.02
Skewness	0.19	0.02	0.97	0.62
Kurtosis	1.43	2.06	2.76	2.33
Jarque-Bera	8.84	3.02	12.82	6.66
Probability	0.01	0.22	0.00	0.04
Sum	-163581.10	66425.19	-61390.37	239263.70
Sum Sq. Dev.	139000000.00	23336441.00	4732582.00	232000000.00
ADF t-Stat (Level)	-1.2673	-1.7031	1.0291	-0.5448
p-value	0.8886	0.7409	0.9999	0.9794
Remark	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary
Observations	81.00	81.00	81.00	81.00

From Table: 1 we can see that the mean values of W for China, Japan, Eurozone and USA are $(-)2019.52, $(-)757.91, $820.06 and $2953.87 billion respectively. This implies that China and Japan have so far transferred $2019.52 and $757.91 billion of wealth (goods, services and/or ownership of physical assets) to the rest of the world and have accumulated some paper currencies in return. On the other hand, Eurozone and USA have acquired $820.06 and $2953.87 billion equivalent in real assets in the process. As anticipated, the values of W for Chinese and Japanese data are significantly negative (as evident from their soaring foreign currency reserve) while for Eurozone and US, the values are significantly positive (which is also discernible from the dominance of US dollar and euro in the official reserve portfolio of the rest of the world). Moreover, the standard deviations of the 04 (four) W series are high as anticipated. Absolute values of skewness for all the four series are found to be less than 1 (one) which imply that the series are roughly unskewed. However, the kurtosis of the series are greater than 1 (one) in all cases which imply we have peaked series. As evident from the values of kurtosis, Jarque-Bera test also suggests that the series do not follow normal distributions. Moreover, the ADF test statistics suggest that all the series are non-stationary at level.

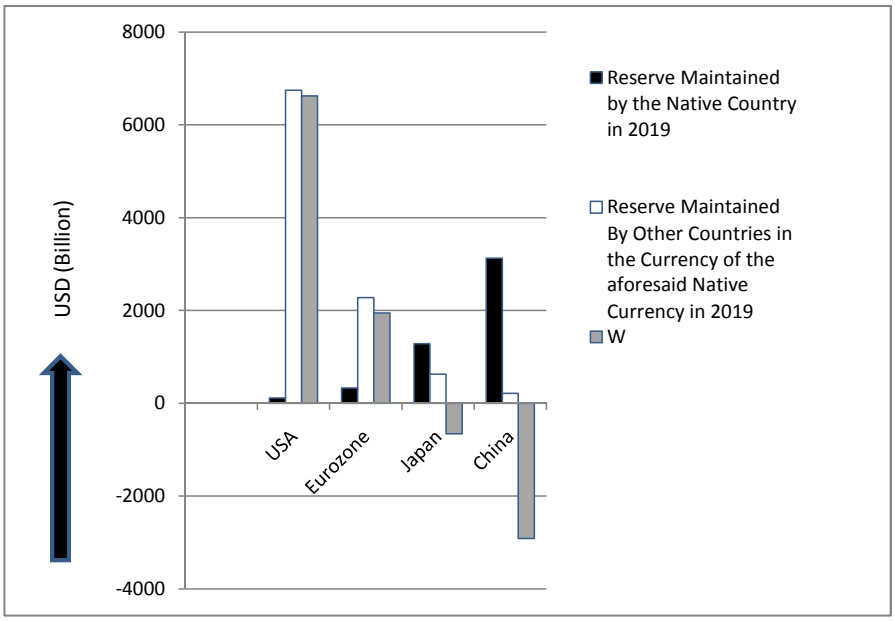

Fig 4. Extent of wealth transfer (W) to US, Eurozone, Japan and China up to 2019. Data sources: [36], [24]

Country/region wise data of national/regional reserve asset, currency-specific global reserve asset and the quantity W for USA, Eurozone, Japan and China up to year 2019 are presented in Fig: 4. From Fig: 4 it can be seen that the reserve maintained by US in 2019 amounts to USD 118.44 billion (shown in black). As for US, reserve assets are maintained in any currency other than US dollar. On the other hand total amount of reserve balance of the rest of the world denominated in US dollar is found to be USD 6744.83 billion (shown in white) resulting into a W value of USD 6626.40 billion (shown in grey). The value of W indicates that net real asset purchased by US by its fiat currencies from the rest of the world amounts to USD 6626.40 billion up to year 2019.

Next from Fig: 4 it is evident that the total official foreign currency reserve maintained by the 19 countries in the Eurozone amounts to nearly USD 329 billion (black column) while the reserve asset of the rest of the world denominated in euro is found to be approximately USD 2279.30 billion (white column) which far exceeds the accumulated reserve asset of the entire Eurozone. This implies that cumulative amount of net wealth up to 2019 that has been transferred to the countries in the Eurozone from the rest of the world in exchange of their fiat money (euro) is simply the difference between the two or USD 1950.30 billion (grey column).

So far we have seen that US and Eurozone have obtained real assets from the rest of the world in exchange of their hard currencies. On the opposite side of the mirror there must be other countries in the globe that have added significantly to the process. In fact the countries that tend to hold the majority of dollar and euro denominated reserves are the ones that fueled such flow. According to the IMF COFER database [24] China and Japan are the two countries that jointly hold a substantial portion of the total foreign exchange reserve of the whole world. In 2019 total foreign exchange reserve of China amounts to nearly USD 3127.49 billion which is mostly denominated in US dollar while Japan comes at second with USD 1284.97 billion. On the other hand Chinese renminbi now appearing as a reserve currency currently accounts for 1.95% of the world reserve. Moreover, Japanese yen has long been treated and used as a reserve currency by the rest of the world and to date 5.70% of the world reserves are denominated in it. Although the Chinese renminbi and Japanese yen nowadays are widely regarded as

reserve currencies across the globe the reserves denominated in these two currencies are disproportionately low as compared to the reserves maintained by these countries resulting into a net transfer of wealth from these regions to the rest of the world. Thus the value of W is expected to be negative for these countries and as can be seen from Fig: 4 it amounts to USD (-) 2911.68 billion and (-) 653.97 billion for China and Japan respectively. How national/regional reserve assets and global currency-specific reserve assets evolve over time are depicted in Fig: 5.

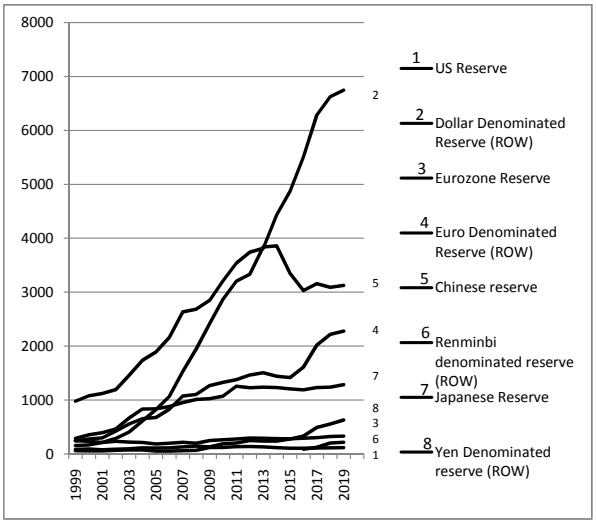

Fig 5. Trend of country-wise and currency-wise reserves. Data sources: [36], [24]

Fig: 5 presents historical data of official foreign currency holding of US (series 1), Eurozone (series 3), China (series 5) and Japan (series 7) from 1999 to 2019. From this figure it is evident reserve assets of US and Eurozone are very low as compared to the reserves of China and Japan. However, the exact opposite holds true for the reserve assets denominated in the currencies of these countries/region where US dollar and euro denominated reserves top the list while the reserves maintained in Japanese yen and Chinese renminbi are quite low. The significant difference between the two series attributes to the net transfer of wealth from China and Japan towards USA and Eurozone. That means China and Japan have so far exchanged a substantial amount of goods, services and/or physical assets to US and Eurozone in exchange of US dollar and euro. By stockpiling US dollar and euro these countries have arguably obtained substantial power to import goods and services to their lands in any time in the future. However, the hoarding of US dollar and euro can be only justified if these countries choose to use up their reserve for purchase and/or import of real goods and services. But, they do not seem to use it at all and rather their reserve holdings are instead skyrocketing day by day as can be seen from Fig: 5. These dynamics result into substantially positive values of W for US and Eurozone at the expense of strikingly negative values of W for China and Japan as can be seen from Fig: 6.

Fig: 6 shows that the values of W for USA, Eurozone, China and Japan have been somewhat stabilized to these days. But, if we extrapolate them into the future using ARIMA model then we can find the values of W for US and Eurozone will rise further above whereas for China and Japan the values will dive into even deeper negatives after crossing the apparent stagnation. The forecasting outcome is graphically presented in Fig: 7. The details regarding ARIMA model selection are available upon request.

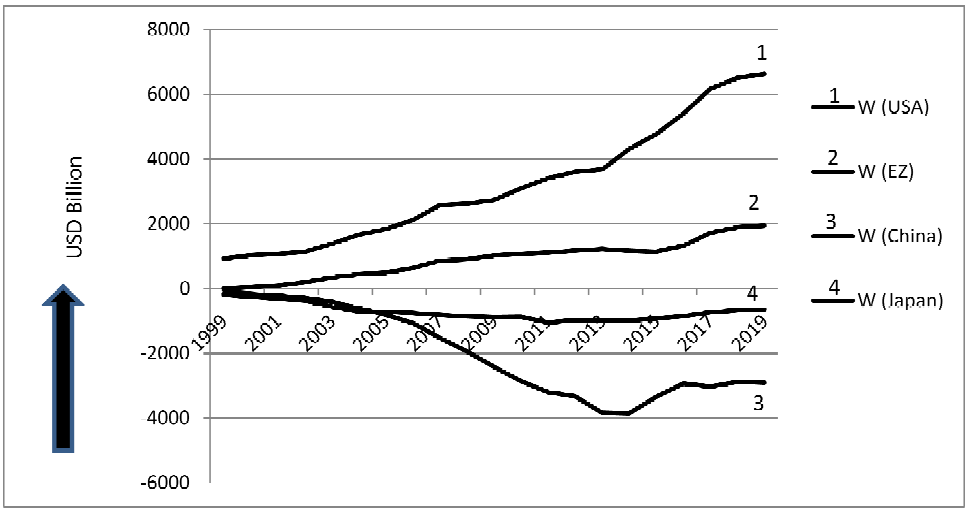

Fig 6. Trends of W for US, Eurozone, China and Japan. Data sources: [36], [24]

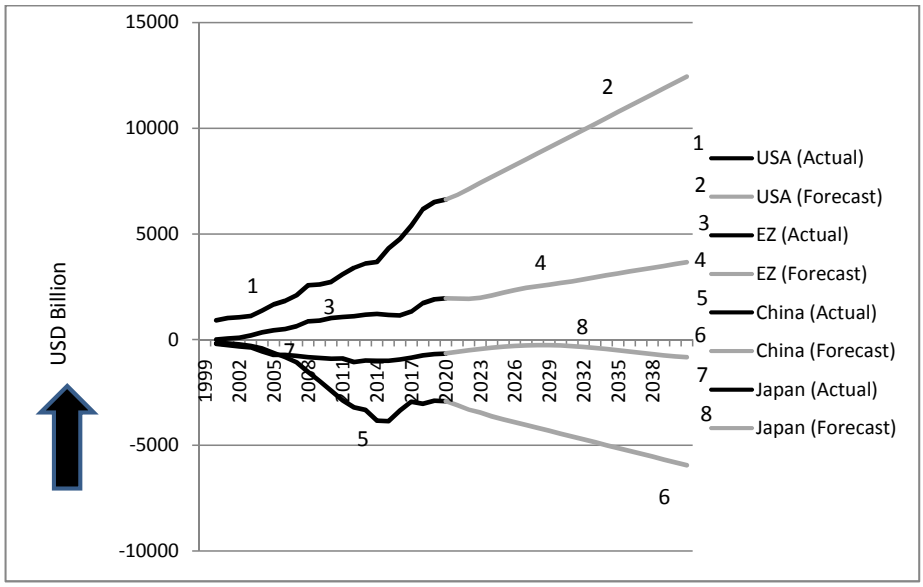

Fig 7. Forecasted values of W for US, Eurozone, China and Japan. Data sources: [36], [24]

8 Statistical methodology

As redistribution W involves transfer of goods, services and/or physical assets from one country to another if we sum up the values of W across all countries around the globe we will get a zero i.e., $\sum_{i=1}^{n} W_i = 0$. This is because if the value of W is positive for a country/region it implies some other countries/regions have transferred net wealth to that particular country/region and hence the value of W will be negative for these *some other countries/regions*. Hence, the values of W across different countries of the globe should move together and in statistical term this co-movement means cointegration. Before we can perform any test for cointegration like the Johansen Test, ARDL Bounds Test or something like this we need to determine the appropriate order of integration of our underlying time series. So the first step of our empirical analysis involves determining the order of integration of W for different countries/regions under consideration. We

use ADF Unit Root Test and Phillips-Perron Test to do so and we consider the time series values of W for USA, Eurozone, China and Japan during the time period $1999Q1$ to $2019Q1$. These time sereis of W for USA, Eurozone, China and Japan are denoted by W_U, W_E, W_C and W_J respectively.

As we will mention in the next section all the time series are found to be $I(1)$ which qualifies them for Johansen Cointegration Test. Johansen Test seeks to determine the probable number of cointegrating relations amongst the variables where each of the cointegrating relations describes a stationary linear combination of W_U, W_E, W_C and W_J. Johansen Test comes up in two different flavors: One intends to rely on Trace Statistic while the other depends upon Max-Eigen Statistic to determine the number of equilibrating relationships. We report both the statistics here.

Once the cointegration amongst the variables has been confirmed we construct the long run cointegrating relation as well as 04 (four) Error Correction Models (ECM) (one for each of the endogenous variables) to describe the short run dynamics. The following long run cointegrating relationship has been estimated:

$$W_J + A_1 \times W_C + A_2 \times W_U + A_3 \times W_E + A_4 = 0 \quad (1)$$

where W_J, W_C, W_U and W_E represent the values of W for Japan, China, USA and Eurozone and A_1, A_2, A_3 and A_4 are constants. As we know from Granger Representation Theorem [8] if a set of non-stationary time series variables are found to be cointegrated then there exists certain Error Correction Mechanisms (ECM) to generate the series. Here, we estimate the following ECMs to analyze the short run dynamics of the underlying time series variables:

$$D(W_J) = C_1 \times CE + C_2 \times D(W_J(-1)) + C_3 \times D(W_J(-2)) + C_4 \times D(W_C(-1)) + C_5 \times D(W_C(-2)) + C_6 \times D(W_U(-1)) + C_7 \times D(W_U(-2)) + C_8 \times D(W_E(-1)) + C_9 \times D(W_E(-2)) + C_{10} \quad (2)$$

$$D(W_C) = C_{11} \times CE + C_{12} \times D(W_J(-1)) + C_{13} \times D(W_J(-2)) + C_{14} \times D(W_C(-1)) + C_{15} \times D(W_C(-2)) + C_{16} \times D(W_U(-1)) + C_{17} \times D(W_U(-2)) + C_{18} \times D(W_E(-1)) + C_{19} \times D(W_E(-2)) + C_{20} \quad (3)$$

$$D(W_U) = C_{21} \times CE + C_{22} \times D(W_J(-1)) + C_{23} \times D(W_J(-2)) + C_{24} \times D(W_C(-1)) + C_{25} \times D(W_C(-2)) + C_{26} \times D(W_U(-1)) + C_{27} \times D(W_U(-2)) + C_{28} \times D(W_E(-1)) + C_{29} \times D(W_E(-2)) + C_{30} \quad (4)$$

$$D(W_E) = C_{31} \times CE + C_{32} \times D(W_J(-1)) + C_{33} \times D(W_J(-2)) + C_{34} \times D(W_C(-1)) + C_{35} \times D(W_C(-2)) + C_{36} \times D(W_U(-1)) + C_{37} \times D(W_U(-2)) + C_{38} \times D(W_E(-1)) + C_{39} \times D(W_E(-2)) + C_{40} \quad (5)$$

In the above set of equations CE represents the long run cointegrating relation amongst the variables and $C_i, \forall_{1 \leq i \leq 40}$ denotes the coefficients of CE in respective ECM (C_1, C_{11}, C_{21} and C_{31}), coefficients of different lagged terms of the endogenous variables ($C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{12}, C_{13}, C_{14}, C_{15}, C_{16}, C_{17}, C_{18}, C_{19}, C_{22}, C_{23}, C_{24}, C_{25}, C_{26},$

$C_{27}, C_{28}, C_{29}, C_{32}, C_{33}, C_{34}, C_{35}, C_{36}, C_{37}, C_{38}$ and C_{39}) as well as fixed regressors (intercept) (C_{10}, C_{20}, C_{30} and C_{40}). The choice of lag length for the endogenous variables in the Error Correction Model (ECM) is inspired from the values of different information criteria which are further elaborated in the next section. There are 04 (four) ECMs for the 04 (four) variables each serving a designated purpose: If any of the variables has been found deviated from its equilibrium position the respective ECM will bring it back to its equilibrium. To serve this purpose the estimated coefficient of cointegrating equation in the respective ECM must be negative and significant. Negativity of the coefficients of cointegrating equation in the ECM represents a kind of mean reversion process which is central to the concept of cointegration.

Apart from examining the presence of mean reversion in ECM we will also measure the goodness of fit for each of them. We report the R-Squared, Adjusted R-Squared, F-Statistic and probability of F-Statistic for each of the Error Correction Models (ECM). Moreover, we also note down the values of Durbin-Watson Statistic for each of the model to determine whether the residuals of the models suffer from serial correlation.

9 Results

We begin our analysis by performing ADF Unit Root Test and Phillips-Perron Test which are intended to determine the order of integration of the time series used in the analysis and the results are available upon request. It is to be noted from the results that all the four variables namely W_J, W_C, W_U and W_E are integrated of order one i.e., $I(1)$ which qualifies them for Johansen Cointegration Test.

Before we can run the Johansen Cointegration Test we need to determine the appropriate number of lags to be used. To do so we build unrestricted VAR models with lag lengths [1-4] for W_U, W_E, W_C and W_J and note down the values of different information criteria including Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn Criterion (HQC). Lag length that minimizes the majority of the information criteria is selected as the optimal lag length to be used in Johansen Test as well as to build appropriate Error Correction Model (ECM). Details of the lag length selection process are available upon request. Optimal lag length is found to be 03 (three) which minimizes 04 (four) out of 05 (five) information criteria.

Table 2. Johansen Cointegration Test using Trace Statistic

Null Hypothesis	Trace Statistic	Critical Value (5%)	p-value
Number of Cointegrating Equation r = 0	71.80764	47.85613	0.0001
Number of Cointegrating Equation r = 1	44.40043	29.79707	0.0006
Number of Cointegrating Equation r = 2	19.09388	15.49471	0.0137
Number of Cointegrating Equation r = 3	0.886672	3.841466	0.3464

Once the optimal lag length has been selected we carry out Johansen Cointegration Test. The results of the Johansen Test are depicted in Table: 2 and 3. From Table: 2 we can see that the values of the Trace Statistics are greater than the corresponding critical values @5% level for $r = 0, 1, 2$ (Here, r denotes the number of cointegrating equations). However, for $r = 3$ the value of the Trace Statistic is found to be 0.886672 which is lower than the critical value of 3.841466. Moreover, the corresponding p-value is found to be 0.3464 which is greater than 5%. So, the null hypothesis of at most 03 cointegrating equations cannot be rejected @5% level.

Table 3. Johansen Cointegration Test using Max-Eigen Statistic

Null Hypothesis	Max-Eigen Statistic	Critical Value (5%)	p-value
Number of Cointegrating Equation r = 0	27.40721	27.58434	0.0526
Number of Cointegrating Equation r = 1	25.30655	21.13162	0.0122
Number of Cointegrating Equation r = 2	18.20721	14.2646	0.0113
Number of Cointegrating Equation r = 3	0.886672	3.841466	0.3464

However, the Max-Eigen Statistic produces quite different results regarding the number of cointegrating equations @5% level. From Table: 3 we can see that null hypothesis of $r = 0$ number of cointegrating equation cannot be rejected @5% level. The Max-Eigen Statistics for no cointegration is 27.40721 which is slightly less than the corresponding critical value of 27.58434 and the p-value is a little bit above 5% (5.26% to be precise). But, if we consider 10% confidence interval instead of 5% then we can reject the null hypothesis up to $r = 2$ number of cointegrating equations and accept it for $r = 3$. In this case i.e., if we consider 10% confidence interval instead of 5% then the results produced by Max-Eigen Statistics would be identical to that produced by Trace Statistics which confers the presence of cointegration amongst the variables.

After the cointeration has been confirmed we construct a long run cointegrating relationship amongst the variables. The estimated coefficients of the cointegrating equation as described by Equation: 1 are given in Table: 4.

Table 4. Coefficients of Endogenous Variables in Cointegrating Relations

Particular	A_1	A_2	A_3
Coefficient	0.089123	−0.795393	2.490755
Standard Error	0.08652	0.13499	0.5034
t-Statistics	1.03014	−5.8924	4.94791

From the above cointegrating relation it can be noted that W_J is negatively related to W_C and W_E (as can be seen from the positive values of A_1 and A_3). However, W_J is found to be positively correlated to W_U as evident from negative value of A_2 in the cointegrating relation. In the next step we substitute the values of A_1, A_2, A_3 along with the estimated value 1248.54 of the fixed regressor A_4 into the Error Correction Models and investigate into the statistical properties of the ECMs. It is to be noted that in the ECMs described by Equation: 2-5 we have considered 02 lags for each of the endogenous variables whereas the lag selection criteria suggest to take 03 lags for unrestricted VAR models. This is because each of the endogenous variables has been differenced one time in the ECMs which reduces the optimal lag length by 01.

Estimation results of the Error Correction Model-1 given by Equation: 2 are presented in Table: 5 and 6. From Table: 5 it is evident that the coefficient of the cointegrating relation (C_1) in the ECM is −0.024521 and the corresponding p-value is 0.0096. Coefficient of the cointegrating relation C_1 also known as the speed of adjustment represents how fast the variable $D(W_J)$ will return to its long run equilibrium once distorted. The negative value of speed of adjustment confers the presence of a mean reverting process in ECM-1 which is highly desirable. Moreover, the p-value corresponding to the speed of adjustment is found to be 0.0096 which is significant @5% level and denotes the presence of a strong mean reverting process.

Apart from the speed of adjustment the only other significant variable in the estimated ECM is C_2 which is actually the coefficient of the first lagged term of W_J in the ECM.

Table 5. Estimation Results for Error Correction Model: 1

Particular	$Coefficient$	$Std.Error$	$t-Statistic$	$Prob.$
C_1	-0.024521	0.009197	-2.666148	0.0096
C_2	0.274989	0.11714	2.34752	0.0218
C_3	0.182757	0.117085	1.56089	0.1232
C_4	0.069893	0.07003	0.998041	0.3218
C_5	-0.088751	0.070849	-1.252681	0.2146
C_6	0.012754	0.029716	0.429209	0.6691
C_7	-0.03601	0.031998	-1.12538	0.2644
C_8	-0.015321	0.052606	-0.291251	0.7717
C_9	0.042422	0.053619	0.791179	0.4316
C_{10}	-2.626181	3.734694	-0.703185	0.4843
Model Properties:				
R-Squared				0.455324
Adjusted R-Squared				0.383235
F-statistic				6.316104
Prob(F-statistic)				0.000002
Durbin-Watson stat				2.153213

Table 6. Wald Test for Error Correction Model: 1

Null Hypothesis:
$C_4 = C_5 = C_6 = C_7 = C_8 = C_9 = 0$

Test Statistic	$Value$	df	$Probability$
F-statistic	0.4307	$(6, 68)$	0.856
Chi-square	2.584201	6	0.8589

Other than C_1 and C_2 none of the variable in the system is significant and it is evident from the relatively small value of Adjusted R-Squared (0.383235). Although individually most of the variables in the estimated ECM are not significant the model as a whole represents a moderately good fit as the probability of F-Statistic is found to be 0.000002 which is significant @5% level. In the next step we perform Wald Coefficient Test in the ECM and see how the lagged terms of $D(W_C), D(W_U)$ and $D(W_E)$ add to the convergence of $D(W_J)$ to its equilibrium. To do so we set the all the coefficients of the lagged terms of $D(W_C), D(W_U)$ and $D(W_E)$ in the ECM to zero and check the corresponding probability. The results are presented in Table: 6. F-Statistic and Chi-Square value of the Wald Test are found to be 0.4307 and 2.584201 whereas the corresponding p-values are estimated to be 0.856 and 0.8589 respectively. As both the p-values are far above the 5% range we can not reject the null hypothesis. Hence, the lagged terms of $D(W_C), D(W_U)$ and $D(W_E)$ have nothing to do with the convergence of $D(W_J)$ to its equilibrium as given by Equation: 2. So, although the ECM given by Equation: 2 can effectively describe the long run relation amongst the variables it is not so successful in explaining the short run dynamics. Moreover, the value of the Durbin-Watson Statistic for the ECM-1 is found to be 2.153213 which is close to 2. This indicates the ECM-1 does not suffer from the problem of auto correlation amongst the residuals which is a desirable trait.

Estimation results of the Error Correction Model (ECM) given by Equation: 3 are

Table 7. Estimation Results for Error Correction Model: 2

Particular	$Coefficient$	$Std.Error$	$t-Statistic$	$Prob.$
C_{11}	-0.001406	0.016467	-0.085381	0.9322
C_{12}	0.086292	0.209734	0.411436	0.682
C_{13}	-0.19331	0.209636	-0.922121	0.3597
C_{14}	0.826442	0.125386	6.591203	0
C_{15}	0.013956	0.126852	0.110017	0.9127
C_{16}	0.169326	0.053205	3.182548	0.0022
C_{17}	0.00466	0.057291	0.081336	0.9354
C_{18}	-0.116843	0.094188	-1.240526	0.219
C_{19}	-0.016188	0.096002	-0.168619	0.8666
C_{20}	-15.69266	6.686806	-2.34681	0.0219
Model Properties:				
R-Squared				0.808305
Adjusted R-Squared				0.782934
F-statistic				31.85893
Prob(F-statistic)				0
Durbin-Watson stat				1.979034

Table 8. Wald Test for Error Correction Model: 2

Null Hypothesis:
$C_{12} = C_{13} = C_{16} = C_{17} = C_{18} = C_{19} = 0$

Test Statistic	$Value$	df	$Probability$
F-statistic	1.870803	$(6, 68)$	0.0985
Chi-square	11.22482	6	0.0817

noted down in Table: 7 and 8. From Table: 7 it is evident that the speed of adjustment C_{11} is -0.001406 which is negative. But, C_{11} is not a significant variable in the estimated ECM as can be seen from its p-value of 0.9322. Large p-value indicates that the ECM-2 represented by Equation: 3 is not mean reverting which is not desirable. Hence, no long run co-movements amongst the variables are captured by this particular ECM. There might be some other ECMs that would probably capture the dynamics better. Still there might exist short run causalities among the variables as described by the ECM under consideration. To check for short run causality running from $D(W_J), D(W_U)$ and $D(W_E)$ to $D(W_C)$ we perform Wald Test on the coefficients of the different endogenous variables. To be precise we set the coefficients of the first and second lagged terms of $D(W_J), D(W_U)$ and $D(W_E)$ to zero and check the corresponding test statistics and p-values. From Table: 8 it is observed that the F-Statistic and Chi-Square values are found to be 1.870803 and 11.22482 with p-values 0.0985 and 0.0817 respectively. Hence, @10% level we can reject the null hypothesis which signifies that the lagged terms of $D(W_J), D(W_U)$ and $D(W_E)$ jointly can cause $D(W_C)$ in the short run @10% level.

Moreover, as can be seen from Table: 7 R-Squared and Adjusted R-Squared values of the ECM are 0.808305 and 0.782934 respectively which are very high and thus represent a very good fit. F-Statistic is found to be 31.85893 with p-value of 0.0. F-Statistic and the corresponding p-value indicate that the model fits the empirical data very well. Last but not the least the Durbin-Watson Statistic of the model is found to be 1.979034 which

is very close to 2. The value of DW Statistic states that the model does not suffer from autocorrelation problem and speaks for the validity of it.

Table 9. Estimation results for Error Correction Model: 3

Particular	$Coefficient$	$Std.Error$	$t-Statistic$	$Prob.$
C_{21}	-0.14657	0.043176	-3.394692	0.0012
C_{22}	1.061627	0.54992	1.930513	0.0577
C_{23}	-1.131434	0.549662	-2.058418	0.0434
C_{24}	0.341059	0.328759	1.037413	0.3032
C_{25}	-0.44473	0.332603	-1.337118	0.1856
C_{26}	-0.172915	0.139501	-1.239525	0.2194
C_{27}	-0.308047	0.150216	-2.050695	0.0442
C_{28}	0.40429	0.24696	1.63707	0.1062
C_{29}	0.768746	0.251716	3.054023	0.0032
C_{30}	75.36625	17.53269	4.298612	0.0001
Model Properties:				
R-Squared				0.306587
Adjusted R-Squared				0.214812
F-statistic				3.34063
Prob(F-statistic)				0.001951
Durbin-Watson stat				2.032231

Table 10. Wald Test for Error Correction Model: 3

Null Hypothesis:
$C_{22} = C_{23} = C_{24} = C_{25} = C_{28} = C_{29} = 0$

Test Statistic	$Value$	df	$Probability$
F-statistic	2.881885	$(6, 68)$	0.0146
Chi-square	17.29131	6	0.0083

In the next step we estimate the coefficients of the Error Correction Model given by Equation: 4 and the results are presented in Table: 9 and 10. From Table: 9 we can see that the speed of adjustment of the ECM is -0.14657 and the corresponding p-value is 0.0012. Negative and significant speed of adjustment indicates a mean reverting process which is a very desirable attribute for ECMs. Moreover, most of the estimated coefficients from C_{22} to C_{30} are found to be significant @5% level which can possibly mean the existence of significant short run causality from the independent to the dependent variables. To check whether short run causality truly exists from $D(W_J), D(W_C)$ and $D(W_E)$ to $D(W_U)$ we perform Wald Test on the coefficients of the estimated ECM. We set the coefficients of first and second lagged terms of $D(W_J), D(W_C)$ and $D(W_E)$ to zero and note the probability of such an exclusion. However, this null hypothesis is soundly rejected even @2% level as can be seen from the last column of Table: 10.

Once the long and short run causality have been confirmed we go on checking how well the empirical data fit the model. R-Squared and Adjusted R-Squared of the model are found to be 0.306587 and 0.214812 which are comparatively low. However, the F-Statistic of the model is 3.34063 with p-value 0.001951. The p-value of the F-Statistic however represents a good fit. Moreover, the Durbin-Watson Statistic is measured as

2.032231 which is very close to 2 and asserts that the estimation does not suffer from the problem of serial correlation.

Table 11. Estimation results for Error Correction Model: 4

Particular	$Coefficient$	$Std.Error$	$t-Statistic$	$Prob.$
C_{31}	-0.113589	0.02154	-5.273295	0
C_{32}	0.201965	0.274351	0.736154	0.4642
C_{33}	-0.958241	0.274222	-3.494395	0.0008
C_{34}	-0.041279	0.164016	-0.251677	0.802
C_{35}	-0.232792	0.165933	-1.402922	0.1652
C_{36}	-0.063282	0.069596	-0.909274	0.3664
C_{37}	-0.313046	0.074942	-4.177199	0.0001
C_{38}	0.234677	0.123206	1.904743	0.061
C_{39}	0.421143	0.125579	3.353605	0.0013
C_{40}	20.75535	8.746936	2.372871	0.0205
Model Properties:				
R-Squared				0.404437
Adjusted R-Squared				0.325612
F-statistic				5.130846
Prob(F-statistic)				0.000027
Durbin-Watson stat				1.976588

Table 12. Wald Test for Error Correction Model: 4

Null Hypothesis: $C_{32} = C_{33} = C_{34} = C_{35} = C_{36} = C_{37} = 0$			
Test Statistic	$Value$	df	$Probability$
F-statistic	6.380645	$(6, 68)$	0
Chi-square	38.28387	6	0

Finally, we estimate the Error Correction Model given by Equation: 5 which describes how $D(W_E)$ reverts to its equilibrium once distorted. The estimation results are presented in Table: 11 and 12. From Table: 11 we can see that the speed of adjustment of the ECM is -0.113589 which is negative and significant (p-value is zero). Negative and significant speed of adjustment points to an underlying mean reversion process which validates the construction of ECM itself. Moreover, a lot of the estimated coefficients are found to be significant @5% level. To check precisely whether the lagged terms of $D(W_J), D(W_C)$ and $D(W_U)$ can really cause $D(W_E)$ we perform coefficient Wald Test and the results are presented in Table: 12. To perform Wald Test we set all the coefficients of different lagged terms of $D(W_J), D(W_C)$ and $D(W_U)$ in the ECM to zero and note down the corresponding F-Statistic and Chi-Square Statistic with the p-values. F-Statistic and Chi-Square Statistic are found to be 6.380645 and 38.28387 respectively with p-value of zero in both cases. So, the null hypothesis is clearly rejected and there exists strong causality running from $D(W_J), D(W_C)$ and $D(W_U)$ to $D(W_E)$.

Last but not the least we will check how well the empirical data fit the model. To do so we check the corresponding R-Squared and Adjusted R-Squared values which are 0.404437 and 0.325612 respectively which although not very good are not bad either.

On the other hand the value of F-Statistic is 5.130846 with p-value 0.000027 which represents a good fit. Moreover, the Durbin-Watson Statistic for the model is found to be 1.976588 which is very close to 2 and thus represents a valid model free from autocorrelation.

10 Limitations and future study

The current study is conducted on a sample of 22 (twenty two) countries around the world, namely USA, China, Japan and 19 (nineteen) countries in the Eurozone. When we choose countries we give weights to two distinct factors: Firstly, we consider the dominance of a country's currency in the international market and secondly, we account for the extent of the foreign exchange reserves maintained by a particular country. Choice of USA and Eurozone (comprising 19 countries to date) is motivated by the fact that 80.48% of the reserve balances of the entire world is denominated in US dollar and euro. On the other hand, China and Japan are the two countries that maintain highest amount of reserve balances in the whole world. To be precise, together they hold nearly 39.80% of the total world reserves. The current study can be logically extended by including more countries into the analysis. For example, there are other countries in the list whose currencies enjoy the *hard currency* status to some extent in the international financial market. The list of countries with reasonably hard currencies includes United Kingdom (UK), Switzerland, Australia and Canada. Moreover, other than China and Japan, there are countries that hold substantial amount of foreign exchange reserves which include India, Kingdom of Saudi Arabia (KSA), South Korea and so on. The study can be further extended by including these countries into the analysis which is supposed to produce more accurate measure of cross border wealth transfer amongst the nations.

11 Conclusion

Here, we argue that the official foreign currency reserve balance of a country when subtracted from the accumulated reserve balances of the rest of the world denominated in the currency of that particular country represents the net amount of real wealth that has been transferred to that particular country from the rest of the world in exchange of its fiat currencies. We have calculated the said amount of wealth transfer for some major economies of the world including United States, China, Japan and Eurozone. We have found that the value of net wealth transferred to United States and Eurozone are positive and the official foreign exchange reserve balances of these regions are remarkably low as compared to their peers. On the other hand, net wealth transferred from the rest of the world to China and Japan are negative i.e., these regions have indeed transferred substantial amount of real goods and services to the rest of the world in exchange of some fiat currencies and that is why these countries have accumulated an astonishing amount of reserve balances. These reserve balances unless utilized for import purposes do not have any intrinsic value i.e., the real values of these reserves can only be discharged once they are actually used for import payments. But, countries like China and Japan do not seem to eat up their reserve balances rather they are accumulating more and more of it and in the process of doing so they are transferring their real assets (goods, services and/or physical asset) to the rest of the world which the other countries consume/use.

12 Declaration of interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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