

## **International Investment Position and Exchange Rate in Brazil: An Application of the Grubel and Lloyd Index**

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**Abstract:** The International Investment Position (IIP) reflects the inventory values of external assets and liabilities of a country. For capital flows that change frequently, IIP may be responsible for the growth of economies and economic cycles on the relationship with the exchange rate. In this context, the research aims to analyze the IIP of Brazil through the application of an adapted Grubel and Lloyd (1975) index and its respective relationship with exchange rate. The methodology search uses the application of the adapted Grubel and Lloyd index for IIP and respective subgroups for analysis of possible links to the exchange rate using a statistical causality test and estimation of vector autoregressive (VAR) model. Among the findings, the existing imbalance in the subgroups of IIP is highlighted. Additionally, the relationship and impact were checked in the exchange rate and IIP on a change in one of the two variables, highlighting the fact that exchange rate movements are a self-correcting mechanism imbalance IIP.

**Keywords:** International Investment Position, Exchange Rate, Grubel and Lloyd Index

**JEL Classification Number:** F21, F23, F41

### **1. Introduction**

The end of the Bretton Woods agreement in the early 1970s and the adoption of floating exchange regimes by the major economies in the period that followed the dismantling of the institutional arrangement of the international monetary and financial system put in place after World War II resulted in a new need for interpretation of the effects of international capital flows on domestic economies. It is noteworthy that, after this period, research on the determinants of exchange rate principal and the effects of changes in the relationship between the currencies of countries has evolved considerably, with special emphasis on the 1990s, which was characterized by a sequence of financial crises.

Unlike with previous events, the international financial crisis of 2007/2008, which began in the US, initially reached the developed countries and, at least for an initial period,

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showed relative immunity for emerging countries, which had higher growth rates than developed countries concurrently with the recovery policies of US and European economies.

A few years after the onset of the crisis, however, emerging economies began to face a loss of momentum at the same time as the US economy began to show signs of recovery. With the onset of a reduced international liquidity process through a contractionary monetary policy, very gradually, through directives offered by the Federal Reserve (Fed), several emerging countries, especially Brazil, have undergone a process of depreciation of the exchange rate and elevation of the interest rate.

The period of abundant international liquidity following the US crisis has resulted in a strong increase in capital flows to emerging countries, especially Brazil. This effect can be seen in flows covered by the balance of payments. In addition to the balance of payments, there is a balance sheet in Brazil that has not been a recurring object of study on analysis of capital flows and impact on the exchange rate: the International Investment Position (IIP).

The IIP reflects the values of stocks of assets and liabilities in foreign currencies. The operations that make up the financial account and are recorded in terms of flows in the balance of payments appear in the IIP as stocks, and the difference in approach is crucial for gaining a more accurate interpretation of the existing effects of capital flows to a country and exchange rate behavior.

In several countries, the study of IIP is as important as the analysis of the balance of payments on research from the private and academic sectors, and for the purposes of economic policy decision-making. In Brazil, however, the instrument is not used on a recurring basis. The discussion and analysis of the IIP of Brazil is not present, usually in market environment analysis reports made by private companies in Central Bank of Brazil reports and academic research, which explains the relevance of research. On basis of academic articles were found few studies that spoke about the IIP of Brazil. One study linked the IIP with external vulnerability, as Van Noije (2014) while the other estimated the possibility of obtaining nominal gains of asset arrest from the analysis of the IIP.

Another factor that contributes to the relevance of the research refers to the publication of studies such as the IMF (2014), which pointed out the Brazilian economy as one of the fragile economies together with other countries in a contraction scenario of international liquidity from the reversal of US monetary policy. Despite the publication, the Brazilian economy continued to receive capital inflows via foreign direct investment and portfolio, despite the risks highlighted in the report, suggesting relative underestimation of the importance of IIP.

Finally, the unprecedented nature application of the Grubel and Lloyd index in the IIP reinforces the relevance of the research to the extent that the content use of suggestion in the balance of payments items first appeared in the study of Grubel (2002), and was not then extensively used in subsequent studies. Few studies have applied the index that way, such as the work of Obstfeld (2004). However, in an important recent study of external imbalances between countries, the research of Obstfeld (2012) applied the index to balance of payment items. The application therefore occurred in terms of flows, while the present study prepares the search index from the inventory of assets and foreign liabilities.

In this context, the research aims to evaluate the relationship between the IIP of Brazil and the exchange rate behavior in the period 2008-2015, through the application of the Grubel and Lloyd index adapted to the IIP and its subgroups with the additional application of a model of autoregressive vectors (VAR) to assess possible effects of exchange rates on the International Investment Position. The hypothesis of the research is that depreciation / appreciation of the exchange rate contributes to the improvement / deterioration of the International Investment Position.

As an additional objective, it is also expected that this method will be able to evaluate the effects of changes in the IIP on the trajectory of the exchange rate so that the research will contribute to the debate on the main determinants of the exchange rate and additionally broaden the discussion on the IIP and the strategy of a country and their residents (firms and households) in relation to the mobility of capital between countries through direct investment and / or investment portfolio.

Thus, the article is structured as follows: in addition to this introduction, Section 2 presents a theoretical discussion of the International Investment Position. Section 3 presents the evolution of Brazil's International Investment Position in 2008-2015. The fourth section presents the methodology used in the survey and the results and discussion are presented. Finally, the last section, the final considerations are presented.

## **2. International Investment Position: Theoretical Aspects**

IIP can be defined as balance sheet that represents the values of assets and foreign currency liabilities, distinguishing the balance of payments through considering the inventories related to transactions between residents and non-residents of a country. In other words, while the balance of payments records flows of capital, goods and services, and financial assets, IIP clears inventories of such variables. The preparation of the IIP follows the recommendations of the International Monetary Fund, which has developed a manual in order to standardize the calculation and disclosure of monetary and financial statistics of the countries so that international comparisons are possible. The manual has been redesigned and updated several times and is currently in the sixth edition, as IMF

(2013). The manual also raises the importance of IIP from the previous view and highlights the importance of analyzing the stocks jointly to analyze flows, i.e., places the IIP at the same level of importance of the Balance of Payments for analysis and understanding of the dynamics economic relations of the country with the rest of the world.

**Table 1: Composition of the International Investment Position**

Total Assets (A)	Direct investment abroad Portfolio investment Financial derivatives Otherinvestments Reserveassets
Total Liabilities (L)	Foreign direct investment Portfolio investment Financial derivatives OtherInvestments
International Investment Position (IIP) = A - L	

Source: Central Bank of Brazil (2014). Self elaboration.

The bills that result in IIP can be seen in Table 1. According to the Central Bank of Brazil (2015), the Assets is determined by the stocks of productive investments and portfolio abroad, as well as transactions involving derivatives and other investments (currency, deposits, loans, trade credits, and quotas of Brazilian participation in international organizations), and the reserve assets, which actually correspond to stocks of international reserves. From the standpoint of Liabilities, the composition is virtually the same as the Assets, except for reserve assets that are obviously excluded from this group.

According to Lane and Milesi-Ferretti (2001a), capital flows that change IIP frequently may be responsible, in many countries, for the growth of economies and the economic cycles. In addition, the analysis of capital flows coupled with inventories, may not adequately reveal the country’s relationship with the rest of the world. Finally, careful analysis of the assets components of inventories and liabilities external to a country can contribute to an improvement of the process of understanding the vulnerability of a country to external shocks.

Nakonieczna-Kisiel (2011) has highlighted the importance of IIP analysis, noting that the indicator is distinct from external debt, which was a variable widely used for the analysis of external imbalances in emerging economies in the 1980s and 1990. According the study, the analysis of IIP can contribute decisively to the analysis of the vulnerability of an economy, which is more accurate than using foreign debt, since it is a view that includes other variables and associates, joint obligations, and the inventory assets that the country

has from the outside. The analysis of the behavior and the consequent management of IIP accounts for Furceri, Guichard, and Rusticelli (2012), can contribute to the reduction of financial imbalances of a country and global growth. The authors emphasize that the economic policies of countries may result in a composition of the IIP that is favorable to the future economic performance of the country.

In a specific analysis of the US economy, which consistently has had one IIP deficit since the 1980s, Mahdavi (1993) cites the ambiguous nature of the situation based on the fact that a negative IIP can damage the standard of the future life of the country on the need for interest payments and obligations for the liabilities. On the other hand, a negative IIP may also mean that foreign creditors have confidence in the economy and in this sense, foreign investment benefits the future standard of life for US citizens. The author also cites the measurement problem of IIP, considering that direct investment is often valued at book value rather than at market value. Thus, as the US assets abroad are, on average, older than direct investment in the US, it is possible to assert that US assets are undervalued.

Another interesting question, contemplated by Curcuru, Dvorak, and Warnock (2008), is that the imbalance in the US IIP is not as worrisome because the assets of US residents abroad present a superior return to their liabilities, which tends to attenuate the imbalance between the inflow and outflow of dollars from the economy. Mann (2002) points out that the reversal of the US IIP imbalance depends on a number of factors, such as economic growth and the increase in the savings rate of residents, which occur only in the long run. He also highlights that devaluation is the only IIP adjustment measure in the short term. Whittard and Khan (2010) analyzed the relationship between current account deficits and the UK IIP from 2003 to 2009 and found that the existence of successive current account deficits contributed to the deterioration of IIP. At the same time, the study looked at the existence of a relationship between exchange rate and the IIP, and stressed that currency depreciation movements during the period contributed to an improvement in the balance of inventories.

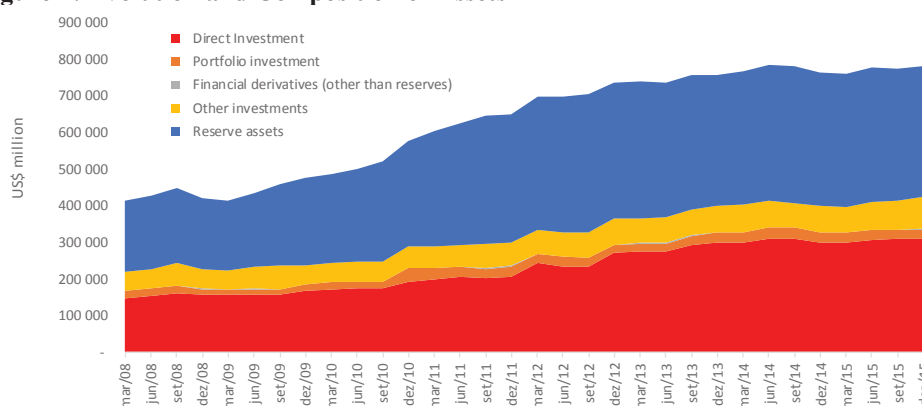
However, the study of Broonstra (2008) shows that the existence of other determinants of IIP, such as gains and / or losses in the values of assets and liabilities stocks, can cause the behavior of the balance of payment flows to be unrelated to the trajectory of IIP. Although the purpose of the study was to evaluate the behavior of IIP facing a population aging process in European countries, the study found that IIP cannot be explained directly by the behavior of the current account of a country. Taking the example of the Netherlands, the author found that despite a favorable balance of payments, the composition of the country's IIP and the loss of asset inventory value resulted in a deterioration of the balance of IIP. Nevertheless, the study also cited the relationship IIP with exchange rate movements.

In analyzing the relationship between external vulnerability and IIP, Van Noije (2014) highlights the effects of a crisis and the exchange rate of foreign assets. According to the author, in crisis situations, one of the recurring features is the exchange rate depreciation. With the exchange rate depreciation, foreign assets become more expensive for residents of the country that went through currency depreciation process, which tends to undermine the IIP. The same analysis can be applied to the external liabilities. A crisis that causes a country’s currency depreciation is usually accompanied by a fall in the stock market and a fall in the price of securities. In this context, only the effect of exchange rate depreciation is enough to reduce the value of portfolio investments. The foreign exchange effect associated with the fall in the stock market causes, therefore, a double reduction effect on the value of part of the external liabilities. As portfolio investments represent a substantial portion of external liabilities, the crises that result in currency depreciation tend to benefit the IIP of a country. In this sense, a floating exchange rate would act as an automatic stabilizer of IIP imbalances.

**3. Evolution of Behavior of International Investment Position during 2008-2015**

For an analysis of IIP from Brazil in the period 2008-2015 and its relationship with the exchange rate, it is important to assess the evolution of assets and liabilities in the period, and of each of the accounts that make up the IIP. Thus, as shown in the previous section, the Assets comprise five groups, namely: direct investment, portfolio investment, financial derivatives, other investments, and reserve assets. Thus, and according to Figure 1, it is possible to realize a Total Assets growth trend in 2008-2015, from \$ 414 billion in 2008 to \$ 780 billion in 2015. There was, therefore, a significant increase of assets in stocks of Brazil’s residents in other countries.

**Figure 1: Evolution and Composition of Assets**

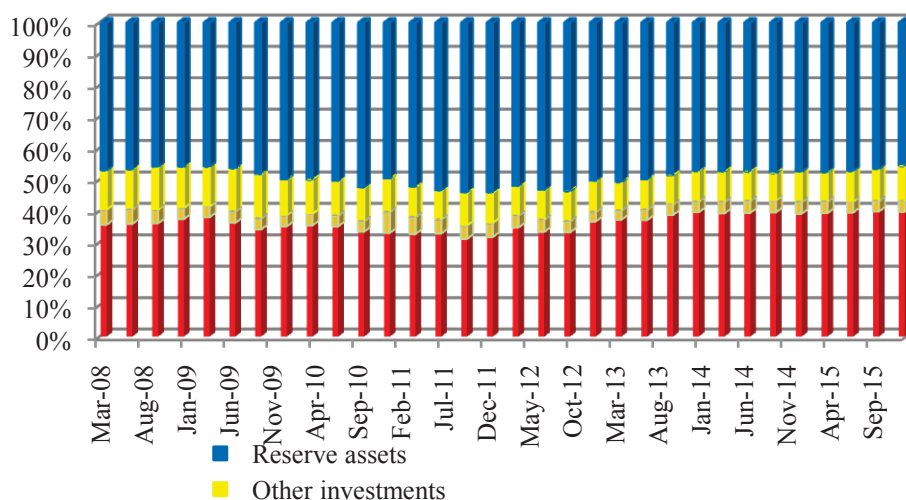


Source: Central Bank of Brazil (2016).

Figure 1 also shows that Brazilian direct investment abroad and reserve assets are mainly responsible for the Total Assets, with a share of 39.77% and 45.67% respectively in the last quarter of 2015, as shown in Figure 2. The increase in Brazilian direct investment abroad is associated with the internationalization process of Brazilian companies, which is in line with the benefits obtained through trade and financial transactions in tax havens. The growth is observed in the assets reserves, marked predominantly by international reserve accumulation in the period.

In proportional terms, we can see that the reserve assets and direct investment abroad make up more than 90% of Assets, as shown in Figure 2. Even if this behavior undergoes minor changes over the period, it is emphasized that the two main groups are responsible for over 80% of assets are active throughout the period. It is noted also that the participation of financial derivatives in Assets composition is very small, with an average holding of less than 1% in the period. This is mainly explained by the fact that domestic investors hold investments abroad precisely to reduce the risk in local currency, which makes financial derivatives in other countries ineffective for risk mitigation.

**Figure 2:** Relative Participation Composition of Assets

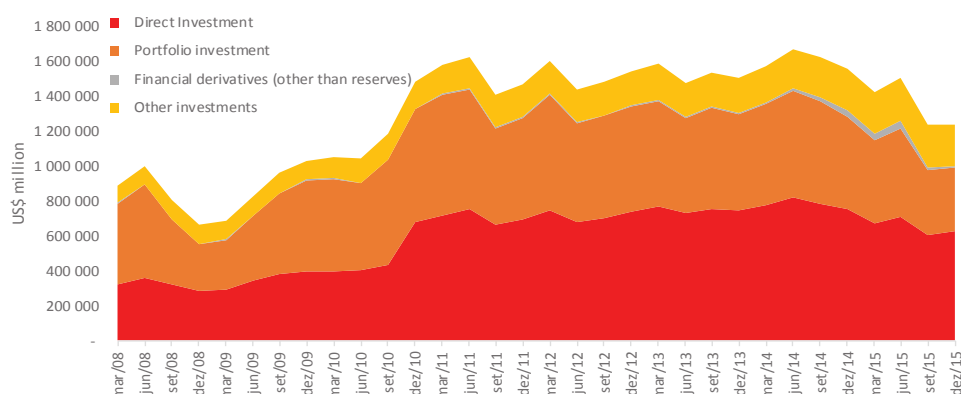


Source: Central Bank of Brazil (2016).

As regards the Liabilities, which is divided into four major groups (foreign direct investment, portfolio investment, derivatives and other investments) it is noted in Figure 3 that there was also growth in the period 2008-2015. However, differently to what happened with the Assets, a growth trend can be observed only in the period 2008-2011;

after 2011 there was a Liabilities oscillatory behavior, with an average of \$ 1.5 trillion in the period from 2012 to 2014, with a change from 2014, to a downward trend, which will be explained later.

**Figure 3:** Evolution and Composition of Liabilities



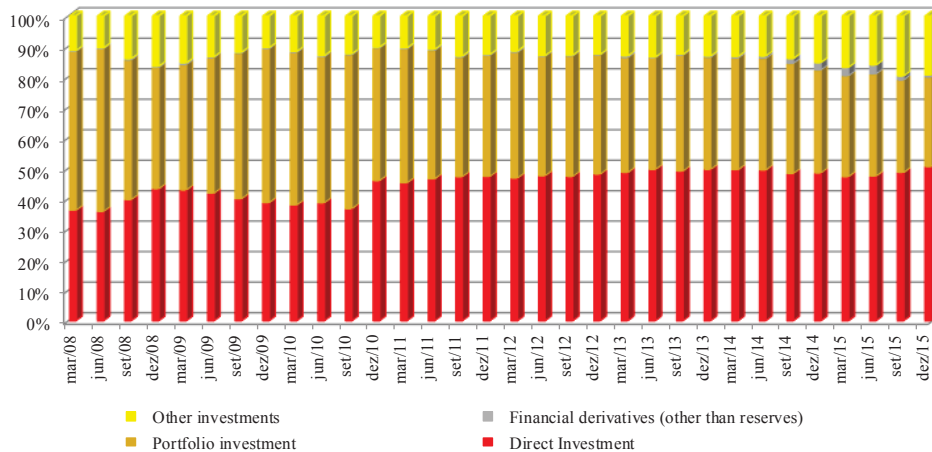
Source: Central Bank of Brazil (2016).

Also in relation to Liabilities composition, represented in Figure 4, there is the importance of the participation of direct investment in the country (50.56%) and portfolio investments (29.37%) in the total composition in the last quarter of 2015. In virtually the entire period, the joint participation represented approximately 80% of the Liabilities. In March 2008, the stock of direct investment in Brazil was US \$ 323 billion. The stock increased significantly during the period analyzed, because in December 2015, it reached US \$ 629 billion. The market size effect, determined by the population, associated with the fact that Brazil is the largest economy in Latin America, explains the growth of direct investment into the country.

With regard to portfolio investments, representing investments in fixed income stocks and bonds, the opposite happened, as the investments in stocks and bonds by non-residents in Brazil decreased from US \$ 465 billion in March 2008 to US \$ 365 billion in December 2015. The loss of the investment grade of the Brazilian economy by two credit rating agencies in 2015 explains much of this behavior in addition to the beginning of the reversal of US monetary policy process. It is also worth noting that, especially from mid-2014, the stocks of financial derivatives widened, which also reflects the increased uncertainty on key financial market variables such as interest rates, dollar, and stock index. In absolute terms, financial derivatives liabilities stocks that amounted to about \$ 2 billion in March 2008, reached a peak of \$ 44 billion in June 2015.



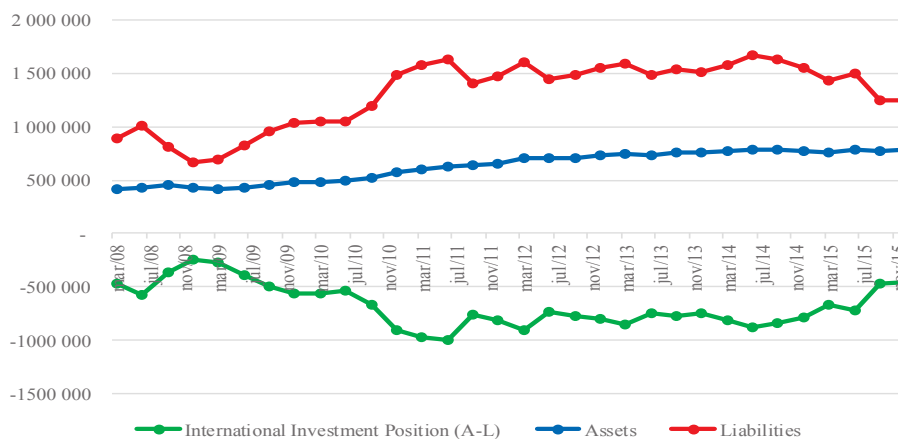
Figure 4: Relative Participation Composition of Total Liabilities



Source: Central Bank of Brazil (2016).

The global analysis of evolution of International Investment Position is shown in Figure 5. First, it is emphasized that, throughout the period, the balance of Assets and Liabilities was negative, which is expected for developing economies. Also, according to Figure 5, you can see that in June 2011, the balance between the stocks of assets and liabilities, which is the very International Investment Position, reached the valley, with a negative difference of US \$ 1 trillion. After this period, there was a significant improvement in the balance, which ended the year 2015 with a negative balance of US \$ 463 billion.

Figure 5: Assets, Liabilities and International Investment Position



Source: Central Bank of Brazil (2016).

Figure 5 also demonstrates the trend of growth throughout the period, both assets and liabilities, and the liabilities was characterized by a relatively less regular pattern with stagnation in the trend in 2011 and a reversal from 2014, when there is the beginning of a downward trend. In general, it can be noted that from June to November 2008 and from June to September 2015, the International Investment Position showed up with a reduction in the deficit of behavior, concomitantly to a devaluation process, that occurred in both periods.

After this brief analysis of the evolution of behavior IIP Brazil, the next section will cover the methodology used in this research, which will consist of applying an index for both the IIP in aggregate and for each of the four subgroups, from the balances of assets and liabilities, then will proceed to estimate the relationship IIP with the exchange rate.

**4. Methodology**

The research methodology can be divided into two blocks. Initially it will apply the Grubel and Lloyd index in the IIP and its four subgroups (direct investment, portfolio investment, derivatives, and other investments). After the calculation of the index, by evaluating possible correlation and statistical precedence a vector autoregressive model (VAR) will be estimated in order to identify with greater abundance, the ratio between the OIP and / or subcomponents IIP and exchange rate.

**4.1. The Grubel Lloyd index adapted to the International Investment Position**

The Grubel and Lloydindex (GL index) has been popularized since the end of the 1970s in the field of international economics and presented in detail in Grubel and Lloyd (1975). According to the authors, the index can be expressed according to equation 1 and its main contribution was to evaluate and identify the pattern of trade between the countries that have intra- or inter-industrial character.

$$I_{CI} = \frac{\sum_{i=1}^n (x_i + m_i) - \sum_{i=1}^n |x_i - m_i|}{\sum_{i=1}^n (x_i + m_i)} \quad \text{on what} \quad 0 \leq I_{CI} \leq 1 \quad (1)$$

On what:  $I_{CI}$  = Intra-industry trade index in the sector;  $x_i$ = Exports of the product or industry;  $m_i$  = Imports of the product or industry

From the original equation of Grubel and Lloyd (1975) an adaptation will be made to the index so that the assets are the “exports”, while liabilities are considered “imports” in equation 1. In this way, the analysis of the period 2008-2015 is relatively uniform with the standardization of different values in the calculated index and it is possible to evaluate the relationship between IIP and / or their subgroups and the exchange rate. As mentioned

earlier, the use of the index suggestion balance of payments items first appeared in the study of Grubel (2002) and was not then used extensively in subsequent studies. Few studies have applied the index in this way. An example of application can be observed in the work of Obstfeld (2004). Additionally, in an important recent study of external imbalances across countries, one study by Obstfeld (2012) applied the index on balance of payment items. The application therefore occurred in terms of flows, while the present study prepares the search index from the inventory of liabilities and assets components and then connects it with the IIP exchange rate. It is considered that stocks are changed by the flows and therefore have a direct relationship with the exchange rate.

Accordingly, for the purposes of this study, the GL index for the International Investment Position is calculated according to the following expression:

$$I_{P_{II}} = \frac{(A+L) - |A-L|}{(A+L)} \quad (2)$$

On what  $I_{P_{II}}$  = adapted GL index of the International Investment Position, A=Assets and L = Liabilities

Additionally, the GL index will be applied and adapted to the subgroups that make up the IIP, with the aim of identifying the behavior of the different groups, namely: direct investment, portfolio investment, derivatives, and other investments.

According to the adapted GL index shown in equation 2, it is possible to calculate the position of the assets and liabilities and understand the dynamics of stocks for a given economy as well as the relation with the exchange rate. It should be noted that the result of the equation where two will lie in the range [0, 1]. When the value of the asset inventory is much greater than the liabilities or vice versa, the calculation result will approach zero. On the other hand, the closer the stocks of assets and liabilities, the closer one will be the result of the equation.

It is necessary to note that the index has some limitations. If a country predominantly has an asset inventory, or a liability one, the result is the same, close to zero, regardless of position. Moreover, when considering a country that has values close to assets and liabilities and a fall in stock in both positions in a given year, the index will continue for the next one. Being a relative index, its interpretation deserves caution. Despite the caveat, the application of the GL index shows relevance for analyzing items of the balance of payments and IIP. It is for this reason that, after the calculation of the GL index for the IIP and their respective subgroups, the correlation coefficients are calculated between the assets, balance and all GL indices calculated with the exchange rate.

**4.2. The VAR model**

With the calculation of the adapted GL index, a VAR model will be estimated with relevant series from the point of view of correlation and causality generated by calculating the GL index IIP, its subgroups and the actual exchange rate effective (US \$ / US \$) on a quarterly basis 100 = Jun / 1994. The series of the Real Exchange Rate was obtained from the Central Bank System Data Manager in Brazil, and the data of the International Investment Position were obtained in the specific section of the IIP from the website of the Central Bank of Brazil. During the estimation process, it will be necessary to evaluate the need to estimate the level variables or differences with the possible need for an error-correction model. The importance of the VAR model in this case is justified mainly by the possibility of simultaneity between the estimated variables. It should also be highlighted that although the Real Exchange Rate of the series is in the form of an index number, we use the search term Real Exchange Rate to refer to this variable.

The mathematical form of the VAR model is as follows:

$$y_t = A_1 y_{t-1} + \dots + A_N y_{t-N} + Bx_t + \varepsilon_t \tag{3}$$

where  $y_t$  = vector of endogenous variable;  $x_t$  = vector of exogenous variable;  $A_1 + \dots + A_N$  and  $B$  = matrices of coefficients to be estimated and  $\varepsilon_t$  = vector autocorrelated innovations

Thus, in a two-dimensional hypothetical model, with varying exchange rate, E, and GL IIP index,  $I_{PII}$  in that adopt the two lags structure of two equations coefficients are estimated in the following format:

$$E = \alpha_1 + \beta_0 E_{t-1} + \beta_1 E_{t-2} + \beta_2 I_{PII t-1} + \beta_3 I_{PII t-2} + e_t \tag{4}$$

$$I_{PII} = \alpha_2 + \beta_4 E_{t-1} + \beta_5 E_{t-2} + \beta_6 I_{PII t-1} + \beta_7 I_{PII t-2} + e_t \tag{5}$$

In the model,  $E$  is the exchange rate at time  $t$ ,  $I_{PII}$  is IIP,  $\alpha_1$  and  $\alpha_2$  are constant,  $\beta_0 \dots \beta_7$  are parameters of Equations 4 and 5, and  $t$  is the error term with mean zero. The Cholesky decomposition algorithm is used to estimate VAR, which results in a matrix calculation applied diagonal covariance matrix of the variables. Due to this procedure used in the estimation, which gives all the systemic effects of the first variable of the model, changes in the order of variables when the estimation of a VAR model, can cause changes in the response function to impulses. The technical procedures regarding this method can be checked in Hamilton (1994). To solve any divergent results in the generation of impulse responses function, recent studies and this study apply the response functions to widespread impulses, to avoid possible bias resulting from an arbitrary ordering of the variables in the estimate. However, the decomposition of the forecast error variance applied to the VAR model considers the Cholesky decomposition and therefore constitutes one of the limitations of the model in terms of analysis.

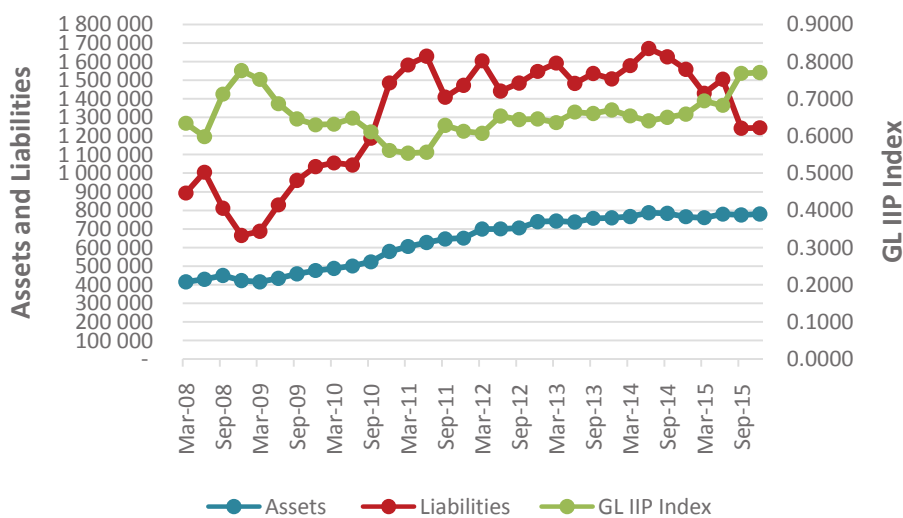
For the purposes of this research, the Real Exchange Rate, as mentioned earlier, will be used, which reflects more adequately Brazil’s relations with the rest of the world and these relations in IIP. The initial period is justified by the need to remove the instability resulting from the international financial crisis (subprime crisis) and the end period is the availability of data in the period of the research.

**5. Results and Discussion**

**5.1. Application of Grubel and Lloyd index in the IIP**

The application of the Grubel and Lloyd index in IIP components showed significant results in terms of imbalances between the stocks of assets and liabilities in Brazil. In relation to the total inventory of IIP, Figure 6 shows that, during the study period, there was an increase in the assets and liabilities oscillatory behavior. In terms of the GL index calculated for the total inventory, it is noted that the index peaked, 0.77 in two phases (December 2008 and December 2015), which took place when is the stock of assets presented values close to those of liabilities.

**Figure 6: Assets, Liabilities, and GLIIP Index**

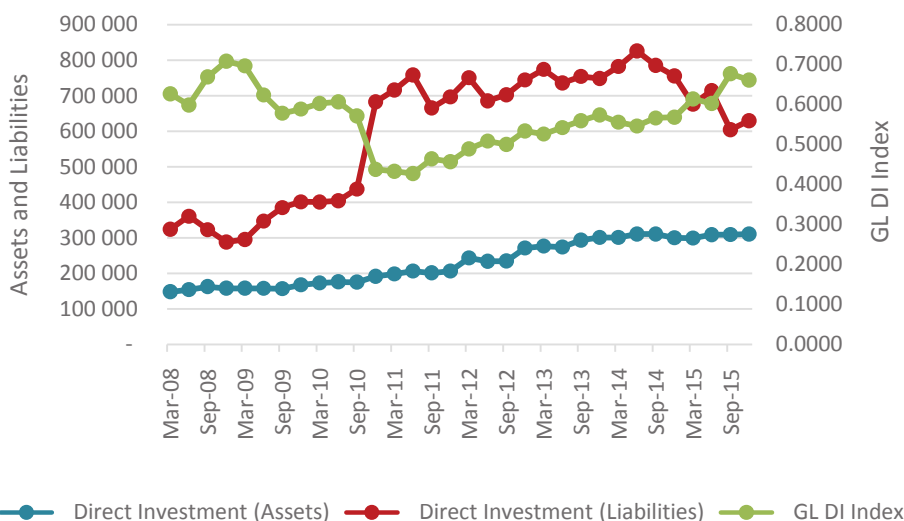


Source: Central Bank of Brazil (2016).

With respect to direct investment, shown in Figure 7, there is the presence of imbalance between asset and liability stocks as a result of a late and incipient process of internationalization of Brazilian companies. It is possible to see the discrepancy between direct investment stocks and Brazilian investment abroad, which has grown especially since September 2010. Already from June 2014, with the fall in non-resident inventory

and maintenance the upward trend of Brazilian investment abroad, the index approached the peak of 0.70 recorded at the end of 2008. The difference, however, between the beginning and the end of the period is that in 2008, the GL index was high due to a drop in stocks liabilities arising from the international financial crisis while, at the end of 2015, the domestic economic crisis and the reversal of US monetary policy, coupled with the growth of the Brazilian investment abroad resulted in the approach of assets and liabilities stocks. Despite the observed imbalance, it is noteworthy that there was a significant growth of direct investment stocks abroad, which increased from US \$ 147 billion in March 2008 to US \$ 310 billion in December 2015.

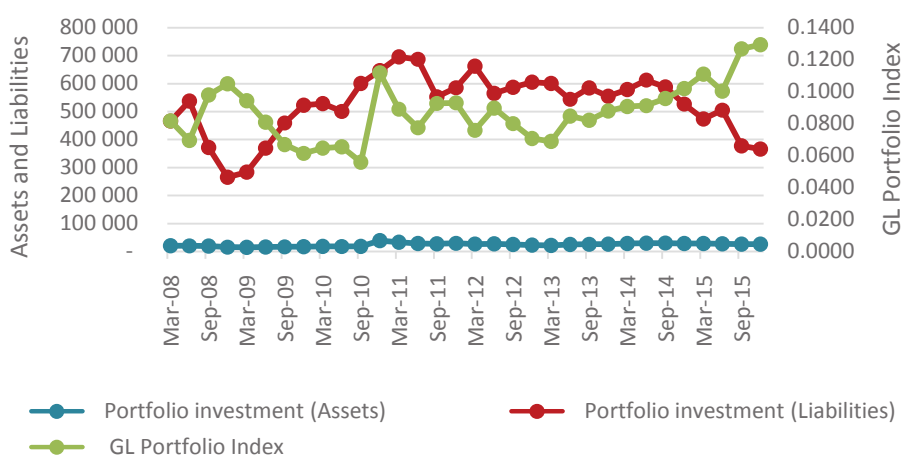
**Figure 7: Direct investment (Assets and Liabilities) and GL Direct Investment Index**



Source: Central Bank of Brazil (2016).

Regarding investment portfolio, there is also a marked discrepancy between the stocks of assets and liabilities. Portfolio investments represent investments in stocks and bonds. Accordingly, Figure 8 shows the trajectory of the stock and it can be seen that the peak index, held in December, 2015, was only 0.13, which reflects the significant difference between this group of assets and liabilities. The differential internal and external interest rate and the unusual characteristic of local investors investing abroad explain such behavior. Here we should note the fact that, while in December 2015, the portfolio investments of residents abroad were \$ 25 billion, the liabilities in this category, namely the holding of securities and foreign-stock totaled US \$ 365 billion.

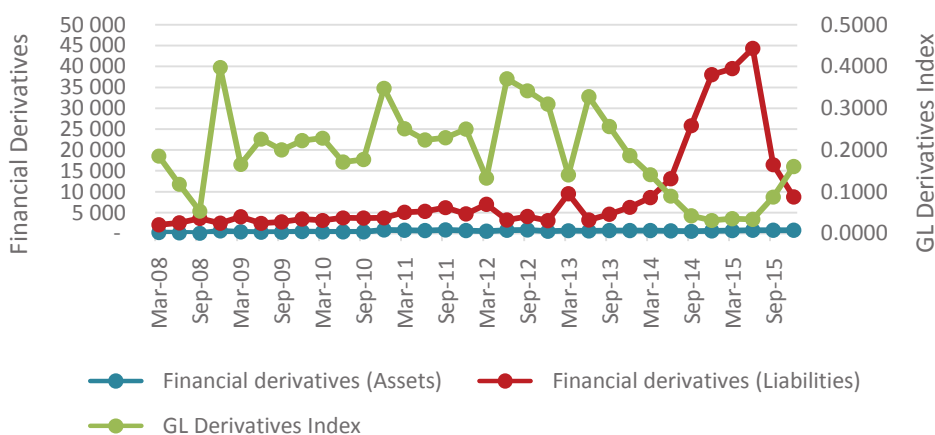
**Figure 8: Portfolio investment (Assets and Liabilities) and GL Portfolio investments index**



Source: Central Bank of Brazil (2016).

Liabilities stocks remained well above the assets even after a significant drop in this category that began in June 2014, when it widened the perception of international investors that the Brazilian economy would go through a review process of the investment grade by credit rating agencies and that there was, in the international financial system, an ongoing process of re-pricing of assets. In just eighteen months the liabilities inventories decreased by US \$ 612 billion to \$ 365 billion.

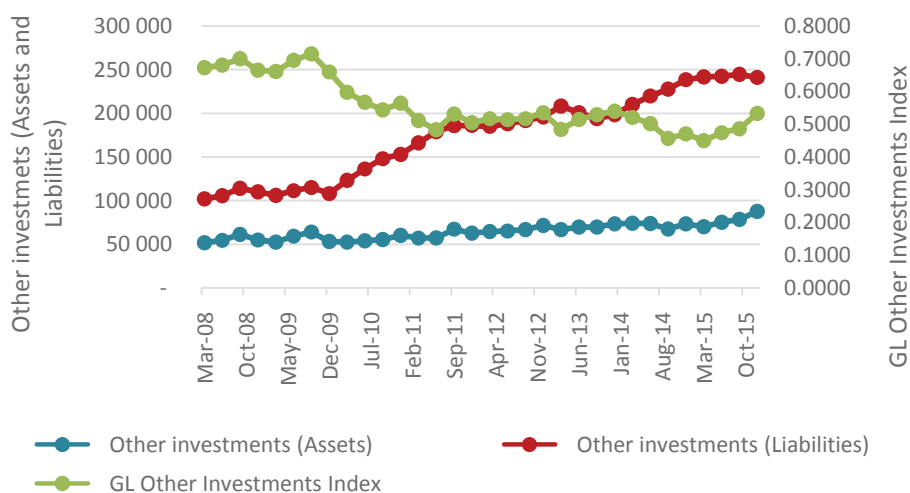
**Figure 9: Financial derivatives (assets and liabilities) and GL Derivatives Index**



Source: Central Bank of Brazil (2016).

In terms of financial derivatives, represented in Figure 9, it is emphasized that the assets are less than US \$ 1 billion in the analyzed period, which reflects a local stock market with low degree of internationalization, and, of course, the increased volatility of local assets relative to foreign ones, theoretically requires less protection. On the other hand, and especially since 2013, there was a sharp increase, and liabilities reached the \$ 44 billion mark, resulting in a calculated GL index of 0.03. At the end of the period, with a reduction in inventories of derivative liabilities, the GL index increased to almost 0.16. Despite the increase, the index also shows an imbalance between assets and liabilities stocks.

**Figure 10: Other investments (assets and liabilities) and GL Other Investments Index**



Source: Central Bank of Brazil (2016).

Finally, in the other investments shown in Figure 10 a greater proximity of the inventory assets and liabilities is realized. The mean value of the period for GL index was 0.55. From 2010, liabilities stocks increased at a greater rate than the inventory assets, which led to a decrease of the GL index calculated for this line.

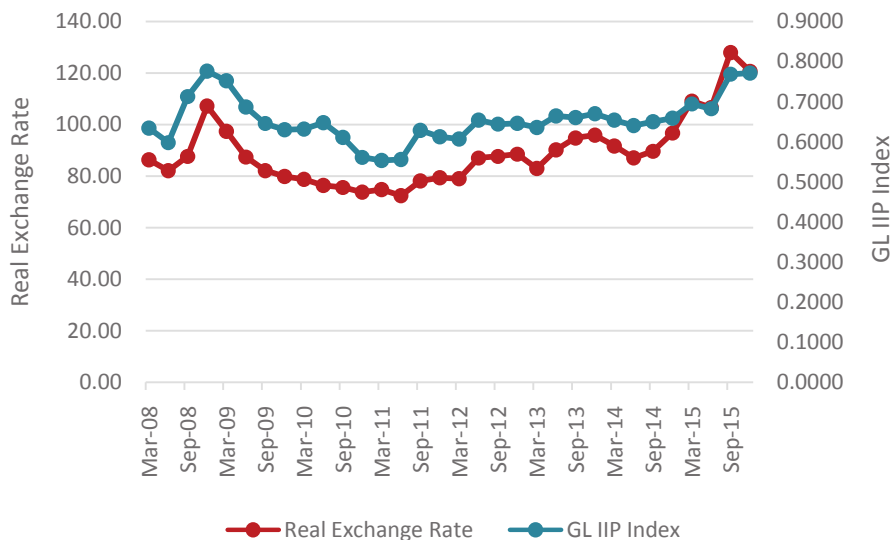
**5.2 The relationship of the International Investment Position with the exchange rate**

The changes in assets and liabilities inventories reflect inflows and foreign output in Brazil, which are expected to identify a significant relationship between the exchange rate and the IIP, plus possibly relationships with subgroups of the OIP. Accordingly, the GL IIP index, shown earlier in Figure 6, can be seen jointly with the series of the Real Exchange Rate in Figure 11. It is possible to realize a common movement between the two series over the time period analyzed (1st quarter 2008 - 4th quarter 2015). In Figure 11,



the left axis shows the Real Exchange Rate, in the form of an index number and the right axis refers to the index scale GL IIP.

**Figure 11: Real Exchange Rate Index and IIP**



Source: Central Bank of Brazil (2016).

To assess possible links Index GL IIP and subgroups, it was decided to calculate initially the degree of correlation between the rate of Real Exchange and all indices calculated for the IIP, the GL IIP index and the four calculated subgroups (Investment direct, portfolio investment, financial derivatives, and other investments). Additionally, it also includes gross of asset inventory, liabilities, and the balance, which is nothing more than the actual IIP.

Thus, Table 1 shows the correlation coefficients between the assets, liabilities, and IIP with the Real Exchange Rate. In addition, the correlation coefficients between the Real Exchange Rate and the GL indexes calculated for the IIP and their subgroups were calculated.

In terms of the modules of the correlation coefficients shown in Table 2, it is noted that the most correlated variable with the Real Exchange Rate is precisely the GL IIP index, with an 85.66% correlation coefficient. The GL index investment portfolio also shows a strong association between sets, with a 73.01% correlation coefficient. It should be noted that the GL IIP index had a higher degree of correlation with its own IIP. In other words, the GL index calculated from its own IIP demonstrated a stronger association with the exchange

rate than the actual IIP, suggesting that the relationship between the balances of assets and liabilities calculated by GL index can be an important determinant of the Real Exchange Rate behavior.

**Table 2: Variables correlation coefficient with the Real Exchange Rate**

Variables	Correlation Coefficient
International Investment Position	.4241
Assets	.3789
Liabilities	-0.1050
GL IIP Score	.8566
GL Direct Investment Index	.6503
GL Index Investment In Portfolio	.7301
Financial Derivatives GL Index	-0.2902
GL Other Investments Index	-0.1752

Source: Self elaboration.

Although there has been a strong correlation between GL IIP index and the Real Exchange Rate, it was considered appropriate to perform a statistical precedence test, popularly known in the literature as Granger causality test, given the fact that it is possible that two variables are strongly correlated without implying some causal relationship. Prior to the performance of the Granger causality test, the unit root Dickey-Fuller test for the real exchange and IIP GL ratio was applied. With the results obtained it was not possible to reject the null hypothesis of the presence of unit root for the two series, as can be seen in Table 3, which also shows the critical values and odds.

**Table 3: Unit Root Tests Dickey-Fuller (ADF)**

Variable	Lags	Constant	Trend	ADF	Prob.	Critical Value 10%	Critical Value 5%	Critical Value 1%
Real exchange	0	Yes	Yes	-1.4258	0.8329	-3.2152	-3.5628	-4.2858
Δ Real exchange	0	No	No	-5.6181*	0.0000*	-1.6102	-1.9524	-2.6443
IIP	0	No	No	-0.5005*	0.8179	-1.6104	-1.9520	-2.6416
ΔIIP	0	No	No	-1.6102*	0.0000*	-1.6102	-1.9524	-2.6443

Source: Prepared based on the calculations made in econometric package Eviews9.0.

Notes: \* Do not reject the null hypothesis of the presence of a unit root. Critical values generated by the econometric package mentioned.

Since the series showed no stationarity level according to the unit root test carried I (1), proceeded to the differentiation of series and thus was able to reject the null hypothesis of the presence of unit root, as shown in Table 3.

Thus, Table 4 shows the Granger causality test results carried out for the two variables with the highest correlation coefficient with the Real Exchange Rate. The Granger causality test was therefore applied in the differentiated series

**Table 4: Granger Precedence Test: Real Exchange, GL, and GL IIP Index Portfolio investments**

<b>Null hypothesis</b>	<b>F Statistics</b>	<b>Prob.</b>
GL IIP index does not cause (in the Granger sense) Real Exchange	3.20470	0.0360
Real exchange does not cause (in the Granger sense) Index GL IIP	4.41773	0.0108
GL Index Portfolio does not cause (in the Granger sense) Real Exchange	0.58956	0.6742
Real exchange does not cause (in the Granger sense) GL Portfolio Index	0.56076	0.6939

Source: Prepared based on the calculations made in econometric package Eviews9.0.

According to the findings of the Granger causality test, the null hypothesis of statistical precedence of the GL Portfolio index for the Real Exchange Rate and also the Real Exchange for the GL Portfolio index cannot be rejected. However, the test suggests the existence of statistical precedence between the Index GL IIP and the Real Exchange Rate and Real Exchange Rate Index for the GL IIP at a significance level of 5%. In this sense, the statistical precedence test confirms a two-way causal relationship between the Real Exchange Rate and the GL IIP index, which reinforces the use of an autoregressive vector model in estimating the relationship between two variables that have concurrency condition.

Whereas the estimate can be performed by an autoregressive vector model given the integration order of the series I (0) after differentiation of the original series, five lags in the number of selection criteria were applied to determine the best VAR model to be used. The criteria were unanimous in pointing to the VAR (2) as the best model, as shown in Table 5. Additionally, the test results of the serial correlation LM waste does not allow the rejection of the null hypothesis of the absence of serial correlation in the model. Therefore, the model is estimated with two lags in the dependent relationship. Note that for estimating through a VAR model, a logarithmic transformation was performed in the series in order to interpret the results the concept of elasticity. With respect to multivariate normality tests, waste was possible to reject the null hypothesis of normality based on the Jarque-Bera statistic when using the orthogonalization method Lutkepohl. In contrast, the

applied orthogonalization method Doornik-Hansen cannot reject, by approximation, the null hypothesis of multivariate normality of waste.

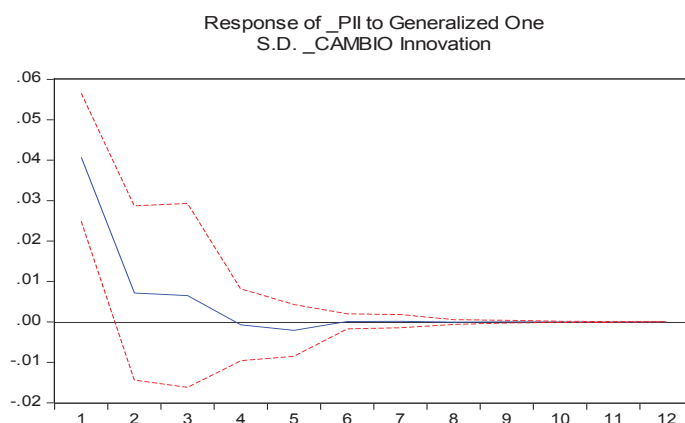
**Table 5: Selecting the model number lags**

VAR Order	Log likelihood	LR **	EPF ***	Akaike	Schwarz	Hannan Quinn
1 lag	90.11444	0.579430	5.32e-06	-6.470341	-6.180011	-6.386737
2 lags	96.80809	10.81283*	4.36e-06*	-6.677546*	-6.193662*	-6.538205*
3 lags	98.77957	2.881394	5.18e-06	-6.521506	-5.844069	-6.326428
4 lags	100.8604	2.721112	6.21e-06	-6.373879	-5.502889	-6.123065
5 lags	101.7218	0.993891	8.34e-06	-6.132446	-5.067903	-5.825896

Source: Prepared based on the calculations made in econometric package Eviews9.0.  
 Note: \* Selection according to the criteria. Statistical test \*\* sequential modified LR (each test at 5%). \*\*\* final prediction error.

From the estimate of the VAR, which had its stability guaranteed by the presence of the inverse roots on the unit circle, the impulse response functions were generated. In order to avoid any arbitrary factors in the Cholesky decomposition and, consequently, the generation of the impulse response functions, it was decided to go by the generalized response functions pulses. In this context, the GL IIP index response function to impulses in the exchange rate demonstrates how the GL Investment International Position Index reacts to a real devaluation, as shown in Figure 12, where you can see that the GL index IIP reacts positively to a shock in the Real Exchange Rate.

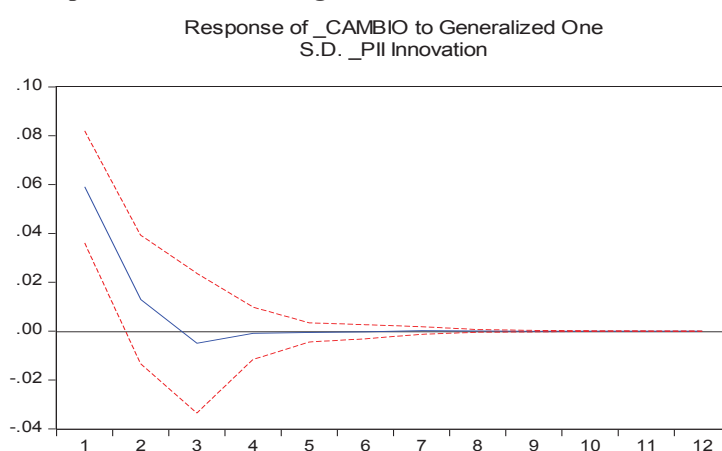
**Figure 12: Response of Index GL IIPto shock in the Real Exchange Rate**



Source: econometric package Eviews 9.0.

Therefore, exchange rate depreciation causes an increase in the IIP index, which can be caused both by an increase in Assets and as a decrease in the Liabilities. In either of these two cases, the index of the International Investment Position increase which suggests a reduction in vulnerability to an approximation of the values of external assets and liabilities. In other words, the devaluation of the Real Exchange Rate reduces the negative IIP of Brazil.

**Figure 13: Response of Real Exchange Rate to shock in the IIP index**



Source: econometric package Eviews 9.0.

Figure 13 shows the effects on the exchange of a shock to the GL index IIP. You can see that an increase in the index, an increase in Assets and / or a reduction in Liabilities promotes a depreciation of the Real exchange rate. This can be explained by the dollars leaving the country that takes place in each of the two cases. An increase in Assets means that residents of Brazil are expanding predominantly Brazilian direct investment stocks or portfolio investment abroad, which requires buying dollars to increase positions. On the other hand, a reduction in liabilities can occur when non-residents sell stocks and bonds in Brazil or reduce the stock of foreign direct investment, which increases the demand for dollars and promotes exchange rate depreciation.

**Table 6: Decomposition of the variance of the IIP index forecast errors**

Quarters	IIP	Exchange
1	37.32121	62.67879
6	40.25056	59.74944
12	40.25076	59.74924

Source: Prepared based on the calculations made in econometric package Eviews9.0.

Note: Order of variables in Cholesky decomposition (Realexchange rate, IIP index).

After analyzing the impulse response function, variance decomposition of the IIP content prediction errors was estimated. In this case, to enhance the effects on VAR bivariate model, land in Cholesky decomposition was adopted: Real exchange rate, IIP index. In this sense, Table 6 shows that in the first quarter after the shock, the exchange rate is responsible for approximately 62% of the behavior of IIP. After six quarters, there is a slight decrease in the share of the exchange rate in IIP explanation for about 59%. It can be seen, therefore, that it is clear the significant importance of the exchange rate on the decomposition of the variance of the IIP prediction errors.

**Table 7: Decomposition of the variance of forecast errors of the Real Exchange Rate**

<b>Quarters</b>	<b>IIP</b>	<b>Exchange</b>
<b>1</b>	62.67879	37.32121
<b>6</b>	60.38283	39.61717
<b>12</b>	60.38164	39.61836

Source: Prepared based on the calculations made in econometric package Eviews9.0.

Note: Order of variables in Cholesky decomposition (IIP index, Realexchange rate)

The decomposition of the variance of the exchange rate forecast errors was also calculated and the results are shown in Table 7. In this case, the ordering in the Cholesky decomposition was adopted: IIP index, Real exchange rate. You can see that in the first quarter after the shock, the exchange rate is explained by approximately 62% by IIP. After six quarters, there is a slight reduction in the share of IIP in the exchange rate of the explanation for about 60% which confirms the important role of the IIP in the decomposition of the variance of the exchange rate forecast errors.

The results in the survey run counter to that observed in the literature. Regarding the application of the index, Grubel (2002) and Obstfeld (2012) showed imbalance situations in the balance of payments, items while Whittard and Khan (2010) and Broomstra (2008) contemplated the relationship between the IIP and the exchange rate as in the present study. As a complement, the short-term effect pointed out by Mann (2002), about the correctness of IIP before devaluation was also noted in the response function to impulses.

**6. Conclusion**

This article aims to analyze the relationship between the exchange rate and the IIP in the period January 2008 to December 2015, with the application of the Grubel and Lloyd index adapted to the IIP and their subgroups, such as direct investment, portfolio investment, financial derivatives, and other investments. Additionally, it applied a vector autoregressive model in order to further examine the relationship between the IIP and the exchange rate. Specifically regarding the adaptation of the Grubel and Lloyd Index for IIP, it is emphasized that, after the study of Grubel (2002), few studies have applied the index

in the suggested format, other than Obstfeld (2004 and 2012). The application in this research for Brazil showed significant imbalances between assets and liabilities. It is emphasized, further, that the implementation of the IIP index also showed interesting results when comparing the evolution of the index with the evolution of the exchange rate.

The results suggest that the Real Exchange Rate has significant effects on the IIP in order to reduce the negative balance with a currency depreciation process. In this sense, the real depreciation process that began in 2013 contributed to an improvement in the IIP of Brazil. The estimate using a VAR model enables to visualize a positive response from the IIP index before a shock (depreciation) in the Real Exchange Rate. Therefore, the results support the hypothesis initially formulated that the movements in the exchange rate contribute to the correction of sharp imbalances in the IIP. Additionally, it was found that an increase of the IIP GL index also had effects on the trajectory of the exchange rate, as a shock in the IIP promoted devaluation of the domestic currency.

Thus, it is important to expand the investigation of the behavior of the IIP and the exchange rate, highlighting the corrective mechanism of the exchange rate on the IIP and the consequent reduction of the vulnerability of the economy. The realization of a new search with a longer period, especially considering more adequately the effects of the devaluation of Brazilian currency on the International Investment Position, can contribute to a more accurate interpretation of the relationship between the two variables. It would also allow an expansion of the number of observations to estimate the VAR model, thus eliminating one of the limitations of the research, which was that there were only a small number of observations. Another issue that deserves attention is the possibility of analysis of future input and output streams before the differential interest rate and return on existing assets between assets and liabilities. In the case of Brazil, this may increase the vulnerability of the economy. In this context, the relevance of the results of possibilities includes such issues as relevant topics for a future research agenda.

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