



**Center for Analytical Finance
University of California, Santa Cruz**

Working Paper No. 52

Sweden's Trilemma Trade-Offs

Orcan Cortuk
Center for Analytical Finance
University of California, Santa Cruz

February 2018

Abstract

In this paper, we empirically examine the theoretical concept of “impossible trinity” (financial trilemma) for Sweden for the period of 2010-2017. While doing this, we modified the Aizenman, Chinn and Ito approach by adding an extra interaction term to the main regression which shows whether these three policies are implemented in harmony without creating any trade-offs. Similarly, this interaction term also reflects the effectiveness of all supportive policies (i.e. hoarding international reserves, liquidity policies etc.) in order to eliminate the trade-offs between the monetary independence, exchange rate stability and capital openness. Our results indicate that the standard ACI approach is not sufficient in explaining Sweden's economic policies and adding an interaction term to the main trilemma regression is both necessary and critical. From the latter perspective, the interaction term has a negative contribution indicating that Sweden could achieve to relax the binding trilemma trade-offs in this period. Lastly, our analysis continues by exploring the implications of the interaction term for inflation in a VAR and Granger Causality analyses where we find that interaction term has certain decreasing impact on inflation.

Keywords: Trilemma, impossible trinity, mitigating policies.

JEL Classification: E44; E58; F41.

About CAFIN

The Center for Analytical Finance (CAFIN) includes a global network of researchers whose aim is to produce cutting edge research with practical applications in the area of finance and financial markets. CAFIN focuses primarily on three critical areas:

- Market Design
- Systemic Risk
- Financial Access

Seed funding for CAFIN has been provided by the Division of Social Sciences at the University of California, Santa Cruz.

Sweden's Trilemma Trade-Offs

Orcan Cortuk¹

February 2018

Abstract

In this paper, we empirically examine the theoretical concept of “impossible trinity” (financial trilemma) for Sweden for the period of 2010-2017. While doing this, we modified the Aizenman, Chinn and Ito approach by adding an extra interaction term to the main regression which shows whether these three policies are implemented in harmony without creating any trade-offs. Similarly, this interaction term also reflects the effectiveness of all supportive policies (i.e. hoarding international reserves, liquidity policies etc.) in order to eliminate the trade-offs between the monetary independence, exchange rate stability and capital openness. Our results indicate that the standard ACI approach is not sufficient in explaining Sweden's economic policies and adding an interaction term to the main trilemma regression is both necessary and critical. From the latter perspective, the interaction term has a negative contribution indicating that Sweden could achieve to relax the binding trilemma trade-offs in this period. Lastly, our analysis continues by exploring the implications of the interaction term for inflation in a VAR and Granger Causality analyses where we find that interaction term has certain decreasing impact on inflation.

Keywords: Trilemma, impossible trinity, mitigating policies

JEL Classification: E44; E58; F41

¹ Center for Analytical Finance (CAFIN), UC Santa Cruz

SWEDISH TRILEMMA TRADE-OFFS

1. INTRODUCTION

A critical challenge for an open economy is mainly on managing exchange rates, interest rates and capital account openness concurrently given the certain trade-offs among policies. These trade-offs may exist between interest rate policy independence, exchange rate stability, and financial integration as manifested by Mundell and Fleming (1963). Accordingly, changing one component is necessarily associated with a corresponding change in other two components. Accordingly, an economy cannot position itself on all three vertexes of the triangle of Figure 1 at once. On the other hand, since each of the three goals is desirable for economies, it is conceivable that policy makers still try to meet all three at least partially. This can be illustrated as being at a point in the interior area of the triangle. For example, a country might have a managed float and some monetary independence, sacrificing some capital openness.

There have been works in the literature on achieving all three goals to some extent: Obstfeld (1998) introduces the term as “open-economy trilemma” and Calvo and Reinhart (2001 and 2002) discusses that there could be limited monetary autonomy even under the free float regime. Rodrik (2000) presented a general overview of the trilemma in an international environment. Bordo and Flandreau (2003) show that monetary autonomy is considerable even under the classical gold standard. Obstfeld, Shambaugh and Taylor (2004) reinterpret the constraints of the trilemma as they are mostly driven by historical applications rather than the necessary theoretical implications of the Mundell-Fleming model.

While there have been such studies in the literature, the underlying theoretical framework of the trilemma, is not easily adapted to analysing the partial attainment of all three goals in formal theoretical modelling. More recently Aizenman, Chinn and Ito (ACI, 2008 and 2011), develop a new methodology to empirically characterize trade-offs in practical policymaking. In their approach, ACI initially measure each policy dimension via an empirical index which takes values between zero and one. The theoretical constraint of trade-offs between the three policy-goals is then captured by the coefficients in a regression where a constant is regressed on the trilemma indices. Multiplying these coefficients with their means result in contribution figures which determines the exact position of the country in the triangle. In their

study, ACI has performed a panel data analysis employing the data of 170 countries whereas Aizenman and Sengupta (2011), Hutchison, Sengupta, and Singh (2012) and Cortuk and Singh (2013) adapt ACI's methodology to emerging market economies (i.e. China, India, Turkey) in a time series approach. This paper also adapts a similar approach to these time series analyses but focuses on a developed country, Sweden, and also proposes to add a new term into the main trilemma regression.

The paper proceeds as follows: Section 2 gives a brief description of Sweden macroeconomic policies. Section 3 describes the methodology and the dataset used. Lastly, Section 4 concludes.

2. SWEDISH ECONOMY

Swedish economy is classified as a small open economy as the term is used in textbooks. Sweden liberalised its policies with respect to cross-border movement of capital and there are no obstacles to cross-border transactions for over two decades in this respect. According to IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)*, Sweden has full capital openness starting from late 1990s. AREAER (IMF, 2016) covers not only exchange rate arrangements but also regulatory for current and capital transactions. According to AREAER, Sweden has a free float exchange rate regime and no controls on payments for invisible transactions and current transfers.

With regard to monetary policy, the objective is to maintain price stability and hence to attain the inflation target in an inflation targeting framework. Weak inflationary pressures and low global interest rates are determinant issues that define Sweden's monetary policy in the post global crisis period (Riksbank, 2017). In this respect, the Central bank of Sweden, the Riksbank, has gradually cut its policy rate to below zero percent level together with special contingency plans to intervene in the foreign exchange market. Riksbank foresees monetary policy to be very expansionary in the upcoming years similar to many other countries whereas stronger economic prospects abroad and upward pressure in the forecast of inflation can also indicate comparatively less expansionary monetary policy. In this framework, domestic weak inflationary pressures and economic uncertainties together with low global interest rates pursued mainly by the Federal Reserve and ECB are main determinant factors for Sweden's monetary policy (Riksbank, 2017). To emphasize, interest rates of other economies have direct impact on Sweden's monetary policy.

The monetary policy has affected the exchange rates together with the market interest rates. In this context, the Swedish krona would have been considerably stronger today if the Riksbank had not conducted such an expansionary monetary policy. With such expansionary policy, exchange rate followed a more stable path leading to a higher inflation. Besides, there has been a weakening in Swedish krona more recently against most currencies, which cannot solely be justified by interest rate differences (Riksbank, 2017). Within this context, during the period of 2010-2017, Sweden implemented an active monetary policy to some extent which has certain implications not only on inflation but also on exchange rate.

3. DATA and METHODOLOGY

3.1 Data

Our approach of constructing the trilemma indices mainly follows ACI approach with some departures. We initially construct indices for each of the three policy objectives of the trilemma: monetary independence, exchange rate stability and capital openness. But instead of using a cross-country sample with time-averages of annual data as in ACI, we use data for a single country, Sweden for the period of 2010:1-2017:6. We also use a different measure of capital account openness which is dictated by the needs of a time series analysis of trilemma policy stances.

The data we employ, being monthly, is higher in frequency than employed by ACI, and subject to substantial time variation. For composing the trilemma indices, we obtain monthly data on exchange rate and capital flows from the Riksbank website. Effective overnight rates are collected from Federal Reserve Bank of St. Louis website. Industrial Production and inflation data are collected from Statistics Sweden website (www.scb.se).

Trilemma indices are constructed as follows:

3.2. Exchange Rate Stability (ERS) Index

Using the monthly standard deviations of the daily change in the log of the Swedish Krona-US dollar exchange rate, the index is constructed according to the formula below:

$$ERS = \frac{0.01}{0.01 + stdev(\Delta(\log(exch_{rate}))}$$

The scaling ensures that the index takes values between 0 and 1 whereas the highest value indicates to the greatest degree of exchange rate stability. The Figure 2 illustrates how the MI index evolved over time.

3.3. Monetary Independence (MI) Index

We again follow ACI (2008) in measuring MI as the reciprocal of the correlation of interest rates between Sweden and the base country (US). Monthly correlations of overnight rates are used as opposed to the yearly correlations of monthly rates used in ACI (2008). The index is constructed as:

$$MI = 1 - \frac{corr(i_t, i_j) - (-1)}{1 - (-1)}$$

This index also lies between 0 and 1, with the highest value implying to the greatest degree of monetary independence as shown in Figure 3.

3.4. Capital Openness (KO) Index

Constructing a Capital Openness Index is the most critical and problematic issue for our purposes. In the literature, there are both de jure and de facto measures. ACI use the de jure measure capital account openness index developed by Chinn and Ito (2006, 2008). According to them, capital openness is based on information regarding restrictions in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)*. Specifically, capital openness is the first standardized principal component of the variables that indicate the presence of multiple exchange rates, restrictions on i) current account transactions, ii) capital account transactions, iii) the requirement of the surrender of export proceeds. According to this Index, capital openness is essentially constant over the entire period for Sweden, and may not capture well the changes that have been occurring in management of the capital account. Other de jure measures also suffer from the same problem as they are only annual, and do not change for Sweden over time during the period of 2010M1-2017M6.

Oppositely, de facto measures which are classified mainly based on price differentials and quantities of capital flows vary over time. Thus, price based measures deal with interest parity conditions while quantity based measures take into consideration of capital flow volumes. The uncovered or real interest rate parity (Cheung, et al., 2003) and international

arbitrage pricing model (APM) or capital asset pricing model (CAPM) (see De Gregorio, 1998) are examples of the de facto measures based on price differentials. De facto measures based on quantities make use of capital flows such as volumes of capital flows, or the ratio of these flows to GDP as discussed by Lane and Milesi-Ferretti (2007). This type of measure can provide sufficient frequency for our purposes.

In our case, the lack of data with sufficient frequency on de jure controls dictates us employing a de facto measure. On the other hand, *de facto* measures are more susceptible to other macroeconomic effects than solely on policy decisions. Hence, they reflect changes in macroeconomic conditions even if there is no regulatory change on capital account transactions. Given the varying nature of de facto measures, we employ a quantity based de facto measure in our analysis.

Following Lane and Milesi-Ferretti (2007), we employed portfolio investments monthly data of non-resident holdings of Swedish interest-bearing securities. Given the GDP figures are quarterly; we simply adjusted portfolio investments with the industrial production index and normalized the figures to take values between 0 and 1. The Figure 4 illustrates this and this index fluctuates between 0 and 1.

Yet, for robustness, we also develop a new index that takes values of only 0.25, 0.50, 0.75 and 1 depending on intensity of the capital flows. This new index can be classified between a de facto measure and de jure measure in terms of its varying behaviour given the fact that it is not constant like a de jure measure but it does not vary each month like a de facto measure as well.

3.5. Methodology

Following ACI (2008), we initially test the validity of the trilemma assuming a linear relation among the policy choices. This reduces to examining the goodness of fit of this linear regression.

$$Z = \alpha(MI)_t + \beta(ERS)_t + \gamma(KO)_t + \varepsilon_t \quad (1)$$

The contributions obtained from equation (1) for the subsamples are reported in Table 1. This table reports the means, coefficients and contributions of the three indices. The overall fit is extremely good, reflected in the high adjusted R-squared figure. The total contribution is

1.99 being close to 2. This indicates that trilemma trade-offs are binding for Sweden. Results show that contribution of exchange rate stability is the sole dominant factor in the trilemma of Sweden and other policies have almost no role in this set up. Besides, capital openness, albeit insignificant, has negative contribution in the trilemma.

In reality, these contributions do not quite reflect the economic policies of Sweden. Especially capital openness having negative contribution is not realistic. This is mainly because even though capital openness may not have a direct contribution, yet it definitely has indirect effect on the policies. Thus, we propose a modified version of ACI approach to capture this.

$$2 = \alpha(MI)_t + \beta(ERS)_t + \gamma(KO)_t + \delta(MI * ERS * KO)_t + \varepsilon_t$$

In this new set-up; we propose to add an interaction term which is the multiplicative term of three policies of MI, ERS and KO. The interaction term acts as the common contribution in the trilemma regression. This term reflects how successfully all three policies are being implemented in harmony in a way to minimize the trade-offs. Accordingly, we expect this term to have a negative coefficient and contribution so that the total contribution of other three policies is higher than 2. This is because this interaction term gives more space to three main policies and mitigates the trade-offs between the policies of monetary independence, capital openness and exchange rate stability. This is in line with the ACI's explanation of reserves indicating that a massive amount of foreign reserves might allow the relaxation of the trilemma, i.e., achieve all three goals at the same time. In other words, if the country has accumulated sufficient amount of international reserves, then it can make use of its policies (MI, ERS and KO) in a way to support each other and hence eliminate the trade-offs among each other. The interaction term represents not only international reserves but also all other supportive policies i.e. liquidity policies, required reserve policies etc. that can be employed in order to eliminate the trade-offs.

Table 2 shows the results of this new modified trilemma regression. Results indicate that exchange rate stability has again the highest contribution. However, contributions of monetary independence and capital openness become statistically significant. As expected, the interaction term has a negative contribution enabling the total contribution of monetary independence, exchange rate stability and capital openness close 3.

3.6. Impact of Interaction Term on Inflation

In this section, we aim to test whether the interaction term is economically meaningful or not. By showing this, we can validate that this term has also significant effect on macroeconomic indicators (namely inflation) and it is a necessary term in the trilemma regression. Similarly, ACI has also shown that reserves have such mitigating impact on macroeconomic variables, namely inflation and growth. In this context, we perform a VAR and a Granger causality analysis between inflation and this interaction term. Table 4A illustrates these results. According to VAR results², the interaction term significantly affects inflation with its first lag³. Moreover, the sign of the impact is negative hence policy mix has a decreasing effect on inflation as expected. Similarly, Granger causality analysis is shown in Table 4B supporting the view that the interaction term (*representing all the supportive policy mix*) has a significant impact on inflation by rejecting the null hypothesis of no Granger causality at 99% confidence level.

3.6 Robustness

As a robustness check, we employ a different capital openness index for Capital Openness for all regressions to eliminate disadvantages of using a de facto capital openness measure. Thus, to construct a new capital openness measure, we divide the capital flow data into 4 sub-categories in a way to represent the highest and lowest 25% percentile, 50% and 75% percentiles. Later, we assign values 0.25, 0.5, 0.75 and 1 to each group. In this set-up, the new index is different from a de facto measure as it does not change each month and as it does not solely depend on the capital flows. Likewise, it is also different from a de jure measure as it is not constant throughout the period. Results from the main trilemma regressions are shown at Table 3A and 3B. Results of this table are parallel to what is found in Table 2 in the sense that while capital openness has a negative contribution in the first equation, it becomes positive in the second equation. Yet, the contribution figures differ from each other indicating to a stronger exchange rate stability contribution and the interaction term has a smaller impact on the trilemma trade-offs as well.

² Lag number is determined as 10 as it takes time before monetary policy has a full impact on inflation.

³ Chosen according to Akaike and Schwarz Information Criteria.

4. CONCLUSION

In this paper, we investigate Sweden's macroeconomic policies for 2010-2017 M6 in the context of financial trilemma trade-offs. Our methodology starts with following ACI (2008) approach. Using monthly data, we construct trilemma indices for each of the three policy objectives: monetary independence, exchange rate stability and capital account openness. Using the main trilemma regression of ACI resulted in poor results in terms of reflecting Sweden's economic policies. According to those, exchange rate stability is the sole factor that drives the policies making all other policies insignificant over the period. Yet, this is not accurate as the exchange rate stability is affected directly from monetary policy as Riksbank's Inflation Report presents. Besides, capital openness should not have negative contribution as indicated by ACI trilemma regression results.

We propose to improve ACI methodology by introducing an interaction term which is the multiplication of three policy indices to better capture Sweden's policies. With addition of this interaction term, the trilemma regressions result in a more realistic picture: exchange rate stability has less contribution giving room to monetary independence and capital openness even though it is still the main factor. The interaction term reflecting the harmony of all policies has a negative contribution mitigating the trade-offs. To understand this further, we run a VAR and Granger causality analysis between inflation and the interaction term. According to our analyses, this interaction term is suggestive in the sense that it has significant and decreasing impact on inflation.

TABLES

Table 1: Results for Standard Trilemma Regression (ACI Approach)⁴

	MI	0.48
Means	ES	0.778
	KO	0.549
Coefficients	MI	0.178**
	ES	2.534***
	KO	-0.12
Contributions	MI	0.085
	ES	1.97
	KO	-0.066

Table 2: Results for Modified Trilemma Regression

	MI	0.48
Means	ES	0.778
	KO	0.549
Coefficients	INTERACTION	0.205
	MI	1.567***
	ES	1.608***
	KO	1.324***
Contributions	INTERACTION	-3.578***
	MI	0.75
	ES	1.25
	KO	0.726
	INTERACTION	-0.733

⁴ *** p<0.01, ** p<0.05, * p<0.1

Table 3A: Results for Standard Trilemma Regression with new Capital Openness Measure (NKO)

	MI	0.48
Means	ES	0.778
	NKO	0.597
Coefficients	MI	0.148*
	ES	2.589***
	NKO	-0.157**
Contributions	MI	0.07
	ES	2.01
	NKO	-0.09

Table 3B: Results for Modified Trilemma Regression with new Capital Openness Measure (NKO)

Means	MI	0.48
	ES	0.778
	NKO	0.597
	INTERACTION	0.222
Coefficients	MI	1.027***
	ES	1.971***
	NKO	0.689***
	INTERACTION	-1.995***
Contributions	MI	0.492
	ES	1.533
	NKO	0.411
	INTERACTION	-0.443

TABLE 4A: VAR Analysis

<u>Variable</u>	INTERACTION TERM		INFLATION	
	<u>Coefficient</u>	<u>t-stat</u>	<u>Coefficient</u>	<u>t-stat</u>
Int. Term(-1)	0.075	0.71	-1.522	-3.305
Inflation (-1)	-0.052	-2.41	-0.327	-3.439
Constant	0.193	8.20	0.418	4.067

TABLE 4B: Granger Causality Test

<u>Variable</u>	<u>F stat</u>	<u>Prob. Value</u>
Int. Term does not Granger Cause Inflation	2.842	0.006
Inflation does not Granger Cause Int. Term	1.001	0.453

TABLE 4C: Robustness

<u>Variable</u>	INTERACTION TERM		INFLATION	
	<u>Coefficient</u>	<u>t-stat</u>	<u>Coefficient</u>	<u>t-stat</u>
Int. Term(-1)	0.33	3.39	-1.015	-3.316
Inflation (-1)	-0.08	-2.65	-0.347	-3.617
Constant	0.15	6.18	0.332	4.202

FIGURES

FIGURE 1: Trilemma Triangle

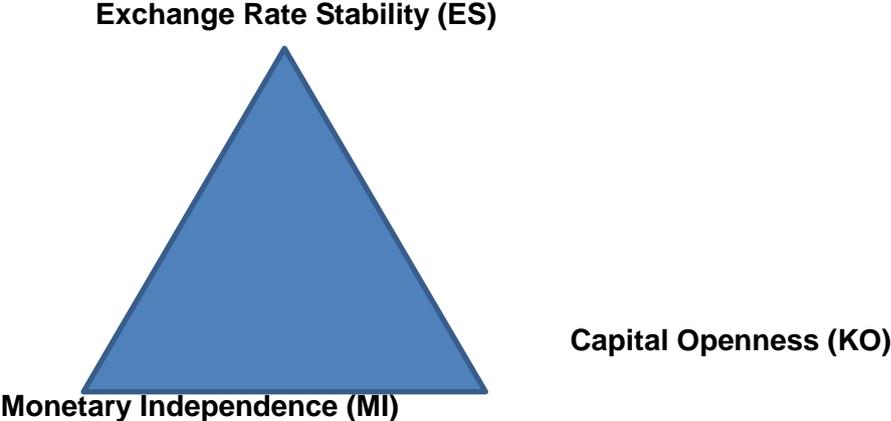


Figure 2: Exchange Rate Stability Index

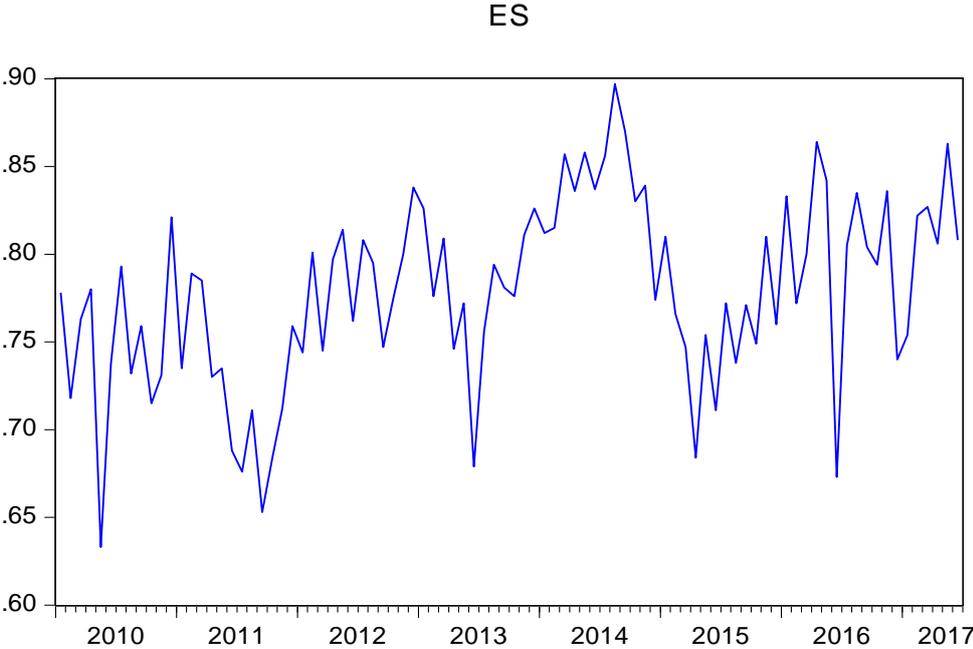


Figure 3: Monetary Independence Index

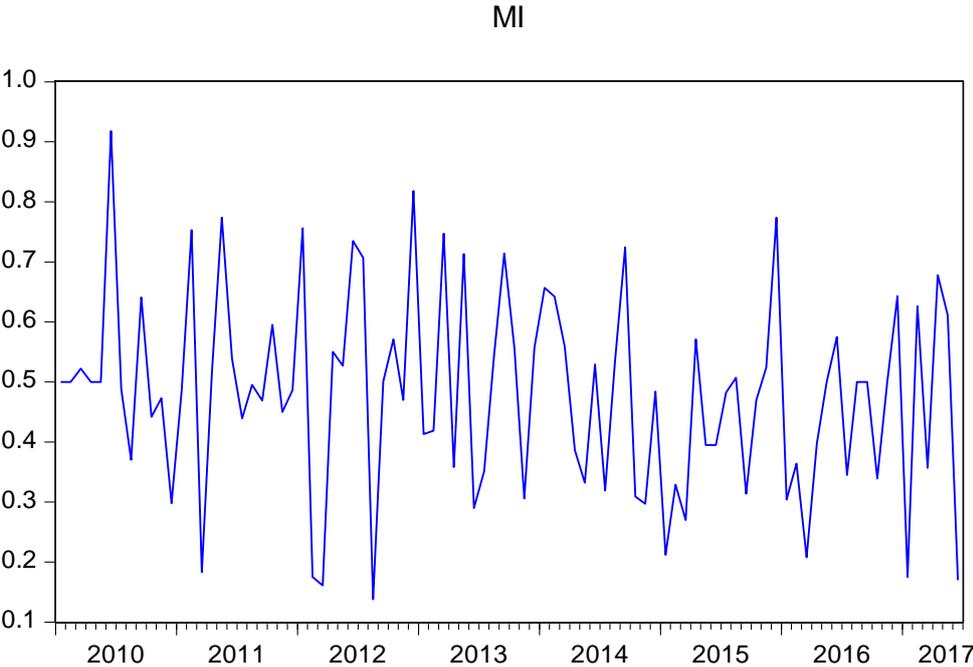
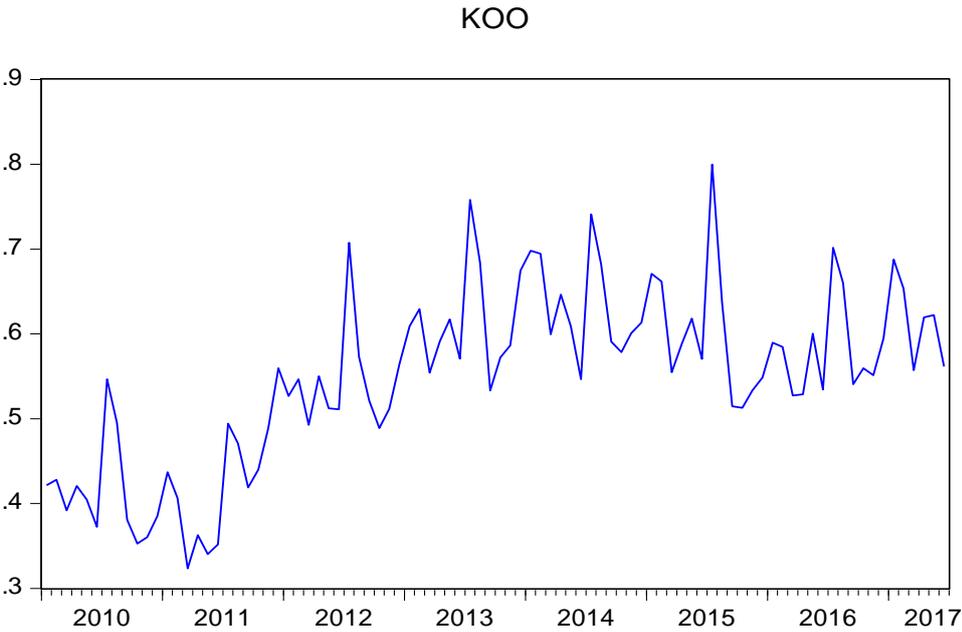


Figure 4: Capital Openness Index



REFERENCES:

- Aizenman, J., Chinn, M. and Ito, H. (2008). "Assessing the Emerging Global Financial Architecture: Measuring the Trilemma's Configurations over Time." *NBER Working Paper*, No. 14533.
- Aizenman, J., Chinn, M. and Ito, H. (2011). "Surfing the Waves of Globalization: Asian and Financial Globalization in the Context of the Trilemma." *Journal of the Japanese and International Economies*, 25(3): 290-320.
- Aizenman, J., Sengupta, R. (2011). The financial trilemma in China and a comparative analysis with India, MRPA Paper No. 34485, University of California, Santa Cruz, CA.
- Bordo, M. and Flandreau, M. (2003). "Core, Periphery, Exchange Rate Regimes, and Globalization." in *Globalization in Historical Perspective*, edited by M. D. Bordo, A. M. Taylor and J. G. Williamson (pp.417-473). Chicago: University of Chicago Press.
- Calvo, G. and Reinhart, C. (2001). "Fixing for Your Life." in *Brookings Trade Forum 2000*, edited by Susan Collins and Dani Rodrik (pp.1-39). Washington D.C. Brookings Institution.
- Calvo, G. and Reinhart, C. (2002). "Fear of Floating." *Quarterly Journal of Economics*, 117 (2): 379-408.
- Cheung Y-W, Ito H (2007) Cross-sectional analysis on the determinants of international reserves accumulation. UC Santa Cruz mimeo
- Chinn, M. D. and H. Ito. (2008). "A New Measure of Financial Openness." *Journal of Comparative Policy Analysis*, Volume 10, Issue 3 (September), p. 309 - 322.
- Cortuk, O., and Singh, N. (2011). "Turkey's trilemma trade-offs: is there a role for reserves?." *Iktisat Isletme ve Finans*, Bilgesel Yayincilik, vol. 28 (328), 67-88
- De Gregorio, J.(1998). "Financial integration, financial development and economic growth". Unpublished manuscript, Department of Industrial Engineering, Universidad de Chile
- Hutchison, M., Sengupta, R. and Singh, N. (2010). "India's Trilemma: Financial Liberalization, Exchange Rates and Monetary Policy." *The World Economy*, 35(1), 3-18
- IMF (2016). Annual Report on Exchange Arrangements and Exchange Restrictions, [online] Available at <https://www.imf.org/en/Publications/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions/Issues/2017/01/25/Annual-Report-on-Exchange-Arrangements-and-Exchange-Restrictions-2016-43741> [Accessed 2 February 2017]
- Lane, Philip and Gian Maria Milesi-Ferretti (2007). "The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970-2004," *Journal of International Economics* 73(2): 223-25
- Mundell, Robert A. (1963) Capital mobility and stabilization policy under fixed and flexible exchange rates, *Canadian Journal of Economic and Political Science* 29 (4): 475-485. doi:10.2307/139336.

Obstfeld, M. (1998). "The Global Capital Market: Benefactor or Menace?" *Journal of Economic Perspectives*, 12(4): 9-30

Obstfeld, M., Shambaugh, J. and Taylor, A. (2004). "The Trilemma in History: Tradeoffs among Exchange Rates, Monetary Policies, and Capital Mobility." *NBER Working Paper*, No. 10396.

Riksbank. (2017). Inflation Report, December 2017,[online] Available at <https://www.riksbank.se/en-gb/monetary-policy/monetary-policy-report/> [Accessed 2 February 2017]

Rodrik, D (2000). How far will economic integration go? *Journal of Economic Perspectives* 14, 177-186