HAL open science

Interest rates, inflation, and exchange rates in fragile EMEs: A fresh look at the long-run interrelationships

Hüseyin Şen, Ayşe Kaya, Savaş Kaptan, Metehan Cömert

▶ To cite this version:

Hüseyin Şen, Ayşe Kaya, Savaş Kaptan, Metehan Cömert. Interest rates, inflation, and exchange rates in fragile EMEs: A fresh look at the long-run interrelationships. 2019. halshs-02095652v1

HAL Id: halshs-02095652
https://shs.hal.science/halshs-02095652v1

Preprint submitted on 10 Apr 2019 (v1), last revised 25 May 2019 (v2)

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright

Interest rates, inflation, and exchange rates in fragile EMEs: A fresh look at the long-run interrelationships

by Hüseyin Şen[a], Ayşe Kaya[b], Savaş Kaptan[a], Metehan Cömert[a]

First complete draft: 10 April 2019

Abstract

This study attempts to establish the possible existence of the long-run interrelationship between interest rates, inflation, and exchange rates in five fragile emerging market economies (Brazil, India, Indonesia, South Africa, and Turkey), what is so-called by Morgan Stanley 'Fragile Five'. To do so, we utilize Li and Lee's (2010) Autoregressive Distributed Lag (ADL) test for threshold cointegration and apply it to sample countries' monthly time-series data from 2013:1 to 2018:12. Overall, our primary results are threefold: First, there seems to be a long-run positive relationship between inflation rates and nominal interest rates supporting the validity of the Fisher hypothesis for all the sample countries. Second, sample countries' data supports the existence of a cointegration relationship between interest rates and exchange rates for the case of Brazil, India, and Turkey but not for the case of Indonesia and South Africa. Lastly, without exception, exchange rates and inflation in all countries examined tend to co-move in the long-run, implying that increases in exchange rates affect inflation through raising the prices of foreign goods imported into the sample countries. The results above are widely compatible with theoretical expectations and with the results of the most previous empirical studies on the long-run interrelationships between interest rates, inflation, and exchange rates in the literature.

Keywords: Macroeconomic policy, macroeconomic policy management, autoregressive distributed lag, threshold cointegration, emerging market economies.

JEL codes: E31, E43, E52, E58, E60

Acknowledgements:

The authors are grateful to İhsan Kulalı, Abdullah Tirgil, Zeynep B. Çevik, and Barış Alpaslan for their valuable comments and suggestions.

[a] Ankara Yıldırım Beyazıt University, Ankara/Turkey.
[b] İzmir Kâtip Çelebi University, İzmir/Turkey.

1. Introduction

Most would agree that interest rates, inflation, and exchange rates are of fundamental macroeconomic pillars for a country's economy. Taken together, they take place at the heart of the economy as the macroeconomic barometers, giving signals regarding the macroeconomic performance of the economy. Even in practical terms, they are the principal macroeconomic policy variables of an economy, playing a critical role in not only determining but also influencing both real and nominal economy. Therefore, the possible presence of the long-run interrelationship between them always receives considerable attention from a broad range of society's interest, ranging from policymakers and academic economists to investors, companies, and even households.

In today's globalized world, this attraction has become layered. Perhaps, the plausible grounds behind this have been the changes in a macroeconomic policy environment pursued by countries with global integration resulted from globalization. So, understanding the link between them constitutes a basis for setting proper macroeconomic policy management. On this point, many countries have put into practice a bunch of macroeconomic policies, i.e., fiscal, monetary, and exchange rate policy, which is compatible with their economic targets in recent decades.

In conducting the present study, several factors motivate us. First and foremost, interest rates, inflation, and exchange rates are dynamic macroeconomic variables for every lively economy. Second, the sample countries have an essential place in the world economy, accounting for, for example, 26 percent[1] of the world population and 8.5 percent[2] of the world GDP respectively. Also, all the sample countries are the G-20 members that incorporate the biggest twenty economies of the world. Despite this fact, to our knowledge, there is no previous study examining the interrelationships between three variables in the context of five fragile economies. Third, in the sample countries the sensitivity of interest rates, inflation, and exchange rates appears to be rather high in relation to other emerging market economies against international economic and political developments that make these countries further fragile against sudden changes in the international environment. It is partly due to their economic and political structure and partly due to the degree of their integration with the world economy. Finally, the sample countries, without exception, have recently introduced new strategies in setting their macroeconomic policies compatible with floating exchange rate regimes, such as inflation targeting.[3] Exchange rate volatility either alone or together with interest rates variability has made the issue more important for these countries examined. In this context, the 2008−09 global crisis compelled countries to reassess how there is coherence between monetary policies pursued and other policies proposed to provide financial stability. In this assessment, in particular, the role of the exchange rate regime they adopted came into prominence.

This study revisits the highly disputed issue in both theoretical and empirical grounds of the interrelationship between interest rates, inflation, and exchange rates by using the data on fragile EMEs on which have not been studied before. In this framework, the study seeks to answer the following questions: is there a long-run interrelationship between interest rates, inflation, and exchange rates in the sample countries? If so, what kinds of empirical relationships exist between them? Against this background, the study aims to examine whether there is any long-run relationship between interest rates, inflation, and exchange rates for the five fragile EMEs:

[1] The calculation is based on the population statistics in 2017 provided by the World Bank: United Nations World Population Prospects.

[2] The calculation is based on the World Bank national accounts data, and OECD National Accounts data files in 2017.

[3] The year of adopting inflation targeting is 1999 for Brazil, 2016 for India, 2005 for Indonesia, 2006 for Turkey, and 2000 for South Africa, respectively.

Brazil, India, Indonesia, South Africa, and Turkey. More specifically, the present study proposes to test empirically the possible existence of the long-run linkage between interest rates, inflation, and exchange rates in the countries under scrutiny from January 2013 to December 2018.

In this study, we use Li and Lee's (2010) Autoregressive Distributed Lag (ADL) test for threshold cointegration as the econometric estimation technique. This estimation technique has several superiorities compared to its rivals. First, the ADL test does not require the classification of variables into $I(1)$ or $I(0)$. Other cointegration procedures, such as those proposed by Engle and Granger (1987) and Johansen (1988), need to check the order of the integration of variables by using unit root tests and all variables in the model must be integrated of the same order. Second, the ADL test technique provides better performance in small sample sizes. Lastly, it allows for estimating the long- and the short-run parameters of the model simultaneously. Because the ADL test for threshold cointegration can overcome these three critical problems, our empirical results contribute to increasing our understanding of the research questions of the present study.

The remainder of the study is organized as follows: The following two sections provide an in-depth analysis to the study, focusing on not only the theoretical aspects of the nexus between interest rates, inflation, and exchange rates but also their empirical aspects respectively. The proceeding section lays out the econometric procedures of the study. As for Section 4, it reports estimation results and then discusses. Section 5, the final section, summarizes and concludes.

2. Theoretical considerations

2.1. Interest rates−inflation−exchange rates nexus in theory

The relationship between interest rates and inflation is one of the most interested as well as the long-debated topics in macroeconomics literature. As is known, central banks, as monetary authorities, have the power of altering interest rates by manipulating the money supply. Then, variations in interest rates are likely to influence both exchange rates and inflation through monetary transmission mechanisms. For instance, in an open economy, under the assumption of perfect capital mobility, an increase in domestic interest rates provide lenders an opportunity of obtaining a higher return stemming from the differential between domestic interest rate and foreign one. Thus, it creates an attractive environment for foreign capital in- and outflows. The influx of foreign capital, all else being equal, leads to an appreciation in national currency, putting pressure over the exchange rate to rise, or vice versa. Of course, it is probable that the volatility effects of interest rates on exchange rates may be mitigated to some extent if there exists a difference in inflation rates between the home country and the rest of the world. Theoretically, at least, it is also expected that interest rates influence inflation.

The standard view that relates interest rates with inflation is often attributed to the Irving Fisher and his seminal work of 1930. In the mentioned study, Fisher establishes a direct link between nominal interest rates and expected inflation and thus postulates that nominal interest rate is equal to the sum of real interest rate plus the expected rate of inflation. According to Fisher (1961[1930]), nominal interest rates, all else equal, positively move one-for-one with expected rates of inflation in the long run, but there is no connection between changes in the expected rates of inflation and changes in real interest rates. Put differently, real interest rates are not affected by the expected inflation.

Then, it is safe to argue that the Fisher hypothesis, or the Fisher equation, is a good starting point to understand the interest rate−inflation nexus. It establishes a one-to-one long-run relationship between nominal interest rates and the expected rate of inflation assuming an unchanging real interest rate. The Fisher hypothesis hints at that permanent changes in the expected rate of inflation —that are equal to actual inflation rates under the assumption of adaptive expectations— exert no long-run impact on the real interest rates. Namely, as long as the hypothesis holds, then nominal interest rates will co-move literally with the expected rates of inflation under the assumption that interest rates are stable. From the Fisher hypothesis standpoint, real interest rates are determined by real factors, such as productivity of the capital in economy and time preference of investors in the economy rather than monetary shocks (Nusair, 2009).

The Fisher equation states that the nominal interest rate [i] is equal to the sum of the real interest rate and the expected rate of inflation [π^e] for the same term in the long run. Algebraically speaking, it can be expressed as $i = r + \pi^e$. In Fisher's framework, changes in expected inflation rate cause an equivalent change in the nominal interest rate. Namely, changes in nominal interest rates are subject to the expected rate of inflation. Needless to say here that the real interest rates and expected rate of inflation are affected by a variety of factors. For example, as noted by Hakkio (1986), the first thing that influences the real interest rate is the demand for and supply of available funds of an economy. In a similar vein, changes in the expected rate of inflation are associated with various temporary and permanent factors, such as one-time changes in the price of food or energy, government policies, military, economic, political issues and the like.

The existing literature holds several transmission mechanisms through which interest rates could influence exchange rates. In the related literature, interest rates are widely linked with inflation and exchange rates alike. Accordingly, for instance, a reduction in interest rates allows consumers to borrow more money with a relatively lower cost. From the consumers' viewpoint, this means that other things being constant, they will have an opportunity to spend more money, stimulating aggregate demand and resulting in inflationary pressure. By contrast, if interest rates increase and then it is expected that consumers will have to borrow more money and then they will have less opportunity to spend, resulting in a decline in inflation. Briefly, the Fisher equation expresses that there exists one to one nexus between the expected rate of inflation and nominal interest rate with causality running from the former to the latter.

2.1.1. Interest rates−inflation nexus

The possible linkages between interest rates and inflation are a long matter of concern among researchers. The origin of the debate over interest rates−inflation is usually attributed to the studies of the Swedish economist Knut Wicksell conducted more than a century ago. Wicksell (1907, 1936[1898]) originally introduced the concept of neutral [natural] interest rate, also known as the Wicksellian rate of interest, which refers to the equilibrium value of the real interest rate at the natural level of output. This interest rate is regarded as an interest rate in the goods market in which demand and supply of goods and services are in equilibrium. In Wicksell's eye, the natural interest rate brings about not only monetary equilibrium, but also a real equilibrium in an economy. Herein, monetary equilibrium implies a stable price level, while real equilibrium refers to consistency between saving decisions by households and investment decisions by firms. Any deviation of the market rate—that is, the money rate of interest appearing at the capital market—from the neutral interest rate results in changes in the prices through the Wicksell's cumulative process which explains how the difference between natural interest rate and market rate results in increases in prices (see Wicksell, 1936[1898]). Accordingly, suppose that if the market interest rate is lower than the natural one, in such case, the economic activity will expand and thus a rise in prices will occur. Increases in prices put further pressure on the real interest rate, resulting in a further rise in economic activity and thus at prices.

A couple of decades later from Wicksell, Fisher (1961[1930]) in his seminal work claimed that the expected rate of inflation affects nominal interest rates. To Fisher, for instance, a decrease in the price level makes companies borrow less since their profit levels fall. Then, less borrowing results in coming down interest rates. For households, the situation would be almost the same in such a way that disinflation makes for them to deposit their money in a bank at a lower interest rate as they care about the real return on their savings.

Sargent (1973) criticized the Fisher hypothesis, expostulating that the Fisher equation is inadequate to explain the relationship between inflation and interest rates. Contrary to Fisher's proposition, the author argued that there is a bi-directional causality between expected rates of inflation and nominal interest rates wherein causality runs from the former to the latter. He further argued that the critical thing in explaining the link between expected inflation rates and interest rates is how price expectations are formed. Accordingly, actual inflation influences expected inflation and then through which it puts pressure on nominal interest rates.

One should keep in mind that price levels may not just affect interest rates but also are likely to be affected by them as well. The standard IS-LM framework can help us in shedding light to understand this relationship. When the standard IS-LM framework is considered, for example, other thing being equal, an increase in the money supply shifts the LM curve to the left, consequently increasing aggregate demand. Therefore, firms will respond by increasing prices to the rising demand for supply cannot respond quickly since the supply curve is inelastic in the short run.

Moreover, interest rates provide information regarding future projections of macroeconomic variables, such as inflation. To illustrate, economic agents and/or market participants consider expected rates of inflation when they manage their savings and budgets. In doing so, they propose to maximize the real rate of return on their savings. So, it can be argued that higher nominal interest rates might be positively associated with higher inflation expectations. Fama (1975) concludes that n-month predictions about inflation can be made with the help of n-month bills. Also, Engsted (1995) establishes a link between interest rates and inflation. However, in contrast to Fama (1975) that took into account short-term interest rates, the author used long-term interest rates as a predictor of inflation.

2.1.2. Interest rates−exchange rates nexus

In reviewing the existing economics literature, one sees that the theoretical relationship between interest rates and exchange rates is usually explained in the context of exchange rate determination. Accordingly, the differential between domestic and foreign interest rates is one of the significant determinants of exchange rates. For instance, the IMF traditionally claims that the interest rate differentials dictate the movement of foreign capital in- and outflows from one country to another.

However, the existing literature also provides some alternative point of view to the above standard explanation. In this regard, Frankel (1979) identifies two basic approaches in explaining the linkages between interest rates and exchange rates. These are international goods market and asset market approaches. Accordingly, interest rates can be linked with exchange rates through the latter one. Because both interest rates and exchange rates may exert an influence on global asset prices while international goods market is not directly related to interest rates. Concerning the asset market approach, Frankel (1979) acknowledged that there exist two alternative views as Chicago and Keynesian views. The Chicago view argues that under perfectly flexible prices, changes in market interest rates are determined in a large extent by expected rates of inflation. If domestic interest rates tend to increase in relation to the rest of the world, then it is thought that market participants have already priced the increases in the expected inflation rate. In this case, it is expected that domestic currency will lose value due to depreciation effect of inflation. Therefore, the exchange rate in terms of domestic currency increases (depreciation) since the demand for domestic currency decreases. Consequently, this purports that exchange rates move in the same direction with nominal interest rates. The Keynesian theory, in contrast, suggests that under the validity of sticky prices, higher market interest rates resulted from contractionary monetary policy actions create an attractive environment for capital inflows towards the home country. This is because higher interest rates in the absence of increases in inflation rate drive up real interest rate that is a real return on domestic currency for foreigners. As a result, there would be an appreciation in the domestic currency due to increasing demand. In brief, exchange rates move with the opposite direction of interest rates under the assumption of sticky prices. Also, developing global financial system contributes to the emerging of such a mechanism through carry-trade operations that enable investors to borrow in terms of currency having lower interest rate and lend in terms of a currency pays higher interest.

In a theoretical contribution aiming to develop a theory of exchange rate movements under perfect capital mobility, Dornbusch (1976) asserted that interest rates are negatively associated with exchange rates in the short run. According to Dornbusch (1976), if economic agents and/or market participants expect depreciation in the domestic currency, then the market will price this instantly increasing interest rate. This pretends to interest rate parity condition which argues expected depreciation of a currency against others is equal to the difference between the interest rates of two countries.

2.1.3. Exchange rates−inflation nexus

A good starting point for analyzing the relationship between exchange rates and inflation is to take a close look at the study by Barro and Gordon (1983). In their pioneering study, the authors proposed a theoretical argument on the exchange rate−inflation nexus in the context of monetary policy credibility. The authors argued that a fixed or stable exchange rate policy could make easier the task of the monetary authority in lowering inflation by increasing credibility. This argument was also put into words in the following years by some scholars, including Giavazzi and Giovannini (1989), Velasco (1996), and Dornbusch (2001). They all contended that a stable exchange rate regime provides not only price stability but also a commitment to the efficiency of monetary policy. Under such a regime, an economy with a relatively higher inflation rate against the rest of the world is likely to face persistent external deficits and thus a reduction in its FX reserves. This may pose a risk to the sustainability of persistent deficits as well as reserves. In order not to come across such problems, the authorities will try to restrain its excessive inflation rate. Under the flexible exchange rate regime, as opposed to a fixed one, this would not be the case since external disequilibria are automatically and instantaneously corrected by variability in the exchange rate.

Another argument in favor of a fixed exchange rate regime is that it will increase the credibility of monetary policy. Increasing the credibility of monetary policy will allow the monetary authority to conduct its commitment to low inflation. All these will provide an anchor for inflationary expectations. Reducing inflationary expectations will help not only lower the velocity of money but also decrease the sensitivity of prices to temporary monetary shocks (Levy−Yeyati and Sturzenegger, 2001). Besides, fixed exchange rate regime may contribute to having lower inflation by creating a confidence effect −that is a greater willingness to hold domestic currency rather than goods or foreign currencies (Ghosh et al., 1997). By contrast with, floating exchange rate regime, unlike fixed one, that is associated with overshooting of the equilibrium exchange rate in both directions and cause prices to rise via pushing up the domestic prices of imported goods when depreciating but fail to reduce prices while appreciating−the so-called ratchet effect. On that account, it could be claimed that inflation is likely to be higher under a floating exchange rate regime when compared to a fixed one.

Against the above unfavorable arguments, of course, there are some counter-arguments in favor of flexible exchange rate regime for having lower inflation. For instance, Tornell and Velasco (1995) argued that flexible rate regime allows the effect of unsound fiscal policies to be reflected in exchange rate movements and given that inflation is costly for fiscal authorities, the flexible rates enforce transparency and provide more policy discipline by forcing them to pay the cost. It is also argued that a flexible regime provides monetary independence, which, in turn, is crucial for tracking the monetary policy in a direction that stimulates growth and reduces unemployment. In terms of its impact on growth, monetary independence with fully flexible exchange rate regime will ensure the government to center on the optimal inflation rate that creates a positive environment for growth (Hernandez−Verme, 2004).

Under an open economy with fully flexible exchange system, it is very probable that an appreciation or depreciation in exchange rates influence the price of imported goods, provocating consumer and producer price indexes to drive up. This is primarily a case for import-dependent economies which are vulnerable to external shocks as in the case of the countries in the present study. The link between exchange rate and inflation comes out through the pass-through effect of exchange rate volatility, inducing changes in domestic prices. It is remarkable to note here that to what extent the exchange rate pass-through effect would occur depends mainly on the price elasticity of demand and supply for imported goods. Accordingly, if the price elasticity of the goods is low, for instance, then the pass-through effect will be rather small since economic agents would prefer other substitutable goods or services that are relatively cheap. It is also important to stress that, as emphasized by Devereux and Yetman (2002), sticky prices may cause to be delayed the pass-through effect on economies for a while. This could be the case especially when prices do not flexibly adjust to changing dynamics. In such cases, changes in the exchange rate may not influence inflation for considerable time periods or vice versa, changing in line with the circumstances. Namely, it is highly likely that inflation affects the exchange rate. Expectations related to inflation may give rise to volatility in the exchange rate. Especially this could be a case when economic agents and/or market participants have inflationary expectations which would result in depreciation in the domestic currency. In such a case, they would tend to sell off the domestic currency as buying foreign currency. This process would end up with weakening the domestic currency against foreign currencies.

Another possible channel that could be considered is that the exchange rate pass-through. It may create an inflationary effect by increasing the prices of imported goods. What we point out is that the effects of exchange rates on domestic inflation emerge by means of exchange rate pass-through. A country's foreign trade is a critical factor that is likely to affect domestic prices and then inflation by depending mainly on the magnitude of a country's foreign trade structure and volume. The overall level of prices is influenced by the prices of all items that take place in the consumption basket of that country. If the country relies heavily on imports of goods for either domestic consumption or investment or another purpose, in such a case, domestic prices in this country would be very sensitive to the changes in prices in the countries made import. As such, an appreciation, for example, in the value of foreign currency, the exchange rates pass through domestic markets, putting pressure over inflation to rising or vice versa. On the other hand, this pass-through effect of volatility in exchange rates also poses a risk on export-oriented countries that relies mainly on import to make export through a process characterized simple as follow: An increase in exchange rate leads to an increase in import prices and an increase in import prices affects the prices of domestic tradable goods. On balance, what emerges from the above theoretical arguments is that there are divergent views regarding exchange rates−inflation link.

2.2. Empirical background to the study

2.2.1. Empirical literature on the interest rates−inflation nexus

An old, but still oft-cited, paper by Fama (1975) studied the possible existence of the nexus between short-term interest rates and inflation considering the case of the U.S. The author's results indicated that there is a strong relationship between interest rates and inflation rates, running from inflation rates to short-term interest rates. This is the case, especially in the bill market. However, the author holds the view that in determining current inflation rates, not only interest rates but also past inflation rates play a critical role. Like Fama (1975), Mishkin (1992) also considered the case of the U.S. and explored the level of interest rates−inflation relationship referring to a strong Fisher effect by using the post-war U.S. data. However, contrary to Fama (1975), Mishkin (1992) found no evidence supporting a short-run Fisher effect whereas enough evidence supporting the existence of a long-run Fisher effect. Based on the findings, the author argued that his findings are consistent with Fisher's original proponent on the inflation-interest rate relationship that was expressed in his 1930's paper. Furthermore, he drew attention to the fact that Fisher did not propose that there should be a robust short-run relationship between expected rates of inflation and interest rates. On the contrary, he asserted that there is a positive relationship between interest rates and inflation, but this is a long-run phenomenon rather than a short-run.

Drawing on the data from four developed countries (the U.S., Belgium, Canada, and the U.K), MacDonald and Murphy (1989) tested the long-run bivariate relationship between interest rates and inflation. The authors found evidence supporting the Fisher hypothesis. However, the validity of the hypothesis was less strong than expected. Instead, the authors' findings confirmed a weak relationship between inflation and interest rates for the U.S. and the U.K and a semi-strong relationship for the other two countries in the long run. The authors justify these findings with reference to the exchange rate regime pursued by these countries. On this point, they argue that when the exchange rate regimes of the sample countries are considered and then they are broken down into two sub-components as the fixed and floating exchange rate regimes, it appears that there is some evidence of cointegration for the U.S. and Canada for the fixed exchange rate periods, while there is no evidence of cointegration for either a weak or semi-strong form in any of the sample countries.

In a follow-up paper, Koustas and Serletis (1999) looked at the possible existence of the Fisherian link between inflation and short-term nominal interest rates in 11 developed countries[4]. The author's findings suggested that the Fisher effect is strong only for Canada, the U.K, and the U.S. as it is weak for France, Germany, and the Netherlands. However, for the remaining

[4] Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Japan, the Netherlands, the U.K, and the U.S.

countries, the long-run Fisher effect was strongly rejected. Overall, the authors argued that the sample countries' data overwhelmingly rejects the Fisher effect, showing similarity with what Mishkin (1992) found. Using the panel smooth transition regression model, a fresh paper by Kim et al. (2018) came to the almost same conclusion with Mishkin (1992), providing no clear-cut evidence regarding the co-movement of inflation and interest rates. The authors, however, suggest that the effects of inflation on interest rates vary with the size of the inflation rate. A paper based on cointegration analysis by Payne and Ewing (1997) also yielded mixed evidence in the context of a set of lesser-developed countries. Their results support the validity of the Fisher hypothesis only for four out of nine sample countries (Malaysia, Pakistan, Singapore, and Sri Lanka). There is no long-run relationship between interest rates and inflation rates in the remaining five countries: Argentina, Fiji, India, Niger, and Thailand. The authors contended that for each of these five countries, the real interest rate is non-stationary in levels. Similarly, Carneiro et al. (2002) revealed no homogenous results for three big Latin American countries: Mexico, Argentina, and Brazil. The authors' analysis revealed that there appears to be a stable long-run relationship between nominal interest rates and inflation rates for just Argentina and Brazil.

For a group of 26 developed and developing countries, on the contrary to what the authors found above, Berument and Jelassi (2002) documented that there is strong evidence in favor of the Fisher hypothesis in more than half of the countries under scrutiny in the long run. Additionally, the authors drew attention to the fact that the Fisher hypothesis holds more for the developed countries rather than the developing ones.

Tsong and Hachicha (2014) examined the validity of the Fisher hypothesis for a group of four developing countries, consisting of Indonesia, Malaysia, Russia, and South Africa. Their results suggested that there is a long-run relationship between interest rate and inflation. However, they noted that the shocks affect the long-run coefficients between nominal interest rates and inflation, hinting at the existence of an unstable relationship between the two. More specifically, in the upper quantiles there is a one-to-one relationship between nominal interest rates and inflation, confirming the validity of the Fisher effect, while in the lower quantiles, the nominal interest rate responds by a lower percentage than the change in inflation, referring to the Fisher effect puzzle. The authors attribute their findings to the existence of the asymmetric monetary policy. A subsequent paper by Güriş and Yaşgül (2015) provided mixed evidence, supporting that the Fisher hypothesis is valid for Canada, Germany, Italy, and Japan but not for France, the U.K, and the U.S.

In a nutshell, in reviewing the existing literature, what we observe that empirical literature on the Fisher hypothesis has been yielded mixed results up to know, although there is a sizeable body of literature examining the issue. Aside from above-reviewed studies, some other studies such as Mishkin (1992), Crowder and Hoffman (1996), Berument and Jelassi (2002), Mignon and Lardic (2003), Westerlund (2007), Lai (2008), inter alia, found strong evidence in favor of the hypothesis. Some others, on the other hand, including Coppock and Poitras (2000), Lanne (2001), Udayaseelan and Jayasinghe (2010), Caporale and Gil-Alana (2017), found no evidence supporting the hypothesis. Also, there is a third party studies which produced either weak and/or mixed evidence [e.g. Barsky (1987), Sun and Phillips (2004), MacDonald and Murphy (1989), Payne and Ewing (1997), Ghazali and Ramlee (2003), Ahmad (2010), Köse et al. (2012)] for the hypothesis especially in the long run.[5]

[5] For a comprehensive survey on the Fisher effect, see Cooray (2002).

As well, in this context it is worth noting that the literature contains some other studies that look the issue from the different vantage points: developed versus developing, inflationist vs. non-inflationist, short- vs. long run, and the like. However, it is worth mentioning here that such studies produce mixed results. This could be attributed to a several factors, such as methodology used, the sample period, expectations, monetary regime shifts, features and the development level of the country, etc. In short, the link between interest rates and inflation still remains a puzzle not only for economists but also for policymakers. So, further studies are needed to clarify the issue.

2.2.2. Empirical literature on the interest rates−exchange rates nexus

Chen (2006) examined the existence of the possible nexus between interest rates and exchange rates for six developing countries[6] during the period 1997-2002. The author found that increases in nominal interest rates result in a higher probability of switching to a crisis regime. The author suggests that a high-interest rate policy is unable to defend the exchange rate.

Turning to the empirical works on the nexus between interest rates and exchange rates, we begin by Furman and Stiglitz (1998). The authors concluded that there are two important channels through which exchange rates are likely to be affected by the increase in interest rates. One is the risk of default and the other is the risk premium. Since the uncovered interest parity theory assumes no role for both these channels, the interest rate represents the promised return on domestic assets, i.e., actual interest receipts are equal to promised interest receipts.

Sargent and Wallace (1981) argued that high-interest rate policy might give rise to reductions in demand for money and increases in inflation since increases in interest rates imply increases in the level of government debt which, in turn, would be financed by printing money. As a result, there will be exchange rate depreciation. Similarly, it is highly likely that an increase in interest rate adversely affects the future export performance of a country which would reduce the future flow of foreign exchange reserves and thereby, leads to depreciation of its currency (Furman and Stiglitz, 1998). Another study by Goldfajn and Baig (2002) explored the linkage between real interest rates and real exchange rates for the five Asian countries during the 1997−1998 period by using a VAR model based on the impulse response function from the daily interest rates and exchange rates. They observed the existence of a weak correlation between interest rates and exchange rates.

On the other hand, two separate studies by Patnaik and Pauly (2001) and by Dash (2004), working on a single country, India, yielded mixed results. The study by the former documented that a high-interest rate differential brings about an increase in capital flows and causes an appreciation of the Indian rupee from January 1993 to December 1998. On the other hand, the results of the study by Dash (2004) found the existence of bidirectional causality between interest rates and exchange rates which runs from the former to the latter and thus an increase in interest rates results in an appreciation of the Indian rupee.

2.2.3. Empirical literature on the exchange rates−inflation nexus

Concerning the nexus between exchange rate and inflation, the current literature contains numerous studies. Choudhri and Hakura (2006) for 71 developing and industrial countries, Ca'Zorzi et al. (2007) for 12 emerging markets, Kataranova (2010) for Russia, Leigh and Rossi (2002), Kara and Öğünç (2008) and Arslaner et al. (2014) for Turkey, Caselli and Roitman

[6] Indonesia, South Korea, the Philippines, Thailand, Mexico, and Turkey.

(2016) for 28 emerging markets are just some case studies that we observed at first glance in the context of developing and emerging market economies.

Choudhri and Hakura (2006) studied with a large dataset for 71 countries, 52 of which are developing countries, covering the 1979-2000 period. The authors examined the pass-through effect and found that it runs from exchange rates to domestic prices. Specifically, they draw attention to the fact that the pass-through effect depends on the inflation regime, high inflation versus low inflation regime. Accordingly, the pass-through effect is more significant in countries with higher inflation, purporting that the higher inflation, the higher pass-through effect.

Employing the VAR technique, a study on Turkey by Kara and Öğünç (2008) analyzed exchange rate pass-through effects on inflation before and after the adoption of inflation targeting in 2001. Their findings showed that unlike the pre-inflation targeting period, the pass-through from imported inflation to domestic inflation weakens and slows in the post-period in Turkey. The authors explain this on the ground of the followings: i) the decline in the indexation of prices to exchange rates; ii) the enhanced role of inflation targets in price-setting behavior. Based on their findings, the authors argue that successfully implementing the inflation targeting may give rise to reduced exchange rate pass-through if the main anchor switches from exchange rates to inflation targets. Another but a similar study on Turkey by Arslaner et al. (2014) revealed that as with many developing countries, exchange rate pass-through works and affects domestic inflation in Turkey. Additionally, their study revealed two more important things: i) the pass-through is higher for producer price index compared to consumer price index; ii) the past currency crisis and the openness are two prominent factors for the pass-through in the Turkish case.

Using a sample of 12 EMEs in Asia (China, South Korea, Singapore, Taiwan, and Hong Kong), Latin America (Argentina, Chile, and Mexico), and Central and Eastern Europe (Czech Republic, Hungary, Poland, and Turkey), Ca'Zorzi et al. (2007) investigated the degree of exchange rate pass-through to prices. They found that for those EMEs with only one-digit inflation, pass-through to imports and consumer prices appears to be low. Accordingly, excluding two high inflation countries, Argentina and Turkey, from the analysis, for the others there is robust evidence for the degree of the exchange rate pass-through and inflation, supporting Taylor's hypothesis, that is, the responsiveness of prices to exchange rate volatility depends positively on inflation. In short, the findings of Ca'Zorzi et al. (2007) provided partial evidence in supporting of exchange rate pass-through to domestic prices in the EMEs and thus rejected the hypothesis that exchange rate pass-through is always higher in the EMEs in relation to their developed country counterpart.

There is also considerable empirical literature that examines the causal relationship between interest rates and exchange rates. About exchange rates–inflation nexus, the current literature mostly associates exchange rates with inflation.[7] Accordingly, there is a co-movement between the two wherein causality runs from exchange rates to inflation. In this relation, the determinant of inflation is considered to be exchange rates. Especially in those countries which depend very much on raw materials and energy-related imports, an increase in exchange rates affects the domestic prices of imported goods and thus gives rise to an increase in general price level. This process is named in the literature as exchange rate pass-through, indicating how exchange rates affect domestic inflation.

[7] Of course, also, there are some but relatively fewer counter-arguments claiming that inflation causes movements in exchange rates. In this regard, see, e.g. Clarida and Waldman (2008).

3. Empirical analysis

3.1. Data and variables

In this study, we work with monthly time series data for five emerging market economies. The economies included in the sample are Brazil, India, Indonesia, Turkey, and South Africa. On the other hand, the variables used in our estimation model are made up of interest rates, inflation, and exchange rates. Our first variable is interest rates which we symbolize throughout this study as "i". The widespread practice treats interest rates as either T-bond rates, money market rates, or the lending rates. However, in the literature, the commonly used proxy for long-term interest rates is the T-bond rates. So, we do the same due to the following two major reasons: i) T-bond rate is a relatively better indicator of the long-run interest rates compared to its rivals. In view of market depth, T-bond rate is seen a more credible indicator for interest rates in the economy relative to their alternatives, such as deposit or loan rates. Because T-bond rates are more sensitive to economic and political developments at both national and international levels in relation to their rivals. However, deposit or loan rates, in contrast to T-bond rates, do not show an immediate reaction to economic and political changes in the economy, creating time-inconsistency problem; ii) harmonized data availability for the sample countries.

Our second variable is consumer price inflation (π) proxied for the expected rate of inflation. As is known, inflationary expectations are not easy to observe directly. The existing related literature widely considers the actual rate of inflation as the proxy of the expected rate of inflation to overcome this problem. Throughout this study, we follow the same manner, taking the actual rate of inflation into consideration instead of the expected one. The magnitude of the changes in consumer price inflation refers to the inflation rate. Accordingly, we measure the inflation rate as the monthly percentage changes in the consumer price index over the previous month. Our third, the final, variable is the exchange rates (*NEER*). In this study, we take into account nominal effective exchange rates as the exchange rates variable. More precisely, we employed nominal effective rates as a proxy for exchange rates for all the sample countries. This is because the *NEER* is an index denoting the value of a country's currency in relation to major foreign currencies, such as the US dollar and the Euro. The index represents a weighted average of foreign currencies by their share in trade volume.[8]

As highlighted above, data availability and its frequency are the prime factors for the selecting observation period. Subject to data availability at the highest frequency, the sample period extends from January 2013 to December 2018 with a total of 72 observations.[9] The data on CPI inflation and exchange rate variables were retrieved from the Bank for International Settlement's official web site (www.bis.org) whereas the data on interest rates were from international investment web site (www. investing.com).

The summary statistics of the variables and the line graphs on the relationship of interest rates, inflation, and exchange rates trend for the sample countries are depicted in Table 1 and Figure 1, respectively.

[8] *NEER* index helps us to understand the pass-through effect of an import dependent country. The *NEER* index can also useful in analyzing the relationship between interest rates and exchange rates. It determines not only the trade competitiveness of a country but also affects interest rates through monetary policy.

[9] Working with monthly time series data, for instance, rather than annual data, can be justified on the ground that using annual data may lead to the aggregation-biased problem as argued by Rossana and Seater (1995). One plausible way to overcome this problem is to study with monthly data as suggested by Berument and Jelassi (2002). Following the suggestions in Berument and Jelassi (2002), in this study, we work with the available highest frequency data, that is monthly data, instead of lower frequency data, such as quarterly and annual data.

Table 1. Summary statistics for the sample countries

	Brazil			India			Indonesia			South Africa			Turkey		
	i	π	*NEER*	i	π	*NEER*	i	π	*NEER*	i	π	*NEER*	i	π	*NEER*
Mean	0.11798	0.06239	72.66708	0.07693	0.04984	76.42944	0.07576	0.04956	76.95903	0.08334	0.05444	65.20028	0.10401	0.09858	59.38556
Median	0.11777	0.06300	71.58000	0.07747	0.04901	76.31000	0.07735	0.04350	76.30500	0.08475	0.05408	65.26500	0.09920	0.08785	61.09500
Maximum	0.16490	0.10706	90.50000	0.09060	0.09532	82.97000	0.09624	0.08359	91.97000	0.09770	0.07046	81.63000	0.20700	0.25240	84.03000
Minimum	0.09320	0.02455	54.64000	0.06246	0.01460	70.64000	0.05343	0.02793	67.94000	0.06010	0.03812	52.11000	0.06170	0.06133	27.79000
Std. Dev.	0.01736	0.02352	8.725306	0.00695	0.01628	2.797170	0.00905	0.01806	5.561384	0.00742	0.00808	6.612399	0.02744	0.03902	14.40063
Skewness	0.85550	0.09136	0.012452	-0.03692	0.41505	0.260710	-0.50176	0.59471	1.380224	-0.96612	-0.10334	0.402052	1.68251	2.38515	-0.312810
Kurtosis	3.48300	2.07773	2.606930	2.41850	3.00072	3.113113	2.92990	1.79751	4.803390	4.04536	1.88862	3.074477	6.14100	8.69787	2.344325
Jarque-Bera	9.48255	2.65190	0.465373	1.03077	2.06722	0.854018	3.03599	8.58206	32.61686	14.4790	3.83366	1.956391	63.5678	165.665	2.463927
Probability	0.00872	0.26555	0.792402	0.59726	0.35571	0.652458	0.21915	0.01369	0.000000	0.00071	0.14707	0.375989	0.00000	0.00000	0.291719
Sum	8.49460	4.49255	5232.030	5.53897	3.58853	5502.920	5.45514	3.56865	5541.050	6.00110	3.91995	4694.420	7.48870	7.09820	4275.760
Std. Dev.	0.02141	0.03930	5405.298	0.00343	0.01883	555.5154	0.00582	0.02316	2195.958	0.00391	0.00464	3104.391	0.05347	0.10813	14723.86
N. of.Obs.	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72

Note: In the table, i stands for the nominal interest rate, π for the inflation rate, and *NEER* for the exchange rate, respectively.

Figure 1. The line graphs of variables

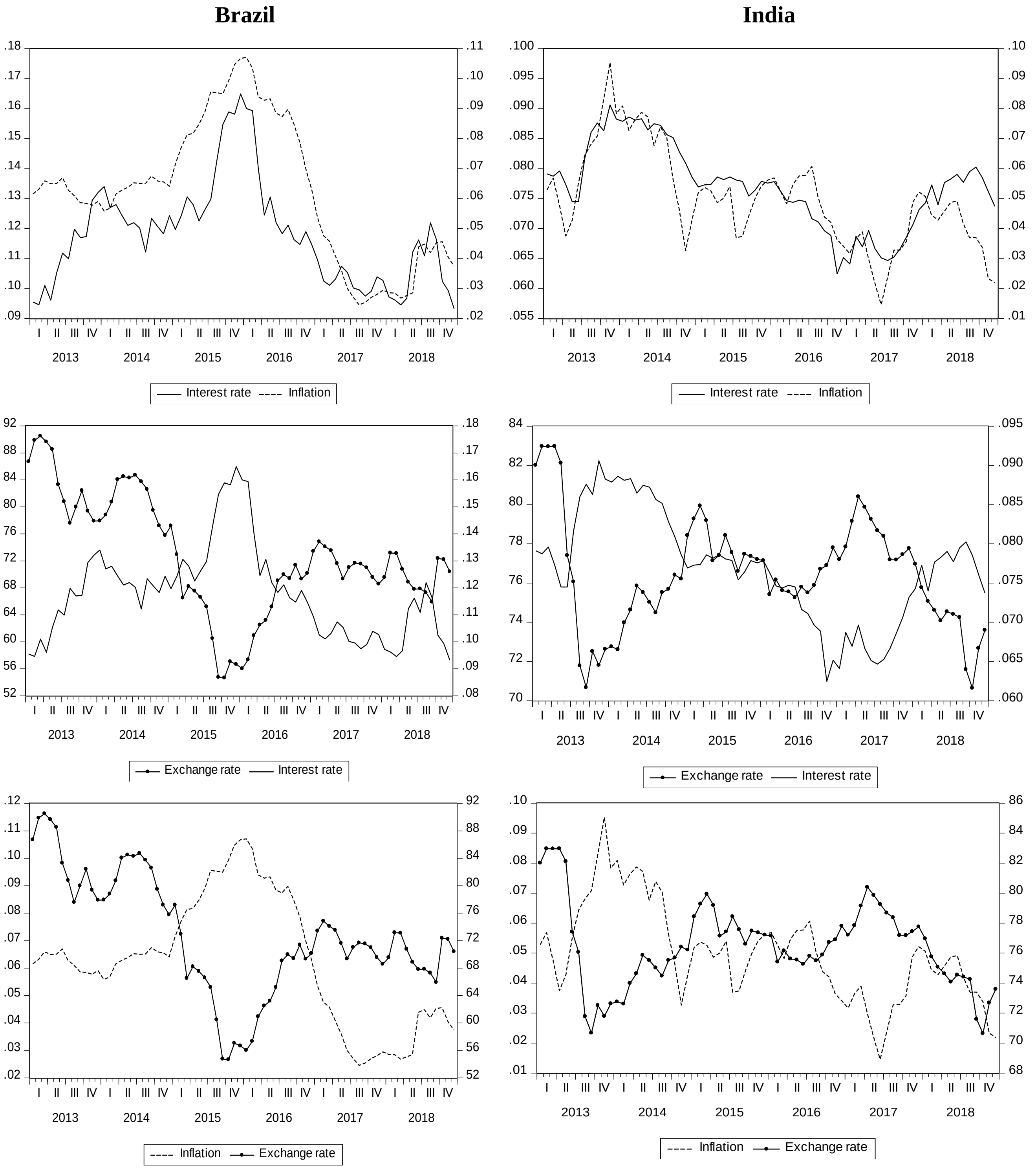


Figure 1: continued …

Indonesia   South Africa

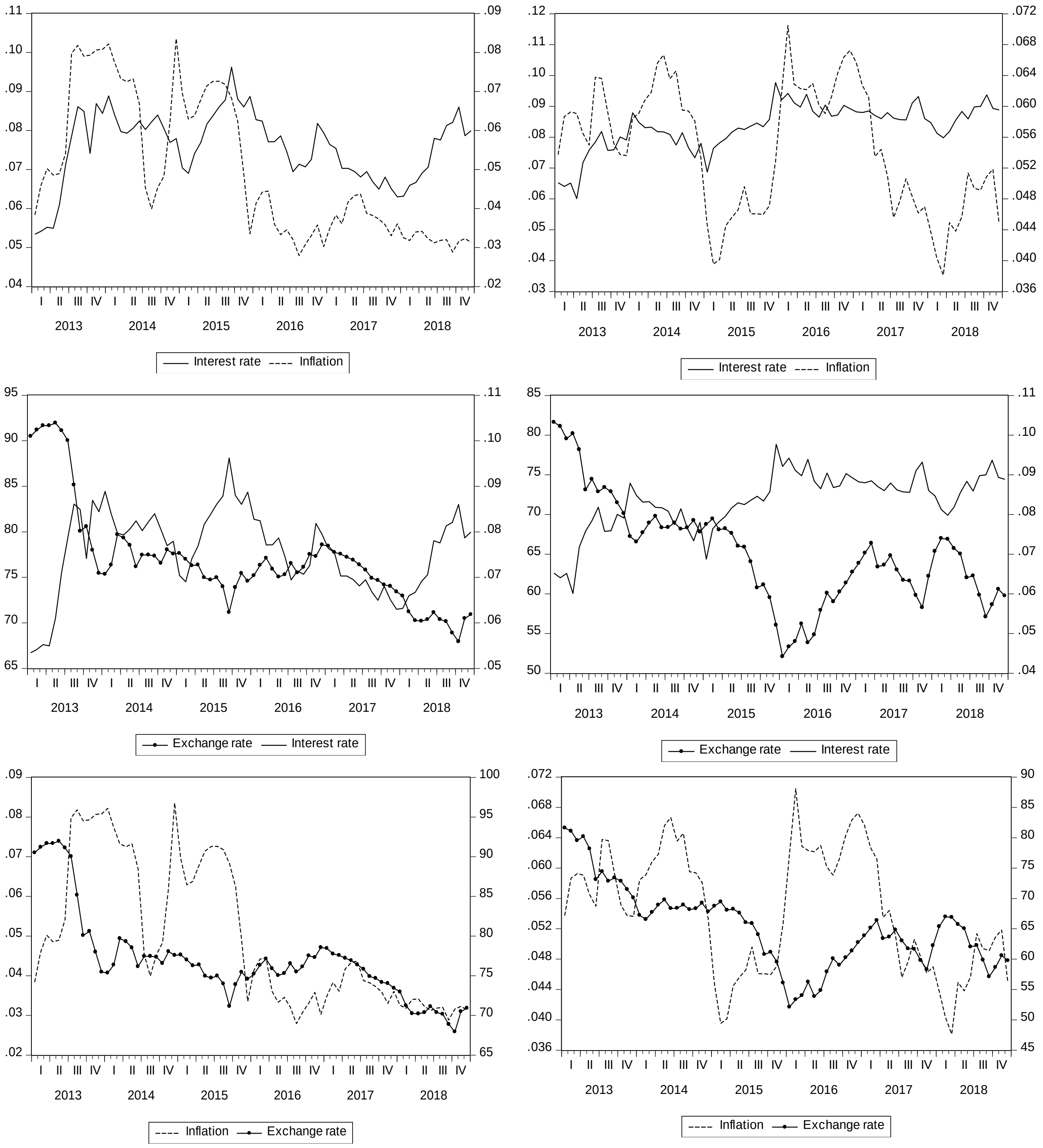
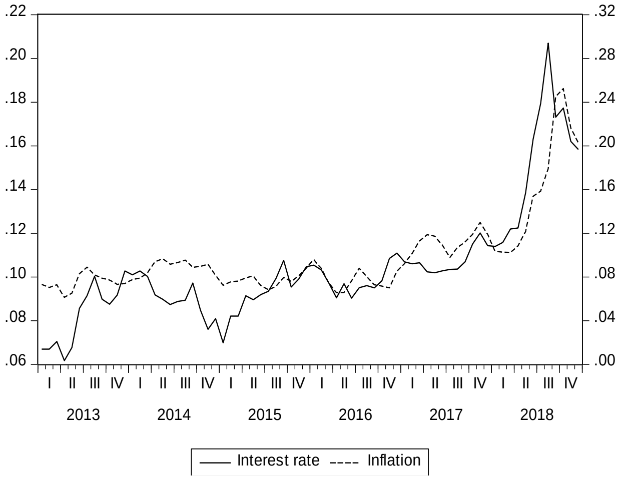
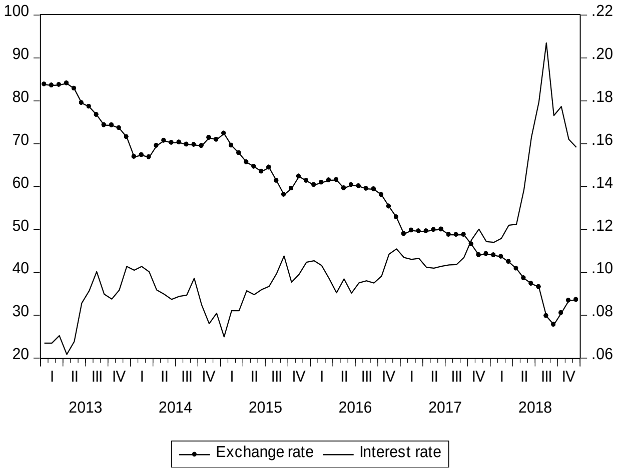
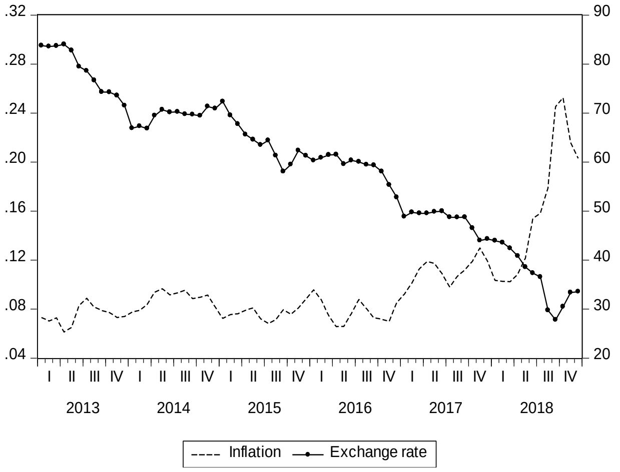


Figure 1: continued …

Turkey







3.2. Model: Le and Lee's (2010) ADL test for threshold cointegration

Utilizing Li and Lee's (2010) ADL tests for threshold cointegration, this study investigates the possible existence of the long-run interrelationship between interest rates, inflation, and exchange rates in five fragile emerging market economies. The major advantage of Li and Lee's (2010) test is that it allows us to investigate nonlinearity and cointegration simultaneously. By this way, the present study intends to fill the existing gap in the literature. To the best of our knowledge, this study is the first of its kind to utilize the ADL test for threshold cointegration to examine the long-run relationship between interest rates, inflation, and exchange rates for the countries under study.

As stated earlier, the ADL test provides researchers to simultaneously investigate nonlinearity and cointegration (Pan et al., 2012). This econometric technique yields possible to test the presence of cointegration relationship without requiring the same order of integration of all variables (Chang and Xu, 2012). This superiority of the ADL technique allows us to avoid poor size and power properties of the conventional unit root tests as pointed out by Harris (1995). Additionally, the aforementioned test improves the loss of power frequently encountered in tests such as those tests presented by Engle and Granger (1987) and Johansen (1988) and reflects nonlinearity such as threshold effects. Furthermore, the further advantage of the Li and Lee's (2010) test is that the cointegrating vector is not pre-specified which extends the linear ADL test to a nonlinear threshold model framework. Therefore, the threshold ADL model is appropriate for our analysis and threshold cointegration tests are suggested.

To investigate the presence of a long-run interrelationship between interest rates, inflation, and exchange rates, we establish Eq. (1), (2), and (3) respectively. Eq. (1) stands for the nexus between nominal interest rates and inflation, Eq. (2) stands for the nexus between nominal interest rates and nominal exchange rates, and Eq. (3) stands for the nexus between nominal exchange rates and inflation. In establishing these equations, we consider available literature related to the issue. So, in line with the theoretical and empirical studies, a large body of which was explained in detail in Section 2, the equations that we attempt to estimate in this study are as follows:

$$\Delta i_t = \beta_0 + \beta_1 i_{t-1} I_t + \beta_2 i_{t-1}(1\text{-}I_t) + \beta_3 \pi_{t-1} I_t + \beta_4 \pi_{t-1}(1\text{-}I_t) + \beta_5 \Delta\pi_t + \beta_6 \Delta i_{t-1} + \beta_7 \Delta\pi_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta i_t = \beta_0 + \beta_1 i_{t-1} I_t + \beta_2 i_{t-1}(1\text{-}I_t) + \beta_3 NEER_{t-1} I_t + \beta_4 NEER_{t-1}(1\text{-}I_t) + \beta_5 \Delta NEER_t + \beta_6 \Delta i_{t-1} + \beta_7 \Delta NEER_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta NEER_t = \beta_0 + \beta_1 NEER_{t-1} I_t + \beta_2 NEER_{t-1}(1\text{-}I_t) + \beta_3 \pi_{t-1} I_t + \beta_4 \pi_{t-1}(1\text{-}I_t) + \beta_5 \Delta\pi_t + \beta_6 \Delta NEER_{t-1} + \beta_7 \Delta\pi_{t-1} + \varepsilon_t \quad (3)$$

where *i* denotes T-bond rates as the nominal interest rate variable, π is the actual inflation rate as a proxy for the expected inflation rate, *NEER* is the nominal effective exchange rate as a proxy for the exchange rate, I_t is the indicator function.

Li and Lee (2010) suggest two indicators: Indicator A with I_t^A = I ($e_{t-1} < e_{t-1}^*$ (τ)) and Indicator B with I_t^B = I ($\Delta e_{t-1} < \Delta e_{t-1}^*(\tau)$). $e_t^*(\tau)$ stands for the threshold value. Here, τ can be viewed as the τth percentile of the empirical distribution of e_{t-1}or Δe_{t-1} and τ is obtained by maximizing the test statistic for the null hypothesis between the lower and upper 15% percentiles of the sorted series e_{t-1} or Δ e_{t-1}. There is no prescribed rule regarding the choice of the indicator in the three equation presented above. Adjustment speed towards the long-run equilibrium, which is measured by β_i (i = 1~4) is allowed to vary in the threshold model. Thus, the conventional ADL model is a special form of the threshold ADL model. Here, the lag selection is guided by the partial autocorrelation function of Δi_t, $\Delta \pi_t$ and $\Delta NEER_t$.

Li and Lee (2010) propose two tests for threshold cointegration. The first test is the BO-type test which was developed by Boswijk (1994) who suggests testing the coefficients of i_{t-1}, π_{t-1} and $NEER_{t-1}$. The null hypothesis of no threshold cointegration for the BO-type test can be expressed as follows:

H_0 : β_1 = β_2 = β_3 = β_4 = 0

Conversely, the second test is the BDM-type test which was developed by Banerjee et al. (1998) who suggest adding lead of i_{t-1}, π_{t-1}, and $NEER_{t-1}$ to their regression so that the asymptotic results are valid in the absence of strict exogeneity. The threshold BDM test is based on testing following null hypothesis:

H_0 : β_1 = β_2 = 0

Li and Lee (2010), based on their Monte Carlo experiment, indicated that the BO test performs better than any of its other rivals in terms of both size and power. Given this, we take into consideration the BO threshold cointegration test in the present study. It is important to note here that there is no generally prescribed rule as to whether to use Indicator A or B in the Li and Lee's (2010) model. In this regard, Lu et al. (2012) recommend selecting an adjustment mechanism using a model selection criterion such as the Akaike Information Criteria (AIC) or Schwartz Criteria (SC). Here, only one lag of $\Delta \mathrm{i_t}$, $\Delta \pi_t$ and $\Delta NEER_\mathrm{t}$ are included to our regressions presented above by following the parsimony principle. Critical rules that will be used for different circumstances are illustrated by Li and Lee (2010).

4. Results and discussion

Tables 2 through 4 report the results of the ADL test for threshold cointegration using Indicator A and Indicator B functions, respectively. The results obtained from Eq. 1 are tabulated in Table 2. As noted earlier, there is generally no prescribed rule as to whether using Indicator A or B in our model, the recommendation is to select the adjustment mechanism using a model selection criterion such as the AIC or SC.

The appropriate indicator for the ADL test for threshold cointegration is determined by means of the Akaike information criterion (AIC) as suggested by Liu et al. (2012) and Chang et al. (2012). If the AIC is chosen, as we do in this study, the ADL model with Indicator B is favored in all of the cases except Indonesia. In other words, referring to the results reported in Table 2, we can safely argue that indicator B is appropriate for four sample countries: Brazil, India, South Africa, and Turkey. The BO test statistics are bigger than the critical values, thus rejecting the null hypothesis at the 1%, 5%, and 10% levels or better of statistical significance. All these imply that interest rates and inflation are moving together. It seems that the ADL test for threshold cointegration employed in the present study provides evidence in favor of the long-run validity of interest rates-inflation nexus for all the sample countries except Indonesia.

Turning to Table 3, it presents the results obtained from Eq. 2. As shown in the table, indicator A is not appropriate for the sample countries. However, indicator B is relevant for three out of five sample countries, Brazil, India, and Turkey. For three sample countries, the BO test statistics are higher than their critical values, thus rejecting the null hypothesis at the 10% or better of statistical significance level. This means that there is a co-movement between interest rates and exchange rates just for three of the sample countries: Brazil, India, and Turkey.

As for Table 4, it indicates the results obtained from Eq. 3. It is significant from the BO test statistics that the null hypothesis of no threshold cointegration is rejected in the case of all the countries under scrutiny. In other words, the threshold cointegration relationships between exchange rates proxied by nominal effective exchange rates and inflation exist. The significant coefficients of β_i(i = 1∼ 4) indicate that the long-run adjustment process towards its equilibrium is asymmetric. All these results imply that exchange rates are positively associated with inflation in the sample countries without exception.

The results above clearly indicate that monthly data on the sampling countries for the observation period tends to corroborate the validity of the Fisher hypothesis for the whole sample countries. Put differently, our empirical findings support the view that changes in the expected rate of inflation, measured in this study as the actual rate of inflation, lead to an equivalent change in the nominal interest rates. This finding is compatible with several earlier empirical studies conducted on the same issue [see, inter alia, Mishkin (1992), Crowder and Hoffman (1996), Westerlund (2007)]. On the other hand, from a macroeconomic policy perspective, our finding related to the Fisher hypothesis implies that in the sample countries, real interest rates are not affected by monetary policy. This is to say that monetary authorities' actions do not exert any effect on real interest rates in the sample countries during the period on which we studied.

However, our sample data produces mixed results about the interest rates–exchange rates nexus. Simply put, our empirical results display that there is a cointegration relationship between interest rates and nominal exchange rates for only three sample countries: Brazil, India, and Turkey. However, such a relationship does not exist for the remaining two countries, Indonesia and South Africa. These conflicting results may be explained by referring to country-specific factors. Of five sample countries, three countries (Brazil, India, and Turkey) have higher private sector debt denominated in foreign currency vis-a-vis the other two. So, in these countries, the relationship between interest rates and exchange rates is more obvious. A good case in point is Turkey. When the Turkish lira depreciates against major currencies, T-bond rates are likely to go up due to increased risks. This is because market players would launch to sell out Turkish T-bonds in contemplation of that Turkey would suffer from defaulting foreign exchange liabilities. These developments will end up with an increase in the Turkish T-bond rates. The second possible argument verifying the interest rates-exchange rates relationship as shown in some sample countries may be explained in the context of the Feldstein chain, –that is an important explanation of the twin deficits phenomenon (see Feldstein, 1986). The Feldstein chain argues that under a floating exchange rate regime, in an open economy, persistently widening government deficits financed through domestic borrowing push the interest rates up which attract the country for foreign capital inflows. Increases in foreign capital inflows, other things being equal, cause the local currency to appreciate driving trade balance into deficit. Schematically, the Feldstein can be described as follows:

Government budget deficits $\uparrow \Rightarrow$ Government's deficit-financing requirement $\uparrow \Rightarrow$ Domestic interest rates $\uparrow \Rightarrow$ Foreign capital influx $\uparrow \Rightarrow$ Local currency appreciation $\uparrow \Rightarrow$ Worsening trade balance $\uparrow \Rightarrow$ NX $\downarrow$

Depending upon the country case, a reverse causality between government budget deficits and trade deficits are also likely to emerge. In such a case, the Feldstein chain will work reversely and then trade deficits would lead to budget deficits. This is because expansionary fiscal policies are more responsive to foreign trade shocks than budgetary shocks are. If so, expansionary fiscal policies would lead to the appreciation of the local currency against foreign currencies, which in turn worsens the trade balance and thereby government budget balance.

On the other hand, our empirical results suggest that there exist a cointegration relationship between the two variables for all countries under scrutiny. To put it simply, exchange rates and inflation move together in the long-run in the countries examined. These findings fully match with the theoretical foundation as well as consistent with the most of previous empirical studies [see, e.g. Choudhri and Hakura (2006), Arslaner et al. (2014), Ca'Zorzi et al. (2007) among many others]. As also mentioned earlier, the sample countries are a total of five fragile EMEs. Broadly speaking, all of these countries are countries with persistent current account deficits. At the same time, these countries are import-dependent countries. Increases in the value of major trading countries' currency against local currency will push the prices of goods and services imported up, resulting in increases in domestic prices and thereby inflation.

Table 2. ADL threshold cointegration test results: Eq. 1

Brazil							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
-0.020	0.110	-0.247	5.158	18.903	0.059	-0.016	7.603
(-1.043)	(0.229)	(-1.229)	(0.335)	(2.210)	(1.573)	(-0.005)	(2.139)
BO =	5.618	$e_{t^*}(\tau)$ =	0.160	τ =	0.330	AIC =	-1.127
Part B: Indicator B (I_t^B)							
0.0480	-0.051	-0.430	13.620	3.405	1.238	-0.803	-3.694
(0.0211)	(-5.229)	(-2.110)	(5.602)	(1.770)	(1.168)	(-1.572)	(-2.337)
BO =	27.709*	$e_{t^*}(\tau)$ =	-0.160	τ =	0.779	AIC =	-1.026
India							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
-0.4677	0.001	-1.395	7.362	25.521	3.806	0.903	-4.290
(-1.1170)	(0.074)	(-1.772)	(1.809)	(0.689)	(0.227)	(1.504)	(-1.745)
BO =	8.779	$e_{t^*}(\tau)$ =	0.552	τ =	0.093	AIC =	-0.873
Part B: Indicator B (I_t^B)							
-0.2380	0.336	-0.221	9.167	7.205	4.706	0.693	-5.360
(-0.227)	(0.680)	(-3.047)	(2.391)	(1.429)	(1.046)	(0.836)	(-1.447)
BO =	13.228***	$e_{t^*}(\tau)$ =	-0.118	τ =	0.558	AIC =	1.228
Indonesia							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.0480	-0.227	0.338	3.662	5.621	1.451	0.903	3.146
(0.018)	(-1.004)	(1.369)	(0.118)	(0.880)	(0.452)	(0.994)	(0.773)
BO =	4.782	$e_{t^*}(\tau)$ =	-1.903	τ =	1.228	AIC =	-1.552
Part B: Indicator B (I_t^B)							
0.1033	0.449	-0.338	1.057	5.442	-0.809	-0.904	-1.004
(0.5510)	(1.604)	(-1.338)	(0.558)	(1.260)	(-0.101)	(-0.611)	(-0.327)
BO =	7.431	$e_{t^*}(\tau)$ =	-0.890	τ =	0.867	AIC =	-0.375
South Africa							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.036	0.045	-0.683	1.984	0.793	1.962	1.832	0.227
(1.804)	(2.763)	(0.894)	(1.052)	(0.550)	(0.220)	(3.532)	(1.416)
BO =	4.842	$e_{t^*}(\tau)$ =	6.042	τ =	0.773	AIC =	-0.558
Part B: Indicator B (I_t^B)							
0.118	-0.560	-0.314	1.025	5.228	0.573	-0.730	-2.016
(1.666)	(-0.528)	(-0.335)	(0.392)	(2.503)	(0.551)	(0.068)	(1.558)
BO =	15.688***	$e_{t^*}(\tau)$ =	-0.277	τ =	0.038	AIC =	-0.557
Turkey							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.669	0.331	0.667	1.521	-0.725	-0.127	-0.338	1.546
(0.117)	(0.217)	(0.909)	(0.549)	(-0.325)	(-0.224)	(-0.331)	(0.318)
BO =	7.603	$e_{t^*}(\tau)$ =	1.770	τ =	0.420	AIC =	-0.965
Part B: Indicator B (I_t^B)							
-0.668	-0.335	0.340	2.023	3.519	6.440	3.449	-6.278
(-0.130)	(-1.725)	(0.539)	(0.443)	(1.582)	(1.903)	(0.664)	(-2.027)
BO =	21.712*	$e_{t^*}(\tau)$ =	-1.773	τ =	0.073	AIC =	-1.478

Notes: β is the estimated coefficient for Eq. 1. The t-statistics for the variables are in parentheses. $e_{t^*}(\tau)$ is the threshold value. τ is the τth percentile of the empirical distribution of e_{t-1} or Δe_{t-1}. The critical values for BO statistic are presented in Li and Lee (2010). For Indicator A, the critical values of BO test for 10%, 5% and 1% are, 16.90, 19.04, and 24.00, respectively. For Indicator B, the critical values of BO test for the statistical significance at 10%, 5% and 1% are, 16.36, 18.66, and 23.88, respectively. *,** and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3. ADL threshold cointegration test results: Eq. 2

Brazil							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1
-0.071	0.476	-0.118	0.336	-1.279	0.504	-0.559	0.562
(-1.179)	(0.925)	(-0.552)	(1.667)	(-1.229)	(0.730)	(-0.480)	(1.169)
BO =	6.331	$e_{t^*}(\tau)$ =	0.904	τ =	0.325	AIC =	-1.441
Part B: Indicator B (I_t^B)							
0.4712	-0.552	1.278	-0.150	0.517	-0.448	0.663	-0.993
(0.0415)	(-1.737)	(0.663)	(-2.327)	(0.775)	(-4.620)	(1.440)	(-3.403)
BO =	37.031*	$e_{t^*}(\tau)$ =	-1.559	τ =	0.763	AIC =	-1.130
India							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.331	0.983	-0.487	0.325	0.559	0.364	0.571	0.893
(0.661)	(0.436)	(-1.617)	(0.552)	(0.333)	(0.633)	(0.599)	(0.233)
BO =	6.351	$e_{t^*}(\tau)$ =	4.904	τ =	0.673	AIC =	-1.092
Part B: Indicator B (I_t^B)							
0.0618	1.063	-0.784	0.428	0.164	0.403	0.157	0.824
(0.6009)	(0.082)	(0.651)	(0.178)	(0.462)	(1.745)	(0.625)	(2.543)
BO =	31.754*	$e_{t^*}(\tau)$ =	-0.830	τ =	0.150	AIC =	-0.293
Indonesia							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.051	-0.227	-0.372	0.947	-0.372	0.138	0.342	0.774
(0.043)	(-0.173)	(-0.652)	(1.248)	(-0.361)	(0.362)	(0.276)	(0.453)
BO =	8.334	$e_{t^*}(\tau)$ =	0.438	τ =	0.164	AIC =	-1.562
Part B: Indicator B (I_t^B)							
0.0452	0.433	-0.438	0.822	0.625	0.356	0.504	0.620
(0.3362)	(0.193)	(-0.244)	(0.610)	(1.379)	(0.481)	(0.173)	(0.463)
BO =	9.450	$e_{t^*}(\tau)$ =	0.432	τ =	0.501	AIC =	0.149
South Africa							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.067	0.149	0.386	0.195	0.528	1.275	-0.432	-0.381
(0.571)	(0.234)	(0.095)	(0.144)	(0.148)	(0.276)	(-0.310)	(-0.302)
BO =	7.440	$e_{t^*}(\tau)$ =	-0.126	τ =	0.179	AIC =	-0.776
Part B: Indicator B (I_t^B)							
0.635	0.263	0.201	0.239	0.273	-0.894	-0.083	0.415
(0.563)	(0.483)	(0.415)	(1.802)	(0.337)	(-0.984)	(-0.892)	(0.431)
BO =	5.179	$e_{t^*}(\tau)$ =	-0.867	τ =	0.403	AIC =	-0.891
Turkey							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.441	0.164	0.483	0.367	0.484	0.759	0.382	0.172
(0.226)	(0.071)	(0.181)	(0.250)	(0.371)	(0.035)	(0.113)	(0.173)
BO =	8.372	$e_{t^*}(\tau)$ =	0.371	τ =	0.153	AIC =	-1.221
Part B: Indicator B (I_t^B)							
0.0722	0.263	0.473	0.452	0.460	0.258	0.234	0.137
(0.407)	(0.356)	(0.392)	(0.195)	(0.395)	(0.270)	(0.225)	(0.181)
BO =	22.016*	$e_{t^*}(\tau)$ =	0.287	τ =	0.187	AIC =	-0.331

Notes: β is the estimated coefficient for Eq. 2. The t-statistics for the variables are in parentheses. $e_{t^*}(\tau)$ is the threshold value. τ is the τth percentile of the empirical distribution of e_{t-1} or Δe_{t-1}. The critical values for BO statistic are presented in Li and Lee (2010). For Indicator A, the critical values of BO test for 10%, 5% and 1% are, 16.90, 19.04, and 24.00, respectively. For Indicator B, the critical values of BO test for the statistical significance at 10%, 5% and 1% are, 16.36, 18.66, and 23.88, respectively. *,** and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4. ADL threshold cointegration test results: Eq. 3

Brazil							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.049	0.447	0.277	0.629	0.015	0.359	0.278	0.195
(0.338)	(0.462)	(0.083)	(0.074)	(0.364)	(0.146)	(0.316)	(0.460)
BO =	6.802	$e_{t^*}(\tau)$ =	0.367	τ =	0.047	AIC =	-0.742
Part B: Indicator B (I_t^B)							
0.036	0.176	0.416	0.487	1.384	0.772	0.286	0.346
(0.014)	(0.206)	(0.305)	(0.175)	(0.407)	(0.463)	0.572	0.473
BO =	12.709***	$e_{t^*}(\tau)$ =	0.079	τ =	0.321	AIC =	-0.895
India							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.094	0.279	0.337	0.470	0.273	0.501	0.194	0.094
(0.004)	(0.223)	(0.370)	(0.422)	(0.601)	(0.469)	(0.012)	(0.503)
BO =	7.951	$e_{t^*}(\tau)$ =	0.447	τ =	0.228	AIC =	-0.935
Part B: Indicator B (I_t^B)							
0.277	0.490	0.480	0.276	0.518	0.332	-0.405	-0.701
(0.2280)	(0.447)	(0.226)	(0.094)	(0.447)	(0.412)	(-0.370)	(-0.268)
BO =	19.704***	$e_{t^*}(\tau)$ =	0.450	τ =	0.236	AIC =	-0.927
Indonesia							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.071	0.337	0.225	0.489	0.0169	0.390	0.445	0.194
(0.082)	(1.278)	(1.632)	(0.011)	(0.025)	(0.080)	(0.457)	(0.240)
BO =	6.809	$e_{t^*}(\tau)$ =	0.011	τ =	0.083	AIC =	0.195
Part B: Indicator B (I_t^B)							
0.025	-0.574	-0.851	0.918	0.001	-0.801	0.017	0.225
(0.0980)	(-0.085)	(-0.112)	(0.550)	(0.072)	(-0.262)	(0.304)	(0.073)
BO =	15.549***	$e_{t^*}(\tau)$ =	0.332	τ =	0.424	AIC =	-0.894
South Africa							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.277	0.412	0.668	0.503	0.125	-0.506	-0.407	-0.809
(0.446)	(0.604)	(0.553)	(0.159)	(0.122)	(-0.360)	(-0.406)	(-0.711)
BO =	8.609	$e_{t^*}(\tau)$ =	0.336	τ =	0.079	AIC =	-0.890
Part B: Indicator B (I_t^B)							
0.006	0.558	0.336	0.116	0.604	0.501	0.347	0.153
0.040	0.335	0.208	0.664	0.351	0.401	0.223	0.601
BO =	29.553*	$e_{t^*}(\tau)$ =	01180	τ =	0.150	AIC =	0.065
Turkey							
Part A: Indicator A (I_t^A)							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.176	0.557	0.032	0.278	-0.017	0.179	0.136	0.301
0.337	0.227	0.036	0.015	-0.084	0.065	0.116	0.336
BO =	9.558	$e_{t^*}(\tau)$ =	0.036	τ =	0.175	AIC =	0.891
Part B: Indicator B (I_t^B)							
0.067	0.158	-0.143	0.336	0.087	0.064	0.674	0.179
0.0046	0.116	-0.325	0.168	0.349	0.156	0.406	0.305
BO =	32.709*	$e_{t^*}(\tau)$ =	0.096	τ =	0.052	AIC =	0.936

Notes: β is the estimated coefficient for Eq. 3. The t-statistics for the variables are in parentheses. $e_{t^*}(\tau)$ is the threshold value. τ is the τth percentile of the empirical distribution of e_{t-1} or Δe_{t-1}. The critical values for BO statistic are presented in Li and Lee (2010). For Indicator A, the critical values of BO test for 10%, 5% and 1% are, 16.90, 19.04, and 24.00, respectively. For Indicator B, the critical values of BO test for the statistical significance at 10%, 5% and 1% are, 16.36, 18.66, and 23.88, respectively. *,** and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

5. Summary and conclusions

In this study, we investigated whether there are the long-run interrelationships between interest rates, inflation, and exchange rates in five emerging market economies (Brazil, India, Indonesia, South Africa, and Turkey), what is so-called the fragile five, using monthly data from January 2013 to December 2018. To this end, we employed Li and Lee's (2010) ADL test for threshold cointegration. As far as we know, this is the first empirical study for the sample countries that investigates the validity of the long-run interrelationship.

The study arrived at, overall, the following conclusions: First, the sample countries' monthly time series data corroborate the validity of the Fisher hypothesis that asserts the presence of a one-to-one relationship between nominal interest rate and the expected rate of inflation in the long run. Accordingly, changes in expected inflation rate lead to a one-to-one change in nominal interest rates in the long run for the sample countries. Second, our empirical results confirm that there is a cointegrated relationship between interest rates and exchange rates for three sample countries (Brazil, India, and Turkey). However, unlike theoretical expectations, our data do not confirm the existence of such a relationship for the remaining two sample countries (Indonesia and South Africa). Finally, the data on all the sample countries affirm that there exists a long-run unidirectional causality between exchange rates and inflation running from the former to the latter.

Considering the empirical findings of this study, we can safely make the following arguments. The first argument is related to the Fisher hypothesis. The validity of the hypothesis allows us to make the following generalization: in the sample countries, in the long run, monetary policy actions do not influence real interest rates. In other words, monetary policy actions conducted by their monetary authorities of the sample countries do not produce an effect on real interest rates. Rather, in the countries examined, real interest rates are determined by economic agents' decisions on consumption, saving, and investment and their reactions to keep purchasing power parity. The second argument is about the nominal interest rates–exchange rate nexus. Interest rate policy does not guarantee exchange rate stability for the all sample countries without exception. Only for three out of five sample countries, Brazil, India and Turkey, interest rates policy matters for stabilizing exchange rates. As a macroeconomic policy prescription, this empirical finding implies that market actors in these three countries can utilize interest rates in predicting movements in exchange rates. Having obtained such empirical findings may be attributed to especially the following two things: first, high differentials between domestic and foreign interest rates in Brazil, India, and Turkey in relation to the remaining two sample countries (Indonesia and South Africa) make these countries more attractive in terms of foreign capital inflows, resulting in appreciation of local currency or vice versa; and second, two sample countries, Indonesia and South Africa, have relatively lower private sector debt denominated in foreign currency compared to Brazil, India, and Turkey. Any volatility emerged in exchange rates in the countries with high private sector debt denominated in foreign currency affects treasury T-bonds' prices and thereby their interest rates.

The last argument is on the relationship between exchange rates and inflation. Without exception, in all the sample countries, over the long run, changes in exchange rates create an inflationary effect on domestic prices through raising the price of imported goods owing to their being highly import-dependent countries. Consequently, the sample countries' monetary authorities should give further importance to exchange rate stabilization for being able to control inflation.

References

Ahmad, S. (2010), “The Long-run Fisher Effect in Developing Economies”, *Studies in Economics and Finance*, Vol: 27(4), pp. 268−275.

Arslaner, F., Karaman, D., Arslaner, N. and Kal, S.H. (2014), The Relationship between Inflation Targeting and Exchange Rate Pass-through in Turkey with a Model Averaging Approach, *Central Bank of the Republic of Turkey Working Paper*, No: 14/16, pp. 1−54.

Banerjee, A., Dolado, J. J. and Mestre, R. (1998), “Error-Correction Mechanism Tests for Cointegration in a Single-Equation Framework”, *Journal of Time Series Analysis*, Vol: 19(3), pp. 267−283.

Barro, R. J. and Gordon, D. B. (1983), “A Positive Theory of Monetary Policy in Natural Rate Model”, *Journal of Political Economy*, Vol: 91(4), pp. 589−610.

Barsky, R. B. (1987), “The Fisher Hypothesis and the Forecastability and Persistence of Inflation”, *Journal of Monetary Economics*, Vol: 19(1), pp. 3−24.

Berument, H. and Jelassi, M. M. (2002), “The Fisher Hypothesis: A Multi-Country Analysis”, *Journal of Applied Economics*, Vol: 34(13), pp. 1645−1655.

Boswijk, P. (1994), “Testing for an Unstable Root in Conditional and Structural Error Correction Models”, *Journal of Econometrics*, Vol: 63(1), pp. 37−60.

Caporale, G. M. and Gil-Alana, L. (2017), Testing the Fisher Hypothesis in the G-7 Countries Using I(d) Techniques, *DIW Berlin German Institute for Economic Research Discussion Papers*, No: 1667, pp. 1−18.

Carneiro F. G., Divino, J. A. C. A, and Rocha C. H. (2002), “Revisiting the Fisher Hypothesis for the Cases of Argentina, Brazil and Mexico”, *Applied Economics*, Vol: 9(2), pp. 95−98.

Caselli, F. G. and Roitman, A. (2016), Non-Linear Exchange Rate Pass-Through in Emerging Markets, *IMF Working Paper*, Vol: 16(1), pp. 1−36.

Ca'Zorzi, M., Hahn, E., and Sánchez, M. (2007), Exchange Rate Pass-Through in Emerging Markets, *ECB Working Paper*, No: 739, pp. 1−31.

Chang, T. and Xu, Y.Y. (2012), Rational Bubbles in G-7 Countries: An Empirical Note Based on the ADL Test for Threshold Cointegration, *in Asian Finance Association (Asian) and Taiwan Finance Association (TFA) Joint International Conference*, pp. 6−9.

Chen, S. (2006), “Revisiting the Interest Rate–Exchange Rate Nexus: A Markov-Switching Approach”, *Journal of Development Economics*, Vol: 79(1), pp. 208−224.

Choudhri, E. U. and Hakura, D. S. (2006), “Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?”, *Journal of International Money and Finance*, Vol: 25(4), pp. 614−639.

Clarida, R. H. and Waldman, D. (2008), Is Bad News about Inflation Good News for the Exchange Rate? and, If So, Can That Tell Us Anything about the Conduct of Monetary Policy?, in John Campbell (Ed.), *Asset Prices and Monetary Policy*, Chicago: University of Chicago Press, pp. 371−396.

Cooray, A. (2002), The Fisher Effect: A Review of the Literature, *Economics Research Papers, Macquarie* University, Department of Economics, No: 0206, pp. 1−25.

Coppock, L. and Poitras, M. (2000), "Evaluating the Fisher Effect in the Long-Term Cross-Country Averages", *International Review of Economics and Finance*, Vol: 9(2), pp. 181−192.

Crowder, W. J. and Hoffman, D. L. (1996), "The Long-run Relationship between Nominal Interest Rates and Inflation: The Fisher Equation Revisited", *Journal of Money, Credit and Banking,* Vol: 28(1), pp. 102−118.

Dash, P. (2004), The Relationship between Interest Rate and Exchange Rate in India, *Sixth Annual Conference on Money and Finance in the Indian Economy*, http://oii.igidr.ac.in:8080/jspui/bitstream/2275/214/1/dash_1_.pdf.

Devereux, M. B. and Yetman J. (2002), "Menu Costs and the Long Run Output-Inflation Trade-off", *Economics Letters*, Vol: 76(1), pp. 95−100.

Dornbusch, R. (1976), "Expectations and Exchange Rate Dynamics", *The Journal of Political Economy*, Vol: 84(6), pp. 1162−1163.

Dornbusch, R. (2001), "Fewer Monies, Better Monies", *The American Economic Review*, Vol: 91(2), pp. 238−242.

Engle, R. F. and Granger, C. W. J. (1987), "Cointegration and Error Correction: Representation Estimation and Testing", *Econometrica*, Vol: 55(2), pp. 251−276.

Engsted, T. (1995), "Does the Long-Term Interest Rate Predict Future Inflation? A Multi-Country Analysis", *The Review of Economics and Statistics*, Vol: 77(1), pp. 42−54.

Fama, E. F. (1975), "Short-Term Interest Rates As Predictors of Inflation", *The American Economic Review*, Vol: 65(3), pp. 269−282.

Feldstein, M. S. (1986), "The Budget Deficit and the Dollar", *NBER Macroeconomics Annual*, Vol: 1, pp. 355−392.

Fisher, I. (1961 [1930]), *The Theory of Interest*, New York: Macmillan.

Frankel, A. J. (1979), "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials", *The American Economic Review*, Vol: 69(4), pp. 610−622.

Furman, J. and Stiglitz, J. (1998), "Economic Crises: Evidence and Insights from East Asia", *Brooking Papers on Economic Activity*, Vol: 1998(2), pp. 1−135.

Ghazali, N. A. and Ramlee, S. (2003), "A Long Memory Test of the Long-Run Fisher Effect in the G7 Countries", *Applied Financial Economics*, Vol: 13(10), pp. 763−769.

Ghosh, A. R., Gulde, A-M, Ostry, J. D. and Wolf, H. C. (1997), Does the Nominal Exchange Rate Regime Matter?, *NBER Working Paper,* No: 5874, pp. 1–35.

Giavazzi, F. and Giovannini, A. (1989), Limiting Exchange Rate Flexibility, Cambridge, Mass.: MIT Press.

Goldfajn, I. and Baig, T. (2002), "Monetary Policy in the Aftermath of Currency Crises: The Case of Asia", *Review of International Economics*, Vol: 10(1), pp. 92−112.

Güriş, B. and Yaşgül, Y. S. (2015), "Does the Fisher Hypothesis Hold for the G7 Countries? Evidence from ADL Threshold Cointegration Test", *Quality & Quantity*, Vol: 49(6), pp. 2549−2557.

Hakkio, C. S. (1986), "Interest Rates and Exchange Rates–What is the Relationship?", *Economic Review, Federal Reserve Bank of Kansas City*, Vol: 71(9), pp. 33−43.

Harris, R. I. (1995), Using Cointegration Analysis in Econometric Modelling, London: Prentice Hall.

Hernandez-Verme, P. (2004), "Inflation, Growth and Exchange Rate Regimes in Small Open Economies", *Economic Theory*, Vol: 24(4), pp. 839−856.

Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, Vol: 12(2-3), pp. 231−254.

Kara, H. and Öğünç, F. (2008), "Inflation Targeting and Exchange Rate Pass-Through: The Turkish Experience", *Emerging Markets Finance & Trade*, Vol: 44(6), pp. 52−66.

Kataranova, M. (2010), "The Relationship between the Exchange Rate and Inflation in Russia", *Problems of Economic Transition*, Vol: 53(3), pp. 45−68.

Kim, D-H, Lin S-C, Hsieh J. and Suen, Y. B. (2018), "The Fisher Equation: A Nonlinear Panel Data Approach", *Emerging Markets Finance and Trade*, Vol: 54(1), pp. 162−180.

Koustas, Z. and Serletis, A. (1999), "On the Fisher Effect", *Journal of Monetary Economics*, Vol: 44(1), pp. 105−130.

Köse, N., Emirmahmutoğlu, F. and Aksoy, S. (2012), "The Interest Rate and Inflation Relationship Under an Inflation Targeting Regime: The Case of Turkey", *Journal of Asian Economics*, Vol: 23(4), pp. 476−485.

Lai, K. S. (2008), "The Puzzling Unit Root in the Real Interest Rate and Its Inconsistency with Intertemporal Consumption Behavior", *Journal of International Money and Finance*, Vol: 27(1), pp. 140−155.

Lanne, M. (2001), "Near Unit Root and the Relationship between Inflation and Interest Rates: A Reexamination of the Fisher Effect", *Empirical Economies*, Vol: 26(2), pp. 357−366.

Leigh, D. and Rossi, M. (2002), Exchange Rate Pass-through in Turkey, *IMF Working Paper*, No: 02-204, pp. 1−19.

Levy-Yevati, E. and Sturzeegger, F. (2001), Exchange Rate Regimes and Economic Performance, *IMF Staff Papers*, Vol: 47, pp. 62−98.

Li, J. and Lee, J. (2010), "ADL Tests for Threshold Cointegration", *Journal of Time Series Analysis*, Vol: 31(4), pp. 241−254.

Lu, Y.C.R., Chang, T. and Lee, C.H. (2012), "Nonlinear Adjustment to Purchasing Power Parity in Transition Countries: The ADL Test for Threshold Cointegration", *Applied Economics Letters*, Vol: 19(7), pp. 629−633.

MacDonald, R. and Murphy, P. D. (1989), "Testing for the Long Run Relationship between Nominal Interest Rates and Inflation Using Cointegration Techniques", *Applied Economics*, Vol: 21(4), pp. 439−447.

Mignon V. and Lardic, S. (2003), “Fractional Cointegration between Nominal Interest Rates and Inflation: A Re-Examination of the Fisher Relationship in the G7 Countries”, *Economics Bulletin*, Vol: 3(14), pp. 1−10.

Mishkin, F. S. (1992), “Is the Fisher Effect for Real? A Reexamination of the Relationship between Inflation and Interest Rates”, *Journal of Monetary Economics*, Vol: 30(2), pp. 195−215.

Nusair, S. (2009), “Non-Linear Co-Integration between Nominal Interest Rates and Inflation: An Examination of the Fisher Hypothesis for Asian Countries”, *Global Economic Review*, Vol: 38 (2), pp. 143−159.

Pan, G., Chang, T., Tang, D. P. and Lee, C. H. (2012), “Nonlinear Adjustment to Purchasing Power Parity in Latin American Countries: The ADL Test for Threshold Cointegration”, *Applied Economics Letters*, Vol: 19(9), pp. 857−862.

Patnaik, I., and Pauly, P. (2001), “The Indian Foreign Exchange Market and the Equilibrium Real Exchange Rate of the Rupee”, *Global Business Review*, Vol: 2(2), pp.195–212.

Payne, J. E. and Ewing, B. T. (1997), “Evidence from Lesser Developed Countries on the Fisher Hypothesis: A Cointegration Analysis”, *Applied Economics Letters*, Vol: 4(11), pp. 683−687.

Rossana, R. J. and Seater, J. J. (1995), “Temporal Aggregation and Economic Time Series”, *Journal of Business & Economic Statistics*, Vol: 13(4), pp. 441−451.

Sargent, T. J. (1973), “Interest Rates and Prices in the Long Run: A Study of the Gibson Paradox”, *Journal of Money, Credit and Banking*, Vol: 5(1), pp. 385−449.

Sargent, T. J. and Wallace, N. (1981), “Some Unpleasant Monetarist Arithmetic”, *Federal Reserve Bank of Minneapolis Quarterly Review*, Vol: 9(1), pp.15−31.

Sun, Y. and Phillips, P. C. B. (2004), “Understanding the Fisher Equation”, *Journal of Applied Econometrics*, Vol: 19(7), pp. 869−886.

Tornell, A. and Velasco, A. (1995), “Fiscal Discipline and the Choice of Exchange Rate Regime”, *European Economic Review*, Vol: 39(3-4), pp. 759−770.

Tsong, C. C. and Hachicha, A. (2014), “Revisiting the Fisher Hypothesis for Several Selected Developing Economies: A Quantile Cointegration Approach”, *Economic Issues*, Vol: 19(1), pp. 57−72.

Udayaseelan, T. and Jayasinghe, P. (2010), The Validity of Fisher Hypothesis: Evidence from Sri Lanka, *The Proceedings of the Seventh International Conference on Business Management*, University of Sri Jeyawardenapura, Sri Lanka.

Velasco, A. (1996), “Fixed Exchange Rates: Credibility, Flexibility and Multiplicity”, *European Economic Review*, Vol: 40(3-5), pp. 1023−1035.

Westerlund, J. (2007), “Panel Cointegration Tests of the Fisher Effect”, *Journal of Applied Econometrics*, Vol: 23(2), pp. 193−233.

Wicksell, K. (1907), “The Influence of the Rate of Interest on Prices”, *The Economic Journal*, Vol: 17(66), pp. 213−220.

Wicksell, K. (1936[1898]), Interest and Prices a Study of the Causes Regulating the Value of Money, London: Macmillan and Co.