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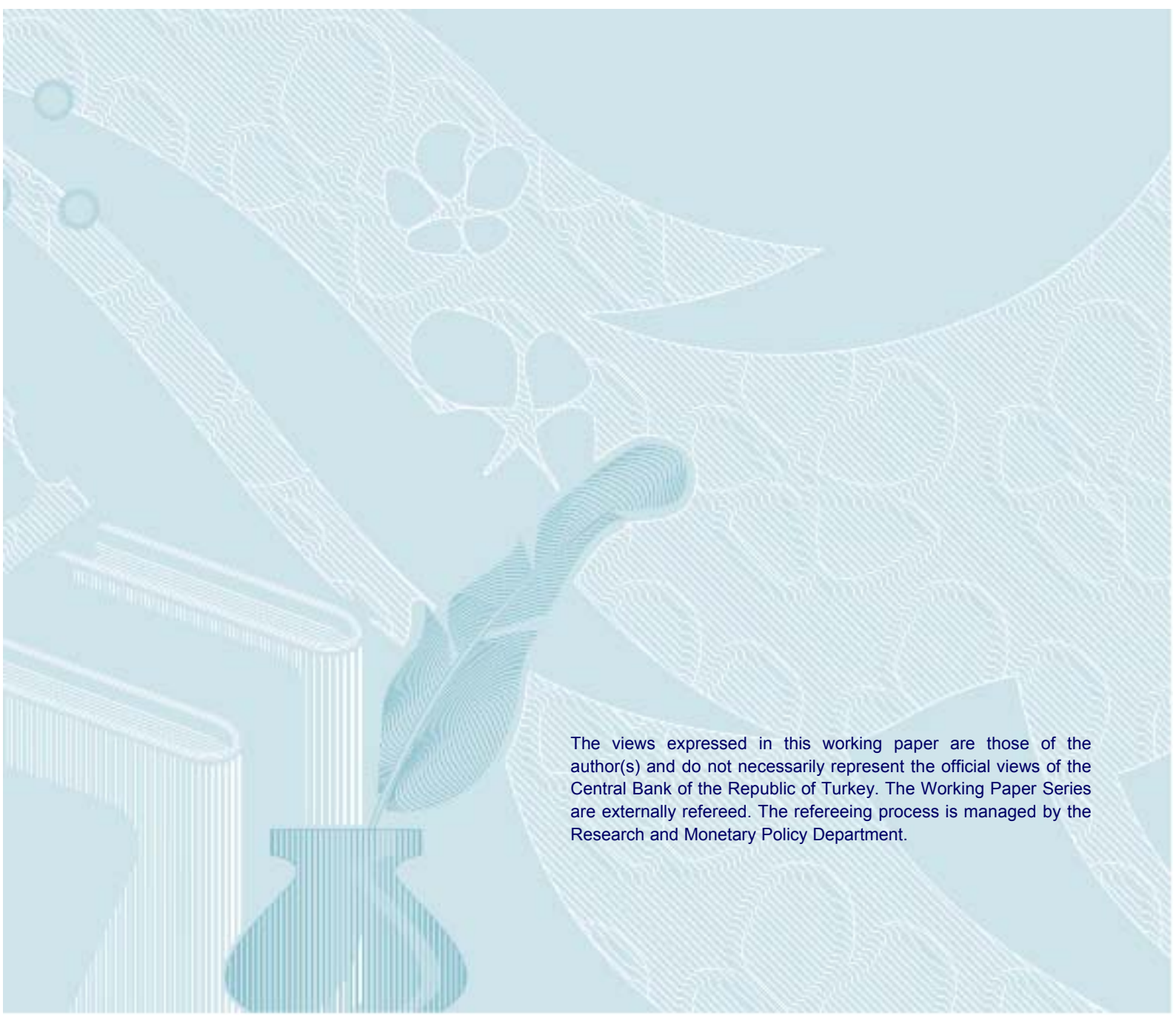
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Oil Prices and Emerging Market Exchange Rates

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Abstract

This paper investigates the role of oil prices in explaining the dynamics of selected emerging countries exchange rates. Using daily data series, the study concludes that a rise in oil price is leading to a significant appreciation in emerging economies currencies against the US dollar. In our study, we divide daily returns from 03/01/2003 to 02/06/2010 into 3 sub-samples and test the role of oil price changes on exchange rate movements. We employ generalized impulse response functions to trace out the dynamic response of each exchange rate in three different time periods. Our findings suggest that oil price dynamics are changing significantly in the sample period and the relation between oil prices and exchange rates becomes more relevant after the 2008 financial crisis.

Keywords: oil prices; emerging market exchange rates; financial crisis

JEL codes: F31, G01, Q43

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1. Introduction

Oil is one of the most important forms of energy and is a significant determinant of global economic performance. Oil price levels can affect the world economy in many different ways. An increase in the oil price will raise the cost of production of goods and services in the economy so it will lead to an increase in price levels. While leading inflation, concerns about the likely increases in price level in the near future will also produce a negative sentiment in the financial markets. At the same time as affecting other asset classes' prices, oil price can set economic trends by dominating GDP growth. An oil price increase will also have an effect on a nation's wealth as it leads to a transfer of income from oil importing to oil exporting countries through a shift in the terms of trade. Through a shift in the balance of trade, exchange rates are also expected to change.

The last decade has seen extraordinary price fluctuations in the oil market. Therefore, it becomes essential to study the impact of oil price changes on the world economy. Figure 1 shows the history of the oil price from 01/02/2003 to 06/02/2010. Crude oil prices are always cyclical however during financial crisis, a clear structural change is apparent. In mid 2008, the price of oil was close to 150 US dollars per barrel but by the end of December 2008, oil had been knocked down to 40 US dollars. After coming down to year-earlier levels, the crude oil prices again reached to 70 US dollars per barrel in 2010. These dramatic oil price variations in a very short period have had large consequences for both oil importer and oil exporter countries' policy makers and for international investors.

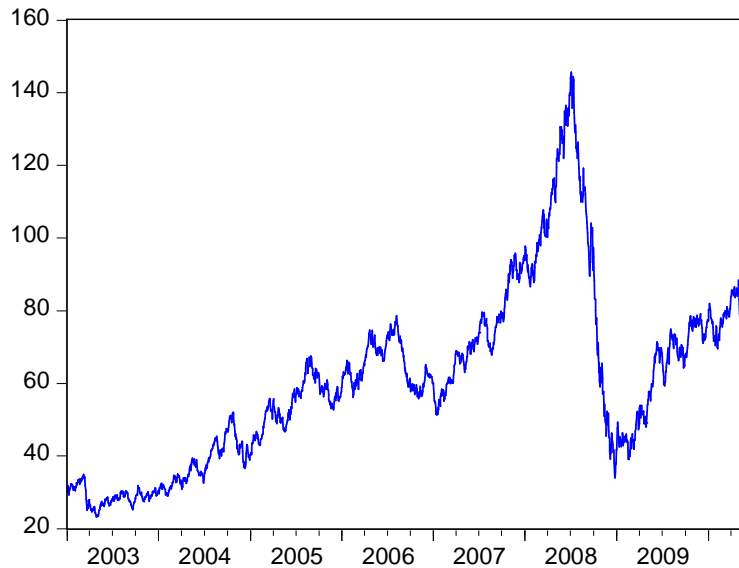


Figure 1: Oil price movements (01.03.2003-06.02.2010)

There is a diverse body of literature on the effects of oil prices. Many of these studies have focused on the channels through which oil price shocks influence economic variables and exchange rates in the mature markets. Unlike the vast majority of literature available investigating oil price US dollar dynamics, this study concentrates on emerging market economies. There are several reasons for selecting the emerging markets to study.

An important reason for studying the emerging markets is the expectation about their increasing dominance in the international landscape. During the last decade emerging markets' share in world GDP has been growing significantly. Furthermore after the financial crisis economic growth in emerging market countries has been very strong compared to the mature markets and it is expected that they will drive global growth in the years ahead. According to EIU, emerging markets are projected to account for 41 per cent of global GDP by 2015. As the economic growth is heavily tied to energy growth, emerging countries become more vulnerable to the changes in oil prices.

Another reason for selecting emerging markets to analyze is the dramatic changes in the capital flows to emerging markets. According to a report of IIF (2011) net private capital inflows to emerging economies are estimated to have been \$990 billion in 2010. This is \$350 billion higher than in 2009 and the upward trend is expected to continue. This increase in capital flows make emerging markets more vulnerable to international investors' cross-border rebalancing decisions as their financial system is not adequately deep compared to those of developed economies, hence, their markets can lose resilience rapidly. As the uncertainty about the extent and duration of the crisis increases, examining effects of oil price fluctuations on emerging markets becomes more vital.

An important factor which determines the capital flows to emerging markets is the recycling of the petrodollars. As the oil price increases, understanding recycling mechanism becomes fundamental for the international investors. In theory, an increase in oil price is expected to depress an oil importing economy as it increases the trade deficit of the subject country and parallel with these facts, depreciation in the local currency is expected. However this is not the case for U.S. in 1970's since the increase in OPEC (Organization of Petroleum Exporting Countries) countries' export receipts has also increased the capital flows to dollar-denominated assets. This cash flow can be treated as an investment preference of OPEC members but we must keep in mind that direct recycling of petrodollars by the use of international banking systems brings significant advantage for developed countries in reaching these funds. Investing in risk free assets allows the developed economies finance their balance of payment deficits caused by rising energy prices. In the last decade, this reliance on the international banking system for recycling the petrodollars seems to change as the financial institutions of oil exporting countries responsible from managing the reserves begin to purchase emerging market economies' assets directly. This change increases the

linkage between oil prices and capital flows to emerging market economies and therefore the exchange rates.

Besides the changes in the petrodollar recycling mechanism, oil price level will also affect the cash flows to emerging markets (and henceforth the exchange rates) by changing the investment strategies of oil exporting countries. Governments can use extra revenues for reducing the government debt or alternatively they can use it to save for future generations. A third alternative is to increase the spending. Increasing spending to finance domestic consumption and investment is the optimum choice if the increase in oil prices (henceforth the extra revenue) is projected to be permanent. Otherwise, if the high level of oil price is believed to be temporary and business cycles are likely, increasing the saving ratio will be a better choice. Saving the revenues from oil is expected to create a cushion to protect an oil exporting country against future economic shocks. While protecting the countries budget from the boom and bust cycle of oil, using the petrodollars for buying foreign financial instruments also enables to earn excess returns or creates diversification opportunities. Determining the recycling mechanism of petrodollars and diversification preferences of oil exporting countries is important for emerging economies as they are more dependent on capital inflows and outflows.

This study examines the dynamic relationship between oil prices and exchange rates of selected emerging economies. It contributes to the literature in at least three points. First, contrary to general use of developed economies, we choose emerging markets to study the relationship between oil prices and exchange rates. Second, un-parallel to the literature using monetary models to explore the exchange rates with low frequency data, we take oil as an alternative asset class and use daily oil price data to investigate the dynamics of exchange rates of an emerging market. Third, this paper shows how this relation has changed by comparing the relationship before and after the financial crisis. We use exchange rates of 13

emerging countries during 2003-2010. Our point while selecting this time period is to cover the periods where both rise and fall of the oil prices are observed. Our results show that the relation has changed dramatically in each sample period. We show that the exchange rates of emerging markets become more vulnerable to oil shocks in the latest period.

The paper is organized as follows. Section 2 presents an overview of the most recent relevant empirical literature. Section 3 introduces the data descriptions and sources. Section 4 explains the methodology use. Section 5 reports the empirical results. Finally, section 6 provides some concluding remarks.

2. Literature review

There has always been an interest in analytical studies investigating the information transmission between oil prices and exchange rates. Krugman (1980) employed a model to investigate the effect of an oil price increase on US dollar and found that US dollar will appreciate in the short run, however in the long run it will depreciate. Golub(1983) investigated the effect of oil prices increases on exchange rates and found that the differences in the response of foreign exchange markets to oil shocks seen in 1970's can be explained by the fundamentals. Golub also draw attention to the importance of wealth transfer effects and portfolio preferences on the reallocation of world wealth mechanism. Along similar lines, Amano and Norden (1998), Caudhuri and Daniel (1998), Chen and Chen (2006) also suggest that exchange rates are cointegrated with the real price of oil. Relatively recent studies imply that the relationship between oil prices and exchange rates may not be constant through time and they can vary for different time periods. Recent literature in this area including Wiegand (2008), Miller and Rati (2008), Basher, Haug and Sadorsky (2010), Narayan, Narayan and Prasad (2008), and Lizardo and Mollick (2010) yield important results.

Lizardo and Mollick (2010) show that an increase in the real price of oil leads to a significant depreciation of the US dollar relative to oil exporting countries, however oil

importer countries currency depreciated relative to US dollar in the same scenario. They also find that currencies of countries that are neither oil exporter nor importer have appreciated relative to US dollar when oil prices rise. The results reported suggest that there is an important information transmission between commodity and currency world markets. Narayan, Narayan and Prasad (2008) investigate the relationship between oil prices and the Fijian dollar -US dollar exchange rate using daily data for the period of 2000-2006 via GARCH and EGARCH models. Their main result is that a rise in oil prices leads to an appreciation of the Fijian dollar. Similar results are reported by the authors who test for the significance of the relationship between oil prices and emerging markets stock prices. Miller and Rati (2008) analyze the relationship between the world price of crude oil and international stock markets using VEC model over 1971 to 2008. In their study, although they find a statistically significant negative relationship between two variables in some sub-samples, they observed a conjecture of change in the last decade. Basher, Haug and Sadorsky (2010) also examined the relationship between oil prices, exchange rates and emerging markets stock prices via SVAR models for the period of 1988 to 2008. The authors study the relationship between oil prices and exchange rates and offer limited support for the relationship between these variables. In addition the authors find that while responding negatively to a positive oil price shock, oil prices respond positively to a positive emerging market shock. While interpreting these results, they emphasize that behavior of stock markets can be treated as a leading economic indicator since they signal the expectation of higher economic growth. This is especially the case after the financial crisis as emerging economies are leading the growth pattern of the global economy. The different results in the study imply that the relationship between oil prices and exchange rates can vary in different time periods.

Although the focus of most of the studies in this line of literature was on exploring the relationship between oil prices and exchange rates and stock markets, there are also some

studies which concentrated on recycling of petrodollars. Wiegand (2008), for example, discusses the mechanism of recycling of petrodollars and its importance for emerging market economies. Wiegand points out that even though bank lending is still an important vehicle for recycling of petrodollars, investing in global securities market has become an important alternative of this route in the last decade. He also emphasizes that although the importance of deposit flows differs sharply between emerging economies, in case of a drop in oil prices, they will all experience a funding squeeze. Arezki and Hasanov (2007), on the other hand, analyze the role played by oil-exporting countries in global imbalances and state that both oil prices and fiscal policy are determinants of current account dynamics. The authors conclude that investment preferences of sovereign wealth funds or other financial institutions responsible from reserve management of the countries are important for the global balances. They also claim that the importance of petrodollar flow will become more crucial in the future. McKinsey Global Institute (2007) also reported a shift in the role of management of reserve assets from central banks to sovereign wealth funds. The report points out that sovereign wealth funds are more active investors when compared with central banks as they are interested in long-term potential of their investment. According to the report, in the near future, petrodollar sovereign wealth funds are likely to allocate a larger part of their portfolios to emerging market securities. BIS (2005) reported a similar finding about the recycling of petrodollars. The report argued that petrodollars are invested more broadly to alternative asset classes in the last decade and the international banking system becomes less important as a repository.

From the recent literature it is apparent that the petrodollar flow is becoming increasingly important. Furthermore, although alternative energy sources are fiercely promoted, the importance of oil price movements in explaining exchange rate changes are not expected to decline in the near future.

3. Data Definitions and Properties

In this study, we use 5-day week daily time series data for the period 01/03/2003-06/02/2010. Dated Brent oil price and the US dollar price of J.P. Morgan Emerging Market Bond Index Plus (EMBI+) countries exchange rates are sourced from Bloomberg. All data are converted to logged returns. Although our initial sample covers all EMBI+ countries, because of the limitations of comparable data (some countries in the original sample have different exchange rate regimes in the full sample period, while others have capital controls), the study is limited to Argentina, Brazil, Columbia, Indonesia, Mexico, Nigeria, Peru, Philippines, Poland, Russia, South Africa, South Korea and Turkey. The exchange rates are all in terms of a price of a US dollar in local currency. Hence, an increase in exchange rate means depreciation of the local currency against the dollar.

The complete sample is divided into the following sub-samples: 03/01/2003-03/07/2008, 04/07/2008-25/12/2008, 26/12/2008-02/06/2010. The sub-sample periods are selected according to the major trend breaks of oil prices that can be seen in Figure 1. We divide data from start to 07/03/2008 during which there is an upward trend in oil. Then starting at the peak date 07/03/2008 and ending at the trough date 12/25/2008 we observe a declining trend in oil price. Hence, this period constitutes our second time frame. After 12/25/2008 the upward trend in oil price resumes, but with higher volatility than earlier periods. This constitutes our third time frame of analysis. These breaks are also consistent with the distortions rising from the 2008 financial crisis. The vector autoregressive (VAR) method employed to investigate the dynamic link between log returns of oil prices and each exchange rate requires the stationarity of the series used. As Maddala and Kim (1998) point out the traditional unit root tests have low power. Therefore, we employ Elliot, Rothenberg, and Stock's (1996), Dickey-Fuller GLS detrended (DF-GLS) and point optimal (PO), and Ng

and Perron's (2001) MZ_{α} (NP) unit root tests. The summary statistics and stationarity test results for all series and time frames are reported in Table 1.

Table 1. Summary statistics and unit root test results for log returns of all series

| | Brent | | | Argentina | | | Brazil | | |
|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|--------------------------|
| Time period | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 |
| Mean | 0.001083439 | -0.01146041 | 0.002081891 | -0.00007 | 0.001020433 | 0.000355589 | -0.00055 | 0.00314 | -0.000693651 |
| Median | 0.001430615 | -0.010217756 | 0.001284672 | 0.00000 | 0.000980824 | 0.000210283 | -0.00087 | 0.00316 | -0.000616333 |
| Maximum | 0.074126794 | 0.097187375 | 0.134668198 | 0.03709 | 0.02076033 | 0.010877251 | 0.06682 | 0.08455 | 0.028505493 |
| Minimum | -0.084692225 | -0.112540992 | -0.07512734 | -0.03023 | -0.034095065 | -0.009641354 | -0.05191 | -0.11938 | -0.034884723 |
| Standard deviation | 0.019745572 | 0.041115078 | 0.026018063 | 0.00420 | 0.004878986 | 0.001834191 | 0.00839 | 0.02576 | 0.01068382 |
| Skewness | 0.018327123 | 0.201457949 | 0.345211379 | 0.46480 | -2.48876353 | 0.500330792 | 0.85659 | -0.57344 | 0.035603584 |
| Kurtosis | 3.491216592 | 3.208074665 | 5.229583658 | 19.56959 | 25.0191249 | 12.64816441 | 10.08798 | 7.72858 | 3.339936749 |
| Coefficient of variation | 18.22490422 | -3.587574958 | 12.4973207 | -63.42677411 | 4.781289283 | 5.153818907 | -15.25658823 | 8.211781511 | -15.40228849 |
| DF-GLS Intercept | -1.955214b (14) | -9.126414a (0) | -0.845824 (12) | -0.644137 (23) | -6.801265a (1) | -4.775733a (7) | -38.40408a (0) | -12.22621a (0) | -6.866610a (7) |
| DF-GLS Int. and trend | -3.553807a (14) | -12.47488a (0) | -5.449320a (5) | -2.321630 (15) | -9.969736a (0) | -4.961750a (7) | -38.42223a (0) | -12.71777a (0) | -7.230709a (7) |
| ERS-PO Intercept | 0.163161a (0) | 0.480009a (0) | 0.153502a (0) | 0.032915a (3) | 0.504326a (0) | 0.145536a (0) | 0.511860a (0) | 0.398012a (0) | 0.103768a (1) |
| ERS-PO Int. and trend | 0.259341a (0) | 1.566819a (0) | 0.527395a (0) | 0.073687a (3) | 1.589581a (0) | 0.536963a (0) | 0.505743a (0) | 1.467697a (0) | 0.374391a (1) |
| NP Intercept | -2.42334 (14) | -62.2567a (0) | -71.5429a (12) | -2.16653 (23) | -44.6092a (1) | -14.3699a (7) | -115.904a (0) | -61.3350a (0) | -283.086a (7) |
| NP Int. And trend | -6.29967 (14) | -60.1955a (0) | -79.9831a (5) | -13.9505 (15) | -60.8426a (0) | -17.9259b (7) | -332.627a (0) | -61.3051a (0) | -248.655a (7) |
| | Colombia | | | Indonesia | | | Mexico | | |
| Time period | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 |
| Mean | -0.00034 | 0.00159 | -0.000313296 | 0.00002 | 0.00137 | -0.000454237 | 0.00000 | 0.00194 | -0.000107477 |
| Median | -0.00037 | 0.00237 | -0.000299271 | 0.00000 | 0.00000 | 0 | -0.00026 | 0.00057 | -0.0007013 |
| Maximum | 0.05160 | 0.04736 | 0.029729765 | 0.03747 | 0.09890 | 0.036242103 | 0.02126 | 0.07097 | 0.035401076 |
| Minimum | -0.05139 | -0.07676 | -0.026455693 | -0.03063 | -0.07722 | -0.031775249 | -0.01885 | -0.04681 | -0.038161289 |
| Standard deviation | 0.00601 | 0.01560 | 0.009209412 | 0.00471 | 0.01831 | 0.008031327 | 0.00438 | 0.01644 | 0.008821492 |
| Skewness | 0.53824 | -1.00503 | 0.243041164 | 0.49924 | 0.75599 | 0.463632873 | 0.39766 | 0.61728 | -0.005406068 |
| Kurtosis | 16.00068 | 7.85070 | 4.062166385 | 11.78562 | 11.47109 | 6.802911389 | 4.71436 | 6.77368 | 4.655613279 |
| Coefficient of variation | -17.87220193 | 9.802193706 | -29.39527728 | 212.6714965 | 13.37718542 | -17.68092029 | 6257.074463 | 8.458821116 | -82.07775808 |
| DF-GLS Intercept | -1.581456 (13) | -4.077851a (3) | -12.76268a (0) | -4.935595a (8) | -5.551905a (3) | -0.382125 (8) | -35.93907a (0) | -12.51313a (0) | -3.827552a (5) |
| DF-GLS Int. and trend | -2.834421c (12) | -5.109472a (3) | -15.22733a (0) | -8.646339a (7) | -5.554712a (3) | -1.941982 (8) | -37.38204a (0) | -13.15057a (0) | -15.81515a (0) |
| ERS-PO Intercept | 0.197344a (0) | 1.753521a (0) | 0.137437a (0) | 0.034932a (0) | 0.556198a (3) | 0.103572a (1) | 0.038423a (0) | 0.415063a (0) | 0.216504a (0) |
| ERS-PO Int. and trend | 0.318166a (0) | 2.950577a (0) | 0.503688a (0) | 0.127415a (0) | 2.051128a (3) | 0.381318a (1) | 0.129486a (0) | 1.518926a (0) | 0.60271a (0) |
| NP Intercept | -0.52137 (13) | -2.09697 (3) | -182.457a (0) | -210.191a (8) | -37.8816a (3) | -63.4195a (8) | -712.028a (0) | -60.9049a (0) | -20.1637a (5) |
| NP Int. And trend | -8.68622 (8) | -4.93952 (3) | -182.346a (0) | -317.268a (7) | -42.5515a (3) | -63.5036a (8) | -716.951a (0) | -60.6854a (0) | -174.609a (0) |

Table 1. Summary statistics and unit root test results for log returns of all series (continued)

| | Nigeria | | | Peru | | | Philippines | | |
|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|--------------------------|
| Time period | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 |
| Mean | -0.00005 | 0.00134 | 0.000213888 | -0.00013 | 0.00045982 | -0.000259737 | -0.000114155 | 0.000432953 | -5.44E-05 |
| Median | 0.00000 | 0.00000 | 0 | -6.29E-05 | 0.00042026 | -0.000138778 | 0 | 0.001655382 | -0.000129929 |
| Maximum | 0.11983 | 0.06444 | 0.053990131 | 0.025975486 | 0.067992037 | 0.020530522 | 0.021510809 | 0.016092906 | 0.013774807 |
| Minimum | -0.07710 | -0.01112 | -0.025001302 | -0.020209604 | -0.044593376 | -0.011393022 | -0.014886318 | -0.017587274 | -0.015977473 |
| Standard deviation | 0.00897 | 0.00801 | 0.006221408 | 0.002480504 | 0.009985923 | 0.003222347 | 0.00320347 | 0.006493332 | 0.004660512 |
| Skewness | 1.07936 | 6.44873 | 2.634350503 | 0.199634997 | 1.326981609 | 0.56160317 | 0.184788902 | -0.356395032 | 0.035422891 |
| Kurtosis | 48.56583 | 47.03092 | 28.938765 | 23.07943487 | 22.42077898 | 9.695272586 | 6.009220892 | 2.893586402 | 4.010292146 |
| Coefficient of variation | -173.6876355 | 5.967153592 | 29.08717963 | -18.86415446 | 21.71704295 | -12.40619625 | -28.06247819 | 14.99776892 | -85.68854729 |
| DF-GLS Intercept | -15.11479a (9) | -1.762946c (6) | -4.720292a (15) | -0.854132 (22) | -4.797525a (4) | -8.700607a (3) | -1.645904c (16) | -11.34663a (0) | -1.412433 (7) |
| DF-GLS Int. and trend | -15.19572a (9) | -2.255940 (6) | -7.840871a (7) | -1.111078 (22) | -5.668921a (4) | -8.703204a (3) | -2.779134c (16) | -11.51879a (0) | -2.904323b (8) |
| ERS-PO Intercept | 2.238866b (9) | 14.05878 (6) | 0.004025a (3) | 0.394597a (0) | 0.120382a (4) | 0.131383a (0) | 0.064322a (0) | 0.802996a (0) | 0.132454a (0) |
| ERS-PO Int. and trend | 2.828715a (9) | 37.90969 (6) | 0.013057a (3) | 0.633059a (0) | 0.202638a (4) | 0.486823a (0) | 0.180964a (0) | 1.763833a (0) | 0.489981a (0) |
| NP Intercept | -0.41480 (9) | -1.64150 (6) | -106.727a (15) | 27.8950 (22) | -1.79376 (4) | -109.143a (3) | -27.6546a (16) | -54.1575a (0) | -121.459a (7) |
| NP Int. And trend | -2.37100 (9) | -2.12022 (6) | -4951707a (7) | 9.09316 (22) | -5.05345 (4) | -111.153a (3) | -9.04271 (16) | -61.9262a (0) | -132.149a (7) |
| | Poland | | | Russia | | | South Africa | | |
| Time period | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 |
| Mean | -0.000121886 | 0.001585279 | -1.99620E-05 | -0.000213476 | 0.001609458 | 0.000216935 | -6.36723E-05 | 0.00171753 | -0.000635368 |
| Median | -0.000251522 | 0.002482993 | -0.000388887 | -7.32E-05 | 0.001002184 | -0.000487431 | -0.000251541 | 0.00106954 | -0.000878136 |
| Maximum | 0.023785797 | 0.031099487 | 0.041821839 | 0.00995021 | 0.023741318 | 0.036625321 | 0.061870156 | 0.092229153 | 0.041145843 |
| Minimum | -0.019450073 | -0.035083582 | -0.0332271 | -0.010083713 | -0.017445797 | -0.031468957 | -0.049354511 | -0.069446669 | -0.03551902 |
| Standard deviation | 0.005007281 | 0.011402851 | 0.009835188 | 0.002159288 | 0.006572765 | 0.008190685 | 0.010831643 | 0.022657693 | 0.011647192 |
| Skewness | 0.321234467 | -0.279111041 | 0.146542527 | -0.127334988 | 0.539090186 | 0.699435283 | 0.342519685 | 0.284331341 | 0.129904245 |
| Kurtosis | 4.306334894 | 4.272634228 | 4.581074048 | 5.368584286 | 4.476999284 | 5.594697547 | 4.701591298 | 5.550332643 | 3.178988068 |
| Coefficient of variation | -41.08162588 | 7.192959768 | -492.6951271 | -10.11489829 | 4.083838064 | 37.75646827 | -170.1155053 | 13.19201881 | -18.33141291 |
| DF-GLS Intercept | -1.306138 (16) | -9.575439a (0) | -1.015186 (9) | -37.07706a (0) | -4.456996a (3) | -8.758141a (0) | -3.841299a (10) | -10.45279a (0) | -8.032399a (2) |
| DF-GLS Int. and trend | -3.085797b (11) | -9.900553a (0) | -2.325706 (9) | -15.42006a (3) | -10.12661a (0) | -12.93467a (0) | -6.665958a (10) | -11.29669a (0) | -15.54719a (0) |
| ERS-PO Intercept | 0.074280a (0) | 0.518300a (0) | 0.241712a (0) | 0.101057a (0) | 0.557766a (0) | 0.157662a (0) | 0.048238a (0) | 0.469790a (0) | 0.131099a (0) |
| ERS-PO Int. and trend | 0.147795a (0) | 1.643997a (0) | 0.602483a (0) | 0.187855a (0) | 1.590912a (0) | 0.524167a (0) | 0.150833a (0) | 1.526006a (0) | 0.486236a (0) |
| NP Intercept | -4.14961 (16) | -57.5384a (0) | -3.80465 (9) | -664.083a (0) | -20.6437a (3) | -174.965a (0) | -17.3751a (10) | -62.0498a (0) | -163.093a (0) |
| NP Int. And trend | -24.1370a (11) | -61.3752a (0) | -8.10759 (9) | -253.596a (3) | -61.2666a (0) | -178.436a (0) | -39.0571a (10) | -62.4846a (0) | -186.481a (0) |

Table 1. Summary statistics and unit root test results for log returns of all series (continued)

| Time period | South Korea | | | Turkey | | |
|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|--------------------------|
| | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 |
| Mean | -8.96E-05 | 0.002012451 | -0.000191922 | -0.000204061 | 0.001581683 | 9.96084E-05 |
| Median | -9.65E-05 | 0.00269149 | -0.00029676 | -0.000568101 | -0.000330449 | -0.000455685 |
| Maximum | 0.024853995 | 0.082737345 | 0.048391227 | 0.059178604 | 0.065235217 | 0.028443361 |
| Minimum | -0.024620804 | -0.096124465 | -0.049792484 | -0.049474465 | -0.0568394 | -0.027156067 |
| Standard deviation | 0.004167162 | 0.025309536 | 0.010771475 | 0.009074229 | 0.019002271 | 0.008713635 |
| Skewness | 0.235322326 | -0.18446905 | 0.12598842 | 0.680786459 | 0.565531063 | 0.027436119 |
| Kurtosis | 6.476478566 | 5.54781737 | 6.182819145 | 8.741576025 | 5.151191875 | 3.77350555 |
| Coefficient of variation | -46.52457327 | 12.57647094 | -56.12432216 | -44.46827117 | 12.01395363 | 87.47890118 |
| DF-GLS Intercept | -8.126355a (6) | -10.55088a (0) | -0.900788 (5) | -3.730768a (14) | -9.376558a (0) | -1.121608 (8) |
| DF-GLS Int. and trend | -12.17038a (4) | -11.03626a (0) | -2.061697 (5) | -24.01193a (1) | -9.960300a (0) | -7.310228a (6) |
| ERS-PO Intercept | 0.116944a (0) | 0.431365a (0) | 1.046649a (0) | 0.075678a (0) | 0.394935a (0) | 0.169309a (0) |
| ERS-PO Int. and trend | 0.251668a (0) | 1.534346a (0) | 1.208834a (0) | 0.163458a (0) | 1.460526a (0) | 0.518417a (0) |
| NP Intercept | -16.6504a (6) | -62.4814a (0) | -0.90180 (5) | -4.71998 (14) | -61.8761a (0) | -9.07542a (8) |
| NP Int. And trend | -64.7876a (4) | -62.4468a (0) | -4.61426 (5) | -423.705a (1) | -61.9093a (0) | -50.1119a (6) |

All data are in log returns.

A first glance at Table 1 shows that for the middle period, where oil prices have a downward trend, the log returns of all currencies have positive means reflecting the likelihood of local currency's depreciation. In the last period where the link between oil prices and exchange rates are thought to be stronger, all currency returns except for Argentina, Nigeria and Turkey show appreciation signs on the average (negative returns). Average variation relative to mean return is reflected by the coefficients of variation. These point out that except for Peru the exchange rate returns tend to have lower average variations relative to their means when oil prices are declining. Hence the summary statistics combine with Figure 1 suggest the dynamic link between oil price and exchange rates may show differences across different time periods.

4. Methodology

As seen from Table 1, we employ three different unit root tests for each return and each time frame separately. Although the unit root tests sometimes yield contradictory results, the results indicate that in all time frames all exchange rate returns and oil returns are stationary in levels. Hence, we can proceed to the VAR models.

For each currency we estimate the following:

$$Y_t = \alpha_t + \sum_{i=1}^p Y_{t-i} + \varepsilon_t \quad (1)$$

where $Y_t = \{\text{Brent}_t, X_t\}$, and Brent and X are the log returns of oil price and the exchange rate, respectively. In equation 1, α is a vector of constants and ε denote the white noise error terms. The optimum lag length "p" is determined via SIC. A bivariate VAR is estimated for each country for three time periods and a battery of diagnostic test are run to check for serial correlation, heteroscedasticity, parameter instability, and structural breaks (diagnostic test results are available upon request). The VARs are found to be stationary within all three time frames. When heteroscedasticity and autocorrelation are detected standard errors are re-computed using White and Newey-West adjustments, respectively. The joint tests on the

coefficients of oil in each exchange rate equation constitute a Wald test whose significance is interpreted as oil Granger causes the exchange rate. For each country, we conduct a similar test for the three time periods to see whether oil returns can improve the exchange rate forecasts.

In order to trace out the dynamic responses of exchange rates to shocks in oil price we employ the generalized impulse response functions developed by Koop et al. (1996) and Pesaran and Shin (1998). The advantage of generalized approach over the traditional impulse responses is that the generalized approach is not sensitive to the ordering of the variables in the VAR system. Therefore they are not subject to the orthogonality critique. The generalized approach is rather common in the recent literature; therefore we do not discuss the specifics here to conserve space.

5. Empirical Results

We estimate three VAR systems for each country and report the Granger causality tests results in Table 2. All VAR systems have roots within the unit circle, satisfying the stationarity requirement. Table 2 shows the Wald test statistics where the null hypothesis is that oil returns do not Granger cause exchange rate returns. The results reported are after accounting for autocorrelation, heteroscedasticity, parameter instability and break points where necessary. All diagnostic test results are available upon request.

Table 2 shows that in the first period (first column) there is only one country for which the test statistic appears significant, Indonesia. The significance is at 10% only and can be due to random error. The test statistics do not seem to improve for the intermediate period where oil prices tend to decline. Within this period, the test statistics for Columbia, Peru, and Turkey are significant at 10% and that for Russia at 5%. However, after the trough in oil prices in 2008, for the period when oil prices recover, there is an apparent change in the role of oil prices on exchange rates. The Wald statistics are larger than 1% critical values for Brazil,

Indonesia, Mexico, Philippines, and South Africa. They exceed the 5% critical values for Peru and Russia and 10% critical values for Poland and Turkey. It is apparent that in the last period oil prices can improve the forecasts of exchange rate returns in all countries, except for Argentina and Nigeria.

Table 2. Wald test statistics for the impact of oil price changes

| Country name | 01/03/2003 07/03/2008 | 7/03/2008 12/25/2008 | 12/25/2008 06/02/2010 |
|--------------|---------------------------|---------------------------|---------------------------|
| Argentina | 1.884485 (4) | 0.663528 (6) | 0.507882 (3) |
| Brazil | 0.902164 (1) | 2.358843 (1) | 4.574433 ^a (7) |
| Columbia | 2.510316 (1) | 3.877792 ^c (1) | 0.172020 (1) |
| Indonesia | 2.157492 ^c (3) | 0.522146 (5) | 4.295722 ^a (4) |
| Mexico | 0.313409 (1) | 1.522929 (1) | 2.918538 ^a (7) |
| Nigeria | 0.686277 (7) | 0.776096 (7) | 1.495500 (8) |
| Peru | 2.198437 (2) | 1.948111 ^c (7) | 2.802579 ^b (3) |
| Philippines | 0.153885 (1) | 0.528150 (1) | 9.629339 ^a (1) |
| Poland | 1.169365 (2) | 0.223029 (1) | 1.885631 ^c (5) |
| Russia | 0.321794 (1) | 3.961988 ^b (1) | 5.028064 ^b (1) |
| South Africa | 0.994418 (1) | 2.005429 (1) | 4.359098 ^a (7) |
| South Korea | 0.156518 (1) | 2.050593 (3) | 0.311795 (3) |
| Turkey | 0.061249 (1) | 2.109978 ^c (5) | 1.747811 ^c (7) |

The entries are the Wald statistics of joint significance tests for oil price coefficients. Superscripts a, b, and c denote significance at 1, 5 and 10%, respectively. Lag lengths are determined via SIC and are in parentheses.

To see the dynamic response of each exchange rate to a standardized shock in oil price we employ generalized impulse response graphs. We trace out the generalized responses of each exchange rate to a one standard deviation shock in oil price for all three time frames separately in Figures 2-14.

Figure 2. Response of Argentine peso/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

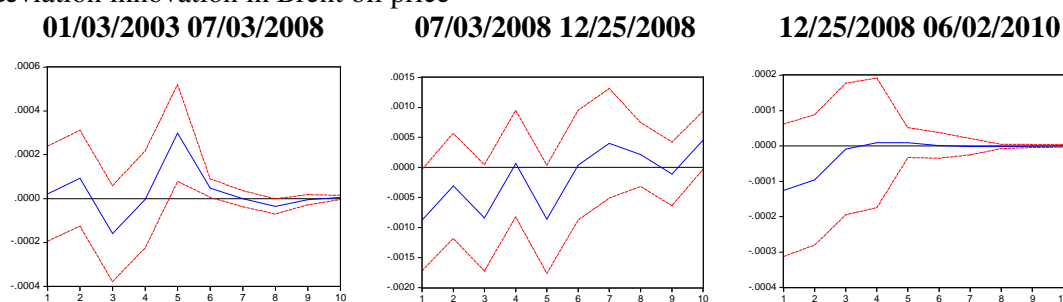


Figure 3. Response of Brazilian real/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

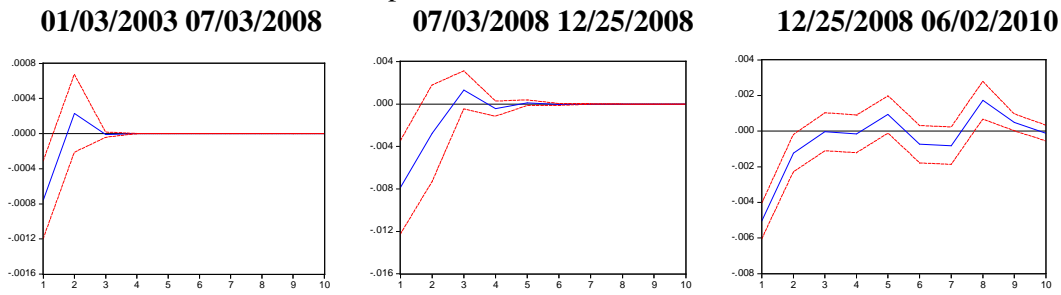


Figure 4. Response of Columbian peso/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

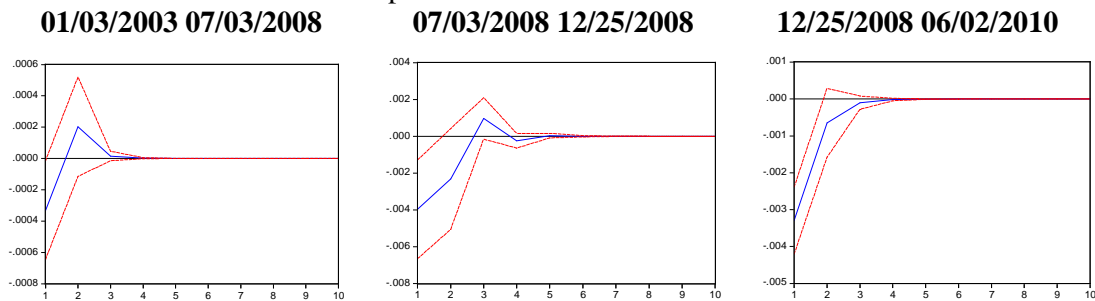


Figure 5. Response of Indonesian rupiah/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

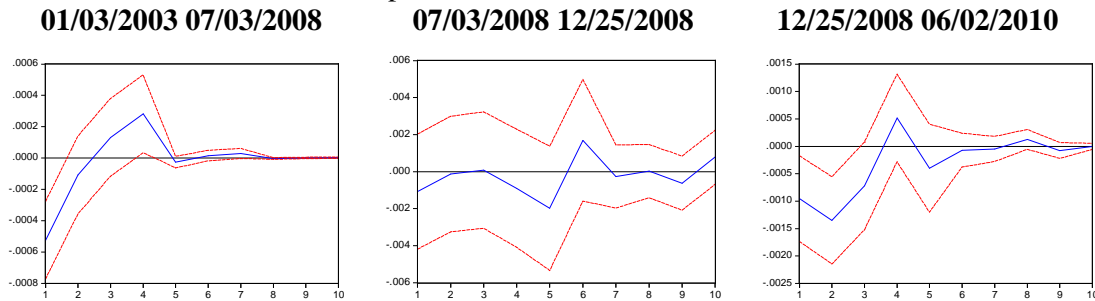


Figure 6. Response of Mexican peso/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

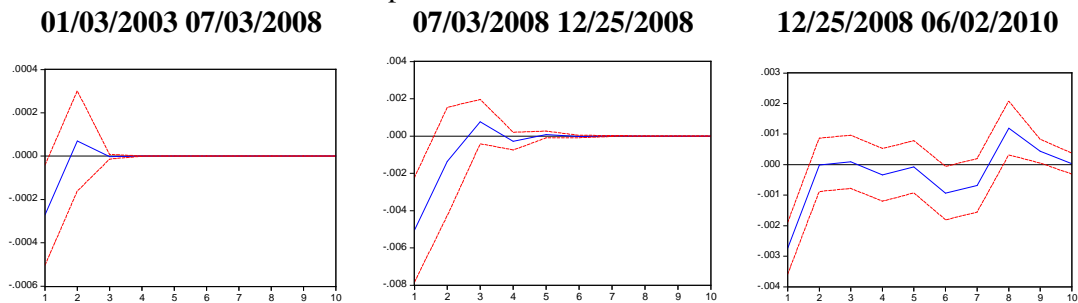


Figure 7. Response of Nigerian naira/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

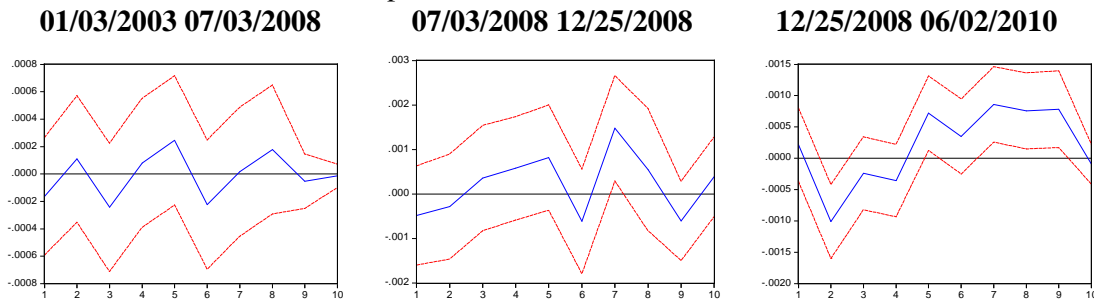


Figure 8. Response of Peruvian nuevo sol/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

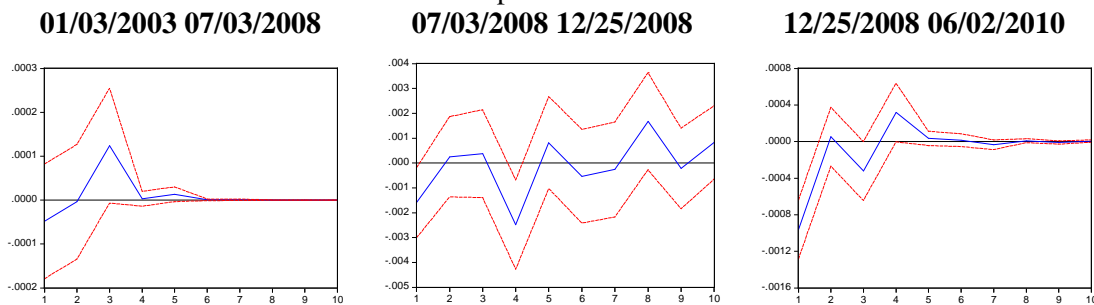


Figure 9. Response of Philippine peso/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

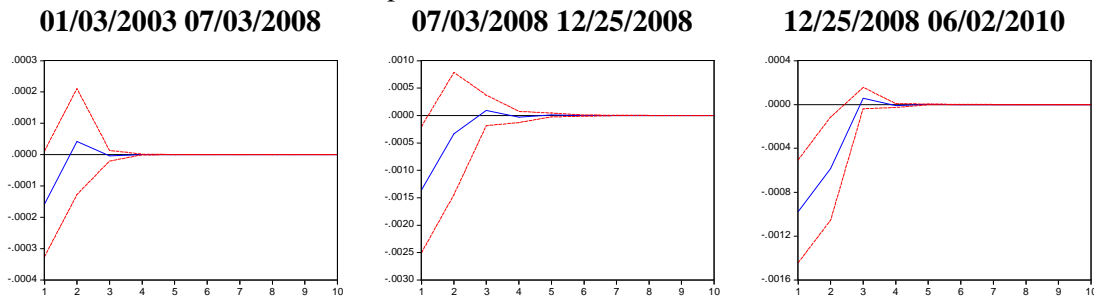


Figure 10. Response of Polish zloty/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

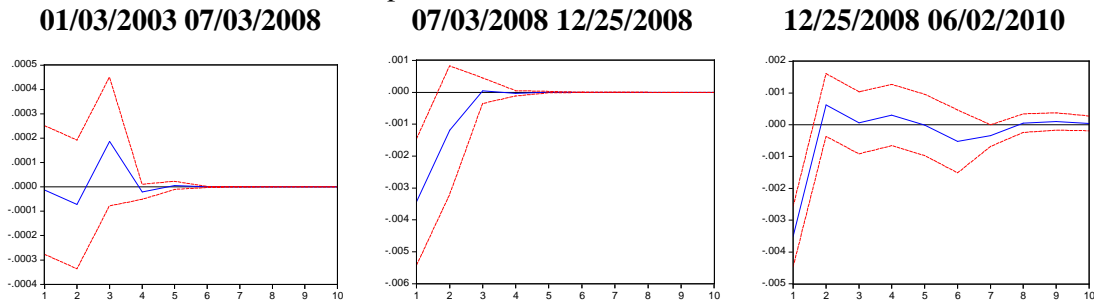


Figure 11. Response of Russian rouble/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

01/03/2003 07/03/2008

07/03/2008 12/25/2008

12/25/2008 06/02/2010

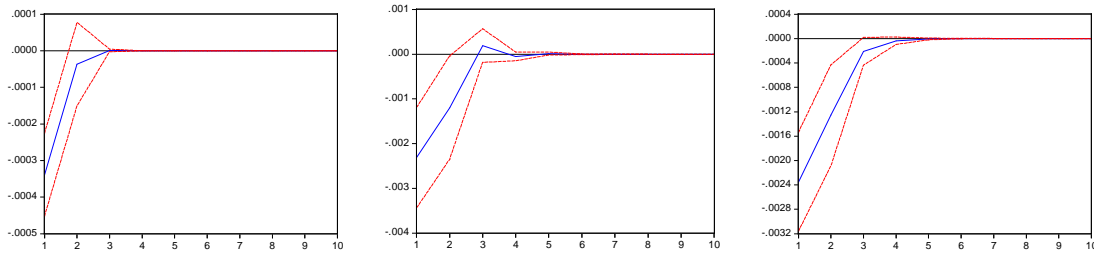


Figure 12. Response of South African rand/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

01/03/2003 07/03/2008

07/03/2008 12/25/2008

12/25/2008 06/02/2010

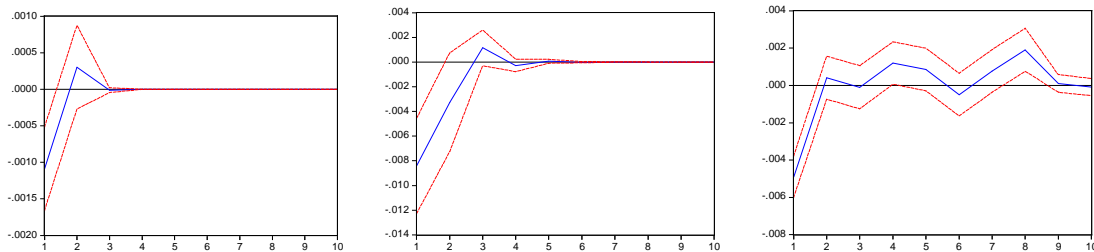


Figure 13. Response of Korean won/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

01/03/2003 07/03/2008

07/03/2008 12/25/2008

12/25/2008 06/02/2010

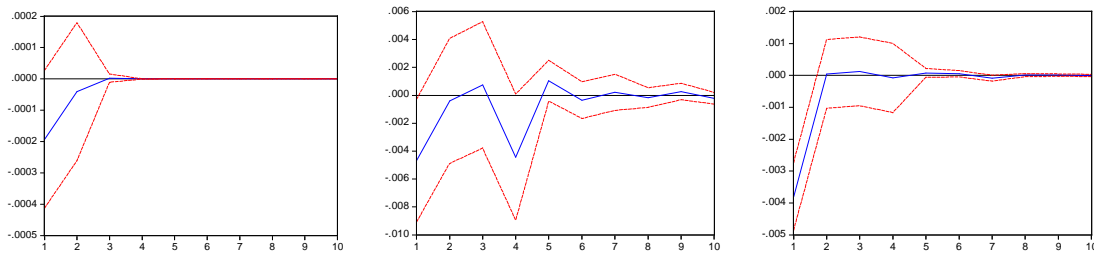
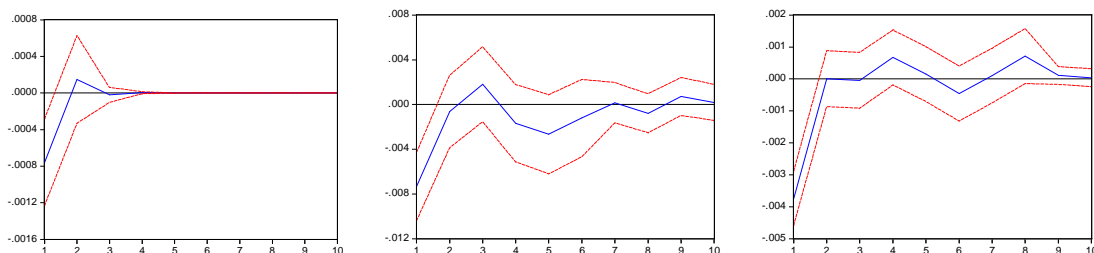


Figure 14. Response of Turkish lira/US dollar exchange rate to generalized one standard deviation innovation in Brent oil price

01/03/2003 07/03/2008

07/03/2008 12/25/2008

12/25/2008 06/02/2010



A close look at figures 2-14 reveals that on all currencies, except for Argentine peso and Nigerian naira, there is a significantly negative initial impact of an oil price shock. A closer look at the currencies with significant initial impacts shows that in the last period all except Indonesian rupiah become more sensitive to oil shocks. Figures 2-14 illustrate the strong depreciation of currencies against the U.S. dollar in emerging countries while oil prices are in the downward trend and the more precise depreciation parallel with the increase in oil prices after 2008. However, the impacts of oil shocks are transitory in all periods and for all exchange rates. Oil price shocks do not appear to have a permanent affect on any of the exchange rates. The generalized impulse response analyses are supportive of the Granger causality results in that increased importance of oil prices in explaining exchange rate movements is observed.

6. Conclusions

This paper investigates the dynamic relationship between oil price and exchange rates of 13 selected EMBI+ countries in three different time frames utilizing VAR and generalized impulse response analyses. The complete sample is divided into the following sub-samples: 03/01/2003-03/07/2008, 04/07/2008-25/12/2008, 26/12/2008-02/06/2010 so that the effects of 2008 financial crisis can be tested.

The recent price fluctuations in all asset classes during 2008 financial crisis period raises the question of what these rapid changes will mean for the emerging market economies as they are more vulnerable to international investors' cross-border rebalancing decisions. An increase in capital flows is expected to drive up the exchange rates in an emerging economy and an appreciation of local currency as a result of these flows is a critical dilemma for policy makers as it can lead to an asset bubble, but controlling flows can become a constraint on the growth of the economy if the saving ratio of the economy is low. The portfolio rebalancing by global investors can also increase exchange rate volatility and hamper the efficiency of the

transmission mechanism. Although, still ongoing low interest rates in developed countries and large liquidity injections by central banks are encouraging the capital flows to emerging economies, considerable attention should be devoted to identifying the role of crude oil prices in the capital flows to emerging markets. Oil prices rose between 2003 and first quarter of 2008 and rapidly declined in the next two quarters of 2008. Since then oil prices are in an upward trend and are moving quickly relative to world economic recovery. This supports the fact that the petrodollar liquidity will be significant in the long-term and adds to the importance of this study.

Our results show an increased importance of oil price movements after the financial crisis. In the most recent sample period, as oil prices rise, there is an apparent depreciation of the local currency against the US dollar and the co-movement has increased during this period. There are a number of reasons why this co-movement is getting stronger. One reason is that emerging economies have recovered far more quickly than developed countries from the crisis. Increasing oil prices create a positive sentiment to emerging economies as they are expected to grow faster than the developed economies. An oil price decrease as a result of an increase of fear in the growth prospects of the world economy (seen in the second half of 2008) increases the outflows from the emerging markets. An increase in the oil prices has the opposite effect as investors are expecting emerging markets to outperform the developed economies growth. With high profit expectations, emerging markets become attractive investment locations with acceptable risk levels and capital flows to them increased (seen in 2009).

Another reason is the strategic changes observed in the mechanism of recycling petrodollars. In 1970, as a result of the oil price shock, oil revenues of the OPEC countries increased their oil revenues dramatically and deposited these excess funds via the international banking system however as a result of the increased globalization in 2000s', this

recycling of oil revenues has changed and excess funds are directly invested in the financial system. Also the investment preferences of the oil exporting countries are changing in the last decade. Parallel with the rise in the oil prices, external surpluses of oil exporting countries increase. It is observed that oil exporters are investing more of these funds to emerging market economies.

Our results present evidence that an oil shock has a stronger impact on the emerging economies now compared to the past and our view remains that oil price dynamics and flows are a major driver of capital flows to emerging markets after 2008. Moreover, this correlation increase points out that oil price level and emerging markets exchange rate relation becomes more immune to the expectations of global investors.

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