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"The Great Recession of 2008 and Oil Prices,"

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THE GREAT RECESSION OF 2008 AND OIL PRICES

*Melike Bildirici, Elçin A. Alp, and Tahsin Bakirtas**

Introduction

This study has two separate purposes. The first one is to explain the financial crisis of 2008 and the second is to improve upon the Hansen and Seo threshold autoregression (TAR) cointegration model. The 2008 great recession has forced many economists to change their perspectives and analyze economic occurrences based upon a variety of key factors; for instance, some of the economists emphasize current balance deficit, while others place greater importance on mortgage credits. Economic views run the gamut of what were the underlying causes of the 2008 financial meltdown. C. Mulligan and L. Threinen consider the 2008 crisis as emerging from a housing price crash that began in 2006.[1] A. Mian, A. Sufi,

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and F. Trebbi comment that "mortgage default crisis" is the source, while G. Dell'Aricci, D. Igan, and L. Laeven assert that the recession was due to a credit expansion crisis.[2] According to P. Mizen, the crisis can be interpreted as a "credit crunch."[3] An alternative theory, offered by K. Arrow, points to the tension between "wanting to spread risk and not wanting to accept the consequences" as a critical driver of the current financial crisis.[4] A. Persaud and J. Danielsson both warn against the overreliance on standardized quantitative risk models.[5] C. Wyplosz, in turn, counsels prudence when analyzing the crisis and its causes in the face of high uncertainty.[6] Our opinion is that the examination of the 2008 great recession within the framework of gross domestic product (GDP), oil prices, budget deficits, and current deficits—while factoring in mortgage rates and exchange rates—is also illuminating.

In the following sections, the 2008 great recession will be examined in comparison with previous financial crises. This study utilizes an econometric method—the threshold autoregressive unit root (TAR unit root) and the threshold autoregressive cointegration (TAR cointegration)—to assess the global financial crisis.

The 2008 Great Recession and Literature on Oil Crises

Examination of the 2008 great recession within the framework of GDP, oil prices, budget and current account deficits, and mortgage and exchange rates is explored in this paper. While academic research on oil prices and their effects on global economics are not new, we find that the works offer different assertions, sometimes contradictory in nature. Oil price shocks have been the topic of study since the first oil crisis in the early1970s, but the majority of these works focused almost exclusively on the macroeconomic impacts. As J. Hamilton states, exogenous oil price shocks were responsible for the post-war U.S. recessions.[7] B. Bernanke, M. Gertler, and M. Watson have demonstrated that macroeconomic effects of oil prices were aggravated by improper monetary policy decisions.[8] O. Blanchard and J. Gali explained the observed change in the effects of the oil price shocks.[9] They argue that the share of oil in production in the major economies has declined since 1970s. M. Woodford asserts that the offered explanations are not convincing enough because they ignore the endogenous responses of the real price of oil to the global economic conditions.[10] J. Hamilton and L. Kilian show that global macroeconomic fluctuations have an impact on the price of oil.[11]

This study differs from others that analyze oil shocks in various ways. Specifically, we shall be evaluating oil crises as a cause as well as an effect. We suggest that before both the 1974 crisis and the 2008 recession, there were military interventions by the United States. Thus, during and after the U.S. military interventions, increases in budget and current account deficits were significant (figure 1). One common characteristic of the 1974 crisis, the 1979 oil shock, and the 2008 financial meltdown is the simultaneous rise in budget and current account deficits prior to an increase in oil price (see figures 2 and 3). These deficits fueled each other and a vicious cycle began. Twin deficits occurred prior to the rise of oil prices. With reference to the twin deficits hypothesis and the United States, the research by A. Darrat should be considered, which looks at the relationship among high budget deficits, an appreciating U.S. dollar against other currencies due to upward pressure on interest rates, and the resulting deterioration in the foreign trade balance.[12] The work of M. Bahmani-Oskooee suggests that budget deficits led to current account deficits in both the short and long term for the period between 1979 and 1985.[13] J. Abell finds that budget deficits during the period 1979-1985 indirectly affected foreign trade deficits through macroeconomic variables such as high interest rates, inflow of foreign capital, and exchange rates.[14] D. Banchman's research reached the conclusion that budget deficits caused current account deficits.[15] C. Kearney and M. Monadjami found that twin deficits in the United Kingdom, Canada, Germany, Italy, Australia, France, Ireland, and the United States were not permanent but temporary for the period January 1972 through April 1987.[16] P. Evans, W. Enders and B. Lee, V. Dewald and M. Ulan, A. Haug, and S. Kaufman et al. have reached findings that are parallel to the Ricardian Equivalence Hypothesis by using micro-based models and have attempted to explain the relationship between budget deficits and current account deficits.[17] There also are studies that analyze the U.S. current account deficits in the context of a global imbalance. M. Obtsfeld and K. Rogoff have emphasized the relation between current account deficit of the United States and the value of U.S. dollar.[18] In addition, M. Obtsfeld and K. Rogoff stress the need to depreciate the U.S. dollar in order to reduce current account deficits to sustainable levels. S. Edwards and P. Krugman emphasize similar results while O. Blanchard, F. Giavazzi, and F. Sa place greater importance on medium-term depreciation.[19] D. Laxton and G. Milesi-Ferretti discuss the implications of the devaluation of the U.S. dollar and its effects on dampening global imbalance.[20]

We present a different approach to the relationship between current account deficits and budget deficits. Prior to the financial meltdown of 2008 and especially after 2000, the U.S. budget and current account deficits increased very rapidly. If the relationship between budget deficits and current account deficits are analyzed for the periods of the two oil crises (1974 and 1979) and the 2008 great recession, the relationship is revealed more explicitly. In the United States, a vast budget deficit that was caused by military expenditures had emerged after the Vietnam War. The budget deficit, fueled by expenditures from the Vietnam War, was accompanied by an increase in the nation's current account deficit.

The costly bill for the Vietnam War caused a fiscal expansion, which resulted in an increase in the overall price level and, consequently, consumed the surplus in the U.S. balance of payments. Although a contractionary monetary policy was adopted, the negative effects of high interest rates on the U.S. construction sector led the Federal Reserve to pursue an expansionary monetary policy for the period of 1967-1968. By 1971, the increasing growth rate of the current account deficit had fostered expectations that the U.S. dollar would be devalued.

On August 15, 1971, then-U.S. President Richard Nixon declared that the country was abolishing the gold standard and, along with this, the fixed rate between the U.S. dollar and gold. In December 1971, in conjunction with the Smithsonian Agreement that was signed in Washington, D.C., the United States sought to influence the exchange rate policies of the United Kingdom, Germany, and especially Japan by urging their policy makers to revalue their currencies. This followed with the U.S. dollar experiencing a partial devaluation of 8 percent against other currencies. However, it was soon apparent that this devaluation of the U.S. dollar was not sufficient. Another devaluation of 10 percent was made on February 12, 1973. The markets were rife with speculative movements resulting in a closure of foreign exchange during the period between March 1-18,1973. When the foreign exchange markets were reopened on March 19, 1973, Japanese and European currencies were left to fluctuate against the U.S. dollar.[21]

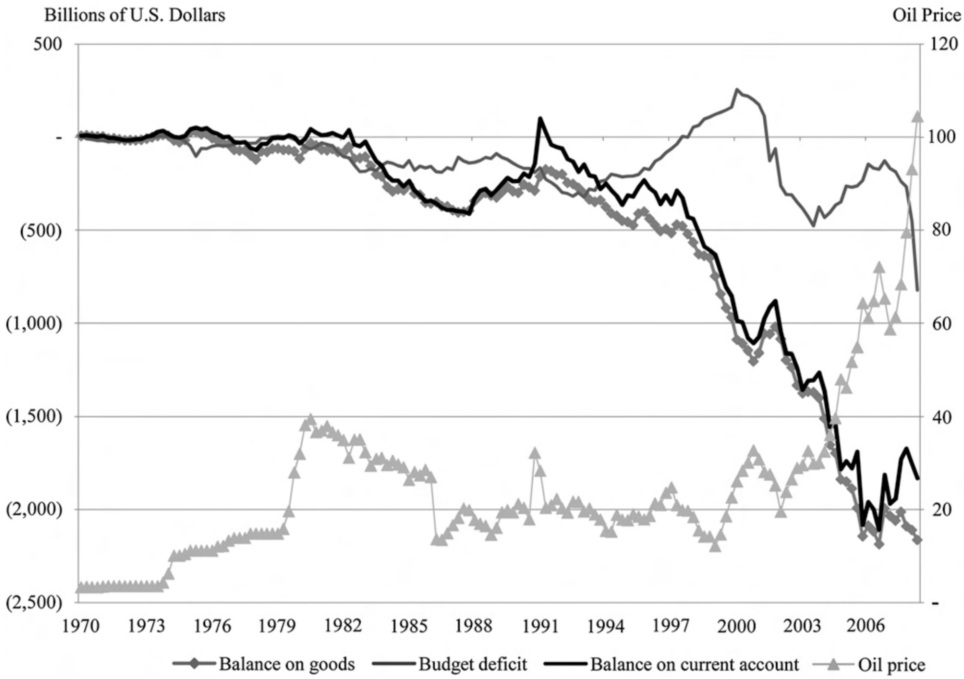
Beginning in 2000 and continuing through the start of the financial collapse in 2008, the U.S. budget and current deficits increased rapidly. By the end of 2000, under then-President Bush, the United States implemented loose monetary policies, which resulted in an increase in asset prices. Credit rates rapidly increased and began to fluctuate around two-digit values. The budget and current account deficits, which increased significantly after 2000, rose higher with the effect of the Iraq War in 2003 and the U.S. dollar continued to depreciate (figure 3).

Budget and current account deficits furthered the depreciation of the U.S. dollar in the 1970s and in the first decade of the 2000s. In the 1970s, the United States wanted a revaluation of their currency versus the United Kingdom, Germany, and Japan. By 2010, the United States wanted the Chinese to appreciate their currency, which has a very low parity. C. F. Bergsten suggests that China has stood against the World Trade Organization (WTO) and refused to revalue its currency, which is on a managed floating exchange rate.[22]

In the 2008 recession, deprecation did not suffice to close the current account deficit as was the case in the 1974 crisis. In 2008, as in the earlier case, oil prices soared. The sudden increase in oil prices pushed many countries into economic crisis due to the fact that, at least in the short term, there was a low price elasticity of demand for oil.

In both the 1974 and 2008 economic crises, the depreciation of the U.S. dollar caused by budget and current account deficits was followed by increasing oil prices (figure 1). Given that the United States is the world's largest net importer of oil, it is easy to understand how raising oil prices would worsen the U.S. trade imbalance. Oil, along with other commodity prices, started to rise by the end of 2007 and accelerated in the first and second quarters of 2008, reaching a peak of close to $150 a barrel in July of 2008. With the onset of the collapse of several

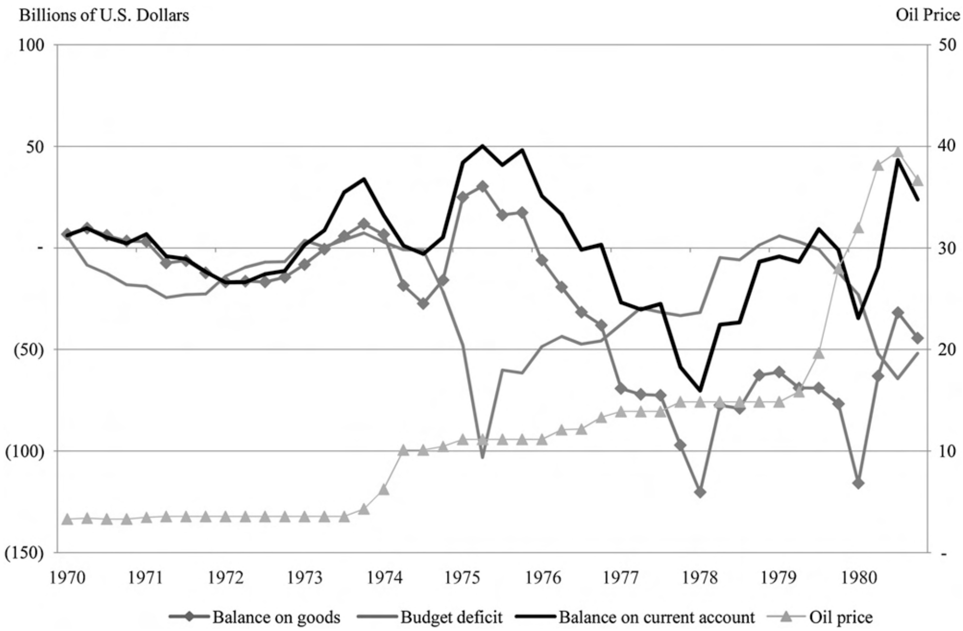
Figure 1
BALANCE ON GOODS, CURRENT ACCOUNT BALANCE, BUDGET DEFICIT, AND OIL PRICES, 1970-2008
(balance on goods, current account balance, budget defict, and oil prices in billions of U.S.$ on left axis; oil price in $ per barrel on right axis)



of the major U.S. investment banks in the fall of 2008, the long-standing access to huge margin accounts contracted, and there was an overall outflow of money from the commodity markets. The forward curves on oil prices and the spot price for oil saw a radical retrenchment. The global markets witnessed a sudden reversal in oil prices as they tumbled to around $65 a barrel by October 2008, similar to the sharp reversal seen in 1974. The rate of increase in oil prices has been looked at as a way of determining the extent of global recovery. The sudden jump in oil price rates was between 2 and 2.65 times their original level. On a crisis-by-crisis comparison, between November 1973 and January 1974, when oil prices reached their highest level, the increase was 2.34; between January 1979 and April 1980, the increase was 2.65. The rate of increase between January 2007 and June 2008 was 2.45. After 1979, the oil price decline exhibited the same steepness as its rise, dropping below its 1974 peak. By December of 2008, the same thing occurred as prices dropped into the mid-$30 per barrel—levels lower than those in 1979.

What differentiates 2008 from 1974 is that the former crisis was accompanied by an environment of rampant mortgage speculation and extremely high leverage

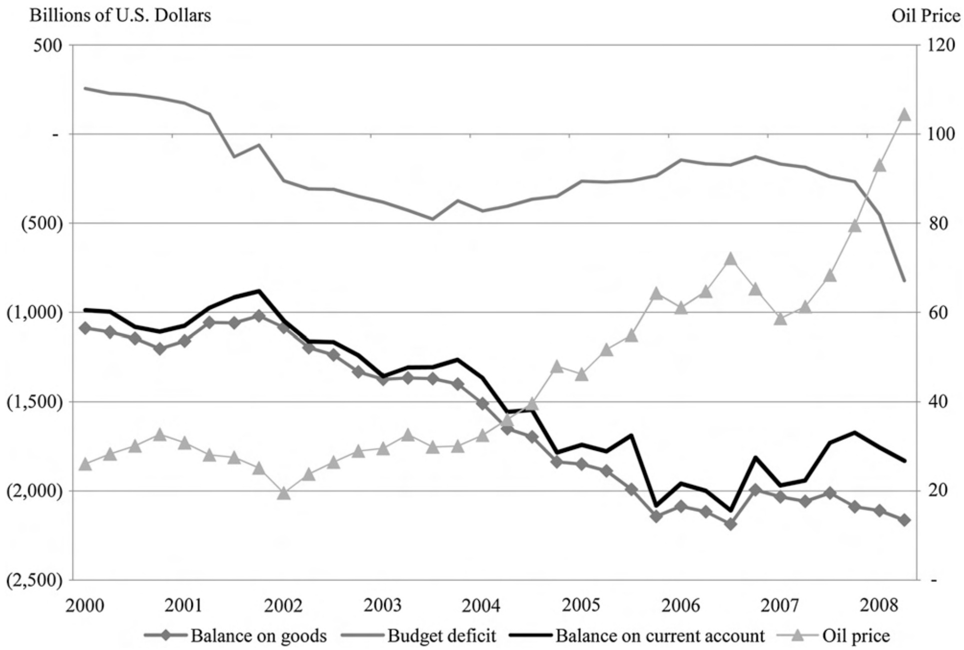
Figure 2
BALANCE ON GOODS, CURRENT ACCOUNT BALANCE, BUDGET DEFICIT, AND OIL PRICES, 1970-1980
(balance on goods, current account balance, budget defict, and oil prices in billions of U.S.$ on left axis; oil price in $ per barrel on right axis)



rates in the financial sector. While many economists have analyzed the effects of the mortgage and banking sectors on the 2008 financial collapse, if we review economic history it is common to see commodity and land/mortgage speculative bubbles being observed prior to major crises. We can witness this in 2007 when mortgage and commodity speculation rose in tandem with oil prices.

Thus, there is a strong link between the collapse of the bubble formed in both developing and developed countries and the economic crisis. Mortgage and real estate speculation expand the existing bubble in the economy and, when that bubble inevitably breaks, it results in a collapse in asset prices triggering an economic meltdown. However, we should point out that even though not every bubble that occurs in real estate markets results in an financial crisis, they tend to cause economic distortions and upheavals. In addition to the real estate speculation and banking sector crisis, the U.S. economy was suffering from other signs of economic weakness.[23] In 2008 the delicately balanced economy experienced a major destabilization, leading to the second greatest financial crisis in U.S. history and resulting in what is referred to as the "great recession," fueled by

Figure 3
BALANCE ON GOODS, CURRENT ACCOUNT BALANCE, BUDGET DEFICIT, AND OIL PRICES, 2000-2008
(balance on goods, current account balance, budget defict, and oil prices in billions of U.S.$ on left axis; oil price in $ per barrel on right axis)



increases in oil prices combined with mortgage speculation and over lending. We now turn to our econometric analysis and the results.

Data and Econometric Methodology

Data: In this study, the relationship among GDP, oil prices, the exchange rate, the current account deficit, mortgage rates, and the budget deficit will be explored. The following data were used in this model: the GDP data were gathered from the U.S. Department of Commerce Bureau of Economic Analysis; oil price information was obtained from the U.S. Department of Energy's Energy Information Administration; the U.S. Federal Reserve Bank of St. Louis and Global Financial Data were the sources for the U.S. current account deficit data; and mortgage rate and budget deficit data were obtained from the Federal Reserve Bank of St. Louis.

Gross domestic product (GDP), current account deficit (CA), oil prices (OP), the U.S. dollar exchange rate (E), mortgage rate data (M), and the budget deficit (BD) were analyzed from the first quarter of 1971 through the fourth quarter of

2008. In the analysis, GDP, (GDP_t/GDP_{t-1}); CA, (CA_t/CA_{t-1}); OP, (OP_t/OP_{t-1}); BD, (BD_t/BD_{t-1}); M, (M_t /M_{t-1}); and E, (E_t/E_{t-1}) data are used.

Before the TAR cointegration analysis, traditional unit-root tests are performed and we test for stationarity of the series. This is followed with a Caner-Hansen unit-root test.[24] Through this analysis, nonlinearity and the existence of nonlinear unit-root is tested in accordance with the study by M. Bildirici and A. Alp, which asserts the need for this process.[25] For detailed information on nonlinear unit-root analysis, the Caner-Hansen unit-root test, and the rationale supporting this procedure in applying the TAR cointegration, refer to M. Bildirici and E. Alp.[26] In this part of the study, only the theoretical explanation of TAR cointegration will be reviewed. We expand the use of the B. Hansen and B. Seo TAR cointegration test to include a case whereby more than two variables are analyzed.[27] In literature, there are many instances of two-variable cases. However, a three-variable case, leaving aside a few unsatisfactory attempts, is analyzed for the first time in this study and supplies a contribution to the existing body of econometric work in the field.

Econometric Methodology—The Caner and Hansen Unit-Root Test: The method followed in the M. Caner and B. Hansen study is outlined below. The TAR model is defined as,

$$\Delta y_t = \theta_1' x_{t-1} I\{z_{t-1} < \gamma\} + \theta_2' x_{t-1} I\{z_{t-1} \geq \gamma\} + e_t. \tag{1}$$

In equation (1), it is defined as $x_{t-1} = (y_{t-1} r'_t \Delta y_{t-1} \ldots \Delta y_{t-k})'$. Where $t = 1, \ldots,$ T and I{.} is the indicator function. It is predicted that e_t □ *i.i.d.* expresses the error term. For some $m \geq 1$, $Z_t = y_t - y_{t-m} \cdot r_t$ is an intersection point and deterministic components vector which covers a linear trend. Z_{t-1} is a pre-determined, firm, stable, and continuous distribution function and ergodic variable. The threshold value γ in unknown, it is located in $\gamma \in \Gamma = [\gamma_1, \gamma_2]$ interval. In this interval for γ_1 and γ_2 $P(Z_t \leq \gamma_1) = \pi_1 > 0$, $P(Z_t \leq \gamma_2) = \pi_2 < 1$ relations can be written.

Here, the main idea is the threshold effect and restrictions related to the unit-root existence. The threshold effect $H_o{:}\theta_1 = \theta_2$ is examined by a composite hypothesis. We test this hypothesis by using the Standard Wald statistics W_T.

In the second step of the analysis, the existence of the unit root is tested $H_0{:}\rho_1 = \rho_2 = 0$ and is established. While equation (1) parameter restrictions were valid, ρ_1 and ρ_2 parameters test the stability of the y_t process. In this case, $H_0{:}\rho_1 = \rho_2 = 0$ hypothesis was examined. If the H_0 hypothesis is accepted, equation number (1) can be written as a stationary TAR model Δy_t stationary variable. In this case, the y_t variable is followed by I(1), which has a unit root. Series stationarity and ergodic in $\rho = 1$ special case $\rho_1 < 0$, $\rho_2 < 0$ and $(1 + \rho_1)(1 + \rho_2) < 1$ is modal stationarity. The alternative of the H_0 hypothesis can be established as $H_1{:}\rho_1 < 0$ and $\rho_2 < 0$. But, there is a third case. In the partial unit-root case,

$$H_2: \begin{cases} \rho_1 < 0 \quad and \quad \rho_2 = 0, \\ \qquad or \\ \rho_1 = 0 \quad and \quad \rho_2 < 0. \end{cases} \tag{2}$$

the hypothesis is valid. If the H_2 hypothesis is accepted, the y_t process moves like a unit root in one regime, but in another regime it follows a stable process. If the H_2 hypothesis is accepted, the process is not stable; yet, it does not have a classic unit-root process.

The method used to test the H_o hypothesis is the Wald test, which can be used to test the true value of the parameter based on the sample estimate. The unrestricted alternative is $\rho_1 \neq 0$ or $\rho_2 \neq 0$. The test statistic is $R_{2t} = t_1^2 + t_2^2$.

In this test, t_1 and t_2 are t rates for $\hat{\rho}_1$ and $\hat{\rho}_2$, which are obtained from the estimate of equation (1). H_1 and H_2 hypotheses are one-sided alternatives. Two-sided statistics have less power relative to one-sided test. $\rho_1 < 0$ and $\rho_2 < 0$ is a one-sided Wald statistics, which is a one-sided alternative of the H_0 hypothesis and can be calculated with $R_{1T} = t_1^2 I_{\{\hat{\rho}_1 < 0\}} + t_2^2 I_{\{\hat{\rho}_2 < 0\}}$.

In the research by Caner and Hansen, it was determined that the R_{1T} and R_{2T} tests are more powerful against the H_1 and H_2. If the test statistic is significant, the H_0 hypothesis, that is, the series having a unit root, is rejected, but to clarify whether the H_1 hypothesis or H_2 hypothesis is valid, t_1—which allows one to test for the unit root under two different regimes or scenarios—becomes important. If one of these—t_1 and t_2—is valid, it means that the H_2 alternative is consistent and it gives one the opportunity to make a choice among the H_0, H_1, and H_2 hypotheses.

Econometric Methodology—TAR Cointegration: In threshold models, cointegration studies were combined with incidences of non-stationarity and non-linearity. Non-linear speed in turning to balance and single equation cointegration relation is searched. In the studies, a process in which the cointegration relationship is examined and where the error is near zero and the error correction mechanism acts slowly, was attempted to be modeled.

N. Balke and T. Fomby utilize the two-step method and the Engle-Granger method developed for linear time series.[28] This method is used in detecting the existence of cointegration relations in non-linear time series. In the next step, after examining the existence of cointegration, the behavior of the threshold was analyzed and shown that the non-linearity tests developed for a double TAR (double threshold autoregression) can be used.

B. Hansen and B. Seo used the maximum-likelihood (ML) procedure, and by this method, the TAR model was predicted and, along with the algorithm used, trimming was made for the cointegration vector and threshold vector.[29] A method was developed for testing the existence of a threshold effect. In this way, the model becomes a linear vector error-correction model (VECM), which can lead to a better understanding of the nature of any non-stationarity among the different component series. Reduced rank regression is estimated under a null hypothesis. In this case, a test can be established according to a Lagrange multiplier (LM) test principle. If the threshold parameter is not determined under the null hypothesis, the analysis is continued via a SupLM test.

In M. Seo's study, like the studies of N. Balke and T. Fomby and B. Hansen and B. Seo, if the alternative hypothesis is TAR cointegration, a criticism is asserted that the power of conventional cointegration tests can be low. M. Pippenger, G. Goering, and A. Taylor also mentioned this loss of power in their studies.[30] Other applications about the joint issues of nonstationarity and non-linearity are as follows: M. Wohar and N. Balke; C. Baum et al.; C. Baum and M. Karasulu; W. Enders and B. Falk; M. Lo and E. Zivot; M. Martens et al.; P. O'Connell; A. Taylor; P. G. J. O'Connell and S.-J. Wei; M. Obstfeld and A. Taylor; and P. Michael et al.[31] The following academic researchers also employed the Hansen and Seo threshold vector error-correction model (TVECM) test: T. Root and D. Lien; O. Bajo-Rubio et al.; N. Aslanidis and G. Kouretas; J. Gascoigne; M. Clementsa and A. Galvao; and V. Esteve et al.[32] In this work, we have improved upon the Hansen and Seo test for threshold cointegration by expanding the null hypothesis in a two-regime TVECM for more than two variables.[33]

This paper examines the relationship among GDP, budget deficits, current account deficits, the exchange rate, mortgage interest rates, and oil prices on the basis of the Hansen and Seo test.[34] As in their approach, we also use the maximum likelihood estimation (MLE) of the threshold model. The second step is to test for the presence of a threshold effect. Under the null hypothesis, the model transforms into the linear VECM.

The two-regime threshold model, where the γ is the threshold parameter, takes the following form,

$$\Delta x_t = \begin{cases} A_1' X_{t-1}(\beta) + u_1, & w_{t-1}(\beta) \leq \gamma \\ A_2' X_{t-1}(\beta) + u_1, & w_{t-1}(\beta) > \gamma \end{cases} \tag{3}$$

where

$$X_{t-1}(\beta) = \begin{pmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta x_{t-1} \\ \Delta x_{t-2} \\ \vdots \\ \Delta x_{t-1} \end{pmatrix}$$

There are two regimes defined by the error correction terms value. As described in Hansen and Seo, the parameters A_1 and A_2 are coefficient matrices and require the dynamics in these regimes.[35] If $P(w_{t-1} \le \gamma)$ has the relation $0 < P(w_{t-1} \le \gamma) < 1$, this signifies the threshold effect; otherwise the model characterizes linear cointegration. The following constraint also is formed,

$$\pi_0 \le P(w_{t-1} \le \gamma) \le 1 - \pi_0 \tag{4}$$

where the trimming parameter is $\pi_0 > 0$.

Hansen and Seo proposed two heteroskedastic-consistent LM test statistics to test whether there is linear cointegration under the null against the alternative threshold cointegration. If there is no threshold under the null, the model reduces to a conventional linear VECM. The first test statistic would be used when the true cointegrating vector is known a priori and is denoted as:

$$\text{Sup LM}^0 = \sup_{\gamma_L \le \gamma \le \gamma_U} LM(\beta_0, \gamma), \tag{5}$$

where β_0 is the known value at fixed β (hereafter, set β_0 at unity), while the second case can be used when the true co-integrating vector is unknown, and the test statistic is given by:

$$\text{Sup LM} = \sup_{\gamma_L \le \gamma \le \gamma_U} LM\left(\tilde{\beta}, \gamma\right), \tag{6}$$

where $\tilde{\beta}$ is the null estimate of β. In both tests, $[\gamma_L, \gamma_U]$ is the search region so that γ_L is the π_0 percentile of $\tilde{w}_{t-1}$, and γ_U is the $(1 - \pi_0)$ percentile.

Table 1
AUGMENTED DICKEY-FULLER (ADF) TEST RESULTS[a]

	t-Statistic		**t-Statistic**
CA	-2.221998	ΔCA	-13.5365
OP	0.937368	ΔOP	-4.70345
E	-2.218933	ΔE	-5.28671
M	-1.258	ΔM	-7.254
GDP	-0.209467	ΔGDP	-13.50660
BD	-2.164658	ΔBD	-11.38307

[a] Test critical values: 1-percent level (-3.475), 5-percent level (2.88), and 10-percent level (-2.577); CA = current account deficit; OP = oil prices; E = exchange rate; M = mortgage rate data; GDP = gross domestic product; and BD = budget deficit.

Econometric Results

The TAR Unit-Root Test: As noted earlier, in the analysis the TAR unit-root test is used, but at the first stage, the unit-root analyses of the variables are made. In the unit-root analysis, as a result of the augmented Dickey-Fuller (ADF) test, it was found that all the variables were I(1). As mentioned previously, taking into consideration that the variables are non-linear, traditional unit-root tests can give misleading results.

To be able to capture the threshold effect, the Caner and Hansen procedure will be applied.[36] The Caner and Hansen unit-root test results are given in table 2. The *m* parameters for all variables are also given in table 2. The lag length of the delay parameter *k* is calculated by the Akaike information criteria (AIC).

The bootstrap threshold test analyzes the threshold effect on the time series we are investigating. Tables 2 and 3 provide an overview of the threshold and unit-root test results for the TAR model. We reported the bootstrap probability values and asymptotic probability values resulting from the Wald test. As can be seen in tables 2 and 3, at a lag length of *m* periods, both variables contain the threshold effect. As a result, although the variable *w* has the threshold effect at a 0.95 confidence level, the H_0 hypothesis that points out stationarity can be rejected for the variable *P* by the 5[th] lag. Consequently, the alternative hypothesis that states the threshold effect exists for the series is not rejected against the null hypothesis of stationarity.

In the study, following the bootstrap threshold test, we analyzed the R_1 and R_2 tests. As observed by the Wald statistics and *p* values, the null hypothesis of stationarity is rejected only for the GDP variable (but just for lag length of k). As

Table 2
THRESHOLD AND UNIT-ROOT TESTS FOR TAR MODEL[a]

Variable	**m=12 CA(m)**	**k=12 CA(k)**	**m=1 OP(m)**	**k=12 OP(k)**	**m=4 E(m)**	**k=10 E(k)**
Wald Stat	115.78	115.78	216.95	157.38	38.85	24.65
Bootstrap p-value	0	0	0	0	0.014	0.26
Asymptotic p-value	0	0	0	0	0.016	0.29
Variable	**m=2 BD(m)**	**k=6 BD(k)**	**m=7 GDP(m)**	**k=10 GDP(k)**	**m=4 M(m)**	**k=10 M(k)**
Wald Stat	82.16	41.82	43.39	65.45	71.66	29.03
Bootstrap p-value	0	0	0.05	0	0	0.1
Asymptotic p-value	0	0	0.032	0	0	0.1

[a] CA = current account deficit; OP = oil prices; E = exchange rates; BD = budget deficit; GDP = gross domestic product; M = mortgage rate.

Table 3
WALD AND STATIONARITY TEST RESULTS[a]

Variable	Wald Statistic	Bootstrap p-Value	Asymptotic p-Value	Wald Statistic	Bootstrap p-Value	Asymptotic p-Value
	Two-Sided Wald Tests for UR (R_2)			**One-Sided Wald Tests for UR (R_1)**		
CA(m)	1.84	0.85	0.96	0.00	0.98	0.99
CA(k)	1.84	0.85	0.96	0.00	0.98	0.99
OP(m)	0.50	0.96	0.99	0.15	0.96	0.99
OP(k)	2.77	0.79	0.89	0.75	0.90	0.98
E(m)	8.27	0.19	0.26	7.85	0.16	0.26
E(k)	10.90	0.37	0.55	5.59	0.24	0.38
BD(m)	1.53	0.82	0.98	1.46	0.78	0.94
BD(k)	2.82	0.71	0.88	2.78	0.67	0.83
GDP(m)	18.28	0.03	0.03	10.71	0.22	0.78
GDP(k)	22.29	0.01	0.00	21.60	0.01	0.07
M(m)	13.79	0.60	0.40	6.90	0.20	0.30
M(k)	3.28	0.60	0.80	3.28	0.56	0.77
	t1 Test for Stationary			**t2 Test for Stationary**		
CA(m)	-0.97	0.93	0.87	-0.95	0.94	0.87
CA(k)	-0.97	0.93	0.87	-0.95	0.94	0.87
OP(m)	0.40	0.77	0.95	-0.58	0.92	0.93
OP(k)	0.86	0.65	0.89	-1.42	0.98	0.72
E(m)	2.80	0.07	0.14	-0.64	0.87	0.93
E(k)	2.10	0.15	0.30	1.08	0.49	0.85
BD(m)	-0.27	0.77	0.96	1.21	0.47	0.81
BD(k)	-0.19	0.79	0.96	1.67	0.40	0.63
GDP(m)	-2.75	0.99	0.99	3.27	0.05	0.14
GDP(k)	-0.83	0.82	0.99	4.64	0.00	0.003
M(m)	2.63	0.09	0.19	-2.62	0.99	0.19
M(k)	1.80	0.28	0.56	0.15	0.78	0.96

[a] CA = current account deficit; OP = oil prices; E = exchange rates; BD = budget deficit; GDP = gross domestic product; M = mortgage rate.

can be seen in tables 2 and 3, all variables have threshold effects and they are not stationary. According to the t_1 and t_2 tests, we obtained similar results that signify the stationarity of GDP, BD, CA, OP, E, and M. $H_0 : \rho_1 = \rho_2 = 0$ is rejected against the unit root, while the alternative hypothesis that series have unit root $H_0 : \rho_1 < 0$, $\rho_2 < 0$ is not rejected.

For the first stage, the unit-root test is performed for the variables. At the second stage, the TAR cointegration analyses are conducted. During these analyses, information about the nonlinearity and stationarity of each variable, as well as the threshold values, were obtained. After determining that all the variables are of first degree stationarity, the TVEC and TAR cointegration analyses were conducted.

The TAR Cointegration Results: However, the TVECM relations are estimated for variables' long-run relationships, which is very important in assessing their longer-term tendencies. Three models are utilized in this process. In the first model, we analyze the effects of mortgage interest rates and oil prices exogenously; earlier in our study we gave the results of the analysis in which these variables are endogenous. Thus, the first and second part of the study considers the relation among gross domestic product (GDP), budget deficit (BD), current account deficit (CA), oil prices (OP), exchange rate (E), and mortgage interest rate (M) with TVEC analysis. In the third model, the relation between current account deficit (CA) and oil prices (OP), exchange rates (E) and oil prices (OP), current account deficit (CA) and exchange rates (E), and, finally, the relation between current account deficit (CA) and mortgage interest rates (M) are observed with pairwise TVEC models. However, the relationship between budget deficits (BD), gross domestic product (GDP), and oil prices (OP) with mortgage rates (M) are not analyzed.

In this study, the three TVECM models can be denoted as follows,

Model 1:

$$\begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \end{pmatrix}_t + \Delta M_t + \Delta OP + u_{1t}, v_{t-1} \leq \gamma$$

$$\begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \end{pmatrix} + \Delta M_t + \Delta OP_t + u_{2t}, \ \ v_{t-1} > \gamma$$

Model 2:

$$\begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \\ \Delta OP_t \\ \Delta M_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \\ \Delta OP_t \\ \Delta M_t \end{pmatrix} + u_{1t}, \ \ v_{t-1} \leq \gamma$$

$$\begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \\ \Delta OP_t \\ \Delta M_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta GDP_t \\ \Delta BD_t \\ \Delta CA_t \\ \Delta E_t \\ \Delta OP_t \\ \Delta M_t \end{pmatrix} + u_{2t}, \quad v_{t-1} > \gamma$$

and Model 3:

$$\text{a)} \begin{pmatrix} \Delta CA_t \\ \Delta OP_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta CA_t \\ \Delta OP_t \end{pmatrix} + u_{1t}, \quad v_{t-1} \leq \gamma$$

$$\begin{pmatrix} \Delta CA_t \\ \Delta OP_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta CA_t \\ \Delta OP_t \end{pmatrix} + u_{1t}, \quad v_{t-1} > \gamma$$

$$\text{b)} \begin{pmatrix} \Delta E_t \\ \Delta OP_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta E_t \\ \Delta OP_t \end{pmatrix} + u_{1t}, \quad v_{t-1} \leq \gamma$$

$$\begin{pmatrix} \Delta E_t \\ \Delta OP_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta E_t \\ \Delta OP_t \end{pmatrix} + u_{1t}, \quad v_{t-1} > \gamma$$

$$\text{c)} \begin{pmatrix} \Delta CA_t \\ \Delta M_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta CA_t \\ \Delta M_t \end{pmatrix} + u_{1t}, \quad v_{t-1} \leq \gamma$$

$$\begin{pmatrix} \Delta CA_t \\ \Delta M_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta CA_t \\ \Delta M_t \end{pmatrix} + u_{1t}, \quad v_{t-1} > \gamma$$

$$\text{d)} \begin{pmatrix} \Delta CA_t \\ \Delta E_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta CA_t \\ \Delta E_t \end{pmatrix} + u_{1t}, \quad v_{t-1} \leq \gamma$$

$$\begin{pmatrix} \Delta CA_t \\ \Delta E_t \end{pmatrix} = \mu_1 + \alpha_1 w_{t-1} + \beta_1 z_{t-1} + \Gamma_1 \begin{pmatrix} \Delta CA_t \\ \Delta E_t \end{pmatrix} + u_{1t}, \quad v_{t-1} > \gamma$$

In this paper, different models were used to analyze our expected outcomes. In most of the models, it was seen that especially the error correction factors of typical regimes, which cover an important part of the observation values, were negative and statistically significant. So the existence of the cointegrating relationship cannot be determined.

The important inference obtained from these models is that the long-run relations between the variables exist with different lag lengths. So if the shocks are above a certain ratio, returning to equilibrium can be at different levels for different economic variables.

Another important point is the difference between the threshold values estimated for these models, especially in the case of the first model, which has the largest threshold value of 83 percent. As can be seen from our analysis, the models that give the relationship between just two endogenous variables have a smaller threshold than the first model. This finding also verifies the reliability of this analysis. In addition, we looked at the pairwise relations between the variables, which show us the effects of the crises in 1974, 1979, and 2008.

TVEC Model I: For the first part of the TVEC analysis, the cointegrating relations for the first (in a recession period) and second (an expansion period) regimes are given as follows:

$$GDP_t \leq 0.378BD_t - 0.925CA_t - 0.096E_t$$

$$GDP_t > 0.378BD_t - 0.925CA_t - 0.096E_t$$

This long-run relation shows that in both regimes (either an economic recession or an expansion), current account deficits and exchange rates affect GDP negatively and budget deficits positively. See appendix 1 for the complete model.

The effect on GDP in the system, where the simultaneous relation is analyzed with four lags, is presented in the first equation; an increase in current account deficit (CA) positively affects GDP, especially in the first regime (a recessionary economic situation). During a significant recessionary period, an increase in the budget deficit increases GDP, but this relation cannot be seen in an expansionary economic regime (the second regime). Oil prices positively affect GDP in a recession, while negatively affecting GDP in an expansionary economy. Another visible outcome in the model is the relationship between mortgage interest rates (M) and GDP; mortgage interest rates (M) effect GDP positively in both of the regimes that we tested.

In the budget deficit equation, oil prices had a decreasing effect on budget deficits in a recession, but an increasing effect in an expansion regime. Similarly, we can see this relationship also exists for current account deficits under both recessionary and expansionary economic regimes.

TVEC Model II: In the second TVEC analysis—in which whole variables are endogenously analyzed—the cointegrating relations for the first (a recessionary economy) and second (an expansionary economy) regimes are:

$$GDP_t \leq 2.33BD_t - 0.739CA_t + 0.0756E_t - 0.154M_t - 0.314OP_t$$

$$GDP_t > 0.486BD_t - 0.405CA_t - 0.564E_t + 0.385M_t - 0.06OP_t$$

The long-run relationships yield similar results to the TVEC Model I analysis for the current account deficit (CA) and budget deficit (BD) variables. While the exchange rate (E) has a positive effect in a recession and a negative one in an expanding economic situation (regime).

In the second part of this analysis there are statistically and economic insignificant parts (like positive error correction terms). However, these models are estimated for comparison; similar relationships for some of the variables can be seen with the TVEC model I. Appendix 2 provides an overview of the TVEC model II results for the variables.

TVEC Model III: In TAR cointegration analysis, the relation between current account deficits (CA) and oil prices (OP), exchange rates (E) and oil prices (OP), current account deficits (CA) and exchange rates (E) and, finally, the relation between current account deficits (CA) and mortgage interest rates (M) are observed. The cointegration relation between current account deficits (CA) and oil prices (OP) is obtained as $\upsilon_t = CA_{t-1} - 0.99OP_t$ following the minimization of the likelihood function. The estimated threshold value is $\hat{\gamma} = 0.51$. As a result, the first regime is not rejected to be prevailing where the current account deficit (CA) is less than 51 percent lower than the oil price (OP). Consequently, the first regime we obtained in the analysis dominated as the typical regime at 90 percent of the whole period, whereas the second regime corresponded only to 10 percent. The first regime is achieved so that, (typical regime) $CA_t \leq 0.99OP_t + 0.51$ whereas the second regime, (extreme regime) is dominant if $CA_t > 0.99OP_t + 0.51$. See appendix 3 for the estimated TVEC model for current account deficits (CA) and oil prices (OP).

It was detected that there was a long-run relationship between current account deficits and oil prices. The calculated long-term relationship was determined as 0.99 and the threshold value was 0.51. The first regime covers 90 percent of the data while the second regime covers 10 percent of the data. Thus, if the current deficit is 51 percent lower than oil prices, the first regime is realized.

When the relation between oil prices and current account deficits was analyzed in the long run, the relation between three lags of current account deficit and oil prices is found to be consistent with expectations. An increase in oil prices has a negative effect that decreases the current account deficit. Also supporting this finding is that the cointegration relation between current account deficits and oil prices reveals a similar relation for two lags of a current account deficit.

Another relationship that we tested was that of exchange rates (E) and oil prices (OP). Appendix 3 provides the complete estimated TVEC model for exchange rates (E) and oil prices (OP). The cointegration relation is $\upsilon_t - E_{t-1} + 0.40OP_t$. The estimated threshold value is $\hat{\gamma} = 0.61$. The long-run relations for these variables are expressed under two scenarios (an extreme regime and a typical regime) below:

First regime (extreme regime): $E_t \leq -0.40OP_t - 0.61$ (22 percent)

Second regime(typical regime): $E_t > -0.40OP_t - 0.61$ (78 percent)

The relation between the exchange rate (E) and oil prices (OP) was calculated as 0.4. When the regime magnitudes were examined, it was seen that the first (extreme) regime was 22 percent and the second was a typical regime with 78 percent. In this analysis, where the long-run relationship of these two variables was examined, the threshold value was calculated as -0.61. The first regime was created in a situation where the oil prices were 61 percent lower than the exchange rate. The second regime was realized if the difference between oil prices and exchange rate is less than 61 percent.

The TVEC model III results of the relationship between current account deficits and exchange rate can be seen in appendix 3. The long-run relationship between current account deficit (CA) and exchange rate (E) was obtained as 0.72, and the estimated threshold value was 0.75. In the examined period, 85 percent of the data were in the first regime, while 15 percent were in the second regime. If the current account deficit is increased less than 0.75 from the exchange rate, then the first regime was realized. The cointegration relationship between the current account deficit (CA) and exchange rate (E) can be expressed as $\upsilon_t = CA_{t-1} - 0.72E_t$. The relationship between these variables under two scenarios (an extreme regime and a typical regime) is given below:

First regime (typical regime): $CA_t \leq 0.72E_t + 0.75$ (85 percent)

Second regime (extreme regime): $CA_t > 0.72E_t + 0.75$ (15 percent)

In most of the models, it was seen that, in particular, the error correction terms of typical regimes, which cover an important part of observation values, were negative and statistically significant. The important inference obtained from these models is that the long-run relations between the variables exist with different lag lengths. So, if the shocks are above a certain ratio, returning to the balance can be in different levels, for different economic variables.

The last relationship we tested was for the cointegration relation between current account deficits (CA) and mortgage interest rates (M). Appendix 3 provides our complete estimated TVEC model for these variables. The cointegration relationship between the current account deficit (CA) and mortgage interest rates (M) can be expressed as $\upsilon_t = CA_{t-1} + 0.89M_t$, with an estimated threshold value of $\hat{\gamma} = 0.84$. The realtionship between these variables under two scenarios (an extreme regime and a typical regime) is given below:

First regime (extreme regime): $CA_t \leq -0.89M_t + 0.84$ (20 percent)

Second regime (typical regime): $CA_t > -0.89M_t + 0.84$ (80 percent)

The relation that was obtained from the TVEC models shows that mortgage interest rates affect current account deficit positively in first regime but negatively in second regime.

Conclusion

As a result, it can be stated that GDP, oil prices, current account and budget deficits, mortgage rates, and exchange rates are related. When current account and budget deficits increase, oil prices are affected. These effects are observed and experienced prior to and during the 1974 crisis, the 1979 crisis, and the 2008 great recession. For the period from January 1971 through January 2008, the relationship among GDP, the budget deficit, the current account deficit, the exchange rate, oil prices, and mortgage interest rates in the United States were examined by TAR unit-root, TAR cointegration, and TVEC analyses.

In the first and main part of the econometric analysis, the estimation results show the relation among GDP, budget deficits, current account deficits, and the exchange rate. The long-run relation between these variables was analyzed with TAR cointegration analysis. This analysis showed that in periods of economic expansion, an increase in the current account deficit and oil prices affects GDP positively. Another important relation visible from this analysis was the positive effect of oil prices on the budget deficit in periods of recession. The second part of our analysis offered an estimation model of the relations among GDP, budget deficits, current account deficits, the exchange rate, oil prices and mortgage interest rates variables for comparison. The third part of the analysis modeled the long-run pairwise relations between current account deficits and oil prices, the exchange rate and oil prices, current account deficits and mortgage interest rates, and current account deficits and exchange rates. The long-run relations show that an increase in oil prices has a negative effect that decreases current account deficits. Another pairwise long-run relation shows the negative relation between oil prices and positive relation between current account deficits with the exchange rate. Finally, a long-run relation shows the negative effect of mortgage interest rates on the current account deficit.

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[23]In 2008, the U.S. land and mortgage speculative bubble was no different from other historic incidences. The primary distinguishing factor was that this financial crisis occurred in combination with a substantial increase in oil prices, along with the soaring of other commodity values. At the end of 2000, with recessionary indicators on the horizons, the major world economies through the U.S. Federal Reserve and central banks of Europe and Japan decreased their interest rates to historically low levels. Loose monetary policies, along with changes in market regulations and over-leveraging, created inflation in asset prices. Additionally, it allowed banks access to short-term and very low-interest-rate debt. This in turn fueled an expansion of long-term credit investment, which manifested firstly as real estate loans, and resulted in the rate of credit increasing in the United

States and European Union into double digit numbers in real terms. Particularly in the United States, interest rates (over the 2001 to 2004 period) increased the real estate prices and these increased real estate prices themselves facilitated new credit lending. In 2002, in an attempt to bolster the U.S. economy via the construction sector, new arrangements were made and "subprime mortgage" opportunities proliferated. This led to a growth in low-qualified credit lending called "NINJA" (No Income, No Job, No Assets) lending. Thus, to be able to give more loans, investment banks sold the existing credit debts (securitization) and provided new sources and new credits to replace these. With the effect of decreased risk sensitivity, banks undertook many of these profit-focused transactions, but with weak inspection, follow-up, recording, and oversight. At this point, a very important problem developed: these types of assets and bonds did not have a secondary market and were not inspected sufficiently; so that, ultimately, the risks undertaken by these entities were not priced correctly.

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Appendix 1

TVEC MODEL I: ESTIMATED FOR GROSS DOMESTIC PRODUCT (GDP), BUDGET DEFICITS (BD), CURRENT ACCOUNT DEFICITS (CA), AND EXCHANGE RATES (E)

$$
\Delta GDP_t = \begin{cases}
\underset{(0.04)}{-0.152 v_t} - \underset{(0.12)}{0.73 \Delta GDP_{t-1}} - \underset{(0.14)}{0.398 \Delta GDP_{t-2}} - \underset{(0.11)}{0.29 \Delta GDP_{t-3}} \\
\underset{(0.027)}{-0.65 \Delta BD_{t-1}} - \underset{(0.033)}{0.091 \Delta BD_{t-2}} - \underset{(0.03)}{0.027 \Delta BD_{t-3}} \\
\underset{(0.03)}{+0.105 \Delta CA_{t-1}} + \underset{(0.0198)}{0.062 \Delta CA_{t-2}} + \underset{(0.015)}{0.026 \Delta CA_{t-3}} & \lambda \leq 0.83 \\
\underset{(0.011)}{+0.005 \Delta E_{t-1}} - \underset{(0.012)}{0.006 \Delta E_{t-2}} + \underset{(0.011)}{0.015 \Delta E_{t-3}} \\
\underset{(0.013)}{+0.022 \Delta M_{t-1}} + \underset{(0.003)}{0.003 \Delta OP_{t-1}} + \varepsilon_{1t} \\
\\
\underset{(0.02)}{0.008 v_t} - \underset{(0.133)}{0.73 \Delta GDP_{t-1}} - \underset{(0.127)}{0.52 \Delta GDP_{t-2}} - \underset{(0.107)}{0.33 \Delta GDP_{t-3}} \\
\underset{(0.0014)}{+0.002 \Delta BD_{t-1}} + \underset{(0.0012)}{0.0008 \Delta BD_{t-2}} - \underset{(0.001)}{0.0009 \Delta BD_{t-3}} \\
\underset{(0.024)}{+0.0077 \Delta CA_{t-1}} - \underset{(0.025)}{0.092 \Delta CA_{t-2}} + \underset{(0.027)}{0.029 \Delta CA_{t-3}} & \lambda > 0.83 \\
\underset{(0.017)}{+0.001 \Delta E_{t-1}} - \underset{(0.0139)}{0.006 \Delta E_{t-2}} + \underset{(0.0133)}{0.007 \Delta E_{t-3}} \\
\underset{(0.011)}{+0.018 \Delta M_{t-1}} - \underset{(0.0075)}{0.013 \Delta OP_{t-1}} + \varepsilon_{2t}
\end{cases}
$$

Appendix 1 (continued)

TVEC MODEL I: ESTIMATED FOR GROSS DOMESTIC PRODUCT (GDP), BUDGET DEFICITS (BD), CURRENT ACCOUNT DEFICITS (CA), AND EXCHANGE RATES (E)

$$\Delta BD_t = \begin{cases} \underset{(0.24)}{-0.203}v_t - \underset{(0.71)}{0.446}\Delta GDP_{t-1} - \underset{(0.83)}{0.204}\Delta GDP_{t-2} - \underset{(0.67)}{0.359}\Delta GDP_{t-3} \\ -\underset{(0.161)}{0.893}\Delta BD_{t-1} - \underset{(0.194)}{0.799}\Delta BD_{t-2} - \underset{(0.175)}{0.505}\Delta BD_{t-3} \\ +\underset{(0.175)}{0.092}\Delta CA_{t-1} - \underset{(0.115)}{0.1096}\Delta CA_{t-2} - \underset{(0.085)}{0.084}\Delta CA_{t-3} & \lambda \leq 0.83 \\ +\underset{(0.069)}{0.024}\Delta E_{t-1} - \underset{(0.711)}{0.064}\Delta E_{t-2} + \underset{(0.068)}{0.021}\Delta E_{t-3} \\ +\underset{(0.078)}{0.035}\Delta M_{t-1} + \underset{(0.015)}{0.017}\Delta OP_{t-1} + \omega_{1t} \\ \\ \underset{(3.46)}{13.63}v_t - \underset{(20.84)}{8.84}\Delta GDP_{t-1} + \underset{(17.58)}{9.61}\Delta GDP_{t-2} + \underset{(0.235)}{8.23}\Delta GDP_{t-3} \\ +\underset{(0.23)}{0.0297}\Delta BD_{t-1} + \underset{(0.196)}{0.061}\Delta BD_{t-2} - \underset{(0.175)}{0.009}\Delta BD_{t-3} \\ -\underset{(3.929)}{7.42}\Delta CA_{t-1} - \underset{(4.019)}{5.35}\Delta CA_{t-2} - \underset{(4.428)}{3.83}\Delta CA_{t-3} & \lambda > 0.83 \\ -\underset{(2.817)}{9.59}\Delta E_{t-1} - \underset{(2.277)}{8.36}\Delta E_{t-2} - \underset{(2.185)}{4.507}\Delta E_{t-3} \\ +\underset{(1.851)}{0.595}\Delta M_{t-1} - \underset{(1.243)}{0.435}\Delta OP_{t-1} + \omega_{2t} \end{cases}$$

Appendix 1 (continued)

TVEC MODEL I: ESTIMATED FOR GROSS DOMESTIC PRODUCT (GDP), BUDGET DEFICITS (BD), CURRENT ACCOUNT DEFICITS (CA), AND EXCHANGE RATES (E)

$$\Delta CA_t = \begin{cases} \underset{(0.27)}{-0.688}v_t + \underset{(0.81)}{0.7}\Delta GDP_{t-1} + \underset{(0.94)}{1.012}\Delta GDP_{t-2} + \underset{(0.76)}{1.6195}\Delta GDP_{t-3} \\ \underset{(0.184)}{-0.465}\Delta BD_{t-1} + \underset{(0.22)}{0.596}\Delta BD_{t-2} - \underset{(0.20)}{0.144}\Delta BD_{t-3} \\ \underset{(0.199)}{-0.114}\Delta CA_{t-1} - \underset{(0.132)}{0.03}\Delta CA_{t-2} + \underset{(0.096)}{0.052}\Delta CA_{t-3} & \lambda \leq 0.83 \\ +\underset{(0.079)}{0.064}\Delta E_{t-1} + \underset{(0.08)}{0.0798}\Delta E_{t-2} - \underset{(0.078)}{0.068}\Delta E_{t-3} \\ \underset{(0.089)}{-0.034}\Delta M_{t-1} - \underset{(0.017)}{0.016}\Delta OP_{t-1} + e_{1t} \\ \\ \underset{(0.134)}{-0.13}v_t + \underset{(0.852)}{1.6}\Delta GDP_{t-1} + \underset{(0.81)}{0.95}\Delta GDP_{t-2} + \underset{(0.684)}{0.73}\Delta GDP_{t-3} \\ \underset{(0.009)}{-0.008}\Delta BD_{t-1} - \underset{(0.0077)}{0.0052}\Delta BD_{t-2} - \underset{(0.007)}{0.0006}\Delta BD_{t-3} \\ \underset{(0.153)}{-0.523}\Delta CA_{t-1} - \underset{(0.156)}{0.43}\Delta CA_{t-2} + \underset{(0.172)}{0.002}\Delta CA_{t-3} & \lambda > 0.83 \\ +\underset{(0.109)}{0.116}\Delta E_{t-1} - \underset{(0.088)}{0.008}\Delta E_{t-2} - \underset{(0.085)}{0.008}\Delta E_{t-3} \\ \underset{(0.072)}{-0.096}\Delta M_{t-1} + \underset{(0.048)}{0.51}\Delta OP_{t-1} + e_{2t} \end{cases}$$

Appendix 1 (continued)

TVEC MODEL I: ESTIMATED FOR GROSS DOMESTIC PRODUCT (GDP), BUDGET DEFICITS (BD), CURRENT ACCOUNT DEFICITS (CA), AND EXCHANGE RATES (E)

$$\Delta E_t = \begin{cases} \underset{(0.41)}{-0.485}v_t \underset{(1.20)}{-0.157}\Delta GDP_{t-1} \underset{(1.404)}{-2.056}\Delta GDP_{t-2} \underset{(1.133)}{-1.404}\Delta GDP_{t-3} \\ \underset{(0.275)}{-0.154}\Delta BD_{t-1} \underset{(0.33)}{-0.185}\Delta BD_{t-2} \underset{(0.299)}{-0.194}\Delta BD_{t-3} \\ \underset{(0.297)}{+0.403}\Delta CA_{t-1} \underset{(0.196)}{+0.03}\Delta CA_{t-2} \underset{(0.144)}{-0.0002}\Delta CA_{t-3} & \lambda \leq 0.83 \\ \underset{(0.119)}{-0.40}\Delta E_{t-1} \underset{(0.12)}{-0.274}\Delta E_{t-2} \underset{(0.116)}{-0.307}\Delta E_{t-3} \\ \underset{(0.133)}{+0.069}\Delta M_{t-1} \underset{(0.026)}{-0.064}\Delta OP_{t-1} + s_{1t} \\ \\ \underset{(0.272)}{-0.597}v_t \underset{(1.72)}{-0.556}\Delta GDP_{t-1} \underset{(1.637)}{-2.568}\Delta GDP_{t-2} \underset{(1.381)}{-1.374}\Delta GDP_{t-3} \\ \underset{(0.0185)}{-0.048}\Delta BD_{t-1} \underset{(0.015)}{-0.029}\Delta BD_{t-2} \underset{(0.014)}{-0.017}\Delta BD_{t-3} \\ \underset{(0.309)}{+0.408}\Delta CA_{t-1} \underset{(0.316)}{+0.33}\Delta CA_{t-2} \underset{(0.348)}{+0.23}\Delta CA_{t-3} & \lambda > 0.83 \\ \underset{(0.22)}{-0.364}\Delta E_{t-1} \underset{(0.1789)}{-0.283}\Delta E_{t-2} \underset{(0.171)}{-0.231}\Delta E_{t-3} \\ \underset{(0.145)}{-0.2496}\Delta M_{t-1} \underset{(0.098)}{-0.0398}\Delta OP_{t-1} + s_{2t} \end{cases}$$

Appendix 2
TVEC MODEL II RESULTS

	ΔGDP $\lambda \leq 0.83$	ΔGDP $\lambda > 0.83$	ΔBD $\lambda \leq 0.83$	ΔBD $\lambda > 0.83$	ΔCA $\lambda \leq 0.83$	ΔCA $\lambda > 0.83$	ΔE $\lambda \leq 0.83$	ΔE $\lambda > 0.83$	ΔM $\lambda \leq 0.83$	ΔM $\lambda > 0.83$	ΔOP $\lambda \leq 0.83$	ΔOP $\lambda > 0.83$
Error	0.052	0.017	-0.340	11.40	0.266	-0.272	0.004	-1.309	0.1365	0.723	2.981	-0.125
correction term	(0.025)	(0.03)	(0.128)	(4.939)	(0.147)	(0.196)	(0.215)	(0.363)	(0.204)	(0.341)	(0.836)	(0.502)
ΔGDP_{t-1}	-0.703	-0.729	1.173	-2.804	-0.005	1.721	-0.724	-0.461	1.510	0.033	-2.933	1.381
	(0.152)	(0.145)	(0.793)	(23.18)	(0.910)	(0.922)	(1.329)	(1.704)	(1.261)	(1.601)	(5.174)	(2.358)
ΔGDP_{t-2}	-0.329	-0.584	1.619	-3.993	0.957	1.093	-2.078	-1.891	-1.123	-1.411	-10.923	2.719
	(0.181)	(0.136)	(0.94)	(21.68)	(1.079)	(0.862)	(1.576)	(1.593)	(1.495)	(1.496)	(6.135)	(2.204)
ΔGDP_{t-3}	-0.299	-0.339	0.389	-6.989	1.766	0.601	-0.256	-1.054	-0.088	0.693	-12.103	-0.514
	(0.144)	(0.118)	(0.751)	(18.78)	(0.862)	(0.746)	(1.259)	(1.381)	(1.194)	(1.296)	(4.902)	(1.910)
ΔBD_{t-1}	-0.101	0.001	-0.205	-0.268	-0.649	-0.008	0.020	-0.054	-0.485	0.0042	-5.913	-0.041
	(0.050)	(0.001)	(0.262)	(0.207)	(0.301)	(0.008)	(0.439)	(0.015)	(0.417)	(0.014)	(1.711)	(0.021)
ΔBD_{t-2}	-0.099	0.001	-0.153	-0.210	0.686	-0.005	0.142	-0.035	-0.332	0.003	-4.402	-0.016
	(0.046)	(0.001)	(0.239)	(0.187)	(0.274)	(0.007)	(0.399)	(0.014)	(0.379)	(0.012)	(1.556)	(0.019)
ΔBD_{t-3}	-0.040	0.000	-0.150	-0.149	0.215	-0.003	-0.230	-0.014	-0.521	0.003	-1.722	-0.070
	(0.036)	(0.001)	(0.186)	(0.145)	(0.213)	(0.006)	(0.311)	(0.011)	(0.295)	(0.010)	(1.211)	(0.014)
ΔCA_{t-1}	0.031	0.011	-0.159	-4.274	-0.460	-0.542	0.158	0.529	0.035	-0.022	0.853	-0.351
	(0.021)	(0.025)	(0.109)	(4.046)	(0.126)	(0.161)	(0.184)	(0.297)	(0.175)	(0.279)	(0.717)	(0.411)
ΔCA_{t-2}	0.007	-0.092	-0.139	-1.296	-0.168	-0.408	-0.023	0.372	0.062	-0.313	-0.200	-0.250
	(0.016)	(0.026)	(0.088)	(4.156)	(0.101)	(0.165)	(0.147)	(0.305)	(0.140)	(0.286)	(0.574)	(0.422)
ΔCA_{t-3}	-0.001	-0.025	-0.104	-2.222	-0.087	-0.036	-0.153	0.038	0.063	0.337	-0.096	0.098
	(0.014)	(0.028)	(0.073)	(4.498)	(0.083)	(0.179)	(0.122)	(0.330)	(0.115)	(0.311)	(0.474)	(0.457)
ΔE_{t-1}	0.001	-0.007	-0.036	-6.319	-0.043	0.148	-0.367	-0.315	-0.059	-0.396	-0.741	0.277
	(0.014)	(0.015)	(0.074)	(2.422)	(0.085)	(0.096)	(0.125)	(0.178)	(0.118)	(0.167)	(0.485)	(0.246)
ΔE_{t-2}	-0.016	-0.003	-0.113	-5.877	0.042	0.113	-0.238	-0.289	-0.041	-0.252	0.169	-0.359
	(0.014)	(0.014)	(0.070)	(2.218)	(0.081)	(0.088)	(0.118)	(0.163)	(0.112)	(0.153)	(0.459)	(0.225)

(*continued*)

Appendix 2 (continued)
TVEC MODEL II RESULTS

	ΔGDP $\lambda \le 0.83$	ΔGDP $\lambda > 0.83$	ΔBD $\lambda \le 0.83$	ΔBD $\lambda > 0.83$	ΔCA $\lambda \le 0.83$	ΔCA $\lambda > 0.83$	ΔE $\lambda \le 0.83$	ΔE $\lambda > 0.83$	ΔM $\lambda \le 0.83$	ΔM $\lambda > 0.83$	ΔOP $\lambda \le 0.83$	ΔOP $\lambda > 0.83$
ΔE_{t-3}	0.007	0.0003	-0.004	-2.136	-0.024	0.053	-0.310	-0.243	-0.108	-0.472	-0.088	0.368
	(0.013)	(0.012)	(0.066)	(1.966)	(0.076)	(0.077)	(0.111)	(0.144)	(0.104)	(0.135)	(0.430)	(0.199)
ΔM_{t-1}	-0.022	-0.010	-0.014	0.716	0.228	-0.057	0.290	-0.490	-0.326	-0.064	0.867	0.082
	(0.016)	(0.017)	(0.084)	(2.769)	(0.096)	(0.110)	(0.140)	(0.203)	(0.133)	(0.191)	(0.546)	(0.282)
ΔM_{t-2}	-0.010	-0.002	0.080	3.598	0.032	0.017	-0.238	-0.522	-0.298	-0.119	1.882	0.135
	(0.018)	(0.015)	(0.091)	(2.336)	(0.104)	(0.092)	(0.153)	(0.171)	(0.145)	(0.161)	(0.596)	(0.237)
ΔM_{t-3}	0.008	-0.006	0.051	0.871	0.092	-0.034	0.078	-0.352	-0.120	0.172	0.496	0.514
	(0.015)	(0.014)	(0.076)	(2.166)	(0.088)	(0.086)	(0.128)	(0.159)	(0.122)	(0.149)	(0.501)	(0.220)
ΔOP_{t-1}	0.009	0.006	-0.091	-0.743	0.0652	0.003	0.0635	0.0482	0.055	-0.253	0.027	-0.479
	(0.007)	(0.007)	(0.034)	(1.159)	(0.038)	(0.046)	(0.056)	(0.085)	(0.053)	(0.08)	(0.221)	(0.118)
ΔOP_{t-2}	0.003	0.004	-0.040	-2.479	0.0839	-0.006	0.0927	0.116	0.075	-0.206	-0.042	-0.541
	(0.005)	(0.007)	(0.027)	(1.169)	(0.031)	(0.046)	(0.045)	(0.085)	(0.042)	(0.080)	(0.176)	(0.119)
ΔOP_{t-3}	0.000	0.005	-0.001	0.347	0.066	0.014	0.0163	0.090	0.037	-0.233	0.064	-0.497
	(0.004)	(0.007)	(0.020)	(1.127)	(0.023)	(0.044)	(0.033)	(0.082)	(0.032)	(0.077)	(0.131)	(0.115)

Appendix 3

TVEC MODEL III: ESTIMATED TVEC MODEL FOR CURRENT ACCOUNT DEFICITS (CA) AND OIL PRICES (OP), AND EXCHANGE RATES (E) AND OIL PRICES (OP)

The estimated TVEC model for current account deficits (CA) and oil prices (OP) is:

$$\Delta CA_t = \begin{cases} \underset{(0.12)}{-0.20} - \underset{(0.09)}{1.048} v_{t-1} + \underset{(0.09)}{0.14} \Delta CA_{t-1} + \underset{(0.75)}{0.01} \Delta CA_{t-2} + \underset{(0.076)}{0.12} \Delta CA_{t-3} + \underset{(0.86)}{0.97} \Delta OP_{t-1} + \underset{(0.06)}{0.09} \Delta OP_{t-2} - \underset{(0.61)}{0.04} \Delta OP_{t-3} + u_{1t}, & v_{t-1} \le 0.51 \\ \underset{(1.74)}{-0.45} - \underset{(1.38)}{0.54} v_{t-1} + \underset{(1.10)}{1.21} \Delta CA_{t-1} - \underset{(0.1854)}{71} \Delta CA_{t-2} - \underset{(1.82)}{1.19} \Delta CA_{t-3} - \underset{(0.6245)}{1.08} \Delta OP_{t-1} + \underset{(0.296)}{4.27} \Delta OP_{t-2} + \underset{(0.14210)}{11.3} \Delta OP_{t-3} + u_{2t}, & v_{t-1} > 0.51 \end{cases}$$

$$\Delta OP_t = \begin{cases} \underset{(0.01)}{-0.001} + \underset{(0.006)}{0.05} v_{t-1} - \underset{(0.006)}{0.05} \Delta CA_{t-1} - \underset{(0.15)}{0.0055} \Delta CA_{t-2} - \underset{(0.004)}{0.005} \Delta CA_{t-3} + \underset{(0.013)}{0.46} \Delta OP_{t-1} + \underset{(0.002)}{0.003} \Delta OP_{t-2} + \underset{(0.1)}{0.114} \Delta OP_{t-3} + u_{1t}, & v_{t-1} \le 0.51 \\ \underset{(0.02)}{-0.009} - \underset{(0.01)}{0.04} v_{t-1} + \underset{(0.01)}{0.6} \Delta CA_{t-1} - \underset{(0.19)}{1.085} \Delta CA_{t-2} + \underset{(0.02)}{0.04} \Delta CA_{t-3} + \underset{(0.43)}{0.87} \Delta OP_{t-1} + \underset{(0.023)}{0.2} \Delta OP_{t-2} + \underset{(0.29)}{0.73} \Delta OP_{t-3} + u_{2t}, & v_{t-1} > 0.51 \end{cases}$$

The estimated TVEC model for exchange rates (E) and oil prices (OP) is:

$$\Delta E_t = \begin{cases} \underset{(0.08)}{0.05} + \underset{(0.12)}{0.05} v_{t-1} - \underset{(0.24)}{0.69} \Delta E_{t-1} + \underset{(0.04)}{0.01} \Delta E_{t-2} - \underset{(0.14)}{0.47} \Delta E_{t-3} + \underset{(0.03)}{0.12} \Delta OP_{t-1} + \underset{(0.19)}{0.43} \Delta OP_{t-2} + \underset{(0.03)}{0.09} \Delta OP_{t-2} + u_{1t}, & v_{t-1} \le -0.61 \\ \underset{(0.04)}{-0.03} - \underset{(0.07)}{0.04} v_{t-1} - \underset{(0.10)}{0.4} \Delta E_{t-1} + \underset{(0.02)}{0.02} \Delta E_{t-2} - \underset{(0.08)}{0.5} \Delta E_{t-3} + \underset{(0.019)}{0.012} \Delta OP_{t-1} - \underset{(0.08)}{0.17} \Delta OP_{t-2} + \underset{(0.018)}{0.019} \Delta OP_{t-3} + u_{2t}, & v_{t-1} > -0.61 \end{cases}$$

$$\Delta OP_t = \begin{cases} \underset{(0.04)}{-1.48} - \underset{(0.6)}{2.49} v_{t-1} + \underset{(1.04)}{2.87} \Delta E_{t-1} + \underset{(0.14)}{0.01} \Delta E_{t-2} + \underset{(1.03)}{2.71} \Delta E_{t-3} - \underset{(0.14)}{0.03} \Delta OP_{t-1} + \underset{(0.17)}{2.40} \Delta OP_{t-2} - \underset{(0.09)}{0.01} \Delta OP_{t-3} + u_{1t}, & v_{t-1} \le -0.61 \\ \underset{(0.32)}{-0.77} - \underset{(0.55)}{1.28} v_{t-1} + \underset{(0.54)}{1.4} \Delta E_{t-1} + \underset{(0.12)}{0.08} \Delta E_{t-2} + \underset{(0.41)}{1.13} \Delta E_{t-3} - \underset{(0.07)}{0.03} \Delta OP_{t-1} + \underset{(0.35)}{0.17} \Delta OP_{t-2} - \underset{(0.05)}{0.04} \Delta OP_{t-3} + u_{2t}, & v_{t-1} > -0.61 \end{cases}$$

Appendix 3 (continued)

TVEC MODEL III: ESTIMATED TVEC MODEL FOR CURRENT ACCOUNT DEFICITS (CA) AND OIL PRICES (OP), AND EXCHANGE RATES (E) AND OIL PRICES (OP)

The estimated TVEC model for current account deficits (CA) and exchange rates (E) is:

$$\Delta CA_t = \begin{cases} \underset{(0.22)}{1.066} - \underset{(0.30)}{1.47} v_{t-1} + \underset{(0.21)}{0.099} \Delta CA_{t-1} - \underset{(0.38)}{1.01} \Delta CA_{t-2} + \underset{(0.22)}{0.3} \Delta E_{t-1} - \underset{(0.35)}{0.59} \Delta E_{t-2} + u_{1t}, & v_{t-1} \leq 0.75 \\ \underset{(0.47)}{0.35} - \underset{(0.37)}{0.62} v_{t-1} - \underset{(0.25)}{0.24} \Delta CA_{t-1} + \underset{(3.19)}{0.41} \Delta CA_{t-2} - \underset{(0.13)}{0.04} \Delta E_{t-1} - \underset{(4.64)}{13.16} \Delta E_{t-2} + u_{2t}, & v_{t-1} > 0.75 \end{cases}$$

$$\Delta E_t = \begin{cases} \underset{(0.01)}{0.006} - \underset{(0.01)}{0.009} v_{t-1} + \underset{(0.01)}{0.01} \Delta CA_{t-1} - \underset{(0.09)}{0.43} \Delta CA_{t-2} - \underset{(0.006)}{0.001} \Delta E_{t-1} - \underset{(0.08)}{0.52} \Delta E_{t-2} + u_{1t}, & v_{t-1} \leq 0.75 \\ \underset{(0.008)}{0.0168} - \underset{(0.007)}{0.017} v_{t-1} + \underset{(0.004)}{0.0087} \Delta CA_{t-1} - \underset{(0.13)}{0.41} \Delta CA_{t-2} + \underset{(0.003)}{0.004} \Delta E_{t-1} - \underset{(0.22)}{0.08} \Delta E_{t-2} + u_{2t}, & v_{t-1} > 0.75 \end{cases}$$

The estimated TVEC model for current account deficits (CA) and mortgage interest rates (M) is:

$$\Delta CA_t = \begin{cases} \underset{(0.14)}{1.07} - \underset{(0.18)}{1.29} v_{t-1} - \underset{(0.04)}{0.11} \Delta CA_{t-1} + \underset{(0.17)}{0.26} \Delta M_{t-1} + u_{1t}, & v_{t-1} \leq 0.84 \\ \underset{(0.19)}{0.63} - \underset{(0.21)}{0.71} v_{t-1} - \underset{(0.09)}{0.21} \Delta CA_{t-1} - \underset{(0.12)}{0.46} \Delta M_{t-1} + u_{2t}, & v_{t-1} > 0.84 \end{cases}$$

$$\Delta M_t = \begin{cases} \underset{(0.15)}{0.08} - \underset{(0.18)}{0.02} v_{t-1} + \underset{(0.10)}{0.22} \Delta CA_{t-1} - \underset{(0.30)}{0.02} \Delta M_{t-1} + u_{1t}, & v_{t-1} \leq 0.84 \\ \underset{(0.06)}{0.35} - \underset{(0.06)}{0.399} v_{t-1} + \underset{(0.03)}{0.16} \Delta CA_{t-1} - \underset{(0.06)}{0.15} \Delta M_{t-1} + u_{2t}, & v_{t-1} > 0.84 \end{cases}$$