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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

THE EFFECTS OF COMMODITIES DISTURBANCES ON OPEN ECONOMIES

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ECONOMICS

by

Richard Whittaker

2017

To: Dean John F. Stack, Jr.
Steven J. Green School of International and Public Affairs

This dissertation, written by Richard Whittaker, and entitled The Effects of Commodities Disturbances on Open Economies, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Laura De Carli

Brice Dupoyet

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Cem Karayalcin

Prasad Bidarkota, Major Professor

Date of Defense: February 24, 2017

The dissertation of Richard Whittaker is approved.

Dean John F. Stack, Jr.
Steven J. Green School of International and Public Affairs

Andres G. Gil
Vice President for Research and Economic Development
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Florida International University, 2017

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ABSTRACT OF THE DISSERTATION

THE EFFECTS OF COMMODITIES DISTURBANCES ON OPEN ECONOMIES

by

Richard Whittaker

Florida International University, 2017

Miami, Florida

Professor Prasad Bidarkota, Major Professor

This dissertation investigates the effects of commodity disturbances on underlying economies. The analysis conducted in this dissertation comprises of two main themes. The first is investigating which commodity disturbances affect a country's GDP. I examine twenty three OECD countries and nineteen primary commodities in the energy, metal, food and timber sectors using a New Keynesian model that was estimated using the DSGE method. It was found the oil disturbances and to a lesser extend natural gas were the only commodity disturbances that affect a country's GDP. Also, it was found that a country's openness plays an important role in shaping the response to these shocks. The second theme expands on these findings by analyzing the effects of oil and gas disturbances on Trinidad and Tobago by asking (1) How long are the effects from oil and gas disturbances on the economy? (2) How do the long-run effects from oil and gas disturbances differ within the economy? VECM and SVEC methods were used, and the results show that the effects from an oil disturbance are larger in magnitude and duration when compared to a gas disturbance. In addition, the effects of oil and gas disturbances had opposite movements on Trinidad and Tobago's CPI, interest rate, and narrow money velocity, whereas both disturbances were positively correlated in regards to Trinidad and Tobago's output and effective real exchange rate in the long-run.

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE PAGE

CHAPTER 1

PREFACE

My research agenda considers the importance of commodity disturbances on global investment decisions. When I am talking about investments, I am particularly focus on investments that are conducted by firms and governments in the area of energy sourcing, delivery and utilization. The question is do firms and governments make proactive investments in regards to commodity price movements. Does this even matter in the economy at all? Or do financial markets work efficiently to allocate the commodity risk to the appropriate parties such that key macro variables are unaffected. How long and large must be a fossil commodity disturbance before markets divest from their legacy infrastructure? What is needed that would permit renewable energy systems to dominate energy generated by fossil fuels and ultimately what is the optimal allocation of fossil and renewal infrastructure that maximizes growth within the global economy?

The goal of my research is to empirically estimate the importance of commodity disturbances on energy investment decisions by firms and governments, and how these decisions influence firms' specializations and countries' growth paths.

I started on this research agenda by understanding the composite makeup of commodity disturbances and their effects on underlying economies. To achieve this, I analyzed how commodity disturbances within the energy, metal, timber, and food sectors could affect a countrys GDP. I developed a Dynamic Stochastic General Equilibrium (DSGE) model. The model was estimated for twenty-three countries using nineteen primary commodities. It was found that petroleum and to a lesser extent natural gas shocks were the only commodity disturbances that were significant in affecting a countrys GDP.

I extended my findings by investigating the difference of oil and natural gas disturbances on the Trinidad and Tobago economy by addressing the following two questions: (1) How long are the effects from oil and gas disturbances on the economy? (2) How do the long-run effects from oil and gas disturbances differ within the economy? Trinidad and Tobago was the ideal candidate for this investigation due to its unique characteristics: it is a leading exporter in Liquefied Natural Gas (LNG), it has a well developed oil exploration and refinement infrastructure, and being a small island nation. This environment makes Trinidad and Tobago an ideal candidate to analyze the long-run effects from the oil and gas disturbances.

To understand the long-run effect, a Vector Error Correction Model (VECM) following the concept of the long-run dynamics of an economy presented in [GLHPS03] was estimated. To gain insight into the effects of transitory and permanent shocks, I utilized the Beveridge-Nelson moving average representation that I estimated with a Structural Vector Error Correction (SVEC) model. The key findings are that the effects from an oil disturbance are larger in magnitude and duration when compared to a gas disturbance. The duration of an oil disturbance lasted seven to nine quarters which is aligned with findings in the literature; whereas gas disturbance was fleeting after five to seven quarters. In addition, oil and gas disturbances were only positively correlated in regards to Trinidad and Tobago's GDP and effective real exchange rate in the long-run.

CHAPTER 2

SHOULD INVESTORS WORRY ABOUT COMMODITY SHOCKS?

2.1 Introduction

For the past two decades, key commodities have seen a dramatic change in their trade volumes. When comparing global trade percentages of revenues from 1990-1994 to 2010-2014 for twenty commodities shown in table 2, both export and import percentages have declined in the majority of the commodities. Only coal, iron-ore, natural gas, natural rubber, and petroleum have seen sizable increases in their percentage share of the global trade revenue. What is the outcome of these changes?

The objective in this chapter is to examine which commodity disturbances are significant in regards to a country's business cycle. This question is of great importance to policy makers who are concerned with stabilization of commodity price fluctuations. Reason being that, it can give policy makers some insights into the types of intervention instruments that are best suited in dealing with fluctuations of export revenues or import costs. This is of particular importance to small economies whose major source of revenue consists of one or two primary commodities [Dea92].

Recently, we have witnessed a rebalancing of the commodity boom of the early 2000's. In particular, petroleum has been on a roller coaster ride ever since the Great Recession of 2008. This has ignited an interest in the research community to investigate the underlying principles and importance of the commodity markets. The media's fall-man, the speculator, has been one area of interest to researchers. It has been shown by [BH11] and [FKM12] that speculators play no role in the price movements of crude oil prices. In a similar vein, [AM09] have analyzed the effect of oil shocks on international stock prices, and found that oil shocks do not play a major role in the price movements of international stock markets. On another front, researchers have been interested in understanding the composite makeup of oil shocks. It has been found that oil supply shocks affect the macroeconomy 5 quarters after their inception, and are persistent for 4 quarters. In addition, the magnitudes of oil supply shocks have ranged from -7% to 3% of global crude oil production [Kil08b].

The investigation undertaken here differs in the area of focus from the ones mentioned above. I took a similar approach as [BG07], by utilizing a New Keynesian Model. But instead of focusing on just the oil commodity, I expanded it to a commodity group that consists of nineteen primary commodities covering energy, metal, timber, rubber, cotton and food sectors. In a similar fashion as [MS05], who studied the effects of oil price shocks on the Chilean economy, I utilized a Dynamic Stochastic General Equilibrium(DSGE) model as the workhorse of the analysis. But, I extended this work by covering a larger array of countries, twenty three in total, with a longer time horizon.

A novelty in this chapter is the introduction of a commodity index within the DSGE model. The reason for introducing this commodity price index is that it acts as a proxy for a financial commodity market within the model. As shown in table 3, the commodity price index is negatively correlated with both the major interest rates of the United States and the global lending rates. Whereas, with respect to for inflation, the index is negatively correlated with most countries except the United Kingdom, India, and Australia. In regards to GDP, all countries in our study showed a positive correlation. An interesting finding was the effects of price movements from the index on trade volume. Most countries show a positive correlation. The only country that is negatively correlated in both export and import volume is the United Kingdom. Combining this finding with the United Kingdom's positive correlation in GDP, the commodity index may show insights on how the United

Kingdom internalizes demand. In addition, having a commodity index simplifies the investigation of the effects of price movements within the primary commodity groups that play a vital role in the global manufacturing supply chain. This is contrary to other investigations where researchers focus on one or two commodities, I believe that this method could be misleading in understanding the importance of commodity price movements in a global setting. The reason being that they lack the complex dynamics of the interdependence of the core commodities as they pertain to the global supply chain.

Since I am interested in addressing how a country's income relates to commodity activities, I utilized a cobb-douglas production function that partitions the production process into two sectors: commodity and non-commodity production. The commodity production sector covers all raw commodity production activities. Whereas, the non-commodity production sector focuses on remaining production, whose inputs are labor and raw commodities. By opting for this arrangement, I gain a finer granularity on how the income distribution and its effects play out within the economy. In addition, I assumed that all countries have the same technology. Hence, I have one global technology parameter. Second, I assumed that a country's labor force is flexible and mobile between its commodity and non-commodity sectors.

By focusing my attention on the following variables; namely, domestic output, domestic inflation, domestic interest rate, real exchange rate, nominal exchange rate, and CPI, I was able to investigate the interaction of different channels that the commodity shock dynamics utilized. I find the following interesting results: (1) Petroleum shocks were the only commodity shocks that were significant in affecting a country's output. (2) A country's openness plays an important role in shaping the dynamics of its output response initiated by a petroleum shock. (3) The effect of Petroleum disturbances on the economy settle within six to ten quarters. This is a surprising finding because, I was under the impression that the core metals would play a more dominant role in an economy. But it turned out neither copper, aluminum nor iron-ore displayed any significance.

The rest of the chapter is organized in the following manner. First, I present the underpinnings of the structural components of the small open economy model. Second, I cover the Data. Third, I focus on empirical analysis where I discuss the parameter calibrations, priors, shock decompositions, the openness relationship, and impulse response functions, and fourth conclude the chapter with closing statements.

2.1.1 Households

Each economy has a representative household who seeks to maximize their utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{Z_{1,t}^{1-\phi}}{1-\phi} - \frac{Z_{2,t}^{1-\zeta}}{1-\zeta} \right) \tag{2.1}$$

where $0 < \beta < 1$ is the household's discount factor, C_t represents household consumption with σ as the coefficient of relative risk aversion. Whereas, $Z_{1,t}$ denotes hours of labor in the commodity sector whose inverse elasticity is ϕ and $Z_{2,t}$ designates non-commodity hours of labor with its inverse elasticity represented by ζ. There is no restriction in a household supplying labor in both commodity and non-commodity sectors. To maximize its utility function, the household must account for its budget constraint.

$$\int_0^1 P_{H,t}(j)C_{H,t}(j)\,\mathrm{d}j + \int_0^1 \int_0^1 P_{i,t}(j)C_{i,t}(j)\,\mathrm{d}j\,\mathrm{d}i + E_t[Q_{t,t+1}D_{t+1}] \leq D_t + W_tN_t + T_t \tag{2.2}$$

Since the economies are open, each household's consumption can be comprised of domestic and foreign goods. The levels of domestic and foreign consumption are aggregated into a single consumption index represented by C_t. Within this consumption index, α represents the openness of an economy and η measures the elasticity of substitution between domestic and foreign goods.

$$C_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{2.3}$$

The consumption index is an aggregation of domestic consumption, $C_{H,t}$, and foreign consumption indices, $C_{F,t}$, which are both CES aggregators.

$$C_{H,t} = \left(\int_0^1 C_{H,t}(i)^{\frac{\epsilon-1}{\epsilon}}\,\mathrm{d}i\right)^{\frac{\epsilon}{\epsilon-1}} \qquad C_{F,t} = \left(\int_0^1 C_{F,t}(i)^{\frac{\epsilon-1}{\epsilon}}\,\mathrm{d}i\right)^{\frac{\epsilon}{\epsilon-1}}$$

The optimal allocation of domestic and foreign goods depends on the relative price level of each economy respectively. In addition, it depends on ϵ, which is the elasticity of substitution among goods.[1]

$$C_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} C_{H,t} \qquad C_{F,t}(i) = \left(\frac{P_{F,t}(i)}{P_{F,t}}\right)^{-\epsilon} C_{F,t}$$

Following the same reasoning, I can aggregate the entire demand for domestic and foreign goods for individual goods.

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \qquad C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t$$

The primary price level is represented by the CPI index that aggregates the domestic and foreign price index in a similar fashion as the consumption index. A key difference is that instead of having ϵ, I use η, which is the elasticity of substitution.

$$P_t \equiv \left[(1-\alpha) P_{H,t}^{\frac{\eta-1}{\eta}} + \alpha P_{F,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{2.4}$$

[1] The assumption that all households in all economies share the same ϵ is far from reality, but this is done to reduce the number of parameters within the model and to ease the mathematics in the market clearing condition.

$$P_{H,t} = \left(\int_0^1 P_{H,t}(i)^{\epsilon-1}\,\mathrm{d}i\right)^{\frac{1}{\epsilon-1}} \qquad P_{F,t} = \left(\int_0^1 P_{F,t}(i)^{\epsilon-1}\,\mathrm{d}i\right)^{\frac{1}{\epsilon-1}}$$

Having aggregated consumption, I rewrite the household's budget constraint into a more compact form. This eases both the notation, as well as, the solving of the household optimization problem.

$$P_t C_t + E_t[Q_{t,t+1} D_{t+1}] \leq D_t + W_{1,t} Z_{1,t} + W_{2,t} Z_{2,t} + T_t \tag{2.5}$$

The optimization of the household problem yields the following first order conditions. The first of these conditions is the relationship between the real wage of the commodity sector and the amount of commodity labor hours supplied by the household.

$$\frac{W_{1,t}}{P_t} = \frac{Z_{1,t}^{\phi}}{C_t^{-\sigma}} = Z_{1,t}^{\phi} C_t^{\sigma} \tag{2.6}$$

Log linearizing the equation

$$w_{1,t} - p_t = \phi z_{1,t} + \sigma c_t \tag{2.7}$$

The second condition is the relationship between the real wage of the non-commodity sector and the amount of non-commodity labor hours supplied by the household.

$$\frac{W_{2,t}}{P_t} = \frac{Z_{2,t}^{\zeta}}{C_t^{-\sigma}} = Z_{2,t}^{\zeta} C_t^{\sigma} \tag{2.8}$$

Log linearizing the equation

$$w_{2,t} - p_t = \zeta z_{2,t} + \sigma c_t \tag{2.9}$$

The last of the first order conditions is the intertemporal Euler equation that governs the consumption path of the household through time. Using the Euler equation in addition with the market clearing condition, I establish the IS curve in the coming subsections.

$$c_t = E_t[c_{t+1}] - \frac{1}{\sigma}(r_t - E_t[\pi_{t+1}] - \rho) \tag{2.10}$$

2.1.2 Firms

The firm's production function is of the Cobb-Douglas form, and it is a composite of the commodity and non-commodity production function. The exponent o represents the measure of commodity openness.

Production Function

$$Y_t = Y_{t,c}^{o} Y_{t,nc}^{1-o} \tag{2.11}$$

The idea is that a good is manufactured by both production in the commodity and the non-commodity sectors. For example, to manufacture an automobile the commodity sector produces oil and metals, and the non-commodity sector produces seats or tires for the car. Both sectors use raw commodity inputs, represented by $Z_{3,t}$, to produce their output.

$$Y_{t,c}^{o} = A_{t,c}^{o} Z_{1,t}^{\alpha_c o} Z_{3,t}^{(1-\alpha_c)o} \qquad Y_{t,nc}^{1-o} = A_{t,nc}^{1-o} Z_{2,t}^{\alpha_{nc}(1-o)} Z_{3,t}^{(1-\alpha_{nc})(1-o)}$$

I assume that both sectors have access to the same technology; therefore, $A_{t,c} = A_{t,nc}$, this assumption is a restriction of reality, but since I am not investigating the effects of technology on the volatility of GDP I find this restriction warranted.

$$Y_t = A_t Z_{1,t}^{\alpha_c o} Z_{2,t}^{\alpha_{nc}(1-o)} Z_{3,t}^{(1-\alpha_c)o+(1-\alpha_{nc})(1-o)} \tag{2.12}$$

To ease the notation we let $f = \alpha_c o$, $g = \alpha_{nc}(1-o)$ and $h = (1-\alpha_c)o+(1-\alpha_{nc})(1-o)$. Hence, the production function reduces to

$$Y_t = A_t, Z_{1,t}^f Z_{2,t}^g Z_{3,t}^h \tag{2.13}$$

Marginal Cost

The marginal cost plays a critical role in the development of the model. As I proceed, there will be multiple various derivations of the marginal cost. The first of these derivations relates the marginal cost to the frictional markup that is developed by monopolistic competition and the Calvo pricing dynamics. Defining the cost function as

$$COST_t = Y_t^{\frac{1}{m}} A_t^{\frac{-1}{m}} \left(\frac{W_{1,t}}{P_{H,t}}\right)^{\frac{f}{m}} \left(\frac{W_{2,t}}{P_{H,t}}\right)^{\frac{g}{m}} \left(\frac{W_{3,t}}{P_{H,t}}\right)^{\frac{h}{m}} f^{\frac{-f}{m}} g^{\frac{-g}{m}} h^{\frac{-h}{m}} (f+g+h) \tag{2.14}$$

where $m = f + g + h$. Since the marginal cost is the cost of producing one more unit holding all other inputs as constant, I take the derivative of the cost function with respect to output to obtain the marginal cost.

$$MC_t = \frac{1}{m} Y_t^{\frac{1-m}{m}} A_t^{\frac{-1}{m}} \left(\frac{W_{1,t}}{P_{H,t}}\right)^{\frac{f}{m}} \left(\frac{W_{2,t}}{P_{H,t}}\right)^{\frac{g}{m}} \left(\frac{W_{3,t}}{P_{H,t}}\right)^{\frac{h}{m}} f^{\frac{-f}{m}} g^{\frac{-g}{m}} h^{\frac{-h}{m}} (f+g+h) \tag{2.15}$$

Log linearizing the marginal cost function, I obtain

$$
\begin{aligned}
mc_t = &-Log(m) + \frac{1-m}{m}y_t - \frac{1}{m}a_t \\
&+ \frac{f}{m}(w_{1,t} - p_{H,t}) + \frac{g}{m}(w_{2,t} - p_{H,t}) + \frac{h}{m}(w_{3,t} - p_{H,t}) \\
&- \frac{f}{m}Log(f) - \frac{g}{m}Log(g) - \frac{h}{m}Log(h) + Log(f+g+h)
\end{aligned} \tag{2.16}
$$

Therefore, the marginal cost at time $t+k$ is denoted by

$$
\begin{aligned}
mc_{t+k} = &\frac{1-m}{m}y_{t+k} - \frac{1}{m}a_{t+k} + \frac{f}{m}(w_{1,t+k} - p_{H,t+k}) \\
&+ \frac{g}{m}(w_{2,t+k} - p_{H,t+k}) + \frac{h}{m}(w_{3,t+k} - p_{H,t+k})
\end{aligned} \tag{2.17}
$$

Since the firm must estimate its marginal cost in the future, giving the current information at time (t), I need a notation to convey this idea. This is precisely annotated by $mc_{t+k|t}$. Therefore, the difference between projected marginal cost and actual marginal cost at time, $t+k$, can be equated by

$$
mc_{t+k|t} - mc_{t+k} = \frac{1-m}{m}\left(y_{t+k|t} - y_{t+k}\right) \tag{2.18}
$$

Combining the goods market clearing condition with the demand equations, and log linearizing it gives a useful relationship.

$$
\begin{aligned}
Y_{t+k|t} &= \left(\frac{P_t^*}{P_{t+k}}\right)^{-\epsilon} Y_{t+k} \\
y_{t+k|t} &= -\epsilon(p_t^* - p_{t+k}) + y_{t+k} \\
y_{t+k|t} - y_{t+k} &= -\epsilon(p_t^* - p_{t+k})
\end{aligned} \tag{2.19}
$$

Plugging this into the above equation

$$
mc_{t+k|t} = mc_{t+k} + \frac{\epsilon(m-1)}{m}\left(p_t^* - p_{t+k}\right) \tag{2.20}
$$

Sticky Prices

The Calvo sticky pricing mechanism assumes that $(1-\theta)$ number of firms randomly choose to adjust their prices during a time period, and the remaining θ hold their prices fixed. When $\theta < 1$, I have the average duration of prices, which is given by

$$\sum_{k=0}^{\infty} \theta^k \to \frac{1}{1-\theta}.$$

Since there is price stickiness from the firms that do not adjust their prices, the aggregated pricing dynamics is represented by

$$P_t = \left[\theta P_{t-1}^{1-\epsilon} + (1-\theta)(P_t^*)^{1-\epsilon}\right]^{\frac{1}{1-\epsilon}} \tag{2.21}$$

Here P_t^* is a firm's newly set price and P_{t-1} is last period price. By log linearization around a zero inflation steady state ($\pi_t = 1$) the aggregated pricing dynamic is

$$\pi_t = (1-\theta)\left(p_t^* - p_{t-1}\right) \tag{2.22}$$

Since a firm is monopolistic it has pricing power over its pricing decisions. Its objective is to maximize its profits by taking into account the optimal price setting of its goods. By utilizing the discount factor and the demand equations, the firm's optimization problem becomes

$$\max_{P_t^*} \sum_{k=0}^{\infty} \theta^k E_t \left\{ \beta^k \left(\frac{C_{t+k}}{C_t}\right) \left(\frac{P_t}{P_{t+k}}\right) \left[P_t^* \left(\frac{P_t}{P_{t+k}}\right)^{-\epsilon} C_{t+k} - \Psi\left(\left(\frac{P_t^*}{P_{t+k}}\right)^{-\epsilon} C_{t+k} \right) \right] \right\} \tag{2.23}$$

After mathematical manipulation and log linearizing I have the optimal pricing equation of the firm.

$$p_t^* = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\left[\widehat{mc}_{t+k|t} + p_{t+k}\right] \tag{2.24}$$

This is done by using the fact that $\widehat{mc}_{t+k|t} = \widehat{mc}_{t+k} + \frac{\epsilon(m-1)}{m}\left(p_t^* - p_{t+k}\right)$ and letting $\Theta = \frac{m}{m+\epsilon(m-1)}$. We can link the firm's optimal pricing equation to the New Keynesian Phillips Curve (NKPC) by subtracting p_{t-1} and substituting for $\widehat{mc}_{t+k|t}$ in equation (2.24)

$$p_t^* - p_{t-1} = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t\left[\Theta\widehat{mc}_{t+k} + p_{t+k} - p_{t-1}\right] \tag{2.25}$$

This can be further simplified to

$$p_t^* - p_{t-1} = (\beta\theta)\, E_t[p_{t+1}^* - p_t] + (1-\beta\theta)\Theta\widehat{mc}_t + \pi_t \tag{2.26}$$

Combining this with the linearized aggregate price index $\pi_t = (1-\theta)(p_t^* - p_{t1})$, I finally derive the New Keynesian Phillips Curve (NKPC)

$$\pi_t = \beta E_t[\pi_{t+1}] + \lambda\widehat{mc}_t \tag{2.27}$$

where $\lambda \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}\Theta = \frac{(1-\theta)(1-\beta\theta)}{\theta}\frac{m}{m+\epsilon(m-1)}$. With the NKPC in hand, we can now link this equation to the output gap that governs the business cycle. By deriving the log linearized marginal cost from utilizing the first order conditions of both the household and firm problem we have a useful marginal cost equation that is a function of the output gap.

$$\widehat{mc}_t = \Omega\widetilde{y}_t \tag{2.28}$$

Let $\kappa_\alpha = \lambda\Omega$ to ease the notation. Hence, I derive the desired equation.

$$\pi_t = \beta E_t[\pi_{t+1}] + \kappa_\alpha \widetilde{y}_t \tag{2.29}$$

2.1.3 Term of Trade, CPI and PPI

To be able to establish equilibrium conditions within the paper I must institute some key definitions. I will define the Bilateral Terms of Trade and the Effective Terms of Trade. By having these definitions in addition to the CPI, I can illustrate the relationship between Producer Price Inflation (PPI) and Consumption Price Inflation.

The Bilateral Terms of Trade is the price of country's i goods in terms of domestic goods. It is a measurement that compares country's i good prices to the domestic prices.

$$S_t \equiv \frac{P_{i,t}}{P_{H,t}} \tag{2.30}$$

Since I am in a global environment with more than one country, I would like to have a similar definition as the bilateral terms of trade in a global sense. Hence, I define the Effective Terms of Trade as the aggregate Bilateral Terms of Trade. This provides inroads into the linkage of producer price inflation to consumption price inflation.

$$S_t \equiv \frac{P_{F,t}}{P_{H,t}} = \left(\int_0^1 S_{i,t}^{1-\gamma} di \right)^{\frac{1}{1-\gamma}} \tag{2.31}$$

The log linearized Effective Terms of Trade is given by

$$s_t = log(S_t) = p_{F,t} - p_{H,t} = \int_0^1 s_{i,t}\, di \tag{2.32}$$

By using the Consumer Price Index (CPI) equation, (2.4), in addition with the Effective Terms of Trade equations I can establish a relationship between domestic and consumer price levels.

$$p_t = p_{H,t} + \alpha\, s_t \tag{2.33}$$

Therefore, the Consumer Price Inflation can be represented by the Producer Price Inflation, the percentage change of the Effective Terms of Trade and the level of openness of the domestic economy.

$$\pi_t = \pi_{H,t} + \alpha \Delta s_t \tag{2.34}$$

Since I take the domestic economy as a small economy that has no influence in a global setting, I take the global economy as a closed economy. Hence $\alpha = 0$, and therefore the world's CPI inflation equals foreign inflation.

$$\pi_t = \pi^*_{F,t} \tag{2.35}$$

2.1.4 The Law of One Price and Real Exchange Rate

Having established a connection between price levels and the terms of trade in the previous section, I extend the relationship of the Effective Terms of Trade with the nominal exchange rate, foreign and domestic price levels and the effective real exchange rate. In this model, I assume no transport or shipping cost for individual goods. I also assume that there is a sufficient level of market arbitrage to permit the Law of One Price (LOOP) to hold for an individual good. The LOOP relationship is represented by

$$P_{i,t}(j) = \xi_{i,t} P^{i}_{i,t}(j) \ \ \forall i, j \in [0,1] \tag{2.36}$$

where $\xi_{i,t}$ represents the bilateral nominal exchange rate, and $P_i(j)$ represents the price of a country's i, good j is expressed in terms of country's i currency.

Since this must hold for all countries, I take the effective nominal exchange rate and the country's i Producer Price Index measured, in the country's i currency, to establish the Producer Price Index.

$$P_{i,t} = \xi_{i,t} P^{i}_{i,t} \ \ \forall i, j \in [0,1] \quad where \quad P^{i}_{i,t} \equiv \left(\int_0^1 P^{i}_{i,t}(j)^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}} \tag{2.37}$$

By log linearizing equation (2.37) and noting that the foreign price level is the summation of all the countries' Producer Price Index, I have the following useful relationship

$$\begin{aligned} p_{i,t} &= e_{i,t} + p^{i}_{i,t} \\ p_{F,t} = \int_0^1 p_{i,t} di &= \int_0^1 (e_{i,t} + p^{i}_{i,t}) di = e_t + p^*_t \end{aligned} \tag{2.38}$$

where e_t is the log effective nominal exchange rate and p^*_t is the log world price index. Using equation (2.32), I see that the terms of trade is related to the log effective nominal exchange and the difference of both global and domestic price levels.

$$\begin{aligned} p_{F,t} &= e_t + p^*_t \\ s_t + p_{H,t} &= e_t + p^*_t \\ s_t &= e_t + p^*_t - p_{H,t} \end{aligned} \tag{2.39}$$

Since the small domestic economy does not affect price levels in the global setting, I assume that the world's consumer and producer prices are the same.

The nominal exchange rate depends on price dynamics. So, I would like to have an exchange rate that removes the price movements from the exchange rate. From this, the effective real exchange rate is selected, it is defined as the ratio of country i and its domestic consumption price indices, expressed in the domestic currency

$$\mathcal{Q}_{i,t} \equiv \frac{\xi_{i,t} P_t^i}{P_t} \tag{2.40}$$

Taking the log and using equation (2.39), I have that the log effective real exchange rate is proportional to the terms of trade. The level of this proportionality depends on the level of openness of the economy.

$$q_t = (1 - \alpha)s_t \tag{2.41}$$

2.1.5 International Risk Sharing

I define the one period discount bond as

$$E_[Q_{t,t+1}] \equiv Q_t = \beta E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \right] \tag{2.42}$$

Since, I assume to have an international bond market, households in other countries have the same condition as (2.42). This is possible through the use of the nominal exchange rate. Therefore, I have the bilateral risk sharing condition.

$$Q_t = \beta E_t \left[\left(\frac{C_{t+1}^i}{C_t^i} \right)^{-\sigma} \left(\frac{P_t^i}{P_{t+1}^i} \right) \left(\frac{\xi_t^i}{\xi_{t+1}^i} \right) \right] \tag{2.43}$$

Using the equation (2.40), I simplify the bilateral risk sharing condition.

$$C_t = \upsilon_i C_t^i \mathcal{Q}_{i,t}^{\frac{1}{\sigma}} \tag{2.44}$$

Since υ_i is an initial condition dependent, I choose the convenient value, $\upsilon_i = 1$, to ease the mathematics.

$$C_t = C_t^i \mathcal{Q}_{i,t}^{\frac{1}{\sigma}} \tag{2.45}$$

By log linearizing the consumption equation and noting that the small open economy bears no weight on the aggregate world consumption, I arrive at

$$c_t^* \equiv \int_0^1 c_t^i \, di \tag{2.46}$$

which is the log index of world consumption. Using the fact that the effective exchange rate is related to the terms of trade by equation (2.41), I link the domestic consumption to the foreign (world) consumption and the terms of trade.

$$c_t = c_t^* + \frac{1-\alpha}{\sigma} s_t \tag{2.47}$$

2.1.6 Market Clearing Conditions

To establish the model's equilibrium I need to have the market clearing conditions. In a simplistic view, the model consists of a domestic and global economy both of which have a different market clearing condition. The primary reason, as stated earlier, is that the small open economy does not have any affect on the global economy. Also, I assume the model as symmetric and the aggregate of all terms of trade is equal to zero. This presents the situation that global output is equal to global consumption. This is a key difference between the domestic and global market clearing conditions.

Since the small open economy trades its goods with the rest of the world, its output equals domestic consumption plus consumption from the world. On an individual good (i) basis this can be represented by

$$\begin{aligned} Y_t(i) &= C_{H,t}(i) + C^*_{H,t}(i) \\ &= C_{H,t}(i) + \int_0^1 C^j_{H,t}(i)\, dj \end{aligned} \tag{2.48}$$

Using the demand equations, I can rewrite the output in its full representation. The key parameters that are present are α: the level of openness of the economy, ϵ: the elasticity substitution between goods in a category and η: the elasticity of substitution between domestic and foreign goods. The other parameter α^*, in addition with, Y^*_t represents the percentage of consumption that a foreign country consumes out of its output from the small open economy.

$$Y_t(i) = (1-\alpha)\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon}\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \int_0^1 \left(\frac{P^j_{F,t}(i)}{P^j_{F,t}}\right)^{-\epsilon}\left(\frac{P^j_{F,t}}{P^j_t}\right)^{-\eta} \alpha^* Y^* dj \tag{2.49}$$

Since I have assumed that LOOP holds for all goods that are produced domestically, I can aggregate the demand for domestic goods into a simple equation. It shows that domestic output depends on Global output, terms of trade, and the effective exchange rate. Taking a closer look at the parameters, it can be noticed that the key parameters are majority household parameters. The only parameter that is not under the control of the household is α, which represents the openness of the economy. This gives the importance the household has in international trade.

$$Y_t = \upsilon Y_t^* S_t^\eta \left[(1-\alpha)\mathcal{Q}_t^{\frac{1}{\sigma}-\eta} + \alpha \right] \tag{2.50}$$

Since the equation is nonlinear, I take the first order taylor approximation of the equation at the steady-state. Doing so establishes a linear relationship between domestic output with global output and terms of trade. Where $\omega_\alpha = 1 + \alpha(2 - \alpha)(\sigma\eta - 1)$.

$$y_t \approx y_t^* + \frac{\omega_\alpha}{\sigma} s_t \tag{2.51}$$

By letting $\Phi_\alpha = \frac{1-\alpha}{\omega_\alpha}$ in addition with equation (2.47) and $y_t^* = c_t^*$, I derive at a convenient equation illustrating that domestic consumption is the ratio of domestic production plus the ratio of global production. This equation is convenient because it's well-suited to be plugged into the household's Euler equation.

$$c_t = \Phi_\alpha y_t + (1 - \Phi_\alpha) y_t^* \tag{2.52}$$

By substituting (2.60) into the household's Euler equation (2.10), I establish the IS curve. It illustrates that domestic output is governed by the expected future domestic output, the expected difference of the global economy output, and the expected real domestic interest rate.

$$y_t = E_t[y_{t+1}] + (\omega_\alpha - 1)\, E_t[\Delta y_{t+1}^*] - \frac{\omega_\alpha}{\sigma}(r_t - E_t[\pi_{H,t+1}] - \rho) \tag{2.53}$$

It must be noted that the domestic IS curve depends on domestic real interest. In the derivation of the IS curve, I start with global inflation and rewrite the equation in terms of domestic inflation. This is a subtle point that can be easily overlooked.

To build the IS for the global economy is simple because I have $y_t^* = c_t^*$. This is due to the assumption of symmetry in the terms of trade within the model. Hence equation (2.47),

$$\begin{aligned} y_t^* &= \int_0^1 = c_t^i \, di = c_t^* + \int_0^1 \frac{1-\alpha}{\sigma} s_t^i \, di \\ y_t^* &= \int_0^1 = c_t^i \, di = c_t^* + 0 \\ y_t^* &= c_t^* \end{aligned} \tag{2.54}$$

Using this fact, I have that the global IS curve is represented by

$$y_t^* = E_t[y_{t+1}^*] - \frac{1}{\sigma}(r_t^* - E_t[\pi_{t+1}^*] - \rho) \tag{2.55}$$

Because I am interested in displaying these equations (2.53) (2.55) in terms of domestic and global output gaps, I rewrite the equation using the output gap

$$\widetilde{y}_t = E_t[\Delta\widetilde{y}_{t+1}] - \frac{\omega_\alpha}{\sigma}(r_t - E_t[\pi_{H,t+1}] - r_{n,t}) \tag{2.56}$$

where $r_{n,t} = \rho + \frac{\sigma}{\omega_\alpha} E_t[\Gamma_a \Delta a_{t+1}] + \frac{\sigma}{\omega_\alpha} E_t[\Gamma_{w_3} \Delta w_{3,t+1}] + \frac{\sigma(\omega_\alpha + \Gamma_{y^*} - 1)}{\omega_\alpha} E_t\left[\Delta y_{t+1}^*\right]$ is the natural domestic rate of interest. The global IS curve in terms of global output gap is represented by

$$\widetilde{y}_t^* = E_t[\Delta\widetilde{y}_{t+1}^*] - \frac{1}{\sigma}(r_t^* - E_t[\pi_{t+1}] - r_{n,t}^*) \tag{2.57}$$

where $r_{n,t}^* = \rho + \sigma E_t[\Gamma_a^* \Delta a_{t+1}^*] + \sigma E_t[\Gamma_{w_3^*} \Delta w_{3,t+1}^*]$ is the natural global rate of interest.

By looking at the two natural rates of interest it becomes apparent that the domestic economy is affected by the external factors that manifest themselves from global output changes and commodity price movements. Once again, since the domestic economy is considered small it does not have any affect on the global stage. As a result, the natural rate of interest in a global context is not affected by domestic affairs. The global natural rate of interest dynamics adheres to the movements of global technology innovations and commodity price movements, as shown above.

2.1.7 Policy Mechanism

For a policy mechanism that permits control over the nominal interest rate, I have chosen to utilize a simple taylor rule. This mechanism could easily be interchanged for CPI targeting or exchange rate peg mechanism, but I am not investigating these situations. The taylor rule comprises of the following

$$r_t = r_{n,t} + \phi_\pi \pi_{H,t} + \sigma_y \widetilde{y}_t \tag{2.58}$$

2.1.8 Commodity Input Index

I established a commodity index that represents the cost of key manufacturing input commodities. This index is designed to serve as a proxy for a commodity price index that is independent of any particular economy. Primarily, the commodity index is made up of nineteen commodities that are categorized into the following categories: energy, metals and agriculture. Each commodity in the index is governed by AR(1) process, which represents the dynamics of price movements in the underlying commodity. The commodity index is given by

$$
\begin{aligned}
w_{3,t} = {} & petroleum_{weight}\ petroleum_t + coal_{weight}\ coal_t + naturalgas_{weight}\ naturalgas_t \\
& + ironOre_{weight}\ ironore_t + copper_{weight}\ copper_t + aluminum_{weight}\ aluminum_t \\
& + zinc_{weight}\ zinc_t + tin_{weight}\ tin_t + timber_{weight}\ timber_t + cotton_{weight}\ cotton_t \\
& + naturalrubber_{weight}\ rubber_t + wheat_{weight}\ wheat_t + beef_{weight}\ beef_t \\
& + maize_{weight}\ maize_t + sugar_{weight}\ sugar_t + rice_{weight}\ rice_t + cocoa_{weight}\ cocoa_t \\
& + coffee_{weight}\ coffee_t + tobacco_{weight}\ tobacco_t
\end{aligned} \tag{2.59}
$$

Having set up the commodity index in the following fashion permits me to analyze how the shock of a particular commodity affects both the domestic and global economies. Knowing how disturbances in the commodity markets could affect an underlying economy would be of particular interest to policymakers and speculators.

$$
\begin{aligned}
petroleum_t &= \rho_{petroleum} * petroleum_{t-1} + \epsilon_{petroleum,t} \\
coal_t &= \rho_{coal} * coal_{t-1} + \epsilon_{coal,t} \\
naturalgas_t &= \rho_{naturalgas} * naturalgas_{t-1} + \epsilon_{naturalgas,t} \\
ironore_t &= \rho_{ironore} * ironore_{t-1} + \epsilon_{ironore,t} \\
copper_t &= \rho_{copper} * copper_{t-1} + \epsilon_{copper,t} \\
aluminum_t &= \rho_{aluminum} * aluminum_{t-1} + \epsilon_{aluminum,t} \\
zinc_t &= \rho_{zinc} * zinc_{t-1} + \epsilon_{zinc,t} \\
tin_t &= \rho_{tin} * tin_{t-1} + \epsilon_{tin,t} \\
timber_t &= \rho_{timber} * timber_{t-1} + \epsilon_{timber,t} \\
cotton_t &= \rho_{cotton} * cotton_{t-1} + \epsilon_{cotton,t} \qquad (2.60) \\
rubber_t &= \rho_{rubber} * rubber_{t-1} + \epsilon_{rubber,t} \\
wheat_t &= \rho_{wheat} * wheat_{t-1} + \epsilon_{wheat,t} \\
beef_t &= \rho_{beef} * beef_{t-1} + \epsilon_{beef,t} \\
maize_t &= \rho_{maize} * maize_{t-1} + \epsilon_{maize,t} \\
sugar_t &= \rho_{sugar} * sugar_{t-1} + \epsilon_{sugar,t} \\
rice_t &= \rho_{rice} * rice_{t-1} + \epsilon_{rice,t} \\
coffee_t &= \rho_{coffee} * coffee_{t-1} + \epsilon_{coffee,t} \\
cocoa_t &= \rho_{cocoa} * cocoa_{t-1} + \epsilon_{cocoa,t} \\
tobacco_t &= \rho_{tobacco} * tobacco_{t-1} + \epsilon_{tobacco,t}
\end{aligned}
$$

The pricing dynamics of each commodity is based on a simple AR(1) process that does not have any correlation with other commodity price movements. This may seem unrealistic, but I wish to start from a simple reference point to ensure consistency within the model. In the future, I will develop a more robust index that addresses this non-correlation issue.

2.2 The Data

The model was estimated at a quarterly frequency, although I utilized monthly, quarterly and annual data when I estimated the model. The data was sourced from the OECD, the Worldbank and the United Nations Comtrade database. I estimated the model's parameters using Dynare where I applied twenty-five time series in total such that two time series were used for the global economy, another four for the domestic economy, and the remaining nineteen for the commodity index.

The data covers the time frame from 1990 to 2014. I opted for this time span for two reasons. First, I wished to have a time frame where the global trade pattern is stable. Post 1989 , global trade connectivity became more diversified [REH+12], and this resulted in a shift in the international trade pattern. This shift resulted in different pricing dynamics within the non-commodity and commodity sectors. Second, I was interested in having a time frame that included global rebalancing within the commodity sector, which was evident in the 2008 downturn.

For my main domestic and global economic variables, I used OECD data. For the global economy output (y_t^*), I used the annual per capita total OECD GDP series. In addition, for the global economy inflation variable (π_t^*), I employed the Total OECD CPI data at quarterly frequency and whose values are given in terms of the annual growth rate. For the domestic GDP variable (y_t), I used the annual per capita GDP for each country in the panel. For the domestic CPI variable (p_t), I used CPI quarterly, and Total OECD CPI, its values are in terms of the annual growth rate. The last two domestic variables comprised of hours worked (h_t), and nominal interest (r_t). The hours worked series is the total annual hours worked per worker. For a proxy of the nominal interest rate, I deployed the short-term Interest Rate between Financial Institutions series in quarterly frequency whose values are given per annum. Before mapping the empirical data to the model, we preprocessed the data following the procedures outlined in [Pfe13].

To construct the commodity index, I utilized both the Worldbank's Commodity Pink Sheet and the United Nations' Comtrade data. We constructed the commodity index by using [Rad08] list of primary commodities following SITC REV 1 codes: Petroleum (33), Cotton (2631), Natural gas (341), Natural Rubber (2311), Hard Coal (3214 + 3215), Wheat (041), Iron-Ore (2813), Beef (0111), Copper (2831 + 6821), Maize (044), Aluminum (2833 + 6841), Sugar (0611 + 0612), Zinc (2835 + 6861), Coffee (0711), Tin (2836 + 6871), Cocoa (072), Rice (042), Timber (24), Tobacco (2835 + 6861). We model each commodity pricing dynamics as an AR(1) process. To make this possible we relied on the Worldbank's Commodity Pink Sheet data in monthly frequency ranging from 1990:M1 to 2014:M12. In addition the commodity index's weights for each commodity were calculated by adding the imports and exports trade values of the commodity and then dividing it by the total trade value durning the time frame of 1990 to 2014.

2.3 Empirical Analysis

2.3.1 Calibrated Parameter

I calibrated the following forty five parameters: the global Taylor rule paramaters ϕ_r^*, ϕ_π^*, ϕ_y^*, $\rho_{r,f}$, $\rho_{\pi,f}$; the temporal discount factor (β); the technology persistence (ρ_a); and the nineteen commodity index persistence and the nineteen commodity index weights parameters. I opted to calibrate each of the global Taylor rule parameters because each economy within the panel is considered to be small and non-influential in a global setting. If I had estimated the global Taylor rule parameters, I would have obtained different estimates for each country. This would have resulted in the small economy having an influence on the global economy. Instead, I ran preliminary estimations of the global Taylor rule parameters and averaged them to obtain our calibration values: $\phi_r^* = 1.0$, $\phi_\pi^* = 1.9$, $\phi_y^* = 0.9$, $\rho_{r,f} = 0.657$, $\rho_{\pi,f} = 0.101$. In addition, I set the temporal discount factor, $\beta = 0.99$, and the technology persistence parameter to $\rho_a = 0.9$. These values are well established within the literature.

2.3.2 Parameter Priors

For the twenty-three countries, I estimated the following twenty parameters: domestic Taylor rule nominal interest (ϕ_r), domestic Taylor rule inflation (ϕ_π), domestic Taylor rule output, (ϕ_y), commodity share, (cs), elasticity of substitution between domestic and foreign goods, (η), within sector substitution, (ϵ), intertemporal consumption elasticity, (σ), Calvo price change probability, (θ), commodity labour disutility, (ϕ), non-commodity labour disutility, (ζ), output elasticity of commodity labor, (α_c), output elasticity of non-commodity labor, (α_{nc}), domestic interest rate shock persistence, ($\rho_{r,d}$), domestic inflation shock persistence, ($\rho_{\pi,d}$), domestic interest rate shock, ($e_{r,d}$), domestic inflation shock, $e_{\pi,d}$), commodity labor shock persistence, ($\rho_{z1,d}$), non-commodity labor shock persistence, ($\rho_{z2,d}$), commodity labor shock, ($e_{z1,d}$), and non-commodity labor shock ($e_{z2,d}$).

I utilized three types of prior distributions for our priors, namely, the inverse gamma and the normal distribution. For the domestic reaction function parameters, I used normal distributions for each parameter and set their initial values in proximity to their global Taylor rule counterparts. Hence, I set the domestic Taylor rule nominal interest, $\phi_r = 1.0$ with a variance to 0.1. For the Taylor rule inflation parameter, it is common to have a stronger response to inflationary events. Therefore, I followed suit by setting the initial domestic Taylor rule inflation parameter to $\phi_\pi = 1.7$ with a variance of 0.25. Lastly, I set the prior value of the domestic Taylor rule output parameter $\phi_y = 0.5$ and its variance to 0.1.

The preliminary crude analysis that conducted using Comtrade data showed the set of country cs parameters to be in the range of 0.11-0.63. For the commodity share (cs), I therefore selected beta prior with mean of 0.40 and variance of 0.1. T For the elasticity of substitution between domestic and foreign goods, (η), I used a beta prior with mean of 1.0 and variance of 0.1. When selecting this prior, I wish to have a starting point such that domestic and foreign goods would trade in a one to one ratio. I linked the within sector substitution parameter (ϵ) to the markup in order to establish the mean of the beta prior, which I set to 5.0 resulting in a markup of 25%. This may seem as a high markup at first when compared to [KK13], who found that the gross markup on Canada's oil prices range 2.2% in 1992 and 6.6% in 2005 with added-value markup ranging in the 12% mark. In a study investigating Italian manufacturing markups using data from 1970 - 1995, [Mar02] found the following markups: Ferrous and non-ferrous ores and metal 8%, timber and furniture 27%, and rubber and plastic product 29%. In addition, the investigation on food markups [Hei80] found that beef, rice and sugar have a retail to wholesale markup of around 57%. Since our commodity index is composed of all the core commodities stated above and whose markups vary greatly, I took the middle ground by settling on a markup prior of 25%.

For the intertemporal consumption elasticity (σ), I chose a beta prior with mean of 1.0 and variance of 0.1. The reason being that I wished for the household savings decision to move in a one to one fashion with the interest rate from the onset. It has been shown by [EF07] that the Calvo price change probability (θ), can have a range of $[0.57 - 0.97]$. For our initial prior value for Calvo price change probability, I choose a mean of $\theta = 0.71$ with a variance of 0.05. This initial value states that firms on average re-optimize their prices every 3.4 quarters. For the commodity labour disutility (ϕ), non-commodity labour disutility (ζ), output elasticity of commodity labor (α_c), and output elasticity of non-commodity labor (α_{nc}), I had little knowledge but expected that the values needed to be positive. I chose a beta prior distribution with a mean of 1.0 and variance of 0.1 for these parameters. Our knowledge of the shock persistence parameters and shock was limited, and so we ended choosing a beta prior distribution with a mean 0.85 and variance of 0.1 for the persistence parameter. For the shock distributions, we followed the standard convention by choosing inverse gamma distribution.

2.3.3 Parameter Estimations

I estimated the parameters' posterior modes for each of the twenty three countries. The results are shown in Table 4. In this section, I use the average of the point estimates shown in Table 4. The average of the domestic Taylor rule inflation parameter is 2.7948 with a standard deviation of 0.045. This shows that the countries' central banks have strong inflationary responses. This is especially true for Japan which had the maximum value for the inflation response parameter with a value of 3.262. It is surprising because Japan has had a mostly negative CPI inflation since 1998. This may support the finding of [Car01], which hints that the Central Bank of Japan for the past two decades has been too restrictive in its monetary policies.

The elasticity of substitution between domestic and foreign goods (η), can be viewed as a proxy for barriers to trade or home bias preferences [OR01]. The range for $\eta \in [-1, \infty)$. When $\eta = -1$, I have perfect substitutability, which implies the simplistic abstraction that there are no barriers to trade or home bias. Whereas,

$\eta = \infty$ I have a perfect complement condition, and it illustrates that there is some type of trade or preference restriction. We selected to use a prior of $\eta = 1$, which implies a constant elasticity of substitution. Upon estimation we found on average that η took an average value of 1.354 with a standard deviation of 0.168. The highest value came from Australia with a value of 1.650. The lowest value was the United States whose elasticity of substitution between domestic and foreign goods was 1.080. Since I used macro data, the values can be compared to the findings of [CD02], who found the elasticity of substitution to range from 1.5 - 2.

The intertemporal consumption elasticity (σ) parameter gives an insight to how the household consumption growth rate relates to the real interest rate. The average estimates of $\sigma = 0.4939$ and has a range from 0.4556 - 0.8701. This reveals that the households are very sensitive to interest rate movements. The findings are in accordance with [HHIR15], whose study of 104 countries' intertemporal consumption elasticity, that found on average the value to be 0.5.

The estimates reveal that firms set their prices an average every 3.07 quarters. The slowest price setting country was Switzerland, which had a price setting period of 4.18 quarters, and fastest was the United States, which reset price every 1.73 quarters.

2.3.4 Variance Decompositions

It is important to have an understanding of the variance decomposition of endogenous variables within the model. What we were particularly interested in was to see if any commodity shocks had any significance in an endogenous variable's variance decomposition. We elected to calculate the variance decomposition of the following endogenous variables: domestic output, domestic inflation, domestic interest rate, CPI, real exchange rate and nominal exchange rate. The results for each country in the panel are shown in tables 6 - 13. In addition, I have calculated for each country the conditional variance decomposition for following quarters: 1, 4, 12, 20, 40, 80, 120. We illustrated the variance dynamics in figures 3-8. I have truncated the conditional variance decomposition graphs to the period where the dynamics had settled down.

For the domestic output, table 6, I saw that for all countries a technology shock accounted for more than 90% of the variance. Whereas, the only commodity shock that contributed in any significant amount to domestic output deviations was a petroleum shock. A petroleum shock seemed to have the greatest effect on the United States, Japan and Australia which accounted for 0.21%, 0.22% and 0.21% in the variance decomposition of domestic output, respectively. The remaining countries report that petroleum shocks contributed to the variance decomposition in the range of [0.04%, 0.13%]. We did notice a minuscule variance signal for a natural gas shock of 0.01% for United States, Japan and Australia with the remaining countries having a flat reading. It was shown in figure 2.1, that a petroleum shock contribution settled within 12 quarters. Whereas, the natural gas shock effects settled within 7 quarters for Japan and Australia and 12 quarters for United States.

I was surprised to find that the only commodity that registered in contributing to the variance of domestic inflation was a petroleum shock (see table 7), and this contribution was quite weak at best. A petroleum shock only contributed at its maximum 0.03%, and this was for Japan. The petroleum shock dynamics were quite fleeting also and were absorbed instantaneously for most countries and within two to three quarters for Japan.

I found that the petroleum shocks were relevant in the deviations of the domestic interest rate, and this significance was increasing with the openness of a country. As

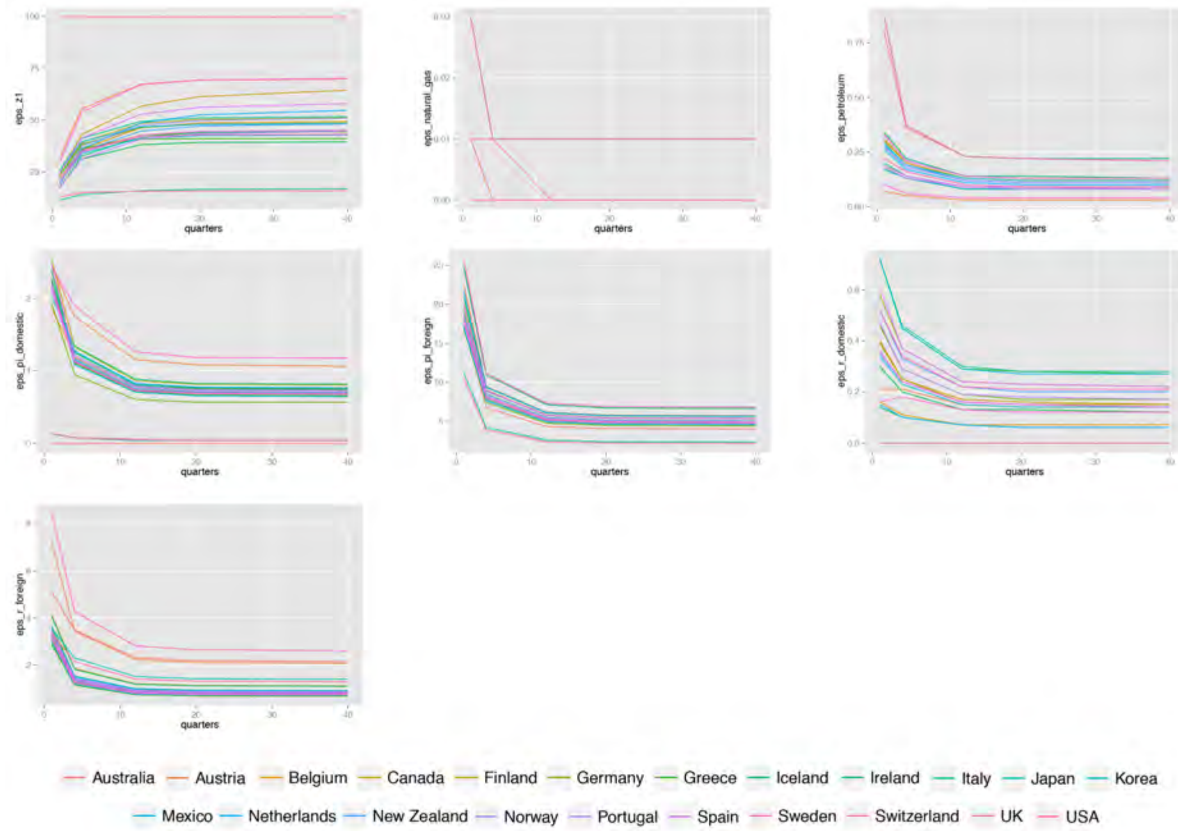

Figure 2.1: Conditional Variance Decomposition of Domestic Output

shown in table 8, a petroleum shock at its maximum accounted for as much as 32.04% in the variance decomposition of the domestic interest rate for Ireland. For most countries, besides United States, Japan and Australia, a petroleum shock reported more than 3.7% of the deviation. Hence, it would be prudent for policymakers to monitor petroleum price movements if they wish to conduct effective interest rate policies. This is especially true for the following countries: Netherlands, Belgium and Ireland. For all these countries, a petroleum shock had registered more than 23% of the deviation of domestic interest rate. Also, coal and natural gas have shown some relevance, especially for the more open countries. At their maximum, coal and natural gas had accounted for 0.13% and 0.191% in the variance decomposition, respectively. I found that it took an average of 4 quarters for a petroleum shock to reach its maximal effects on the domestic interest rate.

Investigating the CPI, I found that there were no commodities that played an important role in its variance decomposition. The CPI variance depends mainly on the domestic interest rate and inflation shocks, foreign inflation shock and technology shock.

The only commodity that was relevant for the real exchange rate was petroleum. This is shown in table 10. A petroleum shock did not have much of an effect on the real exchange rate. At its maximum value, a petroleum shock accounted for 0.03% of the variance in the real exchange rate, and the effects from a petroleum shock are simultaneously induced. There were three countries where petroleum shock effects took multiple quarters to settle.

The last of our endogenous variables, the nominal exchange rate, has shown that only petroleum shocks contributed to four countries' nominal exchange rate variance. They were the United States, Japan, Australia and Ireland. Each country registered a petroleum shock variance decomposition value of 0.01%. This value is minuscule in magnitude; hence, I have taken the position that for all countries nominal exchange rate is independent of all commodity shocks.

2.3.5 Country's Openness Relationships

Each country's openness parameter relates to key domestic variables. In addition, I inspected which shocks played a key role in these relationships. As shown in Figure 2.2, as the openness of a country increased, the role of a technology shock decreased slightly, but it still accounted for at least 90% of the composition in domestic output. Also, the foreign inflation shock became more relevant as openness increased. I did not see a crucial role for petroleum shocks on output throughout the range of the openness parameter.

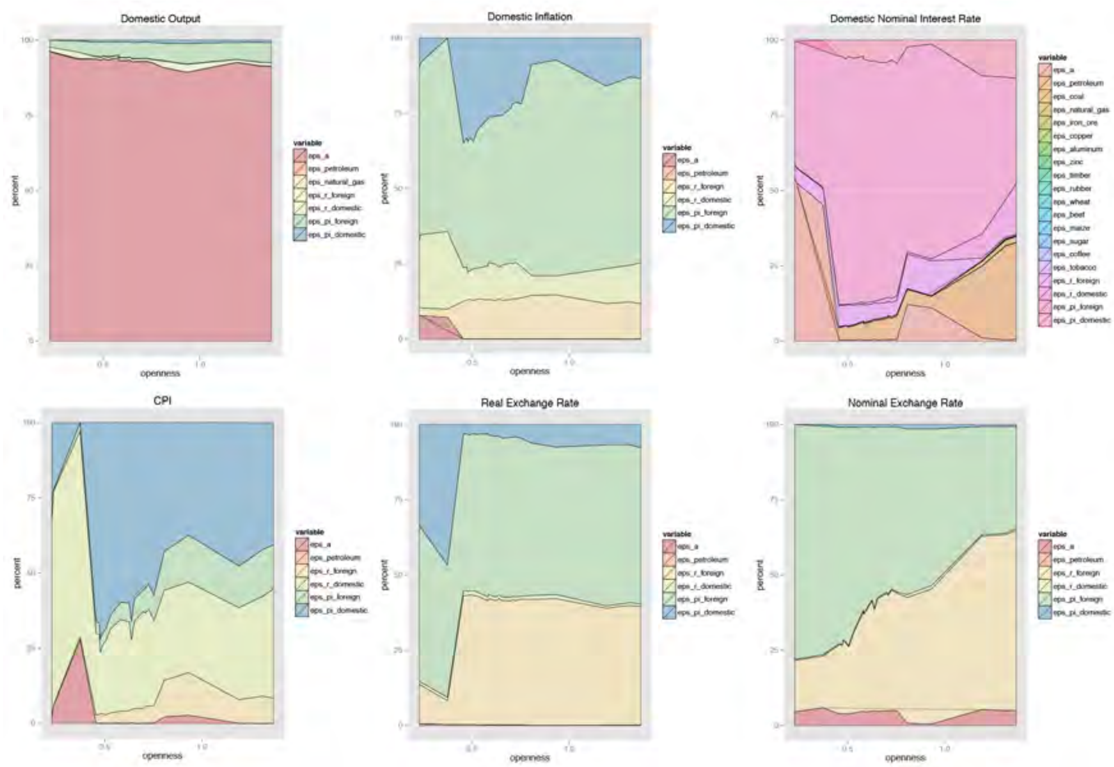

Figure 2.2: Openness Relationships

In the case of domestic inflation, I again saw that petroleum shocks played a nonexistent role for all ranges of the openness parameter. A key contributor to domestic inflation was actually foreign inflation. This foreign inflation pass-through had a steady increase in relevance for countries whose openness saw in the range of [0.5, 0.9]. In addition, both the domestic and foreign interest rate shocks were key contributors. The dominance of the foreign interest shocks was evident for countries in the upper openness spectrum.

The only place where I saw relevance of petroleum shocks was in the domestic nominal interest rate. I saw a dramatic increase in this relevance when the country's openness was greater than one, which includes Netherlands, Belgium and Ireland.

As with output, technology played a major role in the domestic nominal interest rate, with its dominance mainly in countries whose openness was in the mid-range.

The CPI shock decomposition as it related to openness was governed by six shocks. The two predominant shocks that governed the CPI were domestic interest rate and inflation, they are inversely correlated. At their max, openness, of around 0.47, these two shocks accounted for almost 95% of the composition in CPI. For countries whose openness was greater than 0.5, the significance of domestic interest and foreign inflation shocks was increasing with openness. This was not the case with foreign interest rate shocks. Instead, foreign interest rate shocks were increasing with openness until they reached their high values in the openness range of [0.80 - 0.95]. Whereas, technology shocks had a dominant role in the lower tier of the openness spectrum i.e. below 0.5. As before, petroleum shocks did not contribute any major disturbances in the CPI.

A relative steady shock composition was shown by the real exchange rate. Throughout the openness range, the relationship between openness and the real exchange rate was dominated by the following three shocks foreign interest rate, foreign inflation and domestic inflation. Once a country's openness was greater than 0.45, I saw a leveling off of these shocks in their relevance as openness increased. The foreign interest rate shocks accounted for about 40% of the deviation. Another 40% came from foreign inflation shocks, and domestic inflation around 10% in the deviation of the real exchange rate.

For the nominal exchange rate, there were two shocks, foreign interest rate and inflation, that represented around 93% of the composite. The foreign interest rate shocks significance was increasing with openness. This significance strengthens from around 18% on the low side of openness, 0.226 for the United States, to 60% on the high side of openness, 1.369 for Ireland. There was a small technology influence of

5% on the shock composite of the nominal exchange rate. Domestic inflation shocks played a minor role, and as before petroleum shocks played a a minor part in the nominal exchange rate shock composite.

The take away from this subsection is that a country's domestic output, domestic inflation, CPI, real and nominal exchange rates are not affected by commodity shocks regardless of a country's level of openness. The only place where a commodity shock is relevant is in the domestic interest rate. The domestic interest rate was affected by petroleum shocks, and these shocks become relevant when a country's openness was greater than one.

2.3.6 Shock Decompositions

Having investigated the variance decomposition of key endogenous variables, I now explore the shock decomposition of domestic output, inflation, interest rate and the real exchange rate. I have done this for each of the twenty three countries and the results are shown in figures 1 - 10. By combining both variance and shock decompositions it is possible to gain insights on which shocks are important in the dynamics of the endogenous variables. When investigating shock decomposition, I was particularly interested in how the decomposition was composed at the onset of the great recession and its recovery phase.

When comparing each countries' domestic output shock decomposition, I found a few shocks that did not register any importance in the deviation of output from its steady state. These shocks were: rubber, wool, wheat, beef, maize, sugar, rice and cocoa. In addition, labor, domestic interest and inflation, foreign interest and inflation shocks at best orchestrated a minuscule effect on output deviations. I found that the majority of the countries' commodity shocks that came from the metal group were beneficial. Whereas petroleum shocks were detrimental to output in years of 2009 to 2012. But these actions were reversed for Australia, Japan, New Zealand and the United States.

When looking at figures 1 - 10 for domestic inflation deviations for each country, we noticed that they had cyclic components to them that were not apparent in domestic output deviations. This was especially evident from 1990 to 2004. Two primary reasons that could have been responsible for this cyclicality was that wage setters demanded an increase in their reservation wage or that firms adjusted their markup. Since we modeled the labor market without any frictions, not reflecting true labor markets, I noticed that labor shocks played a pronounced role in the domestic inflation deviations, and they were accompanied by metal and petroleum shocks that caused firms to adjust the markup. The main shocks that governed domestic inflation deviations were foreign inflation, interest rate shocks, and domestic inflation and interest rate shocks.

There was a consistent picture that emerged when investigating the deviations of the domestic interest rate. The only outliers were Australia and Japan, whose shock decomposition illustrated an unusual finding when compared to the other countries. The findings show that, from 2003 onward, energy and metal shocks had a negative effect for domestic interest rates, except for the UK and United States. Whereas post 2008, petroleum shocks mainly had a negative effect on UK's interest rate deviations and a positive effect of United States interest rate deviations. Whereas, coal, natural and metal shocks had positive effect for the UK, and these shocks had a negative effect on the United States. As for the outliers, Australia and Japan had a distinctive importance in petroleum shocks and foreign interest rate and inflation.

For the real exchange rate deviations, the major theme that came across was that from 2004 to 2007, foreign inflation, foreign interest rate and petroleum shocks were mainly responsible for deviations in the real exchange rate. These shocks for the most part resulted in positive deviations in the real exchange rate. But after 2008, foreign inflation and interest rate were starting to have negative effects on the real exchange rate deviations for all countries except Belgium, Ireland and New Zealand. New Zealand was a real anomaly. It was the only country where its real exchange rate deviations were the primary result of foreign inflation shocks.

2.3.7 Impulse Responses Function

As the previous sections have pointed out, energy and metal commodities caused disturbances in the endogenous variables that I investigated. But, only petroleum had consistent effects of significant magnitude. Therefore, I only elected to investigate how domestic output and the CPI respond to a one deviation petroleum shock. This gave us some insights on the business cycle dynamics that are associated with a petroleum shock. I was interested in the magnitude and the duration necessary to establish a new steady-state from these responses. The findings are illustrated in figures 2.3 and 2.4, which are arranged by the openness values of the countries.

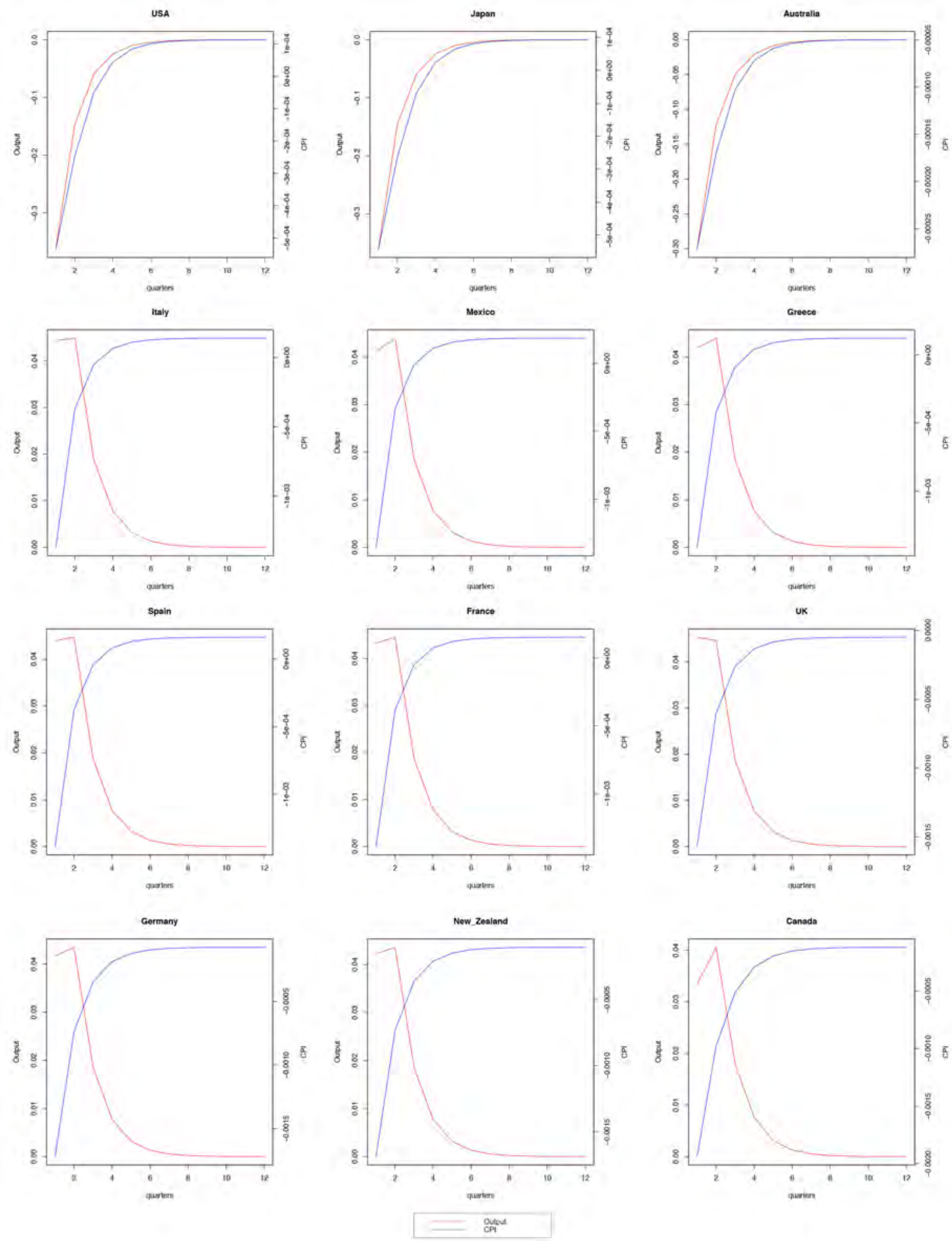

Figure 2.3: IRFs Petroleum Shock Openness One

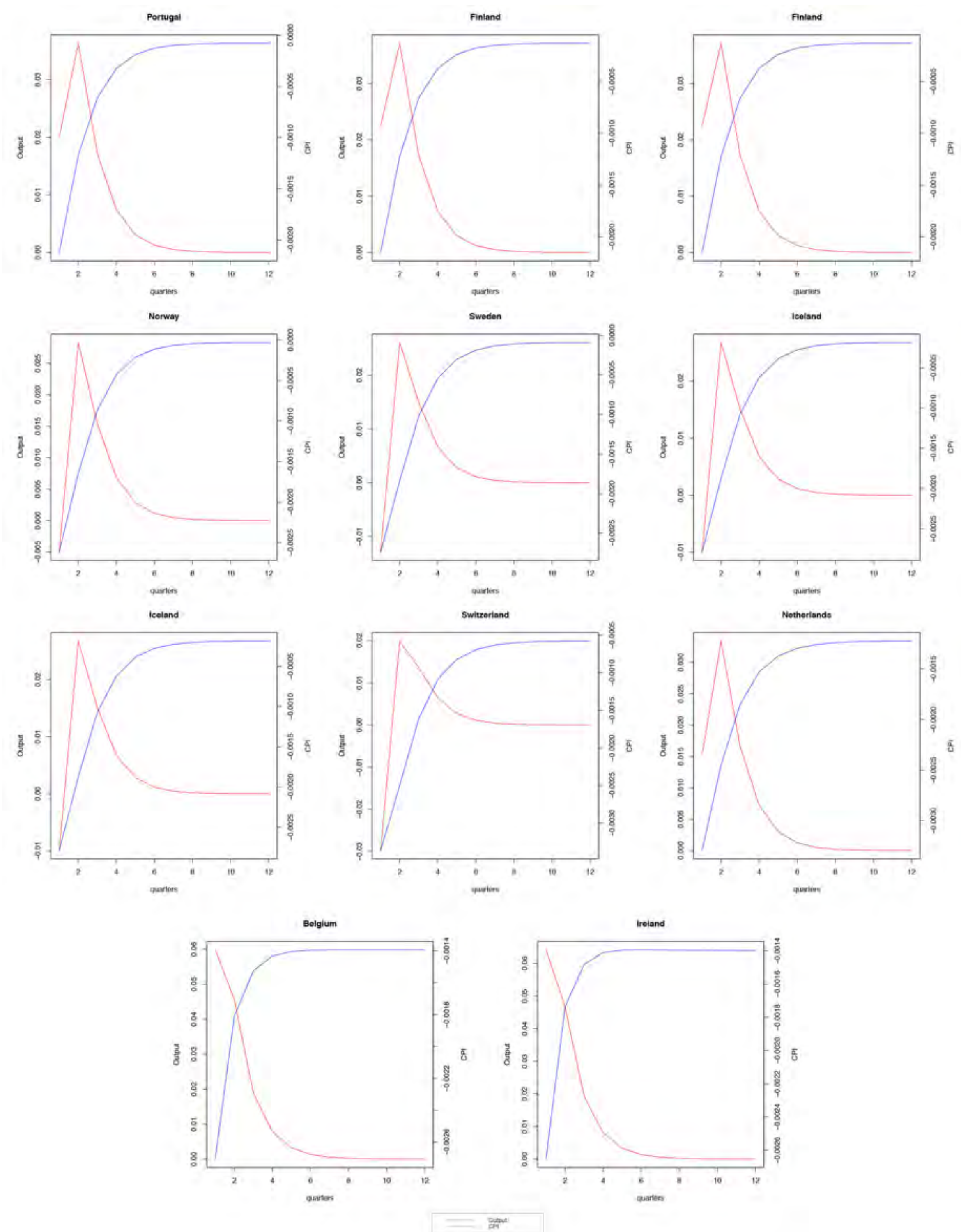

Figure 2.4: IRFs Petroleum Shock Openness Two

The findings showed that output had four distinct characteristics when responding to a petroleum shock, and these characteristics were related to the country's openness. The first type was related to three countries with a low openness ranging from [0.226 - 0.372]. Each country's output responded with a sharp drop in output in the first quarter that was followed by a steady increase for seven quarters, after which it establishes equilibrium. The output response had a strong pull back, where more than 50% of the negative deviation was reclaimed within the first three quarters. The second output response was related to countries whose openness was in the range [0.454, 0.652]. For these countries, the output response was an initial positive response that was followed by an increase in output for two more quarters. Hence, reaching its maximum that the three quarters. Thereafter, the output smoothly decayed to its steady state within the next six quarters. The third output response seemed to be a combination of the first two characteristics. It covered countries whose openness ranged from [0.753 - 1.191]. The output responded by turning negatively first for one quarter and then overshooting its equilibrium in the next two quarters. After reaching its maximum, the output decayed smoothly over the next six quarters to reach its equilibrium. The last type of response involved two countries with the openness of 1.3114 and 1.369. For these countries, their output response reached its maximum from the onset of the first quarter and decayed to equilibrium within six quarters.

For the CPI response to petroleum shock, all countries had the same response characteristics, which consisted in most cases in a initial drop in CPI ranging from [-0.0035%, -0.0020%] within the first quarter. Afterwards, the CPI rose for six to ten quarters. This recovery duration was directly related to openness of a country, where a more open country responded faster. In addition, there seemed to have been a relationship to the new CPI equilibrium value and the openness of a country. For countries which had an openness in [0.266, 0.625] the CPI migrated to a positive CPI steady state value. Whereas, more open countries ranging in [0.637, 1.369] found the new negative CPI steady state value. After six to ten quarters, I found that the CPI settled in the range of (-0.00003%, 0.00005%).

I conclude that there was no CPI effect from a petroleum shock due to the small magnitude in deviations of the CPI. In addition, petroleum shock disturbances that affected the household's consumption and wage setting, in tandem with the firm's price setting decisions, were cleared within six to ten quarters. This clearing duration was also shown to be dependent on the country's openness.

2.4 Conclusion

By utilizing a Small Open Keynesian DSGE model with an embedded commodity pricing index, the investigation has shed some light on which commodity disturbances practitioners and policy makers should monitor. Out of the nineteen commodities analyzed, I found that only petroleum was significant. This was surprising because I believed that the metal commodities would play a more significant role. I found that petroleum disturbances required six to ten quarters to dissipate. This is in accordance with the literature. In addition, it was found that there are four output response types that were dependent on the openness of a country.

CHAPTER 3

ARE LONG-RUN EFFECTS FROM OIL AND GAS DISTURBANCES DIFFERENT? INSIGHTS FOR TRINIDAD AND TOBAGO

3.1 Introduction

Trinidad and Tobago have been endowed with rich deposits of oil and natural gas that have proven reserves of 716 million barrels of oil and 23,500 billion cubic feet of natural gas. In 2014 the energy sector accounted for 48.1% of government fiscal revenue and 42.1% share of the GDP. On the export, side the energy sector encompass 85% of export receipts combining extraction, refining and processing.[1] This reliance on the energy market has put Trinidad and Tobago in a tough position after the commodity downturn following the great recession of 2008 and the onset of the US shale revolution. These events had adverse effects on the Trinidad and Tobago economy.

With its heavy reliance on oil and gas exports, policymakers and market practitioners need to have insights on the long-run effects on Trinidad and Tobago's economy from external oil and gas disturbances. This paper sheds some light on this topic by answering the following two questions for Trinidad and Tobago's economy: (1) How long are the effects from oil and gas disturbances on the economy? (2) How do the long-run effects from oil and gas disturbances differ within the economy? This paper's questions are in similar to those in [Kil08b], [TWZ10] and [CdG03] who investigated the effects from oil shocks alone. But differs by focusing on the interplay of both oil and gas disturbances. Combining the study of the long-run effects for these two commodities is important, as hydraulic fracking becomes a

[1] Sources: Central Bank of Trinidad and Tobago, Central Statistical Office, Ministry of Finance and Ministry of Energy.

more dominant practice. Since a byproduct of oil fracking is natural gas. Fracking has already changed the energy landscape of the United States in just a few years. Trinidad and Tobago was the ideal candidate for this investigation due to its unique characteristics: it is a leading exporter of Liquefied Natural Gas (LNG), it has a well developed oil exploration and refinement infrastructure, and its exclusivity due to it being a small island nation. This environment permits the analysis of the long-run effects from the oil and gas disturbances.

The methodologies deployed were the same as the ones utilized in [GLHPS03] to study the long run structural macroeconomy of the UK. In addition, investigating the duration and persistence of the commodity disturbances were decomposed using the Beveridge-Nelson moving average representation in a similar fashion as [RW94] and [Cud92]. The estimation methods draw upon VECM and SVEC due to the unit roots contained within the empirical data.

In an analysis covering 1948-1980, [Ham96] found that oil price movement had a negative correlation to GNP growth of the United States. In an analysis of twelve countries [Abe01] showed that the indirect and direct effect on GDP growth from an oil price shock took 12-20 quarters on average to dissipate. It was shown by [BG07] that post-1981 oil shocks did not affect core inflation for the United States. For three commodity exporting countries Norway, Russia and Saudi Arabia [HK07] illustrated that oil shocks had at best marginal effect on the real effective exchange rate of these countries. A study of 23 commodity exporting countries by [Dau14] found that the countries currency appreciation were positively correlated with the oil price movements.

The paper is organized as follows: In section 3.2, the long-run macroeconomic model is presented. A brief summary of the empirical data is found in section 3.3. In section 3.4, the VECM and VAR models are estimated and a benchmark comparison analysis is conducted. The SVEC model is estimated and its findings are presented in Section 3.5. The chapter's concludes are in section 3.6.

3.2 Model

The model was constructed following the concept of the long-run dynamics of an economy presented in [GLPS12]. I will be the first to admit that short-run dynamics play an important part in the key activities in capital specificity [Nea78], wealth distribution [GZ93] and labor productivity [MB81]. But due to complexities of measurable nuances of key variables, the focus of the model was on the long-run. By utilizing this model, it was possible to investigate the effects of the linkages between a small open economy to the rest of the world.

3.2.1 Model Overview

As illustrated in figure 3.1, the coupling between economies is established by the following long-run relationships the Relative Purchasing Power Parity, Domestic and Foreign Interest Rate Differential, Domestic and Foreign Output Differential, Domestic High Power Money Solvency, and the Domestic Real Interest, which are respectively labeled by the mumbers one thru five.

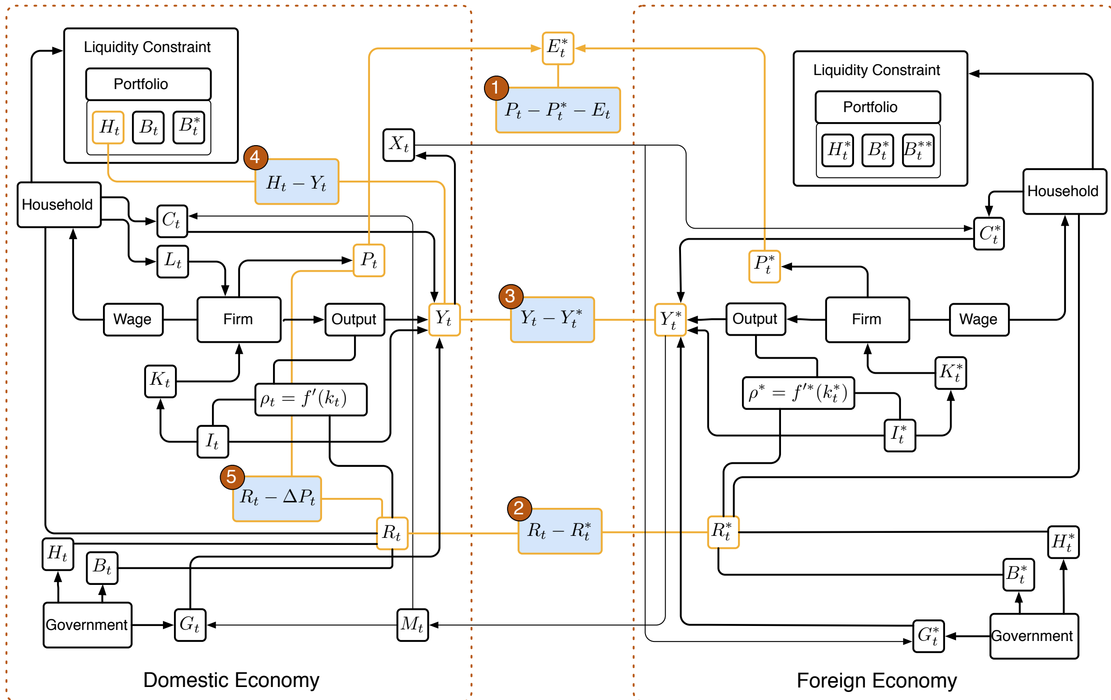

Figure 3.1: Model Overview

These relationships were established by utilizing Relative Purchasing Power Parity (PPP), Fisher Inflation Parity (FIP), Uncovered Interest Parity (UIP), Economic Stock-Flow Identies, and the use of equilibrium portfolio balance of private sector assets that governed long-run solvency requirements. These long-run relationships are the stabilizers that bring the economies back into a steady-state after exogenous shocks cause disequilibrium between the domestic and foreign economy.

Production

The firm's production function, shown by equation 3.1, is governed by three inputs: Technology, Capital and Labor. It is assumed that the production function, $F(K_t, A_t N_t)$, has constant return to scale, which permits us to rewrite the production function such that it solely depends on capital. The firms production function is represented by the real aggregate output where $\tilde{Y}_t$ is the gross domestic production (GDP) which is measured in Trinidadian dollars, and P_t is the Consumer Price Index (CPI) of Trinidad and Tobago.

$$\frac{\tilde{Y}_t}{P_t} = F(K_t, A_t N_t) = A_t N_t F\left(\frac{K_t}{A_t N_t}, 1\right) = A_t N_t f(k_t) \tag{3.1}$$

The labor enhancing technology process A_t has a trend component that represents the accumulation of technology and an exogenous random process u_{at} that encompasses innovation and destruction of technology within the economy.

$$ln(A_t) = a_0 + g\,t + u_{at} \tag{3.2}$$

In addition to the technology process, the real output is coupled to the unemployment process and the population. By letting $(1 - \lambda)$ represent the unemployment steady-state value, and also having $\eta_{\eta t}$ be a stationary process with a mean of zero that governs the deviation from the steady-state unemployment, employment is defined as

$$N_t = \lambda\, POP_t\, e^{\eta_{\eta t}} \tag{3.3}$$

Hence the domestic production function, after taking the nature log, can be written as

$$y_t = a_0 + g\,t + ln(\lambda) + ln(f(k_t)) + u_{at} + \eta_{\eta t} \tag{3.4}$$

Technology innovations are not established in a vacuum, but instead are the results of break throughs from different areas of the world. Hence, the domestic and foreign technology levels are connected. But there exists lag time in the transfer of knowledge from the rest of the world to the domestic economy. Therefore, there will be a differential between the domestic and foreign technology levels, which is represented by γ in equation 3.5 below:

$$A_t = \gamma \, A_t^* \, e^{\eta_{at}} \tag{3.5}$$

It is assumed that the technological innovations follow the stationary process η_{at}, which has a mean of zero. As a result, the domestic economy output is now linked to the foreign economy through a technology channel. In addition, it is assumed that the foreign output function follows the same constructs of the domestic output function. Therefore the natural log of foreign output can be written as in equation 3.6.

$$y_t^* = a_0 + g\,t - ln(\gamma) + ln(\lambda^*) + ln(f^*(k_t^*)) + u_{at} - \eta_{at} + \eta_{\eta t}^* \tag{3.6}$$

Having constructed the domestic and foreign output equations, it is possible to establish the output differential between the domestic and foreign economies. Equation 3.7 illustrates this relationship, which is one of the five long-run cointegrated relationships that will be estimated.

$$y_t - y_t^* = \ln(\gamma) + ln\left(\frac{\lambda}{\lambda^*}\right) + ln\left(\frac{f(k_t)}{f^*(k_t)}\right) + \eta_{at} + (\eta_{\eta t} - \eta_{\eta t}^*) \tag{3.7}$$

Following the Neoclassical framework, it is possible to obtain the real rate of return of capital $\rho_t = f'(k_t)$, where ρ_t is the marginal productivity of capital. This dynamic is governed by equation 3.8, where $\eta_{\rho,t+1}$ represents a normalized stationary process with a mean zero, such that ρ is the mean of the steady state distribution of the real rate of return of capital.

$$(1 + \rho_{t+1}) = (1 + \rho)\, e^{\eta_{\rho,t+1}} \tag{3.8}$$

It is assumed that the expected rate of return of capital follows the process shown below.

$$(1 + \rho^e_{t+1}) = (1 + \rho_{t+1})\, e^{\eta^e_{\rho,t+1}} \tag{3.9}$$

Arbitrage Conditions

The model makes use of three arbitrage relationships to establish its long-run cointegrated relationships. The first, relative Purchase Power Parity (PPP) deals with the price differential of domestic and foreign goods. It is governed by the law of one price that states that the price of good should be the same regardless of its location. The second, the Fisher Interest Parity (FIP) addresses the relationship between the rates of returns of bonds and the physical asset. If the deviation of the asset rates of bonds or physical assets are too large, an arbitrage opportunity would arise. The third relationship is the Uncovered Interest Parity (UIP), which establishes the arbitrage rules between domestic and foreign bonds. Hence through the use of arbitrage rules from PPP, FIP, and UIP the channels between price levels, rates of return on physical assets, and domestic and foreign bonds are connected. The PPP provide a direct long-run cointegrated relationship. Whereas, the FIP and UIP are used to establish the steady state levels of an agent's asset allocations, which will be shown in a later section.

The relative Purchasing Power Parity (PPP) is defined in equation 3.10. In this equation P_{t+1}, P^*_{t+1} and E_{t+1} are the domestic and foreign price indices and the effective exchange rate, respectively. The term $\eta_{ppp,t+1}$ is a trend-stationary process with a mean zero, and it accounts for the short-run deviation in the PPP relationship.

$$P_{t+1} = E_{t+1} P^*_{t+1} \, e^{\eta_{ppp,t+1}} \tag{3.10}$$

Rewriting equation 3.10 in log-linear form and rearranging the terms results in the PPP long-run relationship using $ln(P_{t+1}) = p_{t+1}$, $ln(P^*_{t+1}) = p^*_{t+1}$ and $ln(E_{t+1}) = e_{t+1}$.

$$p_{t+1} - p^*_{t+1} - e_{t+1} = \eta_{ppp,t+1} \tag{3.11}$$

FIP is defined by equation 3.12, where R_t is the nominal interest rate on domestic assets held, ρ^e_{t+1} is the expected real rate of return on physical assets over the period t to t + 1, and $(P^e_{t+1} P_t)/P_t$ is the expected inflation. The innovations of FIP are captured by $\eta_{fip,t+1}$ which represents the risk-premium, and it is assumed that $\eta_{fip,t+1}$ is a stationary process.

$$(1 + R_t) = (1 + \rho^e_{t+1}) \left(1 + \frac{P^e_{t+1} - P_t}{P_t}\right) e^{\eta_{fip,t+1}} \tag{3.12}$$

The last of the arbitrage relationships UIP is defined by equation 3.13. In this equation R_t is the interest rate paid on domestic bonds, and R^*_t is the interest rate paid on foreign bonds. Since the UIP anticipates a full transaction cycle (buy/sell) of the exchange rate, the UIP relationship must take into account the current exchange rate and its expected value, which are represented by E_t and E^e_{t+1}, respectively.

$$(1 + R_t) = (1 + R_t^*) \left(1 + \frac{E_{t+1}^e - E_t}{E_t}\right) e^{\eta_{uip,t+1}} \tag{3.13}$$

The risk premiums of the bond and exchange rate uncertainties are embedded within $\eta_{uip,t+1}$, which is assumed to be stationary and ergodic. To complete the dynamics it is assumed that the expected exchange rate and expected price level follow the processes 3.14 and 3.15, respectively.

$$(1 + E_{t+1}^e) = (1 + E_{t+1})\, e^{\eta_{e,t+1}^e} \tag{3.14}$$

$$(1 + P_{t+1}^e) = (1 + P_{t+1})\, e^{\eta_{p,t+1}^e} \tag{3.15}$$

Using equations 3.8, 3.9, 3.14 and 3.15, it was possible to rewrite the FIP and UIP in log-linear form, which results in the domestic nominal interest rate and the interest differential shown in equations 3.16 and 3.17:

$$r_t - \Delta p_t = ln(1 + \rho) + \eta_{fip,t+1} + \eta_{\rho,t+1} + \eta_{\Delta\Delta p,t+1} + \eta_{p,t+1}^e + \eta_{\rho,t+1}^e \tag{3.16}$$

$$r_t - r_t^* = \eta_{\Delta e,t+1} + \eta_{uip,t+1} + \eta_{e,t+1}^e \tag{3.17}$$

where $r_t = ln(1 + R_t)$ and $r_t^* = ln(1 + R_t^*)$.

Accounting Identities and Stock and Flow Relations

The next items that needed to be established are the stock flow relationships of the accounting identities. The stock identities for the government debt, the net foreign asset position, and financial assets held by the private sector are represented by equations 3.18 - 3.20.

$$\tilde{D}_t = \tilde{H}_t + \tilde{B}_t \tag{3.18}$$

$$\tilde{F}_t = E_t\,\tilde{B}^*_t - (\tilde{B}_t - \tilde{B}^d_t) \tag{3.19}$$

$$\tilde{L}_t = \tilde{H}_t + \tilde{B}^d_t + E_t\,\tilde{B}^*_t \tag{3.20}$$

The flow identity for the government debt is shown by equation 3.21. It states that the flow of the government debt at time t+1 is equal to the government spending, G_t, plus payments of outstanding domestic bonds, R_tB_t, minus taxes, T_t.

$$\Delta\tilde{D}_{t+1} = \tilde{G}_t + R_t\tilde{B}_t - \tilde{T}_t \tag{3.21}$$

To establish the flow identities for the net foreign asset position and financial assets, the output expenditure flow and the private sector disposable income needs to be defined. The output expenditure flow is defined by equation 3.22, and the private sector disposable income is shown by equation 3.23. As shown in the output expenditure flow equation, the output flow depends on consumption expenditures, $\tilde{C}_t$, investment expenditures, $\tilde{I}_t$, government expenditures, $\tilde{G}_t$, export expenditures, $\tilde{X}_t$, and import expenditures, $\tilde{M}_t$.

$$\tilde{Y}_t = \tilde{C}_t + \tilde{I}_t + \tilde{G}_t + (\tilde{X}_t - \tilde{M}_t) \tag{3.22}$$

The private sector disposable income depends on income minus taxes plus the revenue gain from holding domestic and foreign bonds. The income is represented by $\tilde{Y}_t$ and taxes by T_t. The income from domestic bonds is $R_t\,\tilde{B}^d_t$ with the remaining term being the income from foreign bonds, $R^*_t\,\tilde{B}^*_t$.

$$\tilde{Y}^d_t = \tilde{Y}_t - \tilde{T}_t + R_t\,\tilde{B}^d_t + E_t\,R^*_t\,\tilde{B}^*_t \tag{3.23}$$

Using both equations 3.22 and 3.23 it is possible to define the flow of financial assets shown in equation 3.24.

$$\Delta \tilde{L}_{t+1} = \tilde{Y}_t^d - \tilde{C}_t - \tilde{I}_t + (\tilde{E}_{t+1}^e - E_t)\tilde{B}_t^* \tag{3.24}$$

The flow equation of the net foreign asset is shown by equation 3.26. It equates to the net trade plus the net factor income from abroad, $\widetilde{NFA}_t$ of equation 3.25, the expected value in domestic currency of foreign bonds.

$$\widetilde{NFA}_t = E_t\, R_t^* \tilde{B}_t^* - \tilde{R}_t(\tilde{B}_t - \tilde{B}_t^d) \tag{3.25}$$

$$\Delta \tilde{F}_{t+1} = \tilde{X}_t - \tilde{M}_t + \widetilde{NFA}_t + (\tilde{E}_{t+1}^e - E_t)\tilde{B}_t^* \tag{3.26}$$

Solvency Requirement, Asset Demand and Liquidity

To ensure the log-run solvency by the private sector, it is assumed that the private sector maintains the ratio of the total financial assets to the nominal income level as shown by equation 3.27. This ratio, in addition with the stock-flow relationships, and portfolio restrictions ensures that there is no over-extension in debt to the private sector, domestic and foreign governments.

$$\frac{\tilde{L}_{t+1}}{\tilde{Y}_t} = \mu\, e^{\eta_{y,t+1}} \tag{3.27}$$

It is also assumed that the private sector uses a Balance Portfolio Approach, as in [Bra80], to establish their allocations of holdings of high-power money, domestic and foreign bonds. The Balance Portfolio Approach determines the exchange rate in the short-run via the current account, [Ugu02]. Two other characteristics of the Balance Portfolio Approach are that it is well suited to dealing with large deviations from PPP, and that it maintains the stylized fact that a country with a current account surplus has an appreciating exchange rate.

It is now possible to define the ratio of high-power money to total financial assets by equation 3.28. This equation represents the demand for high-power money and, with the long-run solvency requirement, the last long-run cointegrated relationship can be established.

$$\frac{\tilde{H}_{t+1}}{\tilde{L}_t} = F_h\left(\frac{Y_t}{P_t}, \rho^e_{b,t+1}, \rho^{*e}_{b,t+1}, \frac{\Delta P^e_{t+1}}{P_t}, t\right) e^{\eta_{h,t+1}} \tag{3.28}$$

The demand for high power money, F_h, depends on real per capita output, and the real returns of the three asset classes: domestic bonds, foreign bonds, and high power money. In addition, F_h has the properties of $F_{h1} \geq 0$, $F_{h2} \leq 0$, $F_{h3} \leq 0$ and $F_{h4} \leq 0$. The short-run deviations $\eta_{h,t+1}$ follow a stationary mean zero process.

In a similar manner as the demand for high power money, the demand for foreign assets is defined by equation 3.29 with the following properties $F_{f1} \leq 0$, $F_{f2} \leq 0$, $F_{f3} \geq 0$ and $F_{f4} \geq 0$, and the short-run deviation $\eta_{f,t+1}$ follows a stationary mean zero process.

$$\frac{\tilde{F}_{t+1}}{\tilde{L}_t} = F_f\left(\frac{Y_t}{P_t}, \rho^e_{b,t+1}, \rho^{*e}_{b,t+1}, \frac{\Delta P^e_{t+1}}{P_t}, t\right) e^{\eta_{f,t+1}} \tag{3.29}$$

In the steady state, the returns of all asset classes are equivalent. Hence, the assets can be treated as perfect substitutes. Therefore, in the steady state, it is possible to rewrite the demand for high-power money and demand for foreign assets as shown in equations 3.30 and 3.31.

$$\frac{\tilde{H}_{t+1}}{\tilde{L}_t} = F_{hl}\left(\frac{Y_t}{P_t}, R_t, t\right) e^{\eta_{hl,t+1}} \tag{3.30}$$

$$\frac{\tilde{F}_{t+1}}{\tilde{L}_t} = F_{fl}\left(\frac{Y_t}{P_t}, R_t, t\right) e^{\eta_{fl,t+1}} \tag{3.31}$$

The terms $\eta_{hl,t+1}$ and $\eta_{fl,t+1}$ are the short-run deviation from demand balances and encompass the deviations from the FIP equation 3.12, and UIP equation 3.13.

Using the newly defined demand for high-power money equation 3.30 and the log-run solvency equation 3.27, the liquidity cointegration relationship can be established by equation 3.32.

$$\frac{\tilde{H}_{t+1}}{\tilde{L}_t} = F_{hl}\left(\frac{Y_t}{P_t}, R_t, t\right) e^{\eta_{hl,t+1}} \tag{3.32}$$

Equation 3.32 can be estimated using a log-linear form, which is shown by equation 3.33. This estimation equation serves as the last long-run liquidity cointegration relationship.

$$(h_t - y_t) = ln(\mu) + u_1\, t + \mu_2\, r_t + \mu_3 y_t + \eta_{hl,t+1} + \eta_{ly,t+1} \tag{3.33}$$

Constructing the Econometric Model

To analyze the interactions of the long-run cointegration relationship and exogenous shocks on the endogenous variables, a Vector Error Correction Model (VECM) of the reduced form 3.34 is utilized.

$$\Delta z_t = a + b\, t - \pi z_{t-p} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + e_t \tag{3.34}$$

The components of interest in equation 3.34 are the m x m matrices π and Γ_i. The π matrix contains the dynamics of the five long-run cointegration relationships that are illustrated in figure 3.1. This matrix can be decomposed into $\pi = \alpha\beta'$ where α controls the speed of the reversion to the long-run steady state, and β' governs the interactions between variables in the cointregation relationships. Whereas, Γ_i contains the the short-run dynamics of the model.

By estimating the VECM model 3.34, it is possible to gain insights into the the steady state attraction forces that are built into equations 3.7, 3.11, 3.16, 3.17, and 3.33. Since these attraction forces have to account for errors in the deviation from the long-run steady-state it is possible to represent these errors in terms of the estimated cointegration relationships. This can be illustrated as follows:

$$\varepsilon_t = \beta' z_{t-p} - a - b\,t \tag{3.35}$$

$$\Delta z_t = \alpha\varepsilon_t + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + e_t \tag{3.36}$$

Let

$$\begin{aligned} z_t &= (p_t^o, p_t^g, p_t - p_t^*, y_t^*, r_t^*, y_t, h_t - y_t, \Delta p_t, r_t, e_t, b)' \\ a &= (a_{10}, a_{20}, a_{30}, a_{40}, a_{50})' \\ b &= (b_{11}, 0, 0, b_{41}, 0)' \\ \varepsilon_t &= (\varepsilon_{1,t}, \varepsilon_{2,t}, \varepsilon_{3,t}, \varepsilon_{4,t}, \varepsilon_{5,t})' \end{aligned}$$

therefore, the long-run cointegration relationships can be represented in terms of the long-run deviation errors

$$\begin{aligned} p_t - p_t^* - e_t &= a_{10} + b_{11}\,t + \varepsilon_{1,t+1} \\ r_t - r_t^* &= a_{20} + \varepsilon_{2,t+1} \\ y_t - y_t^* &= a_{30} + \varepsilon_{3,t+1} \\ h_t - y_t &= a_{40} + b_{41}\,t + \beta_{4,6} y_t + \beta_{4,9} r_t + \varepsilon_{4,t+1} \\ r_t - \Delta p_t &= a_{50} + \varepsilon_{5,t+1} \end{aligned} \tag{3.37}$$

In addition, long-run deviation errors can be represented in terms of long-run structural disturbances, explained by η's

$$\begin{aligned}
\varepsilon_{1,t+1} &= \eta_{ppp,t} - b_{10} - b_{11}\, t \\
\varepsilon_{2,t+1} &= \eta_{uip,t+1} + \eta^{e}_{r,t+1} + \eta_{\Delta e,t+1} - b_{20}\, t \\
\varepsilon_{3,t+1} &= \eta_{a,t} + (\eta_{n,t} - \eta^{*}_{n.t}) + (\eta_{k,t} - \eta^{*}_{k,t}) \\
\varepsilon_{4,t+1} &= \eta_{ly,t} + \eta_{hl,t} \\
\varepsilon_{5,t+1} &= \eta_{fip,t+1} + \eta_{\rho,t} + \eta_{\Delta\Delta\rho,t+1} + \eta^{e}_{p,t+1} + \eta^{e}_{\rho,t+1}
\end{aligned} \tag{3.38}$$

To insure that VECM estimation has the correct identification that follows macro economy theory of the model, it is necessary to impose the appropriate restrictions on β'. These restrictions are illustrated below.

$$\beta' = \begin{array}{c} \begin{array}{ccccccccccc} p^o_t & p^g_t & p_t - p^*_t & y^*_t & r^*_t & y_t & h_t - y_t & \Delta p_t & r_t & e_t & b \end{array} \\ \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \beta_{4,6} & 1 & 0 & \beta_{4,9} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

Since the model does not have any restrictions in the fourth cointegrated relationship in terms of domestic output and nominal interest rate, the estimation variables are considered free variables. This is illustrated above by the $\beta_{4,6}$ and $\beta_{4,9}$ entries.

Before concluding the section and proceeding with the estimation results, it is necessary to clarity the components of the vector $z_t = (p^o_t, p^g_t, p_t - p^*_t, y^*_t, r^*_t, y_t, h_t - y_t, \Delta p_t, r_t, e_t, b)'$. Both the Oil Price Index, p^o_t and the Gas Price Index, p^g_t, components are considered to be forcing variables to the model. Hence they are exogenous to the domestic economy. The remaining components of z_t are the endogenous variables within the model.

3.3 The Data

The data that was used for estimation comprised of three primary categories: commodity price indexes, domestic data - Trinidad and Tobago, and foreign data - the World represented by the OCED. The data is in quarterly frequency and covers 24 years with the timeframe from April 1991 to December 2015. This is the longest possible data set that could be compiled due to the fact that Trinidad's Central Bank did not publicly provide the necessary data sets prior to 1991.

The commodity price indexes consist of the Oil Price index, p_t^o, and Natural Gas Price Index, p_t^g. These indexes are considered exogenous, and were constructed using EIA's Cushing OK WTI Spot Price FOB, a combination Henry Hub Gas Price and US Natural Gas Import prices.[2]

The remaining domestic and foreign variables are considered endogenous to the model and are as follows: Trinidad and Tobago's effective exchange rate, e_t, foreign nominal interest rate, r_t^*, domestic nominal log interest rate, r_t, natural of the domestic price level, p_t, foreign price level, p_t^*, domestic real per capita output, y_t, real per capita domestics output, y_t^*, and the real per capita money stock, h_t.

[2]Further details of that commodity index construction and data sources can be found in the Appendix

3.4 Model Estimation

3.4.1 Unit Root

To ensure that the estimation is properly executed, it is necessary to establish the correct cointegrate order of the empirical data. This task can be achieved by utilizing an array of parametric and non-parametric tests. The Phillips-Perron Test (PP) [PP88] is a non-parametric test that can be applied to weakly dependent data and heterogeneously distributed data. This test is known to have low power in the case that the data follows an AR(1) process. To overcome this issue, the Elliott-Rothenberg-Stock Test (ERS) [ERS96] could be used. The ERS is able to increase the power of the unit root test by localizing the detrending of the data, but this type of detrending technique is ill-suited to the application presented in this paper. This is because the localized detrendeding can alter the long-run structural properties of the data. To this end, the Augmented Dickey-Fuller Unit Root Test (ADF) was used to check for unit roots and cointegration order of the empirical data. The results of the ADF test for lags zero thru four are shown in table 3.1. The results show all variables contain a unit root except domestic inflation at ADF(0). Likewise their cointegration order are of I(1) expect inflation, which is a cointegration order of I(0). To ease the estimation process, the domestic inflation was assumed to have a cointegration order I(1). Hence, all empirical data is considered to have a unit root and cointegration order of I(1).

Augmented Dickey-Fuller Unit Root Test					
			1%	5%	10%
	Critical Values		-4.04	-3.45	-3.15
At levels					
Variable	ADF(0)	ADF(1)	ADF(2)	ADF(3)	ADF(4)
p_t^o	-1.69	-2.63	-1.77	-2.12	-1.85
p_t^g	-2.23	-2.08	-2.04	-1.75	-1.23
e_t	-3.39	-3.29	-2.56	-2.71	-2.49
r_t^*	-1.71	-2.51	-3.21	-3.70	-3.78
r_t	-2.44	-3.15	-2.49	-2.78	-2.47
p_t	-7.17	-7.07	-5.99	-4.65	-4.42
y_t	-2.79	-2.42	-2.27	-2.48	-2.52
$p_t - p_t^*$	-0.71	-0.86	-0.58	-0.61	-0.71
$h_t - y_t$	-1.50	-1.34	-1.33	-1.57	-1.62
y_t^*	-0.55	-1.84	-1.41	-1.34	-1.39
			1%	5%	10%
	Critical Values		-2.6	-1.95	-1.61
First Differnce					
Variable	ADF(0)	ADF(1)	ADF(2)	ADF(3)	ADF(4)
p_t^o	-7.38	-7.77	-5.05	-4.94	-4.88
p_t^g	-10.53	-7.34	-6.45	-6.68	-5.83
e_t	-10.65	-9.13	-6.75	-6.28	-5.56
r_t^*	-6.80	-4.67	-3.96	-3.80	-4.14
r_t	-6.55	-6.34	-4.49	-4.77	-3.99
p_t	-12.31	-10.41	-9.85	-7.78	-8.32
y_t	-12.43	-8.90	-5.79	-5.31	-4.30
$(p_t - p_t^*)$	-5.95	-5.37	-4.05	-2.98	-2.53
$(h_t - y_t)$	-9.85	-6.40	-4.21	-3.49	-2.87
y_t^*	-3.46	-3.69	-3.25	-2.81	-2.80

Table 3.1: Augmented Dickey-Fuller Unit Root Test

3.4.2 Variable Arrangement and Granger Causality

Before pinning down the lag of of the VECM model, the endogeneity order of the empirical data was established. To figure out the order, the Granger Causality Test (GC) [Gra88] was applied for each variable for lags 2-4 with and without trend and constants. This resulted in estimating 122,640 combinations of the GC

VAR Model Estimated Lags				
			Lag: 2,3	
			Type: None, Both	
Lag	Esti Type	Log-Likelihood	AIC	BIC
1	none	2769.47	-5338.95	-5080.45
2	none	2873.85	-5347.69	-4832.75
3	none	2940.24	-5280.47	-4511.17
4	none	3044.07	-5288.15	-4266.60
5	none	3183.79	-5367.58	-4095.93
6	none	3348.40	-5496.79	-3977.24
	Max Value:	3348.40	-5280.47	-3977.24
			Type: None, Both	
Lag	Esti Type	Log-Likelihood	AIC	BIC
1	Both	2810.32	-5380.65	-5070.45
2	Both	2915.84	-5391.68	-4825.25
3	Both	2988.42	-5336.84	-4516.25
4	Both	3095.41	-5350.83	-4278.20
5	Both	3242.79	-5445.58	-4123.07
6	Both	3404.41	-5568.82	-3998.61
	Max Value:	3404.41	-5336.84	-3998.61

Table 3.2: VAR lags selection criteria

test. Afterwards, results that rejected GC test at 95% were passed through an identification process to disentangle any feedback causality to establish the final order. The feedback causality correction process identified the causality order of $(p_t^0, p_t^g, p_t - p_t^*, y_t^*, r_t^*, y_t, h_t - y_t, p_t, r_t, e_t)$.

To determine the lag of the VECM model, multiple estimations of an unrestricted VAR model were conducted. The result of the estimates are shown in table 3.2. The table reveals that the log-likihood and the BIC estimates indicate a lag order of 6 as being appropriate. Whereas, using the AIC a lag order of 3 would be best. Since the interest is to achieve good prediction power in the estimate, the AIC lag order was selected over that of log-likihood and the BIC.

3.4.3 Estimation of Long-Run Relationships

To make it possible to estimate the long-run relationships, it is necessary to identify how many cointegrated relationships are embedded within the empirical data. To achieve this, the method used in [JJ90] was deployed. To test the hypotheses $\mathcal{H}_1(r) : \pi = \alpha\beta'$ the VECM was estimated with rank five and with constant. For robustness, the hypothesis were tested for lags 2-4, and the results are shown in table 3.3. The table shows that there are five cointegration relationships for lag 3 at 95% confidence level.

Cointegration Rank:Trace Statistic					
Type: Constant					
Hypothesis		Statistic	Critical Values		
$\mathcal{H}_1(r) : \pi = \alpha\beta'$	$\mathcal{H}_1(r) : \pi \neq \alpha\beta'$	Lag = 3	10%	5%	1%
r $\leq$ 9	r = 10	4.87	7.52	9.24	12.97
r $\leq$ 8	r = 9	13.86	17.85	19.96	24.60
r $\leq$ 7	r = 8	28.64	32.00	34.91	41.07
r $\leq$ 6	r = 7	47.70	49.65	53.12	60.16
r $\leq$ 5	r = 6	73.14	71.86	76.07	84.45
r $\leq$ 4	r = 5	102.66	97.18	102.14	111.01
r $\leq$ 3	r = 4	155.35	126.58	131.70	143.09
r $\leq$ 2	r = 3	215.50	159.48	165.58	177.20
r $\leq$ 1	r = 2	304.94	196.37	202.92	215.74
r = 0	r = 1	405.95	236.54	244.15	257.68

Table 3.3: Cointegration Rank: Trace Statistic

Using the information in table 3.3, a VECM model with five cointegration relationships was estimated. Resulting α and β matrix estimates for the five cointegration relationships are show in tables 3.4 - 3.5. The entries of the α matrix give the speed of reversion to the steady state after encountering a disequilibrium shock. Where, columns of β i.e. β_1 thru β_5 represent the cointegration equations.

In the estimation of the VECM, it was assumed that all variables were endogenous, and therefore oil and gas price disturbances were affected by shocks from both

Variable	α_1	α_2	α_3	α_4	α_5
Δp_t^o	-0.0216	-0.2067	-0.9793	0.7978	-15.5487
Δp_t^g	0.0542	-0.5898	-1.2866	3.4756	-22.8542
$\Delta(p_t - p_t^*)$	0.0159	-0.0114	-0.0062	0.1192	-2.7969
Δy_t^*	0.0015	-0.0018	-0.0020	-0.0134	0.3419
Δr_t^*	0.0006	-0.0012	0.0093	0.0124	-0.0839
Δy_t	-0.0059	-0.0155	0.5153	0.9561	7.1023
$\Delta(h_t - y_t)$	0.1154	0.0344	0.8600	-0.0015	-5.2483
$\Delta(\Delta p_t)$	0.0159	-0.0131	-0.0050	0.0856	-2.2695
Δr_t	-0.0006	-0.0009	-0.0103	0.0009	-0.1300
Δe_t	0.0071	-0.0221	-0.0152	0.2618	-2.6468

Table 3.4: Unrestricted VECM alphas: weight matrix

domestic and foreign economies. This assumption will be refined in the later sections. It is desirable to consider both oil and gas dynamics to be exogenous to ease the dynamic interdependence of the effects of commodity shocks on the domestic economy because the focus was on the time duration and magnitude of commodity shocks. This is in line with the work of [CLM00], but counters [Kil08a] and [KP09] who investigated the effects of supply and demand effects from commodity shocks.

Variable	β_1	β_2	β_3	β_4	β_5
Δp_t^o	1.0000	0.0000	0.0000	0.0000	0.0000
Δp_t^g	0.0000	1.0000	0.0000	0.0000	0.0000
$\Delta(p_t - p_t^*)$	0.0000	0.0000	1.0000	0.0000	0.0000
Δy_t^*	0.0000	0.0000	0.0000	1.0000	0.0000
Δr_t^*	0.0000	0.0000	0.0000	0.0000	1.0000
Δy_t	-1.1719	-1.0109	-0.2851	-0.2363	-0.0109
$\Delta(h_t - y_t)$	0.0960	0.9112	-0.3308	-0.0039	0.0011
$\Delta(\Delta p_t)$	-25.6612	198.7160	-14.8980	19.7170	-0.7829
Δr_t	35.8230	13.9920	-2.5837	-0.7975	-0.3268
Δe_t	-9.1325	-10.7600	1.1935	-1.1307	-0.0398
a	-35.2991	-57.4831	12.8086	-13.4368	-0.0888

Table 3.5: Unrestricted VECM betas: cointegration matrix

To investigate the dynamic endogenous variables at different levels, the unrestricted VECM model was converted to a VAR model. The Impulse Response Function (IRF) due to oil and gas shocks are shown in figures 3.2 and 3.3. It can be seen that an oil shock has delayed effect on the foreign output for two quarters. Also, the shock causes a steady decline in output for seven quarters. The oil shock had declining effect on the foreign interest, but the scale of the decline was minuscule at best and therefore could be discarded. But difference between the domestic and foreign price indices increased at a steady rate. This illustrated that an oil shock can affect the rate differential of inflation between Trinidad and Tobago in respect to the rest of the world. This is mainly due to Trinidad and Tobago's reliance on oil exports for revenues. The oil IRF shows that Trinidad and Tobago's output had been increasing for three quarters and then followed a sharp decline for the other four quarters. All this movement occurred in the context of a relative steady interest rate and effective exchange rate. These volatile movements in per capita output create difficulties for firms to establish price expectations enhancing the cause of cost push inflation. Surprisingly, this was not the case when Trinidad and Tobago was faced with a gas shock. The price differential between foreign and domestic price levels showed a steady decline. This reflects that the foreign price levels are increasing at a faster rate than Trinidad and Tobago's price levels. In addition, output decline was establish from the onset of the gas shock.

A note of interest is that oil and gas shocks can have opposite effects on the effective exchange rate. Where an oil shock creates an appreciation in the effective real exchange rate, a gas shock caused effective real exchange rate to depreciate. Therefore, practitioners engaging in forex speculation or carry trades related to Trinidad and Tobago should take particular interest in these two shocks.

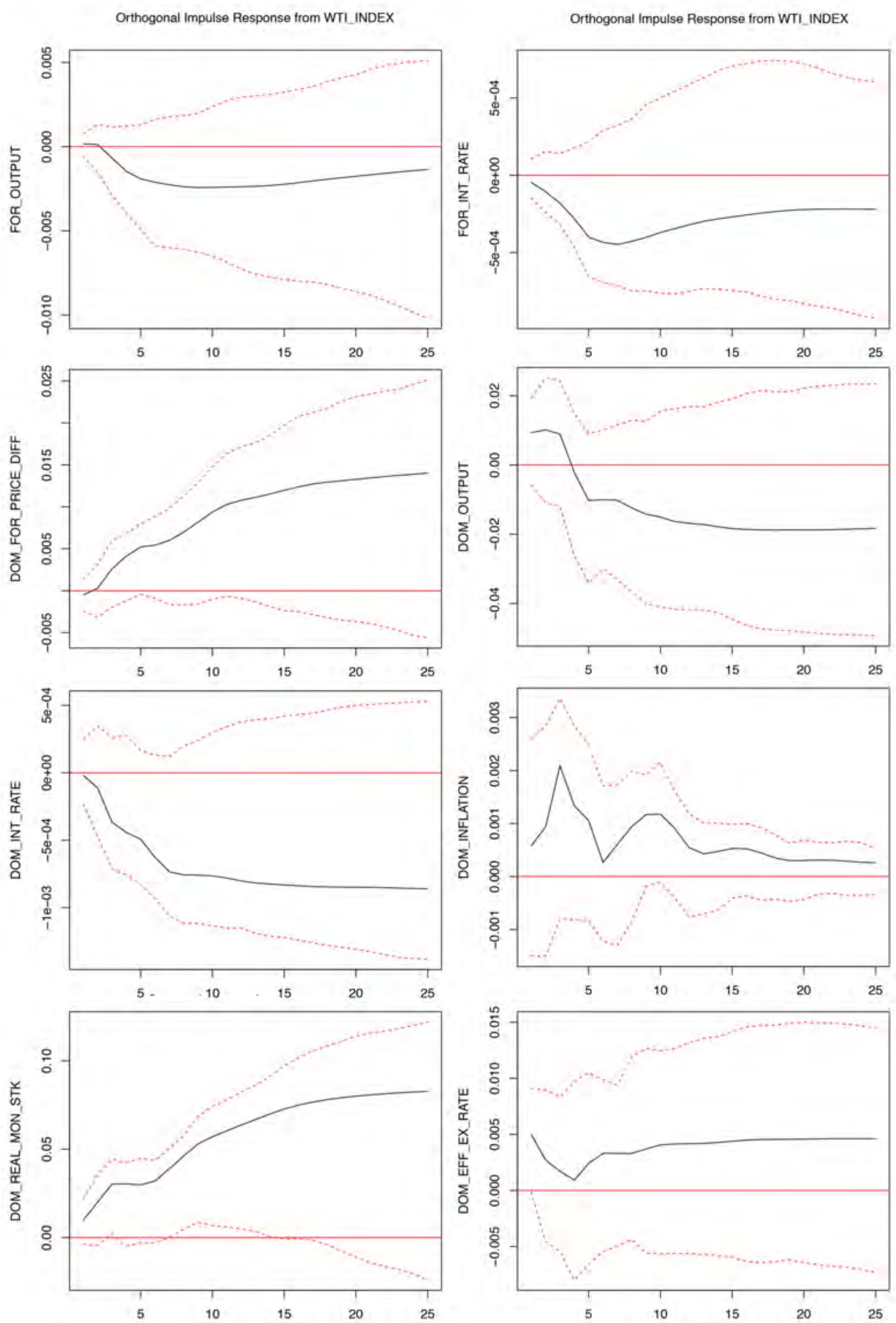

Figure 3.2: VAR IRF WTI shocks

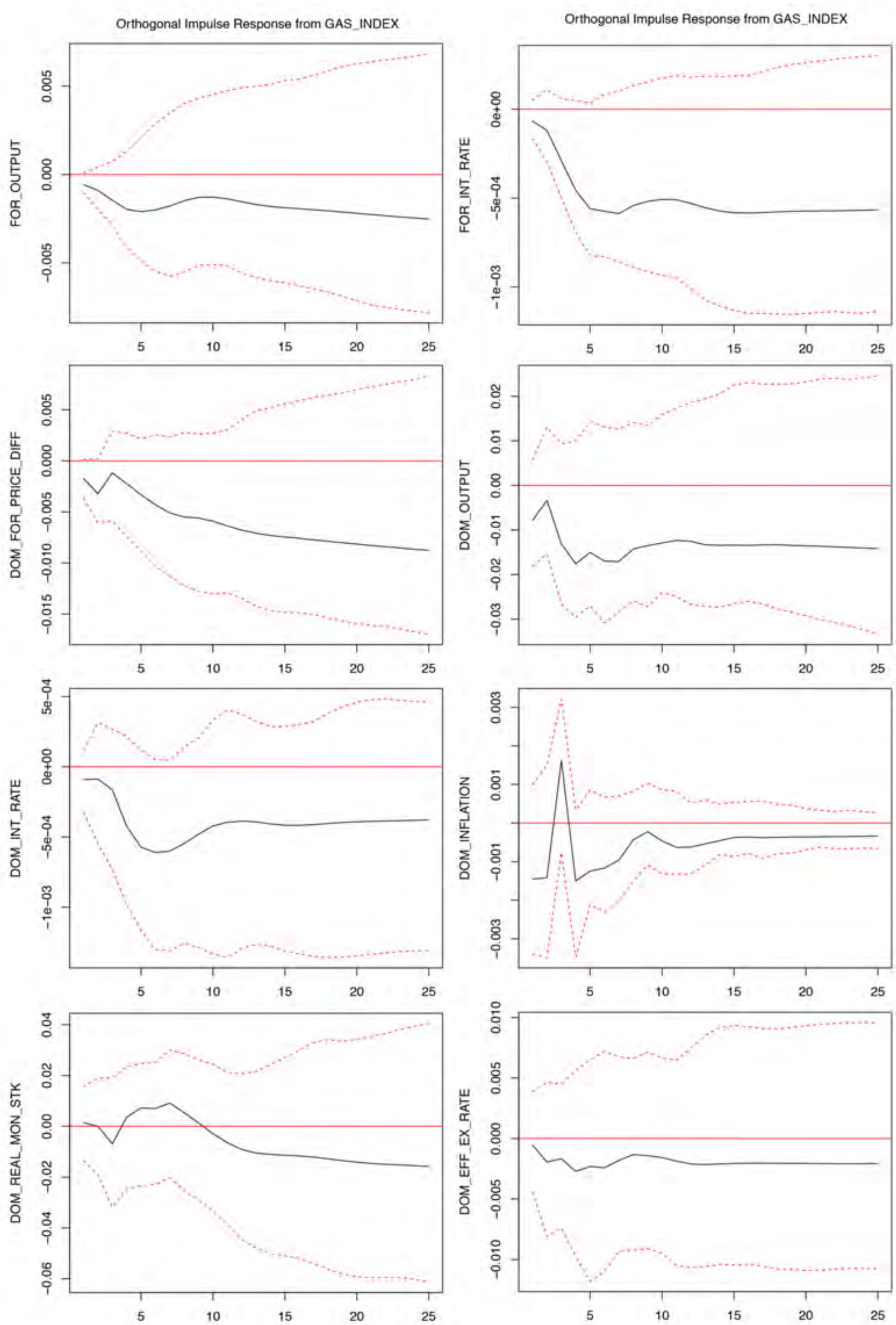

Figure 3.3: VAR IRF GAS shocks

Variable	Ahead	$\xi_t^{p^o}$	$\xi_t^{p^g}$	$\xi_t^{(p-p^*)}$	$\xi_t^{y^*}$	$\xi_t^{r^*}$	ξ_t^{y}	$\xi_t^{(h-y)}$	ξ_t^{p}	ξ_t^{r}	ξ_t^{e}
$(p_t - p_t^*)$	1	0.003	0.042	0.955	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.053	0.043	0.552	0.065	0.018	0.004	0.010	0.179	0.072	0.004
	8	0.146	0.093	0.364	0.041	0.051	0.023	0.008	0.168	0.092	0.014
	12	0.212	0.101	0.234	0.022	0.088	0.072	0.005	0.153	0.101	0.012
	18	0.254	0.107	0.148	0.011	0.116	0.136	0.010	0.116	0.095	0.007
	24	0.264	0.106	0.103	0.013	0.126	0.182	0.019	0.086	0.088	0.013
y_t^*	1	0.004	0.041	0.011	0.944	0.000	0.000	0.000	0.000	0.000	0.000
	4	0.016	0.042	0.010	0.775	0.000	0.011	0.013	0.129	0.000	0.002
	8	0.035	0.034	0.025	0.703	0.000	0.004	0.022	0.166	0.001	0.011
	12	0.037	0.024	0.031	0.676	0.001	0.002	0.023	0.175	0.002	0.030
	18	0.031	0.021	0.035	0.649	0.000	0.002	0.025	0.177	0.003	0.055
	24	0.023	0.021	0.038	0.625	0.000	0.007	0.029	0.172	0.004	0.081
r_t^*	1	0.005	0.011	0.007	0.159	0.818	0.000	0.000	0.000	0.000	0.000
	4	0.033	0.081	0.012	0.386	0.331	0.075	0.017	0.056	0.000	0.009
	8	0.071	0.133	0.007	0.337	0.228	0.101	0.038	0.057	0.002	0.027
	12	0.070	0.136	0.009	0.307	0.209	0.107	0.058	0.043	0.008	0.053
	18	0.057	0.148	0.014	0.277	0.180	0.104	0.070	0.029	0.014	0.107
	24	0.048	0.152	0.018	0.251	0.161	0.101	0.077	0.021	0.017	0.153
y_t	1	0.024	0.017	0.052	0.123	0.014	0.769	0.000	0.000	0.000	0.000
	4	0.029	0.058	0.084	0.300	0.012	0.436	0.025	0.030	0.011	0.016
	8	0.041	0.086	0.069	0.264	0.032	0.294	0.032	0.033	0.028	0.121
	12	0.058	0.076	0.056	0.221	0.052	0.209	0.039	0.036	0.035	0.218
	18	0.073	0.065	0.041	0.193	0.065	0.144	0.038	0.043	0.038	0.299
	24	0.077	0.059	0.032	0.182	0.069	0.115	0.035	0.048	0.037	0.346
$(h_t - y_t)$	1	0.026	0.001	0.001	0.011	0.147	0.000	0.815	0.000	0.000	0.000
	4	0.134	0.004	0.037	0.006	0.180	0.046	0.567	0.007	0.005	0.015
	8	0.227	0.008	0.040	0.006	0.196	0.040	0.412	0.009	0.033	0.028
	12	0.321	0.006	0.025	0.004	0.216	0.022	0.283	0.012	0.053	0.059
	18	0.370	0.008	0.014	0.002	0.233	0.028	0.203	0.017	0.062	0.064
	24	0.387	0.010	0.011	0.003	0.238	0.042	0.180	0.016	0.062	0.051
Δp_t	1	0.005	0.029	0.908	0.002	0.001	0.001	0.002	0.053	0.000	0.000
	4	0.054	0.066	0.558	0.030	0.008	0.016	0.044	0.181	0.027	0.016
	8	0.063	0.083	0.499	0.038	0.012	0.038	0.051	0.164	0.031	0.020
	12	0.083	0.085	0.471	0.039	0.015	0.041	0.052	0.160	0.033	0.021
	18	0.088	0.089	0.460	0.041	0.015	0.044	0.051	0.156	0.033	0.021
	24	0.091	0.092	0.455	0.043	0.015	0.044	0.051	0.155	0.032	0.021
r_t	1	0.000	0.007	0.000	0.013	0.000	0.000	0.051	0.023	0.906	0.000
	4	0.035	0.023	0.007	0.124	0.020	0.007	0.024	0.052	0.683	0.025
	8	0.083	0.063	0.004	0.236	0.019	0.005	0.025	0.021	0.498	0.045
	12	0.109	0.056	0.003	0.247	0.023	0.007	0.026	0.013	0.466	0.049
	18	0.130	0.049	0.003	0.244	0.028	0.013	0.031	0.008	0.431	0.063
	24	0.139	0.045	0.004	0.229	0.031	0.019	0.036	0.006	0.411	0.080
e_t	1	0.041	0.000	0.037	0.009	0.000	0.098	0.001	0.000	0.018	0.795
	4	0.019	0.007	0.013	0.005	0.012	0.278	0.006	0.004	0.011	0.646
	8	0.022	0.009	0.008	0.003	0.007	0.260	0.004	0.004	0.006	0.677
	12	0.027	0.008	0.005	0.002	0.005	0.245	0.003	0.004	0.004	0.696
	18	0.033	0.009	0.004	0.001	0.003	0.226	0.002	0.004	0.003	0.715
	24	0.037	0.009	0.003	0.001	0.003	0.214	0.002	0.005	0.002	0.725

Table 3.6: FEVD VAR

The Forecast Error Variance Decomposition (FEVD) of the unrestricted VAR model is illustrated in table 3.6. It shows that oil and domestic output shocks are the two major factors of the variance of the differential between domestic and foreign price levels, and they account of 44.6% of the variation at 24 month horizon. In all other variables, except for Trinidad and Tobago's money velocity and interest rate, an oil shock does not play a significant role in the forecast error variance. A gas shock only had a sizable effect of 15.2% on the error variance of foreign interest rate.

3.4.4 Model Restrictions Testing for Weak Exogenity

Since it was of interest to isolate the commodities within the model, it was assumed that the oil price index, p_t^o, and the gas price index, p_t^g, were both exogenous. To test this assumption, it was necessary to restrict the α matrix. The restrictions are contained within an $r \times m$ matrix A such that $\alpha = A\Psi$ with Ψ being an unrestricted loading matrix and $0 = \beta'\alpha$. If the hypothesis $\mathcal{H}_4 : \alpha = A\Psi$ cannot be rejected, it can be concluded that the VECM model contains exogenous variables.

By applying exogenous restrictions on both oil and gas, commodities price indexes are considered as forcing variables of the model. It would be ill-suited to just investigate the macroeconomic effects of exogenous oil shock as in the case of [Kil08b], [BK04] and [LNR95] for Trinidad and Tobago because it is an exporter of both oil and gas commodities with natural gas exports yielding a larger concentration of exports. In addition, Trinidad and Tobago and to some extent, the OECD are considered individually small in both demand and supply of oil and gas, and therefore cannot affect the LNG and oil markets. For this reason, it was assumed both commodities were exogenous within the model.

The results of the exogenous restrictions on both the oil and gas commodities are shown in table 3.7. Where $\mathcal{H}_{4,p_t^o}$ and $\mathcal{H}_{4,p_t^g}$ are the tests for the individual variables to be exogenous, $\mathcal{H}_{4,p_t^o,p_t^g}$ are the tests where both variables are considered exogenous. The results of the test are surprising due to the fact that at the individual test have the same order of cointegrations as the combined tests. Table 3.7 shows that there are three cointegration relationships with oil and gas price indexes were considered exogenous.

Hypothesis	Test Statistc	P-Value
$\mathcal{H}_{4,p_t^o} \| \mathcal{H}_1(r=1)$	0.198	0.656
$\mathcal{H}_{4,p_t^o} \| \mathcal{H}_1(r=2)$	0.770	0.680
$\mathcal{H}_{4,p_t^o} \| \mathcal{H}_1(r=3)$	1.169	0.761
$\mathcal{H}_{4,p_t^o} \| \mathcal{H}_1(r=4)$	19.391	0.001
$\mathcal{H}_{4,p_t^o} \| \mathcal{H}_1(r=5)$	19.459	0.002
$\mathcal{H}_{4,p_t^g} \| \mathcal{H}_1(r=1)$	0.000	0.997
$\mathcal{H}_{4,p_t^g} \| \mathcal{H}_1(r=2)$	1.154	0.562
$\mathcal{H}_{4,p_t^g} \| \mathcal{H}_1(r=3)$	1.918	0.590
$\mathcal{H}_{4,p_t^g} \| \mathcal{H}_1(r=4)$	14.064	0.007
$\mathcal{H}_{4,p_t^g} \| \mathcal{H}_1(r=5)$	17.295	0.004
$\mathcal{H}_{4,p_t^o,p_t^g} \| \mathcal{H}_1(r=1)$	0.314	0.855
$\mathcal{H}_{4,p_t^o,p_t^g} \| \mathcal{H}_1(r=2)$	1.512	0.825
$\mathcal{H}_{4,p_t^o,p_t^g} \| \mathcal{H}_1(r=3)$	2.610	0.856
$\mathcal{H}_{4,p_t^o,p_t^g} \| \mathcal{H}_1(r=4)$	26.542	0.001
$\mathcal{H}_{4,p_t^o,p_t^g} \| \mathcal{H}_1(r=5)$	31.847	0.000

Table 3.7: Testing Weak Exogeneity of p_t^o and p_t^g

The model is further restricted to accommodate the economic theory that was presented in earlier sections. To achieve this, we restrict the α and β matrices to encompass the restrictions in equation 3.38. To test the individual restrictions the method introduced in ([J$^+$92]) was utilized. This method permitted to check how many times an individual restriction was embedded within the underlying cointegration equations. In addition to the individual restrictions, a test was conducted with all restrictions applied together as a unit. The results of the tests are shown in table 3.8. For all but the real inflation, the restrictions were present in only one cointegration equation. For the case of the real inflation restriction, there was no evidence at a 0.05% significant level level that it existed in any cointegration relationship of order one thru five. When all restrictions were applied as a unit, there was evidence at 0.05% significant level that restrictions were embedded within one cointegration equation.

These results illustrate a contrast from the unrestricted model, which had evidence of five cointegration relationships. Whereas, the restrictions on both the α and β matrices illustrated the existence of only one cointegration relationship. These results may seem dismal in the sense that there is a reduction in the efficiency of the estimation to produce relevant results. But it will be shown that there were benefits from utilizing the restricted VECM estimated model for analysis when compared to an ARMA(4,4) base model.

The results of the estimated α matrix with all restrictions applied as a unit are shown in table 3.9. The exogenous restrictions on oil and gas are represented by the first two rows of zeros in the α matrix. Hence, the cointegration relationships are not involved in dynamics of the oil and gas price index movements. A surprising find was that both the domestic and foreign interest rates mostly do not depend on the first two cointegration. This is illustrated by the zeros of the first two columns of the rows of the domestic and foreign interest rates.

The estimation of the restricted cointegration matrix, β, are shown in table 3.10. The columns of β have been normalized to each column's first row entry. The complete cointegration matrix, $\Pi = \alpha\beta'$, is shown in table 3.11. The column labeled 'a' represents the constant term of equation (3.34) in this equation b is equal to zero due to the model being estimated without a trend. This is because the data did not positively identify existence of a trend term. The Π matrix clearly illustrates

Hypothesis	Test Statistic	P-Value
$\mathcal{H}_{2,(p_t-p_t^*-e_t)}\|\mathcal{H}_1(r=1)$	2.427	0.297
$\mathcal{H}_{2,(p_t-p_t^*-e_t)}\|\mathcal{H}_1(r=2)$	19.377	0.001
$\mathcal{H}_{2,(p_t-p_t^*-e_t)}\|\mathcal{H}_1(r=3)$	34.219	0.000
$\mathcal{H}_{2,(p_t-p_t^*-e_t)}\|\mathcal{H}_1(r=4)$	48.447	0.000
$\mathcal{H}_{2,(p_t-p_t^*-e_t)}\|\mathcal{H}_1(r=5)$	67.416	0.000
$\mathcal{H}_{2,(r_t-r_t^*)}\|\mathcal{H}_1(r=1)$	12.056	0.002
$\mathcal{H}_{2,(r_t-r_t^*)}\|\mathcal{H}_1(r=2)$	24.765	0.000
$\mathcal{H}_{2,(r_t-r_t^*)}\|\mathcal{H}_1(r=3)$	37.021	0.000
$\mathcal{H}_{2,(r_t-r_t^*)}\|\mathcal{H}_1(r=4)$	42.551	0.000
$\mathcal{H}_{2,(r_t-r_t^*)}\|\mathcal{H}_1(r=5)$	60.147	0.000
$\mathcal{H}_{2,(y_t-y_t^*)}\|\mathcal{H}_1(r=1)$	1.993	0.369
$\mathcal{H}_{2,(y_t-y_t^*)}\|\mathcal{H}_1(r=2)$	15.236	0.004
$\mathcal{H}_{2,(y_t-y_t^*)}\|\mathcal{H}_1(r=3)$	29.779	0.000
$\mathcal{H}_{2,(y_t-y_t^*)}\|\mathcal{H}_1(r=4)$	40.334	0.000
$\mathcal{H}_{2,(y_t-y_t^*)}\|\mathcal{H}_1(r=5)$	56.607	0.000
$\mathcal{H}_{2,(h_t-y_t)}\|\mathcal{H}_1(r=1)$	1.111	0.292
$\mathcal{H}_{2,(h_t-y_t)}\|\mathcal{H}_1(r=2)$	13.802	0.001
$\mathcal{H}_{2,(h_t-y_t)}\|\mathcal{H}_1(r=3)$	23.581	0.000
$\mathcal{H}_{2,(h_t-y_t)}\|\mathcal{H}_1(r=4)$	28.578	0.000
$\mathcal{H}_{2,(h_t-y_t)}\|\mathcal{H}_1(r=5)$	43.421	0.000
$\mathcal{H}_{2,(r_t-p_t)}\|\mathcal{H}_1(r=1)$	15.983	0.000
$\mathcal{H}_{2,(r_t-p_t)}\|\mathcal{H}_1(r=2)$	43.842	0.000
$\mathcal{H}_{2,(r_t-p_t)}\|\mathcal{H}_1(r=3)$	57.487	0.000
$\mathcal{H}_{2,(r_t-p_t)}\|\mathcal{H}_1(r=4)$	74.094	0.000
$\mathcal{H}_{2,(r_t-p_t)}\|\mathcal{H}_1(r=5)$	93.388	0.000
$\mathcal{H}_{2,All}\|\mathcal{H}_1(r=1)$	2.427	0.297
$\mathcal{H}_{2,All}\|\mathcal{H}_1(r=2)$	19.377	0.001
$\mathcal{H}_{2,All}\|\mathcal{H}_1(r=3)$	34.219	0.000
$\mathcal{H}_{2,All}\|\mathcal{H}_1(r=4)$	48.447	0.000
$\mathcal{H}_{2,All}\|\mathcal{H}_1(r=5)$	67.416	0.000

Table 3.8: A and B Restriction on Cointegrated Relationships

the exogeneity of the oil and gas variables by the zeros in each of their respected columns.

Variable	α_1	α_2	α_3	α_4	α_5
Δp_t^o	0.0000	0.0000	0.0000	0.0000	0.0000
Δp_t^g	0.0000	0.0000	0.0000	0.0000	0.0000
$\Delta(p_t - p_t^*)$	0.0019	0.0059	0.0097	-0.0012	-0.0023
Δy_t^*	-0.0006	0.0006	0.0008	-0.0009	-0.0017
Δr_t^*	0.0000	-0.0002	0.0005	0.0008	-0.0004
Δy_t	0.0028	-0.0180	0.0547	-0.0785	-0.0159
$\Delta(h_t - y_t)$	0.0044	0.0207	0.0958	-0.0224	0.0238
$\Delta(\Delta p_t)$	0.0010	0.0055	0.0119	0.0009	-0.0018
Δr_t	0.0000	0.0000	-0.0011	0.0007	0.0001
Δe_t	0.0024	0.0004	0.0227	0.0047	-0.0029

Table 3.9: Estimated Model: Weights (α)

Variable	β_1	β_2	β_3	β_4	β_5
Δp_t^o	1.0000	1.0000	1.0000	1.0000	1.0000
Δp_t^g	-2.4402	-0.7903	0.0681	-0.6517	0.8554
$\Delta(p_t - p_t^*)$	7.3776	-7.1795	5.5297	-1.6595	7.9532
Δy_t^*	58.3769	-5.4381	1.7897	-2.8401	-11.4213
Δr_t^*	-847.7679	-275.5254	36.0902	-88.7329	239.1138
Δy_t	-5.1754	6.2935	-3.6137	1.1067	-0.7091
$\Delta(h_t - y_t)$	-5.5484	1.6180	-1.8224	-0.0957	-0.4321
$\Delta(\Delta p_t)$	1205.2834	-40.0158	-63.0471	-54.0485	-14.4175
Δr_t	223.1180	156.8735	-3.6600	45.1439	1.6275
Δr_t	-7.3776	7.1795	-5.5297	1.6595	-7.9532
a	-518.4243	8.7202	11.4120	26.5994	87.2033

Table 3.10: Estimated Model: β Matrix

3.4.5 Core Vector Error Correction Model

The estimated reduced form VECM model, with the embedded restrictions on α and β discussed in the previous section, is shown in table 3.12. The long-run error specification are represented by $\epsilon_{1,t}$ PPP, $\epsilon_{2,t}$ interest rate differential, $\epsilon_{3,t}$ output differential, $\epsilon_{4,t}$ money stock, $\epsilon_{5,t}$ real inflation relationship. The equations $\Delta(p_t - p_t^*)$,

Variable	p^o	p^g	$(p-p^*)$	y^*	r^*	y	$(h-y)$	Δp	r	Δe	a
Δp_t^o	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Δp_t^g	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta(p_t - p_t^*)$	0.014	-0.009	0.009	0.127	-3.350	-0.007	-0.017	1.567	1.261	-0.009	-1.067
Δy_t	-0.002	0.000	-0.017	-0.017	0.053	0.004	0.004	-0.768	-0.086	0.017	0.169
Δr_t^*	0.001	-0.001	-0.000	0.007	-0.130	-0.002	-0.001	-0.009	0.007	0.000	-0.034
Δy_t	-0.054	0.048	0.456	0.761	7.756	-0.401	-0.129	5.075	-5.975	-0.456	-4.438
$\Delta(h_t - y_t)$	0.122	0.014	0.640	0.109	1.678	-0.280	-0.173	-0.672	2.909	-0.640	0.457
$\Delta(\Delta p_t)$	0.017	-0.008	0.017	0.065	-2.405	-0.011	-0.017	0.158	1.063	-0.017	-0.448
Δr_t	-0.000	-0.000	-0.006	-0.003	-0.105	0.004	0.001	0.074	0.044	0.006	-0.002
Δe_t	0.027	-0.010	0.108	0.196	-2.425	-0.084	-0.053	1.204	0.722	-0.108	-1.097

Table 3.11: Coefficient Matrix: Π

Δr_t^*, $\Delta(h_t - y_t)$, $\Delta(\Delta p_t)$ and $\Delta(\Delta p_t)$ all have at least one or more long-run error specification significant. The VECM model displays a good fit when compared to a benchmark ARMA(4,4) model. In all cases, the VECM model fitted the data better than the benchmark model. The greatest improvement came from the $\Delta(p_t - p_t^*)$ and $\Delta y_t *$. Since the $\Delta y_t *$ equation did not have any long-run error specification significant, this result is from superior transitory dynamics of the VECM model. In the case of $\Delta(p_t - p_t^*)$, contribution of the two significant long-run error specification play an role in improving the R^2.

The plots of the data with an overlay of the VECM estimations are shown in figure 3.4. When looking at the plot of the real effective exchange rate, Δe_t, it is apparent that the model does a poor job of fitting the data. This maybe due to the structural shift that occurred on April 13,1993 when Trinidad and Tobago floated its exchange rate. It took until 1996 for the exchange rate to find its appropriate trading range [WMS00]. Also, the model had difficulties matching the movement of the exchange rate prior to the finance crises of 2008. Also, the VECM had complications with the domestic and foreign interest rates showing particular difficulties in the 2001 to 2008 time range. Lastly, the domestic output, Δy_t, estimation of VECM were sensitive to output swings and the model could not accommodate appropriately and mostly overshot the data.

To assess the core VECM model fit performance, it was compared to a benchmark ARMA(4,4). This is considered the unrestricted comparison. To also gain insights to the short-run, the core VECM model was restricted by dropping lag variables with a p-value greater than 0.25 one at a time. The restricted core VECM model was then compared to ARMA models whose lags were selected by AIC and BIC methods. The result of the comparison is shown in table 3.13 [3]. The unrestricted core VECM model provided an improvement in fitting the data when compared to all the models. This was specially the case in the price difference equation, $\Delta(p_t - p_t^*)$. Even though the core VECM had significant improvements over the other models, it will be ill-advised to utilize this model in its current form for establishing entry points for execution of a carry trade. This is due to difficulties of the core model to replicate the dynamics of the domestic and foreign interest rates and the effective exchange rate. To make the model useful, it needs to be further calibrated. In addition, appropriate testing and forecasting must be executed to utilize the model in real trading scenarios.

3.5 SVEC Estimation

In the prior section, the core VECM model was based on a reduced form VECM model. To gain insight into the effects of transitory and permanent shocks, a Structural Vector Error Correction (SVEC) model was utilized. The VECM model is represented by equation 3.39.

[3]Note for table (3.12). The values in the parentheses represent the standard error. The significane level are indicated by the following symbols: 10% †, 5% ‡, 1% ⋆. For the residual analysis is represented by $\chi^2_{SC}[4]$ and $\chi^2_N[1]$ which indicate the chi-squared statistics for serial correlation and normality.

Equation	$\Delta(p_t - p_t^*)$	Δy_t^*	Δr_t^*	Δy_t	$\Delta(h_t - y_t)$	$\Delta(\Delta p_t)$	Δr_t	Δe_t
$\epsilon_{1,t}$	0.014†	-0.002	0.001	-0.066	0.114†	0.016†	0.000	0.022
	(0.006)	(0.002)	(0.001)	(0.044)	(0.047)	(0.006)	(0.001)	(0.018)
$\epsilon_{2,t}$	-0.009‡	0.000	-0.001‡	0.043	0.009	-0.008‡	-0.001	-0.014
	(0.003)	(0.001)	(0.001)	(0.022)	(0.023)	(0.003)	(0.000)	(0.009)
$\epsilon_{3,t}$	0.018	-0.018	0.000	0.359	0.555†	0.011	-0.006	0.049
	(0.03)	(0.01)	(0.002)	(0.21)	(0.228)	(0.03)	(0.004)	(0.087)
$\epsilon_{4,t}$	0.128‡	-0.017	0.007†	0.762‡	0.109	0.067	-0.003	0.196
	(0.042)	(0.013)	(0.003)	(0.297)	(0.322)	(0.043)	(0.006)	(0.123)
$\epsilon_{5,t}$	-3.144⋆	0.064	-0.122	6.133	0.221	-2.478‡	-0.109	-3.464
	(0.778)	(0.247)	(0.063)	(5.437)	(5.901)	(0.78)	(0.101)	(2.252)
s_{t-1}	-0.005	0.003†	0.000	0.023	-0.008	-0.001	0.000	0.006
	(0.004)	(0.001)	(0.000)	(0.025)	(0.027)	(0.004)	(0.000)	(0.010)
s_{t-2}	-0.006	0.002	0.000	0.036	-0.026	-0.007	0.000	-0.010
	(0.004)	(0.001)	(0.000)	(0.030)	(0.033)	(0.004)	(0.001)	(0.012)
s_{t-3}	0.004	0.003†	0.000	0.063†	-0.027	0.005	0.001	0.002
	(0.004)	(0.001)	(0.000)	(0.029)	(0.032)	(0.004)	(0.001)	(0.012)
p_{t-1}^o	-0.018	0.001	0.000	-0.076	0.170	-0.014	-0.003	0.003
	(0.014)	(0.005)	(0.001)	(0.100)	(0.109)	(0.014)	(0.002)	(0.042)
p_{t-1}^g	-0.011	0.001	0.000	0.046	-0.037	-0.010	0.001	-0.014
	(0.006)	(0.002)	(0.000)	(0.040)	(0.044)	(0.006)	(0.001)	(0.017)
$(p_{t-1} - p_{t-1}^*)$	-1.876⋆	0.269	-0.009	-6.937†	1.862	-1.908⋆	-0.084	-1.145
	(0.49)	(0.156)	(0.04)	(3.427)	(3.719)	(0.491)	(0.064)	(1.419)
y_{t-1}^*	-0.595	0.678⋆	0.121⋆	7.215†	1.022	-0.356	-0.034	1.591
	(0.405)	(0.129)	(0.033)	(2.831)	(3.072)	(0.406)	(0.053)	(1.173)
r_{t-1}^*	-2.771	0.050	-0.025	8.086	8.297	-2.419	0.341	-2.562
	(1.523)	(0.483)	(0.123)	(10.646)	(11.554)	(1.527)	(0.197)	(4.41)
y_{t-1}	0.019	-0.009	-0.004‡	-0.545⋆	-0.284†	0.009	0.006‡	-0.153
	(0.017)	(0.005)	(0.001)	(0.12)	(0.131)	(0.017)	(0.002)	(0.05)
$(h_{t-1} - y_{t-1})$	0.004	0.008	0.002	0.176	0.038	0.006	0.004	-0.055
	(0.016)	(0.005)	(0.001)	(0.109)	(0.118)	(0.016)	(0.002)	(0.045)
(p_{t-1})	2.048⋆	-0.330†	0.009	7.062†	-3.092	1.042‡	0.092	0.988
	(0.495)	(0.157)	(0.04)	(3.458)	(3.752)	(0.496)	(0.064)	(1.432)
r_{t-1}	1.193	0.117	0.039	2.158	0.876	0.900	0.397⋆	-2.860
	(0.877)	(0.278)	(0.071)	(6.128)	(6.65)	(0.879)	(0.114)	(2.539)
e_{t-1}	0.035	0.010	-0.002	-0.025	0.250	0.043	0.005	-0.207
	(0.045)	(0.014)	(0.004)	(0.311)	(0.338)	(0.045)	(0.006)	(0.129)
p_{t-2}^o	0.014	-0.006	0.001	0.104	0.055	0.019	-0.002	0.006
	(0.012)	(0.004)	(0.001)	(0.083)	(0.09)	(0.012)	(0.002)	(0.034)
p_{t-2}^g	0.005	-0.001	-0.001	0.007	-0.060	0.005	0.000	-0.007
	(0.006)	(0.002)	(0.000)	(0.04)	(0.043)	(0.006)	(0.001)	(0.016)
$(p_{t-2} - p_{t-2}^*)$	-0.108	0.310	0.033	3.197	-3.313	0.289	-0.005	-0.724
	(0.51)	(0.162)	(0.041)	(3.566)	(3.87)	(0.512)	(0.066)	(1.477)
y_{t-2}^*	0.212	-0.103	-0.006	-5.460	0.029	0.172	0.065	-0.103
	(0.44)	(0.140)	(0.036)	(3.079).	(3.342)	(0.442)	(0.057)	(1.276)
r_{t-2}^*	-0.875	0.660	0.151	-4.235	-13.323	-0.291	0.158	1.581
	(1.392)	(0.442)	(0.113)	(9.729)	(10.558)	(1.396)	(0.180)	(4.03)
y_{t-2}	-0.014	-0.005	-0.003	-0.212	0.030	-0.013	0.004	-0.104
	(0.024)	(0.008)	(0.002)	(0.167)	(0.181)	(0.024)	(0.003)	(0.069)
$(h_{t-2} - y_{t-2})$	0.050‡	0.002	-0.001	-0.261†	-0.008	0.044‡	-0.003	0.013
	(0.016)	(0.005)	(0.001)	(0.11)	(0.12)	(0.016)	(0.002)	(0.046)
(p_{t-2})	1.961†	-0.691‡	-0.022	5.103	0.918	0.563	0.086	1.766
	(0.775)	(0.246)	(0.063)	(5.417)	(5.879)	(0.777)	(0.1)	(2.244)
r_{t-2}	2.180†	-0.135	0.014	-0.013	7.236	1.730	-0.353‡	0.906
	(0.957)	(0.304)	(0.078)	(6.694)	(7.264)	(0.96).	(0.124)	(2.773)
e_{t-2}	-0.008	0.027	-0.005	-0.431	0.206	0.007	0.007	-0.298
	(0.046)	(0.015)	(0.004)	(0.319)	(0.347)	(0.046)	(0.006)	(0.132)
R^2	0.722	0.811	0.523	0.503	0.439	0.694	0.522	0.290
σ	0.008	0.003	0.001	0.059	0.064	0.009	0.001	0.025
Benchmark R^2	0.238	0.512	0.225	0.173	0.170	0.475	0.369	0.215
Benchmark σ	0.012	0.004	0.001	0.076	0.076	0.011	0.001	0.026
$\chi^2_{SC}[4]$	3.702	1.725	0.776	3.901	2.853	2.624	6.750	3.422
$\chi^2_{N}[1]$	5.833	9.354	15.854†	16.938†	15.042	12.333	15.042	27.229‡

Table 3.12: Reduced Form: Core Model Specification

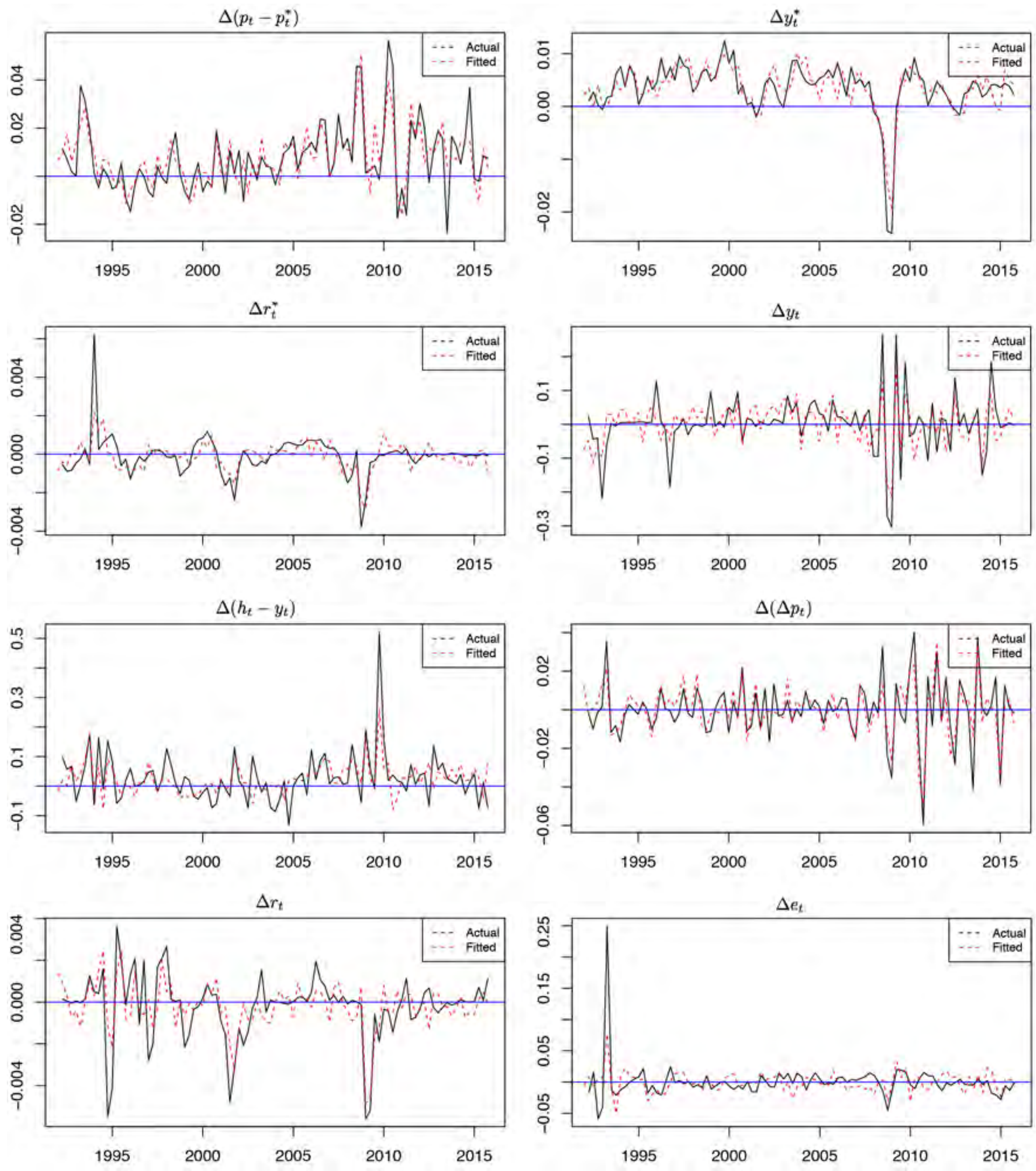

Figure 3.4: Model ECM Plots

Variable		Unrestricted		Restricted		
		ARMA(4,4)	VECM	ARMA(p,q) AIC	ARMA(p,q) BIC	VECM SR Rest.
$\Delta(p_t - p_t^*)$	AIC	-560.970	-586.205	-565.535	-562.854	-599.650
	BIC	-535.121	-511.839	-547.440	-555.099	-545.799
	R^2	0.238	0.722	0.256	0.126	0.714
	$(\widehat{p}, \widehat{q})$	–	–	(3,2)	(0,1)	–
	$\chi^2(m)$	–	–	–	–	2.56(8)
Δy_t^*	AIC	-805.609	-806.519	-813.107	-799.619	-824.806
	BIC	-779.759	-732.153	-802.768	-791.865	-778.648
	R^2	0.512	0.811	0.469	0.412	0.803
	$(\widehat{p}, \widehat{q})$	–	–	(2,0)	(1,0)	–
	$\chi^2(m)$	–	–	–	–	3.71(11)
Δr_t^*	AIC	-1081.673	-1068.747	-1090.716	-1085.575	-1098.462
	BIC	-1055.824	-994.381	-1072.621	-1077.820	-1067.690
	R^2	0.225	0.523	0.256	0.119	0.501
	$(\widehat{p}, \widehat{q})$	–	–	(4,1)	(1,0)	–
	$\chi^2(m)$	–	–	–	–	4.28(17)
Δy_t	AIC	-204.435	-212.822	-210.727	-210.727	-230.014
	BIC	-178.585	-138.456	-202.972	-202.972	-186.420
	R^2	0.173	0.503	0.067	0.067	0.466
	$(\widehat{p}, \widehat{q})$	–	–	(0,1)	(0,1)	–
	$\chi^2(m)$	–	–	–	–	6.81(12)
$\Delta(h_t - y_t)$	AIC	-204.394	-197.118	-206.964	-206.964	-223.996
	BIC	-178.545	-122.752	-201.794	-201.794	-198.352
	R^2	0.170	0.439	0.371	0.371	0.370
	$(\widehat{p}, \widehat{q})$	–	–	(0,0)	(0,0)	–
	$\chi^2(m)$	–	–	–	–	11.12(19)
$\Delta(\Delta p_t)$	AIC	-578.537	-585.661	-582.696	-582.696	-604.991
	BIC	-552.687	-511.295	-564.601	-564.601	-561.397
	R^2	0.475	0.694	0.480	0.480	0.679
	$(\widehat{p}, \widehat{q})$	–	–	(2,3)	(2,3)	–
	$\chi^2(m)$	–	–	–	–	4.67(12)
r_t	AIC	-1000.878	-978.482	-1000.878	-1000.050	-993.475
	BIC	-975.029	-904.115	-975.029	-992.296	-944.752
	R^2	0.369	0.522	0.369	0.192	0.496
	$(\widehat{p}, \widehat{q})$	–	–	(4,4)	(0,1)	–
	$\chi^2(m)$	–	–	–	–	5.01(10)
Δe_t	AIC	-413.057	-382.033	-417.975	-413.239	-409.551
	BIC	-387.207	-307.666	-407.635	-408.069	-378.778
	R^2	0.215	0.290	0.115	0.742	0.240
	$(\widehat{p}, \widehat{q})$	–	–	(1,1)	(0,0)	–
	$\chi^2(m)$	–	–	–	–	6.48(17)

Table 3.13: Core Model Comparison

$$\Delta z_t = \alpha\beta' z_{t-1} + \tau_1 \Delta z_{t-1} + ... + \tau_{p-1} z_{t-p+1} + B\epsilon_t \tag{3.39}$$

In this equation it is assumed that $u_t = B\epsilon_t$ and $\epsilon_t \sim N(0, I_k)$. Using the Beveridge-Nelson moving average representation, it was possible to break up the z_t into its shock representation shown in equation 3.40. Hence, z_t can be decomposed into $I(1)$ and $I(0)$ plus a initial value of z_0. The $I(1)$ term, $\Xi \sum_{i=1}^{t} u_i$, is the component of interest because it represents the common trend of the system. Hence, linking the shocks to the permanent effects.

$$z_t = \Xi \sum_{i=1}^{t} u_i + \sum_{j=0}^{\infty} \Xi u_{t-j} + z_0 \tag{3.40}$$

The long-run effects of the SVEC model are captured in the $\Xi B \sum_{t=1}^{\infty} \epsilon_t$ and the contemporaneous effects are embedded in the B matrix. A transitory shock is represented by a column of zeros in the ΞB. To estimate the contemporaneous impact matrix, B, and the long-run impact matrix, ΞB, it is necessary to have $\frac{1}{2}K(K-1)$ restrictions for identification with mandatory $r(r-1)/2$ restriction on B and $r(k-r)$ restriction on ΞB. The remaining restrictions can be placed on either matrices. To establish the restrictions, it was assumed that the effective real exchange rate was consider not to have a longrun impact. This assumption was established by the results of the VAR's FEVD, table 3.6. It is acknowledged that the effective real exchange rate does contribute a significant amount of forecast error variance to domestic output in the long-run, but in all other variables of interest it orchestrated a minimal role in the long run. It was believed that these minimal roles were due to the slack tolerances within the PPP, FIP and UIP arbitrage conditions.

The estimated contemporaneous impact and long-run impact matrix are shown in tables 3.14 and 3.15, respectively. The t-statistics are presented within the paren-

Shock	$\xi_t^{p^o}$	$\xi_t^{p^g}$	$\xi_t^{(p-p^*)}$	$\xi_t^{y^*}$	$\xi_t^{r^*}$	ξ_t^{y}	$\xi_t^{(h-y)}$	ξ_t^{p}	ξ_t^{r}	ξ_t^{e}
p_t^g	0.071	-0.014	-0.008	-0.067	0.010	0.016	-0.001	-0.028	0.007	0.017
	(2.934)	(-0.739)	(-0.309)	(-1.941)	(0.564)	(1.182)	(-0.069)	(-0.882)	(0.617)	(1.155)
p_t^o	0.043	0.151	0.029	-0.099	-0.022	0.015	0.021	0.002	-0.020	-0.021
	(1.261)	(3.528)	(0.681)	(-1.695)	(-0.605)	(0.632)	(1.03)	(0.092)	(-0.962)	(-1.001)
$(p_t - p_t^*)$	-0.002	-0.001	0.007	-0.001	0.004	0.002	-0.004	0.001	-0.001	0.003
	(-1.215)	(-0.479)	(2.854)	(-0.507)	(2.11)	(1.799)	(-2.69)	(1.185)	(-1.346)	(1.197)
y_t^*	0.002	0.000	0.001	0.002	0.001	0.001	-0.001	-0.001	0.000	0.000
	(2.447)	(0.31)	(1.178)	(2.516)	(1.114)	(2.925)	(-2.008)	(-0.839)	(0.463)	(-0.836)
r_t^*	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
	(0.207)	(0.787)	(-1.675)	(0.271)	(2.899)	(1.478)	(-0.944)	(0.405)	(-0.036)	(-1.004)
y_t	-0.003	-0.008	-0.010	0.004	-0.002	0.068	0.010	-0.003	-0.002	0.009
	(-0.242)	(-0.723)	(-0.863)	(0.397)	(-0.164)	(4.237)	(1.167)	(-0.508)	(-0.29)	(1.021)
$(h_t - y_t)$	0.007	-0.016	0.042	0.008	0.016	-0.001	0.051	-0.005	-0.012	-0.003
	(0.446)	(-1.266)	(2.576)	(0.686)	(1.27)	(-0.086)	(4.259)	(-0.538)	(-1.425)	(-0.645)
Δp_t	-0.002	-0.002	0.007	-0.003	0.004	0.002	-0.005	0.001	-0.001	0.001
	(-0.77)	(-0.814)	(2.956)	(-1.22)	(2.035)	(1.705)	(-2.951)	(0.801)	(-0.934)	(1.053)
r_t	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.001	0.000
	(-1.099)	(0.9)	(-0.233)	(-0.388)	(0.512)	(-0.199)	(-1.728)	(-0.887)	(2.775)	(0.863)
e_t	0.005	0.001	0.007	-0.004	0.006	-0.001	0.000	0.007	0.021	0.002
	(1.284)	(0.226)	(1.469)	(-0.912)	(1.354)	(-0.239)	(-0.15)	(0.773)	(2.936)	(1.153)

Table 3.14: Estimated coefficients of the contemporaneous impact matrix

theses. Even though the estimated contemporaneous impact matrix shows that the oil and gas shocks do not directly affect the domestic and foreign interest rate, there is feedback from two variables in the case of the domestic interest rate. The domestic interest rate has feedback from itself and the effective exchange rate. Whereas,the foreign interest rate has a feedback gain from only itself, which implies the commodity shocks do not affect the foreign interest rate contemporaneously.

In the long run, oil and gas disturbances do not play a significant role in the dynamics of domestic inflation, interest rate, and the real effective exchange rate. It was not surprising to see that both the oil and gas disturbances did not have long-run effects on the inflation dynamics. This is because the Trinidad and Tobago is endowed with both these commodities, and this permits its local markets to absorb inflation pressures manifested by oil or gas disturbances.

Shock	$\xi_t^{p^o}$	$\xi_t^{p^g}$	$\xi_t^{(p-p^*)}$	$\xi_t^{y^*}$	$\xi_t^{r^*}$	ξ_t^{y}	$\xi_t^{(h-y)}$	ξ_t^{p}	ξ_t^{r}	ξ_t^{e}
p_t^o	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(-6.035)									
p_t^g	0.101	0.154	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(-2.346)	(-5.435)								
$(p_t - p_t^*)$	0.006	-0.006	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(-0.555)	(-.595)	(-3.86)							
y_t^*	0.006	0.002	0.007	0.013	0.000	0.000	0.000	0.000	0.000	0.000
	(-0.934)	(-0.349)	(-1.405)	(-2.609)						
r_t^*	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000
	(-0.514)	(-0.661)	(-.665)	(-1.01)	(-3.242)					
y_t	0.010	0.002	-0.009	0.024	0.005	0.050	0.000	0.000	0.000	0.000
	(-0.653)	(-0.171)	(-.518)	(-1.364)	(-0.381)	(-4.476)				
$(h_t - y_t)$	0.030	-0.045	0.105	0.006	0.010	-0.016	0.070	0.000	0.000	0.000
	(-0.76)	(-1.087)	(-2.551)	(-0.235)	(-0.595)	(-1.099)	(-4.666)			
Δp_t	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
	(-0.745)	(-0.712)	(-.346)	(-1.337)	(-2.657)	(-3.859)	(-3.904)	(-0.886)		
r_t	0.000	0.001	-0.001	0.001	0.001	0.000	0.000	-0.001	0.001	0.000
	(-.429)	(-1.254)	(-.917)	(-1.376)	(-2.458)	(-0.494)	(-1.726)	(-.887)	(-2.996)	
e_t	0.006	0.001	0.005	-0.003	0.005	-0.008	0.000	0.008	0.013	0.000
	(-1.185)	(-0.181)	(-0.851)	(-.546)	(-0.915)	(-2.279)	(-.092)	(-0.83)	(-2.996)	

Table 3.15: Estimated coefficients of the long-run impact matrix

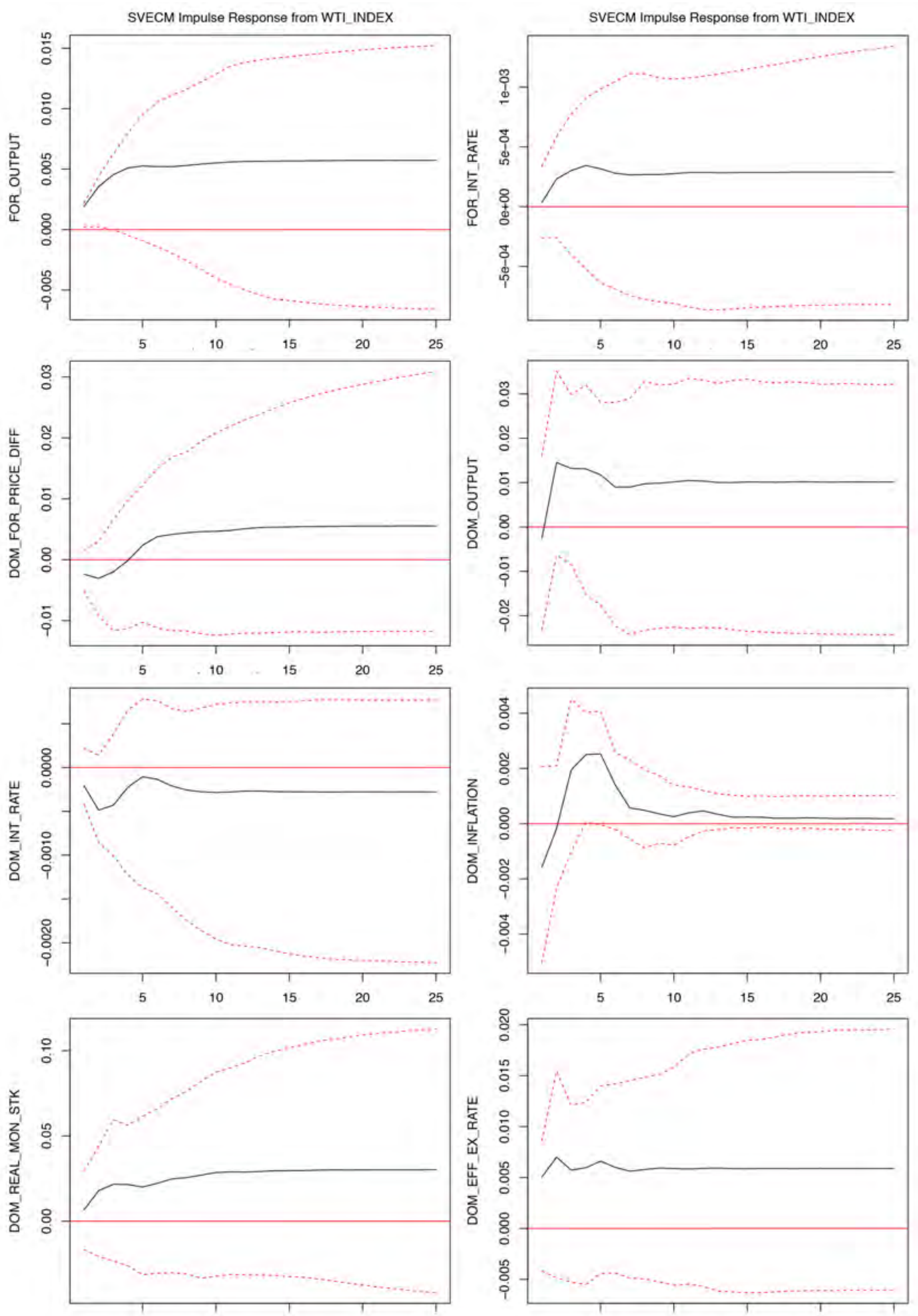

Figure 3.5: Impules Resonpses of WTI shock

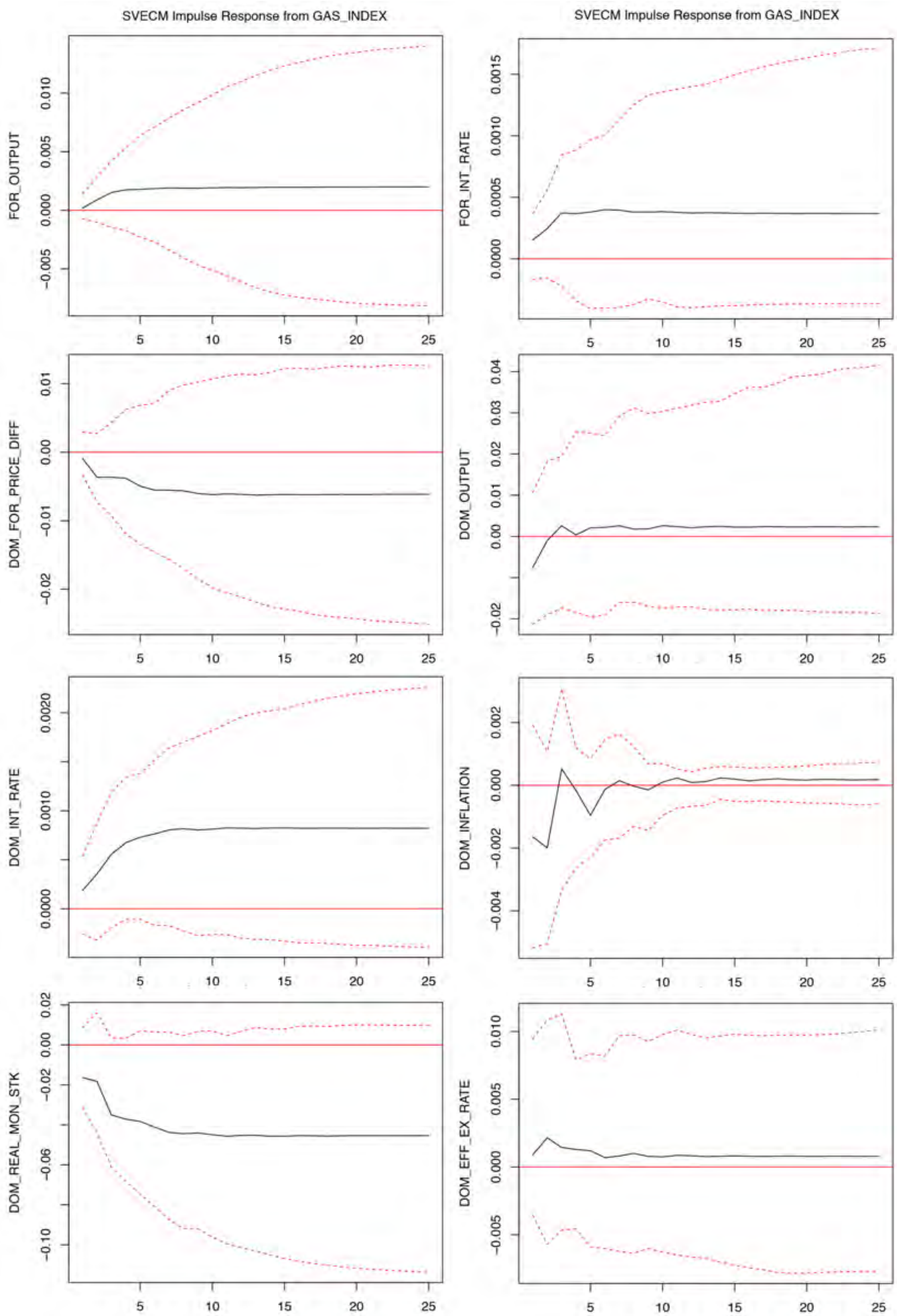

Figure 3.6: Impules Resonpses of GAS shock

The IRF diagrams show that an oil disturbance when compared to a gas disturbance resulted in a prominent response in both magnitude and duration for all domestic variables except the interest rate. This is of particular importance to Trinidad and Tobago's policymakers when trying to conduct both fiscal and monetary policies to offset effects from a weak commodity market.

The Impulse Response Functions (IRF) for both the oil and gas disturbances are illustrated in figures 3.5 and 3.6. The IRF for foreign output and interest rate are shown for reference purposes, but the real interest lies with that of the domestic IRFs. An important finding was that an oil disturbance when compared to a gas disturbance resulted in a prominent response in both magnitude and duration for all domestic variables, except the interest rate. The IRF diagrams show oil shocks settled for all domestic variables within seven to nine quarters after the the initiation of the disturbance. Whereas, a gas disturbance settled on all domestic variables within five to seven quarters. This is of particular importance to Trinidad and Tobago's policymakers when trying to conduct both fiscal and monetary policies to offset effects from a weak commodity market.

It is also shown that an oil and gas disturbance had opposite effects on the price differential between domestic and foreign CPIs; where an oil disturbance caused the domestic CPI to increase more compared to the foreign CPI. There could be many reasons for this phenomenon, one being that a unit of oil exports capture greater profitability when compared to a unit of gas exports. Hence an oil disturbance may result in a greater injection of foreign capital in the domestic economy, which could create inflationary pressures. This is illustrated in the domestic inflation IRF. An oil shock resulted in positive inflation for ten quarters. Whereas a gas shock caused inflation to be in negative territory most of the time. In the case of the domestic interest rate, a gas disturbance played a significant role in increasing the interest rate,

Variable	Qtr Ahead	$\xi_t^{p^o}$	$\xi_t^{p^g}$	$\xi_t^{(p-p^*)}$	$\xi_t^{y^*}$	$\xi_t^{r^*}$	ξ_t^{y}	$\xi_t^{(h-y)}$	ξ_t^{p}	ξ_t^{r}	ξ_t^{e}
$(p_t - p_t^*)$	1	0.051	0.007	0.455	0.009	0.162	0.053	0.151	0.016	0.016	0.079
	4	0.016	0.036	0.687	0.089	0.088	0.019	0.047	0.005	0.003	0.010
	8	0.021	0.044	0.797	0.060	0.046	0.008	0.016	0.002	0.001	0.004
	12	0.025	0.046	0.851	0.037	0.026	0.004	0.009	0.001	0.001	0.002
	18	0.028	0.045	0.882	0.021	0.015	0.002	0.005	0.001	0.000	0.001
	24	0.030	0.043	0.896	0.015	0.010	0.002	0.003	0.000	0.000	0.001
y_t^*	1	0.360	0.003	0.038	0.265	0.047	0.176	0.058	0.043	0.002	0.007
	4	0.296	0.029	0.091	0.520	0.015	0.025	0.015	0.007	0.000	0.002
	8	0.195	0.023	0.143	0.619	0.006	0.007	0.005	0.002	0.000	0.001
	12	0.164	0.019	0.167	0.639	0.003	0.003	0.002	0.001	0.000	0.000
	18	0.146	0.017	0.181	0.651	0.002	0.002	0.001	0.000	0.000	0.000
	24	0.138	0.016	0.186	0.656	0.001	0.001	0.001	0.000	0.000	0.000
r_t^*	1	0.002	0.038	0.243	0.003	0.650	0.027	0.012	0.002	0.000	0.023
	4	0.048	0.064	0.143	0.063	0.662	0.006	0.005	0.001	0.000	0.007
	8	0.036	0.058	0.101	0.092	0.705	0.002	0.003	0.000	0.000	0.002
	12	0.032	0.054	0.085	0.091	0.734	0.001	0.002	0.000	0.000	0.001
	18	0.030	0.051	0.074	0.090	0.753	0.001	0.001	0.000	0.000	0.001
	24	0.029	0.049	0.069	0.089	0.762	0.001	0.001	0.000	0.000	0.001
y_t	1	0.001	0.011	0.019	0.004	0.001	0.924	0.022	0.002	0.001	0.016
	4	0.038	0.004	0.032	0.063	0.009	0.819	0.013	0.005	0.003	0.015
	8	0.034	0.003	0.031	0.109	0.007	0.795	0.007	0.003	0.002	0.009
	12	0.034	0.003	0.030	0.128	0.007	0.785	0.005	0.002	0.001	0.006
	18	0.033	0.002	0.029	0.144	0.007	0.776	0.003	0.001	0.001	0.004
	24	0.032	0.002	0.028	0.152	0.007	0.771	0.003	0.001	0.001	0.003
$(h_t - y_t)$	1	0.009	0.052	0.335	0.012	0.048	0.000	0.512	0.004	0.026	0.002
	4	0.037	0.092	0.381	0.003	0.073	0.012	0.391	0.001	0.005	0.004
	8	0.036	0.107	0.460	0.001	0.047	0.014	0.330	0.000	0.002	0.002
	12	0.040	0.110	0.496	0.001	0.033	0.014	0.304	0.000	0.001	0.001
	18	0.043	0.110	0.523	0.001	0.023	0.014	0.286	0.000	0.001	0.001
	24	0.044	0.109	0.536	0.001	0.018	0.014	0.277	0.000	0.000	0.000
Δp_t	1	0.022	0.024	0.450	0.065	0.152	0.050	0.217	0.003	0.007	0.011
	4	0.061	0.034	0.473	0.088	0.086	0.054	0.150	0.007	0.007	0.040
	8	0.091	0.034	0.456	0.087	0.077	0.059	0.132	0.014	0.007	0.042
	12	0.091	0.033	0.455	0.086	0.076	0.062	0.131	0.015	0.008	0.042
	18	0.091	0.034	0.448	0.085	0.080	0.066	0.131	0.016	0.007	0.042
	24	0.090	0.034	0.439	0.085	0.086	0.069	0.132	0.017	0.007	0.041
r_t	1	0.031	0.025	0.001	0.003	0.005	0.001	0.052	0.653	0.224	0.005
	4	0.046	0.083	0.024	0.014	0.110	0.008	0.032	0.463	0.213	0.005
	8	0.024	0.126	0.057	0.085	0.160	0.006	0.037	0.340	0.161	0.002
	12	0.021	0.134	0.063	0.110	0.191	0.005	0.035	0.298	0.142	0.001
	18	0.019	0.138	0.068	0.121	0.214	0.004	0.033	0.271	0.130	0.001
	24	0.019	0.140	0.071	0.125	0.226	0.004	0.032	0.259	0.125	0.001
e_t	1	0.039	0.001	0.085	0.021	0.061	0.001	0.000	0.082	0.705	0.004
	4	0.072	0.005	0.062	0.017	0.056	0.115	0.009	0.144	0.517	0.004
	8	0.079	0.004	0.066	0.018	0.057	0.132	0.005	0.150	0.487	0.002
	12	0.081	0.003	0.067	0.020	0.057	0.139	0.004	0.154	0.475	0.002
	18	0.082	0.002	0.067	0.022	0.057	0.145	0.003	0.156	0.466	0.001
	24	0.083	0.002	0.067	0.022	0.057	0.147	0.002	0.157	0.461	0.001

Table 3.16: FEVD

and being in the opposite spectrum decreased the interest rate. Another place of the opposite duality from an oil and gas disturbance was shown in the inverse on the narrow money velocity. Lastly, both commodity disturbances caused the effective exchange rate to appreciate with the oil disturbance causing a greater appreciation.

When investigating the FEVD for both oil and gas disturbances. The finding showed that an oil disturbance increased the forecast variance in the following ways: foreign interest rate, domestic output, domestic money stock, domestic inflation and effective exchange rate. A gas disturbance increased the forecast variance on: price differential, foreign output and interest rate, domestic money stock, domestic inflation, domestic interest rate and effective exchange rate.

3.6 Conclusion

It has been illustrated that there are clear distinctions between long-run effects caused by oil and gas disturbances in regards to Trinidad and Tobago's economy. To make it possible to establish these distinctions, an open economy model based on arbitrage, stock and flow connections was utilized, and key long-run cointegration relationships were determined. Since the empirical data contained unit roots, it was necessary to estimate the model using a VECM model with the embedded restrictions from the open economy model. The estimated VECM model showed superior fit performance when compared to traditional time series models. This showed the benefits of incorporating the long-run dynamics of the data when trying to gain insights to the driving factors of the interactions within Trinidad and Tobago's economy.

To tease out the different effects from oil and gas disturbances, the data was free to express itself by estimating a VECM model with the only restriction that it contained the same number of long-term relationships as established in the open economy model. Then, the VECM model was converted into a VAR model making it possible to establish the IRF and FEVD. These results were utilized as a baseline for comparison and in determining the restrictions of a SVEC model. Upon estimating the SVEC, it became apparent that there were distinctions between the two commodity disturbances.

The key findings are that the effects from an oil disturbance are larger in magnitude and duration when compared to a gas disturbance. The duration of an oil disturbance lasts seven to nine quarters, and a gas disturbance was fleeting after five to seven quarters. When investigating the direction from the effects of oil and gas disturbances, it became apparent that these shocks had opposite movements in Trinidad and Tobago's CPI, interest rate, inflation and narrow money velocity; whereas both disturbances were positively correlated in regards to Trinidad and Tobago's output and effective real exchange rate in the long-run.

These findings are of importance for both policymakers and market practitioners due to the sheer magnitude of export revenues that are generated from these two commodities within Trinidad and Tobago's economy. As of 2014, approximately 85% of its export revenues and 42.1% of its share in GDP came from the energy sector. Without a clear understanding of the effects and dynamics of long-run oil and gas disturbances, it is possible that a wrong policy or inappropriate portfolio allocation would be undertaken, resulting in a sub-optimal result.

CHAPTER 4

CLOSING REMARKS

The goal of my research is to empirically estimate the importance of commodity disturbances on energy investment decisions by firms and governments, and how these decisions influence firms' specializations and countries' growth paths. To gain insights as to my research agenda, I utilized DSGE, VECM and SVEC methods. The DSGE method allows me to set a structure for both the short and long run dynamics of a model. This has its advantage of controlling the channels' short-run dynamics, which permit a researcher to control the inactions of the Goods and Financial market. The disadvantage is the short-run dynamics are difficult to model correctly. Hence, the model is misspecified which results in estimation bias of the model's parameters. Since I am interested in the long-run dynamics of commodity disturbances with flexibility the VECM and SVEC methods are ideal choices for this analysis. The VCEM lets the researcher focus on the long-run without having to define the short-run structural interactions. This also holds for the SVEC method if the appropriate restrictions are set. In this dissertation, I utilized DSGE, VECM and SVEC to take advantage of each of the method's unique strength and to assure the reader that a comprehensive analysis was performed.

The key findings of the research show that oil, and to lesser extend gas disturbances, are the only commodity shocks that are significant in affecting a country's output. Also, a country's openness plays an important role in shaping the output response initiated by a petroleum shock. It was found that there is a clear distinction between oil and gas disturbances with oil shocks being larger in magnitude and duration. Also, disturbances had opposing dynamics on key macro variables in the long-run. These findings are important; because without them it is probable that an incorrect policy mix or inappropriate portfolio allocation would be performed, resulting in a sub-optimal result.

Currently, my research has convinced me there is much more we need to know about the affects of commodity disturbances before advancing in understanding their effects on investment. For example, how are the commodity disturbances different on commodity and non-commodity currency economies. This can be easily analyzed using the framework I developed in this dissertation. I hope that by classifying commodity disturbances, economists can identify key correlations between different commodity disturbances under different environments, and permitting them to incorporate this knowledge when analyzing investments and ultimately gain insights on how these decisions influence firms' specializations and countries' growth paths.

APPENDIX

Country Openness and Output Standard Deviation		
Country	Openness	Ln(GDP) Std.Dev
United States	0.226	0.110
Japan	0.235	0.023
Australia	0.372	0.302
Italy	0.454	0.080
Mexico	0.454	0.213
Greece	0.472	0.172
Spain	0.476	0.178
France	0.488	0.094
United Kingdom	0.528	0.122
Germany	0.581	0.062
New Zealand	0.582	0.239
Canada	0.625	0.190
Portugal	0.637	0.142
Finland	0.652	0.126
Korea	0.699	0.210
Norway	0.708	0.279
Sweden	0.726	0.105
Iceland	0.753	0.145
Austria	0.806	0.108
Switzerland	0.932	0.116
Netherlands	1.191	0.137
Belgium	1.314	0.112
Ireland	1.369	0.378

Table 1: Openness and Output Standard Deviation

Commodity Trade Percentage of Total Global Trade by Value

	1990-94		1995-99		2000-04		2005-09		2010-14	
	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import
Aluminum	0.346	0.446	0.381	0.445	0.350	0.405	0.335	0.394	0.261	0.322
Beef	0.393	0.384	0.260	0.258	0.213	0.209	0.206	0.194	0.223	0.199
Coal	0.420	0.547	0.342	0.418	0.306	0.390	0.490	0.617	0.687	0.787
Coffee	0.194	0.233	0.226	0.261	0.111	0.120	0.131	0.134	0.174	0.176
Copper	0.367	0.443	0.366	0.375	0.327	0.322	0.619	0.633	0.716	0.751
Cotton	0.146	0.211	0.123	0.179	0.090	0.113	0.070	0.087	0.101	0.115
Iron Ore	0.191	0.290	0.157	0.224	0.152	0.227	0.333	0.506	0.731	0.912
Iron and Steel	2.866	2.973	2.673	2.748	2.404	2.461	3.123	3.135	2.697	2.622
Maize	0.249	0.237	0.192	0.208	0.140	0.160	0.138	0.156	0.183	0.192
Natural Gas	0.707	0.958	0.828	0.967	1.287	1.427	1.695	1.881	1.984	2.357
Natural Rubber	0.114	0.116	0.102	0.113	0.072	0.079	0.109	0.109	0.189	0.168
Petroleum	5.604	7.633	4.890	5.919	7.263	8.079	10.546	11.874	12.037	13.843
Rice	0.123	0.104	0.142	0.130	0.099	0.091	0.112	0.099	0.133	0.106
Sugar	0.213	0.196	0.194	0.201	0.132	0.137	0.136	0.137	0.183	0.177
Timber	0.710	0.931	0.621	0.736	0.497	0.574	0.375	0.420	0.304	0.344
Tin	0.038	0.036	0.030	0.027	0.022	0.022	0.030	0.031	0.037	0.040
Tobacco	0.138	0.160	0.112	0.133	0.081	0.103	0.068	0.073	0.067	0.074
Wheat	0.407	0.330	0.317	0.311	0.219	0.231	0.216	0.226	0.254	0.245
Wool	0.172	0.175	0.113	0.113	0.066	0.070	0.039	0.040	0.038	0.040
Zinc	0.140	0.140	0.120	0.120	0.090	0.090	0.130	0.130	0.110	0.100

Table 2: Commodity Trade Percentage of Total Global Trade by Value [a]

[a] Data source COMTRADE using SITC Rev. 1 Codes: Petroleum 33, Iron and steel 67, Natural gas 341, Timber 24, Copper 2831 + 6831, Hard coal 3214 + 3215, Aluminum 2833 + 6841, Beef 0111, Iron Ore 2813, Wheat 041, Maize 044, Sugar 0611 + 0612, Coffee 0711, Cotton 2631, Rice 042, Rubber 2311, Cocoa 072, Zinc 2835 + 6861, Tobacco 121, Wool 262, Tin 2836 + 6871.

Commodity Index Correlations 1990-2014										
US Interest Rate		Lending Rate		Inflation		GDP		Trade Volume		
									Export	Import
GS30	-0.80	United States	-0.68	United States	-0.20	United States	0.87	United States	0.90	0.76
GS20	-0.85	China	-0.47	China	-0.20	China	0.95	China	0.97	0.95
DGS10	-0.79	Japan	-0.51	Japan	-0.02	Japan	0.57	Japan	0.86	0.87
DGS7	-0.80	Germany	0.00	Germany	-0.14	Germany	0.91	Germany	0.89	0.92
GS5	-0.80	UK	-0.68	UK	0.07	UK	0.82	UK	-0.30	-0.06
DGS3	-0.78	France	-0.16	France	-0.13	France	0.89	France	-0.17	0.18
DGS1	-0.73	Brazil	-0.86	Brazil	-0.35	Brazil	0.92	Brazil	0.84	0.91
TB3MS	-0.70	Italy	-0.62	Italy	-0.44	Italy	0.86	Italy	0.35	-0.02
DFF	-0.69	India	-0.63	India	0.12	India	0.95	India	0.94	0.96
		Russian	-0.38	Russian	-0.34	Russian	0.98	Russian	0.78	0.96
		Canada	-0.60	Canada	-0.11	Canada	0.96	Canada	-0.10	0.93
		Australia	-0.49	Australia	0.03	Australia	0.98	Australia	0.95	0.94
		Korea, Rep.	-0.68	Korea, Rep.	-0.47	Korea, Rep.	0.92	Korea, Rep.	0.93	0.90
		Spain	0.04	Spain	-0.46	Spain	0.85	Spain	0.95	0.11
		Mexico	-0.60	Mexico	-0.56	Mexico	0.87	Mexico	0.81	0.84
				Low income	-0.20	Low Income	0.96			
				Middle income	-0.44	Middle Income	0.96			
				High income	-0.20	HighIncome	0.93			

Table 3: Commodity Index Correlations

paramater	Dist.	Prior Mean	SE	Australia AUS	Austria AUT	Belgium BEL	Canada CAN	Finland FIN	France FRA	Germany DEU	Greece GRC	Iceland ISL	Ireland IRL
alpha	calibrated to (IM+EX)/GDP			0.372	0.806	1.314	0.625	0.652	0.488	0.581	0.472	0.753	1.369
dom_tal_r	norm	1.000	0.100	0.8321	0.7113	0.6260	0.6164	0.6653	0.6545	0.6429	0.6540	0.6234	0.5938
dom_tal_inf	norm	1.700	0.250	3.1794	3.1480	3.1759	2.9285	2.9606	2.7884	2.7044	2.6611	2.9433	3.2112
dom_tal_out	norm	0.500	0.100	0.3029	0.8964	0.8496	0.8876	0.8671	0.8862	0.9288	0.8847	0.8555	0.8021
rho_r_domestic	beta	0.850	0.100	0.4277	0.6054	0.4992	0.5011	0.4948	0.5035	0.5083	0.5055	0.5129	0.5279
rho_pi_domestic	beta	0.850	0.100	0.5893	0.2629	0.2619	0.2157	0.1750	0.1761	0.1616	0.1421	0.2049	0.2761
rho_z1	beta	0.850	0.100	0.8002	0.9127	0.9239	0.9538	0.9209	0.9096	0.9176	0.8840	0.9062	0.9195
rho_z2	beta	0.850	0.100	0.8604	0.9063	0.8940	0.9023	0.9380	0.9159	0.8985	0.9195	0.9184	0.9262
cs	beta	0.400	0.100	0.7296	0.2542	0.1759	0.1330	0.1254	0.1334	0.1406	0.1356	0.1270	0.1606
eta	beta	1.000	0.100	1.6503	1.5929	1.4590	1.4270	1.4339	1.3469	1.4588	1.3433	1.5103	1.4642
epsilon	beta	5.000	0.500	4.6308	4.9677	4.8306	5.1192	4.9455	4.8545	5.1150	4.8651	4.8553	4.9932
sigma	beta	1.000	0.100	0.4538	0.8239	0.4537	0.4537	0.4537	0.4538	0.4537	0.4537	0.4537	0.4537
phi	beta	1.000	0.100	1.1995	0.9825	1.0313	0.9760	0.9490	0.9795	1.0134	1.0118	1.0063	0.9622
zeta	beta	1.000	0.100	1.1727	0.9789	0.9907	0.9539	0.9577	0.9592	1.0072	0.9674	0.9735	0.9557
theta	beta	0.710	0.050	0.4737	0.7437	0.7546	0.7220	0.7212	0.7487	0.7236	0.7497	0.7281	0.7554
alpha1	beta	1.000	0.100	1.5804	0.9974	0.9736	0.9507	1.0223	0.9922	0.9820	0.9953	0.9844	0.9643
alpha2	beta	1.000	0.100	1.7207	1.2296	1.3326	1.4331	1.4330	1.4078	1.3840	1.4027	1.3998	1.3360
eps_r_domestic	invg	1.000	Inf	0.1405	0.2094	0.1922	0.1922	0.1928	0.1936	0.1923	0.2056	0.1788	0.1852
eps_pi_domestic	invg	1.000	Inf	0.1787	0.1533	0.1575	0.1233	0.1368	0.1185	0.1223	0.1201	0.1331	0.1629
eps_z1	invg	1.000	Inf	26.6217	0.4630	0.4847	0.4933	0.4861	0.4576	0.4671	0.4791	0.4255	0.4519
eps_z2	invg	1.000	Inf	0.7673	0.4577	0.5176	0.5521	0.4658	0.4440	0.4767	0.4737	0.4662	0.4396

Table 4: Estimated Posterior Modes AUS - IRL

	Italy ITA	**Japan JPN**	**Korea KOR**	**Mexico MEX**	**Netherlands NLD**	**New_Zealand NZL**	**Norway NOR**	**Portugal PRT**	**Spain ESP**	**Sweden SWE**	**Switzerland CHE**	**UK GBR**	**USA USA**
alpha	0.454	0.235	0.699	0.454	1.191	0.582	0.708	0.637	0.476	0.726	0.932	0.528	0.226
dom_tal_r	0.6710	0.9304	0.6352	0.6754	0.6297	0.6515	0.6618	0.6048	0.6563	0.6385	0.6988	0.6644	0.9622
dom_tal_inf	2.7031	3.2615	2.9567	2.6600	3.2462	2.8366	3.0102	2.8070	2.7622	2.9123	3.1994	2.6661	3.1975
dom_tal_out	0.8898	0.4435	0.8874	0.9115	0.8811	0.8998	0.9044	0.9010	0.8831	0.8705	0.8556	0.8879	0.4516
rho_r_domestic	0.5200	0.4509	0.5287	0.5112	0.4966	0.5028	0.5114	0.4548	0.4734	0.5000	0.6214	0.5434	0.3968
rho_pi_domestic	0.1562	0.4740	0.2187	0.1713	0.2502	0.1950	0.1925	0.2079	0.1616	0.1869	0.2607	0.1742	0.4874
rho_z1	0.9176	0.9199	0.9098	0.8503	0.9441	0.9291	0.9278	0.9313	0.9406	0.9184	0.9192	0.9042	0.9017
rho_z2	0.9085	0.8943	0.8659	0.8508	0.9348	0.9380	0.9045	0.9096	0.9197	0.9343	0.9333	0.8786	0.8977
cs	0.1219	0.6617	0.1295	0.1462	0.1578	0.1352	0.1307	0.1270	0.1212	0.1132	0.2842	0.1323	0.6479
eta	1.3427	1.1500	1.4668	1.3431	1.5585	1.4103	1.4620	1.4476	1.3437	1.4954	1.5825	1.4014	1.0802
epsilon	4.9397	4.7147	5.2297	5.0451	4.8670	4.8590	5.0991	5.1321	4.8886	4.7989	4.9405	4.9621	4.5567
sigma	0.4538	0.4537	0.4537	0.4800	0.4537	0.4538	0.4537	0.4537	0.4537	0.4537	0.8701	0.4537	0.4537
phi	0.9501	1.053	1.0071	0.9998	1.0189	0.9913	0.993	1.0412	1.0059	1.0284	0.9971	0.9523	0.9986
zeta	0.978	0.9909	0.9795	0.9793	0.9859	0.971	0.9437	0.9807	0.9748	0.944	0.9797	0.9717	0.9538
theta	0.7517	0.4288	0.7245	0.7557	0.7307	0.7314	0.7235	0.7314	0.7494	0.7236	0.7605	0.7434	0.4217
alpha1	0.995	1.5798	0.9486	0.9861	0.9451	0.9784	0.9671	0.9597	0.9953	0.9869	1.0051	0.9933	1.5802
alpha2	1.3993	1.6874	1.4127	1.395	1.3232	1.4321	1.4026	1.3698	1.3963	1.4077	1.1872	1.4117	1.6491
eps_r_domestic	0.2049	0.1221	0.1914	0.2234	0.1865	0.2047	0.1988	0.2009	0.193	0.1922	0.207	0.1846	0.1202
eps_pi_domestic	0.1181	0.1446	0.1286	0.1269	0.161	0.1202	0.1315	0.1246	0.1206	0.1305	0.1678	0.1203	0.1432
eps_z1	0.5039	0.4392	0.4407	1.0887	0.4569	0.4324	0.468	0.4059	0.492	0.4371	0.4747	0.4554	0.4849
eps_z2	0.464	0.4489	0.4595	0.9332	0.4398	0.432	0.4409	0.5065	0.4455	0.4198	0.4627	0.5061	0.4562

Table 5: Estimated Posterior Modes ITA - USA

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	y	96.180	0.210	0.000	0.010	0.000	0.000	0.000	0.000	0.000
Japan	0.235	y	95.900	0.220	0.000	0.010	0.000	0.000	0.000	0.000	0.000
Australia	0.372	y	93.620	0.210	0.000	0.010	0.000	0.000	0.000	0.000	0.000
Italy	0.454	y	93.670	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mexico	0.454	y	93.7	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	y	93.56	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	y	93.5	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	y	93.3	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	y	93.38	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	y	94.1	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	y	93.15	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	y	93.13	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	y	93.38	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	y	92.65	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	y	92.84	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	y	92.82	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	y	92.84	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	y	92.46	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	y	90.97	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	y	89.26	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	y	92.51	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	y	91.32	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	y	91.25	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	y	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	y	0.00	0.00	0.00	1.3	0.00	2.26	0.04	0.00	0.00
Japan	0.235	y	0.00	0.00	0.00	1.4	0.00	2.44	0.04	0.00	0.00
Australia	0.372	y	0.00	0.00	0.00	2.15	0.00	4.01	0.00	0.00	0.00
Italy	0.454	y	0.00	0.00	0.00	0.71	0.28	4.58	0.69	0.00	0.00
Mexico	0.454	y	0.00	0.00	0.00	0.73	0.27	4.57	0.64	0.00	0.00
Greece	0.472	y	0.00	0.00	0.00	0.75	0.27	4.69	0.65	0.00	0.00
Spain	0.476	y	0.00	0.00	0.00	0.74	0.22	4.73	0.72	0.00	0.00
France	0.488	y	0.00	0.00	0.00	0.79	0.22	4.88	0.72	0.00	0.00
UK	0.528	y	0.00	0.00	0.00	0.78	0.21	4.87	0.67	0.00	0.00
Germany	0.581	y	0.00	0.00	0.00	0.68	0.17	4.4	0.56	0.00	0.00
New_Zealand	0.582	y	0.00	0.00	0.00	0.81	0.2	5.06	0.67	0.00	0.00
Canada	0.625	y	0.00	0.00	0.00	0.8	0.15	5.09	0.7	0.00	0.00
Portugal	0.637	y	0.00	0.00	0.00	0.78	0.17	4.92	0.67	0.00	0.00
Finland	0.652	y	0.00	0.00	0.00	0.87	0.15	5.4	0.8	0.00	0.00
Korea	0.699	y	0.00	0.00	0.00	0.85	0.14	5.33	0.73	0.00	0.00
Norway	0.708	y	0.00	0.00	0.00	0.87	0.14	5.35	0.7	0.00	0.00
Sweden	0.726	y	0.00	0.00	0.00	0.84	0.14	5.36	0.68	0.00	0.00
Iceland	0.753	y	0.00	0.00	0.00	0.92	0.12	5.63	0.75	0.00	0.00
Austria	0.806	y	0.00	0.00	0.00	2.08	0.14	5.72	1.06	0.00	0.00
Switzerland	0.932	y	0.00	0.00	0.00	2.62	0.12	6.8	1.17	0.00	0.00
Netherlands	1.191	y	0.00	0.00	0.00	0.91	0.06	5.65	0.76	0.00	0.00
Belgium	1.314	y	0.00	0.00	0.00	1.12	0.07	6.63	0.73	0.00	0.00
Ireland	1.369	y	0.00	0.00	0.00	1.1	0.06	6.63	0.81	0.00	0.00

Table 6: Variance Decomposition of Output for all Countries

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	ppi_h	9.460	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Japan	0.235	ppi_h	9.170	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Australia	0.372	ppi_h	7.410	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Italy	0.454	ppi_h	0.010	0.070	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	ppi_h	0.01	0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Greece	0.472	ppi_h	0.01	0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Spain	0.476	ppi_h	0.01	0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00
France	0.488	ppi_h	0.01	0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00
UK	0.528	ppi_h	0.01	0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Germany	0.581	ppi_h	0.01	0.12	0.00	0.01	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	ppi_h	0.01	0.11	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Canada	0.625	ppi_h	0.01	0.12	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	ppi_h	0.02	0.11	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Finland	0.652	ppi_h	0.01	0.11	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Korea	0.699	ppi_h	0.01	0.12	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Norway	0.708	ppi_h	0.01	0.12	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	ppi_h	0.01	0.13	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	ppi_h	0.01	0.12	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Austria	0.806	ppi_h	0.35	0.2	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	ppi_h	0.39	0.19	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	ppi_h	0.01	0.15	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	ppi_h	0.01	0.15	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	ppi_h	0.01	0.15	0.00	0.01	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	ppi_h	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	ppi_h	0.00	0.00	0.00	1.42	27.63	41.58	19.9	0.00	0.00
Japan	0.235	ppi_h	0.00	0.00	0.00	1.5	29.85	42.82	16.65	0.00	0.00
Australia	0.372	ppi_h	0.00	0.00	0.00	2.64	26.43	63.46	0.06	0.00	0.00
Italy	0.454	ppi_h	0.00	0.00	0.00	2.58	10.16	10.56	76.61	0.00	0.00
Mexico	0.454	ppi_h	0.00	0.00	0.00	2.53	9.41	10.27	77.69	0.00	0.00
Greece	0.472	ppi_h	0.00	0.00	0.00	2.66	9.79	10.61	76.85	0.00	0.00
Spain	0.476	ppi_h	0.00	0.00	0.00	2.96	7.72	11.81	77.41	0.00	0.00
France	0.488	ppi_h	0.00	0.00	0.00	3	8.41	11.59	76.9	0.00	0.00
UK	0.528	ppi_h	0.00	0.00	0.00	3.3	9.77	12.85	73.98	0.00	0.00
Germany	0.581	ppi_h	0.00	0.00	0.00	4.25	10.67	17.17	67.78	0.00	0.00
New_Zealand	0.582	ppi_h	0.00	0.00	0.00	4.57	11.01	17.61	66.69	0.00	0.00
Canada	0.625	ppi_h	0.00	0.00	0.00	5.5	9.99	21.13	63.23	0.00	0.00
Portugal	0.637	ppi_h	0.00	0.00	0.00	4.88	8.58	18.19	68.2	0.00	0.00
Finland	0.652	ppi_h	0.00	0.00	0.00	5.59	9.01	20.84	64.43	0.00	0.00
Korea	0.699	ppi_h	0.00	0.00	0.00	6.15	10.18	22.68	60.84	0.00	0.00
Norway	0.708	ppi_h	0.00	0.00	0.00	6.21	9.7	22.33	61.63	0.00	0.00
Sweden	0.726	ppi_h	0.00	0.00	0.00	6.6	9.8	24.25	59.2	0.00	0.00
Iceland	0.753	ppi_h	0.00	0.00	0.00	6.64	8.38	23.37	61.47	0.00	0.00
Austria	0.806	ppi_h	0.00	0.00	0.00	8.13	8.92	12.93	69.46	0.00	0.00
Switzerland	0.932	ppi_h	0.00	0.00	0.00	9.29	7.89	13.75	68.47	0.00	0.00
Netherlands	1.191	ppi_h	0.00	0.00	0.00	10.26	6.47	35.59	47.51	0.00	0.00
Belgium	1.314	ppi_h	0.00	0.00	0.00	11.44	6.78	37.14	44.47	0.00	0.00
Ireland	1.369	ppi_h	0.00	0.00	0.00	11.69	6.74	38.1	43.3	0.00	0.00

Table 7: Variance Decomposition of Product Price Inflation for all Countries

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	r	53.980	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Japan	0.235	r	52.580	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Australia	0.372	r	45.310	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Italy	0.454	r	0.360	4.050	0.020	0.250	0.010	0.010	0.010	0.000	0.000
Mexico	0.454	r	0.340	4.360	0.020	0.270	0.010	0.010	0.010	0.000	0.000
Greece	0.472	r	0.350	4.430	0.020	0.270	0.010	0.010	0.010	0.000	0.000
Spain	0.476	r	0.390	4.310	0.020	0.270	0.010	0.010	0.010	0.000	0.000
France	0.488	r	0.350	4.570	0.020	0.280	0.010	0.010	0.010	0.000	0.000
UK	0.528	r	0.340	4.720	0.020	0.290	0.010	0.010	0.010	0.000	0.000
Germany	0.581	r	0.460	5.780	0.020	0.360	0.010	0.010	0.010	0.000	0.000
New_Zealand	0.582	r	0.300	5.470	0.020	0.340	0.010	0.010	0.010	0.000	0.000
Canada	0.625	r	0.360	6.090	0.030	0.380	0.010	0.010	0.010	0.000	0.000
Portugal	0.637	r	0.620	6.250	0.030	0.390	0.020	0.010	0.010	0.000	0.000
Finland	0.652	r	0.340	6.500	0.030	0.400	0.020	0.010	0.010	0.000	0.000
Korea	0.699	r	0.450	7.010	0.030	0.430	0.020	0.010	0.010	0.000	0.000
Norway	0.708	r	0.520	7.350	0.030	0.460	0.020	0.010	0.010	0.000	0.000
Sweden	0.726	r	0.540	7.020	0.030	0.440	0.020	0.010	0.010	0.000	0.000
Iceland	0.753	r	0.530	7.890	0.030	0.490	0.020	0.010	0.010	0.000	0.000
Austria	0.806	r	12.130	5.040	0.020	0.210	0.010	0.010	0.010	0.000	0.000
Switzerland	0.932	r	11.070	3.780	0.010	0.150	0.010	0.010	0.010	0.000	0.000
Netherlands	1.191	r	1.080	23.780	0.100	1.440	0.060	0.030	0.040	0.000	0.000
Belgium	1.314	r	0.400	31.220	0.130	1.870	0.080	0.050	0.050	0.010	0.000
Ireland	1.369	r	0.630	32.040	0.130	1.910	0.080	0.050	0.050	0.010	0.000

counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	r	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Japan	0.235	r	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Australia	0.372	r	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Italy	0.454	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mexico	0.454	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Greece	0.472	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Spain	0.476	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
France	0.488	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
UK	0.528	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Germany	0.581	r	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
New_Zealand	0.582	r	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Canada	0.625	r	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Portugal	0.637	r	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Finland	0.652	r	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Korea	0.699	r	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Norway	0.708	r	0.020	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Sweden	0.726	r	0.010	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Iceland	0.753	r	0.020	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Austria	0.806	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Switzerland	0.932	r	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Netherlands	1.191	r	0.050	0.000	0.010	0.000	0.020	0.010	0.010	0.010	0.000
Belgium	1.314	r	0.070	0.000	0.010	0.000	0.030	0.020	0.010	0.010	0.000
Ireland	1.369	r	0.070	0.000	0.010	0.000	0.030	0.020	0.010	0.010	0.000

counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	r	0.000	0.000	0.000	4.730	0.100	40.590	0.590	0.000	0.000
Japan	0.235	r	0.000	0.000	0.000	4.880	0.170	41.880	0.490	0.000	0.000
Australia	0.372	r	0.000	0.000	0.000	5.520	0.290	48.880	0.000	0.000	0.000
Italy	0.454	r	0.000	0.000	0.000	6.980	0.250	82.600	5.450	0.000	0.000
Mexico	0.454	r	0.000	0.000	0.000	7.040	0.160	82.290	5.480	0.000	0.000
Greece	0.472	r	0.000	0.000	0.000	6.960	0.220	82.280	5.420	0.000	0.000
Spain	0.476	r	0.000	0.000	0.000	6.810	0.120	82.220	5.810	0.000	0.000
France	0.488	r	0.000	0.000	0.000	6.760	0.220	81.520	6.220	0.000	0.000
UK	0.528	r	0.000	0.000	0.000	6.450	0.530	81.610	5.990	0.000	0.000
Germany	0.581	r	0.000	0.000	0.000	5.750	0.640	81.490	5.430	0.000	0.000
New_Zealand	0.582	r	0.000	0.000	0.000	5.820	0.660	80.930	6.380	0.000	0.000
Canada	0.625	r	0.000	0.000	0.000	5.360	0.860	79.800	7.050	0.000	0.000
Portugal	0.637	r	0.000	0.000	0.000	5.480	0.410	79.900	6.860	0.000	0.000
Finland	0.652	r	0.000	0.000	0.000	5.200	0.950	79.140	7.370	0.000	0.000
Korea	0.699	r	0.000	0.000	0.000	4.820	1.560	78.120	7.500	0.000	0.000
Norway	0.708	r	0.000	0.000	0.000	4.810	1.350	78.270	7.130	0.000	0.000
Sweden	0.726	r	0.000	0.000	0.000	4.730	1.360	79.210	6.600	0.000	0.000
Iceland	0.753	r	0.000	0.000	0.000	4.570	1.480	77.130	7.800	0.000	0.000
Austria	0.806	r	0.000	0.000	0.000	11.410	0.710	68.140	2.300	0.000	0.000
Switzerland	0.932	r	0.000	0.000	0.000	11.630	0.660	71.320	1.350	0.000	0.000
Netherlands	1.191	r	0.010	0.000	0.010	0.910	7.900	52.650	11.870	0.000	0.000
Belgium	1.314	r	0.010	0.000	0.010	0.590	12.440	40.620	12.380	0.000	0.000
Ireland	1.369	r	0.010	0.000	0.010	0.400	16.910	34.930	12.680	0.000	0.000

Table 8: Variance Decomposition of Domestic Interest Rate for all Countries

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	cpi	2.070	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	cpi	5.960	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	cpi	27.790	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	cpi	0.150	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	cpi	0.160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	cpi	0.170	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	cpi	0.180	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	cpi	0.160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	cpi	0.140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	cpi	0.190	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	cpi	0.120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	cpi	0.150	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	cpi	0.260	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	cpi	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	cpi	0.140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	cpi	0.140	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	cpi	0.170	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	cpi	0.160	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	cpi	2.190	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	cpi	2.750	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	cpi	0.100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	cpi	0.050	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	cpi	0.060	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	cpi	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	cpi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	cpi	0.00	0.00	0.00	0.06	65.37	0.56	31.93	0.00	0.00
Japan	0.235	cpi	0.00	0.00	0.00	0.13	71.09	0.37	22.44	0.00	0.00
Australia	0.372	cpi	0.00	0.00	0.00	1.02	68.23	2.87	0.09	0.00	0.00
Italy	0.454	cpi	0.00	0.00	0.00	2.63	27.27	3.71	66.24	0.00	0.00
Mexico	0.454	cpi	0.00	0.00	0.00	2.68	24.7	3.7	68.76	0.00	0.00
Greece	0.472	cpi	0.00	0.00	0.00	2.83	26.51	3.86	66.64	0.00	0.00
Spain	0.476	cpi	0.00	0.00	0.00	3.07	20.52	4.28	71.95	0.00	0.00
France	0.488	cpi	0.00	0.00	0.00	3.1	22.69	4.18	69.87	0.00	0.00
UK	0.528	cpi	0.00	0.00	0.00	3.35	27.83	4.59	64.09	0.00	0.00
Germany	0.581	cpi	0.00	0.00	0.00	3.89	30.39	5.72	59.82	0.00	0.00
New_Zealand	0.582	cpi	0.00	0.00	0.00	3.99	30.41	5.77	59.71	0.00	0.00
Canada	0.625	cpi	0.00	0.00	0.00	4.13	29.49	6.19	60.04	0.00	0.00
Portugal	0.637	cpi	0.00	0.00	0.00	4.41	23.18	6.07	66.06	0.00	0.00
Finland	0.652	cpi	0.00	0.00	0.00	4.88	28.99	7.4	58.62	0.00	0.00
Korea	0.699	cpi	0.00	0.00	0.00	4.83	32.27	7.2	55.56	0.00	0.00
Norway	0.708	cpi	0.00	0.00	0.00	5.56	31.08	8.16	55.05	0.00	0.00
Sweden	0.726	cpi	0.00	0.00	0.00	5.61	31.99	8.41	53.82	0.00	0.00
Iceland	0.753	cpi	0.00	0.00	0.00	5.76	28.35	8.31	57.41	0.00	0.00
Austria	0.806	cpi	0.00	0.00	0.00	12.14	29.91	12.92	42.84	0.00	0.00
Switzerland	0.932	cpi	0.00	0.00	0.00	14.16	30.02	15.6	37.46	0.00	0.00
Netherlands	1.191	cpi	0.00	0.00	0.00	7.83	30.53	13.85	47.69	0.00	0.00
Belgium	1.314	cpi	0.00	0.00	0.00	9.06	33.1	15.55	42.23	0.00	0.00
Ireland	1.369	cpi	0.00	0.00	0.00	8.32	36.32	14.61	40.68	0.00	0.00

Table 9: Variance Decomposition of CPI for all Countries

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	q	0.600	0.030	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	q	0.570	0.030	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	q	0.410	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	q	0.250	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	q	0.250	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	q	0.250	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	q	0.240	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	q	0.240	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	q	0.230	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	q	0.200	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	q	0.200	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	q	0.190	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	q	0.220	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	q	0.190	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	q	0.190	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	q	0.190	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	q	0.190	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	q	0.190	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	q	0.040	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	q	0.030	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	q	0.140	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	q	0.140	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	q	0.140	0.020	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	q	0.00	0.00	0.00	13.15	1.02	51.69	33.51	0.00	0.00
Japan	0.235	q	0.00	0.00	0.00	12.78	0.99	51.28	34.36	0.00	0.00
Australia	0.372	q	0.00	0.00	0.00	7.83	1.11	43.96	46.67	0.00	0.00
Italy	0.454	q	0.00	0.00	0.00	42.85	1.61	52.13	3.16	0.00	0.00
Mexico	0.454	q	0.00	0.00	0.00	42.98	1.6	52.09	3.07	0.00	0.00
Greece	0.472	q	0.00	0.00	0.00	43.02	1.64	51.94	3.14	0.00	0.00
Spain	0.476	q	0.00	0.00	0.00	42.94	1.32	52.04	3.44	0.00	0.00
France	0.488	q	0.00	0.00	0.00	43.12	1.38	51.76	3.48	0.00	0.00
UK	0.528	q	0.00	0.00	0.00	42.68	1.35	52.44	3.28	0.00	0.00
Germany	0.581	q	0.00	0.00	0.00	41.24	1.23	54.25	3.07	0.00	0.00
New_Zealand	0.582	q	0.00	0.00	0.00	41.83	1.38	53.05	3.53	0.00	0.00
Canada	0.625	q	0.00	0.00	0.00	41.3	1.15	53.38	3.96	0.00	0.00
Portugal	0.637	q	0.00	0.00	0.00	41.98	1.25	52.78	3.75	0.00	0.00
Finland	0.652	q	0.00	0.00	0.00	41.33	1.15	52.69	4.62	0.00	0.00
Korea	0.699	q	0.00	0.00	0.00	41.27	1.14	53.09	4.29	0.00	0.00
Norway	0.708	q	0.00	0.00	0.00	41.52	1.17	52.83	4.27	0.00	0.00
Sweden	0.726	q	0.00	0.00	0.00	41.35	1.15	53.2	4.1	0.00	0.00
Iceland	0.753	q	0.00	0.00	0.00	41.71	1.03	52.43	4.61	0.00	0.00
Austria	0.806	q	0.00	0.00	0.00	41.82	1.34	50.62	6.16	0.00	0.00
Switzerland	0.932	q	0.00	0.00	0.00	42.09	1.37	48.98	7.52	0.00	0.00
Netherlands	1.191	q	0.00	0.00	0.00	38.8	0.79	53.45	6.8	0.00	0.00
Belgium	1.314	q	0.00	0.00	0.00	39.74	0.91	52.39	6.81	0.00	0.00
Ireland	1.369	q	0.00	0.00	0.00	39.39	0.87	51.82	7.76	0.00	0.00

Table 10: Variance Decomposition of Real Exchange Rate for all Countries

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	e	4.44	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	e	4.66	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	e	5.91	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	e	3.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	e	3.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	e	3.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	e	4.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	e	3.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	e	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	e	4.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	e	4.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	e	4.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	e	4.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	e	4.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	e	4.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	e	4.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	e	5.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	e	4.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	e	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	e	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	e	5.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	e	4.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	e	5.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	e	0.00	0.00	0.00	17.6	0.24	77.56	0.15	0.00	0.00
Japan	0.235	e	0.00	0.00	0.00	17.07	0.3	77.85	0.12	0.00	0.00
Australia	0.372	e	0.00	0.00	0.00	17.13	0.47	76.48	0.00	0.00	0.00
Italy	0.454	e	0.00	0.00	0.00	22.85	0.33	71.96	0.92	0.00	0.00
Mexico	0.454	e	0.00	0.00	0.00	22.29	0.28	72.64	0.92	0.00	0.00
Greece	0.472	e	0.00	0.00	0.00	22.75	0.31	72.14	0.9	0.00	0.00
Spain	0.476	e	0.00	0.00	0.00	24.16	0.22	70.58	0.93	0.00	0.00
France	0.488	e	0.00	0.00	0.00	23.61	0.27	71.2	0.97	0.00	0.00
UK	0.528	e	0.00	0.00	0.00	26.36	0.37	68.16	0.95	0.00	0.00
Germany	0.581	e	0.00	0.00	0.00	33.26	0.36	60.79	0.79	0.00	0.00
New_Zealand	0.582	e	0.00	0.00	0.00	32.34	0.38	61.93	0.86	0.00	0.00
Canada	0.625	e	0.00	0.00	0.00	36.6	0.37	57.37	0.85	0.00	0.00
Portugal	0.637	e	0.00	0.00	0.00	33.44	0.28	60.37	0.96	0.00	0.00
Finland	0.652	e	0.00	0.00	0.00	37.26	0.36	56.81	0.83	0.00	0.00
Korea	0.699	e	0.00	0.00	0.00	38.97	0.46	54.77	0.86	0.00	0.00
Norway	0.708	e	0.00	0.00	0.00	38.24	0.42	55.59	0.81	0.00	0.00
Sweden	0.726	e	0.00	0.00	0.00	39.96	0.4	53.84	0.74	0.00	0.00
Iceland	0.753	e	0.00	0.00	0.00	39.05	0.38	54.79	0.84	0.00	0.00
Austria	0.806	e	0.00	0.00	0.00	41.75	0.96	54.97	1.53	0.00	0.00
Switzerland	0.932	e	0.00	0.00	0.00	44.83	1.17	51.94	1.54	0.00	0.00
Netherlands	1.191	e	0.00	0.00	0.00	57.59	0.45	35.95	0.67	0.00	0.00
Belgium	1.314	e	0.00	0.00	0.00	58.37	0.53	35.54	0.62	0.00	0.00
Ireland	1.369	e	0.00	0.00	0.00	59.8	0.62	33.94	0.6	0.00	0.00

Table 11: Variance Decomposition of Nominal Exchange Rate for all Countries

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	z1	76.19	0.2	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Japan	0.235	z1	74.45	0.21	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Australia	0.372	z1	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	z1	26.89	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	z1	29.14	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	z1	32.66	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Spain	0.476	z1	22.9	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	z1	30.34	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	z1	30.95	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	z1	28.96	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	z1	27.49	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	z1	18.64	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	z1	29.44	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	z1	25.16	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	z1	29.1	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	z1	25.41	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	z1	28.31	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	z1	29.96	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	z1	2.01	0.23	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	z1	0.79	0.24	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	z1	21.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	z1	21.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	z1	23.49	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	z1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	z1	0.00	0.00	0.00	2.77	0.00	4.82	0.09	15.91	0.00
Japan	0.235	z1	0.00	0.00	0.00	3.03	0.00	5.27	0.08	16.96	0.00
Australia	0.372	z1	0.00	0.00	0.00	0.01	0.00	0.03	0.00	99.77	0.00
Italy	0.454	z1	0.00	0.00	0.00	2.41	0.94	15.64	2.35	51.73	0.00
Mexico	0.454	z1	0.00	0.00	0.00	2.64	0.97	16.54	2.33	48.34	0.00
Greece	0.472	z1	0.00	0.00	0.00	3.09	1.12	19.3	2.7	41.08	0.00
Spain	0.476	z1	0.00	0.00	0.00	2.17	0.66	13.92	2.12	58.2	0.00
France	0.488	z1	0.00	0.00	0.00	3.03	0.86	18.63	2.75	44.36	0.00
UK	0.528	z1	0.00	0.00	0.00	3.09	0.82	19.28	2.65	43.17	0.00
Germany	0.581	z1	0.00	0.00	0.00	2.62	0.66	16.92	2.14	48.67	0.00
New_Zealand	0.582	z1	0.00	0.00	0.00	2.9	0.72	18.15	2.41	48.3	0.00
Canada	0.625	z1	0.00	0.00	0.00	1.94	0.37	12.35	1.71	64.97	0.00
Portugal	0.637	z1	0.00	0.00	0.00	3.09	0.69	19.41	2.64	44.69	0.00
Finland	0.652	z1	0.00	0.00	0.00	2.84	0.5	17.74	2.61	51.12	0.00
Korea	0.699	z1	0.00	0.00	0.00	3.36	0.56	21.13	2.89	42.92	0.00
Norway	0.708	z1	0.00	0.00	0.00	2.91	0.48	17.89	2.34	50.92	0.00
Sweden	0.726	z1	0.00	0.00	0.00	3.17	0.54	20.14	2.56	45.24	0.00
Iceland	0.753	z1	0.00	0.00	0.00	3.79	0.51	23.06	3.08	39.57	0.00
Austria	0.806	z1	0.00	0.00	0.00	6.46	0.43	17.74	3.29	69.82	0.00
Switzerland	0.932	z1	0.00	0.00	0.00	7.06	0.32	18.31	3.14	70.11	0.00
Netherlands	1.191	z1	0.00	0.00	0.00	2.94	0.2	18.32	2.47	54.99	0.00
Belgium	1.314	z1	0.00	0.00	0.00	3.85	0.24	22.72	2.52	49.55	0.00
Ireland	1.369	z1	0.00	0.00	0.00	4.07	0.23	24.47	3	44.71	0.00

Table 12: Variance Decomposition Hours Worked Commodity Sector all Countries

counry	Openness	var.	a	petrol	coal	nat_gas	iron_ore	copper	alum	zinc	tin
USA	0.226	z2	53.94	0.73	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Japan	0.235	z2	51.59	0.71	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Australia	0.372	z2	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	z2	80.81	1.43	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	z2	80.68	1.42	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Greece	0.472	z2	78.61	1.39	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Spain	0.476	z2	80.12	1.42	0.00	0.04	0.00	0.00	0.00	0.00	0.00
France	0.488	z2	81	1.43	0.00	0.04	0.00	0.00	0.00	0.00	0.00
UK	0.528	z2	82.07	1.44	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Germany	0.581	z2	81.52	1.45	0.00	0.04	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	z2	77.23	1.35	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Canada	0.625	z2	76.15	1.33	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	z2	78.07	1.4	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Finland	0.652	z2	74.57	1.3	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Korea	0.699	z2	85.19	1.51	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Norway	0.708	z2	82.49	1.46	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	z2	78.79	1.39	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	z2	78.87	1.4	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Austria	0.806	z2	79.63	1.75	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	z2	73.82	1.64	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	z2	77.34	1.42	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	z2	79.35	1.45	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	z2	79.09	1.44	0.00	0.04	0.00	0.00	0.00	0.00	0.00
counry	Openness	var.	timber	cotton	rubber	wool	wheat	beef	maize	sugar	rice
USA	0.226	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Japan	0.235	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	0.372	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.454	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	0.454	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.472	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	0.476	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
France	0.488	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UK	0.528	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germany	0.581	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New_Zealand	0.582	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canada	0.625	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	0.637	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.652	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	0.699	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	0.708	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sweden	0.726	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iceland	0.753	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.806	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	0.932	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	1.191	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	1.314	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	1.369	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
counry	Openness	var.	coffee	cocoa	tobacco	r_for	r_dom	pi_for	pi_dom	z1	z2
USA	0.226	z2	0.00	0.00	0.00	0.2	0.00	0.34	0.01	35.12	9.64
Japan	0.235	z2	0.00	0.00	0.00	0.2	0.00	0.36	0.01	38.02	9.09
Australia	0.372	z2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.96	0.02
Italy	0.454	z2	0.00	0.00	0.00	0.06	0.02	0.41	0.06	0.22	16.94
Mexico	0.454	z2	0.00	0.00	0.00	0.07	0.02	0.42	0.06	0.24	17.04
Greece	0.472	z2	0.00	0.00	0.00	0.07	0.02	0.42	0.06	0.17	19.21
Spain	0.476	z2	0.00	0.00	0.00	0.06	0.02	0.41	0.06	0.28	17.57
France	0.488	z2	0.00	0.00	0.00	0.07	0.02	0.45	0.07	0.2	16.72
UK	0.528	z2	0.00	0.00	0.00	0.07	0.02	0.46	0.06	0.18	15.64
Germany	0.581	z2	0.00	0.00	0.00	0.06	0.02	0.38	0.05	0.26	16.21
New_Zealand	0.582	z2	0.00	0.00	0.00	0.07	0.02	0.46	0.06	0.21	20.55
Canada	0.625	z2	0.00	0.00	0.00	0.07	0.01	0.44	0.06	0.37	21.52
Portugal	0.637	z2	0.00	0.00	0.00	0.06	0.01	0.38	0.05	0.17	19.8
Finland	0.652	z2	0.00	0.00	0.00	0.08	0.01	0.48	0.07	0.21	23.23
Korea	0.699	z2	0.00	0.00	0.00	0.08	0.01	0.49	0.07	0.17	12.44
Norway	0.708	z2	0.00	0.00	0.00	0.08	0.01	0.47	0.06	0.24	15.13
Sweden	0.726	z2	0.00	0.00	0.00	0.07	0.01	0.45	0.06	0.13	19.05
Iceland	0.753	z2	0.00	0.00	0.00	0.08	0.01	0.48	0.06	0.14	18.9
Austria	0.806	z2	0.00	0.00	0.00	0.06	0.00	0.17	0.03	1.41	16.88
Switzerland	0.932	z2	0.00	0.00	0.00	0.05	0.00	0.13	0.02	2.18	22.08
Netherlands	1.191	z2	0.00	0.00	0.00	0.06	0.00	0.37	0.05	0.45	20.25
Belgium	1.314	z2	0.00	0.00	0.00	0.08	0.01	0.49	0.05	0.53	17.99
Ireland	1.369	z2	0.00	0.00	0.00	0.08	0.00	0.47	0.06	0.34	18.47

Table 13: Variance Decomposition Hours Worked Non-Com. Sector all Countries

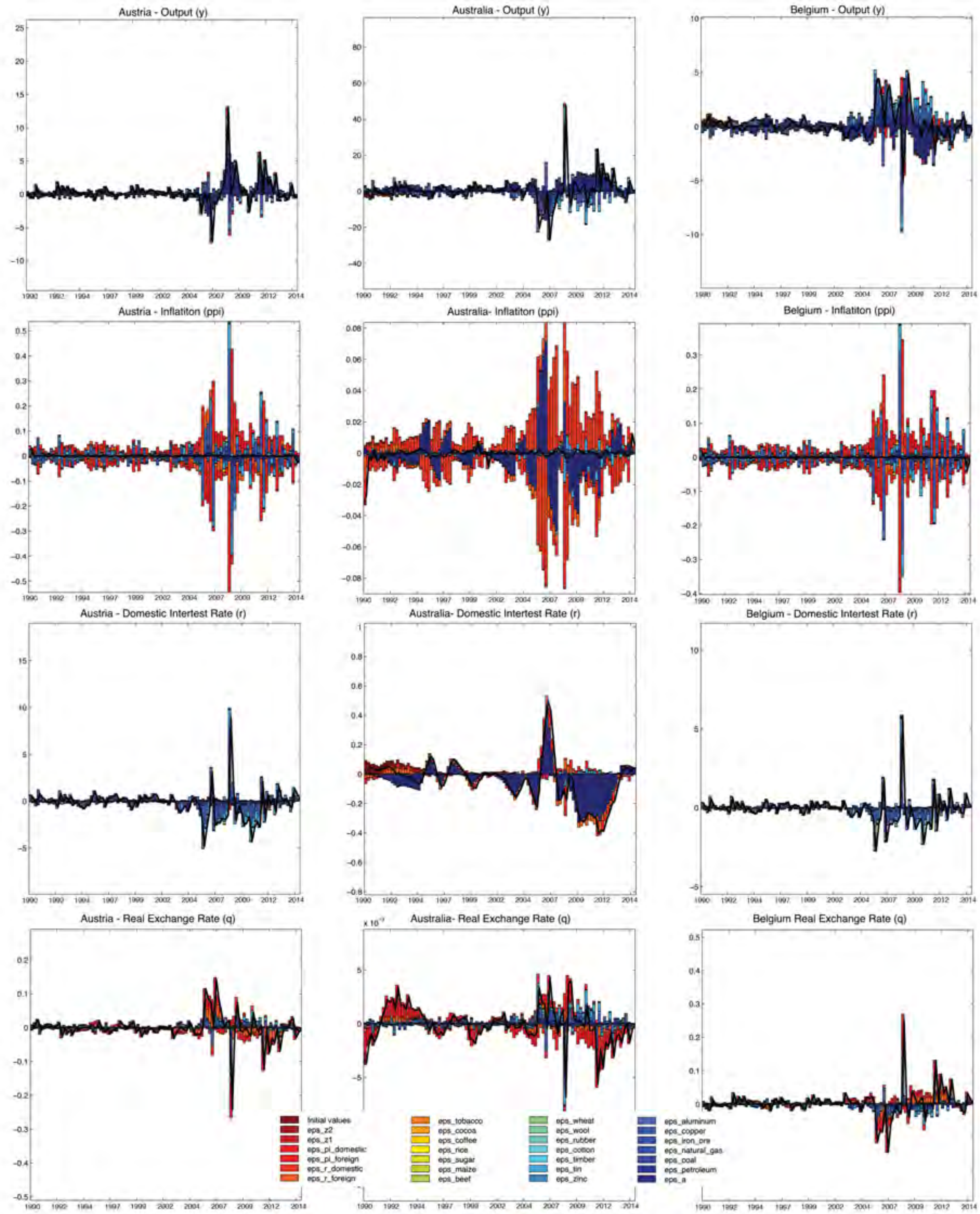

Figure 1: Shock Decomposition Austria

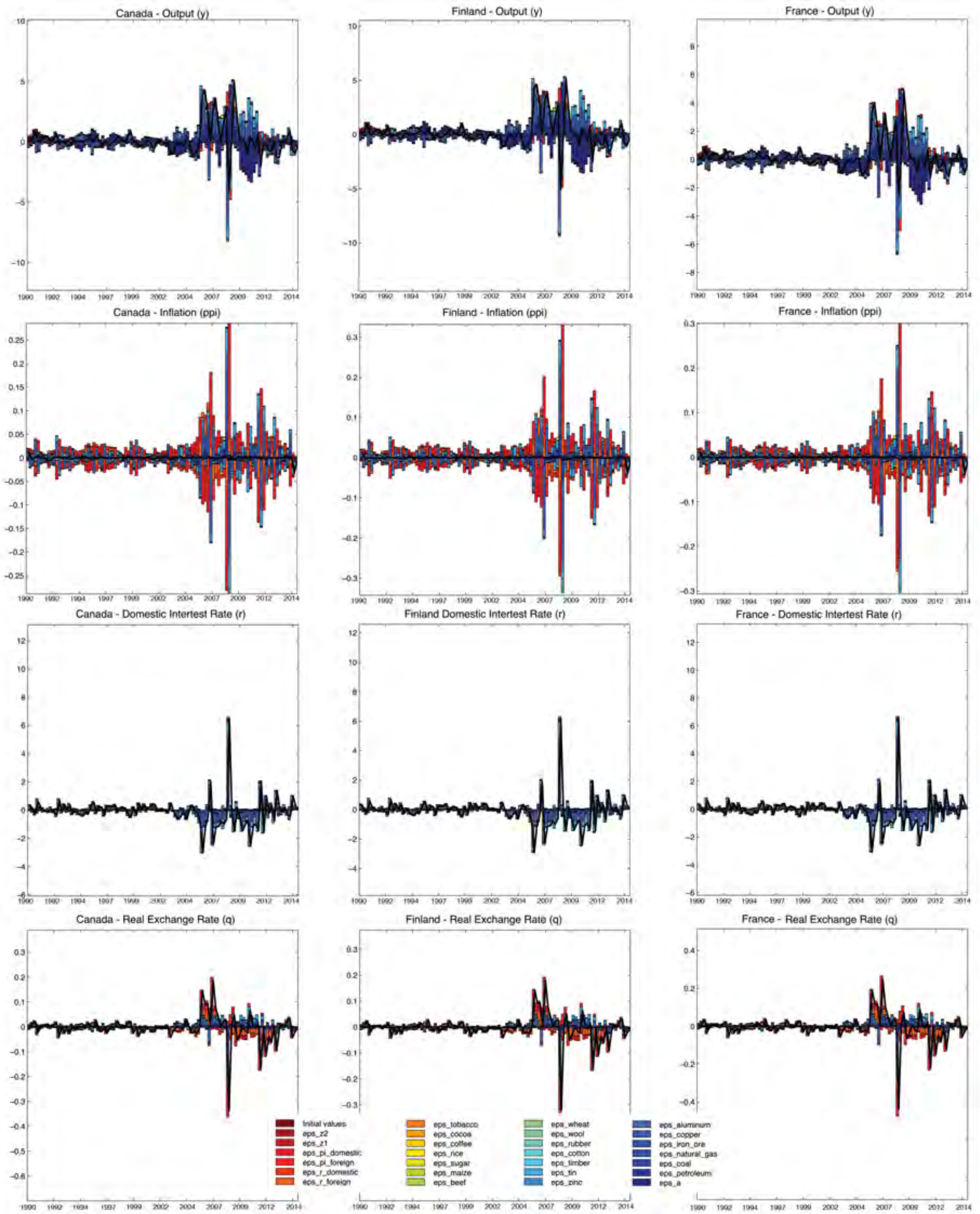

Figure 2: Shock Decomposition Canada

Figure 3: Shock Decomposition Germany

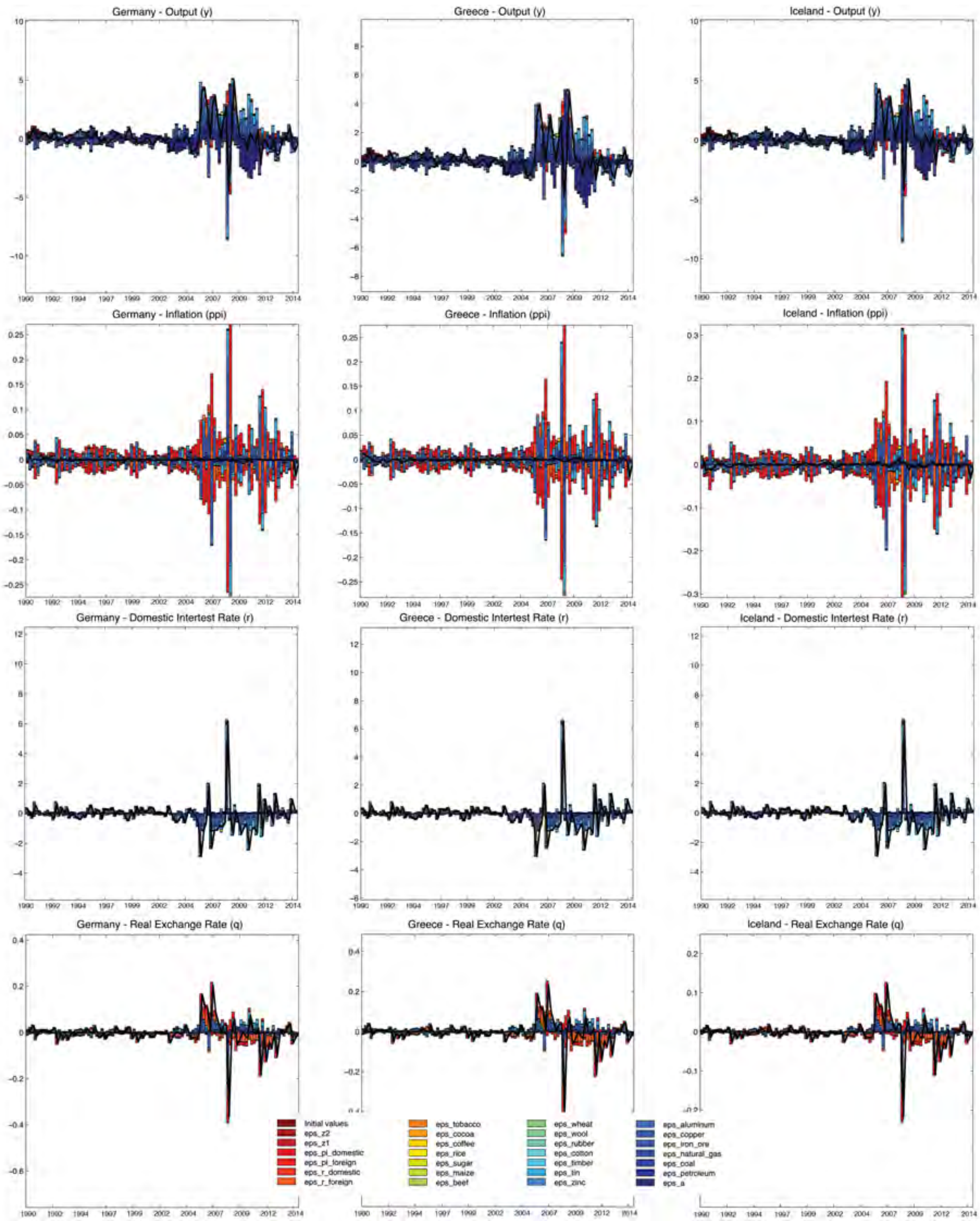

Figure 4: Shock Decomposition Canada

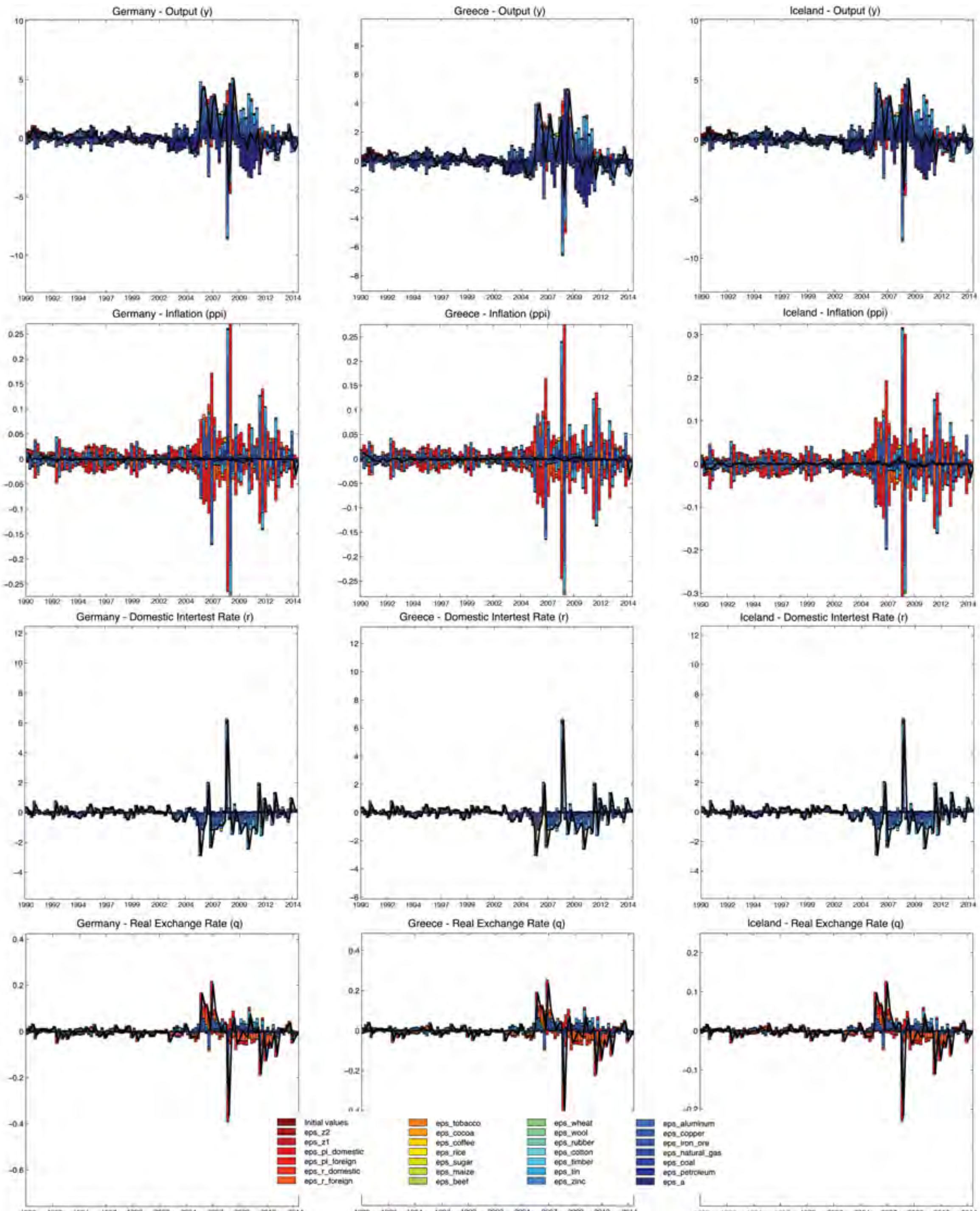

Figure 5: Shock Decomposition Ireland

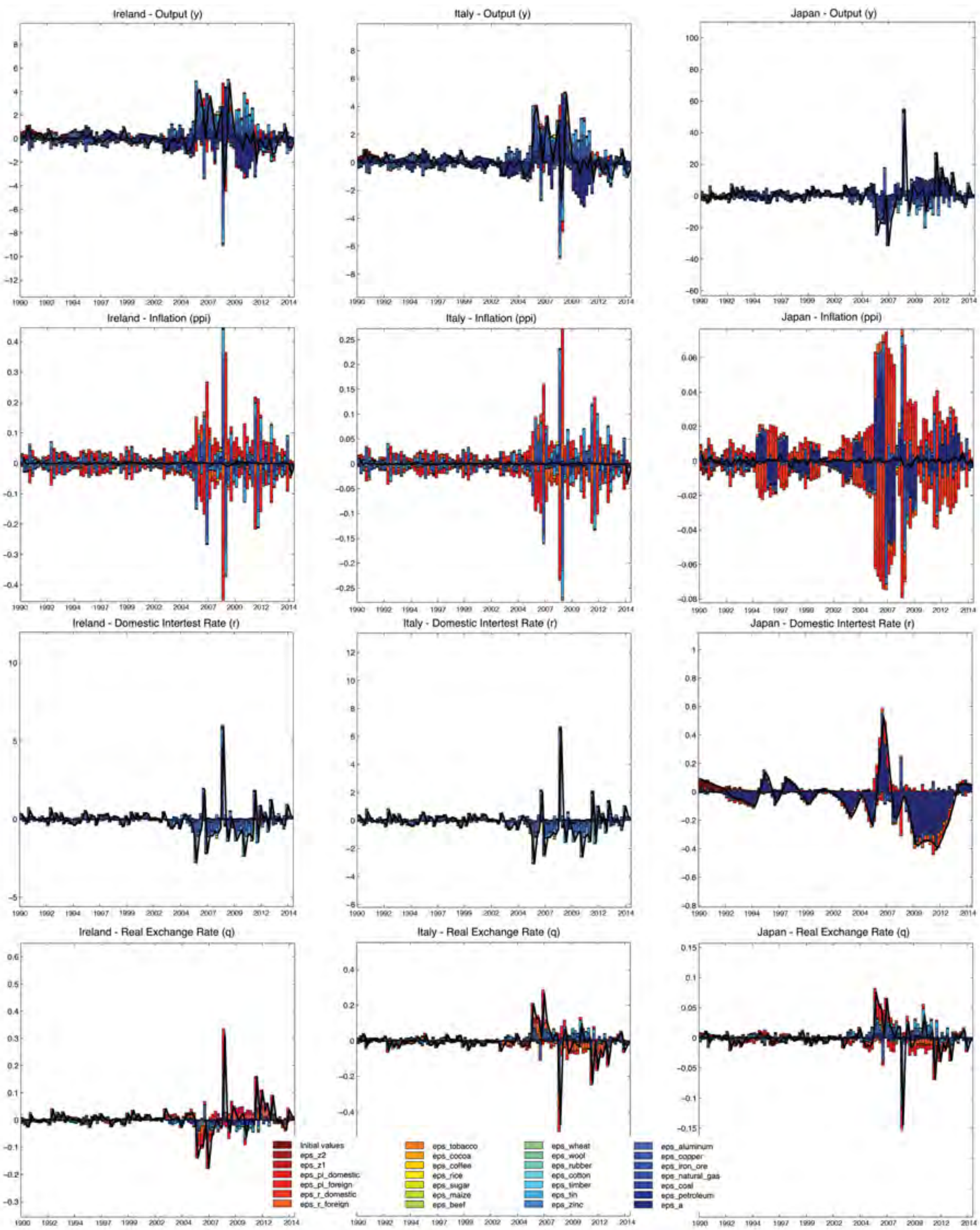

Figure 6: Shock Decomposition Korea

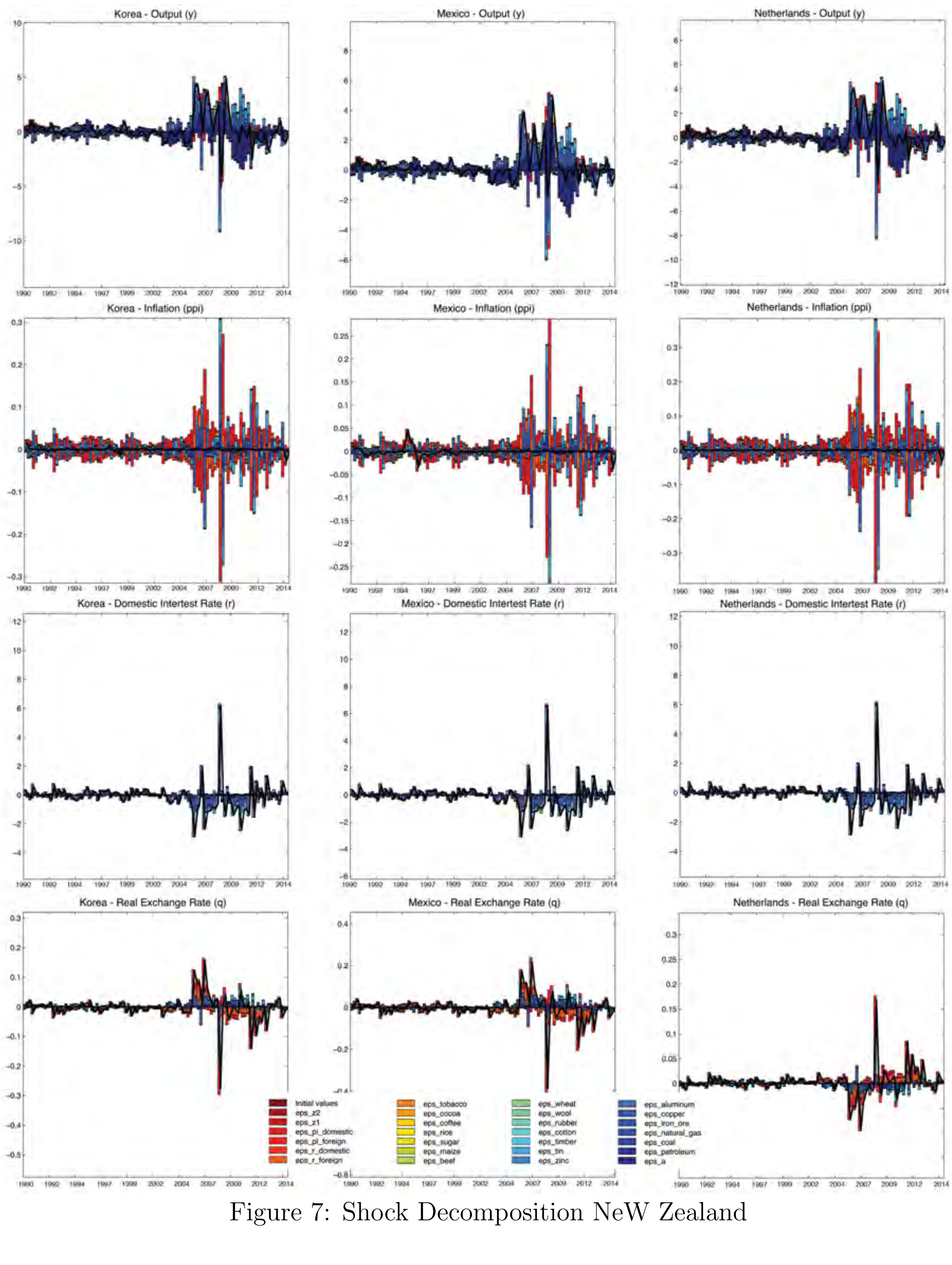

Figure 7: Shock Decomposition NeW Zealand

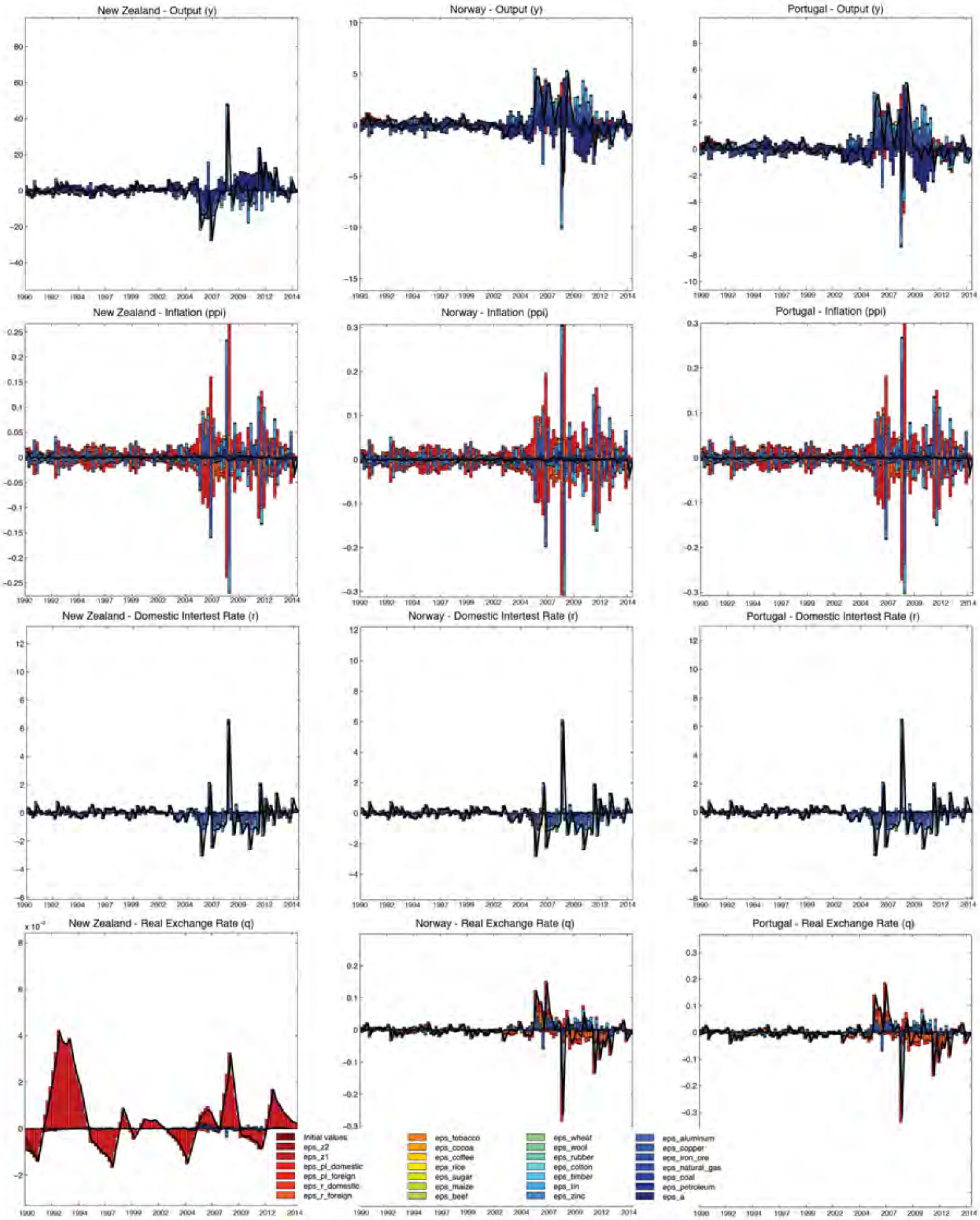

Figure 8: Shock Decomposition Spain

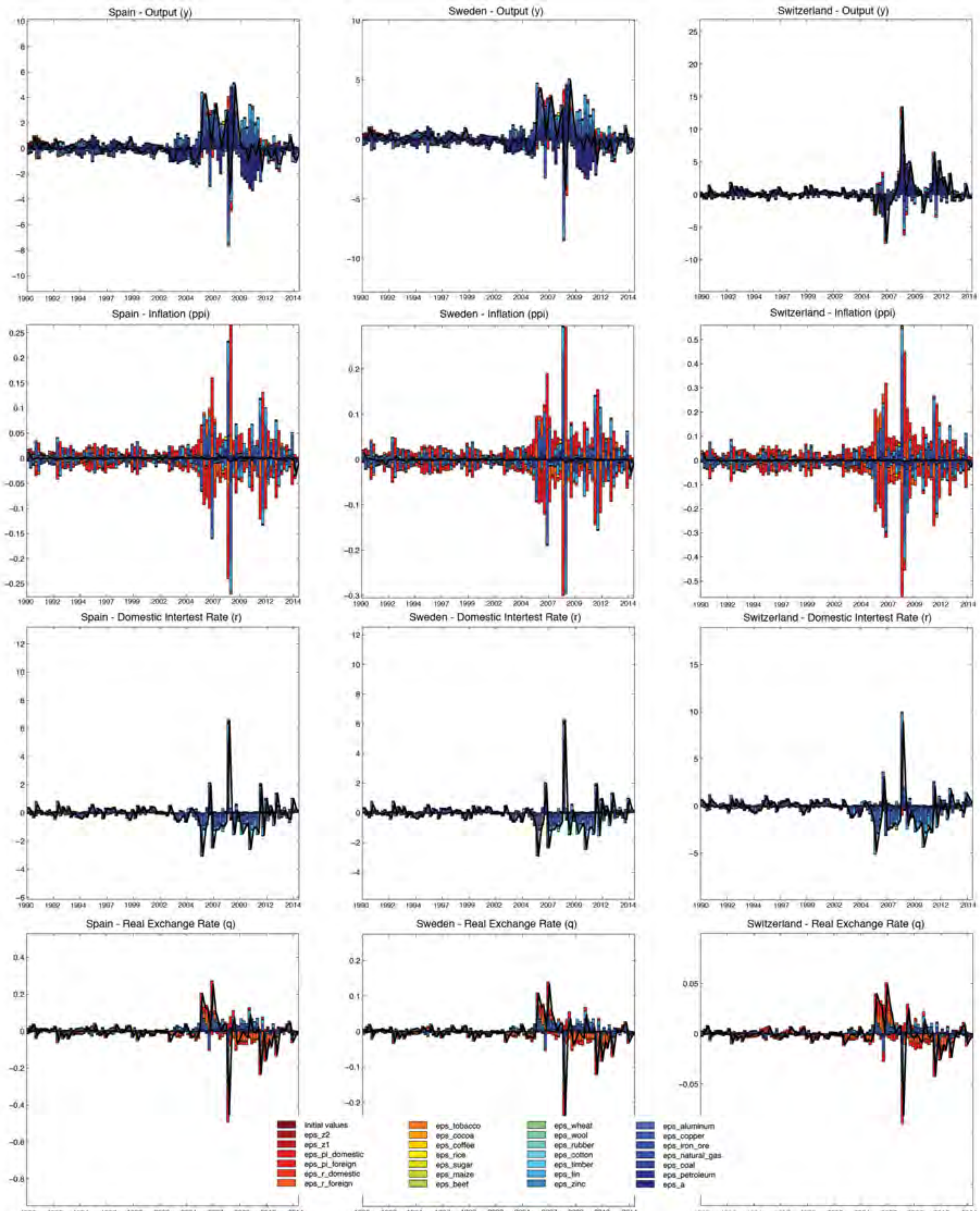

Figure 9: Shock Decomposition United Kingdom

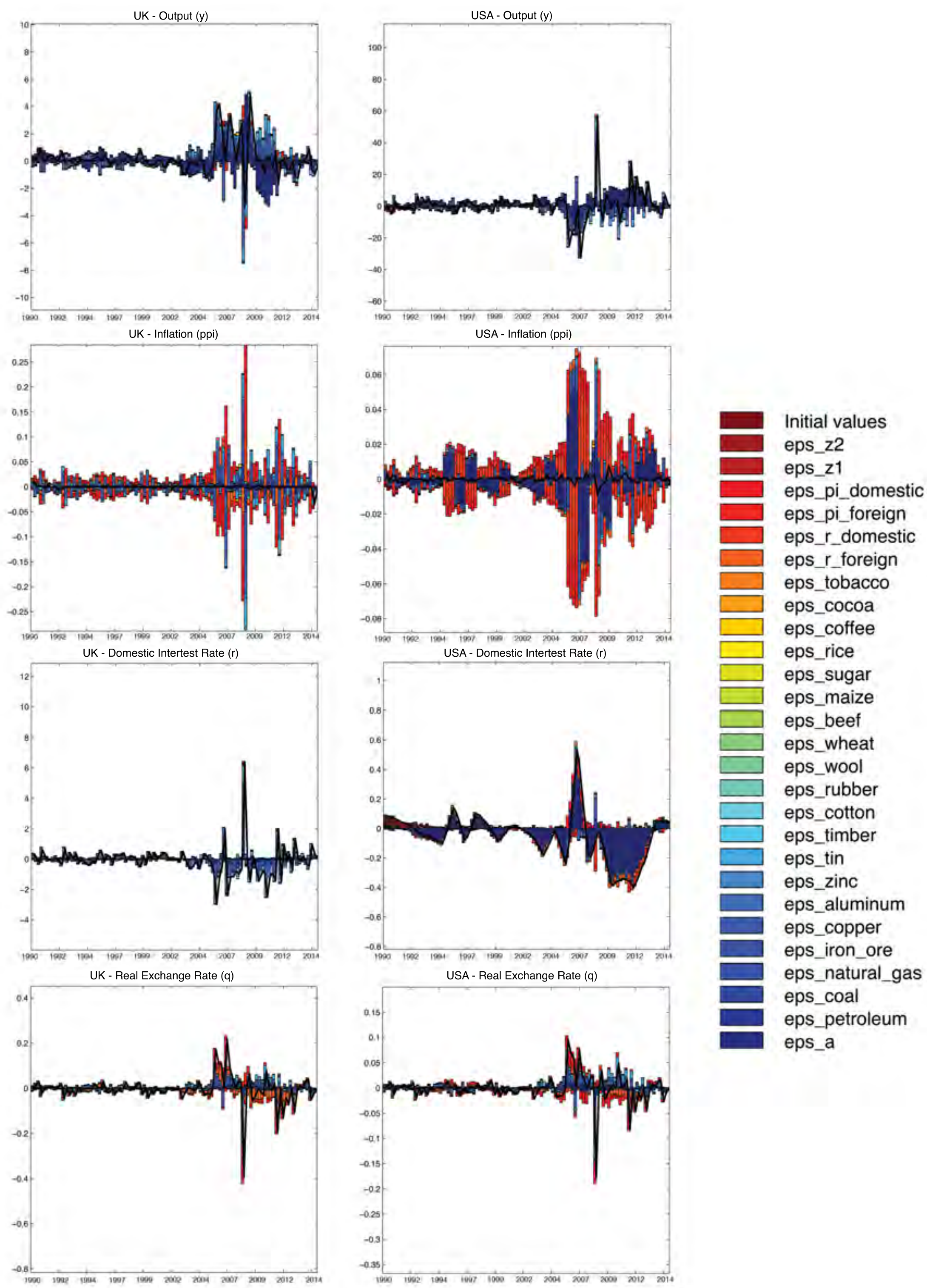

Figure 10: Shock Decomposition United States

The model was estimated in quarterly frequency using the timeframe from April, 1991 to December, 2015, using data from multiple sources. The data that was used to estimate the model can be classified into three categories: commodity price indexes, domestic data - Trinidad and Tobago, and foreign data - the World represented by the OCED members. To make the data suitable for model estimation each variable in the dataset has gone through a processing phase. Below one will find a detailed description of each variable and the transformations that were appiles to the variable. In addition, plots of the levels and first differences of key variables within the model are provided after their descriptions.

[1] p_t^g: Natural Gas Price Index, this series was constructed using two gas price timeseries, because the primary series, Henry Hub Gas Price does not cover the entire time range of our investigation. Therefore, the US Natural Gas Import prices were used as a proxy for the missing gas price, which covers the time range from 1/1/1991 to 10/1/1996. After October 1996, the Henry Hub Gas prices were used. We define the natural gas price index as

$$p_t^g = ln(P_t^g) \tag{1}$$

where P_t^g is the natural gas price, which has been normalized to the 2010Q1 price. The data was sourced from the EIA's websites.[12] The data was in monthly frequency, but was aggregated to quarterly frequency to have it adhered to our model.

[2] p_t^o: Oil Price Index, used the EIA's Cushing OK WTI Spot Price FOB monthly data that has been aggregated to quarterly frequency. This index is defined as follows

$$p_t^o = ln(P_t^o) \tag{2}$$

[1]EIA's gas price url: https://www.eia.gov/dnav/ng/hist/rngwhhdM.htm

[2]EIA's gas price url: https://www.eia.gov/dnav/ng/hist/n9100us3M.htm.

where P_t^o is the Cushing OK WTI Spot Price FOB series, which can be downloaded from EIA's website.[3]

[3] e_t: the natural log of Trinidad and Tobago's effective exchange rate. It has been sourced from the IMF's International Financial Statistics (IFS) website[4], which has been indexed to 2010 = 100. We defined it as follows

$$e_t = -ln(E_t) \tag{3}$$

where E_t is Trinidad and Tobago's effective exchange rate.

[4] r_t^*: the foreign nominal interest rate. It has been calculated using the following formula

$$r_t^* = 0.25ln\left(1 + \frac{R_t^*}{100}\right) \tag{4}$$

where R_t^* is the weighted average annual interest rate Money Market Rate for US, UK, Euro and JPY, and each corresponding Money Market Rate has been weighted to the Special Deposit Rights (SDR) weights from 2011: US(0.419), UK(0.113), EURO(0.374) and JPY(0.094). Hence,

$$R_t^* = \sum_{j=1}^{4} w_j R_{j,t} \tag{5}$$

where w_j's are the SDR drawing weights and $R_{j,t}$ is the individual Money Market Rate for each currency.

[5] r_t: the domestics nominal interestes rate. We calculated the domestic nominal domestic interest in the following manner

$$r_t = 0.25ln\left(1 + \frac{R_t}{100}\right) \tag{6}$$

[3]http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=M

[4]http://data.imf.org/?sk=5DABAFF2-C5AD-4D27-A175-1253419C02D1&sId=1409151240976

where R_t is the average annual interest 90-day Treasury Bill Rate for Trinidad and Tobago. As with the effective exchange rate, the domestics nominal interestes rate the was sourced from the IMF's International Financial Statistics website.[4]

[6] p_t: the domestic price level. The IMF's International Financial Statistics quarterly Consumer Price Index (CPI) was utilized with the data index to 2010 = 100, Hence,

$$p_t = ln(P_t) \tag{7}$$

with P_t being the CPI. The CPI data can be found at IMF's website.[4]

[7] Δp_t: the Trinidad and Tobago's inflation rate that was calculated as:

$$\Delta p_t = ln(P_t) - ln(P_t) \tag{8}$$

with P_t being define above.

[8] p_t^*: the foreign price level. The monthly Consumer Price (MEI) from the OECD was used, and it was aggregated to quarterly frequency with an index of 2010 = 100. The foreign price level was calculated as:

$$p_t^* = ln(P_t^*) \tag{9}$$

where P_t^* is the OECD Consumer Price (MEI). The dataset can be obtain as the OECD.Stat website.[5]

[9] $p_t - p_t^*$: domestic and foreign price level differences.

[10] y_t: the Trinidad and Tobago real per capital domestics output. Trinidad and Tobago's Central Bank only publishes annual GDP data. Therefore the data needed to be interpolated in quarterly frequency. The interpolated process was done using the Trinidad

[5] http://www.oecd.org/std/

and Tobago's Real GDP Growth, which was available in quarterly frequency. The real per capital output was calculated as follows:

$$y_t = ln\left(GDP_t/(POP_t * P_t)\right) \tag{10}$$

where P_t is Trinidad's CPI.

[11] y_t^*: the foreign real per capital domestics output, which was calculated as:

$$y_t^* = ln\left(GDP_t^*/(POP_t^* * P_t^*)\right) \tag{11}$$

where GDP_t^* the total gross domestic product, expenditure approach, of all OECD members at US dollars and which has been seasonally adjusted. The GDP_t^* was sourced for the OECD.Stat website. The POP_t^* variable is the total population of the OECD. To estimate quarterly population values we interpolated the population from an estimated growth rate from the annual population figures. Lastly, the P_t^* is the CPI of the OECD, whose details were mentioned above.

[12] $h_t - y_t$: the natural log of real per capita money stock, which is calculated as:

$$h_t - y_t = ln\left(H_t/Y_t)\right) \tag{12}$$

where H_t is the M0 money stock, and Y_t is the real per capita GDP of Trinidad and Tobago. The M0 money stock data was obtained from the Trinidad Central Bank website.[6]

[6]http://www.central-bank.org.tt/content/data-centre

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