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Three Essays on Economic and Financial Development in Latin America: Evidence from the 2000s Commodity Boom

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THREE ESSAYS ON ECONOMIC AND FINANCIAL DEVELOPMENT

IN LATIN AMERICA: EVIDENCE FROM THE

2000s COMMODITY BOOM

A Dissertation

by

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ABSTRACT

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The dynamic forces of commodity prices have become a subject of large interest due to the uprise of a commodity supercycle in the beginning of the 21st century. The main purpose of this dissertation is to assess the role of commodity shocks and international trade in Latin American financial and economic development in the last two decades. The first essay examines how commodity market structural shocks explain the variations in commodity prices. Structural Vector Autoregression (SVAR) results from 1997 to 2015 show that aggregate demand shocks are more evident during the recent commodity boom period and are robust to different time spans and selection of commodities. The second essay analyzes the impacts of those commodity market structural shocks on Latin American stock markets. I select stock exchange benchmark indices and individual firm stock prices to test the responses of the region's stock markets to supply, demand and idiosyncratic shocks to commodities that correspond to the largest listed firms in Latin American stock markets. Results are consistent with the hypothesis that aggregate demand shocks play a larger role in Latin American real stock returns during the commodity boom period as compared to the pre- and post-boom periods for all commodity markets. The third essay investigates the relationship between international trade and economic growth in 14 Latin American economies from 1997 to 2014. Fixed effects panel data regressions adopting an endogenously-determined threshold estimation method examine for evidence of nonlinearity related to the increased economic volatility in the period, especially due to the 2000s commodity boom. The strong trade-growth nexus is robust to different time spans, selection of countries and controlling for the 2008-2009 financial crisis. Two-stage least squares (2SLS) regressions add robustness to results while addressing the potential endogeneity in the trade-growth relationship.

DEDICATION

The completion of my doctoral studies would not have been possible without the love and support of my family. My dear wife, Caroline, my parents, Plinio and Flavia, my uncle Morris and my aunt Jussara, and my sister, Fernanda, supported me by all means to accomplish this degree. I dedicate this dissertation to these important people and to my daughters, Isadora and Gabriela, who have inspired and motivated me to work hard every day. Thank you, my family, for your unconditional love and support.

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CHAPTER I

INTRODUCTION

1.1 Latin America and the Recent Commodity Boom

The 2000s commodity boom is considered the largest commodity supercycle since the two post-World War II commodity booms which took place in the early 1950s and early to mid-1970s. Each of the first two booms lasted around two years as macroeconomic policies were employed to tackle inflation in the developed economies – the largest consumers of commodities. The most recent commodity boom is different from these previous booms because it combines a strong macroeconomic expansion in the period with a large use of commodity in the emerging markets (Baffes et al. 2008; Radetzki 2006; Radetzki et al. 2008).

It is important to analyze Latin America's role in the commodity boom since the region is one of the most commodity-dependent regions within the emerging market world. According to Harrup (2016), the region's exposure to commodities is unique in the world, even greater than middle-income African countries. Besides, the rebound in Latin American economic growth in the 2000s is often attributed to the commodity boom (Rosnik and Weisbrot, 2014).

In this dissertation, I analyze the commodities associated with the most profitable businesses in current days: crude oil, copper and iron ore, as well as the historically important coffee market for a robustness check. Table 1.1 shows that crude oil, copper, iron ore and soybeans were the top exported commodities produced in Latin America in 2015. Together, these four commodities account for 24.2% of Latin American exports: crude oil with 13.3%, followed by copper (4.9%), iron ore (3.0%) and soybeans (3.0%). It is also noteworthy to reference that these four commodities accounted for 80% of Latin America's exports to China in the period from 2008 to 2014 (Casanova et al., 2015). In that sense, a recent study by Vianna (2016) provides evidence that exports to China are important to Latin American economic growth.

About five decades ago, Latin America's dependence of commodities had an extra ingredient: most of the countries relied on a single commodity. Table 1.2 provides evidence of the region's dependence on single commodities' exports in the late 1950s.

Historically, coffee is the commodity that has been exported by most Latin American economies. Blumenfeld (1961) demonstrates that, between 1957 and 1959, the following countries' exports were extremely dependent on coffee, by value: Brazil (58%), Colombia (77%), Costa Rica (51%), El Salvador (72%), Guatemala (72%) and Haiti (63%). Today, although Latin America is less dependent on coffee, around 50% of the world's coffee production still comes from the region (Faostat, 2017).

Crude oil is a major commodity in Latin America. The largest oil exporters in the region are Argentina, Brazil and Venezuela. Iron ore production in the region comes mainly from Brazil. Chile is the largest copper producer worldwide, while Brazil and Colombia are in the top three exporters of coffee (UN Comtrade, 2017).

In this dissertation, I provide evidence that not only commodity prices are highly impacted by the increasing demand during the commodity boom period, but the Latin American stock market experiences a large uprise pulled by the growing demand for the region's commodity exports. This study also aims to show that international trade plays a major role in

Latin American economic growth and this relationship is not necessarily a linear one: it may sharply increase in periods of high volatility of trade such as the 2000s commodity boom.

1.2 Motivation

The main purpose of this dissertation is to assess the role of commodity shocks and international trade in the Latin American financial and economic development in the last two decades. The determinants of commodity prices have been investigated by many authors who have provided insightful evidence that economic activity, fiscal imbalances, real interest rates, real exchange rate, the effect of former Soviet Union and commodity supply and demand (market forces) are some of those determinants (Arango et al., 2012). Borensztein and Reinhart (1994, p. 236) explain that "the 'traditional structural approach' to determining real commodity prices has relied exclusively on demand factors as the fundamentals that explain the behavior of commodity prices". They argue, however, that this framework could not explain the weakness in commodity prices during the 1980s and 1990s and, therefore, incorporate commodity supply in the analysis. Deaton (1999, p. 30) argues that supply shocks are usually large and related to "wars, pestilence, disease, weather, and political upheaval (…) capable of causing large, albeit usually temporary, shortfalls in production". Kilian (2009), nevertheless, provides evidence from the crude oil market showing that the commodity price shocks are driven by a combination of global aggregate demand shocks and precautionary demand shocks, rather than oil supply shocks, as commonly believed. More generally, a demand shock captures a shift in consumer and investor expectations that has a causal effect on cyclical fluctuations (Lorenzoni, 2009), while a "supply shock is an event that directly alters firms' costs and prices, shifting the economy's aggregate-supply curve" (Mankiw & Taylor, 2017, p. 748).

Little has been done in the literature on the relationship between commodity prices and emerging stock markets and on the nonlinear link between international trade and Latin American economic growth. First, I examine different commodity shocks and their effects on global commodity prices. Supply, demand and idiosyncratic shocks may have played different roles in the variation of commodity prices in the commodity boom period. I compare and contrast these shocks with those in the pre- and post-commodity boom periods. Then, I analyze their effects on Latin American stock market returns. By examining different commodity shocks, I show that aggregate demand has played a major role in the large growth experienced by Latin American stock markets during the commodity boom period. Finally, I examine the trade-growth nexus (or trade-led growth hypothesis) in order to check for the existence of a nonlinear relationship that derives from the increased economic volatility in the commodity boom period.

1.3 Research Questions

This dissertation focuses on the last two decades of Latin American financial and economic development and seeks to answer the following research questions: (1) how do different commodity market structural shocks explain the variations in commodity prices?; (2) are these shocks more evident during the recent commodity boom period?; (3) are these results robust to different time spans and selection of commodities?; (4) how do these different commodity market structural shocks impact the Latin American stock market?; (5) are these results robust to different stock exchange benchmark indices and individual firm stock prices?; (6) is there evidence of a nonlinear relationship between international trade and economic growth (trade-growth nexus or trade-led growth hypothesis) in Latin America?; (7) does the regime with above-threshold volatility display a larger coefficient for the trade-growth nexus?; and (8) is this result robust to different time spans, country sizes and measures of international trade?

In the first essay of this dissertation, “Decomposing Variance in Commodity Prices”, I provide empirical evidence that commodity market structural shocks play a significant role in explaining the variations in the prices of oil and copper markets, some of the most profitable businesses among commodity exporting firms in Latin America. During the commodity boom period, aggregate demand shocks play a major role in the variations in crude oil and copper real prices. The role of the coffee market structural shocks in influencing coffee prices is relatively weaker, in line with the decreased participation of this traditional Latin American commodity in the region’s exports. Furthermore, I conclude that iron ore prices cannot be analyzed in this context, since prices were negotiated based on annual renegotiations of long-term contracts, not allowing free flotation of the iron ore price time series.

In the second essay, “Decomposing Variance in Latin American Stock Returns”, results are consistent with the hypothesis that aggregate demand shocks have an increased contribution to Latin American stock returns during the commodity boom period as compared to the pre- and post-boom periods for all commodity markets. From 16 tables, the exceptions are: the Argentine oil company YPF S.A. and the Brazilian Bovespa index, for which stock returns are more largely explained by aggregate demand shocks in the post-boom period; as well as the Brazilian oil company Petrobras and the Mexican IPC index, which have larger variance decomposition coefficients in the pre-boom period. These four exceptions are from the crude oil market, suggesting that these results are related to the major decline in non-OPEC supply between 2004 and 2008 which resulted in the production increase by OPEC members.

In the third essay, “Latin America and the Trade-Growth Nexus”, I examine for evidence of a nonlinear international trade-growth link in Latin America in the last two decades using a threshold estimation method to examine the nonlinearity related to the increased economic volatility in the period, especially during the 2000s commodity boom.

The common thread between the first and second essays is the investigation on market forces (supply and demand) in regards to which are the main determinants of the variance in commodity prices and stock market returns. I provide evidence supporting the hypothesis that aggregate demand shocks played a fundamental role during the 2000s commodity boom period. These essays are connected with the third essay by two main factors. First, there is an extensive empirical literature on finance and growth assessing the effect of the financial system on economic growth. Levine (2005, p. 888) explains that these studies investigate “whether the impact is economically large, and whether certain components of the financial system, e.g., banks and stock markets, play a particularly important role in fostering growth at certain stages of economic development”. Second, the commodity boom period, focus of the three essays, is analyzed through both time-series and panel-data approaches. Specifically, in the third essay terms-of-trade volatility is a key threshold mediating the nonlinear trade-growth link in Latin America, consistent with the increased economic volatility in the 2000s commodity boom period.

The remainder of this dissertation is organized as follows. Chapter II examines different commodity market structural shocks and their role in explaining the variations in the prices of crude oil, iron ore, copper and coffee markets. Chapter III explores the hypothesis that aggregate demand shocks have a major contribution to Latin American stock returns during the commodity boom period. Chapter IV investigates the nonlinear relationship between international trade and Latin American economic growth in the past two decades and concludes the dissertation.

Table 1.1

Latin American Top Commodity Exports in 2015.

Commodity	Value (US$ million)	%
Mineral fuels, oils and products (27)	161,621	17.1%
Crude oil (2709)	125,465	13.3%
Copper	46,729	4.9%
Copper ore (2603)	24,168	2.6%
Copper and articles thereof (74)	22,561	2.4%
Iron ore	28,686	3.0%
Iron ore (2601)	15,426	1.6%
Iron and steel (72)	13,260	1.4%
Oil seeds and oleaginous fruits (12)	29,729	3.1%
Soybeans (1201)	27,981	3.0%
Pearls, precious stones and metals etc. (71)	24,875	2.6%
Edible fruits and nuts etc. (08)	21,232	2.2%
Meat and edible meat offal (02)	20,405	2.2%
Cereals (10)	12,866	1.4%
Coffee, tea, mate and spices (09)	12,677	1.3%
Other commodities*	587,679	62.1%
Vehicles other than railway rolling stock (87)	107,898	11.4%
Electrical machinery and equipment (85)	90,195	9.5%
Nuclear reactors, boilers etc. (84)	74,187	7.8%
Remaining commodities	315,400	33.3%
All Exports	946,500	-

Source: UN Comtrade (2017). Notes: Data for Honduras and Venezuela are from 2014 and 2013, respectively. Number in parentheses refers to 2-digit commodity code at Comtrade database. Right-aligned commodity groups correspond to subgroups of left-aligned values.
* Other commodities include manufactured commodities.

Table 1.2
Latin America's Dependence on Single Commodities' Exports Between 1957 and 1959.

Country	Commodity	Percentage of total exports, by value
Argentina	Meat	26
Bolivia	Tin	62
Brazil	Coffee	58
Chile	Copper	66
Colombia	Coffee	77
Costa Rica	Coffee	51
Cuba	Sugar	77
Dominican Republic	Sugar	48
Ecuador	Bananas	67
El Salvador	Coffee	72
Guatemala	Coffee	72
Haiti	Coffee	63
Honduras	Bananas	51
Mexico	Cotton	25
Nicaragua	Cotton	39
Panama	Bananas	69
Paraguay	Timber	24
Peru	Cotton	23
Uruguay	Wool	54
Venezuela	Petroleum	92

Source: Blumenfeld (1961) and International Monetary Fund (1960).

CHAPTER II

DECOMPOSING VARIANCE IN COMMODITY PRICES

2.1 Introduction

This essay analyzes the impacts of commodity supply, demand and idiosyncratic shocks on real commodity prices from 1997 to 2015. I focus on contrasting the different shocks and commodity cycle periods in the past twenty years. The 2000s commodity boom is regarded as a period of high demand for commodities from the industrialized countries. The large surge in commodities happens from 2003 to 2010, even though the global financial crisis in the 2008-2009 period adds some negative pressure to the boom. Structural Vector Autoregression (SVAR) analyses in the commodity boom period are expected to show evidence of stronger responses of commodity prices to aggregate demand shocks than the ones in the pre- and post-commodity boom periods. I expect demand shocks to account for a larger portion of the variance decomposition of commodity prices in the 2003-2010 period than in the 1997-2002 and 2011-2015 periods.

I focus on crude oil, iron ore and copper, which are some of the most profitable businesses among commodity exporting firms in Latin America. For robustness, I also analyze the coffee market, a historically important commodity for the region.[1] Results indicate that

[1] Soy producing companies from Argentina and Brazil are among the largest commodity exporting firms in Latin America. However, I do not include soy because: a) of confounding effects from the U.S., the world's top soy producing country; b) the headquarters of the largest soybean exporting companies in Brazil (Bunge Alimentos and

commodity market structural shocks play a significant role in explaining the variations in the commodity prices. Oil, copper and coffee prices display negative responses to supply shocks, consistently with the literature. Regarding demand shocks, these commodity prices exhibit positive responses. The variance decomposition test results provide evidence of the hypothesized increased contribution of aggregate demand shocks to variations in commodity prices during the commodity boom period.

The rest of chapter proceeds as follows. Section 2.2 reviews the previous literature on commodity booms and Latin American commodity markets. Section 2.3 explains the methodology. Section 2.4 describes the data. Section 2.5 brings the empirical analysis and results, and section 2.6 provides the conclusions.

2.2 Previous Literature

The first two post-World War II commodity booms are evidenced by strong rises in global demand in the early 1950s and early to mid-1970s. The third one has started in 2003 (Radetzki, 2006) and is said to be over since 2011 (The Economist, 2014a).

Radetzki et al. (2008) explain that the first two booms had short duration of around two years and ended suddenly due to macroeconomic policies carried out in the major commodity consuming economies in order to control inflation. Those policies drove the commodity booms into busts because of the worldwide recessions that followed the declines in demand and prices. They state that the 2000s commodity boom arose from a demand shock, but it is different from

Cargill) are in the United States; and c) firms are not listed in Latin American stock markets, subject of this study in the next chapter.

the previous booms due to a combination of macroeconomic expansion and high intensities of commodity use in many emerging nations.

The period from 1995 to 2002 represents an era of economic deterioration in Latin America. Calvo and Talvi (2005) discuss the negative effects of the Tequila crisis in 1995 and, later, the Russian crisis of 1998 on capital inflows to the region. The shortage in those capital flows lasted until the end of 2002 (Izquierdo et al., 2008). From 2003 to 2007, the global economy rose more than 4% each year, the highest economic growth sequence since early 1970s. China has grown 73.5% in this 5-year period, speeding up from 10 to 14.2 percent yearly growth, at the same time that the prices of many mineral materials began to increase in 2003 (International Monetary Fund, 2016).

Staritz (2012) states that the commodity price boom in the 2000s has a longer duration than seen for some decades and argues that nominal commodity prices have increased in that period and remained well above their historical levels. She also discusses the high fluctuations that commodity prices have gone through, a feature that has, besides each commodity-specific factor, one important common factor: the low short-run elasticities of supply and demand. Price fluctuations result from shocks in production or consumption as demand and supply slowly adjust. Latin America, in particular, experienced a fast increase in the share of commodities in its exports during the 2000s. Humphreys (2010), for instance, shows that the metals boom in the 2003-2008 period represents the most powerful and sustained boom since the Second World War. As the boom gained momentum, the idea started to grow that commodities were starting a demand-driven *supercycle* carried out by emerging economies, with China as the main one. Roberts (2008), for example, stresses that one of the characteristics of the recent cycle is that prices were strongly synchronized across metals.

In the empirical literature on economic growth and commodity prices, studies differ in their conclusions about commodities being a "blessing" (e.g., Alexeev and Conrad 2009; Brunnschweiler and Bulte 2008; Lederman and Maloney 2006; Sala-i-Martin et al. 2004) or a "curse" (Sachs and Warner 1999, 2001; Gylfason et al. 1999; Sala-i-Martin and Subramanian, 2012). More recently, Collier and Goderis (2012) have provided evidence that commodity booms have unconditional positive short-term effects on output, but non-agricultural booms in countries with poor governance have adverse long-term effects that dominate the short-run gains. In that sense, many studies have investigated whether Latin American countries were catching the Dutch disease[2] – exchange rates appreciation affecting the competitiveness of the non-commodity exportable sectors – or even becoming deindustrialized. This concern has grown especially in regard to Brazil, a country that saw total exports growing from US$ 72 billion in 2003 to US$ 197 billion in 2008, with GDP growth averaging 4.8% in the period. Nevertheless, Bacha and Fishlow (2011) assert that several studies on Brazilian commodities' exports have failed to support the Dutch disease or deindustrialization thesis.[3] In the case of Argentina, although the country went through a growth of exports over GDP over the last twenty years, its natural resources have not translated into an effective development. Its trade policy helped avoid an impact of price volatility on farmers' income, taxing high foreign prices and granting subsidies when prices were low. However, the industry still suffered from internal problems and political struggles (Della Paolera and Taylor, 2003). Chudnovsky and Lopez (2007) argue that these internal problems have origins in the instability of policy regimes, regulatory norms and

[2] The British magazine *The Economist* first used the term "Dutch Disease" in 1977 to describe the decline of the manufacturing sector in Netherlands after the discovery of large natural gas reserves in the North Sea. The sharp increase in natural gas exports caused a large inflow of foreign exchange to the Netherlands, appreciating the Dutch currency, reducing industrial competitiveness and leading to deindustrialization (The Economist, 2010).

[3] The articles cited by Bacha and Fishlow (2011) are mostly written in Portuguese: Puga (2007), Barros and Pereira (2008), Jank (2008), Nassif (2008), Souza (2009), and Bonelli and Pessôa (2010). Palma (2014) and Bresser-Pereira (2008) are the main articles written in English with discussions on the Dutch disease with references to Latin America.

property rights enforcement. Moreover, Cashin et al. (2002) show that cycles are a dominant feature of commodity prices, arguing that dealing with the economic consequences of price booms and slumps remains one of the most challenging issues facing policymakers in commodity-exporting developing countries. Chile, the world's most active country in achieving free trade agreements, not only exports copper, but fruits, vegetables, fish, wine and forest products. Chile is the world's top producer of copper, which represents 48.4% of the country's exports, which in turn account for 26% of Chile's GDP in 2015 (Central Bank of Chile, 2017). During the commodity boom, Chile observed a huge increase in the price of copper, especially after 2003. Interestingly, the country used its fiscal policy tools to save the exports surplus within its sovereign wealth fund, later using those resources to compensate for the drastic drop in copper price to US$ 1.40 in 2009 and for the economic impact of a severe earthquake in 2010 (Bacha and Fishlow, 2011).

Chen and Rogoff (2003), Cashin et al. (2004) and Bodart et al. (2012) are some of the recent papers providing evidence, by using time-series techniques, of a long-run positive effect of commodity prices on real exchange rates. In that same line, Koranchelian (2005) examines the relationship between oil prices and the real exchange rate of Algeria, while Habib and Kalamova (2007) focus on that relationship in Norway, Russia and Saudi Arabia. Coudert et al. (2008) show that the long-run impact of commodity prices on real exchange rates differs between oil exporters and non-oil commodity exporters.

Adler and Sosa (2011) explain that Latin America has many net commodity exporting countries, especially in South America, and is one of the most commodity-dependent regions within the emerging market world. They argue that in most of these countries, this dependence on commodities has lingered unchanged for the last four decades. Costa et al. (2016) show that, between 2000 and 2010, three of the agricultural and extractive sectors in Brazil were responsible for 82% of the growth in the country's exports to China: mining of nonprecious metals (45%), soybeans (23%) and oil and gas (14%). They argue that this breakdown actually understates the level of concentration of Brazil's exports to China, because the nonprecious metals sector is almost entirely comprised by iron ore. Notably, crude oil is a major commodity in Latin American economies such as Argentina, Brazil and Venezuela, while the majority of the region's iron ore production comes from Brazil. Chile is not only the largest copper producer worldwide (Ebert and La Menza, 2015), but also the economy with the largest reserves of the red metal in the world, according to the U.S. Geological Survey (USGS, 2012). Colombia is the second largest coffee exporter in the region and third in the world, with 7.2% share of the country's total exports. Brazil is the largest coffee exporter in the world. However, the commodity exports only amount to 2.9% of its total exports (UN Comtrade, 2017).

Articles on the causes of commodity prices variations emphasize either fundamentals or the financialization aspect of commodity markets in order to analyze the dynamic forces of commodity prices. Some studies have found no impact of financial investors on commodity futures' prices, stating that prices are exclusively defined by fundamentals (e.g., Irwin and Sanders 2010). Other studies argue that financial markets have significant effects on spot and future prices (e.g. Gilbert 2010; Mayer 2009; Schulmeister 2008; Lescaroux 2009; Tang and Xiong 2010; Silvennoinen and Thorp 2013). Baffes and Haniotis (2010) and Baffes (2011) show that the use of commodities by investment funds may have been partly responsible for the spike in commodity prices during the first stage of the financial crisis. Kilian (2009) proposes a structural VAR model of the global crude oil market and shows that oil price shocks historically have been driven mainly by a combination of global aggregate demand shocks and precautionary demand shocks, rather than oil supply shocks, as is commonly believed.

2.3 Methodology

Focusing on commodities from the Latin American market, I adopt a methodology based on Kilian (2009), who originally develops a SVAR model that measures the relationship between shocks to world oil demand and supply and real oil prices. The commodities I examine are crude oil, iron ore, copper and coffee, which are some of the most profitable businesses among commodity exporting firms in Latin America. I examine different shocks (supply, demand and commodity-specific demand) before, during and after the 2000s commodity supercycle.

Literature on the length of the commodity boom period considers the timespan starting in 2003, which is adopted by authors such as Radetzki (2006) as the beginning of the boom. More recent studies have considered 2010 as the last boom year: although the 2008-2009 financial crisis had negative effects on the commodity markets, Latin America was able to start recovering during 2009 and push the commodity price growth up to the end of 2010. Figure 2.1 shows the performance of the Thomson Reuters/CoreCommodity (TR/CC) CRB Index deflated by the U.S. PPI from the U.S. Bureau of Labor Statistics from 1997 to 2015. The boom starts in 2003 and, during the 2008-2009 financial crisis period, there is negative pressure to commodity prices although without ending the commodity boom period, which goes on up to the end of 2010.

This essay performs a SVAR analysis that involves the variance decomposition of real commodity price changes into three constituents: commodity-supply shocks, global aggregate demand shocks and idiosyncratic commodity demand shocks. This last component relates to commodity-specific features of each commodity market, such as precautionary demand changes that relate to uncertainty about future commodity supplies. The proposed based on monthly-frequency data for the vector time series z_t. It comprises the log-difference of global commodity production, the first-difference of the index of global real economic activity in industrial commodity markets proposed by Kilian's (2009) and updated up to December 2015, and the log-difference of real commodity prices, in the order given.[4] I add an exogenous binary variable, *dum_crisis*, which is equal to 1 during the market crash period of the 2008-2009 financial crisis, otherwise zero. I follow the NBER's Business Cycle Dating Committee (2012) in the selection of the months for the crisis period, from December 2007 to June 2009.[5]

The structural representation of the VAR model is

$$A_0 z_t = \alpha + \sum_{i=1}^{4} A_i z_{t-i} + \mu\, dum\_crisis_t + e_t, \tag{1}$$

where Z is a 3x1 vector of the variables in the SVAR model and A_0^{-1} has a recursive structure such that e_t is a vector of serially and mutually uncorrelated structural innovations that has the following structural pattern:

$$\begin{bmatrix} e_{1t}^{\Delta\, global\ commodity\ production} \\ e_{2t}^{\Delta\, global\ real\ economic\ activity} \\ e_{3t}^{\Delta\, real\ price\ of\ commodity} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{1t}^{commodity\ supply\ shock} \\ \varepsilon_{2t}^{aggregate\ demand\ shock} \\ \varepsilon_{3t}^{idiosyncratic\ demand\ shock} \end{bmatrix}$$

This model imposes a recursive structure on the contemporaneous relationship between the reduced-form VAR innovations (e_t) and the underlying structural disturbances (ε_t). The

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[4] Augmented Dickey Fuller unit root tests with Akaike information criteria and Phillips-Perron unit root tests with Newey-West bandwidth show that all the three variables are I(1), i.e., stationary in first-differences. Johansen tests for cointegration fail to reject that the combination of these three variables using the different measures in the study are not cointegrated. Thus, the properties of the data are consistent with the choice of the structural VAR approach. These results are in line with Apergis and Miller (2009), who adopt a model similar to Kilian and Park's (2009) but employ first-difference operators for these three variables in the model representation, after unit root tests indicate non-stationarity in levels.

[5] Examples of recent articles that adopt the crisis dates established by the NBER are Kim et al. (2011) and Mollick and Assefa (2013).

SVAR models include four lags. These lags are determined by pre- and postestimation lag-order tests that show consistent results in the AIC (Akaike information criterion), LR (likelihood ratio) and FPE (final prediction error) criteria. In this essay, I study the commodity market block similarly to the analysis of the oil market block from Kilian (2009), i.e., I assign variations in the real price of commodities in response to one-standard-deviation increases in structural innovations: e_{1t} captures shocks to the global supply of commodities (hereafter *commodity supply shock*); e_{2t}denotes shocks to the global demand for all industrial commodities (exactly as in Kilian, 2009) that are driven by global real economic activity (*aggregate demand shock*); and e_{3t}captures a commodity-specific demand shock (*idiosyncratic demand shock)*. This last shock is formally analyzed by Alquist and Kilian (2010), who adopt an indicator of precautionary demand shifts based on the difference between spot and futures oil prices. I adopt the concept from the VAR approach by Kilian (2009) that these disruptions may be due to a surprising growth of demand, or due to unexpected decline of supply or due to both, and that these are exogenous shifts in a precautionary demand.

Furthermore, it seems reasonable to follow the main assumptions for the VAR identifying restrictions from Kilian (2009). I adapt those assumptions to the commodities market as follows: (1) commodities supply will not respond to commodity demand shocks within the month, given the production adjustment costs and the uncertainty over the condition of the commodities market; (2) rises in the real price of commodities that are driven by commodity-specific shocks will not reduce global real economic activity within the month, given the sluggishness of global real activity; (3) those innovations to the real commodity price that cannot be explained by commodity supply or aggregate demand shocks are idiosyncratic demand shocks, i.e., specific to the commodity market.

2.4 Data

All data used are taken at monthly frequency. The sample period is 1997.1-2015.12. I select 1997 as the starting year due to the data availability. Additionally, there is a gain from selecting this time frame, which is avoiding the inclusion in the pre-boom period – defined in this dissertation as the 1997-2002 period – of statistical noises from economic turbulences in some Latin American economies.[6] I leave out of the sample a transition period from the Mexican "Tequila crisis" in 1994-1995 and the Brazilian hyperinflationary period until mid-1995 to a more stable period in both economies with a clearer stabilization of the Mexican and Brazilian consumer prices, the latter due to the adoption of "The Real Plan"[7]. In addition, since the data are on a monthly frequency, I choose to start the sample period from January 1997 in order to account for the same number of monthly observations for each year.

Global commodity production and real commodity price measures are in logs. I obtain the world crude oil production, in thousand barrels per day (for each month), from the U.S. Energy Information Administration (EIA). The global iron ore production, in thousand metric tons, is hand-collected from the Steel Statistical Yearbook from the World Steel Association. The global copper production is proxied by Chile's copper production, in thousand metric tons, taken from Datastream.[8] Similarly, for the global coffee production, I proxy the global coffee production

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[6] A previous version of this dissertation defined the pre-commodity boom period from 1995 to 2002 and the VAR results for oil and copper were very similar to the current ones, with slightly smaller percentages of demand shocks in the variance decomposition of the commodity prices. Since iron ore prices are available starting in April 1996, results for this commodity are quite unchanged. The change in the pre-commodity boom period is a conservative approach to the objective of this dissertation of showing differences between the commodity boom period and the pre- and post-boom periods, therefore providing robustness to results.

[7] See Franco (1996) for a full explanation of the Real Plan, a stabilization plan that reduced Brazilian inflation from levels superior to 50% monthly rates to less than 20% per year within a very short period of time.

[8] Since the methodology adopted in this study uses the log difference of this measure, it is fair to consider the world's largest copper producer's pace of production as a proxy for growth in the global copper production.

with Colombia’s monthly coffee production, in thousand 60kg bags, retrieved from the Colombian Coffee Growers Federation. Figure 2.2 displays the production of these four commodities from 1997 to 2015. Oil and iron ore productions have steady increases with over 20% increases in the total period. Copper production doubles between 1997 and 2005 and then fluctuates between 400 and 500 thousand metric tons until 2015, showing an increase of 85% in the entire period. Coffee production is the most volatile as compared to the other three commodities, with prices fluctuating between 500 and 1,500 thousand 60kg bags during most of the time span. Between 2007 and 2009, there is a decrease in production levels, reaching down to 400 thousand bags around the global financial crisis. Then, from 2009 to 2015, production recovers and climbs to an average of 1,181 thousand bags monthly production in 2015.

The global real economic activity measure is an updated version of the one proposed in Kilian (2009), who calculates an index of the percent growth rates of dry-cargo single voyage ocean shipping freight rates. The deviation of the real freight rate index from its long-run trend constitutes the index of real economic activity. Figure 2.3 shows a graph of the real economic activity measure from 1997 to 2015. This updated and extended up to 2015 measure can be found at Kilian’s website. The idea behind this proxy is that rising global demand is followed by rising trade and demand for shipping services. The index has deviations well above mean between October 2007 (0.633) and May 2008 (0.630), consistent with a strong world economic activity, right before the international financial crisis of 2008-2009. In December 2008, the deviation is well below the mean (-0.419) and then grows positive again until the end of 2010. From 2011 and on, the global economic activity index slows down again and hits the sample bottom of -0.6555 in December 2015, comparable to the lowest levels in the entire series from Kilian (2009), which is reaching down to -0.69 in March 1972.

The producer price index (PPI) is obtained from the U.S. Bureau of Labor Statistics. The U.S. consumer price index (CPI) is obtained from the U.S. Bureau of Labor Statistics while the CPI for the Latin American countries is obtained from the Federal Reserve Economic Data (FRED) database. The nominal price of oil is based on the West Texas Intermediate (WTI) crude oil spot price, which is a better measure to account for the impacts on the Latin American markets than the U.S. refiner's acquisition cost of crude oil from Kilian (2009).[9] The real price of oil is calculated by deflating the WTI price by the U.S. PPI from the U.S. Bureau of Labor Statistics. The same procedure applies to the calculation of the real prices of iron ore, copper and coffee obtained from Datastream. Figure 2.4 displays the real prices of these commodities from 1997 to 2015. Real oil price grows 245% from January 1997 to June 2008 and then suffers a sudden drop in May 2008 due to the international financial crisis. It partially recovers until 2012 and then starts a new decline, similarly to the trends in iron ore and copper prices. Iron ore shows a quick drop in price during the crisis period as well. Its price, however, stagnates from January 2009 to March 2010 and then goes up to levels above the before-crisis peak between 2010 and mid-2011 and then slows down in line with the other commodities. Copper price has an early peak in June 2006 and then shows strong fluctuations until mid-2008, when it drops due to the international financial crisis. It recovers at a steady pace reaching a new all-time high in March 2011 and then the trend becomes negative until the end of the sample. Coffee price rises from 2003 to 2010, and does not seem much impacted by the 2007-2009 crisis. Yet, after 2011 coffee prices follow the downtrend in the commodities market, although showing a temporary jump in late 2014 / early 2015 due to the drought in Brazil and Colombia driven by El Niño that brought adverse conditions to the coffee farms (Business Insider, 2015).

[9] WTI is often used in the literature as the benchmark for crude oil in the Americas.

Figure 2.5 displays results of Bai-Perron tests of multiple structural breaks, allowing for a maximum of 5 breaks, to check for further evidence for the selection of the commodity boom period from 2003 to 2010. I test the CRB-TRCC and CRB-BLS indices. The difference between these two indices is explained as follows. The CRB-TRCC index is the Thomson Reuters Core Commodity CRB index which comprises 19 commodities: aluminum, cocoa, coffee, copper, corn, cotton, crude oil, gold, heating oil, lean hogs, live cattle, natural gas, nickel, orange juice, silver, soybeans, sugar, unleaded gas and wheat. The CRB-BLS index is calculated by a private firm but was originally computed by the Bureau of Labor Statistics. It has 22 commodities from two major subdivisions: raw industrials and foodstuffs. Raw Industrials include burlap, copper scrap, cotton, hides, lead scrap, print cloth, rosin, rubber, steel scrap, tallow, tin, wool tops, and zinc. Foodstuffs include butter, cocoa beans, corn, cottonseed oil, hogs, lard, steers, sugar, and wheat. The result for the CRB-TRCC index shows only one structural break in December 2003, suggesting that it captures the global trend of the commodity boom. For the CRB-BLS, there are two structural breaks: the first one in April 2006 and the second one in July 2010, which indicates that the test is capturing the commodity boom before and after the global financial crisis. However, in both tests the results only capture positive structural changes. After this initial test, I run the test for the real economic activity measure (Kilian index) and find two structural breaks: a jump in March 2003 and a decline in December 2010. The resulting dates are even closer to the commodity boom period I adopt in this study. Since my model considers that real economic activity has a direct impact on commodity prices, I perform a test with the interaction of CRB-TRCC, which displayed only one global structural break, with real economic activity (REA). The result is similar to the previous one for REA, with the starting month of September 2003 and the same ending month of December 2010. Given these results, I decide to keep the selection for the commodity boom period from January 2003 to December 2010, i.e., each year with twelve months to avoid biases related to seasonality. The tables with detailed specifications and results of the Bai-Perron tests are available in the Appendix A.

2.5 Empirical Analysis and Results

2.5.1 Unit Root Tests

I test variables for unit roots. Table 2.1 reports the results with and without a trend in levels and first differences. I employ two different unit root tests in order to provide robustness to the results: the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981) and the KPSS test (Kwiatkowski et al., 1992). The null hypothesis for the ADF test is that the time series has a unit root (non-stationarity), while the alternative hypothesis is that it is stationary. For the KPSS, on the other hand, the null hypothesis is that the time series is stationary, while rejecting this hypothesis provides statistical evidence for unit root. The optimal lag length for the ADF test is determined by the Campbell and Perron (1991) data dependent procedure. This procedure is described as follows. The upper bound for the lag length (kmax) starts at 14. If the last included lag is significant, I choose k equal to kmax. If not, I reduce k by one until the last lag becomes significant (I use the 5% value of the asymptotic normal distribution to assess significance of the last lag). If no lags are significant, then I set k=0. The KPSS test adopts a lag truncation parameter equal to 4. The three variables (global commodity production, global real economic activity, and real price of commodity) are initially tested in levels and, after failing to reject the null hypothesis of unit root in the ADF test and rejecting stationarity in the KPSS test, I proceed to the unit root tests in first differences. In first differences, the results show a rejection of the null hypothesis of unit root at the 1% significance level for crude oil, iron ore and copper and at the 5% level for coffee in the ADR test. The KPSS test results in levels consistently reject the null hypothesis of stationarity while, for the first-differenced variables, the test fails to reject the null. For the first difference of iron ore price, however, the KPSS unit root test including trend resulted in the rejection of the null hypothesis of stationarity at the 10% level of significance. Since there is no sign of a unique trend in this commodity price, as observed in Figure 2.4, I will give more weight to the test results without trend and conclude that all time series are stationary in first-differences.

2.5.2 Cointegration Tests

The cointegration tests are based on Johansen and Juselius (1990) and are adopted for the variables that describe the global commodity market: global commodity production, global real economic activity and real commodity prices. I run a pre-estimation test that performs vector autoregressions (VAR) with a lag-order selection test and the results for the appropriate lag length is three in all cases. Table 2.2 reports the cointegration test results, which show no long-term relationship among the three variables. Therefore, I proceed to the structural VAR estimation described in the methodology section.

2.5.3 Responses of Real Commodity Prices to Structural Shocks

The cumulative orthogonalized impulse-response functions obtained using the SVAR model are shown in Figures 2.6 to 2.8. Figure 2.6 presents the responses of the prices of the four commodities – oil, iron ore, copper and coffee – to one standard deviation positive shocks (supply, demand and idiosyncratic shocks) for the entire sample period, from 1997 to 2015. Oil, copper and coffee are the commodities that display negative price responses to positive shocks to supply.[10] Oil price has a short-lived negative response to supply shocks, which starts to revert after three months and stabilizes after five months. Copper price accumulates a negative response up to four months and then remains fluctuating at the achieved levels. Similarly, coffee price has negative response in the first four months that later stabilizes, although coffee price responses are relatively weaker than the ones from copper price. Differently from these three commodities, iron ore price responds positively to supply shocks. With respect to the demand shocks, the prices of all four commodities show positive responses. There is a strong similarity between the impulse-response function graphs for oil and copper prices, which increase by more than 0.015 percentage points in response to a positive one standard deviation shock to aggregate demand. They accumulate positive increases for around four months, and then show a very slight decrease until the seventh month, stabilizing in the subsequent months. Iron ore prices only start showing significant responses after the second month, accumulating positive responses up to the fourth month similarly to the oil, copper and coffee impulse-response functions. The idiosyncratic shocks on commodity prices are positive and statistically significant, showing again similarity between the impulse-response functions for oil, copper and coffee, accumulating increases in the first three months. Iron ore price shows a strong response to idiosyncratic shocks at time 0, and later the cumulative response fluctuates around stability, indicating a permanent response.

Following the definition of the commodity boom period based on the literature and the structural break test results, I split the sample period into three distinct subperiods: the pre-commodity boom period from 1997 to 2002, the commodity boom period from 2003 to 2010, and the post-commodity boom period from 2011-2015. Since the focus of this dissertation is to

[10] This is consistent with recent literature on copper (e.g., Pedersen, 2014). In the same direction, Ubilava (2011) finds a negative association between the El Niño-related weather conditions and international coffee prices. Kilian (2009), however, does not find statistically significant responses to oil supply shocks, but one would expect that positive shocks to oil supply should lead to disruptions in oil price.

compare the different shocks, I present only the impulse-response functions regarding supply shocks in Figure 2.7 and the ones associated with demand shocks in Figure 2.8.

Figure 2.7 displays the responses of each commodity price to one standard deviation positive supply shocks in the commodity boom and the pre– and post–commodity boom periods.

Oil prices show an immediate negative response to supply shocks in the 1997-2002 and 2011-2015 periods. However, at the commodity boom period, the initial response is statistically insignificant until in the first two months. After that, the commodity price accumulates a positive and persistent response to supply shocks, a surprising result that may be related with the first major decline in non-OPEC supply since 1973, between 2004 and 2008, along with the exceptional rise in global demand (Smith, 2009). Since OPEC members reacted by growing their production to compensate the decrease in non-OPEC oil supply, this may be the reason for the statistical noise in the response of oil prices specifically to the supply shocks in the 2003-2010 sample.

Figure 2.7 also shows that iron ore price responses to supply shocks are positive in the three subperiods of the sample. In the pre-commodity boom period from 1997 to 2002, iron ore prices have a positive and persistent response after one month. An immediate response to supply shocks appears in the 2003-2010 period, with positive effects reaching a maximum cumulative response around the fourth and fifth months, with persisting effects afterwards. Iron ore prices responses in the post-boom period, on the contrary, are stronger at time 0, partially dissipating up to the fifth month.

Copper and coffee prices' responses to shocks in supply support the negative sign found in the previous table, but the strongest impact seems to happen during the 2003-2010 commodity boom, when the immediate impact is negative and accumulates up to the third month, with a positive adjustment in the following three months, although the cumulative response persists. In the pre-boom period from 1997-2002, there is a short-lived negative response of copper and coffee prices to supply shocks that later seems virtually insignificant. A similar pattern can be noticed in the responses of copper and coffee prices in the post-boom period from 2011 to 2015, however the significant impacts are the in the first two months.

Figure 2.8 reports the responses of commodity prices to one standard deviation positive aggregate demand shocks in the three sample subperiods.

Oil and copper prices responses again show strong similarities, especially in the commodity boom period from 2003 to 2010, when there is an immediate positive shock that builds up to the fourth month and has a slight downward adjustment up to the seventh month, when price responses reach stability. In the pre- and post-boom periods, copper seems to follow the responses to demand shocks from oil prices although statistically insignificant. Curiously, results demonstrate a negative response of crude oil prices to demand shocks in the post-commodity boom period from 2011 to 2015, which may be associated with noise from the increased price competition between crude oil and shale gas prices in the years 2010s.[11]

Coffee price responses to aggregate demand shocks in the pre-boom period are positive up to the third month, and then adjust until the seventh month, similarly to oil and copper prices. Nevertheless, in the 2003-2010 period the positive response is relatively weaker and only lasts about 3 months, with a sharp adjustment in the responses of coffee prices, which stabilize after six months. In the post-boom period, coffee price responses are not statistically significant.

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[11] According to The Economist (2014b), there are four main reasons for the large drop in oil prices in 2014: (1) a growing switch away from oil to other fuels; (2) turmoil in Iraq and Libya has not affected their output; (3) the U.S. has become the world's largest oil producer and now imports much less crude oil, creating a lot of spare supply; and (4) the Saudis and their Gulf allies have decided not to sacrifice their own market share to restore the price.

Iron ore price responses to aggregate demand shocks are less significant in the pre-boom period, with significant negative impacts in the first two months. In the commodity boom period from 2003 to 2010, the response also appears to be initially negative, but has persistent positive increases from the second to the fourth month after the shock, resulting in a positive cumulative response in the medium term. In the post-boom period from 2011 to 2015, however, iron ore prices have an immediate positive response to demand shocks that later fluctuates close to the initial response level.

2.5.4 Variance Decomposition of Real Commodity Prices

The variance decomposition tests for the effects of different commodity-price shocks involved in the SVAR model are shown in table 2.3. I only show the results for the real price of each commodity to save space. Panels A, B, C and D display the variance decomposition results for the real prices of oil, iron ore, copper and coffee, respectively. Panel E reports a robustness check with the entire sample that adopts time dummy variables for the pre- (1997-2002) and post- (2011-2015) commodity boom periods, for the four commodities under study. The results indicate the variance percentage in each variable that can be attributed to each of the structural shocks at different horizons. I report the percentages for the following selected forecast horizons: 1, 6, 12, 18 and 24 months. Standard errors appear within parentheses after the percentage of variance explained. The numbers within parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

Panel A reports results for the oil price variance decomposition and provides evidence of the hypothesized increased contribution of aggregate demand shocks to changes in real oil prices during the commodity boom period. It also shows a sharp decrease in the contribution from those shocks in the post-boom period. Aggregate demand shocks represent 21.5 percent of the variation in real oil prices in the long run (24 months) during the commodity boom period versus 16.6 percent in the pre-boom period and 5.8 percent in the post-boom period. For all the periods, the variance decomposition results also show that, in the long run, aggregate demand shocks contribute a larger share to the variation in real oil prices than do supply shocks. This is less clear, however, in the post-boom period, where the variance decomposition for the short run horizon (1 month) shows a smaller percentage for the aggregate demand shock (0.05) than the supply shock (2.76). In the long run, however, demand shocks in the post-boom period contribute with 5.8 percent versus a 5.0 percent from supply shocks. For all periods, the variance decomposition reaches a long-run equilibrium around 17 months and the contribution from aggregate demand shocks in the 24-month horizon are larger than the ones from supply shocks. Oil supply and demand shocks account for 23 percent of the variation in real oil prices in the pre-commodity boom period, 30 percent in the commodity supercycle period and only 11 percent in the post-boom period.

Panel B shows a different reality for the iron ore price variance decomposition. Iron ore prices are mainly affected by the commodity-specific shocks during the commodity supercycle period. Moreover, the supply shock contributions to the variation of iron ore prices in the long run (24 months) are larger than the one from aggregate demand shocks in both pre-boom (8.8 vs. 5.5 percent) and commodity-boom periods (6.1 vs. 2.4 percent). In the post-boom period, however, supply and demand shocks display larger and more balanced contributions: 16.4 and 17.6 percent, respectively. In the previous section, I have shown the surprising result that both supply and demand for iron ore have positive impacts in the commodity prices. The variance decomposition test results shown here again demonstrate that supply shocks play a very important role. For all periods, the variance decomposition reaches a long-run equilibrium around 11-17 months. Iron ore supply and demand shocks together account for 14.3 percent of the variation in real iron ore prices in the pre-commodity boom period, 8.5 percent in the commodity supercycle period and 34 percent in the post-boom period! This result suggests an increased role of the market forces in the determination of iron ore prices after the commodity boom period; I investigate further explanation for the iron ore price results in the next section.

Panel C displays results for the variance decomposition tests on real copper prices. Similarly to the variance decomposition results for oil prices, evidence supports the hypothesis of an increasing contribution of aggregate demand shocks to changes in copper prices during the commodity boom period. Aggregate demand shocks represent 24.9 percent of the variation in real copper prices in the long run (24 months) during the commodity boom period versus 10.2 percent in the pre-boom period and 7.0 percent in the post-boom period. Correspondingly to the results for the crude oil, the copper price variance decomposition results show a larger contribution from aggregate demand shocks than from supply shocks. In the post-boom period, the variance decomposition in the short run horizon (1 month) shows an essentially null contribution from the supply and aggregate demand shocks. In the long run, however, aggregate demand shock contributions to variations in copper prices (7.0 percent) are slightly larger than the contributions to changes in crude oil prices (5.8 percent) displayed on panel A. For all periods, the variance decomposition reaches a long-run equilibrium around 16-21 months and the contribution from aggregate demand shocks in the 24-month horizon are larger than the ones from supply shocks. Copper supply and demand shocks together account for 17 percent of the variation in real oil prices in the pre-commodity boom period, 33 percent in the commodity supercycle period and only 12 percent in the post-boom period.

Panel D reports variance decomposition test results for real coffee prices. Differently from the results for oil and copper prices, results suggest a higher contribution of aggregate demand shocks to changes in coffee prices in the pre-boom period. Aggregate demand shocks represent 12.8 percent of the variation in real coffee prices in the long run in the pre-boom period versus 5.1 percent in the commodity boom period and 7.0 percent in the post-boom period. For all periods, the variance decomposition reaches a long-run equilibrium around 17-22 months. While in the pre-boom period the contribution from aggregate demand shocks in the 24-month horizon are larger than the ones from supply shocks, the opposite is true for the commodity boom period. Coffee supply and demand shocks together account for only 20.3 percent of the variation in real oil prices in the pre-commodity boom period, 17.8 percent in the commodity supercycle period and 15.0 percent in the post-boom period.

Panel E displays the variance decomposition results for a SVAR with entire sample that employs time dummy variables for the pre- (1997-2002) and post- (2011-2015) commodity boom periods. Since the subsample split approach could generate biased coefficients due to the small number of observations, especially for the pre-boom (72 observations) and post-boom (60 observations) periods, I adopt this time dummy approach as a robustness check. Controlling for those time dummies, the responses of oil, iron ore, copper and coffee prices to the structural commodity shocks will refer to the commodity boom period.[12] Except for iron ore, the commodity price responses to aggregate demand shocks are larger the ones to supply shock: for the real oil price, the percentages are, respectively, 5.9 and 2.1 percent; for the real price of iron

[12] The corresponding impulse-response functions for this robustness check are similar to the ones reported in Figure 2.6 for the entire period from 1997 to 2015.

ore, 1.2 and 5.3 percent; for the real price of copper, 9.3 and 4.6 percent; and for the real price of coffee, 2.8 and 1.3 percent. Interestingly, among the three commodities that have consistent results (oil, copper and coffee), copper is the one with the largest percentage of its variance explained by both supply and demand shocks. These results are in line with the hypothesis that aggregate demand shocks have an increased contribution to commodity prices during the commodity boom period as compared to the pre- and post-boom periods.

2.5.5 Counterintuitive Results for Iron Ore

After a more detailed investigation on the academic literature and newspaper editorials about the iron ore market, I conclude that the analysis for this commodity is not valid. The reason is that the prices for iron ore have been fixed by long-term contracts between miners and client firms, not allowing a free float of the commodity price. According to Financial Times (2010), miners and steelmakers started to "ditch" the system of annual contracts and use the spot market to sign short-term contracts around March 2010. Before then, they followed prices determined by the long-term annual contracts that were renegotiated every year by the big players in the market. Therefore, since iron ore prices were not allowed to freely float along most of the studied time span, especially during the 2000s commodity boom, I decide to drop iron ore from the subsequent study (Chapter 3), which will analyze crude oil, copper and coffee supply and demand shocks on real stock returns in Latin America.[13]

[13] Sarkar et al. (2015) explain that data on spot iron ore price from before December 2008 are either unavailable or unreliable, in line with my decision to drop iron ore from the next chapter. They use a panel dataset with daily frequency from December 2008 to August 2015 to show evidence that iron ore spot price is positively correlated with the Australian stock market prices in different sectors of the country's economy.

2.6 Conclusions

This essay investigates the effects of supply and aggregate demand shocks on oil, iron ore, copper and coffee markets. I examine three commodities that represent some of the most profitable businesses among commodity exporting firms in Latin America: crude oil, iron ore and copper, as well as the historically important coffee market for a robustness check.

Using the methodology of Kilian (2009), I adopt three different structural shocks for these commodity markets: commodity supply shocks, global aggregate demand shocks and idiosyncratic demand shocks. The results indicate that commodity market structural shocks play a significant role in explaining the variations in the commodity prices.

After investigating the literature and newspaper editorials for information about the commodity pricing system, I conclude that results for iron ore not valid, since miners and steelmakers used to follow annual fixed-price long-term contracts until 2010 when they eventually "ditched" the system and began to adopt spot prices to sign short-terms contracts.

Oil, copper and coffee prices display negative responses to supply shocks, consistently with recent literature on copper and coffee. The influential paper by Kilian (2009), however, does not report significant responses of oil price to the commodity supply shock. Nevertheless, in the 2000s commodity boom period, oil price accumulates a positive and persistent response to supply shocks, a surprising result that may be related with the first major decline in non-OPEC supply since 1973, between 2004 and 2008, along with the exceptional rise in global demand (Smith, 2009). Since OPEC members reacted by growing their production to compensate the decrease in non-OPEC oil supply, this may be the reason for the statistical noise in the response of oil price specifically to the supply shocks in the 2003-2010 sample. Regarding demand shocks, crude oil, copper and coffee exhibit positive responses. The analysis splits the sample period into three distinct subperiods: the pre-commodity boom period from 1997 to 2002, the commodity boom period from 2003 to 2010, and the post-commodity boom period from 2011-2015. Copper and coffee price responses to shocks in supply support the negative sign found in the previous table, but the strongest impact seems to happen during the 2003-2010 commodity boom. Curiously, results show a negative response of crude oil to demand shocks in the post-commodity boom period from 2011 to 2015. The result may be associated with an increased price competition between crude oil and shale gas prices in the years 2010s.

The variance decomposition test results provide evidence of an increased contribution of aggregate demand shocks to variations in real prices of crude oil and copper during the commodity boom period. In the coffee market, the SVAR approach using subsample periods shows that aggregate demand shocks seem to have a stronger effect (12.8 percent) on commodity price variations in the pre-boom period. However, the SVAR approach with the entire sample, using time dummies for the pre- and post-boom periods, reports a larger percentage of coffee price variance explained by aggregate demand shocks (2.8 percent) than by supply shocks (1.3 percent). Since the corresponding standard errors are large (2.12 and 1.47 percent, respectively), its corresponding coefficients are not statistically significant.

In conclusion, oil and copper prices have very similar responses to structural shocks, while coffee prices seem less sensitive to them. For example, if production is negatively impacted by a drought, coffee prices would respond with a less than proportional rise. The similarities between results for oil and copper markets and their differences from the ones for the coffee market may be explained by price elasticities in each commodity market and/or liquidity levels in the corresponding stock markets and should be subject to future research.

I now proceed to Chapter 3 where I analyze the impacts of different commodity shocks on Latin American real stock returns for the oil, copper and coffee markets.

Table 2.1
Unit Root Tests.

Variables	ADF (*k*)		KPSS (4)	
	Without trend	With Trend	Without trend	With Trend
In levels				
Global commodity production				
Crude oil	-1.18 (2)	-3.02 (2)	4.73***	0.34***
Iron ore	-0.52 (13)	-2.57 (13)	4.56***	0.31***
Copper	1.00 (13)	-0.32 (13)	3.80***	0.96***
Coffee	-2.21 (13)	-2.04 (13)	0.72**	0.18**
Global real economic activity				
	-1.77 (4)	-1.74 (4)	0.76***	0.76***
Real price of commodity				
Crude Oil	-1.76 (6)	-1.51 (6)	3.70***	0.39***
Iron ore	-1.51 (10)	-1.16 (10)	3.46***	0.41***
Copper	-1.52 (11)	-2.27 (11)	3.27***	0.45***
Coffee	-1.80 (11)	-1.79 (11)	0.70**	0.72***
In first differences				
Δ Global commodity production				
Crude oil	-13.60 (1)***	-13.58 (1)***	0.05	0.04
Iron ore	-4.32 (12)***	-4.31 (12)***	0.04	0.04
Copper	-3.93 (14)***	-6.72 (11)***	0.23	0.04
Coffee	-5.35 (12) ***	-5.43 (12) ***	0.03	0.02
Δ Global real economic activity				
	-9.66 (3)***	-9.67 (3)***	0.10	0.05
Δ Real price of commodity				
Crude Oil	-7.56 (5)***	-7.64 (5)***	0.13	0.06
Iron ore	-4.00 (14)***	-4.16 (14)***	0.21	0.13*
Copper	-4.25 (10)***	-4.23 (10)***	0.10	0.10
Coffee	-10.113 (1)***	-10.111 (1)***	0.11	0.07

Notes: The null hypothesis for ADF test is that the time series has a unit root, while the null hypothesis for KPSS test is that the time series is stationary. The optimal lag length for the ADF test is shown between parentheses and is determined by data dependent procedure based on Campbell and Perron (1991). The KPSS test adopts a lag truncation parameter k= 4. The critical values for the ADF test are: a) without trend: 1% = –3.45, 5% = –2.87, 10% = −2.56, b) with trend: 1% = –3.99, 5% = –3.42, 10% = –3.13. The critical values for the KPSS test are: a) without trend: 1% = 0.739, 5% = 0.463, 10% = 0.347, b) with trend: 1% = 0.216, 5% = 0.146, 10% = 0.119. *** Rejection of the null at the 1% level; ** Rejection of the null at the 5% level. * Rejection of the null at the 10% level.

Table 2.2
Cointegration Tests.

Rank	max λ statistics	Trace statistics
Global Oil Production, Real Economic Activity and Oil prices		
r = 0	13.2003	20.0861
r <= 1	4.3945	6.8858
r <=2	2.4912	2.4912
Global Iron Production, Real Economic Activity and Iron Ore prices		
r = 0	16.9156	26.3538
r <= 1	8.5007	9.4382
r <=2	0.9375	0.9375
Global Copper Production, Real Economic Activity and Copper prices		
r = 0	15.4902	26.4426
r <= 1	7.8790	10.9524
r <=2	3.0734	3.0734
Global Coffee Production, Real Economic Activity and Coffee prices		
r = 0	13.8479	28.1413
r <= 1	8.5738	14.2934
r <=2	2.7196	2.7196

Notes: The null hypotheses for the cointegration tests with max λ and trace statistics are that there is no cointegration among variables. 5% critical values for the max λ statistics are: r=0: 20.97, r=1: 14.07, r=2: 3.76. 5% critical values for the trace statistics are: r=0: 29.68, r=1: 15.41, r=2: 3.76.

Table 2.3
Commodity Price: Variance Decomposition Tests.

Panel A: Real Price of Oil			
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock
Entire period 1997 – 2015 (11)			
1	0.76 (1.15)	2.03 (1.84)	97.21 (2.15)
6	2.11 (1.91)	6.21 (3.48)	91.69 (3.88)
12	2.12 (1.92)	6.46 (3.62)	91.42 (4.02)
18	2.12 (1.92)	6.46 (3.62)	91.42 (4.02)
24	2.12 (1.92)	6.46 (3.62)	91.42 (4.02)
Pre-Boom period 1997 – 2002 (17)			
1	2.48 (3.62)	9.75 (6.56)	87.77 (7.23)
6	6.10 (5.42)	15.93 (8.21)	77.97 (9.01)
12	6.31 (5.33)	16.59 (8.24)	77.11 (9.32)
18	6.30 (5.33)	16.61 (8.24)	77.08 (9.33)
24	6.30 (5.33)	16.61 (8.24)	77.08 (9.33)
Boom period 2003 – 2010 (17)			
1	0.08 (0.59)	4.70 (4.22)	95.21 (4.25)
6	7.81 (4.89)	21.14 (7.84)	71.05 (8.48)
12	7.86 (4.93)	21.50 (8.03)	70.64 (8.59)
18	7.87 (4.93)	21.50 (8.03)	70.63 (8.59)
24	7.87 (4.93)	21.50 (8.03)	70.63 (8.59)
Post-Boom period 2011 – 2015 (17)			
1	2.76 (4.17)	0.05 (0.57)	97.19 (4.21)
6	4.82 (5.70)	4.80 (5.09)	90.38 (7.46)
12	5.03 (5.70)	5.80 (6.18)	89.16 (8.37)
18	5.04 (5.70)	5.82 (6.22)	89.14 (8.40)
24	5.04 (5.70)	5.82 (6.22)	89.14 (8.40)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 2.3 – Continued)

Panel B: Real Price of Iron Ore			
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock
Entire period 1997 – 2015 (9)			
1	2.00 (1.89)	0.02 (0.18)	97.98 (1.90)
6	4.40 (2.69)	1.22 (1.45)	94.38 (3.06)
12	4.41 (2.70)	1.22 (1.45)	94.37 (3.06)
18	4.41 (2.70)	1.22 (1.45)	94.37 (3.06)
24	4.41 (2.70)	1.22 (1.45)	94.37 (3.06)
Pre-Boom period 1997 – 2002 (11)			
1	0.57 (1.77)	2.71 (3.76)	96.72 (4.13)
6	8.72 (6.39)	5.49 (5.02)	85.79 (7.75)
12	8.77 (6.41)	5.51 (5.01)	85.73 (7.78)
18	8.77 (6.41)	5.51 (5.01)	85.73 (7.78)
24	8.77 (6.41)	5.51 (5.01)	85.73 (7.78)
Boom period 2003 – 2010 (14)			
1	0.34 (1.19)	0.51 (1.45)	99.15 (1.87)
6	5.99 (4.53)	2.35 (2.39)	91.66 (5.40)
12	6.10 (4.56)	2.39 (2.41)	91.52 (5.47)
18	6.10 (4.56)	2.39 (2.41)	91.52 (5.47)
24	6.10 (4.56)	2.39 (2.41)	91.52 (5.47)
Post-Boom period 2011 – 2015 (17)			
1	15.61 (9.63)	15.34 (8.82)	69.05 (11.09)
6	16.30 (9.51)	17.62 (9.46)	66.08 (11.27)
12	16.45 (9.52)	17.62 (9.45)	65.93 (11.32)
18	16.45 (9.52)	17.62 (9.45)	65.93 (11.32)
24	16.45 (9.52)	17.62 (9.45)	65.93 (11.32)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 2.3 – Continued)

Panel C: Real Price of Copper			
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock
Entire period			
1997 – 2015 (18)			
1	2.03 (1.85)	3.23 (2.28)	94.74 (2.88)
6	4.18 (2.78)	9.87 (4.32)	85.96 (4.91)
12	4.32 (2.84)	10.34 (4.51)	85.34 (5.08)
18	4.34 (2.85)	10.34 (4.51)	85.32 (5.08)
24	4.34 (2.85)	10.34 (4.51)	85.32 (5.08)
Pre-Boom period			
1997 – 2002 (16)			
1	3.30 (4.14)	1.81 (3.06)	94.89 (5.05)
6	6.68 (5.20)	9.97 (7.19)	83.34 (8.41)
12	6.92 (5.41)	10.19 (7.27)	82.90 (8.63)
18	6.93 (5.43)	10.19 (7.27)	82.89 (8.64)
24	6.93 (5.43)	10.19 (7.27)	82.89 (8.64)
Boom period			
2003 – 2010 (16)			
1	2.31 (3.03)	5.71 (4.55)	91.98 (5.32)
6	7.14 (5.09)	24.28 (8.62)	68.58 (8.91)
12	7.66 (5.37)	24.91 (8.74)	67.42 (9.01)
18	7.69 (5.38)	24.90 (8.74)	67.41 (9.01)
24	7.69 (5.38)	24.90 (8.74)	67.41 (9.01)
Post-Boom period			
2011 – 2015 (21)			
1	0.00 (0.02)	0.00 (0.05)	100 (0.05)
6	4.71 (4.60)	6.24 (5.26)	89.06 (6.94)
12	5.07 (5.05)	7.03 (5.92)	87.90 (7.77)
18	5.10 (5.10)	7.04 (5.92)	87.86 (7.79)
24	5.11 (5.10	7.04 (5.93)	87.85 (7.80)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 2.3 – Continued)

Panel D: Real Price of Coffee			
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock
Entire period			
1997 – 2015 (20)			
1	0.26 (0.67)	0.01 (0.03)	99.74 (0.67)
6	1.14 (1.27)	2.69 (2.02)	96.17 (2.33)
12	1.30 (1.42)	2.95 (2.20)	95.75 (2.55)
18	1.35 (1.47)	2.95 (2.20)	95.69 (2.59)
24	1.37 (1.48)	2.95 (2.20)	95.68 (2.59)
Pre-Boom period			
1997 – 2002 (22)			
1	1.01 (2.34)	0.54 (1.71)	98.45 (2.88)
6	6.44 (4.69)	12.60 (6.75)	80.96 (7.76)
12	7.12 (5.27)	12.84 (6.87)	80.04 (7.96)
18	7.37 (5.50)	12.84 (6.87)	79.78 (8.04)
24	7.46 (5.58)	12.84 (6.87)	79.70 (8.06)
Boom period			
2003 – 2010 (18)			
1	10.34 (5.88)	0.41 (1.23)	89.25 (5.97)
6	12.53 (6.18)	4.82 (3.86)	82.65 (6.92)
12	12.73 (6.29)	5.04 (4.08)	82.23 (7.02)
18	12.76 (6.29)	5.06 (4.10)	82.19 (7.03)
24	12.76 (6.29)	5.06 (4.10)	82.19 (7.03)
Post-Boom period			
2011 – 2015 (17)			
1	2.83 (4.22)	0.02 (0.36)	97.15 (4.23)
6	7.78 (7.56)	6.49 (6.67)	85.74 (9.31)
12	8.00 (7.52)	6.99 (6.85)	85.01 (9.52)
18	8.02 (7.53)	7.02 (6.86)	84.96 (9.54)
24	8.02 (7.53)	7.02 (6.86)	84.96 (9.54)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 2.3 – Continued)

Panel E: Robustness Check with entire period using dummy variables for pre- (1997-2002) and post- (2011-2015) commodity boom periods			
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock
Real Price of Oil (12)			
1	0.74 (1.13)	1.87 (1.77)	97.39 (2.08)
6	2.06 (1.91)	5.65 (3.30)	92.28 (3.73)
12	2.08 (1.91)	5.91 (3.46)	92.00 (3.88)
18	2.08 (1.91)	5.91 (3.46)	92.00 (3.88)
24	2.08 (1.91)	5.91 (3.46)	92.00 (3.88)
Real Price of Iron Ore (15)			
1	2.56 (2.12)	0.02 (0.21)	97.41 (2.13)
6	5.05 (2.81)	1.15 (1.40)	93.81 (3.10)
12	5.25 (2.90)	1.22 (1.45)	93.53 (3.22)
18	5.26 (2.91)	1.22 (1.45)	93.52 (3.22)
24	5.26 (2.91)	1.22 (1.45)	93.52 (3.22)
Real Price of Copper (16)			
1	2.09 (1.87)	2.95 (2.18)	94.96 (2.82)
6	4.37 (2.79)	8.60 (3.88)	87.03 (4.58)
12	4.56 (2.89)	9.30 (4.20)	86.14 (4.85)
18	4.58 (2.89)	9.30 (4.20)	86.12 (4.86)
24	4.58 (2.89)	9.30 (4.20)	86.12 (4.86)
Real Price of Coffee (19)			
1	0.22 (0.62)	0.01 (0.15)	99.77 (0.63)
6	1.11 (1.24)	2.52 (1.93)	96.38 (2.25)
12	1.27 (1.40)	2.77 (2.12)	95.95 (2.48)
18	1.33 (1.46)	2.78 (2.12)	95.89 (2.51)
24	1.34 (1.47)	2.78 (2.12)	95.88 (2.52)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

Figure 2.1. Real CRB-TRCC Index from 1997 to 2015.

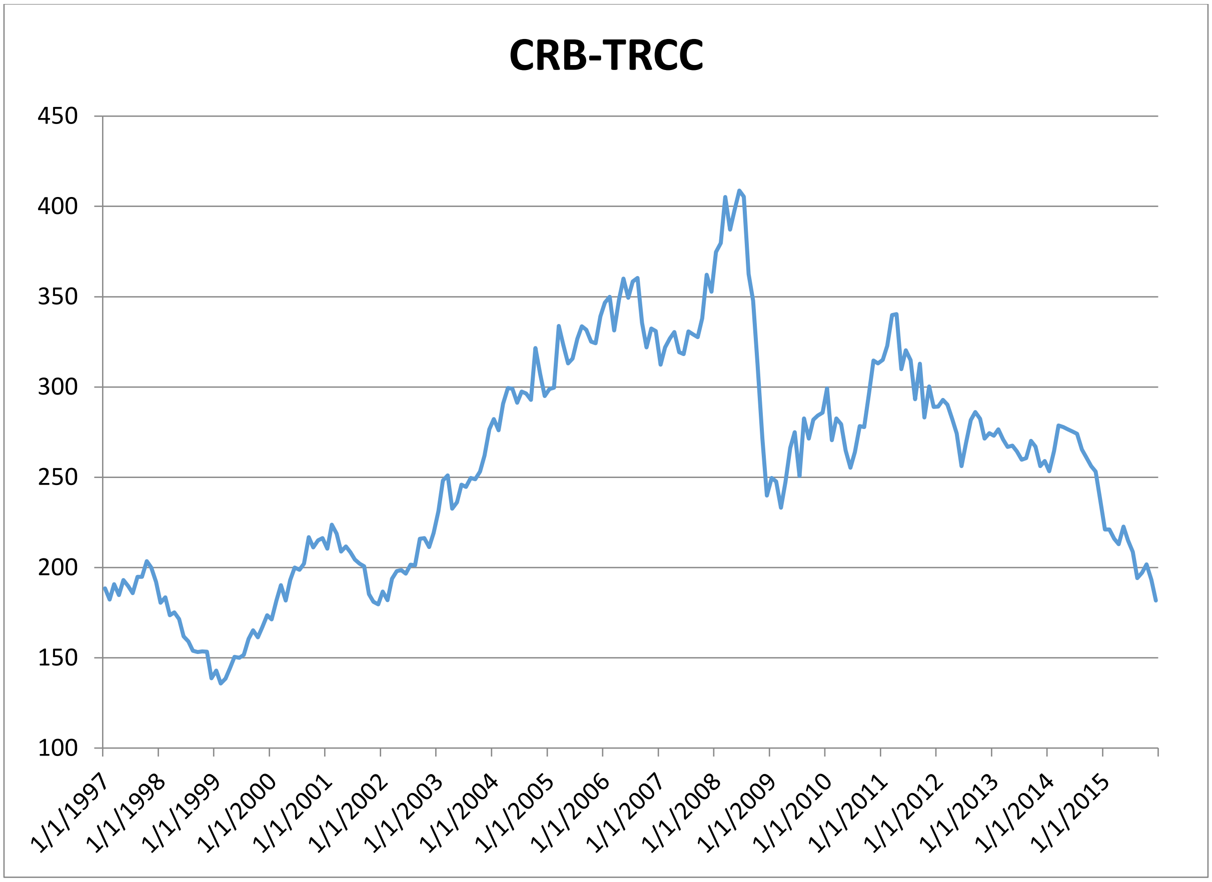


Figure 2.2. Global Oil, Iron Ore, Copper and Coffee Production from 1997 to 2015.

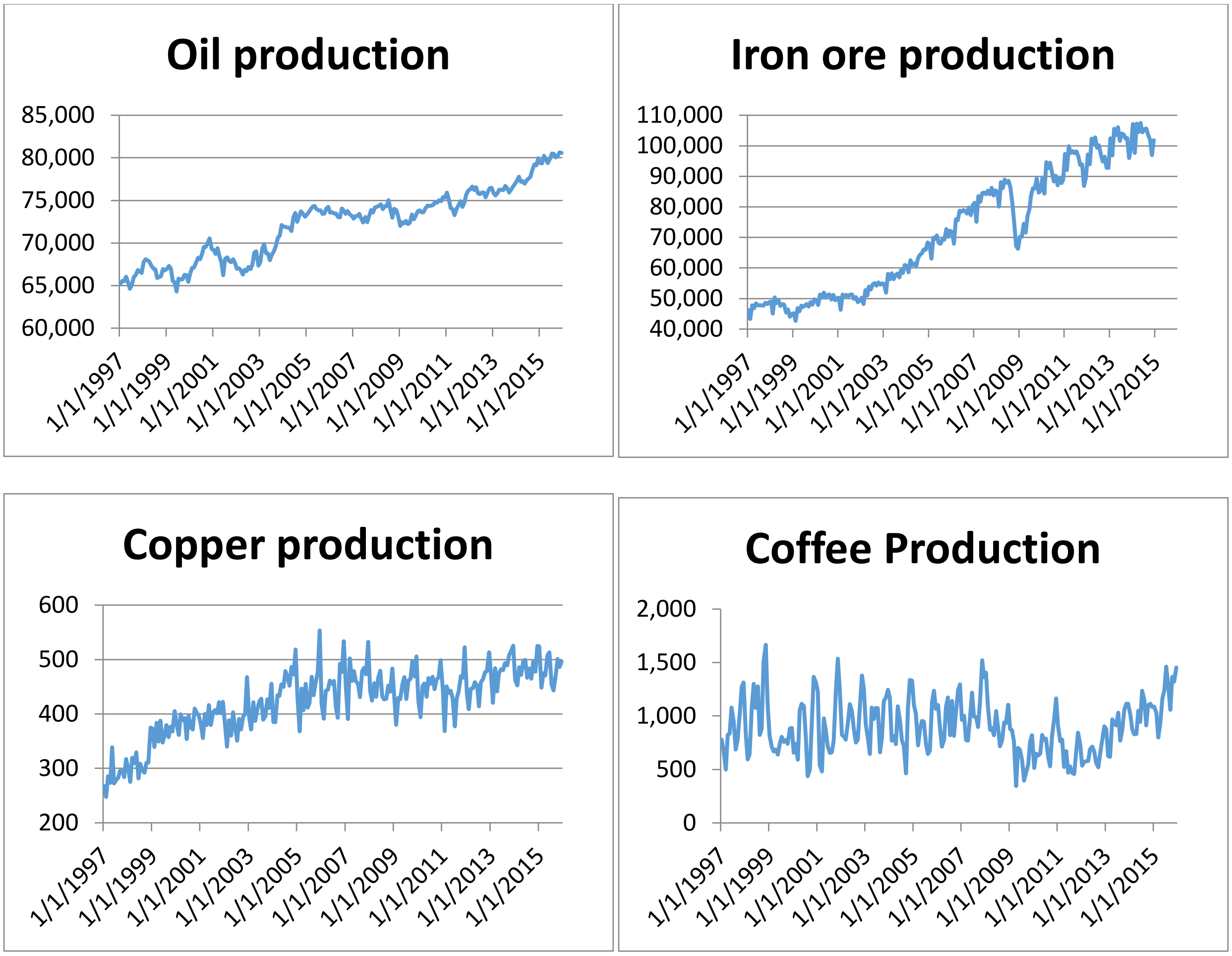


Figure 2.3. Global Real Economic Activity, from 1997 to 2015.

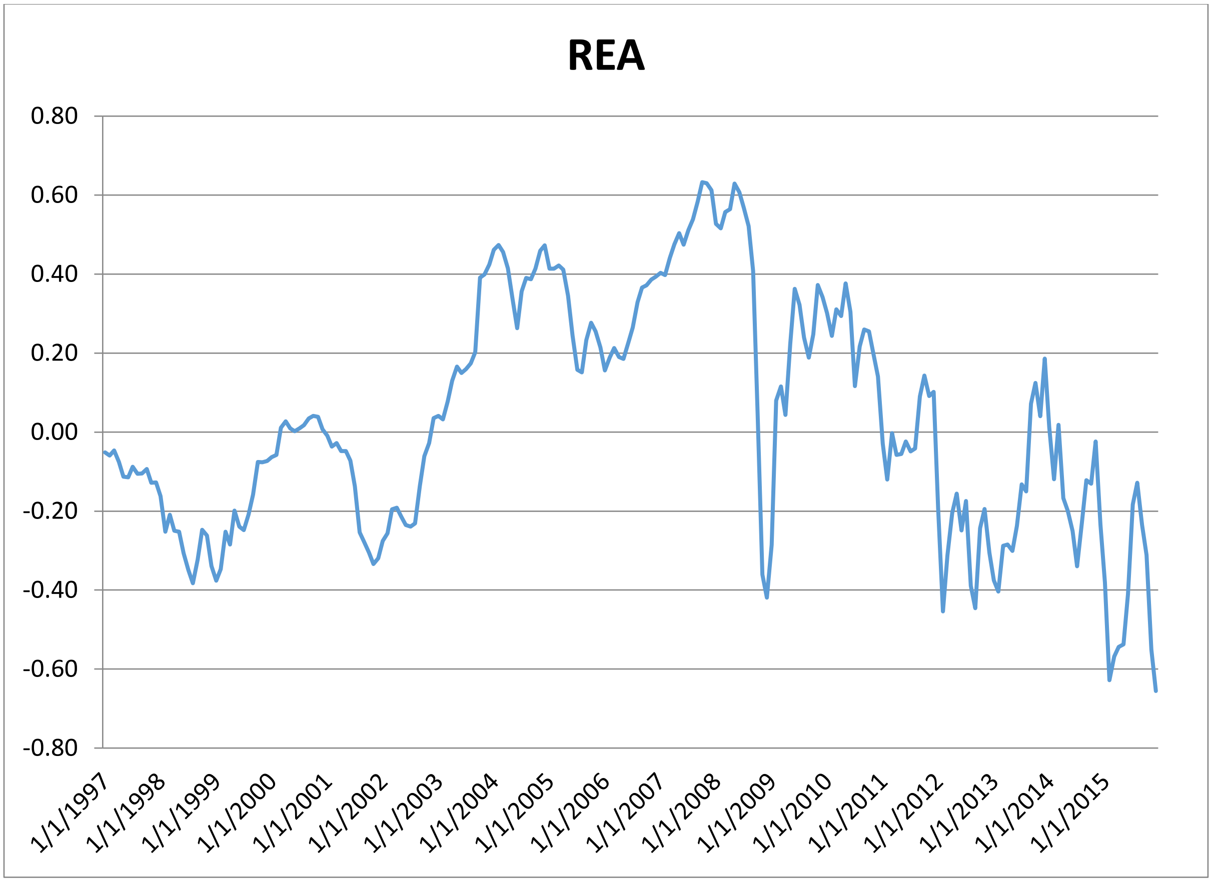


Figure 2.4. Real Prices of Oil, Iron Ore, Copper and Coffee, from 1997 to 2015.

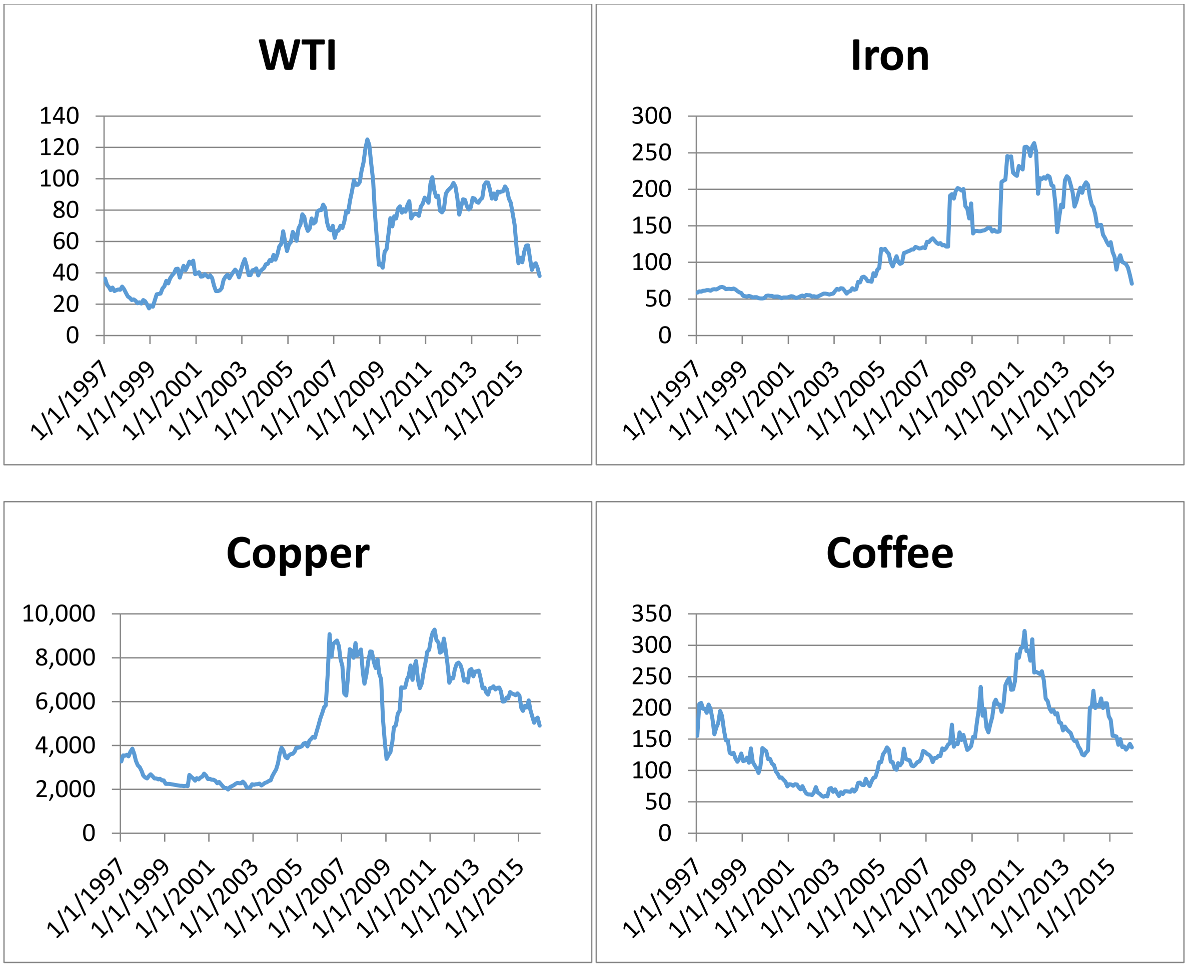
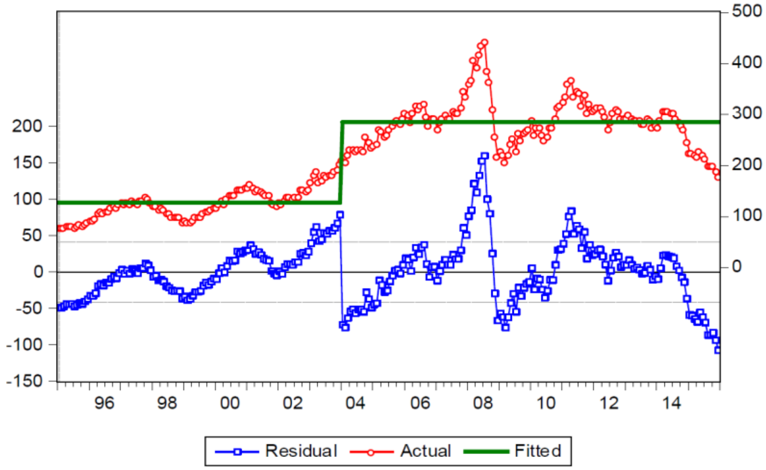
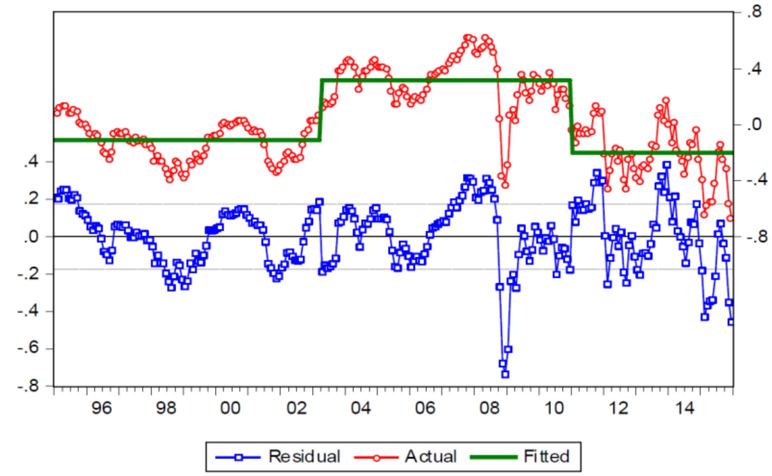


Figure 2.5. Bai-Perron Structural Break Tests.

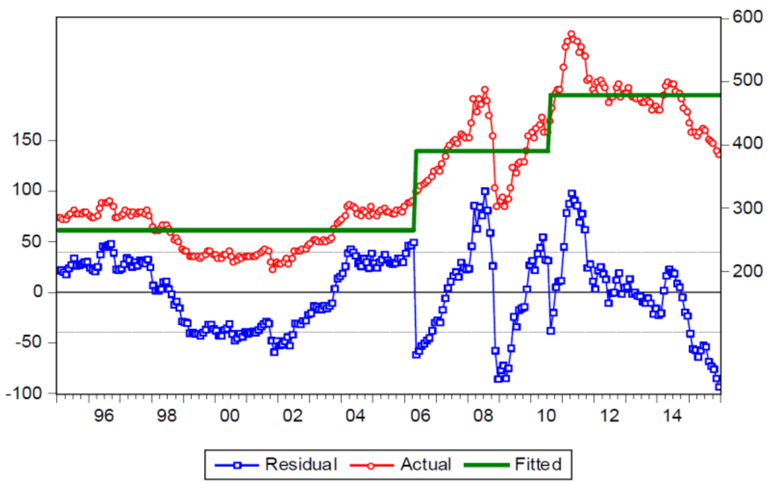
CRB-TRCC index



Real Economic Activity (REA)



CRB-BLS index



Interaction of CRB-TRCC with REA

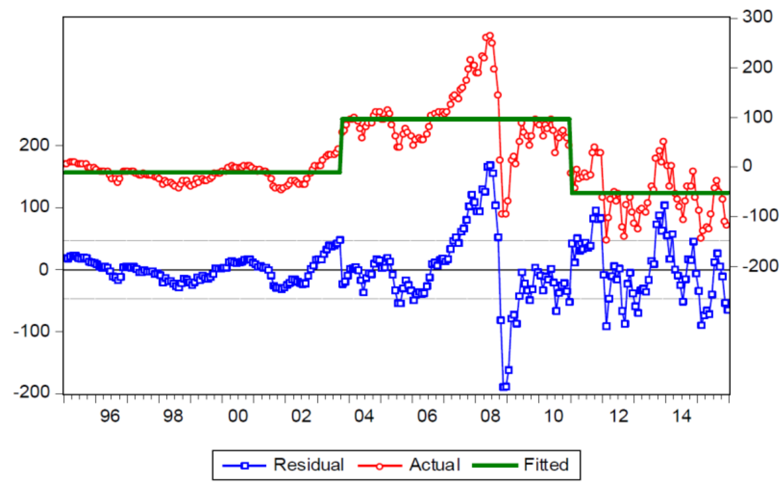
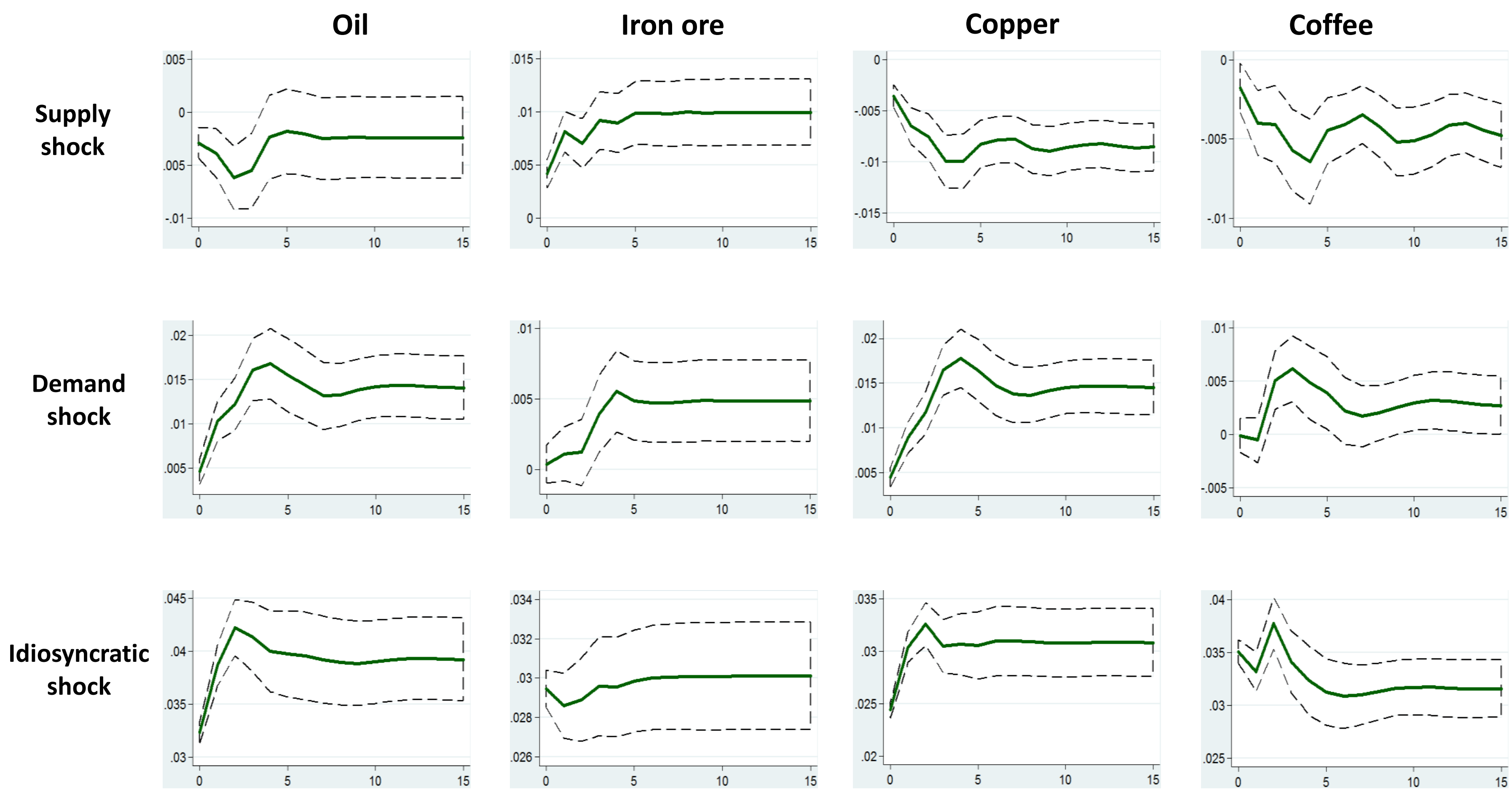
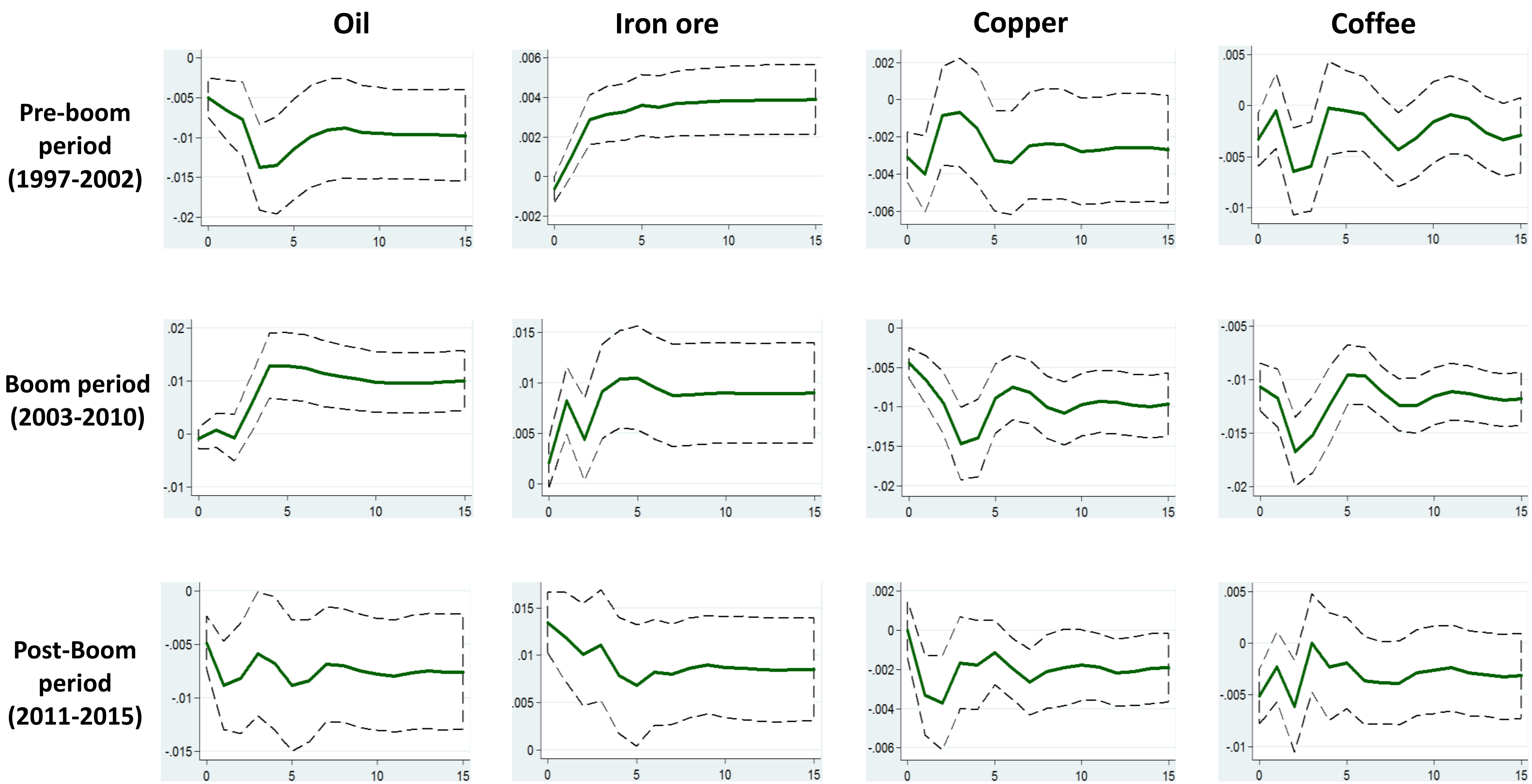


Figure 2.6. Responses of Commodity Prices to Different Shocks, from 1997 to 2015.



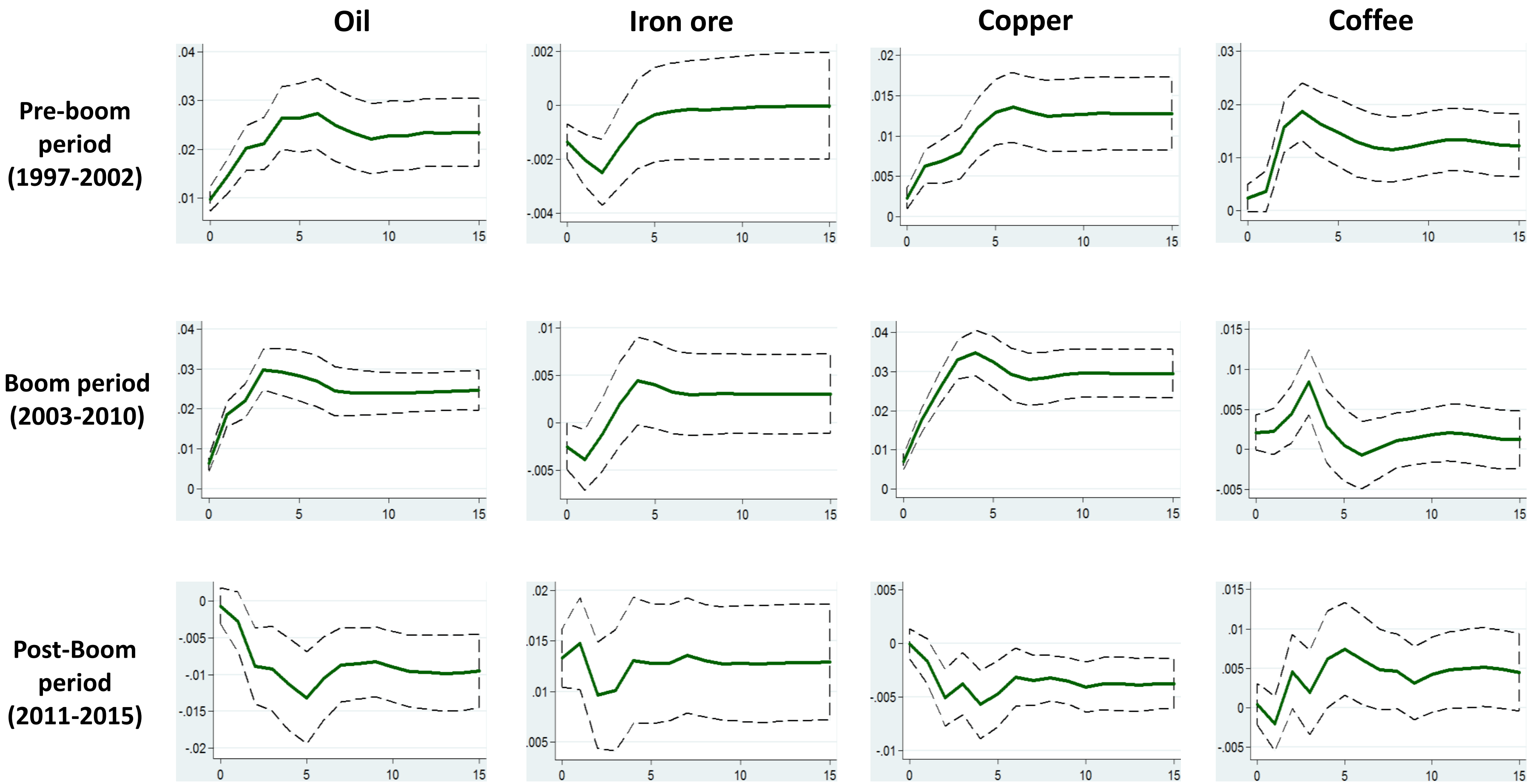
Notes: Cumulative orthogonalized impulse-response functions of real commodity prices to supply, demand and idiosyncratic demand shocks in SVAR(prod, rea, price) in the entire sample period from 1997 to 2015. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

Figure 2.7. Responses of Commodity Prices to SUPPLY Shocks, in Sub-Sample Periods.



Notes: Cumulative orthogonalized impulse-response functions of real commodity prices to supply shocks in SVAR(prod, rea, price) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

Figure 2.8. Responses of Commodity Prices to DEMAND Shocks, in Sub-Sample Periods.



Notes: Cumulative orthogonalized impulse-response functions of real commodity prices to demand shocks in SVAR(prod, rea, price) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

CHAPTER III

DECOMPOSING VARIANCE IN LATIN AMERICAN STOCK RETURNS

3.1 Introduction

This essay analyzes the impacts of commodity supply, demand and idiosyncratic shocks on Latin American stock returns from 1997 to 2015. Similarly to the previous chapter, I focus on contrasting different shocks and periods of the commodity cycle in the past twenty years. In this essay, however, instead of examining the response of commodity prices to supply, demand and idiosyncratic shocks, I search for evidence from stock price reaction to those shocks. Accordingly, I expect aggregate demand shocks to account for a larger portion of the variance decomposition of stock prices in the 2003-2010 period than in the 1997-2002 and 2011-2015 periods. I examine the Latin American stock market by checking the responses of selected stock exchange benchmark indices and individual firm stock prices to different commodity shocks. The commodities under study are crude oil and copper, which correspond to some of the largest listed firms in Latin American stock markets, and coffee, an export commodity that used to be the top export in the region (Blumenfeld, 1961). Results demonstrate that commodity market structural shocks play a significant role in explaining the variations in Latin American stock markets. Aggregate demand shocks account for a larger portion of the variance decomposition of Latin American stock prices during the 2003-2010 commodity boom, a result robust to different benchmark indices and stocks.

The rest of the chapter proceeds as follows. Section 3.2 reviews the previous literature on commodity booms and Latin American stock markets. Section 3.3 explains the methodology. Section 3.4 describes the data. Section 3.5 brings the empirical analysis and results, and the last section provides the conclusions.

3.2 Previous Literature

This essay examines Latin American stock returns and their responses to commodity shocks. In the literature on crude oil and developed markets, most articles find evidence of significant oil price impact on stock market returns. Jones and Kaul (1996) show that oil prices have a negative effect on stock market returns in the U.S., the U.K., Canada and Japan. Sadorsky (1999) provides evidence that oil prices and oil price volatility have a negative impact on the U.S. stock market returns and that the participation of oil prices in the variance of those returns are larger than the ones from interest rates. Some later studies on advanced economies have results in line with Sardosky's (1999): Ciner (2001) for the U.S. stock markets; Park and Ratti (2008)[14] for the U.S. and 13 European countries; Papapetrou (2001) for the Greek stock market; El-Sharif et al. (2005) for the U.K; and Aloui and Jammazi (2009) and Jammazi and Aloui (2010) with evidence for the G7 countries.

A recent article by Kang, Ratti and Yoon (2015) provides new evidence on the U.S. stock market: although structural oil price shocks account for 25.7% of the long-run variation in the U.S. real stock returns from 1968 to 2012, there is substantial change in levels and sources of contribution over time. They show, using a similar methodology to Kilian and Park (2009), that

[14] An interesting result from Park and Ratti (2008) is the positive response of real stock returns to an oil price increase in Norway, an oil exporter. In that sense, one can expect that Brazil and Argentina show positive responses of real stock returns to positive shocks to their oil production.

the contribution of global real economic activity to real stock returns reaches the high levels of 22% in 2009, while the participation of oil-market specific demand price shocks peaks at 15% in 2007. Nevertheless, the contribution of oil supply shocks has trended downward from 17% to 5% between 1973 and 2012. Consistent with these findings, Le and Chang's (2015) results from an empirical analysis on ten Central and Eastern European (CEE) countries show that the reaction of a market to oil price shocks depends on the oil characteristics of the economy and the nature of the shock in oil prices. Asteriou and Bashmakova (2013) also examine CEE countries and provide evidence of a negatively related reaction of stock returns to changes of the oil market. Cunado and de Gracia (2014) also find a negative and significant impact of oil price changes on most European stock market returns. However, they show that stock market returns are mostly driven by oil supply shocks. Similarly, Gupta and Modise (2013) find an interesting result for South Africa, an oil-importing country. Their results from the analysis of the variance decomposition are that the oil supply shock contributes more to the variability in real stock prices than do global demand and speculative demand shocks.

The literature provides only limited evidence on the relationship between commodity prices and emerging markets and not always show significant price effect on stock market returns. In the crude oil literature, the following articles are some important examples. Hammoudeh and Choi (2006) find no significant relationship for the Gulf Cooperation Council (GCC) markets, while Maghyereh and Al-Kandari (2007) show that oil prices have a nonlinear impact on stock returns in the region. Basher and Sadorsky (2006) provide evidence that oil price risk is relevant for explaining variations in stock returns, using a sample with 21 emerging markets, but the impact direction depends on the frequency of data used (daily, weekly and monthly). Maghyereh (2006) does not find any significant impact of oil prices on stock returns of

22 emerging markets, while Cong et al. (2008) shows no significant results for China. Aloui et al. (2012) analyze the impact of oil price shocks on stock market returns in 25 emerging countries and show that oil price risk is more relevant for pricing in emerging stock markets, and that the oil sensitivity of stock returns is particularly significant during bullish periods of rising oil markets. Basher et al. (2012) estimate a structural vector autoregression model to investigate the dynamic relationship between oil prices, exchange rates and emerging stock markets and find that positive shocks to oil prices lowers emerging market stock prices.

From studies on copper and stock markets, the following are key papers in the recent literature. Pellandra (2015) examines Chile’s exposure to copper price shocks and the effects of its export sector on local wages and employment between 2003 and 2011, finding evidence of a decline in poverty rates and income inequality in regions most exposed to the price shock compared to other regions. Rehner et al. (2014) take a long-term perspective to evaluate the links between the degree of export specialization among Chile’s regions to regional GDP growth and to regional export growth. Sadorsky (2014) examines crude oil, wheat and copper price shocks to emerging market equities and shows that, especially for the period between 2008 and 2009, there are increasing volatility spillovers between emerging market equities and these commodities’ prices.

From the literature on coffee and stock markets, a recent study by Bos and van der Molen (2013) shows some interesting results: while most of the changes in coffee prices can be attributed to shifts in demand and particularly supply, speculation is an important part of the coffee price generation process. They also argue that climate change may affect coffee prices (by means of the supply channel) more than is the case with many other commodities.

The risks of contagion or, to say the least, the levels of interdependence between developed and emerging markets – as referred to by Forbes and Rigobon (2002) – have increased since the U.S. financial crisis. For instance, Bekiros (2014) and Garza-García and Vera-Juárez (2010) analyze the BRIC economies, showing that the BRICs have become more internationally integrated and more prone to contagion after the U.S. financial crisis. Other studies find evidence of significant contagion from the emerging markets to the U.S., but no evidence of spillover from the U.S. to the emerging markets, except for the case of Latin America (Samarakoon, 2011). Diamandis (2009) finds a long-run stock market linkage between each of the four Latin American stock markets (Argentina, Brazil, Chile and Mexico) and the U.S. stock market.

3.3 Methodology

This essay employs a SVAR analysis that focuses on the Latin American stock market responses to the commodity shocks. I follow Kilian and Park (2009) in including real stock returns to the 3x1 Y-vector from Kilian (2009) to form a 4x1 Y-vector of variables in the SVAR model. I analyze the impulse-response of Latin American real stock market returns to increases of one standard deviation in structural shocks. The stock returns are calculated as the log-difference of stock prices, forming a four-variable SVAR model[15]:

$$B_0 y_t = \gamma + \sum_{i=1}^{4} B_i y_{t-i} + \pi \, dum\_crisis_t + h_t, \tag{2}$$

[15] Following Park and Ratti's (2008) methodology, I accept that, in levels, the log of global commodity production, global real economic activity, and real price of commodity are I(1) processes. Also, Latin American real stock returns and, in first log differences, global commodity production, global real economic activity, and real price of commodity are I(0) processes.

where Y is a 4x1 vector of the variables in the SVAR model and B_0^{-1} has a recursive structure such that h_t is a vector of serially and mutually uncorrelated structural innovations that has the following structural pattern:

$$\begin{bmatrix} h_{1t}^{\Delta\, global\ commodity\ production} \\ h_{2t}^{\Delta\, global\ real\ economic\ activity} \\ h_{3t}^{\Delta\, real\ price\ of\ commodity} \\ h_{4t}^{Latin\ American\ real\ stock\ returns} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{1t}^{commodity\ supply\ shock} \\ \varepsilon_{2t}^{aggregate\ demand\ shock} \\ \varepsilon_{3t}^{idiosyncratic\ demand\ shock} \\ \varepsilon_{4t}^{shocks\ to\ stock\ returns} \end{bmatrix}$$

The SVAR models include four lags. These lags are determined by pre- and postestimation lag-order tests that show consistent results in the AIC (Akaike information criterion), LR (likelihood ratio) and FPE (final prediction error) criteria. The Latin American real stock returns are allowed to respond to all three commodity supply and demand shocks, while ε_{4t}does not affect global commodity production, global real activity and the real price of commodity. This occurs because of the recursive structure of this SVAR model, which implies that global commodity production, global real activity and the real commodity price are *ex ante* to Latin American real stock returns. Following Kilian and Park (2009), I refer to ε_{4t} as an innovation to real stock returns not driven by global commodity supply, aggregate demand or idiosyncratic commodity shocks.

Since demand shocks are known as the drivers of commodity booms (Radetzki, 2006) and considering the recent evidence from Kang, Ratti and Yoon (2015) showing top levels of global real economic activity and oil-market specific demand price shocks to the U.S. stock market returns during the 2000s commodity boom period, I check for regional and individual stock evidence of demand shocks accounting for a larger portion of the variance decomposition of Latin American stock prices during the commodity boom period between 2003 and 2010, and compare the results to the ones from the pre and post-boom periods. I also expect individual firms to respond more strongly to shocks than the market: for example, demand shocks should display a higher participation in the variance of Brazilian oil company Petrobras' real stock returns than in the variance of Brazilian Bovespa index real returns.

3.4 Data

Additionally to the data described in the previous chapter, I gather real stock returns which are calculated by subtracting the consumer price index (of the country where the stock is listed) from the log returns on each stock. The historical data on stocks prices and indices are obtained from Datastream. The S&P Latin America 40 (SPLAC40) index is an S&P Dow Jones index with around 40 blue-chip firms[16] from the following countries, as of January 31, 2018: Brazil (17 firms; 59.7% country weight), Chile (10; 11.7%), Mexico (10; 22.7%), Peru (2; 3.8%) and Colombia (2; 1.8%) that constitute around 70% of Latin America's market capitalization. These firms are from the following sectors: financials (37.1% sector weight), materials (16.9%), consumer staples (14.3%), energy (13.4%), consumer discretionary (5.6%), telecommunication services (4.2%), industrials (4.0%), utilities (2.4%), and information technology (1.8%). I deflate this index by the CPI for Latin America and the Caribbean available at the World Development Indicators database[17], from the World Bank, to calculate its real returns. Figure 3.1 shows the performance of the SPLAC40 index from 1997 to 2015.

[16] As of January 31, 2018, there are 41 Latin American companies in the list of the index components. See Appendix B for details on the constituents of the S&P Latin America 40 index.
[17] I adopt this deflator instead of a CPI with weights based on the market capitalization of each country in the S&P Latin America 40 index due to lack of data availability at the monthly frequency for some of the countries.

The SPLAC40 index fluctuates with lower volatility from 1997 to 2003 as compared to the rest of the time series. From March 2003 to October 2007, the index rises from 725 to 5,160 points. Then it declines, impacted by the global financial crisis, to 2,206 points in February 2009. The trend starts to revert in March 2009 and the benchmark price reaches 5,245 points in December 2010. From 2011 to 2015, it drops from the 5,000-point area to around 2,000 points.

The stock exchange benchmark indices in the study are the Merval index from Argentina, the Brazilian BM&F Bovespa, the Colcap index from Colombia, the Santiago Stock Exchange (SSE) index from Chile, and the Mexican IPC index. The performance of these indices from 1997 to 2015 is depicted in Figure 3.2.

Argentina has a different performance in the initial years of the series, with a downward movement in the country's stock market from 1998 to 2002. This downtrend has its worst moment in its last two years, known as the Argentine crisis of 2001-2002, when local currency strongly depreciated and Argentina lost its access to foreign finance. Brazil, Colombia, Chile and Mexico display a strong growth from 2003 to 2010, with Mexico showing stability from 2011 to 2015, while Brazil and Chile show a declining trend. The 2008-2009 crisis has a strong negative impact on the four benchmark indices, although they recover later except for Argentina.

The individual stock prices are from the historical series of the largest commodity producing companies in Latin America. To measure the impacts of commodity shocks on Latin American stock markets, I use the prices of the stocks listed on the producing country's stock exchange. Table 3.1 provides company names, tickers at the stock exchanges, related commodity produced by the firm, and a brief description of the company. Although most stocks in this study are listed on the same country where the majority of the firm's production is situated, there is an exception from the copper firm Antofagasta, listed in the London Stock Exchange (LSE).

Figure 3.3 displays the performance of each of these stocks from 1997 to 2015. YPF stocks show a fast increase between 2003 and 2006 and decline back to the 2001-2002 Argentine crisis price levels in 2013. Petrobras and Empresas Copec, as well as the copper firms Southern Copper Corporation and Antofagasta display a steady growth from the start of the series up to around 2008, when the financial crisis hit the global economy, impacting these stocks' performance up to the beginning of 2009. In 2010 and 2011, most stocks recover back to the pre-crisis price levels, except Petrobras' prices which only revert about half of the losses. Between 2012 and 2015, there is a clear decline in all of these Latin American stock prices.

3.5 Empirical Analysis and Results

3.5.1 Unit Root Tests

I perform unit root test results with and without trend for all the measures of real stock returns. The results are shown in table 3.2. To save space, I do not show the unit root results of the first log differences of global commodity production, global real economic activity from the previous chapter, these tests are already reported in table 2.2 of Chapter II.

I employ the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981), KPSS test (Kwiatkowski et al., 1992) and the M-tests developed by Ng and Perron (2001). The optimal lag length for the ADF test is determined by the Campbell and Perron (1991) data dependent procedure, as detailed in the previous chapter. The KPSS test adopts a lag truncation parameter equal to 4, and the M-tests employ Bartlett Kernel lag selection. The results support stationarity of all real stock returns, since all tests reject the null hypothesis of unit root at the 1% significance level, or fail to reject the null of stationarity in the case of the KPSS test. Following

Park and Ratti (2008), I consider that Latin American real stock returns and, in first log differences, global commodity production, global real economic activity, and real price of commodity are I(0) processes. To save space, I do not repeat the cointegration tests from last chapter, because the table does not change. I then proceed to the SVAR analysis without the need of a cointegration test, which is often employed for models that combine I(1) variables.

3.5.2 Responses of Latin American Real Stock Returns to Structural Shocks

Figures 3.4-3.6 report cumulative impulse-responses of Latin American real stock returns to one standard deviation positive shocks to oil, copper and coffee supply. Figure 3.4 shows that, in the pre-boom period, positive oil supply shocks negatively impact the stock returns in Brazil, Chile and Mexico in the short run.

These shocks revert in Chile and Mexico after 5 months, while they display positive effects for Argentina and Brazil in the long run. The results for YPF (Argentina), Petrobras (Brazil) and Empresas Copec (Chile) support a negative impact in the short run, but only Petrobras stocks maintains a positive response in the long term. During the 2000s commodity boom, the short-term response from Argentina and Brazil is a fast growth up to two months, consistent with evidence from Kilian and Park (2009) for Norway, an oil exporting country. For the SPLAC40 index, Chile and Mexico, the immediate impact is negative. It is important to note that the expected sign is negative based on Sadorsky (1999) and subsequent literature, which is consistent with the diversification of the stock exchange indices themselves: as shown in the data section, most of SPLAC40 index constituents are financials (37.1%); the energy sector corresponds to only 13.4% of the index weight. In the mid and long run, only the responses from Argentine stocks persist positively. For individual companies, both YPF and Petrobras respond positively and persistently to supply shocks in the boom period – also consistent with Kilian and

Park's (2009) evidence for Norway – , while Empresas Copec show a non-significant response. The post-boom period shows a negative impact on SPLAC40 that lasts for one or two months before it reverts to zero. Stock market in Argentina and YPF stocks display a negative response to increases in the oil supply, while the impacts on Petrobras and Empresas Copec are not clear. However, in the Bovespa index the persistent impact is positive, suggesting that Brazilian stocks keep responding positively to oil supply shocks in the post-boom period. Although Chile and Mexico stock markets have, respectively, negative and positive short-run responses, the long-term impact is not significant.

Figure 3.5 brings the results from cumulative impulse-response of Latin American stock returns to one standard deviation positive copper supply shocks.

Regarding copper supply shocks in the pre-boom period, there is a positive and persistent response of SPLAC40 and the Chilean real stock market returns. Southern Copper Corporation and Antofagasta, however, experience an immediate negative response to supply shocks. In the commodity boom period, the impact is unclear to Chile and Antofagasta, while SPLAC40 and SCC show positive and persistent responses. On the other hand, Antofagasta shows a positive response to copper supply shocks in the post-boom period, while SCC does not. The Chilean stock market shows a persistent negative response to copper supply shocks in the post-boom period, while SPLAC40 is negatively impacted only at time 0 and then reverts to zero.

The negative coefficients for these large Chilean copper firms suggest that a sudden increase in copper supply (faster than a copper demand increase) will result in a drop in price and, therefore, profitability. Nevertheless, during the 2000s commodity boom, the positive response of the SPLAC40 index and SCC real returns could be associated with a higher sensitivity of the stock market to the bullish period, similarly to Aloui et al.'s (2012) evidence on oil.

Figure 3.6 reports results from the cumulative impulse-responses of Latin American stock returns to one standard deviation positive shocks to the supply of coffee.

In the pre-boom period, coffee supply shocks imply a negative although short-lived impact on SPLAC40 and the Colombian stock market. The Brazilian stock market shows a negative response to supply shocks after one period. In the commodity boom period, the impact is clearly negative to the three indices, but non-significant after one period. In the post-boom period, SPLAC40 and Brazil seem positively impacted by coffee supply shocks while the Colombian stock market only displays a positive effect around the fifth month.

Overall, the response of Latin American real stock returns to coffee supply shocks is negative, consistent with Bos and van der Molen (2013), who show that changes in coffee prices are particularly negatively affected by supply shocks, especially due to climate change.

Figures 3.7-3.9 show the cumulative impulse-response of Latin American stocks to one standard deviation positive aggregate demand shocks using SVAR models that include, respectively, crude oil, copper and coffee.

Figure 3.7 shows that, in the SVAR model with crude oil, the aggregate demand shocks have a positive and persistent effect on SPLAC40 and all the stock exchanges in the period before the commodity boom. YPF, Petrobras and Empresas Copec show similar movement.

In the 2000s boom period, the main finding is that the positive impact of demand on stock returns is immediate (at time 0). For the SPLAC40 index, it reverts to zero after around 4 months, consistent with the diversified nature of the index constituents. The post-boom period results show a negative impact of aggregate demand shocks on SPLAC40, Brazil, Chile and

Mexico, as well as on the stocks of Petrobras and Empresas Copec, a counterintuitive result that may be related with the excess of supply over demand in the oil market in after-boom years, as shown by Staufenberg (2015). The exceptions are Argentina and YPF, which respond positively to these shocks in the period 2011-2015.

Figure 3.8 reports results for the cumulative impulse-response of Latin American stocks to one standard deviation positive aggregate demand shocks in the copper market. In the pre-boom period, SPLAC40, Chile and the copper firms respond positively to aggregate demand shocks.

In the commodity boom period, although the response of SPLAC40 is largely positive at time zero until the end of the first month, it reverts to zero in the long run. Chile, SCC and Antofagasta show significant positive responses to demand shocks. Results from the post-boom period show non-significant responses of SPLAC40 to aggregate demand shocks. The Chilean stock market and the copper firms display negative responses to demand shocks in the short run, which may be due to the declining copper prices in the post-boom period.

Figure 3.9 brings the results for the cumulative impulse-response of Latin American stocks to one standard deviation positive aggregate demand shocks in the coffee market. In the pre-boom and commodity boom periods, the cumulative responses of SPLAC40 and the Colombian and Brazilian stock market indices to demand shocks remain positive in the long-run, except for SPLAC40 during the commodity boom period, which displays a strong immediate response at month 0 but later adjusts the cumulative effect back to zero.

In the post-boom period, the response of Latin American real stock returns to aggregate demand shocks is negative for SPLAC40 and Brazil, in line with the declining coffee prices. For

Colombia, the immediate impulse-response is positive, but then follows a similar downward movement and becomes negative after 4 months.

3.5.3 Variance Decomposition of Latin American Real Stock Returns

The results from the variance decomposition tests measuring the effects of the different commodity-price shocks on Latin American real stock returns involved in the SVAR model are discussed in this section. Tables 3.3-3.5 show the variance decomposition of stock returns for different shocks from crude oil, copper and coffee, respectively. Each table has several panels that show the variance decomposition results for different stock indices and individual stocks.[18] The results indicate the variance percentage in each variable that can be attributed to each of the structural shocks at different horizons. I report the percentages for the following selected forecast horizons: 1, 6, 12, 18 and 24 months. Standard errors appear within parentheses after the percentage of variance explained. The numbers within parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

Table 3.3 shows the results for the variance decomposition of the crude oil shocks on Latin American real stocks returns. From Panel A to H, I show the results for each of the stock indices and individual stocks.

Panel A reports results for the SPLAC40 index variance decomposition for the SVAR model using crude oil as commodity. There is evidence supporting the hypothesis that aggregate demand shocks have an increased contribution to Latin American stock returns during the commodity boom period as compared to the pre- and post-boom periods. Aggregate demand shocks represent 24.6 percent of the variation in real stock returns in the long run (24 months)

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[18] To save space, I only show the results for the impulse-responses of real stock returns.

during the commodity boom period versus 6.2 percent in the pre-boom period and 5.8 percent in the post-boom period, with the pre- and post-boom coefficients not showing statistical significance. Except for the post-boom period, the variance decomposition results show that, in the long run, aggregate demand shocks contribute a larger share to the variation in Latin American stock returns than do supply shocks. The results from the post-boom period show a larger participation of the idiosyncratic demand shock (8.5) than the aggregate demand shock (5.8) after 12 months. Oil supply, aggregate demand and idiosyncratic shocks together account for 14.4 percent of the variation in Latin American real stock returns in the pre-commodity boom period, 39 percent in the commodity supercycle period and 21.5 percent in the post-boom period. Panels B and C show the variance decomposition of the real stock returns in Argentina's Merval index and oil company YPF, respectively. For Argentina, the variance decomposition results are in line with those for Latin America, showing a larger participation of aggregate demand shock in the commodity boom period (10.8 percent) as compared to supply and idiosyncratic shocks and versus aggregate demand shocks in other periods. The three oil shocks together account for 21 percent of the variance decomposition of Argentina's real stock returns in the commodity boom period. For the oil company YPF, although I find a larger participation of aggregate demand shock in the commodity boom period (17.8 percent) as compared to supply (4.8 percent) and idiosyncratic (4.3 percent) shocks, these shocks have a very important participation in the pre-boom period (21 percent) and have an even higher participation in the post-boom period (30.9 percent). The three oil shocks together account for 55.8 percent of the variance decomposition of YPF's real stock returns in the post-boom period. Panels D and E show the variance decomposition of the real stock returns in Brazil's Bovespa index and oil company Petrobras. For Brazil, oil supply shocks are the ones with the largest contribution to real stock returns in the pre-boom period (10.1 percent) and the commodity boom period (13.8 percent), while idiosyncratic demand shocks have the highest participation (11.8 percent) in the post-boom period. Consistently with results for Latin America, the three oil shocks together have a higher total percentage in the commodity boom period (30.8 percent) than in the pre- (19.1 percent) and post-boom (25.1 percent) periods. For Petrobras, I only find a larger participation of aggregate demand shock as compared to supply and idiosyncratic shocks in the pre-boom period (13.2 percent). In the commodity boom and the post-boom periods, the idiosyncratic demand shock has the largest contribution to real stock returns (11.8 and 23.9 percent, respectively). Panels F and G show the variance decomposition of the real stock returns in Chile's SSE index and energy company Empresas Copec. In both cases, I find the hypothesized higher participation of aggregate demand shocks in real stock returns during the commodity boom period as compared to the pre- and post-boom periods. For Chile, aggregate demand shocks represent 18.5 percent of the variation in real stock returns in the long run (24 months) during the commodity boom period versus 6.6 percent in the pre-boom period and 14.1 percent in the post-boom period. For Empresas Copec, aggregate demand shocks account for 13.1 percent versus 5.0 in the pre-boom period and 7.2 percent in the post-boom period. These panels show that, only in the commodity boom period, aggregate demand shocks contribute a larger share to the variation in real stock returns than do supply shocks in Chile (18.5 vs. 10 percent) and Empresas Copec (13.1 vs. 5.8 percent). In the pre- and post-boom periods, oil supply shocks have a higher contribution to real stock returns. Panel H reports the variance decomposition of real stock returns in Mexico's IPC index. Although aggregate demand shock has the highest contribution in all periods (15.1, 10.0 and 14.8 percent, respectively) as compared to supply and idiosyncratic shocks, there is decrease in the participation of oil supply shocks from 12.5 percent in the pre-boom period to 7.3 percent in the post-boom period, while the idiosyncratic demand shocks increase their contribution from 3.4 percent in the pre-boom period to 13.5 percent in the post-boom period.

Table 3.4 shows the results for the variance decomposition of the copper shocks on Latin American real stocks returns. Panels A-D show the results for Latin America (SPLAC40 index), Chile (Santiago Stock Exchange index), and individual firm stocks of Southern Copper Corporation (SCC) and Antofagasta.

Panel A reports results for the SPLAC40 index variance decomposition for the SVAR model using copper as commodity. Consistently with results for crude oil, there is evidence for the hypothesis that aggregate demand shocks had an increased contribution to Latin American stock returns during the commodity boom period as compared to the pre- and post-boom periods. Aggregate demand shocks represent 30.7 percent of the variation in real stock returns in the long run (24 months) during the commodity boom period versus 8.9 percent in pre-boom periods and 4.3 in the post-boom period. In the long run, aggregate demand shocks also contribute a larger share to the variation in Latin American stock returns than do supply shocks in all periods. Copper supply, aggregate demand and idiosyncratic shocks together account for 24.5 percent of the variation in Latin American real stock returns in the pre-commodity boom period, 40.5 percent in the commodity supercycle period and 16.2 percent in the post-boom period. Panel B show the variance decomposition of the real stock returns in Chile's SSE index. Results are in line with those for Latin America, showing a larger participation of aggregate demand shock in the commodity boom period (19.1 percent) as compared to supply (2.4 percent) and idiosyncratic demand (5.4 percent) shocks and versus aggregate demand shocks in other periods. The three copper shocks together account for 26.9 percent of the variance decomposition of Chile's real stock returns in the commodity boom period. Results show, however, that in the pre-commodity boom period copper supply (9.3 percent) and idiosyncratic demand (13.4 percent) shocks have a larger contribution to the real returns of the benchmark index than do aggregate demand shocks (7.4 percent). Panels C and D show the variance decomposition of individual stock real returns of Southern Copper Corporation (SCC) and Antofagasta. Results for these firms also support the hypotheses that aggregate demand shocks had a high participation in real stock returns during the commodity boom period (17.1 and 14.6 percent, respectively) versus the contribution from supply shocks as well as compared to the participation of aggregate demand shocks in the pre- and post-boom periods. Outside of the commodity boom periods, idiosyncratic demand shocks display a larger contribution to these firms' real stock returns than the aggregate demand shock, suggesting that the aggregate demand shock increases during the commodity boom period to become the driver of Latin American stock returns in the commodity boom period.

Table 3.5 reports the results for the variance decomposition of the coffee shocks on Latin American real stocks returns. Panels A-C display the results for Latin America (SPLAC40 index), Colombia (COLCAP index) and Brazil (Bovespa index).

Panel A brings results for the SPLAC40 index variance decomposition for the SVAR model using coffee as commodity. In line with the results for crude oil and copper, there is evidence for the hypothesis that aggregate demand shocks had an increased contribution to Latin American stock returns during the commodity boom period as compared to the pre- and post-boom periods. Aggregate demand shocks represent 24.5 percent of the variation in real stock returns in the long run (24 months) during the commodity boom period versus 6.3 percent in pre-boom period and 4.8 in the post-boom period. In the long run, aggregate demand shocks also contribute a larger share to the variation in Latin American stock returns than do supply shocks in all periods. Coffee supply, aggregate demand and idiosyncratic shocks together account for

23.2 percent of the variation in Latin American real stock returns in the pre-commodity boom period, 30.1 percent in the 2003-2010 commodity boom period and 12.8 percent in the post-boom period. Panel B show the variance decomposition of the real stock returns in Colombia's COLCAP index. Similarly to the results from previous chapter, the variance decomposition percentage for the aggregate demand shock in the pre-boom period (21.3 percent) is larger than the one in the commodity boom period (2.1 percent). Panels C shows the variance decomposition of Brazil's stock market returns. In line with Panel A (SPLAC40 index), the Bovespa index brings support to the hypothesis that aggregate demand shocks had an increased contribution to stock returns in Latin America during the commodity boom period. Aggregate demand shocks represent 10.5 percent of the variation in real stock returns in the long run (24 months) during the commodity boom period versus 7.0 percent in pre-boom period and 6.9 in the post-boom period.

Table 3.6 displays a robustness check with the entire sample, with the SVAR model employing time dummy variables for the pre- (1997-2002) and post- (2011-2015) commodity boom periods. Because of the controls for time dummies, the percentages displayed refer to the responses of real stock returns to different shocks during the commodity boom period. Oil, copper and coffee real prices' responses to aggregate demand shocks are larger the ones to supply shock: for the real oil price, the percentages are, respectively, 5.5 and 2.4 percent; for the real price of copper, 5.7 and 2.3 percent; and for the real price of coffee, 5.0 and 1.5 percent. These results are supportive to the hypothesis that aggregate demand shocks have an increased contribution to Latin American stock returns during the commodity boom period as compared to the pre- and post-boom periods.[19]

[19] The corresponding impulse-response functions for this robustness check are similar to the ones reported in Figures 3.4-3.6 for the SPLAC40 index during the commodity boom period.

Table 3.7 reports a summary of the variance decomposition test results. The coefficients support the hypothesis that aggregate demand shocks have a larger participation in the variation of Latin American real stock returns than do supply shocks, except for the Brazilian Bovespa index (both overall and commodity boom periods) and Petrobras (overall period). This is consistent with the discovery of crude oil in the Brazilian pre-salt layer in 2007, with positive impacts on Petrobras' stock returns.[20] However, my additional proposition that individual firms would respond more intensely (than the market) to the commodity shocks is not supported by the results. For instance, in the oil market, aggregate supply shocks explain 13.8% of the variance in real returns of the Bovespa index versus 5.2% of Petrobras stocks during the commodity boom; similarly, the coefficient is 10% for Chile (Santiago Stock Exchange) versus 5.8% for Copec. In regard to aggregate demand shocks, the SPLAC40 index responds more largely than any of the stock exchange indices, which in turn display higher coefficients than the ones from individual company stocks. For example, in the copper market, aggregate demand shocks explain 30.7% of the variance in the SPLAC40 index real returns, versus a coefficient of 19.1% for Chile, which on its turn is larger than 17.1% and 14.6% for SCC and Antofagasta, respectively. One possible explanation for these results is that the own country CPI (of Argentina, for example) is affected by government manipulation (see, e.g., The Economist, 2012). Although these measurement errors should impact the CPI for the region as well, they would affect the Latin American CPI in a more diluted way if only a few of the countries' consumer price indices are distant from reality. A second possibility, especially regarding the variance associated with aggregate supply shocks, would be measurement errors from the adoption of the West Texas Intermediate (WTI) oil,

[20] Pre-salt layer refers to the geologic layer below the salt layer in the bottom of the ocean. At the end of 2007, a large oil reserve with an extension of 800 kilometers was found in the pre-salt layer between the Brazilian States of Espirito Santo and Santa Catarina (Waisberg, 2011). Petrobras (2017) explains that the pre-salt discoveries are among the world's most important in the 2000s, bringing daily oil output from around 41,000 barrels per day, in 2010, to 1 million barrels per day in mid-2016.

Chilean copper production and Colombian coffee production as proxies for global production of each corresponding commodity. A third possible explanation is that foreign exchange rates played an important role in the real stock returns in the studied period, especially in the 2000s commodity boom, possibly as significant as the role of some of the commodity shocks. Future studies could further investigate the role of foreign exchange rates during the 2000s commodity boom in Latin America expanding the current specification to a 5-variable SVAR model. Fourth, it is possible that the increase in real economic activity (proxied by the Kilian index) during the 2000s commodity boom period led to speculation in different sectors of the Latin American markets, especially the financial sector. For instance, while financials account for 37.1% of the SPLAC40 index, the energy sector corresponds to only 13.4%. Therefore, the larger variance decomposition coefficient of the SPLAC40 index real returns suggests the existence of financial speculation in the boom period. Although Fattouh et al. (2013), a review article on the role of speculation in oil markets, conclude that the existing evidence does not support an important role of speculation in driving the spot price of oil after 2003, future studies could further investigate evidence of financial speculation in emerging economies during the 2000s commodity boom.

3.6 Conclusions

This essay examines the impacts of commodity supply, aggregate demand and idiosyncratic shocks on Latin American stock markets from 1997 to 2015. I analyze stock exchange benchmark indices and individual firm stock prices regarding the responses of the Latin American stock market to supply, demand and idiosyncratic shocks to crude oil and copper. The firms under study are some of the largest listed companies in Latin American stock markets. I also analyze coffee, an export commodity that used to be the top export in the region (Blumenfeld, 1961). Based on Kilian and Park's (2009) methodology, I find that commodity market structural shocks play a significant role in explaining the variations in Latin American stock market returns.

During the 2003-2010 commodity boom, the major crude oil suppliers Argentina and Brazil and respective oil companies YPF and Petrobras show strong positive responses to oil supply shocks, while Chile and Mexico display a negative response. Brazil and its oil company Petrobras real stock returns' variance is largely explained by idiosyncratic demand shocks during the commodity boom and post-boom periods, consistent with the precautionary demand associated with the aforementioned discovery of pre-salt-layer crude oil in Brazil. From copper, SPLAC40 and SCC show positive and persistent responses to the commodity supply, while responses are unclear for Chile, suggesting a more stable stock market (less copper dependent) in the country than in the previous decade. In the coffee market, stock market returns' responses to supply shocks are relatively less significant, in line with the decline of coffee in the share of Latin American exports along the last five decades. With respect to aggregate demand shocks, except for the coffee market, results indicate strong positive responses of Latin American stock returns for different commodities during the 2003-2010 commodity boom.

From the SVAR using subsample periods, I find the following percentages for the three commodity shocks together (supply, demand and idiosyncratic shocks): for oil, 14.4% in the pre-boom, 39% in the commodity boom, and 21.5% in the post-boom periods; for copper, 24.5% in the pre-boom, 40,5% in the commodity boom, and 16.2% in the post-boom periods; for coffee, 23.2% in the pre-boom, 30.1% in the commodity boom, and 12.8% in the post-boom periods. The finding of a more substantial contribution of commodity shocks to the variation of stock returns than the ones from the existing literature (e.g., Kang, Ratti and Yoon, 2015) may be due to the choice of Latin America and the 2000s commodity boom period.

From the robustness check with a SVAR for the entire sample, adopting dummy variables for the pre- and post-boom periods, there is additional evidence supporting the hypothesis that demand shocks account for a larger portion of the variance decomposition of Latin American stock prices than do supply shocks during the commodity boom period.

Overall, there is a strong similarity between findings from Chapters 2 and 3 findings in terms of the crucial role of aggregate demand shocks' contribution to real commodity prices and real stock returns. Since stock exchange data are limited to the largest open economies, a natural an extension to this chapter is the investigation of a larger number of Latin American economies, including the small open economies. I now proceed to Chapter 4, in which I analyze the trade-growth nexus in Latin American using a threshold technique for a panel with 14 Latin American countries.

Table 3.1
List of Individual Stocks.

Company	**Exchange/Ticker**	**Related Commodity produced by firm**	**Brief description**
Petrobras	IBOV: PETR4	Crude Oil	Multinational corporation in the petroleum industry from Brazil.
YPF	BCBA: YPFD	Crude Oil	The largest oil and gas company in Argentina.
Empresas Copec	BCS: COPEC	Crude Oil	Chilean energy and forestry company with a chain of gas stations in Chile.
Southern Copper Corporation	BVL: SCCO	Copper	SCC has operations in Peru and Mexico. It is the fifth largest copper-producing company in the world (Investingnews, 2016).
Antofagasta	LSE: ANTO	Copper	Antofagasta is one of the major copper producers in the world, with its activities concentrated mainly in Chile.

Table 3.2
Unit Root Tests.

Variables	ADF (*k*) Without trend	ADF (*k*) With Trend	KPSS (4) Without trend	KPSS (4) With Trend	MZ_{α} (*k*) Without trend	MZ_{α} (*k*) With Trend	MZ_t (*k*) Without trend	MZ_t (*k*) With Trend
Individual stock returns								
Crude oil								
Petrobras (PETR4)	-4.34 (13)***	-5.02 (13)***	0.35	0.06	-40.40 (1)***	-74.63 (1)***	-4.49 (1)***	-6.09 (1)***
YPF (YPFD)	-14.33 (0)***	-14.31 (0)***	0.06	0.04	-62.95 (6)***	-85.19 (6)***	-5.60 (6)***	-6.52 (6)***
Empresas Copec (COPEC)	-4.71 (13)***	-4.69 (13)***	0.11	0.11	-54.05 (6)***	-98.29 (6)***	-5.13 (6)***	-7.01 (6)***
Copper								
S. Copper Corp (SCCO)	-15.78 (0)***	-15.75 (0)***	0.12	0.12	-63.49 (4)***	-105.6 (4)***	-5.61 (4)***	-7.27 (4)***
Antofagasta (ANTO)	-17.13 (0)***	-17.14 (0)***	0.19	0.15	-87.34 (0)***	-109.6 (0)***	-6.61 (0)***	-7.40 (0)***

Notes: To save space, I do not show the unit root results of the first log differences of global commodity production, global real economic activity from the previous chapter, which are already reported in Chapter II. The null hypothesis for ADF test is that the time series has a unit root, while the null hypothesis for KPSS test is that the time series is stationary. The optimal lag length for the ADF test is shown between parentheses and is determined by data dependent procedure based on Campbell and Perron (1991). The KPSS test adopts a lag truncation parameter k= 4. I report two of the M-tests developed by Ng and Perron (2001) with the Bartlett Kernel used for lag selection. The critical values for the ADF test are: a) without trend: 1% = –3.45, 5% = –2.87, 10% = −2.56, b) with trend: 1% = –3.99, 5% = –3.42, 10% = –3.13. The critical values for the KPSS test are: a) without trend: 1% = 0.739, 5% = 0.463, 10% = 0.347, b) with trend: 1% = 0.216, 5% = 0.146, 10% = 0.119. The critical values for the MZ_{α} test are: a) without trend: 1% =-13.80, 5% =-8.10, 10% =-5.70, b) with trend: 1% =-23.80, 5% =-17.30, 10% =-14.20. The critical values for the MZ_t test are: a) without trend: 1% =-2.58, 5% =-1.98, 10% =-1.62, b) with trend: 1% =-3.42, 5% =-2.91, 10% =-2.62. *** Rejection of the null at the 1% level; ** Rejection of the null at the 5% level.

Table 3.3
Oil Shocks on Real Stocks Returns: Variance Decomposition Tests.

Panel A: Latin America (SPLAC40 index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (10)				
1	0.82 (1.19)	2.91 (2.18)	5.23 (2.82)	91.04 (3.61)
6	2.41 (2.05)	5.35 (2.91)	6.47 (2.98)	85.77 (4.36)
12	2.42 (2.05)	5.36 (2.91)	6.47 (2.98)	85.75 (4.36)
18	2.42 (2.05)	5.36 (2.91)	6.47 (2.98)	85.75 (4.36)
24	2.42 (2.05)	5.36 (2.91)	6.47 (2.98)	85.75 (4.36)
Pre-Boom period 1997 – 2002 (17)				
1	0.26 (1.20)	0.31 (1.30)	0.67 (1.91)	98.76 (2.59)
6	3.80 (3.50)	5.92 (4.68)	4.18 (3.14)	86.11 (6.78)
12	3.92 (3.57)	6.19 (4.93)	4.30 (3.23)	85.59 (7.14)
18	3.93 (3.58)	6.20 (4.94)	4.31 (3.23)	85.57 (7.16)
24	3.93 (3.58)	6.20 (4.94)	4.31 (3.23)	85.57 (7.16)
Boom period 2003 – 2010 (18)				
1	1.44 (2.42)	9.65 (5.69)	6.42 (4.56)	82.49 (7.05)
6	5.74 (4.00)	24.68 (7.04)	8.39 (4.26)	61.19 (7.86)
12	5.79 (3.95)	24.56 (6.91)	8.59 (4.32)	61.06 (7.90)
18	5.79 (3.95)	24.56 (6.91)	8.59 (4.32)	61.05 (7.91)
24	5.79 (3.95)	24.56 (6.91)	8.59 (4.32)	61.05 (7.91)
Post-Boom period 2011 – 2015 (14)				
1	2.72 (4.14)	1.74 (3.31)	8.19 (6.63)	87.34 (8.02)
6	7.02 (6.03)	5.82 (5.56)	8.46 (6.32)	78.70 (9.38)
12	7.19 (6.14)	5.79 (5.51)	8.49 (6.30)	78.53 (9.43)
18	7.19 (6.15)	5.79 (5.51)	8.49 (6.30)	78.52 (9.43)
24	7.19 (6.15)	5.79 (5.51)	8.49 (6.30)	78.52 (9.43)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.3 – Continued)

Panel B: Argentina (Merval index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (13)				
1	0.03 (0.24)	1.72 (1.81)	1.44 (1.65)	96.81 (2.43)
6	2.33 (2.08)	3.95 (2.75)	1.69 (1.61)	92.02 (3.77)
12	2.33 (2.08)	3.96 (2.76)	1.69 (1.61)	92.02 (3.77)
18	2.33 (2.08)	3.96 (2.76)	1.69 (1.61)	92.02 (3.77)
24	2.33 (2.08)	3.96 (2.76)	1.69 (1.61)	92.02 (3.77)
Pre-Boom period 1997 – 2002 (8)				
1	0.15 (0.90)	4.35 (4.70)	0.00 (0.15)	95.49 (4.78)
6	3.64 (4.32)	6.74 (5.61)	2.20 (2.97)	87.42 (7.43)
12	3.64 (4.32)	6.74 (5.61)	2.21 (2.97)	87.41 (7.43)
18	3.64 (4.32)	6.74 (5.61)	2.21 (2.97)	87.41 (7.43)
24	3.64 (4.32)	6.74 (5.61)	2.21 (2.97)	87.41 (7.43)
Boom period 2003 – 2010 (14)				
1	0.00 (0.10)	9.45 (5.68)	6.33 (4.58)	84.22 (6.83)
6	3.93 (3.46)	10.78 (5.86)	6.26 (4.32)	79.03 (7.50)
12	3.94 (3.47)	10.80 (5.85)	6.26 (4.31)	79.00 (7.50)
18	3.94 (3.47)	10.80 (5.85)	6.26 (4.31)	79.00 (7.50)
24	3.94 (3.47)	10.80 (5.85)	6.26 (4.31)	79.00 (7.50)
Post-Boom period 2011 – 2015 (16)				
1	0.05 (0.72)	0.31 (1.88)	5.10 (7.23)	94.55 (7.46)
6	2.63 (4.81)	6.97 (8.22)	4.75 (6.51)	85.65 (11.06)
12	2.65 (4.79)	7.11 (8.45)	4.86 (6.54)	85.38 (11.31)
18	2.65 (4.79)	7.11 (8.45)	4.87 (6.54)	85.37 (11.32)
24	2.65 (4.79)	7.11 (8.45)	4.87 (6.54)	85.37 (11.32)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.3 – Continued)

Panel C: YPF				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (18)				
1	1.47 (1.68)	0.29 (0.75)	0.02 (0.18)	98.22 (1.84)
6	2.12 (1.81)	9.37 (3.77)	2.30 (1.78)	86.21 (4.37)
12	2.17 (1.80)	9.98 (3.92)	2.68 (1.82)	85.17 (4.62)
18	2.17 (1.80)	9.98 (3.91)	2.69 (1.83)	85.16 (4.63)
24	2.17 (1.80)	9.98 (3.91)	2.69 (1.83)	85.16 (4.63)
Pre-Boom period 1997 – 2002 (21)				
1	3.29 (4.14)	1.87 (3.11)	0.06 (0.55)	94.78 (5.11)
6	4.70 (4.09)	17.75 (7.33)	12.89 (6.93)	64.65 (9.29)
12	6.25 (4.75)	20.65 (8.56)	13.89 (7.17)	59.22 (10.45)
18	6.29 (4.81)	20.94 (8.78)	14.01 (7.23)	58.75 (10.74)
24	6.30 (4.83)	21.01 (8.83)	14.05 (7.24)	58.64 (10.84)
Boom period 2003 – 2010 (20)				
1	0.09 (0.61)	2.48 (3.13)	0.24 (0.98)	97.19 (3.32)
6	4.79 (3.47)	17.41 (6.46)	2.68 (2.34)	75.12 (7.23)
12	4.81 (3.33)	17.64 (6.27)	4.23 (2.78)	73.31 (7.41)
18	4.83 (3.32)	17.81 (6.33)	4.30 (2.84)	73.06 (7.52)
24	4.83 (3.32)	17.81 (6.33)	4.32 (2.86)	73.04 (7.53)
Post-Boom period 2011 – 2015 (22)				
1	4.87 (7.10)	1.08 (3.38)	1.91 (4.45)	92.14 (8.73)
6	10.62 (9.44)	30.04 (11.60)	12.13 (7.73)	47.22 (10.91)
12	11.43 (10.33)	30.79 (11.86)	13.21 (8.02)	44.58 (10.93)
18	11.49 (10.62)	30.86 (11.99)	13.37 (8.24)	44.28 (11.03)
24	11.50 (10.71)	30.87 (12.00)	13.41 (8.31)	44.22 (11.06)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.3 – Continued)

Panel D: Brazil (Bovespa index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (14)				
1	0.21 (0.61)	1.13 (1.39)	1.90 (1.78)	96.76 (2.31)
6	3.03 (2.14)	1.50 (1.57)	2.72 (2.00)	92.75 (3.26)
12	3.10 (2.17)	1.52 (1.57)	2.73 (2.00)	92.65 (3.30)
18	3.10 (2.17)	1.52 (1.57)	2.73 (2.00)	92.65 (3.30)
24	3.10 (2.17)	1.52 (1.57)	2.73 (2.00)	92.65 (3.30)
Pre-Boom period 1997 – 2002 (21)				
1	2.83 (3.85)	0.19 (1.02)	0.02 (0.35)	96.95 (3.99)
6	10.00 (6.10)	5.10 (4.42)	2.86 (3.23)	82.04 (7.97)
12	10.12 (6.14)	5.77 (4.52)	3.18 (3.27)	80.93 (8.37)
18	10.12 (6.15)	5.82 (4.54)	3.19 (3.28)	80.88 (8.39)
24	10.12 (6.15)	5.82 (4.54)	3.19 (3.28)	80.87 (8.39)
Boom period 2003 – 2010 (21)				
1	0.35 (1.21)	7.19 (5.07)	6.73 (4.75)	85.73 (6.61)
6	12.78 (5.54)	7.28 (4.62)	9.08 (4.77)	70.86 (7.37)
12	13.73 (5.74)	7.76 (4.72)	9.19 (4.71)	69.32 (7.67)
18	13.75 (5.75)	7.76 (4.72)	9.26 (4.75)	69.23 (7.72)
24	13.75 (5.75)	7.76 (4.72)	9.27 (4.75)	69.23 (7.72)
Post-Boom period 2011 – 2015 (22)				
1	0.87 (2.39)	2.18 (3.71)	11.69 (7.68)	85.26 (8.45)
6	5.16 (4.42)	5.92 (5.34)	12.28 (7.32)	76.64 (9.08)
12	5.11 (4.31)	7.95 (6.16)	11.76 (6.95)	75.17 (9.09)
18	5.17 (4.34)	8.14 (6.27)	11.78 (6.91)	74.91 (9.17)
24	5.17 (4.34)	8.20 (6.32)	11.77 (6.91)	74.86 (9.19)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.3 – Continued)

Panel E: Petrobras				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (16)				
1	1.86 (1.77)	0.00 (0.08)	8.64 (3.52)	89.49 (3.84)
6	2.97 (2.15)	2.06 (1.77)	12.31 (4.01)	82.66 (4.56)
12	2.97 (2.15)	2.18 (1.78)	12.30 (4.00)	82.55 (4.58)
18	2.97 (2.15)	2.18 (1.78)	12.30 (4.00)	82.55 (4.58)
24	2.97 (2.15)	2.18 (1.78)	12.30 (4.00)	82.55 (4.58)
Pre-Boom period 1997 – 2002 (17)				
1	2.55 (3.67)	2.19 (3.37)	1.24 (2.53)	94.02 (5.42)
6	8.82 (5.96)	12.84 (6.46)	4.05 (3.99)	74.28 (8.69)
12	9.13 (6.06)	13.20 (6.34)	4.21 (3.96)	73.46 (8.83)
18	9.13 (6.05)	13.22 (6.34)	4.21 (3.96)	73.44 (8.84)
24	9.13 (6.05)	13.22 (6.34)	4.21 (3.96)	73.44 (8.84)
Boom period 2003 – 2010 (19)				
1	0.05 (0.47)	3.92 (3.88)	11.11 (5.93)	84.91 (6.73)
6	4.54 (3.37)	7.60 (4.19)	11.67 (4.41)	76.19 (6.33)
12	5.15 (3.76)	7.69 (4.18)	11.79 (4.32)	75.37 (6.46)
18	5.16 (3.76)	7.68 (4.18)	11.79 (4.32)	75.38 (6.46)
24	5.16 (3.76)	7.68 (4.18)	11.79 (4.32)	75.37 (6.46)
Post-Boom period 2011 – 2015 (22)				
1	0.08 (0.71)	1.69 (3.30)	18.15 (8.93)	80.08 (9.23)
6	2.70 (3.70)	4.78 (4.42)	24.40 (9.45)	68.12 (9.79)
12	3.61 (4.31)	7.49 (6.40)	23.96 (9.48)	64.95 (10.08)
18	3.64 (4.38)	7.79 (6.81)	23.87 (9.51)	64.70 (10.22)
24	3.64 (4.39)	7.83 (6.87)	23.87 (9.52)	64.66 (10.25)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.3 – Continued)

Panel F: Chile (Santiago Stock Exchange index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (14)				
1	1.12 (1.38)	2.23 (1.92)	1.17 (1.39)	95.48 (2.69)
6	2.86 (2.03)	3.50 (2.44)	2.43 (1.90)	91.22 (3.60)
12	2.88 (2.04)	3.51 (2.45)	2.43 (1.90)	91.19 (3.61)
18	2.88 (2.04)	3.51 (2.45)	2.43 (1.90)	91.18 (3.61)
24	2.88 (2.04)	3.51 (2.45)	2.43 (1.90)	91.18 (3.61)
Pre-Boom period 1997 – 2002 (19)				
1	1.08 (2.43)	0.03 (0.38)	0.67 (1.91)	98.22 (3.09)
6	8.13 (5.11)	6.07 (5.15)	2.89 (3.00)	82.91 (8.09)
12	8.39 (5.24)	6.62 (5.12)	3.10 (3.10)	81.89 (8.41)
18	8.44 (5.28)	6.64 (5.12)	3.10 (3.09)	81.83 (8.44)
24	8.44 (5.29)	6.64 (5.12)	3.10 (3.09)	81.82 (8.44)
Boom period 2003 – 2010 (16)				
1	1.55 (2.50)	19.48 (7.20)	0.33 (1.03)	78.64 (7.42)
6	9.77 (5.15)	17.74 (6.65)	4.94 (3.73)	67.55 (7.61)
12	10.00 (5.00)	18.53 (6.51)	5.14 (3.72)	66.34 (7.70)
18	10.01 (5.00)	18.52 (6.51)	5.15 (3.72)	66.31 (7.70)
24	10.01 (5.00)	18.52 (6.51)	5.15 (3.72)	66.31 (7.70)
Post-Boom period 2011 – 2015 (20)				
1	0.16 (1.02)	4.16 (5.05)	0.15 (0.97)	95.53 (5.21)
6	16.94 (9.17)	11.32 (6.95)	1.48 (1.87)	70.27 (10.25)
12	16.44 (8.89)	14.06 (7.91)	1.71 (2.00)	67.79 (10.57)
18	16.46 (8.88)	14.12 (7.92)	1.73 (2.00)	67.69 (10.59)
24	16.46 (8.88)	14.12 (7.92)	1.73 (2.00)	67.68 (10.59)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.3 – Continued)

Panel G: Empresas Copec				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (11)				
1	0.91 (1.25)	0.65 (1.06)	2.75 (2.12)	95.69 (2.63)
6	2.09 (1.61)	2.04 (1.73)	4.56 (2.50)	91.39 (3.37)
12	2.01 (1.61)	2.17 (1.77)	4.57 (2.50)	91.24 (3.41)
18	2.01 (1.61)	2.17 (1.77)	4.57 (2.50)	91.24 (3.41)
24	2.01 (1.61)	2.17 (1.77)	4.57 (2.50)	91.24 (3.41)
Pre-Boom period 1997 – 2002 (19)				
1	0.05 (0.54)	0.00 (0.07)	2.72 (3.78)	97.23 (3.81)
6	6.23 (4.38)	4.64 (3.87)	6.78 (4.59)	82.35 (7.77)
12	6.29 (4.35)	4.94 (3.85)	6.81 (4.58)	81.95 (7.86)
18	6.30 (4.36)	4.97 (3.85)	6.82 (4.58)	81.92 (7.88)
24	6.30 (4.36)	4.97 (3.85)	6.82 (4.58)	81.91 (7.88)
Boom period 2003 – 2010 (19)				
1	2.10 (2.90)	11.80 (6.12)	0.58 (1.43)	85.52 (6.64)
6	5.20 (4.28)	12.65 (5.51)	7.66 (4.49)	74.49 (7.11)
12	5.70 (4.23)	13.11 (5.27)	8.51 (4.72)	72.68 (7.38)
18	5.75 (4.23)	13.11 (5.27)	8.51 (4.72)	72.62 (7.40)
24	5.76 (4.23)	13.11 (5.27)	8.51 (4.73)	72.62 (7.40)
Post-Boom period 2011 – 2015 (21)				
1	0.00 (0.16)	4.84 (5.40)	7.09 (6.23)	88.07 (7.85)
6	19.77 (9.55)	6.87 (5.57)	5.79 (4.70)	67.56 (10.38)
12	20.11 (9.54)	7.20 (5.60)	5.78 (4.69)	66.91 (10.41)
18	20.11 (9.55)	7.22 (5.60)	5.78 (4.68)	66.89 (10.41)
24	20.11 (9.55)	7.23 (5.60)	5.78 (4.68)	66.89 (10.41)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.3 – Continued)

Panel H: Mexico (IPC index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (15)				
1	0.38 (0.81)	0.96 (1.29)	5.31 (2.87)	93.35 (3.19)
6	3.13 (2.17)	3.42 (2.32)	5.38 (2.73)	88.07 (3.98)
12	3.13 (2.18)	3.50 (2.38)	5.43 (2.72)	87.94 (4.01)
18	3.13 (2.18)	3.50 (2.38)	5.43 (2.72)	87.94 (4.01)
24	3.13 (2.18)	3.50 (2.38)	5.43 (2.72)	87.94 (4.01)
Pre-Boom period 1997 – 2002 (19)				
1	0.02 (0.34)	0.24 (1.14)	0.51 (1.68)	99.23 (2.05)
6	12.29 (7.13)	13.55 (6.92)	2.69 (2.95)	71.47 (9.59)
12	12.49 (7.16)	14.97 (7.07)	3.34 (3.11)	69.20 (10.06)
18	12.48 (7.15)	15.06 (7.09)	3.35 (3.12)	69.11 (10.10)
24	12.48 (7.15)	15.06 (7.09)	3.36 (3.12)	69.10 (10.10)
Boom period 2003 – 2010 (20)				
1	3.06 (3.46)	6.30 (4.73)	7.57 (4.94)	83.06 (6.98)
6	8.33 (5.28)	9.49 (5.41)	7.22 (4.59)	74.96 (7.51)
12	9.12 (5.65)	9.99 (5.51)	7.41 (4.52)	73.48 (7.74)
18	9.22 (5.70)	9.99 (5.51)	7.40 (4.52)	73.39 (7.77)
24	9.23 (5.70)	9.99 (5.51)	7.40 (4.52)	73.39 (7.77)
Post-Boom period 2011 – 2015 (20)				
1	2.92 (4.28)	1.30 (2.87)	15.36 (8.39)	80.42 (9.19)
6	7.52 (6.31)	12.06 (8.39)	14.17 (6.73)	66.25 (10.22)
12	7.29 (6.24)	14.54 (10.13)	13.57 (6.60)	64.60 (10.82)
18	7.27 (6.23)	14.74 (10.38)	13.53 (6.60)	64.46 (10.91)
24	7.27 (6.23)	14.77 (10.42)	13.52 (6.60)	64.44 (10.93)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

Table 3.4
Copper Shocks on Real Stocks Returns: Variance Decomposition Tests.

Panel A: Latin America (SPLAC40 index)

Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period				
1997 – 2015 (12)				
1	1.20 (1.43)	2.64 (2.08)	0.23 (0.62)	95.93 (2.56)
6	2.34 (1.88)	5.49 (2.97)	6.45 (2.85)	85.72 (4.27)
12	2.42 (1.90)	5.54 (2.98)	6.47 (2.86)	85.57 (4.29)
18	2.43 (1.91)	5.54 (2.98)	6.47 (2.87)	85.56 (4.30)
24	2.43 (1.91)	5.54 (2.98)	6.47 (2.87)	85.56 (4.30)
Pre-Boom period				
1997 – 2002 (16)				
1	0.10 (0.76)	0.63 (1.85)	0.48 (1.61)	98.73 (2.56)
6	8.35 (5.66)	8.07 (5.28)	6.88 (5.08)	76.70 (8.40)
12	8.60 (5.79)	8.87 (5.32)	7.02 (5.02)	75.51 (8.76)
18	8.62 (5.81)	8.86 (5.31)	7.04 (5.02)	75.48 (8.78)
24	8.62 (5.81)	8.86 (5.31)	7.04 (5.02)	75.48 (8.78)
Boom period				
2003 – 2010 (17)				
1	3.56 (3.72)	8.24 (5.28)	0.02 (0.28)	88.17 (6.19)
6	2.60 (2.69)	30.52 (7.81)	6.89 (4.14)	59.99 (7.91)
12	2.76 (2.73)	30.66 (7.80)	7.03 (4.12)	59.55 (7.94)
18	2.78 (2.74)	30.66 (7.81)	7.03 (4.12)	59.53 (7.94)
24	2.78 (2.74)	30.66 (7.81)	7.03 (4.12)	59.53 (7.94)
Post-Boom period				
2011 – 2015 (21)				
1	1.03 (2.59)	0.09 (0.76)	1.26 (2.85)	97.62 (3.89)
6	2.97 (3.71)	3.07 (4.14)	7.64 (5.49)	86.32 (7.50)
12	3.12 (3.71)	4.11 (4.68)	8.64 (5.79)	84.12 (8.43)
18	3.17 (3.76)	4.31 (4.79)	8.66 (5.79)	83.87 (8.61)
24	3.18 (3.76)	4.33 (4.81)	8.66 (5.79)	83.84 (8.64)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.4 – Continued)

Panel B: Chile (Santiago Stock Exchange index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (12)				
1	0.07 (0.36)	2.33 (1.97)	0.85 (1.20)	96.74 (2.31)
6	0.59 (0.95)	3.57 (2.49)	1.67 (1.62)	94.17 (3.03)
12	0.69 (1.03)	3.59 (2.50)	1.67 (1.61)	94.05 (3.08)
18	0.69 (1.04)	3.59 (2.50)	1.67 (1.61)	94.05 (3.08)
24	0.69 (1.04)	3.59 (2.50)	1.67 (1.61)	94.05 (3.08)
Pre-Boom period 1997 – 2002 (19)				
1	0.65 (1.88)	0.00 (0.16)	13.94 (7.44)	85.41 (7.69)
6	8.74 (5.78)	6.93 (5.28)	13.14 (6.44)	71.20 (8.88)
12	9.29 (5.90)	7.37 (5.27)	13.33 (6.44)	70.00 (9.07)
18	9.32 (5.92)	7.38 (5.26)	13.37 (6.44)	69.93 (9.08)
24	9.33 (5.92)	7.38 (5.26)	13.37 (6.44)	69.93 (9.09)
Boom period 2003 – 2010 (16)				
1	0.09 (0.61)	17.41 (7.03)	0.54 (1.36)	81.95 (7.11)
6	1.92 (2.21)	18.55 (6.93)	5.43 (4.15)	74.11 (7.59)
12	2.37 (2.43)	19.10 (6.85)	5.42 (4.11)	73.11 (7.82)
18	2.39 (2.45)	19.10 (6.85)	5.42 (4.11)	73.10 (7.82)
24	2.39 (2.45)	19.10 (6.85)	5.42 (4.11)	73.10 (7.82)
Post-Boom period 2011 – 2015 (20)				
1	2.34 (3.86)	0.00 (0.13)	0.34 (1.48)	97.31 (4.12)
6	4.99 (5.43)	8.78 (5.75)	1.29 (2.87)	84.94 (8.02)
12	5.43 (5.76)	10.83 (7.00)	2.19 (3.44)	81.55 (9.69)
18	5.49 (5.81)	10.83 (6.99)	2.28 (3.51)	81.40 (9.80)
24	5.51 (5.82)	10.83 (6.99)	2.29 (3.52)	81.37 (9.82)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.4 – Continued)

Panel C: Southern Copper Corporation				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (15)				
1	0.00 (0.08)	1.82 (1.75)	0.93 (1.25)	97.25 (2.13)
6	0.36 (0.71)	2.68 (2.09)	4.92 (2.74)	92.04 (3.47)
12	0.38 (0.77)	2.76 (2.14)	4.91 (2.73)	91.95 (3.50)
18	0.38 (0.77)	2.76 (2.14)	4.91 (2.73)	91.95 (3.51)
24	0.38 (0.77)	2.76 (2.14)	4.91 (2.73)	91.95 (3.51)
Pre-Boom period 1997 – 2002 (19)				
1	4.21 (4.63)	6.07 (5.34)	12.94 (7.00)	76.78 (8.72)
6	7.53 (5.39)	10.07 (5.90)	12.25 (5.94)	70.14 (8.48)
12	8.00 (5.55)	10.27 (5.75)	13.09 (5.94)	68.64 (8.44)
18	8.01 (5.55)	10.26 (5.75)	13.09 (5.94)	68.64 (8.44)
24	8.01 (5.55)	10.26 (5.75)	13.10 (5.94)	68.63 (8.44)
Boom period 2003 – 2010 (18)				
1	1.64 (2.57)	13.75 (6.48)	0.52 (1.35)	84.09 (6.85)
6	2.44 (2.51)	16.77 (6.75)	10.05 (5.59)	70.74 (7.85)
12	2.60 (2.59)	17.12 (6.79)	10.11 (5.55)	70.17 (7.88)
18	2.61 (2.60)	17.12 (6.79)	10.11 (5.54)	70.17 (7.88)
24	2.61 (2.60)	17.12 (6.79)	10.11 (5.54)	70.17 (7.88)
Post-Boom period 2011 – 2015 (20)				
1	0.09 (0.76)	0.75 (2.22)	1.74 (3.33)	97.43 (4.04)
6	2.27 (3.04)	3.74 (4.98)	5.84 (4.22)	88.14 (6.91)
12	3.47 (4.96)	4.13 (5.75)	6.12 (3.97)	86.27 (8.15)
18	4.10 (5.86)	4.12 (5.76)	6.18 (3.92)	85.61 (8.75)
24	4.19 (5.98)	4.13 (5.75)	6.19 (3.92)	85.49 (8.86)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Continued)

(Table 3.4 – Continued)

Panel D: Antofagasta				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (11)				
1	0.05 (0.31)	2.00 (1.83)	1.84 (1.74)	96.11 (2.51)
6	0.50 (0.78)	2.32 (1.96)	5.19 (2.81)	91.98 (3.41)
12	0.56 (0.85)	2.42 (2.00)	5.19 (2.81)	91.83 (3.47)
18	0.56 (0.85)	2.42 (2.00)	5.19 (2.81)	91.82 (3.48)
24	0.56 (0.85)	2.42 (2.00)	5.19 (2.81)	91.82 (3.48)
Pre-Boom period 1997 – 2002 (15)				
1	0.63 (1.86)	4.30 (4.66)	4.40 (4.61)	90.68 (6.52)
6	2.20 (2.81)	8.94 (5.96)	14.98 (7.21)	73.88 (8.84)
12	2.35 (2.79)	9.14 (5.89)	15.35 (7.25)	73.16 (8.96)
18	2.37 (2.81)	9.15 (5.89)	15.36 (7.26)	73.12 (8.97)
24	2.37 (2.81)	9.15 (5.89)	15.36 (7.26)	73.12 (8.97)
Boom period 2003 – 2010 (13)				
1	0.21 (0.94)	12.24 (6.26)	0.12 (0.66)	87.43 (6.33)
6	1.28 (2.07)	14.23 (6.19)	3.29 (3.34)	81.20 (6.93)
12	1.42 (2.18)	14.64 (6.25)	3.46 (3.41)	80.49 (7.17)
18	1.42 (2.19)	14.64 (6.25)	3.46 (3.41)	80.48 (7.17)
24	1.42 (2.19)	14.64 (6.25)	3.46 (3.41)	80.48 (7.17)
Post-Boom period 2011 – 2015 (21)				
1	0.42 (1.66)	0.59 (1.97)	5.27 (5.59)	93.72 (6.06)
6	9.72 (6.68)	5.37 (5.41)	7.63 (5.93)	77.28 (9.68)
12	11.10 (7.73)	5.39 (5.21)	8.03 (5.95)	75.49 (10.44)
18	11.24 (7.85)	5.56 (5.24)	8.10 (5.92)	75.09 (10.67)
24	11.26 (7.86)	5.59 (5.26)	8.11 (5.92)	75.04 (10.70)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

Table 3.5
Coffee Shocks on Real Stocks Returns: Variance Decomposition Tests.

Panel A: Latin America (SPLAC40 index)

Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (14)				
1	0.28 (1.34)	2.53 (2.05)	1.27 (1.45)	95.92 (2.57)
6	1.18 (3.75)	4.91 (2.83)	2.90 (2.00)	91.02 (3.58)
12	1.36 (1.46)	4.96 (2.87)	2.90 (2.00)	90.78 (3.67)
18	1.39 (1.49)	4.96 (2.87)	2.90 (2.00)	90.75 (3.68)
24	1.39 (1.49)	4.96 (2.87)	2.90 (2.00)	90.75 (3.68)
Pre-Boom period 1997 – 2002 (21)				
1	1.90 (3.19)	0.13 (0.84)	4.46 (4.71)	93.51 (5.62)
6	4.00 (3.97)	6.22 (4.53)	12.12 (6.09)	77.66 (8.05)
12	4.42 (4.12)	6.31 (4.65)	12.19 (6.14)	77.08 (8.07)
18	4.63 (4.27)	6.32 (4.65)	12.21 (6.14)	76.84 (8.14)
24	4.72 (4.36)	6.32 (4.65)	12.21 (6.14)	76.76 (8.17)
Boom period 2003 – 2010 (17)				
1	0.47 (1.40)	8.57 (5.45)	1.54 (2.38)	89.42 (5.94)
6	1.51 (2.07)	24.69 (7.31)	2.88 (2.71)	70.93 (7.48)
12	2.37 (2.58)	24.52 (7.23)	3.04 (2.73)	70.07 (7.59)
18	2.52 (2.67)	24.49 (7.23)	3.11 (2.76)	69.89 (7.65)
24	2.52 (2.67)	24.49 (7.23)	3.11 (2.76)	69.88 (7.65)
Post-Boom period 2011 – 2015 (18)				
1	2.33 (3.85)	0.80 (2.27)	0.11 (0.85)	96.76 (4.50)
6	5.20 (5.03)	4.16 (4.96)	2.32 (3.42)	88.32 (7.48)
12	5.22 (4.80)	4.74 (5.33)	2.74 (3.46)	87.30 (7.71)
18	5.25 (4.80)	4.78 (5.36)	2.75 (3.48)	87.21 (7.75)
24	5.25 (4.80)	4.78 (5.36)	2.75 (3.48)	87.21 (7.75)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Table 3.5 – Continued)

Panel B: Colombia (COLCAP index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period				
1997 – 2015 (17)				
1	0.48 (0.92)	1.80 (1.74)	4.82 (2.74)	92.89 (3.28)
6	1.01 (1.13)	2.48 (2.17)	8.97 (3.87)	87.53 (4.39)
12	1.18 (1.28)	2.51 (2.18)	9.04 (3.88)	87.27 (4.45)
18	1.22 (1.33)	2.51 (2.18)	9.04 (3.88)	87.23 (4.46)
24	1.22 (1.33)	2.51 (2.18)	9.04 (3.88)	87.23 (4.46)
Pre-Boom period				
1997 – 2002 (19)				
1	1.34 (2.69)	0.04 (0.48)	8.61 (6.28)	90.00 (6.71)
6	1.55 (2.05)	21.78 (9.28)	9.42 (5.89)	67.24 (9.58)
12	2.90 (3.25)	21.40 (9.19)	9.30 (5.79)	66.39 (9.65)
18	3.38 (3.78)	21.27 (9.13)	9.32 (5.75)	66.04 (9.74)
24	3.38 (3.78)	21.27 (9.13)	9.32 (5.75)	66.04 (9.74)
Boom period				
2003 – 2010 (16)				
1	1.42 (2.40)	0.71 (1.70)	2.74 (3.25)	95.13 (4.29)
6	2.58 (2.95)	1.76 (2.43)	5.87 (4.75)	89.79 (5.84)
12	2.95 (3.39)	2.09 (2.78)	5.98 (4.80)	88.98 (6.31)
18	3.02 (3.47)	2.09 (2.79)	5.98 (4.79)	88.91 (6.35)
24	3.02 (3.47)	2.09 (2.79)	5.98 (4.79)	88.91 (6.35)
Post-Boom period				
2011 – 2015 (20)				
1	0.25 (1.29)	1.16 (2.75)	1.12 (2.68)	97.47 (4.00)
6	6.48 (5.28)	7.90 (6.79)	4.92 (5.66)	80.70 (9.22)
12	7.94 (6.33)	10.85 (8.43)	4.51 (5.22)	76.70 (10.49)
18	7.91 (6.27)	11.36 (8.94)	4.48 (5.17)	76.25 (10.73)
24	7.91 (6.27)	11.36 (8.94)	4.48 (5.17)	76.25 (10.73)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

(Table 3.5 – Continued)

Panel C: Brazil (Bovespa index)				
Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Entire period 1997 – 2015 (12)				
1	0.80 (1.18)	1.29 (1.48)	2.96 (2.19)	94.95 (2.83)
6	1.36 (1.44)	1.60 (1.63)	5.51 (2.89)	91.52 (3.52)
12	1.37 (1.45)	1.62 (1.64)	5.54 (2.89)	91.47 (3.54)
18	1.37 (1.45)	1.62 (1.64)	5.54 (2.89)	91.47 (3.54)
24	1.37 (1.45)	1.62 (1.64)	5.54 (2.89)	91.47 (3.54)
Pre-Boom period 1997 – 2002 (19)				
1	0.94 (2.26)	0.79 (2.06)	5.48 (5.17)	92.80 (5.87)
6	5.84 (4.98)	6.86 (4.95)	10.74 (5.44)	76.56 (8.11)
12	6.30 (4.96)	6.97 (4.92)	10.67 (5.43)	76.06 (8.14)
18	6.40 (4.98)	6.99 (4.91)	10.65 (5.42)	75.97 (8.15)
24	6.40 (4.98)	6.99 (4.91)	10.65 (5.42)	75.97 (8.15)
Boom period 2003 – 2010 (18)				
1	0.30 (1.11)	9.98 (5.80)	5.95 (4.44)	83.77 (6.89)
6	0.96 (1.83)	10.44 (5.95)	6.16 (4.28)	82.44 (7.00)
12	1.19 (2.05)	10.50 (5.94)	6.20 (4.28)	82.11 (7.08)
18	1.21 (2.08)	10.50 (5.94)	6.21 (4.28)	82.09 (7.09)
24	1.21 (2.08)	10.50 (5.94)	6.21 (4.28)	82.09 (7.09)
Post-Boom period 2011 – 2015 (21)				
1	7.31 (6.47)	2.78 (4.03)	5.04 (5.22)	84.88 (8.52)
6	13.30 (7.18)	4.96 (4.58)	6.04 (4.85)	75.69 (8.98)
12	14.40 (7.27)	6.85 (5.51)	6.39 (4.80)	72.37 (9.59)
18	14.62 (7.36)	6.92 (5.53)	6.39 (4.79)	72.07 (9.67)
24	14.63 (7.37)	6.94 (5.53)	6.39 (4.79)	72.03 (9.69)

Notes: Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

TABLE 3.6

Robustness Check: Variance Decomposition Tests for Different Commodity Shocks on Latin American Returns (SPLAC40 Index).

Months	Supply shock	Aggregate demand shock	Idiosyncratic demand shock	Shocks to stock returns
Real Price of Oil (9)				
1	0.84 (1.20)	2.79 (2.14)	4.90 (2.74)	91.46 (3.54)
6	2.41 (2.05)	5.47 (2.95)	6.51 (2.98)	85.62 (4.38)
12	2.41 (2.06)	5.48 (2.94)	6.52 (2.99)	85.59 (4.39)
18	2.41 (2.06)	5.48 (2.94)	6.52 (2.99)	85.59 (4.39)
24	2.41 (2.06)	5.48 (2.94)	6.52 (2.99)	85.59 (4.39)
Real Price of Copper (14)				
1	1.15 (1.40)	2.45 (2.01)	0.07 (0.33)	96.33 (2.44)
6	2.22 (1.79)	5.59 (2.99)	6.81 (2.85)	85.38 (4.26)
12	2.31 (1.81)	5.68 (3.02)	6.94 (2.90)	85.08 (4.32)
18	2.31 (1.81)	5.69 (3.02)	6.94 (2.90)	85.06 (4.32)
24	2.31 (1.81)	5.69 (3.02)	6.94 (2.90)	85.06 (4.32)
Real Price of Coffee (17)				
1	0.31 (0.73)	2.32 (1.97)	1.09 (1.35)	96.29 (2.46)
6	1.23 (1.35)	4.93 (2.83)	2.64 (1.91)	91.20 (3.56)
12	1.43 (1.50)	5.02 (2.89)	2.65 (1.91)	90.90 (3.67)
18	1.47 (1.53)	5.02 (2.89)	2.65 (2.51)	90.87 (3.68)
24	1.47 (1.53)	5.02 (2.89)	2.65 (2.51)	90.87 (3.68)

Notes: Entire period (1997-2015) adopting dummy variables for pre (1997-2002) and post (2011-2015) commodity boom periods. Standard errors appear in parentheses after the percentage of variance explained. The numbers in parentheses beside the time intervals represent the number of months until the variance decomposition reaches a constant value for all future periods.

TABLE 3.7

Summary Table: Variance Decomposition Test Results.

OIL SHOCKS

Aggregate supply shocks

	SPLAC40	**Argentina (Merval)**	**YPF**	**Brazil (Bovespa)**	**Petrobras**	**Chile (SSE)**	**Copec**	**Mexico (IPC)**
Overall	2.4	2.3	2.2	3.1	3.0	2.9	2.0	3.1
Commodity Boom	5.8	3.9	4.8	13.8	5.2	10.0	5.8	9.2
Aggregate demand shocks								
Overall	5.4	4.0	10.0	1.5	2.2	3.5	2.2	3.5
Commodity Boom	24.6	10.8	17.8	7.8	7.7	18.5	13.1	10.0

COPPER SHOCKS

Aggregate supply shocks

	SPLAC40	**Chile (SSE)**	**SCC**	**ANTO**
Overall	2.4	0.7	0.4	0.6
Commodity Boom	2.8	2.4	2.6	1.4
Aggregate demand shocks				
Overall	5.5	3.6	2.8	2.4
Commodity Boom	30.7	19.1	17.1	14.6

COFFEE SHOCKS

Aggregate supply shocks

	SPLAC40	**Colombia (COLCAP)**	**Brazil (Bovespa)**
Overall	1.4	1.2	1.4
Commodity Boom	2.5	3.0	1.2
Aggregate demand shocks			
Overall	5.0	2.5	1.6
Commodity Boom	24.5	2.1	10.5

Figure 3.1. Performance of the SPLAC40 Index from 1997 to 2015.

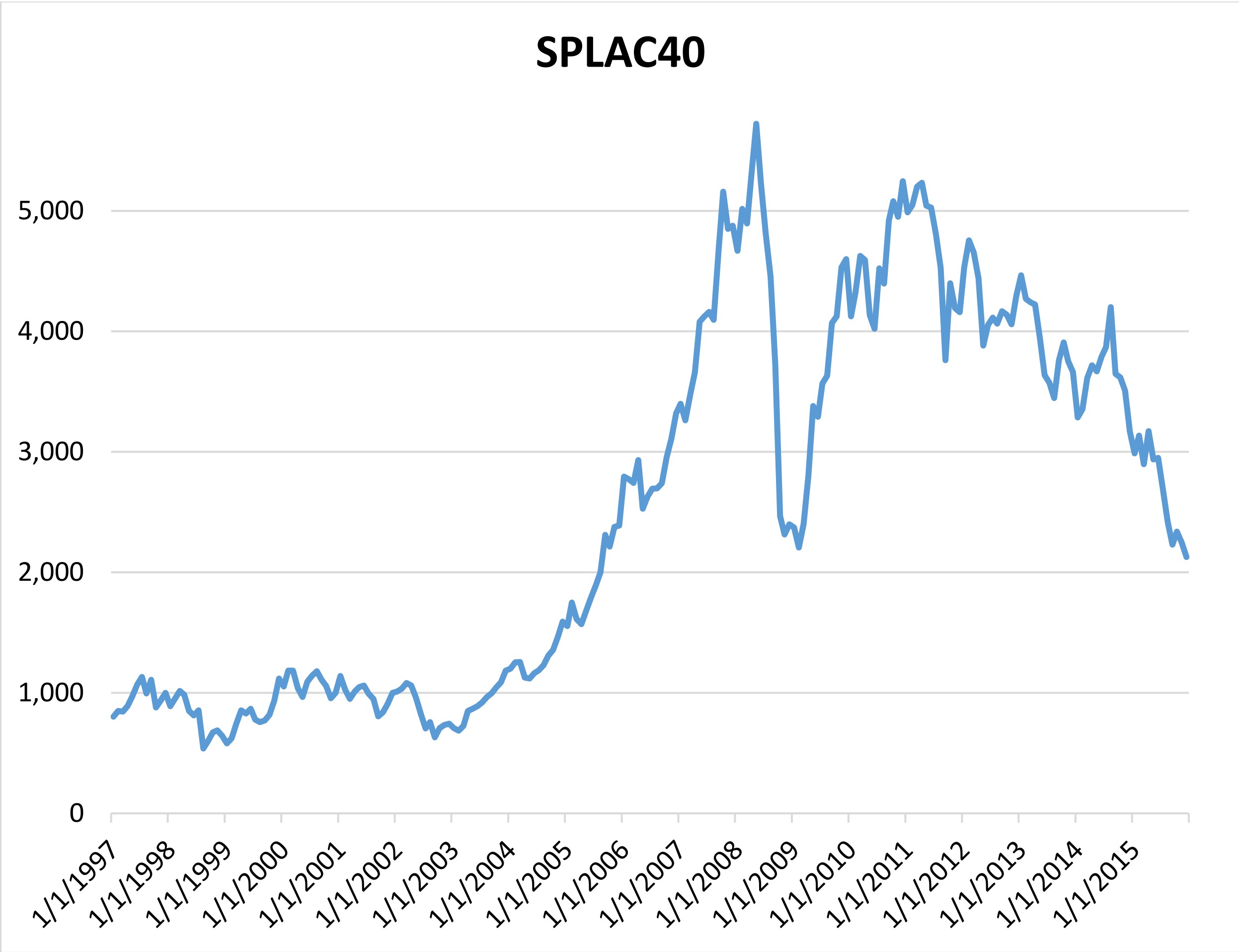


Figure 3.2. Prices of Selected Latin American Stock Exchange Indices from 1997 to 2015.

Figure 3.3. Prices of Selected Latin American Stocks from 1997 to 2015.

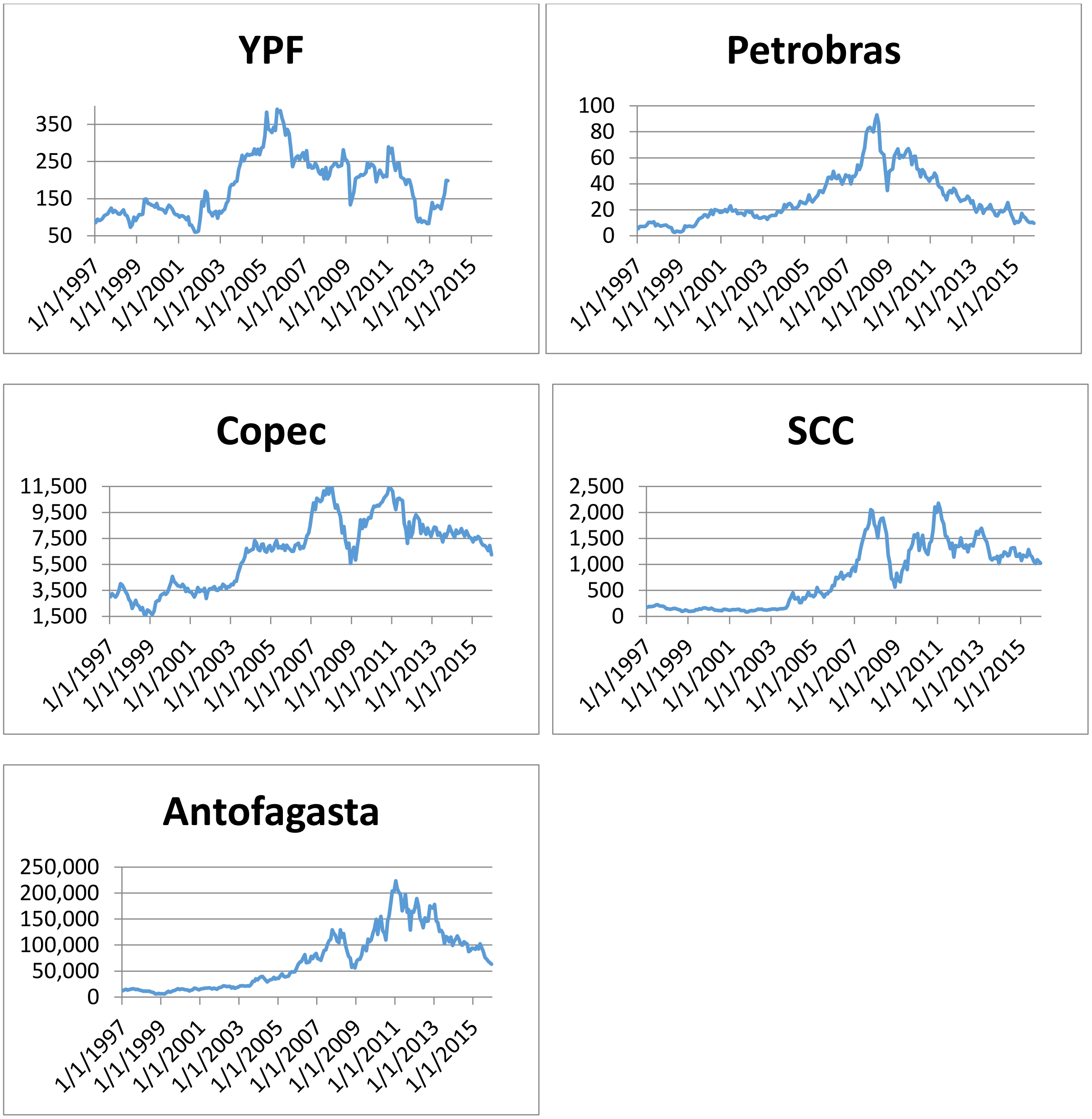
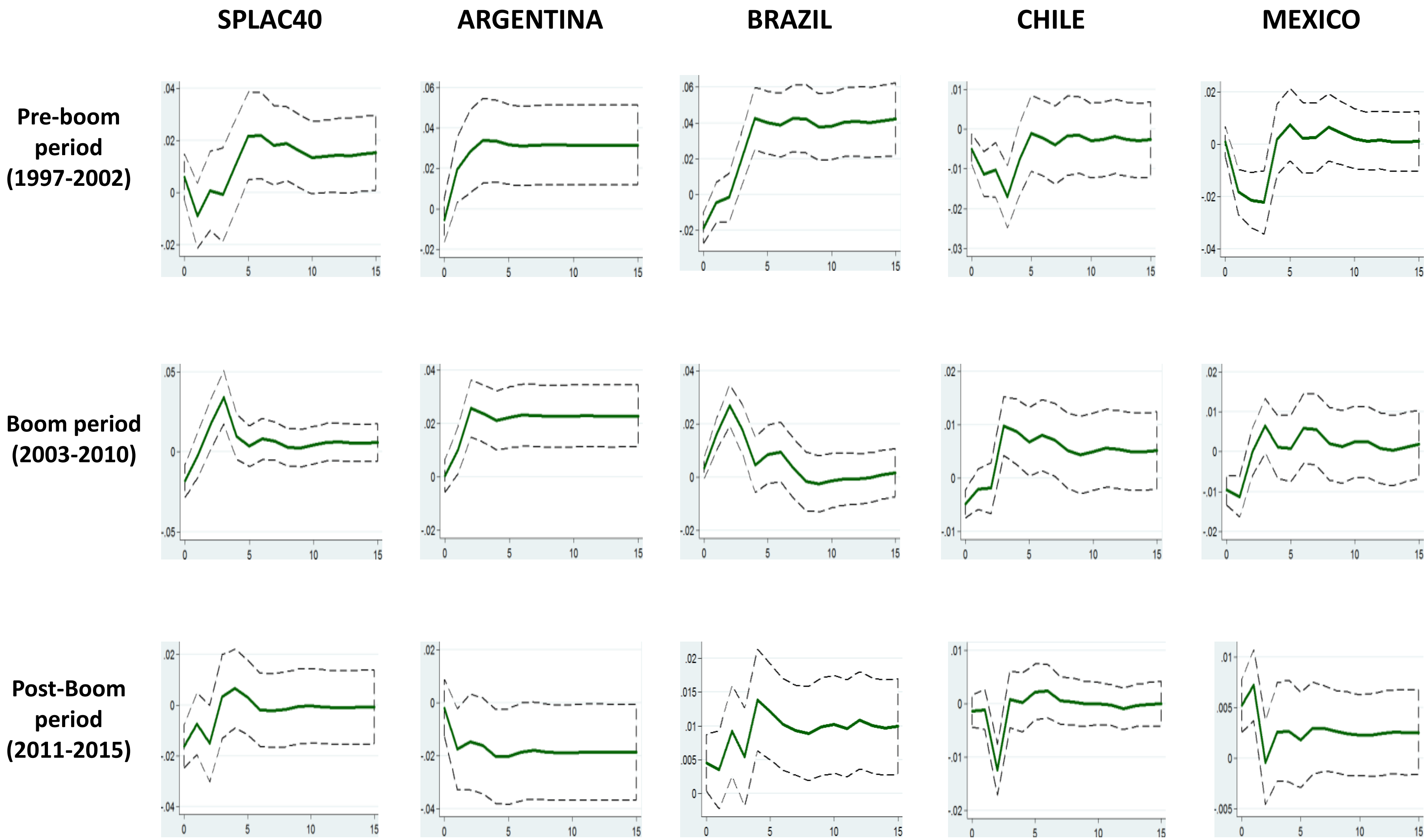
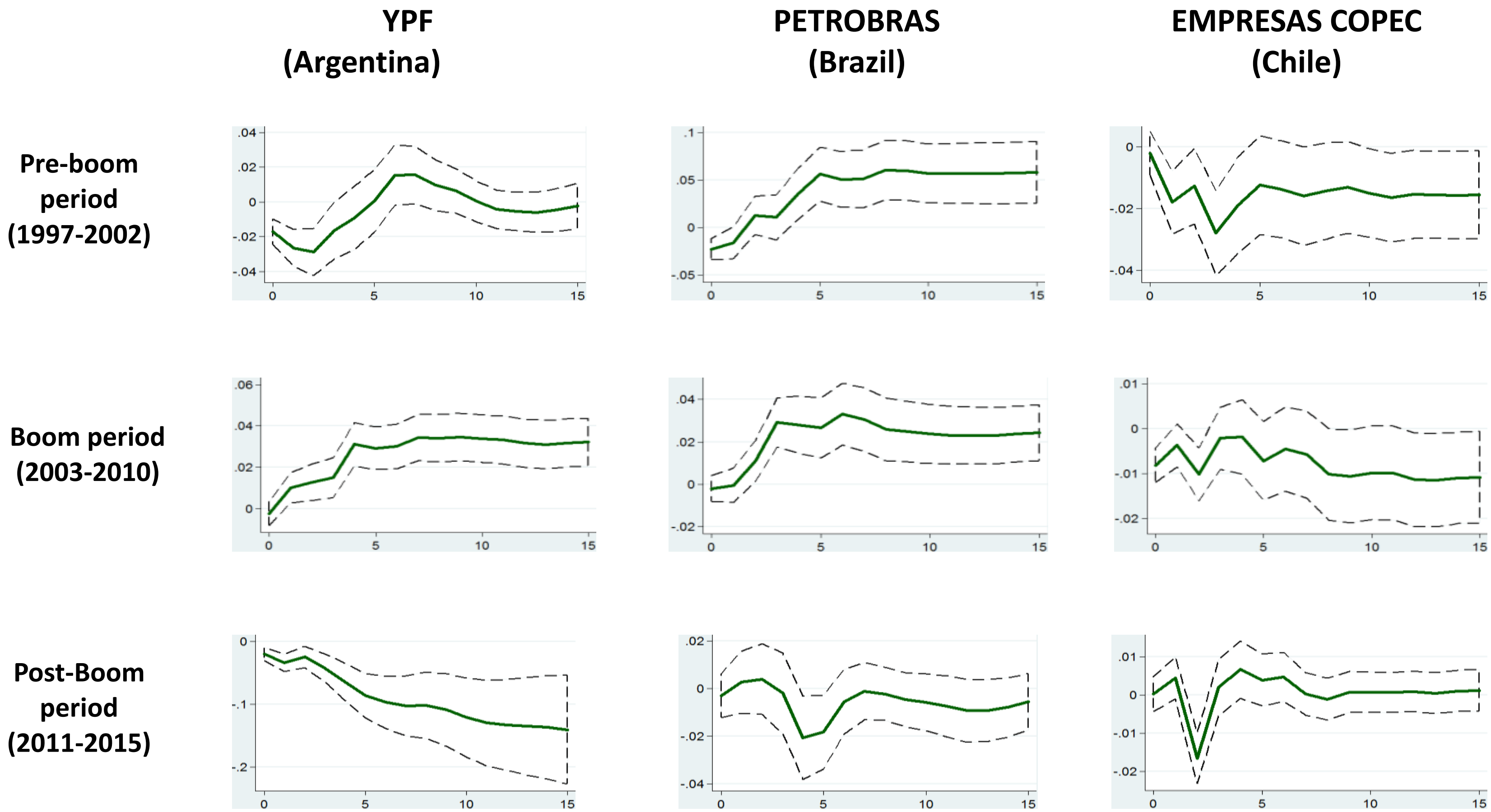


Figure 3.4. Responses of Latin American Stock Returns to OIL SUPPLY Shocks, in Sub-Sample Periods.



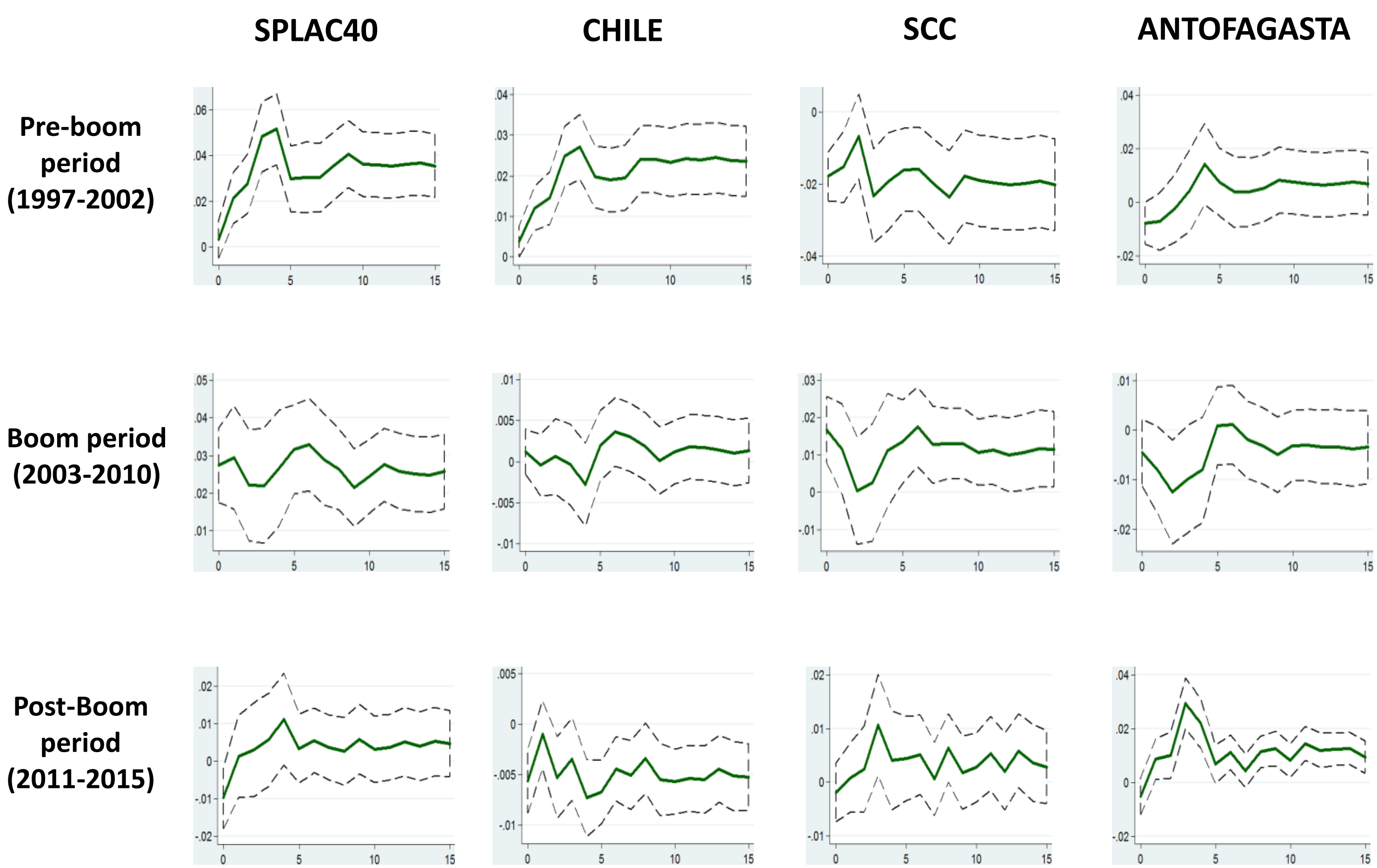
(Continued)

(Figure 3.4 – Continued)



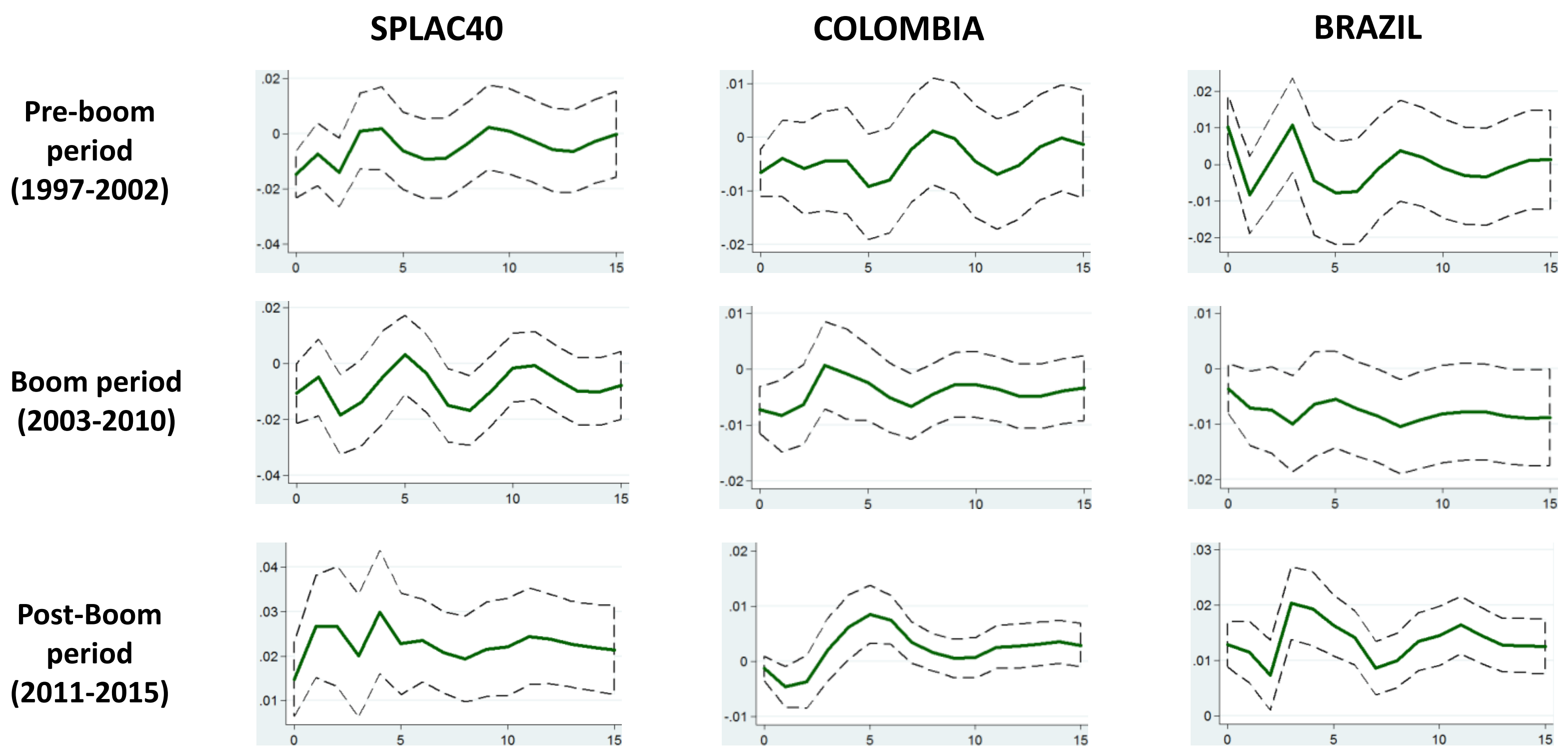
Notes: Cumulative orthogonalized impulse-response functions of real stock returns to supply shocks in SVAR(prod, rea, price, rsr) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

Figure 3.5. Responses of Latin American Stock Returns to COPPER SUPPLY Shocks, in Sub-Sample Periods.



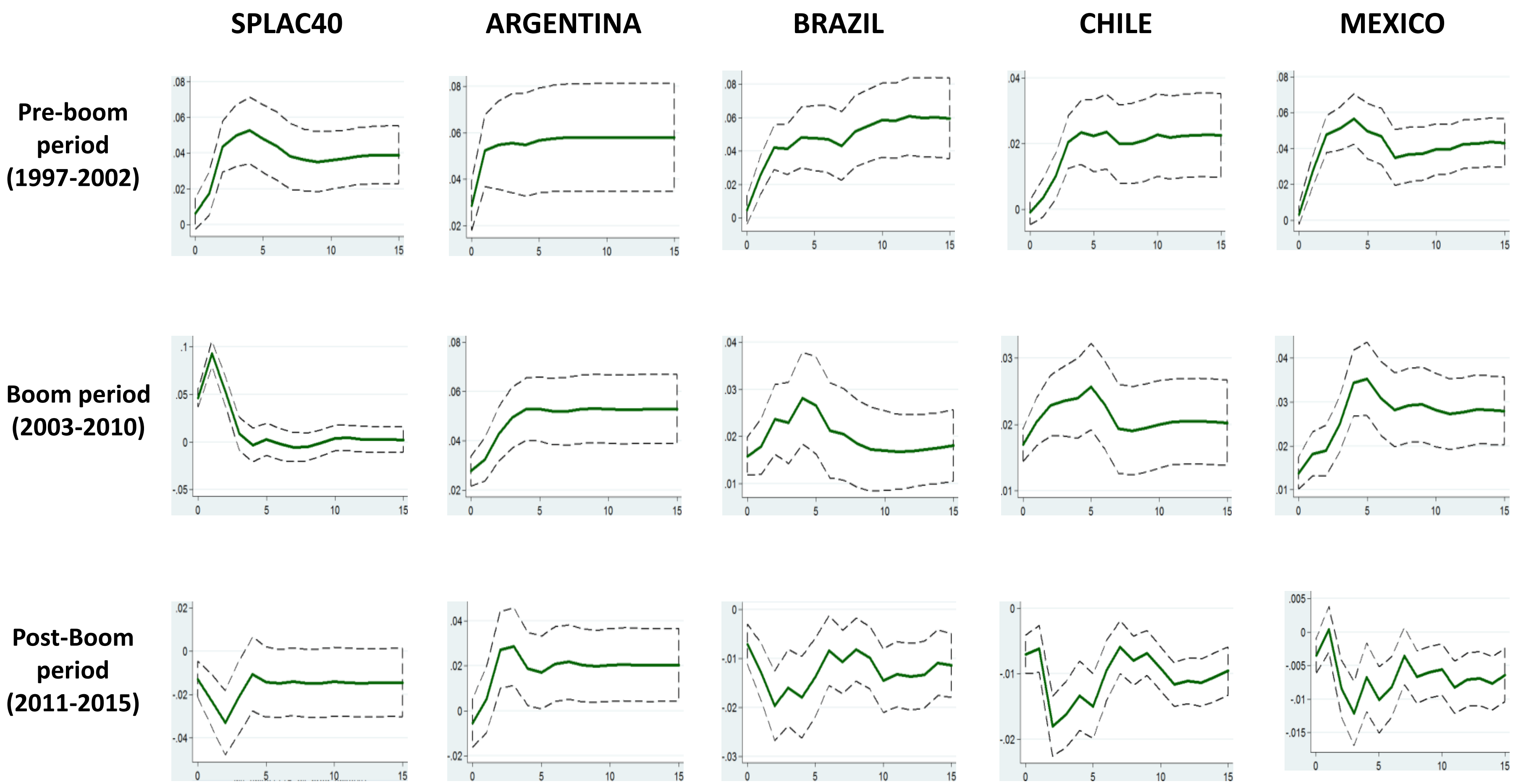
Notes: Cumulative orthogonalized impulse-response functions of real stock returns to supply shocks in SVAR(prod, rea, price, rsr) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

Figure 3.6. Responses of Latin American Stock Returns to COFFEE SUPPLY Shocks, in Sub-Sample Periods.



Notes: Cumulative orthogonalized impulse-response functions of real stock returns to supply shocks in SVAR(prod, rea, price, rsr) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

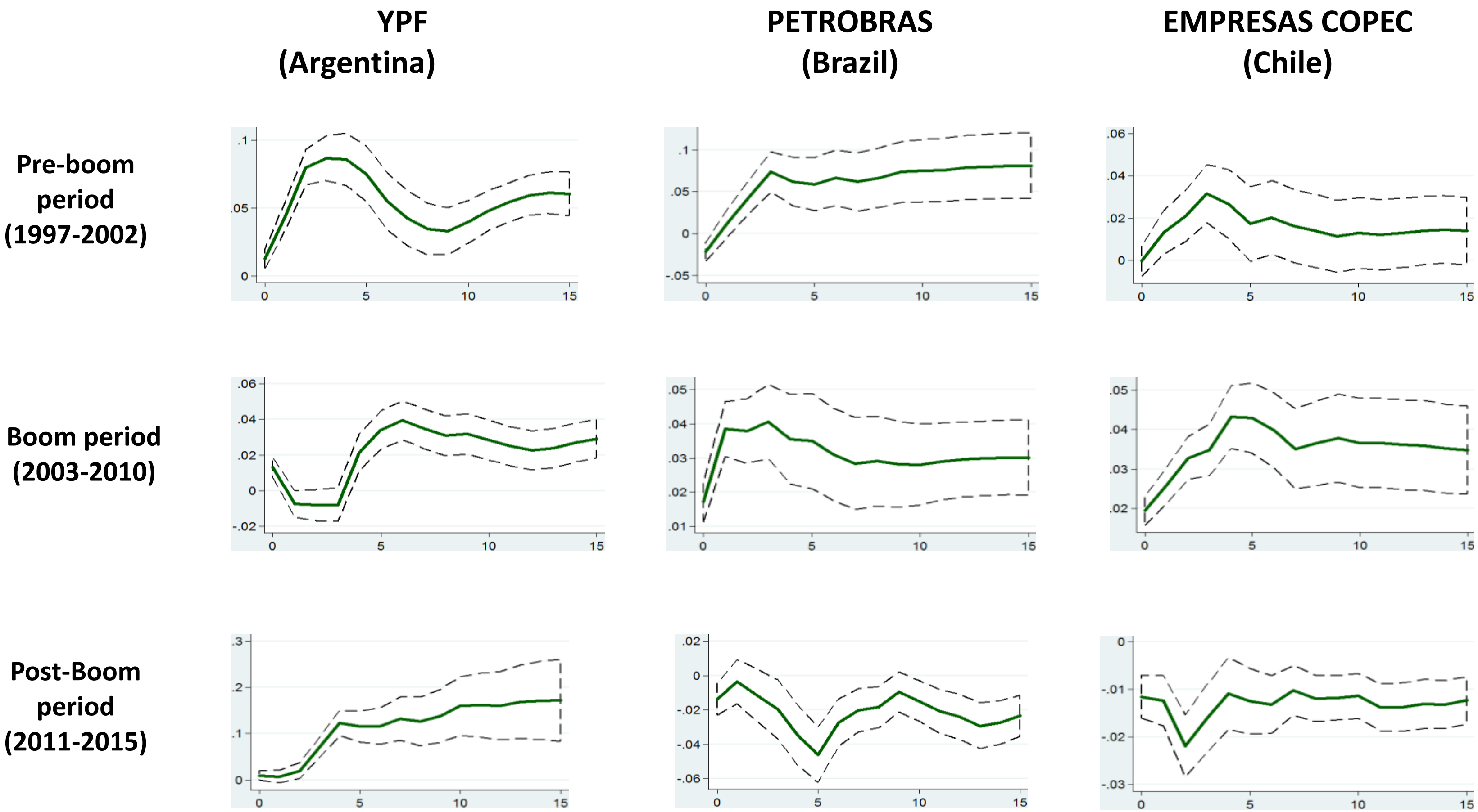
Figure 3.7. Responses of Latin American Stock Returns to AGGREGATE DEMAND Shocks, in the SVAR Model with OIL Prices, in Sub-Sample Periods.



Notes: Cumulative orthogonalized impulse-response functions of real stock returns to aggregate demand shocks in SVAR(prod, rea, price, rsr) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

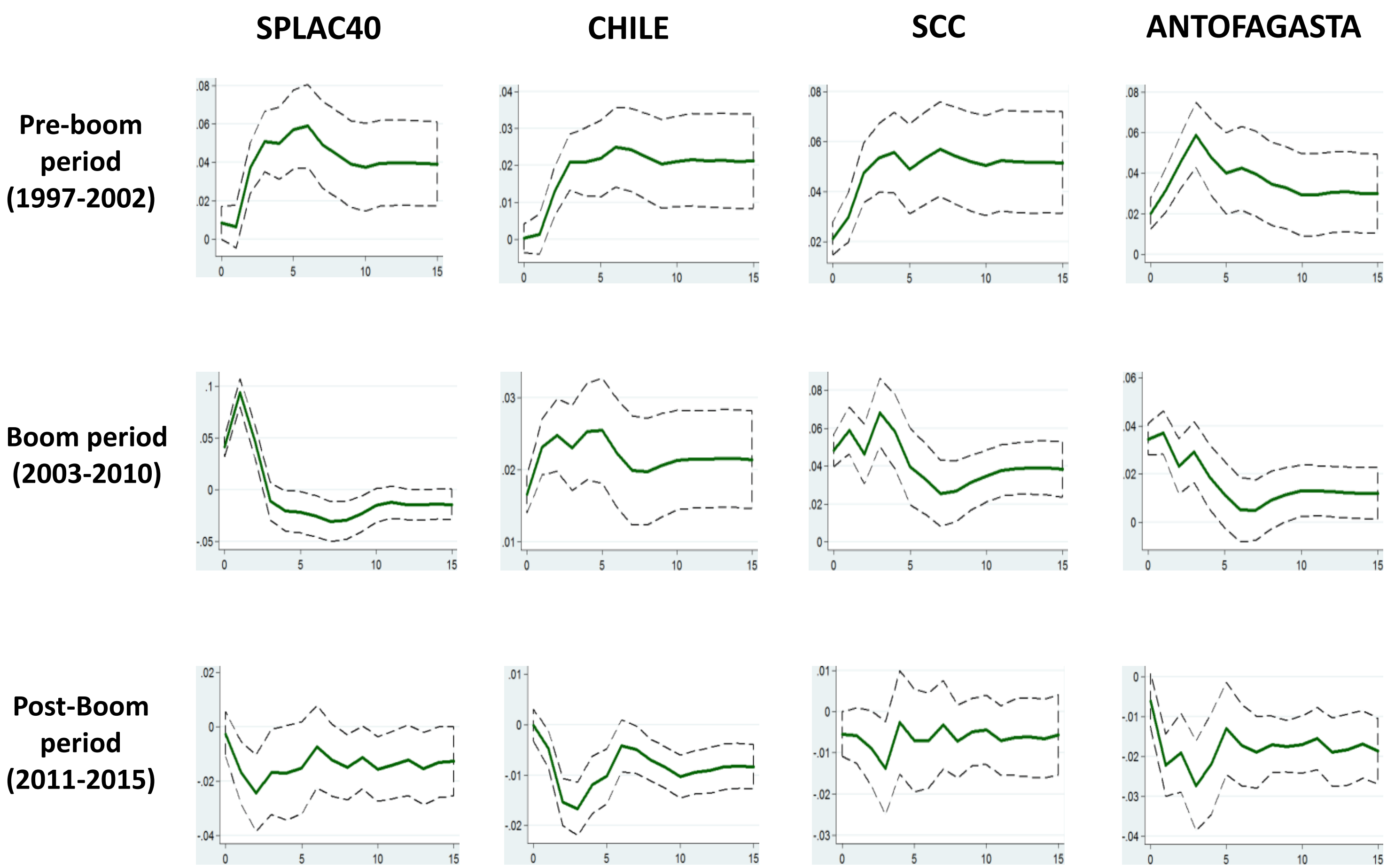
(Continued)

(Figure 3.7 – Continued)



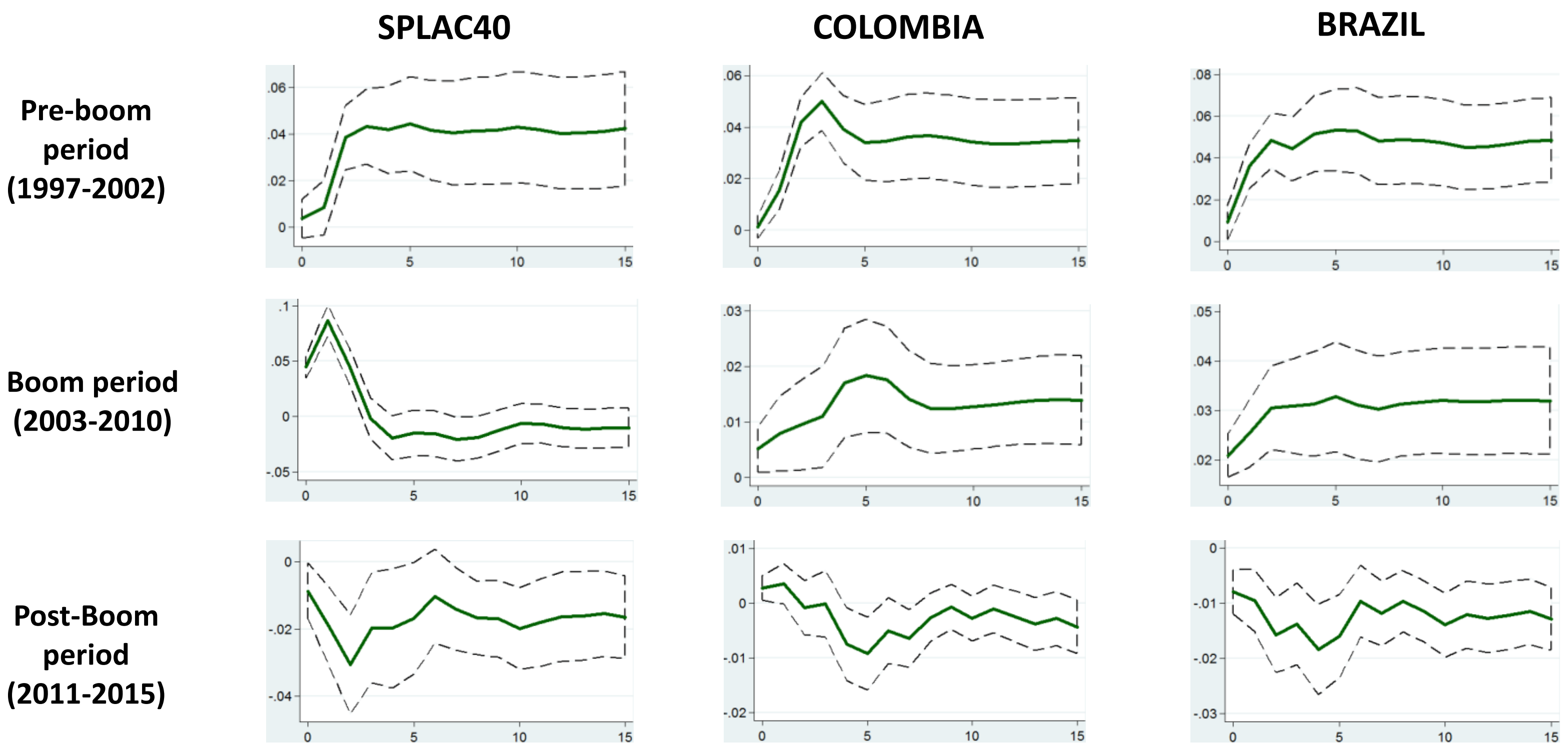
Notes: Cumulative orthogonalized impulse-response functions of real stock returns to aggregate demand shocks in SVAR(prod, rea, price, rsr) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

Figure 3.8. Responses of Latin American Stock Returns to AGGREGATE DEMAND Shocks, in the SVAR Model with COPPER Prices, in Sub-Sample Periods.



Notes: Cumulative orthogonalized impulse-response functions of real stock returns to aggregate demand shocks in SVAR(prod, rea, price, rsr) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

Figure 3.9. Responses of Latin American Stock Returns to AGGREGATE DEMAND Shocks, in the SVAR Model with COFFEE Prices, in Sub-Sample Periods.



Notes: Cumulative orthogonalized impulse-response functions of real stock returns to supply shocks in SVAR(prod, rea, price, rsr) in each of the sub-sample periods. The thick line is the impulse-response function, and the dotted lines represent the 95% confidence interval.

CHAPTER IV

LATIN AMERICA AND THE TRADE-GROWTH NEXUS

4.1 Introduction

This essay investigates for evidence supporting a nonlinear relationship between international trade and economic growth in 14 Latin American economies from 1997 to 2014. I examine the nonlinearity associated with the increased economic volatility in the period since in the 2000s Latin American countries experienced an accelerated economic growth that is often related to the commodity boom. The trade-growth nexus (or trade-led growth hypothesis) has been widely examined in the past literature using cross-sectional, panel data and time series methodologies. In this study, I perform country-year fixed effects panel data regressions that employ an endogenously-determined threshold estimation method. I start by analyzing the entire sample and then split the sample into regimes (subsamples) based on a terms-of-trade volatility (*totvol*) threshold that is determined by a bootstrap threshold test from Hansen (2000). I adopt a methodology similar to Law et al.'s (2013) study on the finance-growth nexus although I implement panel data instead of cross-section regressions in order to ensure a sufficient number of observations. Additionally, I add to the empirical model other important economic channels such as real effective exchange rate, government size and institutions. The threshold variable, *totvol*, is carefully chosen from Rodrik's (1998) discussion on its role in mediating the impact of trade openness on government size. The latter grows to compensate for the economic volatility that arises from higher openness. Results show that the regime with above-threshold volatility displays a stronger coefficient for the relationship between international trade and economic growth.

The rest of the chapter proceeds as follows. Section 4.2 reviews the previous literature on Latin America and the trade-growth nexus. Section 4.3 explains the methodology. Section 4.4 describes the data. Section 4.5 brings the empirical analysis and results, and the last section provides the conclusions.

4.2 Previous Literature

The relationship between trade and economic growth has been subject to extensive investigation in the development literature. In the 1970s, the discussion was centered on strategies concerning either import substituting industrialization or export expansion, especially of manufactured goods (Emery, 1967; Voivodas, 1973; Williamson, 1978). By the end of the decade, neoclassical economists reached a consensus with the theory of export-led growth as "new conventional wisdom" (Tyler, 1981). From the 1980s and 1990s literature, the overall evidence is that exports lead to superior output growth (Krueger, 1980; Feder, 1983, 1986; Kavoussi, 1984; Balassa, 1985; Ram, 1985, 1987; Singer and Gray, 1988; Mbaku, 1989; Fosu, 1990, 1996; Otani and Villaneuva, 1990; Alam, 1991; Dodaro, 1991; Salvatore and Hatcher, 1991; De Gregorio, 1992; Sheehey, 1992; Sprout and Weaver, 1993; Coppin, 1994; Amirkhalkhali and Dar, 1995; Yaghmaian and Ghorashi, 1995; McNab and Moore, 1998).

Helpman and Krugman (1985) argue that export growth accelerates economic development by means of economies of scale, specialization in production and diffusion of technical knowledge. Similarly, Bhagwati (1988) shows that exports promote economic growth which promotes skill formation and technological progress, creating a comparative advantage for a country. In the 2000s literature, research addresses trade openness measured as the sum of exports and imports over GDP as a key variable for economic growth. Rodrik et al. (2004) note that, together with institutions and geography, international trade is a crucial determinant of economic development and is part of one of the three main lines of thoughts in the large literature on the wealth of nations. Hausmann et al. (2007) argue that "what you export matters" and build an index of the income level of a country's exports that predicts subsequent economic growth.

Recently, Law et al. (2013) utilize the threshold estimation technique on a model based on King and Levine (1993a, 1993b) and Levine and Zervos (1998) – regressions of economic growth on financial development and controls – using a bootstrap threshold test from Hansen (2000) and find that the impact of finance on growth is positive and significant only after a certain threshold level of institutional development has been attained. Literature has not yet addressed the question whether there is evidence of a threshold level effect of the terms-of-trade volatility on the relationship between trade openness and economic growth. Rodrik (1998, p. 1014) proposes that terms-of-trade volatility "not only would be the theoretically appropriate measure of external risk, but would be the only relevant measure of such risk".

4.3 Methodology

The main empirical model is based on Law et al. (2013) and methodology on Hansen's (2000) endogenously-determined threshold estimation. However, this paper examines the trade-growth nexus (trade-led growth hypothesis) instead of the finance-growth hypothesis. I add real effective exchange rate (reer), government size (G/Y) and institutions (averaging the 3 WGI measures as selected in Law et al. (2003) to the model due to their importance in the literature.

Given the trade-led growth hypothesis and the sample of countries in this study, the threshold is based on *totvol* (terms-of-trade volatility) instead of institutions.[21]

The analysis starts with a simple country-year fixed effects panel data regression model:

$$GROWTH_{it} = \alpha_i + \beta_1 ln(TRADE)_{it} + \beta_2 X_{it} + \varepsilon_{it} \qquad (1)$$

where $GROWTH_{it}$ is the average growth rate in country *i at time t*, α_i is the unobserved heterogeneity (fixed effect) of each country; TRADE*it* is alternates between the trade flows measure (exports plus imports over GDP) and the exports measure (exports/GDP), X is a vector of controls (population growth rate, investment-gross domestic product (GDP) ratio, real effective exchange rate, government size and institutions), and ε_{it} is a noise term. Except for growth, population growth and institutions, variables are transformed into natural logarithm.

Following Law et al. (2013), I use the threshold regression approach suggested by Hansen (2000) to explore the nonlinear behavior of trade in relation to the economic growth. The model can be expressed as follows:

$$GROWTH_{it} = [\mu_i + \mu_1 \ln(TRADE)_{it} + \mu_2 X_{it}]\, I(totvol_{it} \leq \lambda) + [\gamma_i + \gamma_1 \ln(TRADE)_{it} + \gamma_2 X_{it}]\, I(totvol_{it} > \lambda) + \varepsilon_{it} \qquad (2)$$

where *totvol* is the threshold variable used to split the sample into regimes or groups and λ is the unknown threshold parameter. I(.) is the indicator function that takes the value of 1 if the argument is valid; and 0 otherwise.

This type of modeling strategy allows the role of international trade to differ depending on whether terms-of-trade volatility is below or above some unknown level of λ. In this equation,

[21] Using institutions as a threshold, the bootstrap threshold test fails to reject H0 (no threshold), i.e., it is not a good threshold for the trade-led growth model. Table available upon request.

totvol acts as sample-splitting (or threshold) variables. The impact of international trade on growth will be μ_1 and γ_1 for countries with a low or high regime, respectively. Under the hypotheses $\mu_1 = \gamma_1$ and $\mu_2 = \gamma_2$ the model becomes linear and reduces to Eq. (1).

4.4 Data

All data used in this essay are at annual frequency. The sample period is from 1997 to 2014. I select 1997 as the starting year due to data availability. Since Hansen's (2000) threshold model estimation requires balanced panels, the dataset covers the 14 countries listed on the notes of Table 4.1. Most of the measures are obtained from the World Bank's World Development Indicators (WDI) database, except for the institutions measure that comes from the Worldwide Governance Indicators (WGI) database.

Table 4.1 reports the descriptive statistics of the dataset. Economic growth is calculated as the yearly percentage change in the country's GDP growth rate. The average economic growth rate is 3.8% in the 1997-2014 period with a maximum of 18.3% from Venezuela in 2004 and a minimum of -10.9% from Argentina in 2002. The average population growth rate is around 1.4% with a maximum of 2.39% from Costa Rica in 1997 (closely followed by Paraguay at 2.25% in the same year) and a minimum of -0.06% from Uruguay in 2003. The average investment-to-output ratio is 20.2% with a maximum of 43.3% from Panama in 2014 and a minimum of 11.7% from Bolivia in 2004. The real effective exchange rate (*reer*) is calculated by WDI as an index that is equal to 100 in the year 2010. An increase in *reer* corresponds to an appreciation of the local currency. The average *reer* in the 1997-2014 period is 99.2 with a maximum of 202.8 from Venezuela in 2014 and a minimum of 56.6 from Brazil in 2003. Government size is measured as the government expenses over GDP and has a sample average of 12.98% with a maximum of 22.7% from Colombia in 1999 and a minimum of 6.2% from Dominican Republic in 2004.

Following Law et al. (2013), institutions are calculated as an equally-weighted average of the measures *Control of Corruption*, *Rule of Law* and *Government Effectiveness*. These measures are scaled from -2.5 to +2.5 and have an average of -0.23 points in this Latin American sample. The maximum value is +1.4 from Chile in 2012 and the minimum is -1.5 from Venezuela in 2014.

International trade, the key explanatory variable, has two measures that undergo separate regressions: trade flows (exports plus imports) over GDP and the exports-to-GDP ratio. Trade flows average around 61.6% of GDP with a maximum of 165.3% from Panama in 1997 and a minimum of 16.4% of GDP from Brazil in 1998. The average exports-to-GDP ratio is 30.7% with a maximum of 76.99% from Panama in 1997 and a minimum of 6.98% from Brazil in 1997.

The threshold variable in this study is terms-of-trade volatility, *totvol*, is calculated as the deviation from the mean of the index value (price of exports divided by imports). The average *totvol* is 0.017, the median is 0.0133, with a maximum of 0.37 from Venezuela in 2000 and a minimum of -0.345 also from Venezuela in 1998.

Table 4.2 displays a matrix of correlation coefficients of the variables in the empirical model. The bivariate relationships between the dependent variable (growth) and the explanatory variables are consistent with previous literature: ln(Trade) and ln(Exp) have positive correlation coefficients (0.2709 and 0.2583, respectively); popu shows a positive and small coefficient of 0.0318; ln(I/Y) and inst have positive correlation coefficients of 0.2974 and 0.0483, respectively; ln(reer) and ln(G/Y) are negatively correlated with growth (-0.0980 and -0.1882, respectively). The only high correlation is the one between the two international trade measures; however, this very high coefficient of 0.9773 does not bring a multicollinearity bias to the model since *ln(Trade)* and *ln(Exp)* are used in separate regressions. There are also medium correlation coefficients between population growth rate and institutions (-0.4865) and between government size and international trade: -0.4684 from *ln(G/Y)* versus *ln(Trade)* and -0.4727 from *ln(G/Y)* against *ln(Exp)*.

4.5 Empirical Results

This section begins by reporting the country-year fixed effects panel data regression results using Eq. (1) and comparing them with results from separate regimes (subsamples) that are split by an exogenously-determined threshold. Subsequently, I provide results from the bootstrap threshold test using the Hansen (2000) methodology and report country-year fixed effects panel data regressions using the endogenously-determined threshold as described in Eq. (2). Then, I raise additional questions related to robustness of results when splitting data into subsamples with different selections of Latin American countries and time spans.

4.5.1 Exogenously-Determined Threshold

Table 4.3 reports country-year fixed effects panel data regression results for Eq. (1). In the first three columns, international trade is measured by trade flows over GDP. The first column brings regression results for the linear model, i.e., fixed-effects regressions without threshold. The second and third columns report fixed-effects regressions of regimes that are split by an exogenously-determined threshold. I define this threshold as the median of terms-of-trade volatility (*totvol*) and obtain two regimes (subsamples) of same size: 126 observations each. Column two shows results for regime 1 (above threshold) while column three displays results for regime 2 (below threshold). The last three regressions adopt exports over GDP as the measure for international trade and the criteria for each of them are the same as in the first three columns.

The linear regression results demonstrate that both measures of international trade are highly significant at the 1% level and have a positive relationship with economic growth: I find the coefficients of 7.32 for trade flows over GDP and 5.06 for exports over GDP. There are statistically significant coefficients for some of the control variables: investment shows a very strong and positive association with economic growth that is significant at the 1% level in both linear regression specifications; government size has a negative coefficient that is significant at the 1% level in both linear models; and institutions are positively related to economic growth with 5% and 10% significance levels in the linear models using, respectively, trade flows and exports as the international trade measure. Population growth and the real effective exchange rate do not show any statistical significance. The R-squared for these linear models are 24.5% and 23.4%, respectively.

The threshold model regressions provide evidence of a stronger trade-growth link when terms-of-trade volatility is higher (regime 1). The coefficient of trade flows over GDP is 7.364 in regime 1 (statistically significant at 1%) while it has the value of 6.068 in regime 2 (statistically significant at 5%). The exports measure has coefficients of 4.859 in regime 1 and 4.125 in regime 2, both significant at the 5% level. From the control variables, there are some interesting results as well: investment has a stronger coefficient when terms-of-trade volatility is lower; government size has a stronger negative association with economic growth when terms-of-trade volatility is higher; and institutions are only statistically significant in regime 2, when the economy is subject to less terms-of-trade volatility.

4.5.2 Endogenously-Determined Threshold

Table 4.4 brings the threshold estimation results using the terms-of-trade volatility measure (*totvol*) in Eq. (2). Following Hansen (2000), the statistical significance of the threshold estimate is evaluated by a p-value that results from a bootstrap method with 1000 replications and 15% trimming percentage. Differently from Law et al. (2013), who first run a single-threshold test and then test whether the high-threshold group could be split further into sub-regimes, I am not able to test a second split since the resulting panel is, as expected, an unbalanced panel.[22] For robustness, however, I check for both single- and double-threshold models, which would split the sample in two or three regimes, respectively.

Model 1 (single-threshold) displays bootstrap p-values of 0.003 in both empirical model specifications (with trade flows/GDP or exports/GDP). This indicates that the null hypothesis of no threshold effect can be rejected. Therefore, the sample can be split into two regimes. The point estimate of the threshold value of *totvol* is -0.0486 with a corresponding 95% confidence interval [-0.0497, -0.0481] for both specifications. This implies that observations with *totvol* values of less than -0.0486 are classified into the low-*totvol* group (i.e., low terms-of-trade volatility) while those with greater values are classified into the high-*totvol* group (high terms-of-trade volatility). Model 2 (double-threshold), however, shows insignificant bootstrap p-values for a double-threshold model, suggesting that only the single threshold is suitable for the dataset. Once I have estimated the terms-of-trade volatility threshold, the next step is to examine how *totvol* affects the trade-growth nexus.

Table 4.5 presents country-year fixed effects panel data regression results for Eq. (2) splitting the sample into two regimes accordingly to the endogenously-determined terms-of-trade volatility (*totvol*) threshold. The first two columns show the results from the model specification that adopted trade flows/GDP as the international trade measure, while the last two columns employ exports/GDP as the measure of trade. The main difference between the results from Table 4.5 (endogenously-determined *totvol*) and the ones from Table 4.3 (exogenously-

[22] Law et al. (2013) are able to perform this second split test – in which the threshold did not turn out significant in any case – since their dataset is a cross-section: one observation per country. Therefore, in their case, excluding observations do not result in an unbalanced panel.

determined *totvol*) is the finding that the impact of international trade on economic growth is positive and highly significant (at the 1% level) only after a certain threshold level of *totvol* has been attained. Until then, the effect of trade on growth is nonexistent. This result is robust to both measures of international trade.

The results for the control variables in Table 4.5 are somewhat similar to the previous regression tables: investment again has a larger coefficient when terms-of-trade volatility is lower, although the statistical significance is stronger in the high-totvol group (regime 1); the government size coefficient is a just little more negative and has now higher statistical significance (at the 1% level) when volatility is higher (regime 1), but is insignificant in the low-volatility regime; and institutions remain only statistically significant in regime 2 (less volatile terms of trade), but with larger coefficients than in previous regressions. Once more, population growth and real effective exchange rate do not show any statistical significance.

Interestingly, the R-squared from the regime 1 regressions in Table 4.5 (21.6% and 20.9%, columns 1 and 3) are a little lower than the equivalent ones in Table 4.3 (24.5% and 22.6%), while the R-squared from the regime 2 regressions in Table 4.5 (35.8% and 37.4%, columns 2 and 4) are much higher than the respective ones in Table 4.3 (26.9% and 25.9%). The much higher R-square value indicate that *investment* and *institutions* represent over a third of the variance in Latin American economic growth when the economy is below a certain level of volatility determined by the *totvol* threshold. These results are in line with Vianna and Mollick

(2018), who show evidence that international trade and – especially – institutions represent key variables for Latin American economic development[23].

4.5.3 Additional Questions

The finding of a significant link between international trade and economic growth only after a certain level of *totvol* is attained raises new questions: could this evidence be related with the 2000s commodity boom period? In other words, can I obtain similar evidence (of a non-significant and a highly significant regime) from splitting the sample into pre-commodity and commodity boom periods? In addition, what do I find when the sample is split into large and small country sizes? Do larger countries have a stronger trade-growth nexus? Lastly, are these results robust to a potential endogeneity in the trade-growth relationship? In the subsections below I address these questions that bring new contributions to the previous findings.

4.5.3.1 Different Time Spans: The Commodity Boom Effect. Table 4.6 reports linear country-year fixed effects panel data regression (Eq. (1)) results from splitting the sample into two subsamples: years 1997-2002 (pre-commodity boom) and years 2003-2014. For extra robustness, I test the 2003-2010 period which the literature has defined more clearly as the "commodity boom period".[24] The results for the 1997-2002 period regressions with either of the international trade measures (trade flows or exports) show that the trade coefficient is insignificant in those years, while in the 2003-2014 period the coefficient is equal to 8.88 or 7.73 (trade flows/GDP and exports/GDP, respectively), or equal to 9.03 or 7.92 when a crisis dummy variable representing the global financial crisis years of 2008-2009 is inserted into the model.

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[23] Vianna and Mollick's (2018) find that a 0.1-point increase in their aggregate institutions index, built from the World Governance Indicators (WGI) database, has an effect of 3.9% increase in Latin American per capita output versus a 2.6% impact on the world's economic development.

[24] As in the first two essays, I adopt the period of 2003-2010 to represent the commodity boom period. This choice takes into account evidence from econometric tests and previous literature.

The crisis coefficient is equal to around -1.3 in both model specifications in the 2003-2014 period. The robustness test using the commodity boom period (2003-2010) shows that if the crisis dummy variable is omitted, the coefficient of the trade-growth nexus is not much significant (8.266 with significance at the 10% level and 5.042 with no significance, in each specification, respectively). However, with the inclusion of crisis, the coefficient is highly significant and has a large positive coefficient: 12.2 for the trade flows/GDP measure and 7.83 for the exports/GDP measure, with statistical significance at the 1% and 5% levels, respectively.

Results from the control variables are the following. The coefficient of population growth rate is positive and highly significant (at the 1% level) only in the pre-commodity boom period (1997-2002), while investment shows evidence of statistical significance at the 1% level in the commodity boom period (2003-2010). Government size and institutions have, respectively, negative and positive coefficients that are significant in most specifications. Real effective exchange rate does not show much evidence of any significance (except for one out of the ten regressions where it is only significant at the 10% level).

4.5.3.2 Different Country Selection: The Country Size Effect. Table 4.7 reports linear country-year fixed effects panel data regression (Eq. (1)) results after I split the sample into two subsamples: small and large countries. The split threshold is the average GDP of each country in the 2007-2014 period. The 7 small countries sorted by GDP, in US$ billion, from smallest to highest, are: Paraguay (8.2), Bolivia (8.5), Panama (12.3), Costa Rica (13.2), Uruguay (14.9), Dominican Republic (16.6) and Ecuador (26.9). The 7 large countries sorted by GDP, in US$ billion, from highest to smallest, are: Brazil (781.0), Mexico (257.2), Argentina (143.3), Venezuela (119.4), Colombia (110.3), Chile (76.3) and Peru (56.0).

For extra robustness, I test the large countries group by excluding Argentina and Brazil. Since these two countries are much more closed economies than the region's average, they could be downward-biasing the results, especially the coefficient of international trade. The results for the small countries regressions with either of the international trade measures (trade flows or exports) show that the trade coefficient is significant at the 1% level although smaller than those in the large countries.

When excluding Argentina and Brazil, the international trade coefficients grow in value and significance: the trade flows coefficient jumps from 8.25 to 10.72 and from 5% to 1% significance level while the exports coefficient rises from 4.72 to 6.46 and from 10% to 5% significance level. Results from the control variables are the following. Investment is positively related to economic growth and has a higher coefficient in the group of large countries, but it becomes insignificant when I remove Argentina and Brazil from that group. Government size displays a negative relationship with growth and is highly significant in all six regressions. In large countries, the negative coefficient is much stronger, suggesting that governments should not grow proportionally to its population or exports. Real effective exchange rate shows some evidence of a significant link with economic growth. Interestingly, the coefficient is only positive and significant (at the 5% level) for small Latin American countries. This suggests that in these small economies the expected negative impact of an appreciated local currency on trade competitiveness may be outweighed by higher consumption and/or cost reduction of machinery. In other words, in small Latin American economies there is a net positive effect of local currency appreciation on GDP growth.

4.5.3.3 Two-stage Least Squares Regressions. Table 4.8 reports instrumental variable regressions using the two-stage least squares (2SLS) method. In these regressions, the variable of interest, international trade, is instrumented by Kilian's (2009) real economic activity index based on dry-cargo single voyage ocean shipping freight rates.

This technique is performed to control for the potential endogeneity arising from a reverse causation from economic growth to international trade. For all specifications, the first-stage specification tests show that: (a) the Durbin-Wu-Hausman endogeneity test null hypothesis that international trade can be treated as exogenous (in that case, there would be no need of an instrumental variable) is rejected at the 10% level of significance or better; (b) the Kleibergen-Paap test null hypothesis that the model is underidentified is rejected at the 1% level for all specifications; and (c) the Cragg-Donald test null hypothesis that the model is weakly identified is rejected at the 10% level or better (the F-stat is higher than the corresponding critical value of 16.38). I employ the crisis variable (*crisis*) equal to one in the 2008-2009 years of financial crisis, otherwise zero. I also adopt a commodity boom binary variable (*boom*) that is equal to one for the period from 2003 to 2010, defined as the commodity boom period in this dissertation. In addition, I adopt one more binary variable, *large*, to control for the possibly different growth rates in the largest Latin American economies. The results show that international trade, measured by trade flows/GDP or exports/GDP, has a positive and significant (at the 5% level) impact on economic growth. The coefficients range between 4.07 and 5.80, a little smaller but consistent with the ones in previous tables. While *crisis* has a negative coefficient, *boom* and *large* have positive and significant coefficients at the 1% and 10% significance levels, respectively. The statistically significant results from the control variables are the highly significant (at the 1% level) negative coefficients for population growth, ranging between -0.0263 and -0.0319, and positive coefficient for the investment-to-output ratio, varying from 0.0525 to 0.0677. The initial level of GDP growth and real effective exchange rate are both significant in 2 out of 6 regressions and have negative coefficients: a higher initial GDP is associated with a slower pace of output growth, consistent with a long-run convergence of productivity among countries, while a stronger local currency leads to lower economic growth, suggesting smaller price (exchange rate) competitiveness of an economy.

4.6 Conclusions

This chapter adopts Hansen's (2000) threshold estimation to check for a threshold-level effect of terms-of-trade volatility in the trade-growth nexus, a novel contribution to the literature at the present date. There is evidence of a positive nonlinear relationship between international trade and economic growth in Latin America in the last two decades. Recent articles on emerging markets find results consistent with this chapter, although using different techniques. For example, Dufrenot et al. (2010) apply a quantile regression approach for a panel of 75 developing countries and show that the heterogenous effect of international trade on growth is higher in countries with low growth rates. Vianna and Mollick (2018) perform system GMM dynamic panel regressions for 192 countries and find that international trade and institutions are some of the most important determinants of Latin American economic development.

I provide evidence of a nonlinear trade-growth nexus in Latin America that is related to the increased economic volatility from the 2000s commodity boom. Country-year fixed effects panel data regressions using an endogenously-determined threshold estimation method by Hansen (2000) indicate that terms-of-trade volatility, the threshold variable, mediates the impact of international trade on economic growth. I find that the regime with above-threshold volatility displays a stronger coefficient for the trade-growth nexus. For robustness, I examine the trade-growth nexus using different time spans, country sizes, and controlling for the 2008-2009 financial crisis. I also perform 2SLS regressions to control for potential endogeneity in the relationship between international trade and economic growth. While there is evidence of a statistically significant negative impact of the financial crisis on economic growth, the trade-growth nexus is stronger during the 2000s commodity boom and in larger Latin American economies.

Table 4.1
Descriptive Statistics. 14 Countries, 1997-2014, 252 Observations.

	Unit of Measurement	Mean	Median	Std dev.	Minimum	Maximum
Economic growth	%	3.825	4.169	3.838	-10.894	18.287
Population growth	%	1.396	1.422	0.433	-0.064	2.391
Investment	% of GDP	20.183	19.854	4.373	11.687	43.343
Real effective exchange rate	Index (2010=100)	99.180	98.871	18.580	56.560	202.844
Government size	% of GDP	12.980	12.352	2.993	6.207	22.734
Institutions	Scaled from -2.5 to 2.5	-0.230	-0.322	0.657	-1.501	1.403
International trade						
Trade flows	% of GDP	61.611	56.012	29.348	16.439	165.344
Exports	% of GDP	30.729	27.897	14.565	6.984	76.988
Volatility						
Terms-of-trade volatility	Deviation from index (2000=100) mean	0.017	0.0133	0.090	-0.345	0.370

Countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela.

Table 4.2

Correlation Coefficients.

	growth	ln(Trade)	ln(Exp)	popu	ln(I/Y)	ln(reer)	ln(G/Y)	inst	totvol
growth	1								
ln(Trade)	0.2709	1							
ln(Exp)	0.2583	0.9773	1						
popu	0.0318	0.3722	0.3534	1					
ln(I/Y)	0.2974	0.2569	0.1758	0.1778	1				
ln(reer)	-0.0980	-0.0229	-0.0688	0.0756	0.2364	1			
ln(G/Y)	-0.1882	-0.4684	-0.4727	-0.1	-0.0759	-0.0824	1		
inst	0.0483	0.0183	-0.0078	-0.4865	0.1375	-0.1318	0.1336	1	
totvol	0.2432	0.0183	0.0937	0.0022	-0.0617	-0.0497	-0.1207	-0.0460	1

Notes: growth = economic growth rate; ln(Trade) = log of trade flows; ln(Exp) = log of exports; popu = population growth; ln(I/Y) = log of investment; ln(reer) = log of real effective exchange rate; ln (G/Y) = log of government size; inst = institutions; totvol = terms-of-trade volatility.

Table 4.3
Fixed Effect Panel Data Regression Results Using the Median of Terms-of-Trade Volatility (Totvol) as Threshold.

Dependent variable: economic growth.

	International trade = Trade flows/GDP			International trade = Exports/GDP		
	Linear model	Threshold model (totvol median = 0.0133126)		Linear model	Threshold model (totvol median = 0.0133126)	
	FE without threshold	Regime 1: totvol > median	Regime 2: totvol <= median	FE without threshold	Regime 1: totvol > median	Regime 2: totvol <= median
International trade	7.322***	7.364***	6.068**	5.059***	4.859**	4.125**
	(1.705)	(2.418)	(2.411)	(1.315)	(1.903)	(1.865)
Population growth	-1.189	0.115	-0.848	-1.157	0.289	-0.979
	(1.149)	(1.775)	(1.547)	(1.171)	(1.822)	(1.562)
Investment	4.853***	5.203**	6.339***	6.087***	6.508***	7.063***
	(1.575)	(2.370)	(2.205)	(1.538)	(2.318)	(2.172)
Government size	-7.027***	-7.052**	-5.709*	-7.060***	-7.206**	-6.070*
	(2.249)	(3.348)	(3.179)	(2.277)	(3.401)	(3.186)
R.E. exchange rate	0.000422	-0.567	2.817	0.240	-0.860	3.045
	(1.841)	(2.883)	(2.580)	(1.935)	(2.968)	(2.729)
Institutions	4.066**	0.670	5.938**	3.692*	0.446	5.704**
	(1.934)	(3.264)	(2.433)	(1.939)	(3.306)	(2.441)
Constant	-19.63	-20.20	-36.05*	-11.82	-9.366	-27.36
	(14.65)	(21.77)	(21.19)	(14.15)	(21.02)	(19.98)
Observations	252	126	126	252	126	126
R-squared	24.5%	24.5%	26.9%	23.4%	22.6%	25.9%
Number of countries	14	14	14	14	14	14

Notes: Robust standard errors (White corrected for heteroscedasticity) reported in parentheses. Scripts *, ** and *** correspond to significance at the 10%, 5% and 1% levels, respectively.

Table 4.4

Endogenously-Determined Threshold Estimates of Terms-of-Trade Volatility (Totvol).

	Model 1 Single-Threshold	Model 2 Double-Threshold
	TRADE = Trade Flows/GDP	
Fstat test for no threshold	18.75	-0.44
Bootstrap p-value	0.003	1.000
Threshold estimate(s)	-0.0486	-0.0519; -0.0037
95% Confidence interval(s)	(-0.0497, -0.0481)	(-0.0520, -0.0507); (-0.0048, -0.0031)
	TRADE = Exports/GDP	
Fstat test for no threshold	18.52	0.24
Bootstrap p-value	0.003	0.999
Threshold estimate	-0.0486	-0.0525; -0.0037
95% Confidence interval	(-0.0497, -0.0481)	(-0.0540, -0.0520); (-0.0048, -0.0031)

Notes: H_0: no threshold effect.

Table 4.5
Fixed Effect Panel Data Regression Results Using the Endogenously-Determined Terms-of-Trade Volatility (Totvol) Threshold Estimates.

Dependent variable: economic growth.

	International trade = Trade flows/GDP		International trade = Exports/GDP	
	Regime 1: totvol > -0.0486	Regime 2: totvol < -0.0486	Regime 1: totvol > -0.0486	Regime 2: totvol < -0.0486
International trade	5.977***	3.500	4.342***	3.499
	(1.837)	(3.795)	(1.439)	(2.709)
Population growth	-1.282	1.800	-1.149	2.102
	(1.297)	(1.920)	(1.319)	(1.905)
Investment	4.069**	6.900*	4.891***	7.455**
	(1.725)	(3.553)	(1.691)	(3.391)
Government size	-7.705***	-4.191	-7.697***	-4.157
	(2.410)	(4.794)	(2.431)	(4.719)
R.E. exchange rate	0.165	2.036	0.718	2.859
	(2.037)	(3.366)	(2.159)	(3.335)
Institutions	2.136	6.688*	1.667	7.440**
	(2.165)	(3.465)	(2.156)	(3.507)
Constant	-10.93	-32.33	-6.600	-35.58
	(15.58)	(30.88)	(15.23)	(27.20)
Observations	202	50	202	50
R-squared	21.6%	35.8%	20.9%	37.4%
Number of countries	14	13	14	13

Notes: Robust standard errors (White corrected for heteroscedasticity) reported in parentheses. Scripts *, ** and *** correspond to significance at the 10%, 5% and 1% levels, respectively. In columns 2 and 4 (regressions from regime 2), the number of countries is 13 because all observations for Mexico have *totvol* above the threshold.

Table 4.6
Fixed Effect Panel Data Regression Results Using Different Time Spans.
Dependent variable: economic growth.

	International trade = Trade Flows/GDP					International trade = Exports/GDP				
	1997-2002	2003-2014		2003-2010 (Commodity boom)		1997-2002	2003-2014		2003-2010 (Commodity boom)	
International trade	-0.415	8.881***	9.028***	8.266*	12.20***	-1.414	7.731***	7.915***	5.042	7.833**
	(4.446)	(3.006)	(2.968)	(4.854)	(4.543)	(3.426)	(2.574)	(2.541)	(4.035)	(3.792)
Crisis			-1.275**		-3.355***			-1.294**		-3.226***
			(0.577)		(0.781)			(0.576)		(0.789)
Population growth	8.235***	0.128	0.677	1.265	0.811	8.138***	0.0301	0.589	0.988	0.446
	(2.720)	(2.513)	(2.493)	(3.935)	(3.609)	(2.722)	(2.508)	(2.487)	(3.956)	(3.659)
Investment	4.223	1.898	2.803	4.624	9.745***	3.970	3.022	3.954**	6.302**	11.92***
	(3.616)	(1.978)	(1.995)	(3.204)	(3.170)	(3.566)	(1.893)	(1.913)	(2.949)	(3.053)
Government size	-14.63***	-6.064**	-6.094**	-8.541*	-5.407	-14.78***	-5.326*	-5.312*	-9.603*	-6.701
	(5.160)	(2.940)	(2.902)	(4.910)	(4.560)	(5.165)	(3.042)	(3.001)	(5.063)	(4.733)
R.E. exchange rate	3.144	0.864	0.759	4.331	7.842*	2.229	2.407	2.358	3.667	7.050
	(3.923)	(2.590)	(2.557)	(4.552)	(4.252)	(4.000)	(2.816)	(2.778)	(4.738)	(4.457)
Institutions	7.763*	10.48***	9.427***	8.861*	6.629	7.518*	8.980***	7.883***	8.905*	6.769
	(4.429)	(3.002)	(3.001)	(4.539)	(4.194)	(4.464)	(3.008)	(3.008)	(4.572)	(4.258)
Constant	2.352	-23.28	-26.70	-40.09	-93.78**	10.66	-25.86	-29.77	-22.51	-69.89*
	(34.43)	(22.36)	(22.12)	(39.44)	(38.26)	(32.71)	(22.81)	(22.57)	(37.98)	(36.97)
Observations	84	168	168	112	112	84	168	168	112	112
R-squared	42.7%	22.4%	24.9%	20.6%	34.0%	42.8%	22.5%	25.1%	19.4%	31.9%
Number of countries	14	14	14	14	14	14	14	14	14	14

Notes: Robust standard errors (White corrected for heteroscedasticity) reported in parentheses. Scripts *, ** and *** correspond to significance at the 10%, 5% and 1% levels, respectively. Crisis is a binary variable equal to one in the crisis period between December 2007 and June 2009; otherwise zero.

Table 4.7
Fixed Effect Panel Data Regression Results Using Samples Split by Country Size.
Dependent variable: economic growth.

	International trade = Trade Flows/GDP			International trade = Exports/GDP		
	7 Small Countries	7 Large Countries	7 Large excl. Argentina & Brazil	7 Small Countries	7 Large Countries	7 Large excl. Argentina & Brazil
International trade	6.761***	8.246**	10.72***	4.679***	4.715*	6.456**
	(1.812)	(3.631)	(3.666)	(1.455)	(2.518)	(2.578)
Population growth	-1.162	1.441	1.708	-1.115	0.906	1.118
	(1.195)	(2.593)	(2.939)	(1.222)	(2.600)	(2.960)
Investment	4.052**	5.517*	1.404	4.855***	7.987***	4.351
	(1.663)	(3.160)	(3.319)	(1.659)	(2.982)	(3.138)
Government size	-5.648**	-16.48***	-18.24***	-6.017**	-16.14***	-17.01***
	(2.577)	(4.381)	(5.200)	(2.614)	(4.449)	(5.296)
R.E. exchange rate	7.036**	-0.371	-1.963	7.147**	-1.169	-1.958
	(2.989)	(3.117)	(3.926)	(3.050)	(3.181)	(4.158)
Institutions	2.399	1.888	1.499	3.117	0.240	-0.944
	(2.563)	(3.194)	(3.513)	(2.625)	(3.073)	(3.413)
Constant	-52.61***	-0.867	10.60	-42.10**	11.30	19.93
	(17.17)	(28.11)	(28.18)	(16.40)	(26.95)	(28.29)
Observations	126	126	90	126	126	90
R-squared	29.6%	29.5%	32.4%	27.6%	28.5%	30.5%
Number of countries	7	7	5	7	7	5

Notes: Robust standard errors (White corrected for heteroscedasticity) reported in parentheses. Scripts *, ** and *** correspond to significance at the 10%, 5% and 1% levels, respectively. The 7 small countries are Bolivia, Costa Rica, Dominican Republic, Ecuador, Panama, Paraguay, and Uruguay. The large countries are Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela.

Table 4.8

Two-Stage Least Squares (2SLS) Regression Results. Dependent variable: economic growth.

	International trade = Trade Flows/GDP			International trade = Exports/GDP		
International trade	4.944**	5.014**	5.802**	4.068**	4.122**	4.527**
	(2.189)	(2.122)	(2.536)	(1.791)	(1.740)	(1.974)
Crisis	-1.179*	-2.529***	-2.420***	-1.215**	-2.490***	-2.418***
	(0.626)	(0.745)	(0.737)	(0.617)	(0.727)	(0.725)
Boom		2.070***	1.800***		1.954***	1.774***
		(0.607)	(0.659)		(0.608)	(0.646)
Large			2.253*			1.408*
			(1.236)			(0.789)
Initial	-0.162	-0.196	-1.111*	-0.642	-0.680	-1.299**
	(0.777)	(0.748)	(0.587)	(0.670)	(0.647)	(0.590)
Population growth	-2.963***	-2.766***	-3.194***	-2.816***	-2.627***	-2.881***
	(1.013)	(1.003)	(1.168)	(0.959)	(0.952)	(1.053)
Investment	5.472***	5.827***	5.239***	6.422***	6.770***	6.495***
	(1.615)	(1.579)	(1.750)	(1.430)	(1.400)	(1.444)
Government size	1.549	2.177	1.497	1.069	1.655	1.179
	(2.136)	(2.037)	(1.741)	(1.924)	(1.832)	(1.622)
R.E. exchange rate	-3.346**	-1.638	-2.126	-3.003**	-1.386	-1.666
	(1.532)	(1.583)	(1.623)	(1.484)	(1.517)	(1.510)
Institutions	-1.098	-0.967	-0.812	-0.759	-0.630	-0.500
	(0.699)	(0.684)	(0.624)	(0.579)	(0.570)	(0.527)
Constant	-15.56	-26.98	-17.37	-8.590	-19.29	-12.52
	(17.64)	(16.94)	(12.90)	(14.66)	(14.09)	(11.33)
Observations	252	252	252	252	252	252
R-squared	9.0%	13.2%	14.0%	12.6%	16.4%	16.4%
Durbin-Wu-Hausman endogeneity test (p-value)	0.062	0.026	0.024	0.085	0.028	0.026
Kleibergen-Paap under identification test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
Cragg-Donald weak identification test (F-stat)	27.85	28.63	31.11	35.42	37.16	37.74
Number of countries	14	14	14	14	14	14

Notes: Robust standard errors (White corrected for heteroscedasticity) reported in parentheses. Scripts *, ** and *** correspond to significance at the 10%, 5% and 1% levels, respectively. Instrumented variable international trade. Instrumental variable: Kilian's (2009) real economic activity index based on dry-carg single voyage ocean shipping freight rates. Crisis is a binary variable equal to one in the crisis years from 2007 to 2009; otherwise zero. Boom is a binary variable equal to one in the commodity boom years from 2003 to 2010; otherwise zero. Large is a binary variable equal to one for the following large Latin American countries: Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela; otherwise zero.

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APPENDIX A

APPENDIX A

BAI-PERRON STRUCTURAL BREAK TEST SPECIFICATIONS AND TABLES.

Dependent variable: CRB-TRCC

Dependent Variable: CRB_TRCC
Method: Least Squares with Breaks
Date: 07/11/17 Time: 08:44
Sample: 1995M01 2015M12
Included observations: 252
Break type: Bai-Perron tests of 1 to M globally determined breaks
Break selection: Unweighted max-F (UDmax), Trimming 0.15, , Sig. level 0.05
Break: 2004M01
HAC standard errors & covariance (Quadratic-Spectral kernel, Andrews bandwidth)
Allow heterogeneous error distributions across breaks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	1995M01 - 2003M12 -- 108 obs			
C	127.2747	2.331636	54.58602	0.0000
	2004M01 - 2015M12 -- 144 obs			
C	285.1628	9.777191	29.16613	0.0000

R-squared	0.784556	Mean dependent var	217.4965
Adjusted R-squared	0.783694	S.D. dependent var	88.38802
S.E. of regression	41.10814	Akaike info criterion	10.27819
Sum squared resid	422469.7	Schwarz criterion	10.30621
Log likelihood	-1293.052	Hannan-Quinn criter.	10.28947
F-statistic	910.3926	Durbin-Watson stat	0.150510
Prob(F-statistic)	0.000000		

Dependent variable: CRB-BLS

Dependent Variable: CRB_BLS
Method: Least Squares with Breaks
Date: 07/11/17 Time: 08:46
Sample: 1995M01 2015M12
Included observations: 252
Break type: Bai-Perron tests of 1 to M globally determined breaks
Break selection: Unweighted max-F (UDmax), Trimming 0.15, , Sig. level 0.05
Breaks: 2006M05, 2010M08
HAC standard errors & covariance (Quadratic-Spectral kernel, Andrews bandwidth)
Allow heterogeneous error distributions across breaks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	1995M01 - 2006M04 -- 136 obs			
C	264.6971	2.167312	122.1315	0.0000
	2006M05 - 2010M07 -- 51 obs			
C	389.7408	6.643820	58.66215	0.0000
	2010M08 - 2015M12 -- 65 obs			
C	478.5366	7.970024	60.04205	0.0000

R-squared	0.847000	Mean dependent var	345.1606
Adjusted R-squared	0.845771	S.D. dependent var	100.2865
S.E. of regression	39.38453	Akaike info criterion	10.19646
Sum squared resid	386234.2	Schwarz criterion	10.23847
Log likelihood	-1281.754	Hannan-Quinn criter.	10.21336
F-statistic	689.2238	Durbin-Watson stat	0.130863
Prob(F-statistic)	0.000000		

Dependent variable: REA

Dependent Variable: REA
Method: Least Squares with Breaks
Date: 07/11/17 Time: 08:47
Sample: 1995M01 2015M12
Included observations: 252
Break type: Bai-Perron tests of 1 to M globally determined breaks
Break selection: Unweighted max-F (UDmax), Trimming 0.15, , Sig. level 0.05
Breaks: 2003M04, 2011M01
HAC standard errors & covariance (Quadratic-Spectral kernel, Andrews bandwidth)
Allow heterogeneous error distributions across breaks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	1995M01 - 2003M03 -- 99 obs			
C	-0.110054	0.028347	-3.882422	0.0001
	2003M04 - 2010M12 -- 93 obs			
C	0.317600	0.036038	8.812941	0.0000
	2011M01 - 2015M12 -- 60 obs			
C	-0.199068	0.055682	-3.575079	0.0004

R-squared	0.627953	Mean dependent var	0.026577
Adjusted R-squared	0.624965	S.D. dependent var	0.284747
S.E. of regression	0.174379	Akaike info criterion	-0.643333
Sum squared resid	7.571637	Schwarz criterion	-0.601316
Log likelihood	84.05999	Hannan-Quinn criter.	-0.626426
F-statistic	210.1351	Durbin-Watson stat	0.279508
Prob(F-statistic)	0.000000		

Dependent variable: Interaction between CRB-TRCC and REA.

Dependent Variable: INTERACT
Method: Least Squares with Breaks
Date: 07/12/17 Time: 11:03
Sample: 1995M01 2015M12
Included observations: 252
Break type: Bai-Perron tests of 1 to M globally determined breaks
Break selection: Unweighted max-F (UDmax), Trimming 0.15, , Sig. level 0.05
Breaks: 2003M10, 2011M01
HAC standard errors & covariance (Quadratic-Spectral kernel, Andrews bandwidth)
Allow heterogeneous error distributions across breaks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	1995M01 - 2003M09 -- 105 obs			
C	-10.73840	0.480335	-22.35606	0.0000
	2003M10 - 2010M12 -- 87 obs			
C	96.67989	13.89375	6.958517	0.0000
	2011M01 - 2015M12 -- 60 obs			
C	-52.05500	13.98318	-3.722688	0.0002

R-squared	0.622921	Mean dependent var	16.50920
Adjusted R-squared	0.619893	S.D. dependent var	76.67446
S.E. of regression	47.27199	Akaike info criterion	10.56155
Sum squared resid	556425.5	Schwarz criterion	10.60356
Log likelihood	-1327.755	Hannan-Quinn criter.	10.57845
F-statistic	205.6699	Durbin-Watson stat	0.276442
Prob(F-statistic)	0.000000		

APPENDIX B

APPENDIX B

S&P LATIN AMERICA 40 INDEX: CONSTITUENTS AS OF JANUARY 31, 2018.

Ticker	Name	Weight (%)	Sector	Country
ITUB	ITAU UNIBANCO HOLDING ADR REP PRE	10.1	Financials	Brazil
VALE	VALE ADR REPRESENTING ONE SA	8.7	Materials	Brazil
BBD	BANCO BRADESCO ADR REPTG PREF SA	7.4	Financials	Brazil
ABEV	AMBEV ADR REPRESENTING ONE SA	5.8	Consumer Staples	Brazil
PBRA	PETROLEO BRASILEIRO ADR REPTG PRE	5.0	Energy	Brazil
AMXL	AMERICA MOVIL L	4.2	Telecommunication Services	Mexico
FEMSAUBD	FOMENTO ECONOMICO MEXICANO	4.0	Consumer Staples	Mexico
PBR	PETROLEO BRASILEIRO ADR REPTG SA	3.8	Energy	Brazil
GFNORTEO	GPO FINANCE BANORTE	3.4	Financials	Mexico
BVMF3	B3 BRASIL BOLSA BALCAO SA	3.2	Financials	Brazil
ITSA4	ITAUSA INVESTIMENTOS ITAU PREF SA	3.2	Financials	Brazil
BAP	CREDICORP LTD	3.0	Financials	Peru
BBAS3	BANCO DO BRASIL S/A	2.6	Financials	Brazil
GMEXICOB	GRUPO MEXICO B	2.4	Materials	Mexico
WALMEX	WALMART DE MEXICO V	2.4	Consumer Staples	Mexico
FALABELLA	S.A.C.I. FALABELLA	2.3	Consumer Discretionary	Chile
CEMEXCPO	CEMEX CPO	2.3	Materials	Mexico
UGPA3	ULTRAPAR PARTICIPOES SA	2.1	Energy	Brazil
CIEL3	CIELO S/A	1.8	Information Technology	Brazil
TLEVISACPO	GRUPO TELEVISA	1.7	Consumer Discretionary	Mexico
COPEC	EMPRESAS COPEC S.A.	1.7	Energy	Chile
KROT3	KROTON EDUCACIONAL SA	1.5	Consumer Discretionary	Brazil

BRFS	BRF ADR REPRESENTING SA	1.3	Consumer Staples	Brazil
ENIA	ENEL AMERICAS ADR REPRESENTING SA	1.3	Utilities	Chile
LTM	LATAM AIRLINES GROUP ADR REPRESENT	1.2	Industrials	Chile
CCRO3	COMPANHIA CONCESSOES RODOVIARIAS S	1.2	Industrials	Brazil
BSAC	BANCO SANTANDER CHILE ADR REPRESEN	1.0	Financials	Chile
SQM	SOCIEDAD QUIMICA Y MINERA DE CHILE	1.0	Materials	Chile
CIB	BANCOLOMBIA ADR REPRESENTING PREF	1.0	Financials	Colombia
FUNO11	FIBRA UNO ADMINISTRACION REIT SA	1.0	Financials	Mexico
CMPC	EMPRESAS CMPC S.A.	1.0	Materials	Chile
CHILE	BANCO DE CHILE	0.9	Financials	Chile
ERJ	EMBRAER ADR REPRESENTING FOUR SA	0.9	Industrials	Brazil
EC	ECOPETROL ADR REPRESENTING SA	0.8	Energy	Colombia
SCCO	SOUTHERN COPPER CORP	0.8	Materials	Peru
CENCOSUD	CENCOSUD S.A.	0.8	Consumer Staples	Chile
GGB	GERDAU SA ADR REPRESENTING PREF	0.8	Materials	Brazil
ALFAA	ALFA A	0.7	Industrials	Mexico
EOCC	ENEL GENERACIAN CHILE ADR REPRESEN	0.6	Utilities	Chile
IENOVA	INFRAESTRUCTURA ENERGETICA NOVA	0.5	Utilities	Mexico
CIG	COMPANHIA ENERGETICA MINAS GERAIS	0.4	Financials	Brazil

Source: S&P Dow Jones Indices.

BIOGRAPHICAL SKETCH

Andre Coelho Vianna earned the degree of Doctor of Philosophy in Business Administration with concentration in Finance at the University of Texas Rio Grande Valley in 2018. He received his Master's in Public Economics from the University of Brasilia in 2014 and his Executive MBA in Corporate Finance from IBMEC in Rio de Janeiro in 2002. He received his Bachelor of Science degree in Production Engineering from Universidade Federal Fluminense in Rio de Janeiro in 2000. He has worked as a teaching and research assistant at the Department of Economics and Finance at UTRGV while pursuing his doctorate degree. His work has been published in the peer-reviewed journals: International Review of Financial Analysis, Journal of Asian Economics, Journal of Economics and Business, Research in International Business and Finance, Journal of Economics and Finance, and Revista Nova Economia.

Dr. Vianna is a federal auditor of finance and control at the Brazilian National Treasury, located at the Ministry of Finance of Brazil, since 2007. His professional background in the public sector includes assignments as financial analyst at the Treasury's public debt operations department and as coordinator of the economic advisory department at the Finance Minister's Office. Previously, he worked in the private sector as general manager and financial analyst for two large companies in Brazil. He is married to Caroline B. Vianna and is the father of two girls, Isadora and Gabriela. Dr. Andre Vianna can be reached at the Ministry of Finance of Brazil, Minister's Office, Esplanada dos Ministerios, Bloco P, 5o andar, Brasilia, DF, Brazil 70048-900 or via email: andre.vianna@fazenda.gov.br.