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Research Article

Oil price and financial markets contagion in Pacific Alliance economies during the first two decades of the 21st century

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Abstract

This research studies whether fluctuations in Brent crude prices propagated to the exchange rate and equity markets of the Pacific Alliance (Chile, Colombia, Mexico, Peru) between 2000-2019. This period includes the formation of the block and excludes the structural change caused by the COVID-19 pandemic. Structural var models are employed by country to filter monthly returns, and eight contagion tests are applied: Pearson, Spearman, and Kendall correlations; Forbes-Rigobon adjusted correlation; local Gaussian bootstrap statistics; X^2 covolatility test; and two third-order co-bias tests. Calm and crisis regimes are identified using the Lunde-Timmermann bull/bear algorithm and the Mohaddes-Pesaran realized volatility classifier. The evidence is replicated excluding the 2007-2009 global financial crisis. Results show a marked asymmetry: currency contagion is strong and persistent in Mexico and Chile, moderate in Colombia, and sporadic in Peru. In contrast, stock market contagion is significant only in Colombia and Peru. These findings indicate that homogeneous policy responses within the Alliance may not be effective, and that investors must hedge currency and stock market risks in a differentiated manner.

Keywords: financial contagion; Pacific Alliance; comovement tests; exchange rate; stock market; oil market.

Precio del petróleo y contagio de los mercados financieros en las economías de la Alianza del Pacífico durante las dos primeras décadas del siglo XXI

Resumen

Esta investigación estudia si las fluctuaciones en los precios del crudo Brent se propagaron a los mercados cambiarios y de acciones de la Alianza del Pacífico (Chile, Colombia, México, Perú) entre 2000-2019. Este periodo incluye la formación del bloque y excluye el cambio estructural provocado por la pandemia de COVID-19. Se emplean modelos VAR estructurales por país para filtrar los rendimientos mensuales, y se aplican ocho pruebas de contagio: correlaciones de Pearson, Spearman y Kendall; correlación ajustada de Forbes-Rigobon; estadística de arranque gaussiana local; prueba de covolatilidad X^2; y dos pruebas de co-sesgo de tercer orden. Los regímenes de calma y crisis se identifican mediante el algoritmo alcista/bajista de Lunde-Timmermann y el clasificador de volatilidad realizada de Mohaddes-Pesaran. Las pruebas se replican excluyendo la crisis financiera global de 2007-2009. Los resultados muestran una marcada asimetría: el contagio cambiario es fuerte y persistente en México y Chile, moderado en Colombia y esporádico en Perú. En contraste, el contagio bursátil es significativo solo en Colombia y Perú. Estos hallazgos indican que las respuestas políticas homogéneas dentro de la Alianza podrían no ser efectivas, y que los inversionistas deben cubrir riesgos cambiarios y bursátiles de forma diferenciada.

Palabras clave: contagio financiero; Alianza del Pacífico; pruebas de movimiento; tipo de cambio; mercado de valores; mercado petrolero.

Contágio do preço do petróleo e dos mercados financeiros nas economias da Aliança do Pacífico durante as duas primeiras décadas do século XXI

Resumo

Esta pesquisa estuda se as flutuações nos preços do petróleo Brent se propagaram para os mercados cambial e acionário da Aliança do Pacífico (Chile, Colômbia, México, Peru) entre 2000 e 2019. Esse período inclui a formação do bloco e exclui a mudança estrutural provocada pela pandemia de COVID-19. Utilizam-se Modelos VAR estruturais para filtrar os retornos mensais, e aplicam-se oito testes de contágio: correlações de Pearson, Spearman e Kendall; correlação ajustada de Forbes-Rigobon; estatística bootstrap gaussiana local; teste de covolatilidade X^2; e dois testes de co-sesgo de terceira ordem. Os regimes de calma e crise são identificados por meio do algoritmo de alta/baixa de Lunde-Timmermann e do classificador de volatilidade realizada de Mohaddes-Pesaran. Os testes são replicados excluindo a crise financeira global de 2007-2009. Os resultados mostram uma marcada assimetria: o contágio cambial é forte e persistente no México e no Chile, moderado na Colômbia e esporádico no Peru. Em contraste, o contágio acionário é significativo apenas na Colômbia e no Peru. Esses achados indicam que respostas políticas homogêneas dentro da Aliança podem não ser eficazes e que os investidores devem cobrir riscos cambiais e acionários de forma diferenciada.

Palavras-chave: contágio financeiro; Aliança do Pacífico; testes de comovimento; taxa de câmbio; mercado de ações; mercado de petróleo.

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1. Introduction

Financial contagion—the cross-market transmission of shocks—has become a core subject in international finance because it helps to explain why local disturbances so often escalate into region-wide crises. Within this broad field, sizeable literature analyses linkages between energy prices and financial assets. One strand measures unconditional or regime-specific correlations, concluding that oil and equity markets are only loosely connected in tranquil times but move together under stress (Wen et al., 2012; Baruník & Kočenda, 2018). A second strand focuses on volatility and higher-order co-moments, reporting that oil shocks materially affect risk pricing, especially during global downturns (Reboredo et al., 2014; Ding et al., 2017). A third and newer strand applies non-linear or state-dependent techniques—copulas, local Gaussian correlations—to uncover asymmetric spill-overs that standard correlation tests miss (Jin & An, 2016; Anastasopoulos, 2018). These strands concur that oil-asset linkages are weak in tranquil periods but tighten sharply when global stress events hit. Despite these advances, most evidence still concerns advanced economies; only a handful of studies analyze emerging markets, and those that do often treat them in isolation rather than as part of a regional system (Jamaladeen et al., 2022; Meskini & Chaibi, 2024).

The Pacific Alliance (PA)—a trade-and-financial integration project initiated in 2011 by Chile, Colombia, Mexico, and Peru—offers a natural laboratory to extend the emergingmarket lens. Together, the four economies account for almost 40 per cent of Latin American GDP, three-quarters of the region's equity capitalization, and more than half of its sovereign bond issuance. Institutionally, the bloc is anchored in a Council of Finance Ministers, an Integrated Latin American Market (MILA) that grants mutual access to stock exchanges, and reciprocal swap lines among the four central banks. Yet the PA is also internally heterogeneous: Colombia and Mexico are net oil exporters, while Chile and Peru are net importers; inflationtargeting regimes are common, but fiscal rules and capitalaccount openness differ notably. Understanding how oil shocks propagate through this mixed structure is therefore essential for both investors and policymakers, yet the question has not been examined.

This paper fills that gap by providing the first systematic assessment of oil-price contagion in PA financial markets. The sample goes from January 2000 to December 2019, thereby capturing the Alliance's formative years—including the 2007-09 Global Financial Crisis (GFC) and the 2014-15 oil-price collapse—while deliberately stopping before the structural break created by the COVID-19 pandemic and the 2022-23 energy-price surge. The resulting window offers a clean historical benchmark against which post-pandemic dynamics can later be evaluated.

Methodologically, the estimations include eight complementary tools: three unconditional dependency measures (Pearson, Spearman, and Kendall), the Forbes-Rigobo variance-adjusted correlation, a local Gaussian bootstrap test, a co-volatility test, and two third-order co-bias statistics. Crisis and calm regimes are dated with the rule-based bull/bear algorithm of Lunde & Timmermann and the realized-volatility clustering of Mohaddes & Pesaran. Each specification is estimated twice—on the full sample and on a sub-sample that excludes the GFC—to isolate the influence of that singular event.

Findings reveal a sharp exporter-importer asymmetry. Exchange-rate contagion is strong and persistent in Mexico and Chile, moderate in Colombia, and episodic in Peru, while equity-market contagion is significant only in Colombia and Peru. These results imply that a one-size-fits-macro-financial response within the PA is unlikely to succeed and that hedging strategies must be tailored by asset class and country. More broadly, the paper contributes to the literature by (i) extending energy–finance contagion tests to a multicountry emergingmarket bloc; (ii) demonstrating how exporter status shapes, but does not fully determine, contagion channels; and (iii) establishing a preCOVID baseline against which future studies can measure the impact of pandemicera policy innovations.

The remainder of the article proceeds as follows. Section 2 reviews the relevant literature with an emphasis on emergingmarket evidence. Section 3 describes the data, regime-dating strategies, and econometric methods. Section 4 presents empirical results, and Section 5 discusses policy and investment implications, outlines limitations, and proposes an agenda to extend the analysis into the post-2020 period.

2. Related literature review

Researchers study the links between financial markets to explore whether increased comovements are related to interdependence or financial contagion (Gencer & Demiralay, 2016). Beirne & Gieck (2014) define interdependence as the relationship between financial markets. They also define contagion as the change in the transmission mechanism between financial markets in crisis times. Researchers have employed financial contagion methodologies to examine the relationship between energy prices and financial markets.

One common approach to study contagion is to estimate Pearson's correlations (ρ_{Person}) between two assets' returns (r_i and r_j in different markets), in stable and crisis periods. Contagion may increase the correlation between a crisis and a stable period (see Samarakoon (2011) for a discussion. Using this approach, Ghorbel & Boujelbene (2013) and Mezghani & Boujelbène (2018) find evidence of contagion between oil prices in Brazil, Russia, India, and China (BRIC) stock markets and Islamic stock market, respectively. Aloui et al. (2013) and Zhang & Liu (2018) employ Pearson's correlation to assess the contagion between oil and stock markets in the Central and Eastern European (CEE) transition economies, finding that it happens between those markets.

Other authors use Spearman's ρ ($\rho_{spearman}$) and Kendall's τ ($\tau_{Kendall}$) as an outlier-robust alternative to Pearson's correlations to measure contagion. For example, Reboredo (2013) examines the dependence structure between crude oil markets and European Union allowances (EUAs), suggesting interdependence and no contagion effects. With this same approach, Wen et al. (2012) find contagion between WTI oil spot price and S&P500, Shanghai composite, and Shenzhen indices.

Forbes & Rigobon (2002) argue that given that ρ_{Person} is conditional to market volatility, a greater correlation in periods of turbulence does not necessarily mean contagion. Furthermore, in the presence of heteroscedastic market returns, the linear correlation between markets may be skewed upward after a crisis. To correct for heteroscedasticity, Forbes & Rigobon (2002) propose the following adjusted estimator for the crisis period (*C*) ($\hat{v}_{C|NC}$) using data from the calm period (*NC*):

$$\hat{v}_{C|NC_i} = \frac{\hat{\rho}_C}{\sqrt{1+\left(\left(s_{C_i}^2 - s_{NC_i}^2\right)/s_{NC_i}^2\right)\left(1-\hat{\rho}_C^2\right)}} \tag{1}$$

where s_{NCi}^2 and s_{Ci}^2 are the return's standard deviations in the international market of oil i in *NC* (calm) and *C* (crisis) periods of the oil market, respectively. $\hat{\rho}_C$ is the ρ_{Person} estimator of the oil market and the market index in times of crisis.

Using the Forbes & Rigobon (2002) – F&R estimator, Guesmi et al. (2018) test for the existence of contagion from oil prices to stock market in the European Monetary Union (EMU), Asia-Pacific, Non- EMU countries, and North America (United States of America (US) and Canada), finding that oil price fluctuations amplify contagion in the context of regional markets strongly interlinked with the US. Other authors use F&R approach: Meskini & Chaibi (2024) study the contagion of the Tunisian revolution on the Egyptian stock market finding interdependence between the two economies; Aye et al. (2024) examined contagion involving the aggregate and regional housing markets of the United States (US) with other asset markets during the 2007–2008 global financial crisis.

Fry et al. (2010) and Fry-McKibbin et al. (2014) propose a test to compare the adjusted correlation ($\hat{v}_{C|NC}$) and the correlation in the calm period ($\hat{\rho}_{CN}$) of the source market to the recipient market *j*. They built the adjusted linear correlation contagion statistic ($CR_{\overline{FR}}(i \to j)$) as:

$$CR_{\overline{FR}}(i \to j) = \left(\frac{\hat{v}_{C|NC_i} - \hat{\rho}_{NC}}{\sqrt{Var\left(\hat{v}_{C|NC_i} - \hat{\rho}_{NC}\right)}}\right)^2 \tag{2}$$

These authors show that under the null hypothesis of no contagion $CR_{\overline{FR}}(i \to j)$ follows asymptotically a Chi-square distribution with one degree of freedom.

Mahadeo et al. (2019) use the adjusted linear correlation contagion test to analyze the contagion effect of oil prices on Trinidad and Tobago´s stock market and exchange rate. They find a negative oil-real effective exchange rate dependency, a weak oil-stock returns association, and the existence of energy contagion in both financial relationships. Jamaladeen et al. (2022) also use it to study the contagion and structural break between selected African stock markets, finding a moderate contagion from the Nigerian stock exchange to the South African stock exchange in a crisis period, which it is not reversed in calm periods.

Tjostheim & Hufthammer (2013) introduce the concept of local Gaussian correlation (ψ) as an alternative to measure local dependence. They suggest the following estimator:

$$\psi\left(v,\mu_1(x),\mu_2(x),\sigma_1^2(x),\sigma_2^2(x),\rho(x)\right) = \frac{1}{2\pi\sigma_1(x)\sigma_2(x)\sqrt{1-\rho^2(x)}} \times e^{-\frac{1}{2}\frac{1}{1-\rho^2(x)}\left(\frac{(v_1-\mu_1(x))^2}{\sigma_1^2(x)} + \frac{(v_2-\mu_2(x))^2}{\sigma_2^2(x)} - 2\rho(x)\times\frac{(v_1-\mu_1(x))(v_2-\mu_2(x))}{\sigma_1(x)\sigma_2(x)}\right)}, \tag{3}$$

where $v=(v_1,v_2)^T$ is the vector with the tested variable in this Gaussian distribution (v_1 and v_2 are the oil and stock markets, respectively); $\mu(x)=(\mu_1(x),\mu_2(x))^T$ is the local mean vector; $\sigma_i^2(x)=\sigma_i(x)\sigma_i(x)$ is the local variance; and $\rho(x)=(\sigma_{12}(x))/(\sigma_1(x)\sigma_2(x))$ is the local correlation of point $x=(i,j)$. Tjostheim & Hufthammer (2013) mentions three disadvantages of the conditional correlation concept that justify their approach. First, introducing a function to define the local region implies that the correlation in that region is different from the global correlation for two joint Gaussian variables. Second, the conditional correlation is defined for a local region, not for a pair of points of two joint Gaussian variables. Finally, the conditional correlation employs linear dependence for the local regions

Employing the ψ, Støve et al. (2014) present a bootstrap test for contagion to evaluate the correlation between market increases in times of crisis. Contagion occurs when the local correlation function during the crisis period (*C*) is significantly above the local correlation function during the calm period (*NC*). Therefore, the no-contagion null hypothesis is true when $\rho_{NC}(x_i,y_i) = \rho_C(x_i,y_i)$ for $i = 1,\dots,n$; thus, under the alternative hypothesis of contagion $\sum n(i=1)(\rho C(x_i,y_i) - \rho NC(x_i,y_i))>0$. The bootstrap method to assess this null hypothesis involves drawing at random and, with replacement, a random sample $\{d_1^*,\dots,d_T^*\}$ from the actual filtered observations $\{d_1,\dots,d_T\}$. The next step is to divide bootstrapped samples into periods of calm (*NC*) and crisis (*C*) and calculate $\hat{\rho}^*_{CN}$ and $\hat{\rho}^*_{CN}$ in a grid (*xi,yi*) for all $i = 1,\dots n$. Subsequently, the corresponding statistic is $D_1^*=1/n\sum^{n}_{(i=1)}$

$[\rho^*_C(x_i,x_j) - \rho^*_{NC}(x_i,x_j)]w(x_i,x_j)$. Where w_i is a weight function to filter parts of the local correlation or to focus on a particular region.

Bampinas and Panagiotidis (2017) employ the local Gaussian correlation method to investigate the contagion between oil prices and the stock markets of Mexico, Thailand, and the United States, both prior to and following financial crises. Their findings indicate that the 2007–2009 financial crisis intensified the interdependence between oil and stock markets. Similarly, Yuan et al. (2021) explore the contagion between oil prices and BRIC stock markets in the context of the COVID-19 pandemic. Their study reveals that the connections between oil and BRIC stock markets, except China, experienced a significant increase during the pandemic. Heinlein et al. (2020) examine the relationship between oil prices and the stock markets of selected oil-importing countries (Japan, China, and Sweden) and oil-exporting countries (Canada, Norway, and Russia) during the COVID-19 pandemic. Their findings indicate evidence of contagion between oil and stock markets across all the countries studied. Dimitriou et al. (2025) employ the local Gaussian correlation as a methodological tool to examine the impact of non-synchronous trading on volatility spillover in the G-7 equity markets during the Eurozone Sovereign Debt Crisis (ESDC) and the COVID-19 pandemic crisis.

Fry-McKibbin et al. (2014) and Fry-McKibbin & Hsiao, 2018 propose a contagion test to evaluate the differences between market correlations in calm and crisis periods as a function of changes in co-volatility. Co-volatility contagion from oil prices occurs when the oil price's volatility (i) affects the volatility of a market j. The authors suggest the following metric to measure the co-volatility from market i to market j ($CV(i \rightarrow j; r_i^2, r_j^2)$):

$$CV(i \rightarrow j; r_i^2, r_j^2) = \left(\frac{\hat{\xi}_C(r_i^2, r_j^2) - \hat{\xi}_{NC}(r_i^2, r_j^2)}{(4\hat{v}^4_{C|NC_i} + 16\hat{v}^2_{C|NC_i} + 4)/T_C + (4\hat{\rho}^4_{NC} + 16\hat{\rho}^2_{NC} + 4)/T_{NC}}\right)^2 \quad (4)$$

where $\hat{\xi}_{NC}(r_i^2, r_j^2)$ and $\hat{\xi}_C(r_i^2, r_j^2)$ are standardization parameters defined as:

$$\hat{\xi}_{NC}(r_i^2, r_j^2) = \frac{1}{T_{NC}}\sum_{t=1}^{T_{NC}}\left(\frac{NC_{i,t} - \hat{\mu}_{NCi}}{\hat{\sigma}_{NCi}}\right)^2\left(\frac{NC_{j,t} - \hat{\mu}_{NCj}}{\hat{\sigma}_{NCj}}\right)^2 - (1 + 2\hat{\rho}^2_{NC})$$

$$\hat{\xi}_C(r_i^2, r_j^2) = \frac{1}{T_C}\sum_{t=1}^{T_C}\left(\frac{C_{i,t} - \hat{\mu}_{Ci}}{\hat{\sigma}_{Ci}}\right)^2\left(\frac{C_{j,t} - \hat{\mu}_{Cj}}{\hat{\sigma}_{Cj}}\right)^2 - (1 + 2\hat{v}^2_{C|NC_i})$$

They show that under the null hypothesis of no contagion this statistic follows asymptotically a Chi-square distribution with one degree of freedom. Zou et al. (2025) use co-volatility tests, among others, to explore the risk nexus between the US dollar (USD) market and China's major financial assets.

Another approach to determine contagion is to use second, third, and fourth-order moments. Fry et al. (2010) propose two third-order co-moment contagion tests to evaluate the differences between market correlations in calm and crisis periods based on the co-bias changes. Co-bias contagion can occur in one of two ways. First, it occurs when the average behavior of one market affects the volatility of another. Fry et al. (2010) metric to capture this kind of co-bias contagion for oil prices contagion becomes:

$$CS_1(i \rightarrow j; r_i^1, r_j^2) = \left(\frac{\hat{\psi}_C(r_i^1, r_j^2) - \hat{\psi}_{NC}(r_i^1, r_j^2)}{\sqrt{(4\hat{v}^2_{C|NC_i} + 2)/T_C + (4\hat{\rho}^2_{NC} + 2)/T_{NC}}}\right)^2 \quad (5)$$

where r_i^1 and r_i^2 are the mean and standard deviation of the oil market returns; r_j^1 and r_j^2 are the mean and standard deviation of the returns on financial assets. T_{NC} and T_C are the oil market size in periods of calm and crisis, respectively; $\hat{\rho}_{CN}$ is the correlation between the oil market and exchange rates and market indices in a calm period.

$\hat{\psi}_{NC}(r_i^m, r_j^n)$ and $\hat{\psi}_C(r_i^m, r_j^n)$ are standardization parameters defined as:

$$\hat{\psi}_{NC}(r_i^m, r_j^n) = \frac{1}{T_{NC}}\sum_{t=1}^{T_{NC}}\left(\frac{NC_{i,t} - \hat{\mu}_{NCi}}{\hat{\sigma}_{NCi}}\right)^m\left(\frac{NC_{j,t} - \hat{\mu}_{NCj}}{\hat{\sigma}_{NCj}}\right)^n$$

$$\hat{\psi}_C(r_i^m, r_j^n) = \frac{1}{T_C}\sum_{t=1}^{T_C}\left(\frac{C_{i,t} - \hat{\mu}_{Ci}}{\hat{\sigma}_{NCi}}\right)^m\left(\frac{C_{j,t} - \hat{\mu}_{Cj}}{\hat{\sigma}_{Cj}}\right)^n,$$

where μ and σ are the mean and standard deviation, respectively, for a market i (oil price) or j (asset market) in a period NC (calm) or C (crisis). r^m and r^n are the average return for a market i and squared returns for a market j, respectively.

Fry et al. (2010) demonstrate that under the null hypothesis of no contagion $CS_1(i \rightarrow j; r_i^1, r_j^2)$ is asymptotically distributed as a one-degree of freedom Chi-square distribution.

Co-bias contagion could also occur when the volatility of one market affects the average behavior of another (Fry et al., 2010). The following statistic captures this case:

$$CS_2(i \rightarrow j; r_i^2, r_j^1) = \left(\frac{\hat{\psi}_C(r_i^2, r_j^1) - \hat{\psi}_{NC}(r_i^2, r_j^1)}{\sqrt{(4\hat{v}^2_{C|NC_i} + 2)/T_C + (4\hat{\rho}^2_{NC} + 2)/T_{NC}}}\right)^2 \quad (6)$$

In this case, r_m and r_n are the squared returns for a market i and average return for a market j, respectively. This statistic follows the same asymptotical distribution that CS_1. In this line, Mahadeo et al. (2019) also employ Co-volatility and Co-bias contagion tests, in addition to the adjusted linear correlation contagion test, to study the contagion of the oil stock market on Trinidad and Tobago's stock market. They identify multiple energy contagion routes inside financial ties that are responsive to the recent global financial crisis. Zou et al. (2025) employ co-volatility tests, among other methodologies, to investigate the risk relationship between the US currency (USD) market and China's principal financial assets. Harb and Umutlu (2024) employ the methodology of Fry et al. (2010) to examine contagion across various businesses and nations during the COVID-19 epidemic and the global financial crisis.

There are alternative methodologies to evaluate contagion; for instance, Cong et al. (2008), Park & Ratti (2008), Apergis & Miller (2009), Miller & Ratti (2009), and Filis (2010) employ Vector Autoregressive models (VAR) or Vector Error Correction Models (VECM) to investigate the impact of crude oil shocks on equity returns amidst financial crises. Wen et al. (2012) utilize time-varying copulas to examine the contagion effect between oil spot prices and the Shanghai and Shenzhen stock markets following the collapse of Lehman Brothers. Ding et al. (2017) apply principal component analysis to construct a Chinese stock market investor sentiment index and subsequently use a structural vector autoregression (SVAR) model to analyze the contagion effect of international crude oil price fluctuations on Chinese stock market investor sentiment. Oscelebi et al. (2025) employ a Quantile VAR to explore contagion between oil shocks and sectoral markets in the United States, arguing that their approach relaxes the assumption of a constant relationship across the entire distribution of variables.

Additional studies investigate the contagion effects of oil prices and exchange rates. Reboredo et al. (2014) explore the relationship between oil prices and the US dollar exchange rate using detrended cross-correlation analysis. Baruník & Kočenda (2018) examine asymmetric and frequency-connectedness between oil and forex markets utilizing high-frequency intraday data.

Nevertheless, no extant research has addressed the contagion effects between crude oil prices and stock markets during crisis periods in PA countries. This research endeavors to address this gap. The subsequent section outlines the data.

3. Data and empirical approach

To analyze the contagion of crude oil prices on stock and exchange rate markets in the PA countries during the initial two decades of this century, the approach follows Mahadeo et al. (2019) and monthly data spanning from January 2000 to December 2019. The series encompasses economic activity indices, energy market performance metrics, currency exchange rates, and stock market indices for the countries of the PA and the United States. Table A1 shows the series and their respective sources. The sample encompasses the duration of the Global Financial Crisis (GFC) from December 2007 to June 2009.

The proxy to oil prices is closing prices –USD/Barrel– for the Europe Brent crude oil (BRENT),[1] the reference for most world oil crudes outside the US and Canada. Figure 1 illustrates the oil price and returns over the whole range. From 2000 to the GFC, the oil price showed a rising tendency, whereas during the GFC it showed a negative trend. From 2014 to 2015, the oil price experienced a comparable decline. Each test has two rounds: the first uses the comprehensive 2000-2019 sample, while the subsequent employs a censored sample,[2] referred to as the GFC-excluded sub-sample, that does not consider the period from December 2007 to June 2009.

We use the Real Effective Exchange Rate index ($REER_j$) to measure the value of a country 's currency against an average group of major currencies, weighted by their trade flow. During the GFC, the REER increases as the price of oil decreases (see Figure 2). The REER decreases at the end of the crisis as the oil price increases.

The proxy for the stock market prices is the Composite Stock Price Index ($CSPI_j$) for each country j in the PA: the General Index of the Colombian Stock Exchange (IGBC) for Colombia, the Index of Prices and Quotations (IPC) for Mexico, the Selective Stock Price Index (IPSA) for Chile, and the S&P/BVL LIMA 25 (LIMA) for Peru. During the GFC, all CSPI indices dropped, like the drop in the international oil prices mentioned above (see Figure 3).

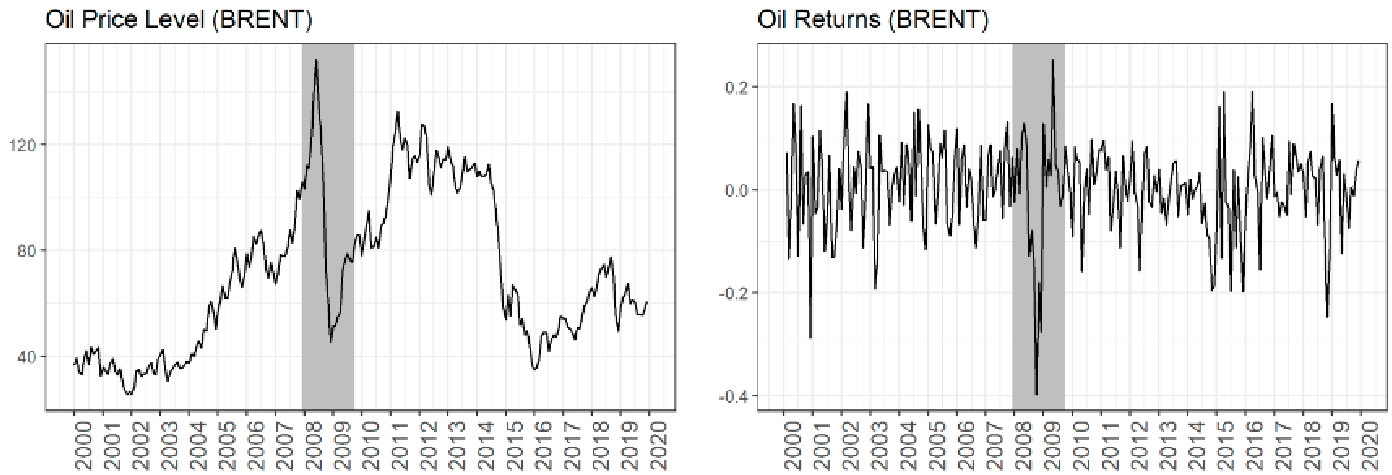
Since the US is the leading trading partner for each PA country, this research uses US Shadow Short Rates (SSR_{US}) to measure foreign economic activity. This series adjusts the exchange rate and stock market performance (See Figure 4). Finally, the following interest rates represent the economic and financial activity of each PA country: CB Total System Rate Ordinary Loans (IR_{COL}) for Colombia, MX Cost of Credit (IR_{MEX}) for México, CL Loan Interest Rate, Indexed – 90 to 365 (IR_{CHI}) for Chile, and PE Lending Rate (IR_{PER}) for Peru (see Figure 4).

Oil Prices (OP) (BRENT), exchange rates (REER), and stock indices (CSPI) continuous returns are the first differences in the natural logarithm. For the analysis, adjusted returns are essential to remove lead-lag effects and serial correlation from the return series (Mahadeo et al., 2019).

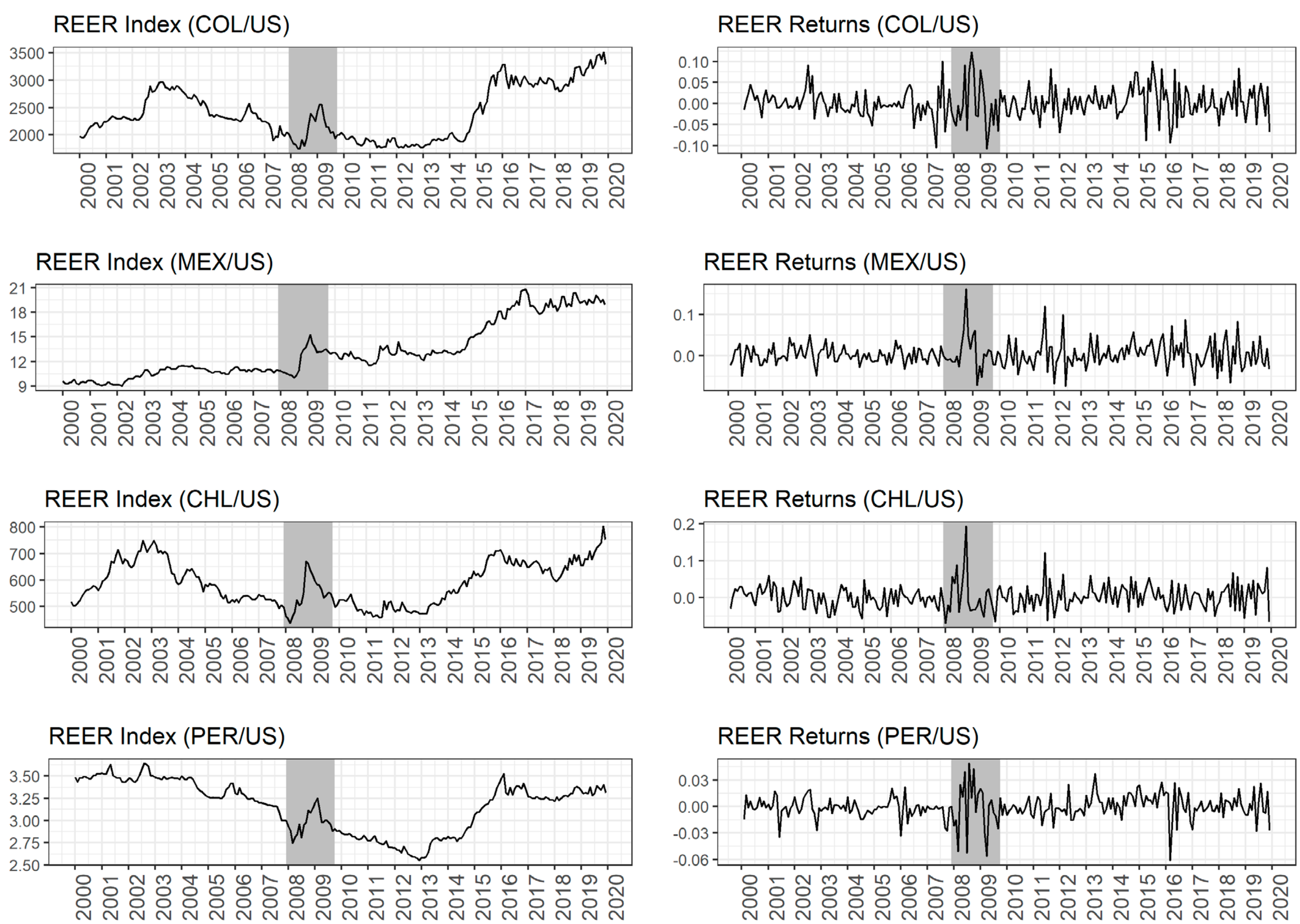
The adjusted financial returns come from a structural VAR system for each PA country. The endogenous variables are the log returns on the REER and the CSPI; the exogenous variables are the changes in IR, OP (BRENT), and SSR series. The SVAR is identified using a short-run AB scheme analogous to Kilian (2009): (i) The global oil-price

1 The analysis also includes West Texas Intermediate (WTI), available upon request. The results are virtually identical, regardless of whether Brent or WTI prices are used.

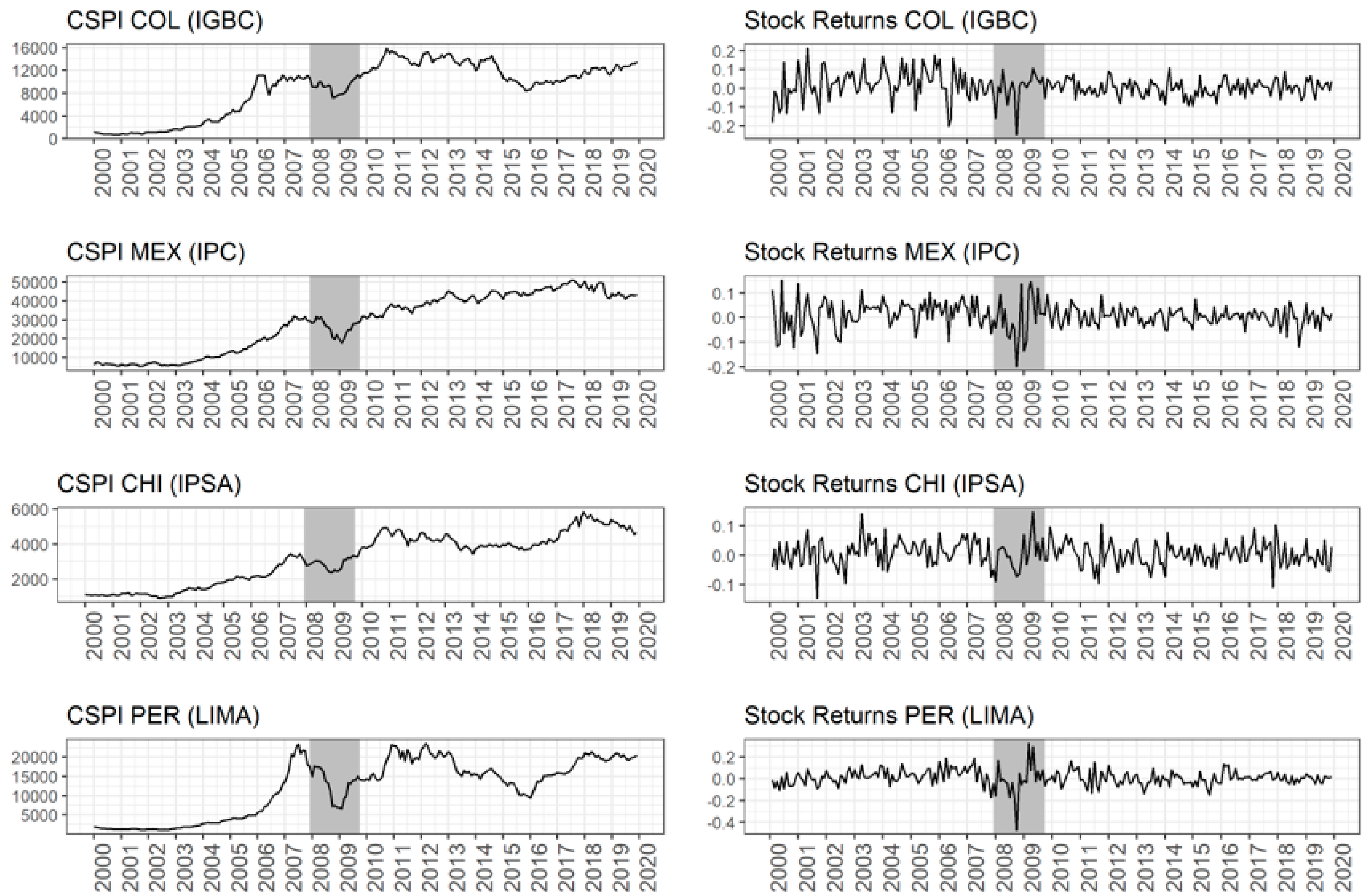
2 In this paper "censored sample" follows the wording of Mahadeo et al. (2019), who use the expression to denote a sub-sample that entirely omits the Global Financial Crisis (GFC). It does not refer to classical statistical censoring, where individual observations are partially observed or top-coded. Throughout the manuscript, "censored sample" should be read as shorthand for the GFC-excluded sub-sample (December 2007 – June 2009).



Note: The shaded area corresponds to the Great Financial Crisis (GFC).
Figure 1. Monthly closing oil price (level) and adjusted returns.
Source: own elaboration.



Note: The shaded area corresponds to the Great Financial Crisis (GFC).
Figure 2. Monthly REER (levels) and adjusted returns for Colombia, Mexico, Chile, and Peru.
Source: own elaboration.



Note: The shaded area corresponds to the Great Financial Crisis (GFC).
Figure 3. Monthly CSPI (levels) and adjusted returns for Colombia, Mexico, Chile, and Peru.
Source: own elaboration.

change shock (BRENT) is contemporaneously exogenous to domestic variables due to production rigidities; (ii) The real effective exchange rate (REER) change responds within the month to the oil shock but not to the stock-market index; (iii) The composite stock-price index (CSPI) return reacts contemporaneously to both BRENT and the REER changes, reflecting information arrival in local capital markets. This ordering (BRENT→REER→CSPI) pins down the A and B impact matrices and yields unique structural innovations.

The first step in obtaining adjusted returns is to estimate the optimal delay order using the AIC information criterion. Then, with successive autocorrelation tests, the appropriate number of lags is identified, such as the autocorrelation disappears. Using Heteroscedastic and autocorrelation-consistent (HAC) estimators for the standard errors, only the significant coefficients are considered, unlike Mahadeo et al. (2019). Finally, residuals are the adjusted returns.

In all cases, the variable SSR_{US} is not significant, therefore it was removed from the model. For Colombia, Mexico, and Chile, the models[3] are:

$$\Delta lnREER_t = \alpha_{10} + \alpha_{11}\Delta lnREERt_{-11} + \alpha_{12}\Delta lnREER_{t-12} + \alpha_{13}\Delta lnREER_{t-13} + \alpha_{14}\Delta lnREER_{t-14} + \alpha_{15}\Delta lnCSPI_{t-11} + \alpha_{16}\Delta lnCSPI_{t-12} + \alpha_{17}\Delta lnCSPI_{t-13} + \alpha_{18}\Delta lnCSPI_{t-14} + \alpha_{19}\Delta IR_{t-11} + \alpha_{110}\Delta IR_{t-12} + (\alpha_{111}IR_{t-13} + \alpha_{112}IR_{t-14} + \alpha_{113}\Delta lnOP_t + \varepsilon_t \quad (7)$$

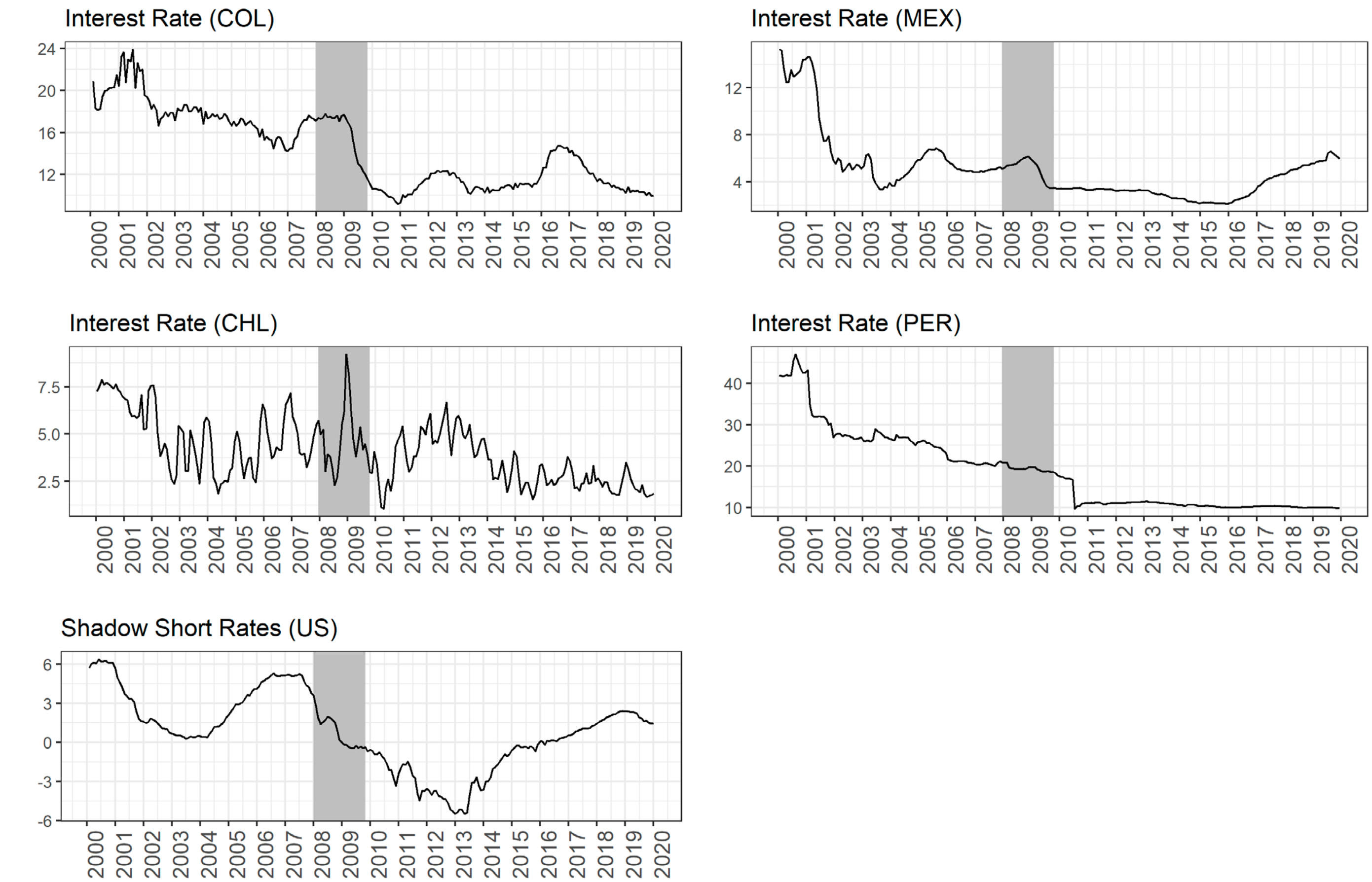
$$\Delta lnCSPI_t = \alpha_{20} + \alpha_{21}\Delta lnREERt_{-11} + \alpha_{22}\Delta lnREER_{t-12} + \alpha_{23}\Delta lnREER_{t-13} + \alpha_{24}\Delta lnREER_{t-14} + \alpha_{25}\Delta lnCSPI_{t-11} + \alpha_{26}\Delta lnCSPI_{t-12} + \alpha_{27}\Delta lnCSPI_{t-13} + \alpha_{28}\Delta lnCSPI_{t-14} + \alpha_{29}\Delta IR_{t-11} + \alpha_{210}\Delta IR_{t-12} + \alpha_{211}\Delta IR_{t-13} + \alpha_{212}I\Delta Rt_{-14} + \alpha_{213}\Delta lnOP_t + \varepsilon^t \quad (8)$$

For Peru, the equivalent models are:

$$\Delta lnREER_t = \alpha_{10} + \alpha_{11}\Delta lnREERt_{-11} + \alpha_{12}\Delta lnREER_{t-12} + \alpha_{13}\Delta lnCSPI_{t-11} + \alpha_{14}\Delta lnCSPI_{t-12} + \alpha_{15}\Delta IR_{t-11} + \alpha_{16}\Delta IR_{t-12} + \alpha_{17}\Delta lnOP_t + \varepsilon_t \quad (9)$$

$$\Delta lnCSPI_t = \alpha_{10} + \alpha_{11}\Delta lnREER_{t-11} + \alpha_{12}\Delta lnREER_{t-12} + \alpha_{13}\Delta lnCSPI_{t-11} + \alpha_{14}\Delta lnCSPI_{t-12} + \alpha_{15}\Delta IR_{t-11} + \alpha_{16}\Delta IR_{t-12} + \alpha_{17}\Delta lnOP_t + \varepsilon_t \quad (10)$$

3 Each series in levels is I(1), but due to space restrictions, there is no table of these results, which are available upon request. The SVAR model in equations (7)-(11) involves only stationary series.



Note: The shaded area corresponds to the Great Financial Crisis (GFC).
Figure 4. Monthly IR for Colombia, Mexico, Chile, and Peru and SSR.
Source: own elaboration.

For Oil prices (OP_t), the adjusted oil returns the model follows:

$$\Delta \ln OP_t = \alpha_0 + \alpha_1 \Delta \ln OP_{t-1} + \varepsilon_t \qquad (11)$$

Initially, the model included the SSR_{US} however, the final model did not include it due to its lack of significance. The next step is to adopt a strategy to identify calm and crisis periods in the energy market.

Before using contagion analysis tools, the crisis (*C*) and calm periods (*NC*) must be identified. The first two decades of this century cover various financial crises such as the Sub-prime crisis in 2007, the collapse of Lehman Brothers in 2008, the European debt crisis from 2010 to 2012, the collapse of oil prices (2014-2015), and Brexit in 2016. The estimations follow two strategies to identify calm and crisis periods in the oil market. The first strategy identifies booming/slumping periods as proxies for the BRENT crisis/calm periods. For the second strategy, the proxies are tranquil/turbulent volatility scenarios. A binary variable (0 if a month is calm and 1 otherwise) identifies the periods for all strategies. Thus, there are different data sets including a variable labeling each month as calm or crisis according to the booming/slumping or tranquil/turbulent approach.

Two rule-based algorithms, Pagan & Sossounov (2003) (P&S from now on) and Lunde & Timmermann (2004) (L&T from now on) identify the oil boom and slumps. Both approaches classify the series into bull and bear based on peaks and valleys, but differ in the criteria for selecting these extremes. P&S uses the condition's duration to label a month, and L&T uses the magnitude of price changes (Kole & van Dijk, 2017).

In P&S's approach, the stock market goes from bull to bear if prices have declined substantially from their previous peak. To determine the inflection points, the authors use the algorithm developed by Bry & Boschan (1971) and make modifications to maintain the outliers and avoid omitting essential behaviors. One modification is not to smooth the series and to define the size of the window $t - T_{window}$ and $t + T_{window}$ to determine if the oil price in month is above or below the other months of that window. Given the lack of smoothness in the series, the authors set $T_{window} = 8$ *months*. Besides, the authors modify the rule to decide the minimum time in any phase based on the Dow Theory developed by Charles Dow at the beginning of the century and popularized by Hamilton (1922). In this way, the authors establish a t_{censor} = *6 months* and t_{phase} = *4 months*.

L&T classifies markets in bull or bear periods by comparing the market index with two thresholds λ_1 and λ_2. λ_1 indicates the percentage change of a market from bear to bull, and λ_2 indicates the percentage change of a market from bull to bear. P&S suggests a filter with $\lambda_1 > \lambda_2$. Following Mahadeo et al. (2019), $\lambda_1 = 20\%$ and $\lambda_2 = 15\%$[4].

Applying both approaches to the sample, the identified crisis periods for the BRENT market are similar (gray columns in Figure 5), and they coincide with events of global impact. These events included the dot-com collapse and the terrorist attacks of September 11 (2001), the Sub-prime crisis (2007), the collapse of Lehman Brothers (2008), the European debt crisis (2010-2012), the oil price crash (2014-2015) and Brexit in 2016. Furthermore, after the collapse of Lehman Brothers (2008), oil prices fell sharply, while during and after the oil price crash (2014-2015), oil prices fell less strongly, but for a longer duration. The World Bank (2015) identifies four reasons for the 2014-2015 oil price drop: i) an excess supply at a time of weak demand; ii) changes in OPEC policies; iii) the decrease in concern about supply interruptions due to geopolitical causes; and iv) the appreciation of the US dollar. The match between P&S and L&T is above 95% for both samples; thus, results only include the more recent L&T method. Very similar results for the P&S strategy are available upon request.

Likewise, two measurements to identify the tranquil (calm) and turbulent (crisis) oil market volatility scenarios are used: a **range estimator** for the stock market proposed by Parkinson (1980) (P-80) and the monthly **realized volatility** (Mohaddes & Pesaran, 2013) (M&P). Additionally, a non-hierarchical k-means clustering algorithm using the Euclidean distance as a similarity/dissimilarity measure maximizes the variance among the group and minimizes the variance within it. In this way, each month is divided into two discrete groups of volatility periods: the low-volatility months for the calm scenario and the high-volatility months for the turbulent scenario.

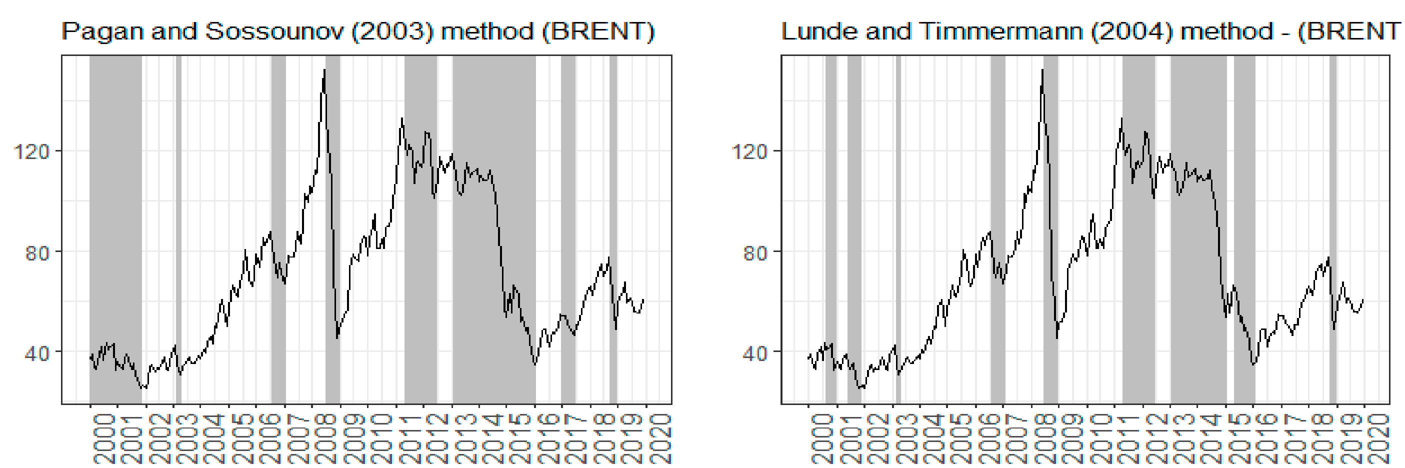
4 Test results are robust at different λ filters.

The identification of calm and turbulent scenarios follows P-80, using the extreme value method applied to the oil market. With the daily maximum oil price for day τ of month *t* ($OP_{t,\tau}^{max}$) and minimum ($OP_{t,\tau}^{min}$), the monthly average price range is:

$$range_t^{OP} = \frac{1}{T}\sum_{\tau=1}^{T}\left(ln\left(\frac{OP_{t,\tau}^{max}}{OP_{t,\tau}^{min}}\right)\right) \quad (12)$$

where *T* is the number of trading days in month *t*. The range ($range_t^{OP}$) clusters the months into two groups. Thus, the following binary variable identifies the groups, $Dummy_t^{range} = \{_{0\ otherwise}^{1,\ if\ [range_t^{OP}-C_1]^2<[range_t^{OP}-C_0]^2}$, where C_0 and C_1 represent the centroids of each group (in this case, the mean).

Andersen et al. (2001, 2003), Barndorff-Nielsen & Shephard (2002, 2004) use intraday data to calculate daily realized volatilities for asset returns. M&P modifies that approach to calculate annual volatility using monthly changes in oil prices. Here, the M&P methodology is advanced in two directions. The first is an adaptation to calculate realized monthly volatilities using daily changes. The second is related to the characteristics of the BRENT series. Since the number of oil trading days is not equal among months, thus, the monthly average daily volatility is appropriate. Modifications imply the following expression for the realized average monthly volatility of the seasonally adjusted daily returns τ of month *t* (rmc_t^{OP}):



Note: The shaded areas identify crises according to the respective method.
Figure 5. Energy crises based on bearish oil price phases in the crude oil market (BRENT) using P&S and L&T methods.
Source: own elaboration.

$$rmv_t^{OP} = \sqrt{\frac{1}{T}\sum_{\tau=1}^{T}\left(\Delta lnOP_{t,\tau} - \overline{\Delta lnOP_t}\right)^2} \quad (13)$$

Where $\Delta lnOP_{t,\tau} = ln(OP_{t,\tau}/OP_{t,\tau-1})$ and $\overline{\Delta lnOP_t} = (1/T)\sum_{\tau=1}^{T}\Delta lnOP_{t,\tau}$ is the average return for month. In this case, the months categorization follows $Dummy_t^{rmv} = \{1, 0, otherwise\ (if[rmv_t^{OP}-C^1]^2 < [rmv_t^{OP}-C_0]^2$.

Applying these two methodologies to the sample yields similarly classified periods of calm and turbulence. The turbulent period coincided with the crash of dot-com and the terrorist attacks of September 11 (2001), the collapse of Lehman Brothers (2008), and the collapse of oil prices (2014-2015). Gray areas identify turbulent periods in Figure 6. Horizontal lines indicate the thresholds between the quiet and turbulent scenarios, where the lower area represents the quiet cluster and the upper, the turbulent area, the latter containing the most prolonged peaks. The match between P-80 – Range Estimator and M&P –Realized Volatility is above 90% for both samples; thus, the report just includes the results for the more recent method M&P – Realized Volatility for the contagion tests. Similar results for the P-80 – Range Estimator strategy are available upon request.

M&P focuses on volatility, finding shorter turbulent periods than the logarithmic returns of calm periods found by the method of L&T, which implies fewer observations.

Tables A2 and A3 report summary statistics of adjusted returns for calm and crisis market conditions according to L&T and M&P for BRENT (Table A2), REER, and CSPI (Table A3) of each PA country. Since the time series shows abnormal behavior during the GFC, two sets of analysis, with and without this period (censored sample), will assess whether the results remain stable in the GFC.

Summary statistics show heterogeneity in each country's exchange rate and market dynamics; Colombia and Mexico, both oil exporters, show more concordance. It also indicates that Chile and Peru, less oil-dependent economies, are less sensitive to the two methods for identifying bear and turbulent periods.

4. Contagion analysis

This research assesses the contagion from oil prices to stock and exchange rate markets in the PA countries using: i) Three correlation measurements (Pearson, Spearman, and Kendall), and ii) Five contagion tests: three based on correlation (CR_{FR}, CV and local Gaussian correlation Bootstrap test) and two contagion tests based on the third-order moment (CS_1[5] and CS_2[6]).

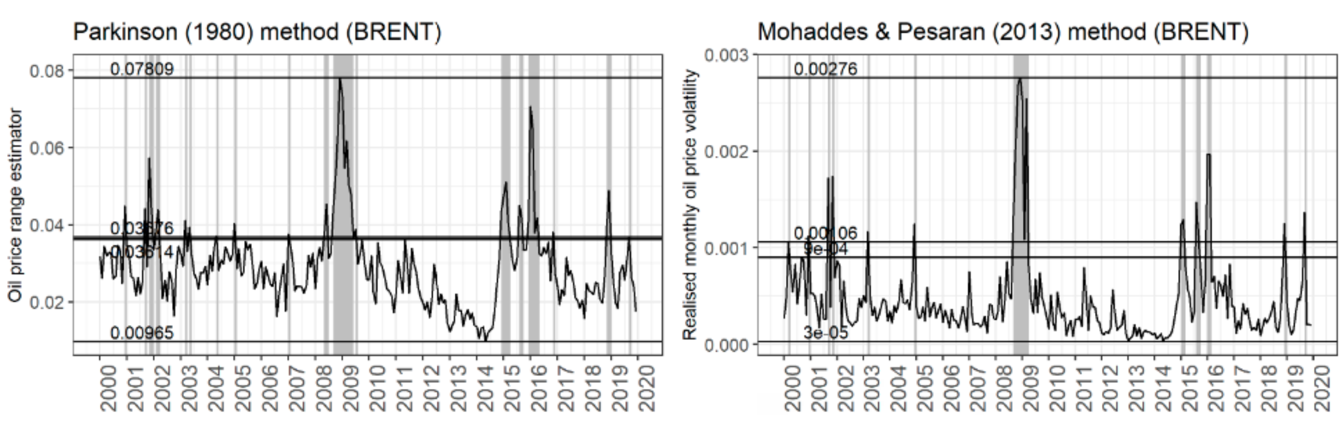
Table 1 summarizes each approach, including its fundamental statistics, primary advantage, and principal limitations; Section 2 presents a detailed description of each approach.

Table 2 to Table 5 present the Pearson, Spearman, Kendall, and adjusted linear correlation between the BRENT, REER, and CSPI during calm and crisis periods for both samples and each country.

In Colombia (Table 2), there is a positive interdependence for the Spearman and Kendall correlation measures in the relationship for the whole and censored samples in the crisis period under the M&P method. This positive relationship is also evident in the censored sample using Pearson's correlation. This result implies that REER depreciates (the local currency appreciates) when oil prices decrease in the crisis period. In Mexico (Table 3), there is a positive interdependence for the whole and censored samples in the calm period under the L&T and M&P methods for the Spearman and Kendall correlation measures; this positive relationship remains for the whole and censored samples using Pearson's correlation; a negative relationship is only observed for the whole sample in the Pearson correlation measure in the crisis period. In Chile (Table 4), there is a positive interdependence for the whole sample in the calm

5 CS_1 studies if the average behavior of the BRENT oil market affects the volatility of REER and *CSPI*.

6 CS_2 studies if the volatility of the BRENT oil market affects the average behavior of REER and *CSPI*.



Note: Shaded areas show calm and crisis periods according to the respective method.

Figure 6. Energy calm/crisis classification based on crude oil market volatility (BRENT) using Parkinson and Mohades & Pesaran strategies.

Source: own elaboration.

Table 1. Overview of contagion methodologies used in this paper.

Method	Description	Main advantage	Main limitation
Pearson correlation (ρ)	Simple linear correlation coefficient (ρ) computed separately for calm and crisis windows; contagion is inferred if ρ rises (in absolute value) during the crisis.	Straightforward benchmark, widely used in contagion studies (Samarakoon 2011).	Upbiased under heteroskedasticity, so it can mistake interdependence for contagion (Forbes & Rigobon 2002).
Spearman's rank correlation (ρ_s)	Correlation of ranked observations, capturing any monotonic (not strictly linear) association between markets across regimes.	Nonparametric and robust to outliers; applied by Wen et al.(2012) and Reboredo (2013).	Less efficient when the true link is linear and still ignores variance shifts (Reboredo 2013).
Kendall's τ	Measures the fraction of concordant minus discordant ranked pairs; provides a probabilistic view of dependence.	Less sensitive to extreme values—suitable for fattailed returns (Ghorbel & Boujelbene 2013).	Needs larger samples for the same power; interpretation is less intuitive (Mezghani & Boujelbène 2018).
Forbes–Rigobon adjusted correlation (ρ^*)	Variance-adjusted correlation that corrects Pearson's ρ for the change in market variance between calm and crisis periods (Forbes & Rigobon, 2002).	Mitigates heteroskedasticity bias, standard reference in linear contagion tests.	Still linear and requires an exogenous regime split; misses nonlinear contagion (Guesmi et al. 2018).
Local Gaussian correlation (ψ) + bootstrap	Fits a bivariate Gaussian kernel around each point to estimate state-dependent dependence; a bootstrap test checks if ψ-crisis > ψ-calm (Tjøstheim & Hufthammer, 2013; Støve et al., 2014).	Detects nonlinear, tailspecific changes in dependence (Bampinas & Panagiotidis 2017).	Computationally demanding; results can be bandwidthsensitive (Yuan et al. 2021).
Covolatility test (*CV*)	x^2 statistic that compares the **s**hift in conditional covariance, $cov(r_1,r_2)$, between regimes, after standardizing by own variances (FryMcKibbin et al., 2014)	Targets volatility transmission, a key risk channel; effective in oil–finance settings (Mahadeo et al. 2019).	Requires reliable covariance estimates and clear regime definition (Fry McKibbin & Hsiao 2018).
Cobias test type 1 (CS_1)	x^2 test on the change in the thirdorder comoment $cov(r_1, r2^2)$, revealing a "volatilitytomean" transmission channel (Fry et al., 2010).	Reveals asymmetric thirdmoment effects hidden to secondmoment tests (Harb & Umutlu 2024).	Thirdmoment estimates are samplehungry and can be unstable.
Cobias test type 2 (CS_2)	Companion x^2 test on $cov(r_1^2, r_2)$ that detects the reverse "meantovolatility" channel (Fry et al., 2010).	Complements CS_1 by showing the reverse channel	Same caveats as CS_1.

Table 2. Correlation between oil prices and the Colombian exchange rate and stock market.

Sample	Strategy	Relationship	Pearson Calm	Pearson Crisis	Spearman Calm	Spearman Crisis	Kendall Calm	Kendall Crisis	Vy Crisis
Whole	L&T	Oil - Exchange Rate	0.07300	-0.10553	0.11079	-0.02635	0.07267	-0.0174	-0.08807
Whole	M&P	Oil - Exchange Rate	-0.04384	0.36469	0.02755	0.45113 *	0.01978	0.32632 *	0.21599
GFC Censored	L&T	Oil - Exchange Rate	0.07494	-0.14336	0.12617	-0.04989	0.08199	-0.03687	-0.1341
GFC Censored	M&P	Oil - Exchange Rate	-0.04202	0.58918 *	0.04542	0.69780 *	0.03085	0.48718 *	0.43558
Whole	L&T	Oil - Stock Market	-0.10012	0.09672	-0.08435	-0.02886	-0.05435	-0.01296	0.08070
Whole	M&P	Oil - Stock Market	-0.04618	0.26790	-0.02474	0.09023	-0.01448	0.06316	0.15515
GFC Censored	L&T	Oil - Stock Market	-0.11193	-0.01669	-0.08103	-0.02527	-0.05326	-0.01054	-0.0156
GFC Censored	M&P	Oil - Stock Market	-0.04268	0.06199	-0.01326	0.10989	-0.00704	0.07692	0.04118

Notes: Column 1 identifies the sample, column 2 indicates the method to identify calm and crisis periods, column 3 indicates the relationship being tested, while the subsequent columns indicate the different correlation approaches for calm and crisis periods. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.

Source: own elaboration.

Table 3. Correlation between oil prices and the Mexican exchange rate and stock market.

Sample	Strategy	Relationship	Pearson Calm	Pearson Crisis	Spearman Calm	Spearman Crisis	Kendall Calm	Kendall Crisis	Vy Crisis
Whole	L&T	Oil - Exchange Rate	0.15326 *	-0.20463 *	0.17744 *	-0.06914	0.11630 *	-0.03962	-0.17159
Whole	M&P	Oil - Exchange Rate	0.07274	-0.13828	0.12519 *	0.02406	0.08437 *	0.02105	-0.07862
GFC - Censored	L&T	Oil - Exchange Rate	0.19418 *	-0.03426	0.21856 *	0.00607	0.14138 *	0.01141	-0.03201
GFC - Censored	M&P	Oil - Exchange Rate	0.09018	0.38508	0.14582 *	0.42857	0.09709 *	0.28205	0.26686
Whole	L&T	Oil - Stock Market	-0.04906	0.05525	-0.0698	0.01414	-0.04829	0.00481	0.04606
Whole	M&P	Oil - Stock Market	0.00072	-0.06655	-0.04278	-0.00602	-0.03065	0.00000	-0.03765
GFC - Censored	L&T	Oil - Stock Market	-0.04323	-0.01956	-0.07757	-0.05306	-0.05498	-0.03951	-0.01827
GFC - Censored	M&P	Oil - Stock Market	-0.03598	0.07205	-0.06687	0.01099	-0.04784	-0.02564	0.04788

Notes: Column 1 identifies the sample, column 2 indicates the method to identify calm and crisis periods, column 3 indicates the relationship being tested, while the subsequent columns indicate the different correlation approaches for calm and crisis periods. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

Table 4. Correlation between oil prices and the Chilean exchange rate and stock market.

Sample	Strategy	Relationship	Pearson Calm	Pearson Crisis	Spearman Calm	Spearman Crisis	Kendall Calm	Kendall Crisis	Vy Crisis
Whole	L&T	Oil - Exchange Rate	0.16216 *	-0.11112	0.14768 *	0.00452	0.10093 *	-0.00111	-0.09276
Whole	M&P	Oil - Exchange Rate	0.05668	-0.21051	0.05465	0.08571	0.03682	0.06316	-0.12073
GFC - Censored	L&T	Oil - Exchange Rate	0.16367 *	0.04356	0.13453	-0.01195	0.09138	-0.00966	0.04070
GFC - Censored	M&P	Oil - Exchange Rate	0.04028	0.36788	0.03309	0.34615	0.02261	0.23077	0.25394
Whole	L&T	Oil - Stock Market	0.05243	-0.00881	0.02765	-0.03541	0.01708	-0.02184	-0.00734
Whole	M&P	Oil - Stock Market	0.00218	0.10963	-0.00741	0.08271	-0.00248	0.07368	0.06218
GFC - Censored	L&T	Oil - Stock Market	-0.02783	-0.02533	-0.02113	-0.06611	-0.01552	-0.03951	-0.02367
GFC - Censored	M&P	Oil - Stock Market	-0.04822	0.06723	-0.03918	-0.07143	-0.02412	-0.02564	0.04467

Notes: Column 1 identifies the sample, column 2 indicates the method to identify calm and crisis periods, column 3 indicates the relationship being tested, while the subsequent columns indicate the different correlation approaches for calm and crisis periods. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

period under the L&T method for the Pearson, Spearman, and Kendall correlation measures; this positive relationship is evident in the censored sample in the calm period using Pearson's correlation. In Peru (Table 5), there is a positive interdependence for the censored sample in the crisis period under the M&P method for the Pearson, Spearman, and Kendall correlation measures.

Regarding the BRENT and CSPI relationship, results show that all countries, except Chile, do not have a significant interdependence in periods of calm and crisis for the whole and censored samples under the L&T and M&P methods for the Pearson, Spearman, and Kendall correlation and the adjusted linear correlation measures. In the case of Chile, there is a negative interdependence for the censored sample in the calm period under the L&T method for the Spearman and Kendall correlation measures.

The following tables report the results for the adjusted linear correlation contagion test, the two co-bias contagion $\mathrm{CR}_{\mathrm{FR}}^{-}$ tests, CS_1 and CS_2, and the CV co-volatility contagion test for Colombia (Table 6), Mexico (Table 8), Chile (Table 10), and Peru (Table 12). Results of the Bootstrap test for contagion for each PA country are presented in Table 7 (Colombia), Table 9 (Mexico), Table 11 (Chile), and Table 13 (Peru). The report includes results of both samples (whole and censored) under the L&T and M&P methods.

In Colombia (Table 6), using the adjusted linear correlation test ($\mathrm{CR}_{\mathrm{FR}}$), the null hypothesis of no contagion between BRENT and REER for the M&P method in both samples is rejected. Using the co-bias contagion test (CS_1) there is a similar result under the L&T method for the whole sample. Results support the contagion effects of oil market returns (return decreases) to the exchange rate

Table 5. Correlation between oil prices and the Peruvian exchange rate and stock markets.

Sample	Strategy	Relationship	Pearson Calm	Pearson Crisis	Spearman Calm	Spearman Crisis	Kendall Calm	Kendall Crisis	Vy Crisis
Whole	L&T	Oil - Exchange Rate	0.06958	-0.03174	0.12543	0.01278	0.08292	0.01222	-0.02644
Whole	M&P	Oil - Exchange Rate	0.01513	0.07468	0.04023	0.21805	0.02586	0.14737	0.04226
GFC - Censored	L&T	Oil - Exchange Rate	0.00922	0.04065	0.08253	0.05165	0.05785	0.03600	0.03798
GFC - Censored	M&P	Oil - Exchange Rate	-0.04597	0.60717 *	0.00497	0.62088 *	0.00332	0.41026 *	0.45227
Whole	L&T	Oil - Stock Market	-0.05402	0.08415	-0.12302	-0.07237	-0.08307	-0.0522	0.07019
Whole	M&P	Oil - Stock Market	-0.0275	0.17573	-0.05337	-0.10075	-0.03586	-0.06316	0.10032
GFC - Censored	L&T	Oil - Stock Market	-0.11722	-0.1616	-0.14472 *	-0.11994	-0.09636 *	-0.08253	-0.15122
GFC - Censored	M&P	Oil - Stock Market	-0.08416	-0.42517	-0.07775	-0.26923	-0.05156	-0.15385	-0.29761

Notes: Column 1 identifies the sample, column 2 indicates the method to identify calm and crisis periods, column 3 indicates the relationship being tested, while the subsequent columns indicate the different correlation approaches for calm and crisis periods. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

Table 6. Contagion tests from oil prices to the Colombian exchange rate and stock markets.

Sample	Strategy	BRENT Vs. REER (CR)	BRENT Vs. REER (CS1)	BRENT Vs. REER (CS2)	BRENT Vs. REER (CV)	BRENT Vs. CSPI (CR)	BRENT Vs. CSPI (CS1)	BRENT Vs. CSPI (CS2)	BRENT Vs. CSPI (CV)
Whole	L&T	1.682	3.357 *	0.581	0.000	2.123	3.436 *	5.489 **	8.931 ***
Whole	M&P	3.435 *	0.032	0.683	0.444	2.015	7.127 ***	2.854 *	1.896
GFC - Censored	L&T	2.272	0.669	0.790	0.000	0.475	0.158	0.005	3.052 *
GFC - Censored	M&P	8.094 ***	1.162	0.521	0.518	0.181	0.303	0.025	1.765

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, column 3 presents the result for the linear correlation (CR) test, column 4 (CS1) presents the results of the co-bias test from the average BRENT to the volatility of REER, column 5 (CS2) presents the results of the co-bias test from the volatility of BRENT to the average REER, columns 6 (CV) presents the results of the co-volatility test between BRENT and REER. The remaining columns repeat the analyses of Column 3 to 6 for BRENT and CSPI. *: p<0.1; **: p<0.05; ***: p<0.01; CR = Forbes-Rigobon adjusted correlation; CS1 = co-bias tests 1; CS2 = co-bias tests; CV = co-volatility test; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

(return increases – COP depreciates against USD). The CS_2 co-bias and *CV* co-volatility contagion tests do not reject the hypothesis of no contagion. Thus, the evidence weakly favors a contagion from BRENT to REER.

The results are different for the relationship between BRENT and the Colombian CSPI. Although there is no evidence in favor of contagion for the censored sample, except for the Co-volatility test under the L&T method, there is evidence favoring Co-bias or Co-volatility from BRENT to CSPI in five of the six tests for the whole sample. Thus, the evidence favors a contagion from BRENT to CSPI associated with a change in the adjusted correlation during de GFC.

Table 7. Local Gaussian correlation contagion tests from oil prices to the Colombian exchange rate and stock markets.

Sample	Strategy	BRENT Vs. REER	BRENT Vs. CSPI
Whole	L&T	-0.179 ***	0.186
Whole	M&P	0.413	0.305
GFC – Censored	L&T	-0.220 ***	0.094 *
GFC – Censored	M&P	0.633	0.106

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, the remaining columns denote the results of the local gaussian correlation tests for each pair of variables. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

The Bootstrap test for contagion (Table 7) provides evidence of contagion from the BRENT to REER using the L&T strategy, regardless of the sample used. Likewise, there is evidence of contagion in the censored sample from BRENT to CSPI in Colombia using the L&T method. There is no evidence of contagion for the Realized Volatility method (M&P). These results reinforce the evidence of contagion from the BRENT to REER reported above.

In Mexico (Table 8), there is statistically significant evidence of contagion from BRENT to REER in the whole sample under the method of L&T according to all the contagion tests (CR_{FR}^-, *CS* and *CV*). When the M&P strategy is used, there is no evidence of contagion for the CR_{FR}^- and CS_1 tests. The evidence indicates contagion effects of the BRENT oil market yields (return decreases) to the Mexican exchange rate, driven mainly by the GFC. Regarding BRENT and CSPI relationship, there is significant evidence of contagion for the whole sample under the method of L&T using CS_1 and *CV* contagion tests. There is also weak evidence of the contagion effects of the BRENT oil market on the Mexican stock index.

Under the Bootstrap test for contagion (Table 9), there are three statistically significant results associated with the $BRENT$ - $REER_{MEX}$ relationship in the whole sample under both methods L&T and M&P, and for the sample censored under the method de L&T, indicating contagion effects of the BRENT oil market at the $REER_{MEX}$ exchange rate. These

Table 8. Contagion tests from oil prices to the Mexican exchange rate and stock markets.

Sample	Strategy	BRENT Vs. REER (CR)	BRENT Vs. REER (CS1)	BRENT Vs. REER (CS2)	BRENT Vs. REER (CV)	BRENT Vs. CSPI (CR)	BRENT Vs. CSPI (CS1)	BRENT Vs. CSPI (CS2)	BRENT Vs. CSPI (CV)
Whole	L&T	7.070 ***	9.219 ***	8.175 ***	29.531 ***	0.582	7.305 ***	1.685	16.363 ***
Whole	M&P	1.120	0.552	2.865 *	3.444 *	0.072	0.229	0.575	2.392
GFC - Censored	L&T	2.660	0.183	0.006	0.265	0.032	0.205	0.000	0.102
GFC - Censored	M&P	0.906	0.399	0.010	0.994	0.182	0.626	0.878	0.086

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, column 3 presents the result for the linear correlation (CR) test, column 4 (CS1) presents the results of the co-bias test from the average BRENT to the volatility of REER, column 5 (CS2) presents the results of the co-bias test from the volatility of BRENT to the average REER, columns 6 (CV) presents the results of the co-volatility test between BRENT and REER. The remaining columns repeat the analyses of Column 3 to 6 for BRENT and CSPI. *: p<0.1; **: p<0.05; ***: p<0.01; CR = Forbes-Rigobon adjusted correlation; CS1 = co-bias tests 1; CS2 = co-bias tests; CV = co-volatility test; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

results reinforce the evidence presented above. There are two statistically significant results associated with the *BRENT - CSPI*$_{MEX}$ relationship for the whole sample for the M&P method and for the censored sample for the L&T method, which indicates contagion effects of the BRENT oil market to the stock index *CSPI*$_{MEX}$ (IPC).

In Chile (Table 10), there is statistically significant evidence for contagion from BRENT to REER in the whole sample using *CS* and *CV* contagion tests. The CR_{FR} and CS_2 for the method of M&P do not provide evidence of contagion. There is no evidence in favor of contagion effects from the BRENT oil market to the Chilean stock index for both samples.

The Bootstrap test for contagion (Table 11) provides evidence of contagion effects of the BRENT oil market at the in the whole sample under both methods and for the censored sample under the L&T method. Again, these results reinforce prior evidence. There are statistically significant results associated with the *BRENT - CSPI*$_{CHI}$ relationship in the whole and censored sample under the L&T method, overall not so strong evidence of contagion effects of the BRENT oil market to the stock index *CSPI*$_{CHI}$(IPSA).

Table 9. Local Gaussian correlation contagion tests from oil prices to the Mexican exchange rate and stock markets.

Sample	Strategy	BRENT Vs. REER	BRENT Vs. CSPI
Whole	L&T	-0.350 ***	0.100
Whole	M&P	-0.202 ***	-0.070 ***
GFC – Censored	L&T	-0.230 ***	0.025 **
GFC – Censored	M&P	0.296	0.111

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, the remaining columns denote the results of the local gaussian correlation tests for each pair of variables. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

Table 11. Local Gaussian correlation contagion tests from oil prices to the Chilean exchange rate and stock markets (Whole and GFC-censored samples).

Sample	Strategy	BRENT - REER	BRENT - CSPI
Whole	L&T	-0.264 ***	-0.059 ***
Whole	M&P	-0.257 ***	0.111
GFC - Censored	L&T	-0.125 ***	0.004 ***
GFC - Censored	M&P	0.327	0.118

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, the remaining columns denote the results of the local gaussian correlation tests for each pair of variables. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

The evidence of the contagion effects of BRENT on the REER in Peru is weak (Table 12). The $\overline{CR}_{FR}$ test with a censored sample and the M&P approach and CS_1 test with the whole sample and L&T methodology indicate that the contagion effect could be due to crises identified under these methods. The evidence of contagion for the BRENT and CSPI relationship, is more robust and driven by the GFC. There are statistically significant results for the whole sample under the L&T method in the contagion tests *CS* and *CV*, for the M&P method in the CS_2 and *CV* tests, and for the censored sample under the L&T method in the test.

Under the Bootstrap test for contagion (Table 13), there are statistically significant results associated with the BRENT and REER relationship for the whole sample for both methods and in the censored sample for the L&T method, indicating contagion effects of the BRENT to the REER exchange rate. There are also statistically significant results associated with the BRENT and CSPI relationship in the censored sample under both methods. However, in the whole sample, there is no contagion, indicating that the contagion effects of the BRENT oil market at the CSPI could be due to crises identified by this method other than the GFC period.

Table 14 shows how conclusions vary across regime-dating strategies and samples. First, exchange-rate contagion evidence is strongest for Mexico and Chile when the full sample and the L&T strategy are used (significant in all eight tests). At the same time, Colombia has robust evidence, and Peru has only modest effects in favor of contagion. Removing the GFC period, the evidence for the exporters yet raises Peru's tally, indicating that crisis-specific shocks may mask longer-run sensitivities. Second, equity market contagion is weaker and more strategy dependent: Colombia and Peru register moderate tallies, whereas Chile and Mexico show almost none, confirming that exporter status does not guarantee equity vulnerability to oil shocks. Third, the contrast between L&T and volatility-based M&P underlines that regime choice matters; nonetheless, both schemes agree on the qualitative ranking. These asymmetries corroborate the theoretical exporter-importer channels and illustrate why a single macro-financial policy for the Pacific Alliance would be unlikely to succeed.

Table 13. Local Gaussian correlation contagion tests from oil prices to the Peruvian exchange rate and stock markets.

Sample	Strategy	BRENT - REER		BRENT - CSPI	
Whole	L&T	-0.095	***	0.117	
Whole	M&P	0.069	*	0.183	
GFC - Censored	L&T	0.030	***	-0.040	***
GFC - Censored	M&P	0.654		-0.340	***

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, the remaining columns denote the results of the local gaussian correlation tests for each pair of variables. *: p<0.1; **: p<0.05; ***: p<0.01; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

Table 10. Contagion tests from oil prices to the Chilean exchange rate and stock markets.

Sample	Strategy	BRENT Vs. REER (CR)		BRENT Vs. REER (CS1)		BRENT Vs. REER (CS2)		BRENT Vs. REER (CV)		BRENT Vs. CSPI (CR)	BRENT Vs. CSPI (CS1)	BRENT Vs. CSPI (CS2)	BRENT Vs. CSPI (CV)
Whole	L&T	4.274	**	24.104	***	3.973	**	100.186	***	0.230	0.007	0.533	0.044
Whole	M&P	1.550		10.879	***	2.392		8.940	***	0.175	0.330	0.012	0.886
GFC - Censored	L&T	0.784		1.774		2.090		2.582		0.001	0.092	0.019	1.321
GFC - Censored	M&P	1.305		0.026		0.153		0.940		0.223	0.721	0.050	0.411

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, column 3 presents the result for the linear correlation (CR) test, column 4 (CS1) presents the results of the co-bias test from the average BRENT to the volatility of REER, column 5 (CS2) presents the results of the co-bias test from the volatility of BRENT to the average REER, column 6 (CV) presents the results of the co-volatility test between BRENT and REER. The remaining columns repeat the analyses of Column 3 to 6 for BRENT and CSPI. *: p<0.1; **: p<0.05; ***: p<0.01; CR = Forbes-Rigobon adjusted correlation; CS1 = co-bias tests 1; CS2 = co-bias tests; CV = co-volatility test; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

Table 12. Contagion tests from oil prices to the Peruvian exchange rate and stock markets.

Sample	Strategy	BRENT Vs. REER (CR)		BRENT Vs. REER (CS1)		BRENT Vs. REER (CS2)	BRENT Vs. REER (CV)	BRENT Vs. CSPI (CR)	BRENT Vs. CSPI (CS1)		BRENT Vs. CSPI (CS2)		BRENT Vs. CSPI (CV)	
Whole	L&T	0.594		5.538	**	0.196	2.255	0.996	30.933	***	6.262	**	112.650	***
Whole	M&P	0.036		0.123		2.173	0.133	0.801	2.044		3.970	**	3.982	**
GFC - Censored	L&T	0.042		1.484		1.336	0.258	0.061	0.113		3.386	*	0.055	
GFC - Censored	M&P	9.056	***	0.025		0.001	0.907	1.361	1.265		0.000		0.004	

Notes: Column 1 identifies the sample, column 2 indicates the strategy to identify calm and crisis periods, column 3 presents the result for the linear correlation (CR) test, column 4 (CS1) presents the results of the co-bias test from the average BRENT to the volatility of REER, column 5 (CS2) presents the results of the co-bias test from the volatility of BRENT to the average REER, column 6 (CV) presents the results of the co-volatility test between BRENT and REER. The remaining columns repeat the analyses of Column 3 to 6 for BRENT and CSPI. *: p<0.1; **: p<0.05; ***: p<0.01. CR = Forbes-Rigobon adjusted correlation; CS1 = co-bias tests 1; CS2= co-bias tests; CV = co-volatility test; L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

Table 14. Synopsis of oil-price contagion evidence (significant tests / 8)

	Exchange-rate market (REER)				Stock-market index (CSPI)			
	Whole L&T	Whole M&P	GFC-Cens. L&T	GFC-Cens. M&P	Whole L&T	Whole M&P	GFC-Cens. L&T	GFC-Cens. M&P
Colombia	5 / 8	4 / 8	5 / 8	3 / 8	3 / 8	2 / 8	2 / 8	1 / 8
Mexico	8 / 8	6 / 8	4 / 8	3 / 8	3 / 8	2 / 8	1 / 8	1 / 8
Chile	8 / 8	6 / 8	2 / 8	2 / 8	1 / 8	1 / 8	1 / 8	1 / 8
Peru	3 / 8	3 / 8	5 / 8	4 / 8	3 / 8	3 / 8	5 / 8	4 / 8

Notes: The eight methods comprise Pearson, Spearman, and Kendall correlations; Forbes-Rigobon adjusted correlation (CR); co-bias tests 1 (CS1) and 2 (CS2); co-volatility test (CV); and the local Gaussian correlation bootstrap test (LG). L&T = Lunde & Timmermann bull/bear dating; M&P = Mohaddes & Pesaran realized-volatility clustering. "Whole" covers 2000–2019; "GFC–Cens." excludes December 2007–June 2009.
Source: own elaboration.

5. Final remarks

This study presents a historical perspective by limiting the sample to 2000-2019, thereby encapsulating the initial two decades of the Pacific Alliance's architecture and its financial connection to the oil market prior to the structural disruption caused by COVID-19 and the energy price escalation of 2022-2023. The evidence indicates that oil price shocks disseminate through various, country-specific pathway (see Table 14). Exchange-rate contagion is the most evident and enduring: utilizing the Lunde and Timmermann dating rule, all eight indicators reject the null hypothesis for Mexico and Chile, five metrics do so for Colombia, and three for Peru, a hierarchy that reflects the robustness of each nation's oil trade balance. Omitting the Global Financial Crisis improves Peru's statistics, suggesting that crisis-related disruptions may hide long-term vulnerabilities in an importing economy and cautioning against emulating the "Mexico-Chile template" for currency rate management across the Alliance. In contrast, contagion to stock indices is selective and does not clearly correlate with exporter status; Colombia and Peru exhibit considerable susceptibility. In contrast, Chile and Mexico demonstrate limited responsiveness, indicating that equity exposure reflects the sector mix and financial openness more than merely crude-export capability.

By documenting those patterns with eight complementary tests applied to four closely linked but structurally diverse economies, this study extends the energy-finance contagion literature from single-country cases to a multi-country emergingmarket bloc and, by ending in 2019, furnishes a clean pre-COVID baseline against which future policy innovations and post-pandemic dynamics can be assessed.

Conversely, methodological selections are significant, but they do not alter the qualitative hierarchy of nations. The volatility-based Mohaddes-Pesaran categorization results in marginally fewer rejections than the Lunde-Timmermann method due to its definition of shorter crisis periods; however, the relative standings of the four economies remain largely consistent. This robustness instills trust in the subsequent consequences for policymakers and market participants.

In the initial two decades of the century, the PA's members demonstrated efforts toward coordination and enhanced unification. In 2011, the PA initiated an endeavor to enhance trade liberalization through improved macrofinancial cooperation. Presidents convened annually; however, substantial tasks were conducted inside specialized entities. The Council of Finance Ministers, established by the Paracas Declaration of 2015 (Pacific Alliance, 2015), meets quarterly to assess fiscal conditions, inflation projections, and exchange rate trends, and to concur on a unified macroeconomic picture for budget preparation by each treasury. The four primary central banks, all focused on inflation targeting, shared high-frequency data regarding foreign-exchange interventions via a confidential "monetary-policy round-up," a procedure formalized in the Cali Summit communiqué of 2018 (Pacific Alliance, 2018). Regulators standardized listing and custody rules in the capital markets, enabling any broker licensed in one nation to trade on the Integrated Latin American Market (MILA), an arrangement finalized with Mexico's accession to the platform in 2014. Pension-fund regulators commenced biannual meetings to synchronize investment-limit schedules and bilateral swap lines to support liquidity. These procedures remained voluntary and consensus-based, although they established a concrete coordinating infrastructure by the conclusion of the first two decades of the century.

The diverse contagion patterns observed indicate that policy discussions should leverage that infrastructure in a nuanced way. For example, tighten swap networks to safeguard the oil-sensitive currencies of Mexico and Chile while enhancing prudential guidelines for the equity portfolios prevalent in institutional investments in Colombia and Peru. Investors must customize hedging strategies: currency futures are crucial for Mexican and Chilean exposures, while stock hedges are more pertinent for Colombian and Peruvian positions.

The study possesses inherent limitations. Initially, monthly data fails to capture intramonth spillovers and may underestimate high-frequency channels. Secondly, it is dubious to extend the findings to the third decade of this century. The COVID-19 pandemic and the energy-price escalation of 2022–2023, coupled with the simultaneous ascendance of left-leaning governments in all four nations, present structural disruptions that may jeopardize the stability of the outcomes.

Consequently, two extensions seem promising. Initially, conducting the test with daily data would demonstrate the rapidity with which oil news is incorporated into PA assets. Secondly, as the post-2020 regimes stabilize, a revised sample could evaluate whether the pandemic and post-pandemic periods have altered contagion dynamics.

The evidence indicates that, in the initial two decades of the century, oil price shocks impacted exchange rates and equity markets in distinct country- and asset-specific manners. Recognizing that historical patterns are essential for evaluating whether the new macro-financial arrangements established after 2020 have only mitigated or fundamentally altered the trajectories of contagion within the Pacific Alliance.

Conflict of interest

The authors declare no conflict of interest.

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Appendix

Table A1. Data definitions and sources

Series	Definition	Source	Observations
OP	Real Oil Price (BRENT)	REUTERS - REFINITIV	Daily: January 2000 - December 2019
IR	Interest Rate (Colombia)	REUTERS - REFINITIV	CB Total System Rate Ordinary Loans NADJ: Monthly: January 2000 - December 2019
IR	Interest Rate (México)	REUTERS - REFINITIV	MX Cost of Credit (CPP) NADJ: Monthly: January 2000 - December 2019
IR	Interest Rate (Chile)	REUTERS - REFINITIV	CL Loan Interest Rate, Indexed - 90 to 365 Day NADJ: Monthly: January 2000 - December 2019
IR	Interest Rate (Perú)	REUTERS - REFINITIV	PE Lending Rate (Disc.) NADJ: Monthly: January 2000 - June 2010
IR	Interest Rate (Perú)	REUTERS - REFINITIV	Pe Lending Rate, Over 360 Days: Monthly: July 2010 - December 2019
CSPI	Real Composite Stock Price Index (Colombia - IGBC)	REUTERS - REFINITIV	Daily: January 2000 - December 2019
CSPI	Real Composite Stock Price Index (México - IPC)	REUTERS - REFINITIV	Daily: January 2000 - December 2019
CSPI	Real Composite Stock Price Index (Chile - IPSA)	REUTERS - REFINITIV	Daily: January 2000 - December 2019
CSPI	Real Composite Stock Price Index (Perú - LIMA)	REUTERS - REFINITIV	Daily: January 2000 - December 2019
Series	Definition	Source	Observations
REER	Real Effective Exchange Rates (US/COL)	Banco de la República de Colombia	Daily: January 2000 - December 2019
REER	Real Effective Exchange Rates (US/MEX)	Banco de México	Daily: January 2000 - December 2019
REER	Real Effective Exchange Rates (US/CHI)	Banco Central de Chile	Daily: January 2000 - December 2019
REER	Real Effective Exchange Rates (US/PER)	Banco Central de Reserva del Perú	Daily: January 2000 - December 2019
SSR	US Interest Rate	The data supplied here are produced from the research of Leo Krippner and are not official Reserve Bank of New Zealand data	Monthly Average: January 2000 - December 2019
CPI	Consumer Price Index (US)	OECD - https://stats.oecd.org/index.aspx?queryid=82186#	Monthly Average: January 2000 - December 2019

Table A2. Descriptive statistics of BRENT adjusted returns

Sample	Strategy	Energy Conditions	Obs	BRENT op (Mean)	BRENT op (SD)	BRENT op (Min)	BRENT op (Max)
Whole	L&T	Bullish	144	0.02849	0.07077	-0.16791	0.24693
Whole	L&T	Bearish	91	-0.04513	0.09854	-0.37948	0.20611
GFC censored	L&T	Bullish	128	0.02548	0.06969	-0.16791	0.18199
GFC censored	L&T	Bearish	85	-0.03528	0.09026	-0.29414	0.20611
Whole	M&P	Tranquil	215	0.00688	0.08049	-0.23657	0.24693
Whole	M&P	Turbulent	20	-0.07421	0.14250	-0.37948	0.17177
GFC censored	M&P	Tranquil	200	0.00525	0.07969	-0.23657	0.20611
GFC censored	M&P	Turbulent	13	-0.06063	0.12008	-0.29414	0.17177

Table A3. Descriptive statistics of adjusted returns REER and CSPI by Country

Colombia

Sample	Strategy	Energy Conditions	Obs	COL REER (Mean)	COL REER (SD)	COL REER (Min)	COL REER (Max)	COL CSPI (Mean)	COL CSPI (SD)	COL CSPI (Min)	COL CSPI (Max)
Whole	L&T	Bullish	144	-0.00067	0.03512	-0.11568	0.09579	0.00343	0.06295	-0.20929	0.16733
Whole	L&T	Bearish	91	0.00146	0.03557	-0.07261	0.11084	-0.00746	0.05026	-0.15543	0.11096
GFC Censored	L&T	Bullish	128	0.00028	0.03295	-0.11568	0.09334	0.00652	0.06275	-0.20929	0.16733
GFC Censored	L&T	Bearish	85	0.00090	0.03144	-0.07261	0.07115	-0.0072279	0.04805	-0.10372	0.11096
Whole	M&P	Tranquil	215	-0.0011	0.03439	-0.11568	0.09579	0.00062	0.05969	-0.20929	0.16733
Whole	M&P	Turbulent	20	0.01178	0.04226	-0.05552	0.11084	-0.00663	0.05666	-0.15543	0.07470
GFC Censored	M&P	Tranquil	200	0.00029	0.0326714	-0.11568	0.09334	0.0023022	0.05926	-0.20929	0.16733
GFC Censored	M&P	Turbulent	13	0.00334	0.02891	-0.05552	0.06413	-0.00055	0.05131	-0.10372	0.07470

Mexico

Sample	Strategy	Energy Conditions	Obs	MEX REER (Mean)	MEX REER (SD)	MEX REER (Min)	MEX REER (Max)	MEX CSPI (Mean)	MEX CSPI (SD)	MEX CSPI (Min)	MEX CSPI (Max)
Whole	L&T	Bullish	144	-0.00026	0.02610	-0.07422	0.09011	0.00142	0.04885	-0.16125	0.12569
Whole	L&T	Bearish	91	0.00056	0.03394	-0.07805	0.11737	-0.00308	0.05027	-0.14521	0.14142
GFC - Censored	L&T	Bullish	128	-0.00006	0.02575	-0.07422	0.09011	0.00170	0.04447	-0.1194	0.12569
GFC - Censored	L&T	Bearish	85	-0.00161	0.03121	-0.07805	0.10642	-0.00126	0.04568	-0.14521	0.10696
Whole	M&P	Tranquil	215	-0.00116	0.02723	-0.07805	0.10642	0.00129	0.04605	-0.12625	0.12569
Whole	M&P	Turbulent	20	0.01249	0.04042	-0.05433	0.11737	-0.01387	0.07586	-0.16125	0.14142
GFC - Censored	M&P	Tranquil	200	-0.00057	0.02775	-0.07805	0.10642	0.00108	0.04429	-0.12625	0.12569
GFC - Censored	M&P	Turbulent	13	-0.00037	0.02512	-0.04527	0.04477	-0.00422	0.05340	-0.14521	0.05917

Chile

Sample	Strategy	Energy Conditions	Obs	CHI REER (Mean)	CHI REER (SD)	CHI REER (Min)	CHI REER (Max)	CHI CSPI (Mean)	CHI CSPI (SD)	CHI CSPI (Min)	CHI CSPI (Max)
Whole	L&T	Bullish	144	-0.00225	0.03012	-0.07722	0.08377	-0.00039	0.04021	-0.10934	0.10372
Whole	L&T	Bearish	91	0.00490	0.03536	-0.05979	0.14769	0.00086	0.04420	-0.12554	0.13423
GFC - Censored	L&T	Bullish	128	-0.00171	0.02862	-0.07273	0.07961	-0.00108	0.03911	-0.10934	0.08580
GFC - Censored	L&T	Bearish	85	0.00382	0.03007	-0.05746	0.10501	0.00210	0.04468	-0.12554	0.13423
Whole	M&P	Tranquil	215	-0.00008	0.03031	-0.07722	0.10501	0.00014	0.04118	-0.10934	0.13423
Whole	M&P	Turbulent	20	0.00088	0.04726	-0.07097	0.14769	-0.00148	0.04498	-0.12554	0.05530
GFC - Censored	M&P	Tranquil	200	0.00035	0.02909	-0.07273	0.10501	-0.00021	0.04067	-0.10934	0.13423
GFC - Censored	M&P	Turbulent	13	-0.00443	0.03068	-0.07097	0.03791	0.00226	0.04585	-0.12554	0.05530

Peru											
Sample	**Strategy**	**Energy Conditions**	**Obs**	**PER REER (Mean)**	**PER REER (SD)**	**PER REER (Min)**	**PER REER (Max)**	**PER CSPI (Mean)**	**PER CSPI (SD)**	**PER CSPI (Min)**	**PER CSPI (Max)**
Whole	L&T	Bullish	144	-0.00058	0.01400	-0.05298	0.04248	0.00218	0.06447	-0.17644	0.30651
Whole	L&T	Bearish	91	0.00112	0.01465	-0.0537	0.03755	-0.00272	0.07857	-0.3529	0.16450
GFC - Censored	L&T	Bullish	128	-0.00015	0.01207	-0.05298	0.02844	0.00131	0.05817	-0.17644	0.15530
GFC - Censored	L&T	Bearish	85	0.00103	0.01215	-0.03191	0.03348	0.00152	0.06335	-0.16094	0.15407
Whole	M&P	Tranquil	215	-0.00037	0.01406	-0.0537	0.04248	0.00001	0.06049	-0.17644	0.15530
Whole	M&P	Turbulent	20	0.00345	0.01561	-0.02839	0.02812	0.00739	0.13238	-0.3529	0.30651
GFC - Censored	M&P	Tranquil	200	0.00010	0.01212	-0.05298	0.03348	0.00106	0.05872	-0.17644	0.15530
GFC - Censored	M&P	Turbulent	13	0.00212	0.01177	-0.01166	0.02260	0.00629	0.07623	-0.16094	0.12991