Domestic Rice Price Co-movement with International Rice Markets during Abnormal Shocks: Evidence from Five Asian Countries

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Academic Year 2025-2026

In order to obtain the Joint Degree

Master 120 en Sciences économiques, Orientation générale, Finalité approfondie (UCL/UNamur)

and

Laurea specialistica in Discipline Economiche e Sociali (Bocconi)

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Master's Thesis

Joint Master degree in Economics Bocconi-UCLouvain

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June 2026

Acknowledgments

I would like to express my sincere gratitude to Professor Vannoorenberghe and Professor Suverato for their valuable assistance and supervision. In particular, I wish to thank Professor Vannoorenberghe for his crucial support in defining the research methodology and for guiding me along this academic path.

I would also like to express my gratitude to everyone I have met over the past few years, both abroad and in Belgium, as well as to my family, who have supported and believed in me.

Declaration on the Use of Artificial Intelligence

For this thesis, I acknowledge the responsible use of generative artificial intelligence, in accordance with academic and scientific integrity standards. AI tools were used to rephrase certain sentences, simplify parts of the code, and facilitate my understanding of several mathematical concepts. They were not used as a substitute for independent analysis, interpretation, or academic judgment. I remain fully responsible for the content of this thesis.

Abstract

This thesis examines how domestic rice prices in five Asian countries co-moved with international rice prices during abnormal rice-market shocks, with particular attention to the 2007–2008 rice crisis. Using monthly price data for Thailand, India, Cambodia, the Philippines, and Bangladesh, the analysis decomposes domestic-international price co-movement into international, regional, and national residual components. The results reveal substantial cross-country heterogeneity. Thailand's domestic rice prices closely co-move with the international benchmark, whereas India appears largely insulated from international price movements. The Philippines, Bangladesh, and Cambodia display intermediate or mixed patterns. These patterns are consistent with differences in trade exposure, public intervention, and domestic market conditions across countries. Rather than providing causal estimates of price transmission, the thesis offers a descriptive account of how domestic rice prices moved with international prices during abnormal shocks.

Contents

1 Introduction

Rice provides more than 20% of worldwide caloric intake [39] and serves as a dietary staple, particularly in Asia and Latin America. It plays a crucial role in developing countries, where approximately 95% of rice is both produced and consumed. More specifically, although rice can be cultivated across a wide range of climates and soils, around 90% of global rice production takes place in Asia.

Beyond its nutritional importance, rice is also central to poverty, rural livelihoods, and food-security policy as it remains a primary staple for many individuals living in poverty [63]. In this respect, Asia is again central. According to the Multidimensional Poverty Index 2025 [81], South Asia accounts for 30% of global multidimensional poverty, despite substantial reductions in poverty over the past few decades. Moreover, many Asian smallholder farmers depend on rice for their livelihoods [19]. As a result, changes in rice prices can have direct consequences for household welfare, producer income, and social stability. At the same time, the region is highly exposed to climate-related risks, including floods, air pollution, and extreme heat. Experts predict that the return on investment in rice cultivation in Asia could decline by approximately 50% by 2100, more than for wheat or corn [63]. These elements make rice particularly relevant for the analysis of Asian economies, as changes in rice prices are likely to affect households' welfare and social instability [12].

This thesis asks how domestic rice prices in selected Asian countries co-moved with international rice prices around selected shocks, and how much of this co-movement can be attributed to international, regional, and national components.

This question is important because rice markets are highly segmented and policy-sensitive. Indeed, with more than 40,000 varieties, the rice market is far from homogeneous or perfectly substitutable [64]. Brown, white, milled, and paddy rice each form distinct submarkets based on quality, while differences in grain length and cooking characteristics, such as stickiness or fragrance, further differentiate them. The rice market can thus be separated into high-quality grain ($< 20\%$ broken) and low-quality grain ($> 20\%$ broken). This segmentation limits substitutability across markets and may weaken the transmission of international price movements to domestic prices.

On the demand side, while some studies often regard rice as an inferior good which is frequently substituted with higher-protein options, such as wheat, fruits, or vegetables [61], others emphasise the role of preferences in shaping substitution patterns. In such a framework, substitutability across cereals is imperfect [5]. Producers, however, are constrained by climatic conditions, and cannot easily switch between rice varieties. In fact, Japonica rice (round rice) is grown in tropical and temperate regions, including China, the European Union, Japan, and Australia. Likewise, farmers primarily cultivate the Indica variety of long-grain rice in tropical regions. However, some new varieties, cultivated in both tropical and temperate regions, blur the heterogeneity and allow producer substitutability. Despite this overlap, the market remains segmented [70], leading to relatively rigid demand and supply curves. As a result, rice submarkets tend to display price-inelastic behaviour [91]. More precisely, the substitution effect is weak [75].

These characteristics are reminiscent of the commodity market characteristics in Fally and Sayre [27]. In such a setting of low substitutability and geographical concentration, gains from trade may be even more significant than in standard economics models. This highlights the importance of studying co-movement between the international and the domestic prices in the rice market.

Since the end of World War II, the global rice market has been considered unstable [62]. Fears of stock shortages or sudden price increases have encouraged governments to implement protective policies. Over time, the market has evolved, and during the 1980s, prices were low and stable. Today, however, only 7% of rice production is traded internationally, compared with 12% for wheat. In 2025, fierce competition among exporters drove prices down to their lowest level in the last three years [29]. In theory, importers could thus rely more on the international market [20]. In practice, multiple financial or sanitary crises have led governments to adopt beggar-thy-neighbour policies to protect themselves, ranging from trade barriers to subsidies for households and farmers [19, 53]. Such measures can insulate domestic consumers from international price movements, but they can also amplify international instability when adopted by major exporters or importers.

The 2007–2008 rice crisis is a perfect illustration of this tension. During this period, international rice prices rose sharply, not only because of supply concerns, but also because of export restrictions, precautionary imports and panic buying as discussed in Section 6.1. A more recent example illustrates the continuing policy relevance of this issue. In July 2023 India responded to a 30% rise in domestic prices caused by weather conditions by banning non-basmati exports. As a result, global rice prices rose due to limited export capacity [84]. This is particularly significant given that India accounts for 40% of global rice exports [84] and is one of the world's largest producers [29]. Consequently, a shock in such a country is highly likely to be transmitted internationally, even though several private and public firms compete in international markets [42]. Nowadays, the question remains highly topical, as recent tensions around the Strait of Hormuz and the associated rise in fertilizer prices illustrate the vulnerability of staple food markets to external shocks.

Such shocks, when falling out of the 95% confidence interval, will be characterised as abnormal in this Thesis (see Section 4.1). These shocks require a different framework compared to normal time adjustment, especially in the case of a non-linear economy [23]. For rice, it is even more stringent as the commodity is difficult to substitute and is of main importance for food security.

To answer its question, this thesis uses monthly rice-price data for Thailand, India, Cambodia, the Philippines, and Bangladesh. The empirical approach is descriptive rather than causal: it decomposes domestic rice-price growth into international, regional, and national residual components. The results show substantial cross-country heterogeneity: Thailand's domestic prices closely co-move with the international benchmark, India appears relatively insulated, and Bangladesh, Cambodia, and the Philippines display intermediate or mixed patterns.

The remainder of the thesis is structured as follows. First, Section 2 reviews the literature on price transmission, market integration, and rice-market heterogeneity. Then Section 3 presents the data and discusses the main limitations of the price series. Section 4 describes the empirical decomposition strategy and is followed by Section 5, which presents the full-sample results and the analysis of abnormal shocks. Section 6 focuses specifically on the 2007–2008 rice crisis. Finally, Section 7 concludes by summarising the main findings, limitations, and possible extensions.

2 Literature Review

This thesis contributes to the literature on price transmission, market integration, and rice-market policy by examining how domestic rice prices co-moved with international prices during periods of abnormal market stress. It also relates to the broader literature on commodity-market co-movement, which has often focused on energy and oil markets [49].

Price transmission, broadly defined as the process through which price changes in one market are reflected in another, is a key issue because of its impact on consumer welfare and household food security [3]. Two forms of price transmission can occur: horizontal or vertical. The former focuses on a single commodity market across different locations, such as the transmission from international to domestic markets used in this thesis, whereas the latter concerns price transmission along the supply chain [62, 60]. While international prices affect the market, domestic prices directly influence consumers [78]. Furthermore, a stronger pass-through can improve producers' incentives to increase supply by allowing domestic prices to better reflect international scarcity and profitability conditions. This trade-off is often referred to as the "food policy dilemma" [11].

In principle, stronger price transmission may indicate greater market integration. Since the wave of economic liberalisation that began in many developing countries in the 1980s, analysts have often expected domestic prices to become more closely linked to world prices [62]. A close relationship between domestic and international prices has, in fact, often been interpreted as evidence of market efficiency and stronger arbitrage links between surplus and deficit markets [26, 57], consistent with the law of one price. However, empirical evidence shows that liberalisation does not mechanically lead to full transmission. Baffes and Gardner find no significant increase in short-run or long-run price adjustment for many countries despite policy reforms, suggesting that liberalisation does not automatically produce full market integration. This is especially relevant for agricultural commodities, where governments often intervene to stabilise domestic prices [6].

Building on this framework, an increasing number of studies have examined how price transmission operates in agricultural markets [57]. Emediegwu and Rogna [26] conducted a study on price transmission between international and domestic markets for various cereals, including rice. They found a pass-through of about 1.3%, occurring within roughly two months. These results are consistent with Qi et al. [67], who found that rice exhibits a lower transmission pattern than soybean or corn due to its lower openness and degree of marketisation in the Chinese market.

Rice is a particularly important case because it is thinly traded internationally and highly differentiated by variety and quality. Therefore, rice should not be treated as a homogeneous commodity. Not all rice varieties exhibit the same transmission pattern, and low quality rice is reported to have a higher transmission rate than high quality varieties [59]. This pattern may be even more pronounced in large net-importing countries, where an international shock can both encourage importers to minimise costs and induce households to substitute away from high-quality rice towards lower-quality varieties [47].

Closely related to price transmission is the issue of price volatility in international markets. Over some periods, rice prices have been found to be less volatile than maize and wheat, despite the thinness of international rice trade [30].

When focusing specifically on Asia, Lee and Valera [58] found that countries such as India and China were more insulated from international market fluctuations, largely due to their control policies. Thailand and Vietnam, however, showed greater sensitivity to these changes [57]. Together, these studies already point to substantial heterogeneity across countries. Evidence for China from Qi et al. [67] and Arnade et al. [4] further supports the view that international-to-domestic price transmission there is limited. By contrast, Ismet et al. [51] focused on Indonesia and demonstrated the role of policy in shaping the country's market integration. Other studies find limited international-to-domestic transmission in the Philippines and Vietnam, but higher transmission in China [66]. This divergence among countries has led some authors to distinguish between "stabilising" countries and "free-trading" countries [78].

This distinction is useful for understanding the countries studied in this thesis. In Thailand and Bangladesh, an important policy feature is the relatively greater role given to the private sector in rice trade, including decisions over export and import quantities. This may help explain why free-trading countries tend to follow international price movements more closely. However, it does not mean these countries do not intervene in the market. Indeed, Thailand offered farmers a minimum price, while Bangladesh varied its tariffs [38]. In contrast to Thailand, prices in Bangladesh did not fully track international price. This may reflect domestic market frictions that weakened the link between domestic and international prices [38]. In addition, Bangladesh banned rice exports in May 2008.

More broadly, four sets of factors explain why price transmission differs across rice markets. Olipra [62] and Timmer [78] highlight four main determinants of price transmission in the agricultural market: First, product homogeneity [18] facilitates substitution across sources of supply. In the case of rice, this condition is often not satisfied, as markets are not easily interchangeable across specific taste preferences [2, 43]. Although prices may differ across imperfectly substitutable varieties, prices in different-quality markets are closely linked [64, 3]. Second, physical infrastructure matters, as lower transport costs and better storage capacity tend to facilitate transmission [57]. The third factor is the frequency and scale of trade. Although its impact may be limited, higher trade volumes can reduce transaction costs and may accelerate price transmission [62]. Finally, the unique characteristics of rice allow it to be stored, making analysis more complex since the market should not be expected to clear from one season to the next [89]. Storage may therefore dampen or delay the effects of exogenous shocks.

A further complication is that international rice prices cannot be treated as fully exogenous. Although domestic rice prices are often assumed to be driven primarily by international markets, Greb et al. show that international rice prices are not purely exogenous to domestic markets: around 40% of the domestic prices series in their sample are found to influence the international price [45]. John's analysis of Thailand is consistent with this view, highlighting low but persistent transmission from domestic prices shocks to international price [55]. This finding is important for the present thesis because major countries such as India and Thailand may influence international prices themselves. Indeed, none of the analysed countries in the sample are below the 1% threshold putting us in the large country general equilibrium scenario. Therefore, a correlation between domestic and international prices cannot be interpreted as international-to-domestic pass-through.

At the global level, John concluded that Asian rice prices acted as price leaders for North and South American markets, thereby qualifying the view that the international rice market is highly fragmented [56].

Finally, this thesis relates to the broader literature on commodity-market co-movement, which has often focused on energy markets [49, 69, 83]. For instance, Rehman et al. [69] compare co-movement and spillovers across different crisis periods in energy markets. This thesis differs from that literature by focusing on rice, a food-security commodity whose price dynamics are strongly shaped by policy intervention, trade restrictions, stock management, and market segmentation.

Against this background, the present thesis does not attempt to estimate causal price transmission. Instead, it provides a descriptive decomposition of domestic-international price co-movement during abnormal rice-market shocks. While existing studies have documented heterogeneous price transmission across Asian rice markets, fewer studies explicitly decompose the observed co-movement between domestic and international rice price growth into international, regional, and country-specific components. This thesis contributes to this literature by providing a descriptive decomposition of price co-movement.

3 Data

The sample used for this thesis consists of five countries selected for their distinct positions in the rice market: three net exporters (Thailand, India, and Cambodia) and two net importers (the Philippines and Bangladesh). This selection allows for a comparison of price transmission patterns across countries with different trade profiles. The domestic prices data were obtained from the World Food Program database [86].

The main production, export, import, and consumption statistics [82] are reported in Table 8.9. It is interesting to observe that Thailand, which only produces 4% of the global rice production, is the second world exporter both in value and quantities. However, in 2003, Thailand was the major global exporter [87] and this remained the case until 2011 [88]. By contrast, the Philippines and Bangladesh are relevant cases because their import dependence exposes them, at least potentially, to international rice-market conditions. Cambodia is included as a smaller exporter.

On the consumption side, China was the largest consumer in 2022, followed by India and Indonesia. Bangladesh and the Philippines rank fourth and fifth, as reported in Table 28.

Regarding location, the analysis was restricted to the capital-city market due to the unavailability of country-level data, as in Ceballos et al. [14]. This remains a limitation, since capital-city prices may differ from rural or secondary-market prices, especially in countries with weak internal market integration. However, Dawe suggests that price trends in capital cities are generally representative of national-level trends [38].

The absence of a single global average international price, due to rice-market segmentation, makes the choice of the international benchmark essential. Following the reasoning of Emediegwu and Rogna [26] and Jamora and von Cramon-Taubadel [52], this thesis uses the Thai 5% broken FOB rice price as the international benchmark. This choice is mainly motivated by Thailand's prominent position in the international rice market and by the fact that 5% broken rice is a high-quality variety that is more comparable across markets than lower-quality rice. By contrast, rice that is 25% broken or fully broken is more often used as animal feed, which makes it less suitable as a benchmark for the domestic rice varieties analysed in this thesis.

However, the use of Thai 5% broken FOB rice also raises an important limitation. The FOB export price is closely related to the Bangkok domestic price, adjusted for export-related costs, margins, and taxes. This is critical with regard to the exogeneity of the international benchmark, since the benchmark is not independent from Thai domestic market conditions. Indeed, the Thai export price does not appear statistically different from the Thai domestic price over the sample period (see Section 2). This issue is particularly relevant because Thailand is included in the country sample, which may mechanically increase the measured co-movement between Thailand's domestic price and the international benchmark.

An alternative would be to use a rice price index, such as the FAO rice price index, which averages prices from major exporters [36]. This option is not used in this thesis because monthly country-level data are not consistently available for the full period. Moreover, price indices may change interpretation over time when major exporters impose trade restrictions, since export restrictions can reduce the availability or representativeness of FOB prices. Some studies also highlight Vietnam's importance as a price setter during the 2007–2013 period. For this reason, the analysis is replicated using a Vietnamese rice export price as an alternative international benchmark. This robustness check assesses whether the baseline results are driven by the use of Thai 5% broken FOB rice. The monthly time series are sourced from the World Bank Pink Sheet [85].

The rice variety selected for each country is assumed to be of high quality, making it a close substitute for Thai 5% broken FOB rice. This condition is explicitly met in the cases of the Philippines and Cambodia. It should be noted, however, that no detailed information was available on the specific rice varieties for India and Thailand. Nevertheless, both countries predominantly export high-quality rice varieties, indicating that their exports are likely close substitutes for Thai 5% broken FOB rice. A notable limitation remains in Bangladesh, where the database is restricted to lower-quality grain. This may mechanically reduce measured co-movement with the international benchmark if lower-quality rice prices respond differently to international shocks. Wholesale prices were used due to data availability. They refer to dried, milled, and transported rice, and are therefore relatively close to retail level [38].

All series were converted into USD using exchange rates from the BIS database and standardised to the same units (USD/100kg) [10]. This conversion improves comparability across countries, but it also means that measured price growth may partly reflect exchange-rate movements rather than changes in local-currency rice prices.

Annual bilateral trade quantities of rice data come from the BACI database, sourced from the CEPII website [15]. These trade data are used to construct the regional prices variable in the empirical decomposition. For each country, regional exposure is measured using trade links with the other countries in the sample. Because the analysis aims to avoid mechanically linking contemporaneous price changes to contemporaneous trade quantities, the baseline specification uses fixed trade weights from the beginning of the sample [13]. However, this choice is also restrictive, since rice-trade patterns changed substantially over the sample period, especially around the 2007–2008 crisis.

Time-series analysis was performed for each country. The Augmented Dickey-Fuller unit root test indicates non-stationarity for all series except Bangladesh. The results may be found in Table 10 in the Appendix. This is consistent with the common finding that commodity price levels often contain a unit root and do not revert quickly to a fixed long-run mean. However, the first differences are stationary across all countries (see Table 11). For consistency across countries and because the analysis focuses on monthly price growth, all series are nevertheless transformed into first differences of log prices. Similarly, seasonality was tested using monthly dummies and rejected as shown in Table 12. This may be due to the ease with which rice can be stored.

4 Methodology

This section presents the empirical strategy used to analyse domestic–international rice-price co-movement. The methodology proceeds in four steps. First, the international price innovation is extracted from an autoregressive model of international rice-price growth. Second, a trade-weighted regional price variable is constructed for each country and purged of the international component. Third, domestic price growth is regressed on the international innovation, the regional residual component, and lagged domestic price growth when necessary. The remaining residual is interpreted as the national component. Finally, the correlation between domestic and international prices growth is decomposed into the contribution of each component.

4.1 Descriptive approach

In this setting, a shock can be viewed as an unpredictable event, which, in econometrics, aligns with residuals in a regression analysis. Residuals are therefore defined as unexpected, even when considering the information available at time t. On the one hand, because the price growth series are stationary (see Section 3), shocks can be interpreted as short-run disturbances to rice price growth whose effects dissipate over time, even if the underlying price level remains highly persistent. On the other hand, residuals in price levels can be seen as a permanent shift in price level.

From an economic perspective, even forecasted events can act as shocks and greatly affect prices. For instance, a heat wave might be predicted weeks or months in advance. However, its actual impact remains uncertain, and the country may not adapt quickly enough, leading to unpredictable supply shortages and price increases. The magnitude, persistence, or deviation from expectations is what creates a shock. Thus, what matters is less the event itself than its predictability.

Moreover, in a commodity market like rice, stocks play a crucial role. Two main types of buyers readily accumulate supplies: the private sector, which helps smooth out regular demand, and the public sector, which is primarily activated during crises. As a result, the extent to which a global price rise is transmitted depends on the country's domestic production and stock levels. When domestic production and stocks are high, international price transmission may be partially dampened, as domestic supply buffers can mitigate external shocks. Consequently, a small, predictable shock can be smoothed out easily by drawing on stock. However, for bigger shocks such as in 2008, the magnitude may be too great to be fully absorbed, leaving buffer mechanisms insufficient and uncertainty as the driver of a price increase. Even more important, the FAO estimates that the market observers did not predict this crisis [1]. Therefore, treating the model's unpredictable component as a shock seems relevant in this case.

Nevertheless, it is worth noting that the residuals, even if they represent the unpredictable part of the model, contain more than just a market shock. They also contain model specification errors, omitted variables, model misspecification or structural breaks. On this last matter, it is worth noting that nearly none of the countries exhibit structural breaks 8.5. Moreover, it is important to understand that, in this case, what is called a shock encompasses a wide variety of economic events: international demand, financial crisis, domestic demand, climate issues, etc., and is not to be interpreted as a single shock.

Moreover, this study focuses exclusively on correlation analysis. In the case of the food crisis, the number of events that occurred in this period makes it difficult to identify a single causal relationship from the data. In particular, endogeneity arises when examining the impact of domestic prices on international price, and the absence of a clear exogenous shock during this period further complicates causal inference. Consequently, this analysis does not attempt to establish causality, but rather aims to synthesise and interpret the observed correlations.

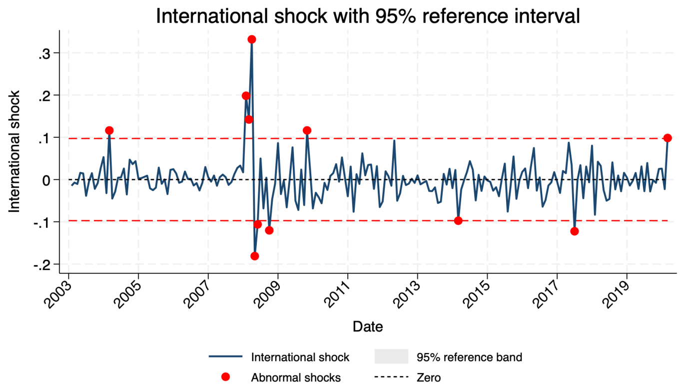
To focus on the most significant and abnormal shocks, the following plot identifies those that fall outside the 95% confidence interval. In such a setting, we then assume that countries could effectively manage their rice stocks when the shock remained between the interval. Eleven exceptional shocks can be identified. The majority of them occur around 2008, reflecting the prolonged effects of the food crisis. Interestingly, no abnormal shocks are detected around 2011 (the second food crisis), which may be because the international rice price was less affected than other commodities [80].

Table 1: Abnormal shocks dates

Date
2004m3
2008m2
2008m3
2008m4
2008m5
2008m6
2008m10
2009m11
2014m3
2017m7
2020m3

Notes: The table reports the dates of abnormal shocks, defined as international shocks that fall outside the 95% confidence interval.

Figure 1: Abnormal international shocks



Notes: The figure displays the series of international shocks. Observations in red indicate abnormal shocks that lie outside the 95% confidence interval. The upper and lower bounds of the confidence interval are depicted by the red dotted lines. Observations outside this interval are interpreted as unusually large short-run disturbances in international rice-price growth and motivate the shock-specific analysis.

4.2 Empirical Decomposition Strategy

The decomposition proceeds in three steps and is based on Huo et al. [50] background of co-movement decomposition, even though this thesis simplifies the analysis. First, the international price innovation is estimated from an autoregressive model of international rice-price growth. Second, for each country, a trade-weighted regional prices-growth variable is constructed using the other countries in the sample. The part of this regional variable that is not explained by its own lag and by the international innovation is interpreted as the regional residual component. Third, domestic price growth is regressed on lagged domestic price growth, the international innovation, and the regional residual component. The remaining residual is interpreted as the national residual component.

The majority of domestic price growth follows an AR(1) process (except India and Cambodia as can be seen in Table 15), we can thus write the domestic process as:

$$\Delta LogP_{t,n} = \alpha_{0,n} + \alpha_{1,n}\Delta LogP_{t-1,n} + u_{t,n} \tag{1}$$

where $P_{t,n}$ denotes the domestic rice price in country n, and $u_{t,n}$ is the residual price innovation not explained by lagged domestic price growth.

By the definition of shocks in Section 4.1, we assume the residuals are thus only composed of the international, regional and national component.

$$u_{t,n} = \gamma_n z_{t,n}^{INT} + \theta_n z_{t,n}^{REG} + z_{t,n}^{NAT} \tag{2}$$

where z_t^{INT} is the international innovation, z_t^{REG} is the regional residual component specific to country n, and $z_t^{NAT,n}$ is the national residual component. The coefficient γ_n and θ_n allow the international and regional components to affect each country with different intensities. Assuming $\alpha_{1,n}$ is similar for all t and $|\alpha_{1,n}| < 1$, the AR(1) process can be written as :

$$\Delta \log P_{t,n} = \frac{\alpha_{0,n}}{1-\alpha_{1,n}} + \sum_{k=0}^{\infty} \alpha_{1,n}^k \gamma_n z_{t-k}^{INT} + \sum_{k=0}^{\infty} \alpha_{1,n}^k \theta_n z_{t-k}^{REG,n} + \sum_{k=0}^{\infty} \alpha_{1,n}^k z_{t-k}^{NAT,n}, \quad |\alpha_{1,n}| < 1. \tag{3}$$

We assume the average of the national shocks across the sample is null. Indeed, if a pattern can still be found among the region, it may mean that the shock was rather regional than local. Similarly, if the region shocks do not have an average of zero, it means the shock can be attributed to an international component. To construct each of these shocks we can use the following methodology.

4.3 International Price Innovation

Starting from the most aggregated data, the first step analyses the international price series. The first difference of the log international price is modeled as an AR(2) process if we want them to follow a white noise process (see Table 13 and 14):

$$\Delta \log P_t^{INT} = \alpha^{INT} + \phi_{t,1}^{INT} \Delta \log P_{t-1}^{INT} + \phi_{t,2}^{INT} \Delta \log P_{t-2}^{INT} + z_t^{INT} \tag{4}$$

where z_t^{INT} denotes the international price innovation. Therefore, what is considered as the international shock is the unpredictable part of the price growth.

4.4 Regional Residual Component

To construct the regional variable for country n, we compute the average variation in prices of the other countries in the region:

$$R_{t,n} = \sum_{\substack{m \in \mathcal{R} \\ m \neq n}} w_{t,n,m} \Delta \log P_{t,m} \tag{5}$$

where $w_{t,m}$ is defined as the share of the total quantity of rice traded between countries n and m in the total rice trade of country n with all other countries k, including those not in the sample.

$$w_{t,n,m} = \frac{Trade_{t,n,m}}{\sum_{k \neq n} Trade_{t,n,k}} \tag{6}$$

$$Trade_{t,n,m} = E_{t,n,m} + I_{t,n,m} \tag{7}$$

and $\mathcal{R} = \{Thailand, India, Bangladesh, Philippines, Cambodia\}$

$E_{t,n,m}$ represents the export from country m to country n at time t while $I_{t,n,m}$ are the import from n to m at time t. The weighting scheme is crucial, since an increase in the domestic prices of a major trading partner is unlikely to affect the home economy in the same way as a comparable increase in the price of a minor partner. However, as explained in the literature, in order to separate the effect of a price variation with a quantity variation, the weights are fixed as the one of the year at the beginning of the sample, so 2003 [13].

Because the regional component may be correlated with the international innovation, we first remove the international influence by estimating a specific autoregressive model for each country based on the SBIC criterion (see Table 16). The SBIC information criteria was chosen because of its parsimony compared to the AIC :

$$R_{t,n} = \alpha_n^{REG} + \theta_n^{REG} R_{t-1,n} + \gamma_n z_t^{INT} + \varepsilon_t \tag{8}$$

ε_t denotes the regional shock $z_{t,n}^{REG}$ specific to country n at time t. Here again, the shock is the part of the weighted regional average growth for country n that is unexplained either by the lagged price, or by the international shock. Indeed, if we did not remove the international shock, the regional one would have included it, which would have biased our analysis. However, it is important to note that this does not solve a potential simultaneity problem through cross-country feedback effects. In this case, the regional effect may thus not be interpreted as a perfect exogenous shock. Nevertheless, since the estimated regional component is not statistically significant in the main results, this limitation does not substantially affect the interpretation of the findings. Future research could address this issue more explicitly by constructing the regional component using lagged regional prices.

4.5 National Residual Component

The national component is thus defined as the residual of the following equation:

$$\Delta \log P_{t,n} = \alpha_{1,n} \Delta \log P_{t-1,n} + \theta_n z_{t,n}^{REG} + \gamma_n z_t^{INT} + \epsilon_{t,n} \tag{9}$$

with $\epsilon_{t,n} = z^{NAT,n}$, or

$$\Delta \log P_{t,n} = \frac{\alpha_{0,n}}{1-\alpha_{1,n}} + \sum_{k=0}^{\infty} \alpha_{1,n}^k \gamma_n z_{t-k}^{INT} + \sum_{k=0}^{\infty} \alpha_{1,n}^k \theta_n z_{t-k,n}^{REG} + \sum_{k=0}^{\infty} \alpha_{1,n}^k z_{t-k,n}^{NAT}. \tag{10}$$

$z^{NAT,n}$ and can thus be interpreted as the part of the price increase which is explained neither by an international shock, nor by a regional one nor by the old price. This accounts for local weather conditions or local policies for small countries for instance. It is indeed important to note that local policies for large exporters or importers can less clearly be attributed to an international or a domestic shock as these countries may have the capacity to influence the international channel.

We define:

$$g_{t,n}^{INT} = \gamma_n z_t^{INT} + \alpha_{1,n} g_{t-1,n}^{INT} \tag{11}$$

$$g_{t,n}^{REG} = \theta_n \varepsilon_{t,n}^{REG} + \alpha_{1,n} g_{t-1,n}^{REG} \tag{12}$$

$$g_{t,n}^{NAT} = z_{t,n}^{NAT} + \alpha_{1,n} g_{t-1,n}^{NAT} \tag{13}$$

the terms g_{t-1}^{INT}, g_{t-1}^{REG}, g_{t-1}^{NAT} equate zero for India and Cambodia as their domestic price growth do not follow an AR(1) process 15. However, for Cambodia, the literature suggests a potential lagged and slow transmission of shocks due to weak infrastructures in the country. For this case only the specification includes one and two month lags of both the international and the regional component. For Cambodia only we thus have :

$$\begin{aligned}\Delta \log P_{t,KHM} = \alpha_{0,KHM} &+ \theta_{0,KHM} z_{t,KHM}^{REG} + \theta_{1,KHM} z_{t-1,KHM}^{REG} + \theta_{2,KHM} z_{t-2,KHM}^{REG} \\ &+ \lambda_{0,KHM} z_t^{INT} + \lambda_{1,KHM} z_{t-1}^{INT} + \lambda_{2,KHM} z_{t-2}^{INT} + \epsilon_{t,KHM}\end{aligned} \tag{14}$$

4.6 Correlation Decomposition

This allows the analysis to compute the correlation between each component and the domestic price growth:

$$\rho_{X,Y} = \frac{\mathrm{Cov}(X,Y)}{\sigma_X \sigma_Y} \tag{15}$$

$$\rho(\Delta \log P_t^n, \Delta \log P_t^{INT}) = \frac{\mathrm{Cov}(\Delta \log P_t^n, \Delta \log P_t^{INT})}{\sigma_{\Delta \log P^n} \sigma_{\Delta \log P^{INT}}} \tag{16}$$

$$\Delta \log P_t^n = g_t^{INT,n} + g_t^{REG,n} + g_t^{NAT,n} \tag{17}$$

$$\begin{aligned}\mathrm{Cov}(\Delta \log P_t^n, \Delta \log P_t^{INT}) &= \mathrm{Cov}(g_t^{INT,n}, \Delta \log P_t^{INT}) \\ + \mathrm{Cov}(g_t^{REG,n}, \Delta \log P_t^{INT}) &+ \mathrm{Cov}(g_t^{NAT,n}, \Delta \log P_t^{INT})\end{aligned} \tag{18}$$

$$\mathrm{Corr}_n^{INT} = \frac{\mathrm{Cov}(g_t^{INT,n}, \Delta \log P_t^{INT})}{\sigma_{\Delta \log P^n} \sigma_{\Delta \log P^{INT}}} \tag{19}$$

$$\mathrm{Corr}_n^{REG} = \frac{\mathrm{Cov}(g_t^{REG,n}, \Delta \log P_t^{INT})}{\sigma_{\Delta \log P^n} \sigma_{\Delta \log P^{INT}}} \tag{20}$$

$$\mathrm{Corr}_n^{NAT} = \frac{\mathrm{Cov}(g_t^{NAT,n}, \Delta \log P_t^{INT})}{\sigma_{\Delta \log P^n} \sigma_{\Delta \log P^{INT}}} \tag{21}$$

$$\rho(\Delta \log P_t^n, \Delta \log P_t^{INT}) = \mathrm{Corr}_n^{INT} + \mathrm{Corr}_n^{REG} + \mathrm{Corr}_n^{NAT} \tag{22}$$

Here is a graphical summary of the co-movement analysed in the empirical section 5.4.

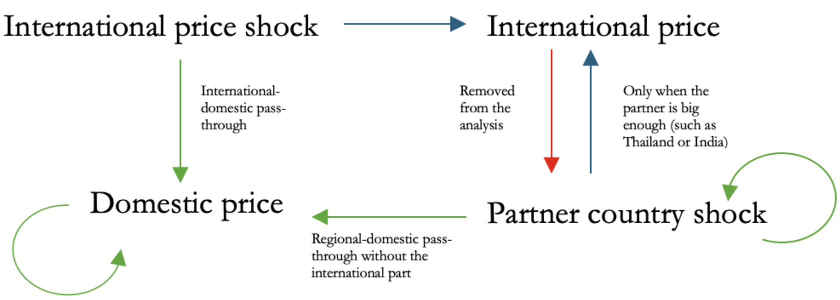


Figure 2: Graphical analysis of the price interactions

Notes: The figure summarises the empirical decomposition strategy. Green arrows indicate the co-movement channels explicitly measured in the analysis, red arrows indicate excluded channels, and blue arrows highlight methodological limitations. The framework separates domestic rice-price growth into international, regional, and national residual components, without claiming causal identification.

Correlations identified by the analysis are indicated in green, the excluded correlation is shown in red, and the methodological limitations are highlighted in blue.

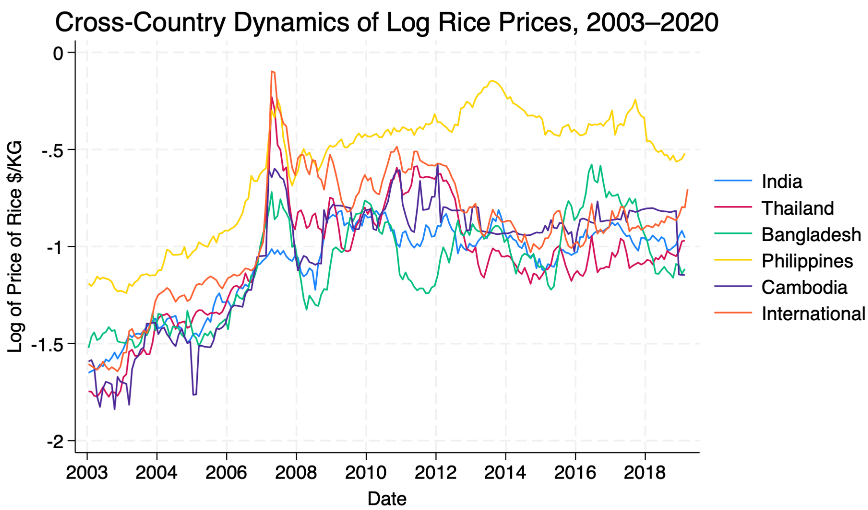
5 Results

This section presents the empirical results in four steps. First, it describes the evolution of domestic and international rice prices over the full sample. Second, it reports simple correlations between domestic and international prices growth for each country. Third, it decomposes these correlations into international, regional, and national components and finally, it interprets the country-level patterns in relation to trade exposure, market structure, and public intervention.

5.1 Descriptive Price Patterns

Figure 3 plots the logarithm of domestic rice prices and the international benchmark for the full sample period. The international benchmark exhibits a sharp increase around 2007–2008, followed by a partial decline. Domestic prices, however, do not respond uniformly. Thailand's prices track the international benchmark closely, while India's show a much flatter trajectory, indicating weaker domestic–international co-movement. Bangladesh, Cambodia, and the Philippines fall in between these two extremes. This descriptive evidence motivates the formal correlation and decomposition analysis presented below.

Figure 3: Evolution of log domestic and international rice prices



Notes: This figure depicts the evolution of the logarithm of domestic and international prices over the period 2003–2020.

5.2 Correlation Matrix

Table 2 confirms the heterogeneity suggested by Figure 3 and the literature. We observe a very strong correlation between Thailand (0.95) and the international price. This correlation is consistent with Thailand's openness to international trade, but it may also partly reflect the fact that the international benchmark is Thai 5% broken FOB rice. For this reason, the use of another international price series will be made as a robustness test 8.1.1. As expected, India has the lowest correlation (0.028). However, the Philippines domestic rice price has the second highest correlation with the international price

(0.3). It is worth noting that the only negative correlation is between India and Cambodia. However, this value is very small and close to zero. It may thus simply reflect the small linkages between India and Cambodia. Overall, these results suggest a clear country ranking: Thailand is highly integrated with the international benchmark, India is largely insulated, and the Philippines, Bangladesh, and Cambodia occupy intermediate positions. The total correlation can be summarised as in Table 2:

Table 2: Correlation matrix

	dLogpriceIND	dLogpriceTHA	dLogpriceBGD	dLogpricePHL	dLogpriceKHM	dLogpriceINT
dLogpriceIND	1.0000					
dLogpriceTHA	0.0188	1.0000				
dLogpriceBGD	0.1100	0.1963	1.0000			
dLogpricePHL	0.1776	0.3078	0.1822	1.0000		
dLogpriceKHM	-0.0234	0.1092	0.0450	0.0956	1.0000	
dLogpriceINT	0.0279	0.9505	0.1702	0.3030	0.1212	1.0000

Notes: The table reports pairwise correlations between monthly first differences of log rice prices. Domestic price growth is compared across the five countries and with the international benchmark. The matrix is used as a descriptive starting point to show the heterogeneity of domestic–international co-movement before decomposing this co-movement into international, regional, and national components.

However, the correlation matrix does not indicate why domestic prices co-move with international price. A positive correlation may reflect direct exposure to international shocks, regional trading-partner dynamics, or domestic residual movements that happen to coincide with international price changes. The decomposition in Section 5.4 separates these channels.

5.3 Decomposition of Co-movement

Table 3 decomposes the total correlation between domestic price growth and international price growth into three components. The total correlation is $corr(\Delta log P^n, \Delta log P^{INT})$, which can be decomposed into international, regional, and national components. The international component can be interpreted as the correlation between the international shock z^{INT} and the international price growth. It therefore captures how strongly the part of domestic price growth associated with international innovations co-moves with international price growth. Similarly, the regional component can be interpreted as follows: it represents the correlation between weighted regional shocks affecting the domestic price growth and the international growth. The regional component captures trade-weighted co-movement with other sample countries after removing the common international component. Such co-movement may occur, for example, when a government-to-government agreement is signed. However, the regional component does not include important regional actors such as Vietnam, which is one of its limitations. The national component should be interpreted with particular caution. It is a residual component and may include domestic policy responses, weather shocks, stock changes, measurement error, omitted regional channels, and model misspecification. It should therefore not be interpreted as a pure domestic structural shock.

Table 3: Correlation statistics by country

Country	Total correlation	International component	Regional component	National component
IND	0.028	0.058	-0.001	-0.029
THA	0.951	0.919	0.001	0.030
BGD	0.172	0.182	-0.000	-0.009
PHL	0.303	0.270	0.002	0.031
KHM	0.119	0.151	-0.005	-0.026

Notes: The table decomposes the total correlation between domestic rice-price growth and international rice-price growth into international, regional, and national components. The international component captures the part of domestic price growth associated with international innovations. The regional component captures trade-weighted co-movement with other countries in the sample after removing the international component. The national component is a residual term and may include domestic policy responses, weather shocks, stock changes, measurement error, omitted variables, or model misspecification.

The results of the main equations: 9 and 14 confirm this correlation matrix. For Cambodia, the pass-through from international shock and domestic prices indeed appears delayed as the second lag of the international shock is statistically significant at 10% and the first lag is significant at 5%. However, none of the variables are statistically significant for India, highlighting a potential lack of co-movement with the domestic component. Overall, all the regional variables are not statistically significant. This may suggest that most of the regional co-movement occurs through the international channel. However, this may reflect the limitation in the construction of the regional variable by the lack of some major importers and the exclusion of informal trade. For Thailand, however, the entire model is significant and the international innovation is strongly associated with domestic price growth. The same pattern is observed for the Philippines.

Once again, we observe the same typology of countries as in [19], with Thailand acting as a free trader and India serving as a stabilizer. It is interesting to note that nearly all the national components are negatively correlated with the price growth. This may result from the protecting policies each country tries to take.

5.4 Cross-country Analysis

Overall, **Thailand**'s domestic price growth is, as expected, driven mainly, and almost exclusively, by international factors, independently of the type of shock 8a. As a reminder, Thailand, together with Bangladesh, is one of the few Asian countries that allows exporters to determine the quantities they trade independently. The country exports thus nearly 40% of its rice production [53]. This institutional arrangement is consistent with the close co-movement between domestic price growth and the international benchmark. Overall, this suggests that regional and purely domestic factors contribute only marginally to the observed co-movement between Thai domestic and international prices. And indeed, the regional and national contributions are much smaller, at 0.001 and 0.03, respectively. The regional component remains close to zero throughout the sample period, suggesting that, once international price movements are accounted for, price movements in other trading partner countries add little explanatory power to Thai domestic price growth. This is consistent with Thailand's position as a major rice exporter rather than a country whose domestic prices are strongly driven by regional import dependence. This interpretation should be qualified by the fact that the international benchmark is itself based on Thai 5% broken FOB rice, which mechanically strengthens the observed relationship.

At the other end of the spectrum, **India** retains its role as a stabilising country, likely due to its trade and market policies. In particular, India seeks to insulate its domestic market from international price movements as much as possible, for example, by banning the export of non-basmati rice. As a result, the domestic component appears to be the primary driver of price dynamics, while the international component is marginal and sometimes even negatively correlated with domestic price growth. Figure 8b reinforces this interpretation. Domestic prices-growth movements are mainly reflected in the national residual component, while the international and regional components remain small for most of the sample. Nevertheless, it does not mean that India is irrelevant for this analysis. On the contrary, India's producer and exporter position makes it an interesting case of analysis.

Cambodia, however, presents a more nuanced case 8c. Its total correlation with the international benchmark is positive but relatively weak, suggesting limited contemporaneous co-movement. Although Cambodia is closely connected to Thailand and Vietnam, a substantial part of this trade takes place through informal cross-border channels. This weakens the ability of official trade data to capture actual regional linkages and limits the capacity of national policy to regulate export flows [21]. In the official trade data used to construct the regional weights, Thailand accounts for 93% of Cambodia's recorded rice imports. The Cambodian results should therefore be interpreted as evidence of imperfect and potentially delayed transmission rather than a complete absence of international or regional exposure. This interpretation is reinforced by the lagged specification used for Cambodia. The significance of lagged international innovations suggests that Cambodian domestic prices may react with delay rather than contemporaneously.

Bangladesh is a major rice producer but remains a net importer. However, for a net importing country, the apparent importance of the international market component may seem relatively limited. Moreover, Bangladesh is the only country in which the regional component is sometimes more correlated with the domestic growth than the international component as illustrated on Figure 8d. This is likely due to the fact that Bangladesh's principal rice supplier is India, which accounted for approximately 89% of its rice imports in 2003. The trade between the two countries occurred predominantly through bilateral contracts that specify particular terms and conditions. Consequently, the import prices faced by Bangladesh may not fully reflect price movements in the Thai or Vietnamese markets. These imports have enabled the country to stabilize domestic rice prices, albeit at the expense of local production incentives [24]. The Bangladeshi case therefore shows that import dependence does not automatically imply strong co-movement with the international benchmark : the form of import dependence matters. If imports are shaped by bilateral contracts, public intervention, tariff changes, or government-to-government arrangements, domestic prices may be partially insulated from the benchmark used in this thesis. In addition, the Bangladesh price series refers to lower-quality rice, which may respond differently from Thai 5% broken FOB rice and limits comparability with the international benchmark.

As shown in Figure 3, the **Philippines** has, on average, higher domestic prices. This is due to higher production costs [9] and lower supply. The Philippines displays the second-highest correlation with the international benchmark as can be seen in Figure 8e. This may be due to its major importance on the import market. Its national component seems to be around zero. However, when we look at the graph, we can see that the domestic component accounts for the majority of the co-movement. The small correlation reported in Table 3 may be due to offsetting movements over the full sample : positive and negative residual movements may cancel out.

5.5 Analysis of Abnormal International Price Innovations

Let us now analyse all the abnormal shocks outside of the 2008-2009 period. The 2007–2008 crisis is analysed separately in Section 6.1 because most abnormal international innovations are concentrated around that period. The discussion below therefore focuses on the remaining abnormal episodes.

In 2000, India recognised that its stockpiles were too large and chose to export them at low prices. Around **March 2004**, however, India withdrew significant amounts of rice from the international market due to poor crop prospects [54, 32]. The March 2004 episode can therefore be interpreted as a supply-side export shock originating in India, with potential spillovers depending on each country's exposure to Indian rice and to international markets. As expected, *India*'s price movement is driven solely by the national component, consistent with its domestic origin, while *Thailand* has the highest co-movement with the international component. The remaining country-level patterns reveal more heterogeneous forms of transmission. In March 2004, domestic price growth in the *Philippines* was highly correlated with the international component and its co-movement with the regional component is close to zero. This may be explained by the fact that the Philippines' major rice supplier is Vietnam (61% in 2004), which is not included in our sample due to data limitations. Therefore, influence through only the Thailand or India price channels, outside of the international channel, is limited, even if Thailand accounted for 35% of the Philippines' imports. *Bangladesh*, however, has a large international component and a positive regional component. This may be explained by India's great importance to the country's imports (87% in 2004), which can thus impact the country through both channels. Moreover, domestic Bangladesh prices are cointegrated with the Indian price of subsidised rice. However, the decomposition shows a negative co-movement between the domestic growth and the national component. This may coincide with the good crop the country experienced this year [71]. *Cambodia* is a special case, as it is the only country with a price decrease in March 2004. However, a small negative co-movement is observed between the international and national components. Cambodia is a net exporter, but most of its trade is informal with its neighbours, Thailand and Vietnam. Therefore, the country seems less integrated, firstly because of its limited integration into formal export markets, and secondly because of its self-sufficient production. For official exports, the rice supplier must have obtained a state export licence, preventing private traders from exporting and reducing their ability to trade. The large rice supply, combined with imperfect export policies, contributes to this negative co-movement with the international price and may explain the decrease in domestic growth. [46].

In **November 2009**, the Philippines bought large quantities of rice after adverse weather earlier that year [33]. Not all countries were equally affected by this shock. On the one hand, India, Thailand, and the Philippines experienced increases in domestic prices. On the other hand, prices in Bangladesh and Cambodia remained stable or decreased. For the *Philippines*, both international and domestic components positively co-moved with the price increase. This aligns with the country experiencing both a domestic shortfall and rising import prices. The decomposition also indicates that the domestic component peaks a few months before November 2009, which coincides with adverse weather conditions. Similarly, *Thailand*'s export prices increased. For *India*, however, the case seems different, as the domestic component is highly correlated with the domestic increase. This may reflect the unusually erratic monsoon in India that year, which affected the autumn harvest and contributed to a 10% decline in production [40, 7]. In *Bangladesh*, stable prices may reflect weaker exposure to international markets, as high domestic production and stock levels reduced import needs that year. *Cambodia*, however, was the only country to experience a decrease in price growth after an important peak.

In **2014**, *India* increased its Minimum Support Price, which, when combined with a poor monsoon forecast, is consistent with the rise in its domestic component. *Bangladesh*, which is tightly linked to India through rice trade, also experienced an increase in domestic price growth. However, its regional component negatively co-moved with the international component. This pattern may reflect the coexistence of two opposite forces: upward pressure from India and downward pressure from falling Thai export prices. *Thailand*, however, experienced the opposite movement, with domestic prices declining [28, 37, 34]. In 2014, the country released large quantities of rice onto the market, leading to a decline in international price. This may explain the negative co-movement between the regional and international component observed in Bangladesh. However, it is important to remember that the international price used in the baseline analysis is Thai 5% broken FOB rice. The prominence of the international component should thus be validated through robustness checks. In the *Philippines*, between 2013 and 2014, the decomposition shows a relatively high national component, often negatively correlated with the international component. This may seem surprising, as the Philippines is one of the major importers. However, during this period, the country tightened its trade borders more than in the past, through the Department of Agriculture's Food Staples Sufficiency Program. Although these import restrictions were intended to develop domestic production, they led to a supply shortage and limited the pass-through of lower international price to domestic markets. Here again, *Cambodia* seems to be more isolated, with a growth rate of around 0. But the country's growth decreased approximately 2 months after the shock, which can illustrate the lagged transmission [65].

In **July 2017**, the international price fell sharply as a period of heavy buying by the Philippines, Bangladesh, and other importing countries, due to adverse weather and the Ramadan celebration, ended [68]. This price decrease should thus be seen more as a backlash than a reaction to specific policies. Moreover, in the same month, *Thailand* released some public stocks [17]. However, because these stocks were not intended for human consumption, their direct relevance for the Thai 5% broken FOB rice benchmark is limited. The *Philippines* exhibits a negative co-movement with the international component, as its domestic price growth appears to be driven mainly by the national component. The explanation remains the import restriction. In *Bangladesh*, the reduction in import tariffs at the end of June 2017 may have facilitated cheaper imports and contributed to the decline in domestic prices [35]. This could explain the negative domestic component despite adverse weather and crop forecasts. *Cambodia* again appears weakly integrated into the international price dynamics captured by our decomposition.

Taken together, the country-level results show that domestic-international rice-price co-movement cannot be interpreted uniformly across countries. Thailand's high co-movement is consistent with export-market integration, although the benchmark choice mechanically strengthens this relationship. India's weak co-movement is consistent with domestic insulation, but India's size means that domestic policies may still influence international price. In Bangladesh and the Philippines, import dependence creates exposure to international markets, but this exposure is mediated by public procurement, bilateral trade, tariffs, import restrictions, and stocks. Cambodia's weaker contemporaneous co-movement is consistent with delayed or informal transmission.

6 The 2007–2008 Rice Crisis

The previous section examined domestic-international rice-price co-movement over the full sample. This section focuses specifically on the 2007–2008 rice crisis because this period concentrates the largest abnormal international price shocks and because policy responses largely differed across countries. The crisis therefore provides a useful setting to examine whether domestic price growth moved mainly with international innovations, regional trade links, or national residual factors.

6.1 Context

The global rice crisis, as it was termed, refers to the shocks that affected the rice market in 2008. International rice prices tripled in roughly six months, driven less by a physical shortage than by trade restrictions, panic buying, a weak dollar, and high oil prices [1]. However, the history of price increases in the rice market has multiple causes and is not solely due to the financial crisis. From the mid-2000s onward, broader pressures on agricultural commodity markets reflected rising incomes, dietary changes, biofuel demand, high energy prices, and tight grain markets. In the case of rice, however, the 2008 spike was less the result of a crop failure or a severe global shortage than of policy responses and market panic [38, 16]. However, the trend gathered pace in 2007 and early 2008 amid adverse weather conditions, which reduced supply: the cyclone Sidr in Bangladesh, abnormal cold weather in China and Vietnam, and the Nargis cyclone in Burma [16, 44]. By early 2008, however, the magnitude of the rice price spike was driven primarily by policy responses and market panic rather than by the financial crisis itself.

In this period, four countries (India, Vietnam, China, and Egypt) imposed export bans, leading to a 60% rise in international market prices. India's ban accounted for 20%, and Vietnam's for 23% of this increase. Together, India and Vietnam accounted for around 15% of internationally traded rice [48]. Their bans reduced the quantity exported by 9% while demand increased by 10%, encouraged by the depreciation of the dollar [16]. These policies were partly connected to broader pressure on food markets, including the wheat market, although the rice price increase began before wheat prices reached their peak [21].

Consequently, India and Vietnam each exported approximately 1 million tonnes less rice. These bans sparked panic among buyers, who began buying rice in large quantities even when it was not necessary, thereby raising international price again. In the first four months of 2008, the Philippines purchased more rice on international markets than it had during the whole of 2007. A large majority of these quantities were traded from Vietnam through government-to-government deals [48, 74]. In this period, there was no lack of rice: stocks were full, and global production even increased in 2007 [21]. Although financial-market dynamics have been widely discussed in relation to commodities such as wheat and maize, their role in the rice market remains more ambiguous. This may be because of the thinness of the futures market for rice [21].

The 2007–2008 rice crisis is therefore particularly suited to a co-movement analysis. The price spike reflected a combination of international panic, trade restrictions, precautionary imports, and country-specific policy responses. This makes it difficult to identify a single exogenous causal shock, but it provides a relevant setting to examine how domestic prices moved with, or were insulated from, international price movements.

6.2 Analysis

To compare full-sample results with crisis-period dynamics, the correlation between monthly domestic rice-price growth and international price growth is recomputed for January 2008 to January 2009. This window captures both the sharp rise and the partial reversal of international rice prices during the crisis. Because the crisis window contains only 13 monthly observations, these correlations should be cautiously interpreted.

Table 4: Correlation between domestic rice price growth and international rice price growth

Country	Correlation with international price growth
India	0.374
Thailand	0.980
Bangladesh	0.494
Philippines	0.615
Cambodia	0.403

Notes: The table reports correlations between monthly domestic rice price growth, $\Delta \log p_{c,t}$, and international rice price growth, $\Delta \log p_{INT,t}$. The sample period is January 2008 to January 2009, inclusive.

Compared with the full-sample correlations, all countries display a higher correlation between their domestic prices and the international benchmark. This suggests that the crisis strengthened co-movement between domestic and international rice price. However, the ranking remains broadly similar: Thailand remains the most closely aligned with the international benchmark, while India remains comparatively more insulated. This stronger correlation highlights a potential shift in volatility which, for further research, could help refine a new methodology, based on a non-linear relationship allowing for a switch in volatility as in [73]. Following such a methodology may help to define not only dates of abnormal shocks but more generally, periods of tranquility and agitation.

Figure 4 presents the decomposition of rice price growth into its international, regional, and national components. The red dots indicate abnormal shocks.

6.2.1 Thailand

In 2008, the decomposition suggests that the international price increase accounts for nearly all of the observed co-movement in domestic prices. As explained in section 6.1, trade policies taken by important trade actors were the main driver of the drastic increase. At the same time, Thailand substantially increased its exports during the first seven months of 2008 [21]. Such an increase was made possible by earlier government decisions to reduce public rice stocks from 5 million to 2.1 million tonnes [21], contributing to global supply. Moreover, it compensated for the reduction in exports from Vietnam and India following their export restrictions [48]. The country's market position helps explain the close synchronization between Thai domestic prices and the international benchmark. Moreover, during the summer of 2008, Thai rice stocks increased sharply as the government offered generous prices to rice farmers, which impacted the country's export volumes and thus negatively affected domestic prices [21].

6.2.2 India

For India, 2008 is one of the few periods in which the international component is visibly associated with domestic price growth. Starting in October 2007, India imposed a minimum export price on non-basmati exports, which later became a full export ban from April 2008 to January 2009. Some form of export restriction remained in place after 2009 until January 2011. By withdrawing large export volumes from the world market, India contributed to an increase in international price [77] while securing its internal market. Moreover, although the country authorised "duty-free imports" [16], India did not import any rice thanks to its increased production [40]. Such restrictions are consistent with upward pressure on international price and with an attempt to limit domestic price increases. However, the decomposition does not show a negative association between the international component and Indian domestic price growth during the crisis (see Graph 4e). Rather, the international component is driven to zero. Nevertheless, India seems to remain isolated from international market fluctuations [40], with a 2008 peak much lower than in other countries, and the prominent importance of the national component.

6.2.3 Cambodia

Cambodia imposed an export ban between March and May 2008, despite its relatively limited formal export volumes. Indeed, although the country is historically a producer, it faces poor infrastructure, making it difficult for its producers to access the international market [76]. As in India, the national component appears to account for most of the price growth in 2008. However, the Cambodian price peak appears larger, suggesting the country was less insulated from international market turbulence than India. One possible explanation is that the export ban was introduced only after the initial international price surge had already affected domestic markets. During the ban period, the international component appears to move in the opposite direction from domestic price growth, suggesting that the timing of the policy coincides with a weakening of measured co-movement.

The Cambodian case also highlights a data limitation. A substantial share of Cambodia's rice trade takes place through informal channels with neighbouring countries, especially Thailand and Vietnam. Since the regional component is based on formal trade data and excludes Vietnam from the baseline sample, it may understate Cambodia's actual regional exposure during the crisis.

6.2.4 Philippines

For the Philippines, the first peak, in March 2008 (2^{nd} red point on the graph), aligns with a first high national component, which can be interpreted as a first panic, as the government urged fast-food restaurants and citizens to reduce portions to avoid importing rice. One month later (3^{rd} red point), the government refused to reduce import tariffs and warned that prices could quadruple. Finally, the peak in June 2008 (4^{th}) occurs at the same time as the announcement of a new purchase of 600,000 tons of rice [77]. As explained in section 6.1, the Philippines purchased exceptionally large quantities of rice despite having enough stocks. This partly contributed to the increase in international price. This could thus explain both the important national and international correlation. On the one hand, the national residual component may capture domestic factors associated with public concern over rice availability, procurement decisions, subsidies, and policy intervention. On the other, the international component represents the transmission of this panic to the international market, with respect to export bans. Additionally, in 2008, subsidies peaked for the NFA (National Food Authority) [53, 79], which imports, stores, and distributes rice. On top of that, the country decided to launch an "Economic Resiliency Program" aiming at increasing rice production through subsidies [8] and increased its support price [77]. All of this supports a high national component.

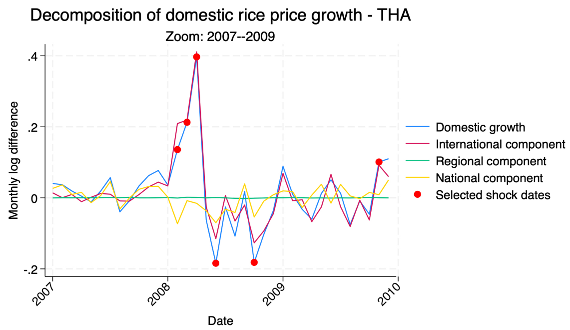
6.2.5 Bangladesh

Bangladesh's crisis-period correlation with international price growth is 0.494, compared with 0.170 over the full sample. This suggests that Bangladesh became more closely associated with international price movements during the crisis, although Figure 4 indicates that this relationship was not purely driven by the international component. The country experienced a crop shortfall [16] following Cyclone Sidr in November 2007 [44]. This domestic supply pressure helps explain why national residual factors remained important during the crisis period. This episode was followed by the elimination of rice import tariffs, aimed at increasing supply, and by a temporary export ban. One notable result is the negative co-movement observed at the end of 2008 between the regional-weighted price component and the international and domestic components. Bangladesh's main rice trade partner is India, which accounts for around 60% of its rice imports [22]. Through a government-to-government agreement with India, Bangladesh continued to receive rice imports. In December 2007 and February 2008, Bangladesh received 500,000 tons of rice from India [77]. This pattern is consistent with the possibility that government-to-government imports from India helped mitigate Bangladesh's direct exposure to the international benchmark. However, the model does not identify a specific co-movement effect associated with these agreements. This limited reaction also raises questions about the way the regional component is defined. Finally, panic and private stockholding also appear to have played an important role in the domestic prices increase [25].

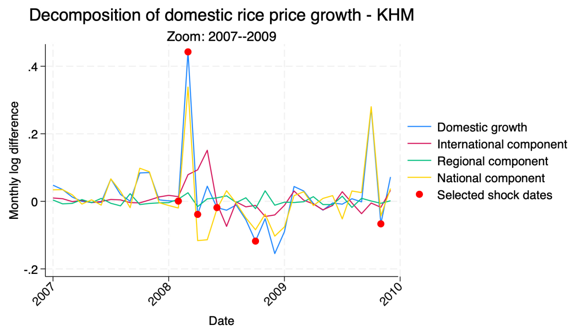
The crisis-period analysis confirms the full-sample typology, but also shows that the 2007–2008 crisis intensified domestic-international co-movement across all countries. Thailand remained the most synchronized with the international benchmark, reflecting both its role as a major exporter and the construction of the benchmark itself. India remained comparatively insulated, but its crisis-period correlation increased substantially, highlighting that even stabilizing countries were not fully disconnected from international rice-market turbulence. The Philippines displayed strong crisis-period co-movement, consistent with its import dependence and large precautionary purchases. Bangladesh and Cambodia occupied intermediate positions, with domestic prices shaped by international conditions, bilateral or informal trade links, domestic supply conditions, and policy responses.

These differences show that the crisis did not generate a uniform transmission mechanism. The same international price spike interacted with different domestic institutions, trade positions, and policy regimes.

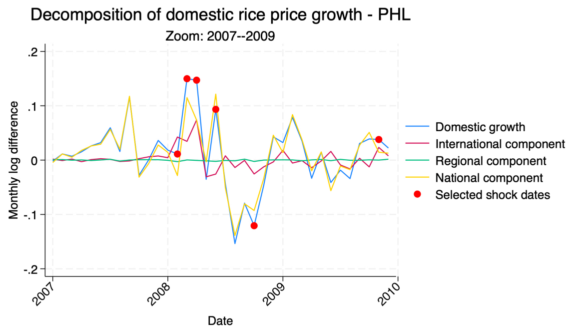
Figure 4: Rice price growth decomposition in selected Asian countries, 2007–2009



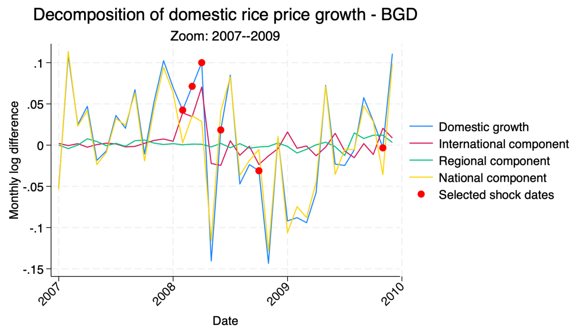
(a) Thailand rice price decomposition 2007–2009



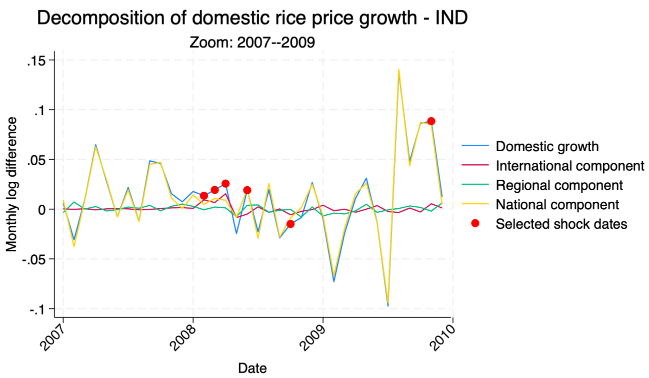
(b) Cambodia rice price decomposition 2007–2009



(c) Philippines rice price growth decomposition 2007–2009



(d) Bangladesh rice price growth decomposition 2007–2009



(e) India rice price decomposition 2007–2009

Notes: This figure presents the decomposition of domestic price growth for each country. The red markers indicate the dates associated with abnormal shocks. The graphs show how the 2007–2008 crisis intensified domestic–international co-movement, while also highlighting that the same international price spike interacted differently with each country's trade position, domestic institutions, and policy responses.

7 Conclusion

This thesis examined how domestic rice prices in five Asian countries co-moved with international rice prices during abnormal rice-market episodes, with particular attention to the 2007–2008 rice crisis. Using monthly price data for Thailand, India, Cambodia, the Philippines, and Bangladesh, the analysis decomposed domestic rice-price growth into international, regional, and national residual components. The objective was not to estimate causal price transmission, but to describe how domestic prices moved with international and regional prices innovations during periods of rice-market disruption.

The results reveal substantial cross-country heterogeneity. Thailand displays very strong co-movement with the international benchmark, consistent with its role as a major rice exporter, although this result is partly shaped by the use of Thai 5% broken FOB rice as the benchmark. India appears comparatively insulated, with domestic price growth only weakly correlated with international price growth over the full sample. Bangladesh, Cambodia, and the Philippines occupy intermediate positions, with domestic prices dynamics shaped by import dependence, bilateral or informal trade links, domestic supply conditions, and public intervention.

The 2007–2008 crisis intensified domestic-international co-movement across all five countries, but not through a uniform mechanism. Thailand and the Philippines were most closely associated with international price movements during the crisis, while India remained more insulated despite its increased crisis-period correlation. Bangladesh and Cambodia illustrate intermediate cases in which international conditions interacted with domestic and regional factors. These findings are consistent with the view that rice-market co-movement is heterogeneous and strongly conditioned by national policy regimes and trade structures.

The analysis has several limitations. It is descriptive and does not identify causal effects. The national residual component may include omitted variables, domestic policy responses, weather shocks, stockholding, measurement error, and model misspecification. Data limitations also matter, especially the lower-quality rice series for Bangladesh, the exclusion of Vietnam from the regional component, and the conversion of domestic prices into US dollars. Future research could extend the analysis by including additional countries, estimating a more explicit transmission matrix, and comparing results in local currency and US dollars.

However, the results also have a broader policy implication. Domestic stabilisation policies can reduce the exposure of consumers to international price movements, as illustrated by India. However, when implemented by large exporters, these policies may also contribute to international market instability. Conversely, import-dependent countries such as the Philippines and Bangladesh may remain exposed to international price movements, but the degree of exposure depends on public procurement, tariffs, stocks, and bilateral trade arrangements. Rice-price co-movement is therefore not only a market outcome: it is also shaped by policy choices.

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8 Appendix

The Appendix supports the main analysis by checking that the results are not driven by one specification. It tests the use of Vietnamese rice prices as an alternative benchmark, examines structural breaks, confirms that price growth is stationary, and shows that seasonality is not a major issue. It also reports the lag-selection criteria, abnormal shocks, regression outputs, decomposition figures, and trade statistics. Overall, it reinforces the main result: domestic-international rice price co-movement differs strongly across countries, while also making clear the main limitations of the analysis, especially the benchmark choice, missing data, and the interpretation of residual components.

8.1 Robustness checks

These robustness checks examine whether the main findings are sensitive to key empirical choices. In particular, they test the role of the international benchmark, the possible presence of structural breaks, and the time-series assumptions used in the decomposition. This helps assess whether the country-level patterns remain consistent beyond the baseline specification.

8.1.1 Vietnam price

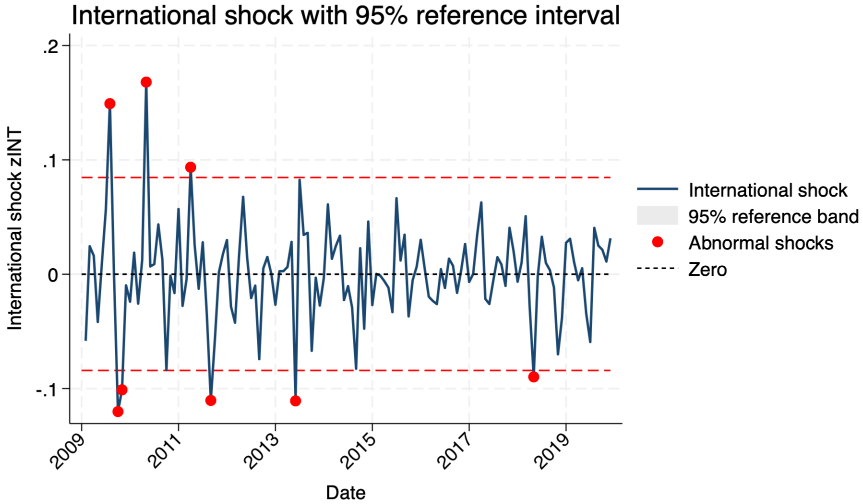
To test the robustness of our results, the international price series is changed. The Thai 5% broken FOB rice export price is thus replaced with the Vietnamese 5% broken rice export price, as they are of the same quality. However, an export ban was imposed by Vietnam during the 2008 crisis, which prevents a complete series from being constructed over the full sample period. This series is nevertheless used in a robustness check to compare outcomes before and after the crisis. Observations are missing between December 2007 and May 2008, which coincides with the peak of the Thai international price. Data are also missing in March 2009. Similarly, the entire year 2003 is not available. Because the sample has to be reduced, the analysis is done on the second subsample only and without breaks, due to concerns about overparameterisation. This subsample is chosen because it contains more years, and the model may be too heavy for only three years of observations. First, the abnormal shocks were recomputed, and more dates were observed than for the Thai 5% broken FOB rice, except that 2020 does not appear as abnormal.

Table 5: Abnormal shocks dates

2009m4	2009m11	2010m1	2010m8	2011m7	2011m12	2013m9	2013m10	2014m12

Notes: The table reports the dates of abnormal shocks, defined as international shocks that fall outside the 95% confidence interval.

Figure 5: Vietnam 5% broken rice price



Notes: The figure displays the series of international shocks. Observations in red indicate abnormal shocks that lie outside the 95% confidence interval. The upper and lower bounds of the confidence interval are depicted by the red dotted lines.

At the country level, as expected, Thailand moves less closely with the Vietnamese 5% price than in the baseline model although its co-movement remains high around 37%. The difference in magnitude may be explained by the Rice Pledging Program implemented by Thailand. Between 2011 and 2014, Thailand offered farmers' prices much above the market price which resulted in losses [31]. Overall, the main trend remained for all of the countries. However, this time, Cambodia seems to be the most insulated one with a negative correlation with the international price.

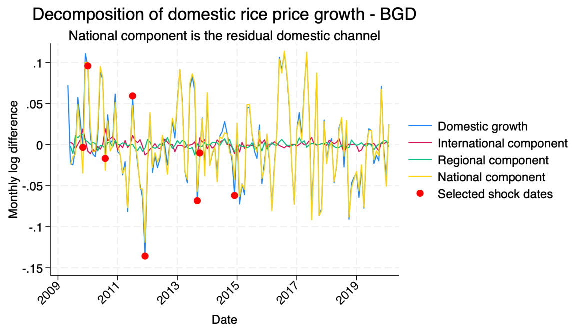
The main notable difference concerns the Philippines, for which the model becomes statistically insignificant. None of the explanatory variables remains significant in this specification. This result should therefore be interpreted with caution, as it may reflect model misspecification rather than the absence of any underlying relationship.

Country	Total	International	Regional	National
IND	0.069	0.049	0.003	0.017
THA	0.394	0.307	-0.002	0.089
BGD	0.108	0.103	0.009	-0.003
PHL	0.044	0.007	-0.001	0.038
KHM	-0.042	-0.010	-0.003	-0.028

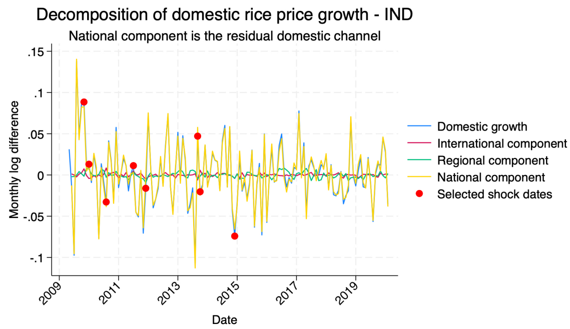
Table 6: Correlation decomposition

Notes: The table decomposes domestic–international co-movement using Vietnam 5% broken rice as the alternative international benchmark. International, regional, and national components are defined as in the baseline decomposition. Comparing these results with the baseline specification indicates whether the measured co-movement is sensitive to the choice of international price series.

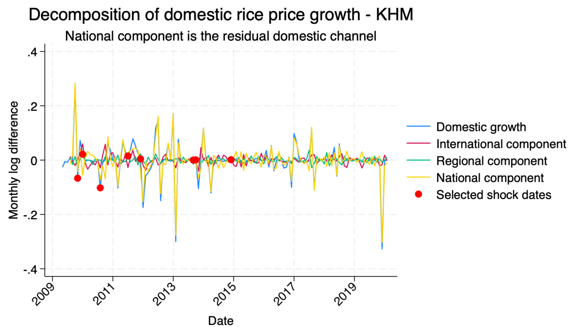
Figure 6: Price growth decomposition - Vietnam 5% broken used as the international benchmark



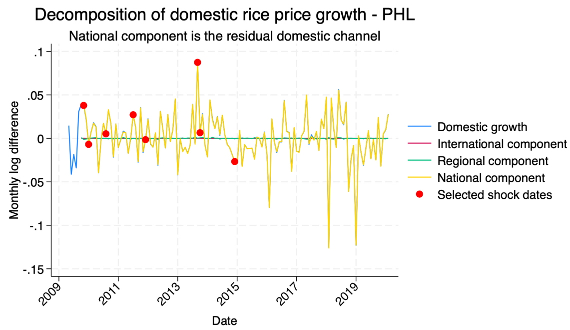
(a) Bangladesh



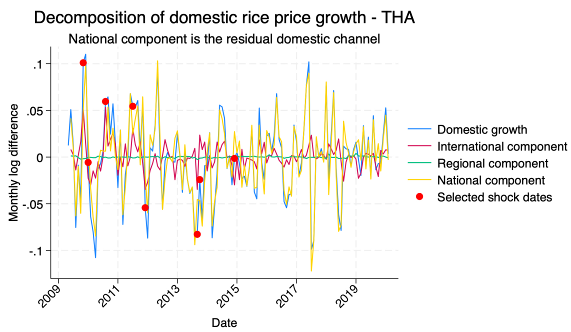
(b) India



(c) Cambodia



(d) Philippines



(e) Thailand

Notes: The figure reports country-level decompositions of domestic rice-price growth using Vietnam 5% broken rice as the international benchmark. The comparison with the baseline decomposition helps assess whether the use of Thai 5% broken FOB rice mechanically strengthens the measured co-movement between Thailand's domestic price and the international price.

8.1.2 Structural breaks

To assess the robustness of the specification, structural breaks were also estimated upon the complete equation (14) using *xtbreak*. Such a test implements Bai and Perron methodology. [90]. The test first examines the null hypothesis of no structural break against an alternative allowing for up to a pre-specified number of breaks. If m breaks are detected, the sample is divided into $m + 1$ subsamples, each corresponding to a distinct regime. The test then assesses whether the parameters are stable across these regimes by testing the null hypothesis $\alpha_1 = \alpha_2 = ... = \alpha_{m+1}$ against the alternative of parameter instability across regimes [41].

Several countries exhibit structural breaks at the 5% significance level as reported in Appendix 8.5. However, given the unrealistic confidence interval for all countries, none of the structural breaks were included in the baseline model and were thus kept for robustness checks as they still allow us to have a broader view on the analysed topic.

On the one hand, structural breaks allow us to account for drastic policy changes or extreme, unanticipated shocks. On the other hand, they introduce additional parameters and may lead to an overfitted model [72].

The final regression equation becomes :

$$\begin{aligned}\Delta \log P_{t,n} = \alpha_{0,n} + \alpha_{1,n}\Delta \log P_{t-1,n} + \gamma_n z_t^{INT} + \theta_n z_{t,n}^{REG} \\ + \sum_{r=1}^{R_n} \lambda_{r,n} D_{r,t,n} + \sum_{r=1}^{R_n} \kappa_{r,n}\left(D_{r,t,n} \times z_t^{INT}\right) + z_{t,n}^{NAT}.\end{aligned} \tag{23}$$

where $D_{r,t,n}$ denotes the regime dummy associated with structural break r for country n. The coefficient $\lambda_{r,n}$ captures a shift in the intercept after the corresponding break, while $\kappa_{r,n}$ captures a change in the association between the international innovation and domestic price growth after the break. The residual $z_{t,n}^{NAT}$ is interpreted, as in the baseline specification, as the national residual component.

Table 7: Retained structural break dates by country

Country	Retained break date(s)
India	2005m8; 2008m2; 2010m9; 2013m3; 2015m12
Thailand	2008m5
Bangladesh	2008m12
Philippines	2009m1
Cambodia	2005m9; 2008m3; 2010m10; 2013m5; 2016m1

Notes: The table reports the structural break dates retained by country. These breaks are identified from tests on the domestic price-growth equation and are used to examine whether the baseline decomposition is sensitive to changes in the relationship between domestic prices, international innovations, and regional components. The dates should be interpreted cautiously because some confidence intervals around the estimated breaks are wide.

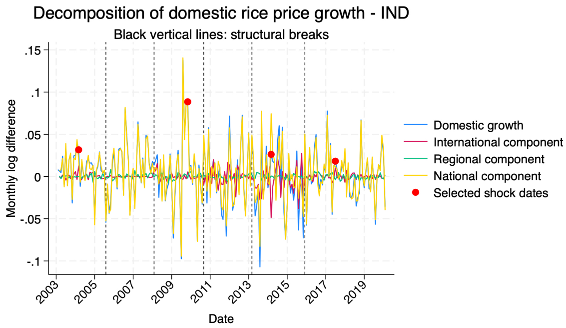
However, despite their confidence interval weakness, some of them appear to be statistically significant as shown in Table 9. Table 8 develops the correlation decomposition per country, no major changes compared to the baseline model can be observed. India, Bangladesh and Cambodia are, nonetheless, graphically the most impacted countries. For the Philippines, it is interesting to observe the striking decrease in co-movement with the international component after January 2009. This coincides with the willingness of the authorities to isolate the domestic market through higher import tariffs. For India, however, the interpretation of each structural break is more delicate, as no clear events or policy changes were reported around these dates. The analysis of these breaks should therefore be conducted with caution, as not all of them are statistically significant.

Table 8: Correlation decomposition results

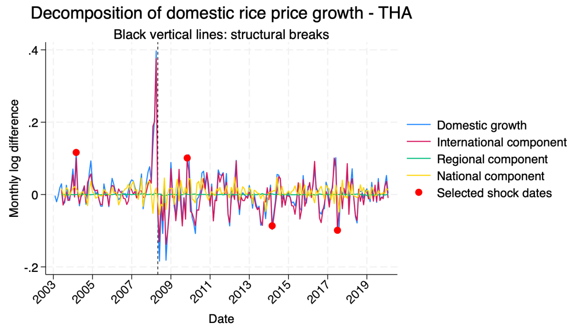
Country	Corr. total	International component	Regional component	National component
IND	0.028	0.056	-0.002	-0.025
THA	0.951	0.915	0.002	0.034
BGD	0.172	0.190	-0.000	-0.017
PHL	0.303	0.279	0.001	0.022
KHM	0.119	0.121	-0.009	0.007

Notes: The table reports the decomposition of domestic–international rice-price co-movement after allowing for selected structural breaks. The total correlation is decomposed into international, regional, and national components. The purpose is to assess whether the baseline country ranking and component structure are robust to potential instability in the domestic price-growth equation.

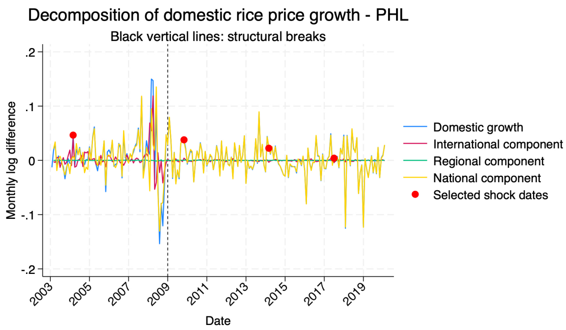
Figure 7: Price growth decomposition with structural breaks



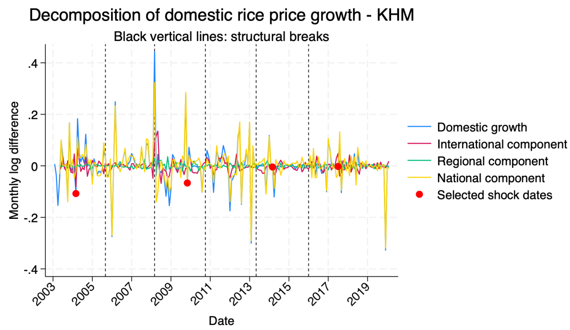
(a) India



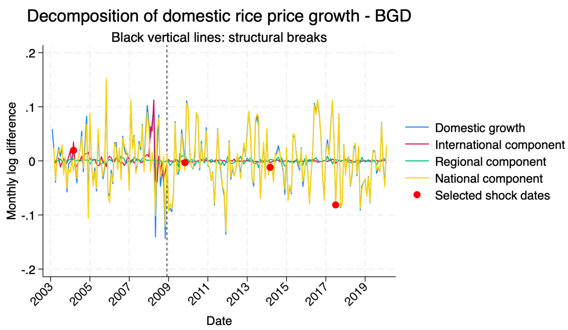
(b) Thailand



(c) Philippines



(d) Cambodia



(e) Bangladesh

Notes: The figure shows the decomposition of domestic rice-price growth after including selected structural breaks. It assesses whether changes in the domestic price equation alter the relative role of international, regional, and national components compared with the baseline specification.

Table 9: Final recursive decomposition equations with structural break dummies

Variable	IND	THA	BGD	PHL	KHM
L1.dLogprice		0.3984***	0.1729**	0.0775	
		(0.0329)	(0.0805)	(0.0848)	
zINT	0.1081	0.8901***	0.3110***	0.3452***	-0.6729**
	(0.0819)	(0.0660)	(0.0962)	(0.0981)	(0.3026)
L1.zINT					0.3768**
					(0.1820)
L2.zINT					0.1773
					(0.1094)
zREG	0.2667	0.5253	0.1198	0.0257	-0.1338
	(0.2090)	(0.9947)	(0.0946)	(0.2238)	(0.3069)
L1.zREG					-0.4540
					(0.4587)
L2.zREG					0.1261
					(0.2743)
Dummy_1	-0.0005	-0.0005	-0.0025	-0.0043	0.0028
	(0.0080)	(0.0028)	(0.0078)	(0.0056)	(0.0196)
Dummy_2	-0.0041				-0.0123
	(0.0109)				(0.0213)
Dummy_3	-0.0034				-0.0002
	(0.0105)				(0.0227)
Dummy_4	-0.0021				0.0004
	(0.0087)				(0.0176)
Dummy_5	0.0037				-0.0078
	(0.0072)				(0.0116)
Interaction_1	-0.1392	0.1762*	-0.2744*	-0.3090**	0.3681
	(0.4057)	(0.0898)	(0.1480)	(0.1221)	(0.3897)
Interaction_2	0.0773				0.3897
	(0.4023)				(0.4173)
Interaction_3	-0.3070**				0.4487
	(0.1464)				(0.4417)
Interaction_4	0.7604***				-0.4379
	(0.2906)				(0.3632)
Interaction_5	-0.5843**				-0.2540
	(0.2755)				(0.1894)
Constant	0.0094**	0.0039*	0.0025	0.0053	0.0128
	(0.0039)	(0.0022)	(0.0065)	(0.0050)	(0.0131)
Observations	204	201	204	204	202
F-statistic	1.48	171.02	4.80	3.61	1.30
Prob > F	0.1327	0.0000	0.0004	0.0038	0.2039
R-squared	0.0858	0.8851	0.1018	0.1491	0.1190
Root MSE	0.03403	0.01954	0.04899	0.03386	0.07304

Robust standard errors in parentheses.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

R_k denotes regime dummies; $I0_k$ denotes interactions between regime dummies and $zINT$.

Notes: The table reports the estimated coefficients associated with the structural-break specification. Break dummies capture shifts in the intercept, while interaction terms capture possible changes in the association between international innovations and domestic price growth after the break. The results are used to evaluate whether structural instability materially changes the baseline decomposition.

8.2 Unit root test

Table 10: Augmented Dickey-Fuller unit root test results for log prices

Country	Obs	Lags	Z(t)	1% critical value	5% critical value	p-value
India	193	12	-1.704	-4.009	-3.438	0.7493
Thailand	193	12	-2.192	-4.009	-3.438	0.4941
Cambodia	193	12	-1.405	-4.009	-3.438	0.8593
Philippines	193	12	-1.020	-4.009	-3.438	0.9413
Bangladesh	193	12	-3.897	-4.009	-3.438	0.0122

Notes: The table reports Augmented Dickey–Fuller unit-root tests for log rice-price levels. The null hypothesis is that the series contains a unit root. These tests motivate the use of first differences of log prices in the empirical analysis, since most price levels appear non-stationary.

Table 11: Augmented Dickey-Fuller unit root test results for first-differenced log prices

Country	Obs	Lags	Z(t)	1% critical value	5% critical value	p-value
India	192	12	-4.909	-4.009	-3.438	0.0003
Thailand	192	12	-4.405	-4.009	-3.438	0.0021
Cambodia	192	12	-4.939	-4.009	-3.438	0.0003
Philippines	192	12	-4.801	-4.009	-3.438	0.0005
Bangladesh	192	12	-4.064	-4.009	-3.438	0.0071

Note: The null hypothesis of the Augmented Dickey-Fuller test is the presence of a unit root. For all countries, the null hypothesis is rejected for the first-differenced log price series.

8.3 Seasonality

Table 12: Tests for monthly seasonality in rice price changes

Series	**F-test p-value**	**Conclusion**
India	0.5864	No evidence of seasonality
Thailand	0.6670	No evidence of seasonality
Bangladesh	0.3321	No evidence of seasonality
Philippines	0.3165	No evidence of seasonality
Cambodia	0.6091	No evidence of seasonality
International	0.6920	No evidence of seasonality

Note: Seasonality is tested by regressing the first difference of log rice prices on monthly dummy variables. The reported p-values correspond to the joint F-test of the monthly dummies. Since all p-values are above 0.05, the null hypothesis of no monthly seasonality cannot be rejected.

8.4 Information criteria

Table 13: Lag-order selection criteria for international rice price growth

Lag	LL	LR	df	p-value	FPE	AIC	HQIC	SBIC
0	280.926	–	–	–	0.003268	-2.88583	-2.87901	-2.86899
1	300.915	39.979	1	0.000	0.002687	-3.08160	-3.06796	-3.04791*
2	303.440	5.0507	1	0.025	0.002645*	-3.09732*	-3.07686*	-3.04679
3	303.899	0.91654	1	0.338	0.002660	-3.09174	-3.06446	-3.02436
4	303.916	0.03501	1	0.852	0.002687	-3.08161	-3.04751	-2.99739
5	303.960	0.08848	1	0.766	0.002713	-3.07176	-3.03083	-2.97069

Notes: Sample period: 2004m2–2020m3. Number of observations: 194. Asterisks indicate the optimal lag selected by the corresponding information criterion.

Table 14: Portmanteau test for white noise

Statistic	Value
Portmanteau Q statistic	13.4095
Degrees of freedom	12
p-value	0.3400

Notes: The null hypothesis of the Portmanteau test is that the series is white noise, meaning no residual autocorrelation up to the tested lag order. Since the p-value is above 0.05, the null hypothesis cannot be rejected.

Table 15: Lag-order selection criteria for domestic rice price growth

Country	Lag	LL	LR	df	p-value	FPE	AIC	HQIC	SBIC
IND	0	372.867	–	–	–	0.001242*	-3.85355*	-3.84670*	-3.83664*
IND	1	373.023	0.31232	1	0.576	0.001252	-3.84480	-3.83111	-3.81099
IND	2	373.034	0.02073	1	0.886	0.001265	-3.83455	-3.81401	-3.78383
IND	3	374.182	2.29550	1	0.130	0.001263	-3.83608	-3.80869	-3.76846
THA	0	277.115	–	–	–	0.003349	-2.86130	-2.85445	-2.84439
THA	1	290.855	27.4790	1	0.000	0.002935	-2.99331	-2.97962	-2.95950*
THA	2	292.624	3.53830	1	0.060	0.002911	-3.00128	-2.98074*	-2.95057
THA	3	292.990	0.73314	1	0.392	0.002930	-2.99472	-2.96733	-2.92710
BGD	0	296.763	–	–	–	0.002732	-3.06490	-3.05805	-3.04799
BGD	1	301.140	8.75430*	1	0.003	0.002638*	-3.09990*	-3.08620*	-3.06609*
BGD	2	301.143	0.00686	1	0.934	0.002665	-3.08957	-3.06903	-3.03885
BGD	3	302.985	3.68420	1	0.055	0.002642	-3.09829	-3.07091	-3.03067
PHL	0	362.754	–	–	–	0.001379	-3.74874	-3.74190	-3.73184
PHL	1	364.806	4.10480	1	0.043	0.001364	-3.75965	-3.74596	-3.72584
PHL	2	366.981	4.34930	1	0.037	0.001347	-3.77182	-3.75128	-3.72111
PHL	3	368.111	2.26040	1	0.133	0.001345	-3.77317	-3.74579	-3.70555
PHL	4	379.068	21.9150	1	0.000	0.001214	-3.87636	-3.84213	-3.79183
PHL	5	382.539	6.94050	1	0.008	0.001183*	-3.90196*	-3.86088*	-3.80052*
KHM	0	228.137	–	–	–	0.005563*	-2.35375*	-2.34690*	-2.33684*
KHM	1	228.692	1.11080	1	0.292	0.005589	-2.34914	-2.33545	-2.31533
KHM	2	228.713	0.04138	1	0.839	0.005646	-2.33899	-2.31846	-2.28828
KHM	3	228.750	0.07346	1	0.786	0.005702	-2.32901	-2.30163	-2.26139

Notes: The table reports the country-specific autoregressive structure of domestic rice-price growth. These results determine whether lagged domestic price growth is included in the domestic decomposition equation. The specification accounts for persistence in price growth before separating domestic price movements into international, regional, and national residual components.

Table 16: Lag-order selection criteria for regional prices-growth variables

Country	Lag	LL	LR	df	p-value	FPE	AIC	HQIC	SBIC
IND	0	590.084	–	–	–	0.000131	-6.10449	-6.09765	-6.08759
IND	1	594.462	8.7556*	1	0.003	0.000126*	-6.13950*	-6.12581*	-6.10569*
IND	2	594.465	0.00687	1	0.934	0.000128	-6.12917	-6.10863	-6.07846
IND	3	596.308	3.68540	1	0.055	0.000126	-6.13790	-6.11052	-6.07028
THA	0	913.349	–	–	–	0.0000046	-9.45439	-9.44754	-9.43748
THA	1	917.301	7.9058	1	0.005	0.0000044	-9.48499	-9.47130	-9.45118
THA	2	918.897	3.1918	1	0.074	0.0000044	-9.49116	-9.47063	-9.44045
THA	3	920.078	2.3609	1	0.124	0.0000044	-9.49303	-9.46565	-9.42541
BGD	0	383.006	–	–	–	0.001118*	-3.95861*	-3.95177*	-3.94171*
BGD	1	383.164	0.31588	1	0.574	0.001127	-3.94989	-3.93620	-3.91608
BGD	2	383.174	0.01951	1	0.889	0.001139	-3.93963	-3.91909	-3.88891
BGD	3	384.328	2.30820	1	0.129	0.001137	-3.94122	-3.91384	-3.87360
PHL	0	323.086	–	–	–	0.002080	-3.33768	-3.33083	-3.32077
PHL	1	336.825	27.4790	1	0.000	0.001822	-3.46969	-3.45600	-3.43588*
PHL	2	338.595	3.5383	1	0.060	0.001808	-3.47766	-3.45713*	-3.42695
PHL	3	338.961	0.73314	1	0.392	0.001820	-3.47110	-3.44372	-3.40348
KHM	0	289.159	–	–	–	0.002956	-2.98610	-2.97926	-2.96920
KHM	1	302.899	27.4790	1	0.000	0.002590	-3.11812	-3.10443	-3.08431*
KHM	2	304.668	3.5383	1	0.060	0.002570	-3.12609	-3.10555*	-3.07537
KHM	3	305.034	0.73314	1	0.392	0.002587	-3.11953	-3.09214	-3.05191

Notes: Sample period: 2004m2–2020m2. Number of observations: 193 for each country. Only lags 0 to 3 are reported for each country. Asterisks indicate the optimal lag selected by the corresponding information criterion. The endogenous variables are the country-specific regional prices-growth variables, R_t^n.

8.5 Break tests

Table 17: Structural break test and estimated break dates: India

Test	Statistic	1% critical value	5% critical value	10% critical value
$F(1\|0)$	1.98	7.68	5.74	4.91
$F(2\|1)$	4.38	8.42	6.47	5.70
$F(3\|2)$	4.68	8.86	7.01	6.14
$F(4\|3)$	4.04	9.34	7.42	6.45
$F(5\|4)$	4.23	9.59	7.64	6.74

#	Index	Date	95% confidence interval	
			Lower	Upper
1	30	2005m8	0879m5	3131m11
2	60	2008m2	-32700	4781m3
3	91	2010m9	-89411	9512m4
4	121	2013m3	-3.0e+05	3.0e+05
5	154	2015m12	1774m12	2256m12

Notes: Number of observations: 204. SSR: 0.21. Trimming parameter: 0.15. No break is detected at the reported significance levels in the sequential test. Confidence intervals are extremely wide and should be interpreted with caution.

Table 18: Structural break test and estimated break date: Thailand

Test	Statistic	1% critical value	5% critical value	10% critical value
$F(1\|0)$	4.49	6.09	4.66	4.03
$F(2\|1)$	2.69	6.59	5.24	4.64
$F(3\|2)$	6.75	6.92	5.61	4.99
$F(4\|3)$	4.63	7.33	5.87	5.23
$F(5\|4)$	5.01	7.49	6.05	5.45

#	Index	Date	95% confidence interval	
			Lower	Upper
1	60	2008m5	2007m8	2009m2

Notes: Number of observations: 201. SSR: 0.07. Trimming parameter: 0.15. The sequential test suggests evidence of structural instability, with the retained estimated break date occurring in 2008m5.

Table 19: Structural break test and estimated break date: Bangladesh

Test	Statistic	1% critical value	5% critical value	10% critical value
$F(1\|0)$	6.08	6.09	4.66	4.03
$F(2\|1)$	3.01	6.59	5.24	4.64
$F(3\|2)$	3.55	6.92	5.61	4.99
$F(4\|3)$	3.58	7.33	5.87	5.23
$F(5\|4)$	4.42	7.49	6.05	5.45

#	Index	Date	95% confidence interval	
			Lower	Upper
1	70	2008m12	0487m3	3530m9

Notes: Number of observations: 204. SSR: 0.44. Trimming parameter: 0.15. The sequential test detects one break at the 5% and 10% levels, but not at the 1% level. The estimated confidence interval is extremely wide and should be interpreted with caution.

Table 20: Structural break test and estimated break date: Philippines

Test	Statistic	1% critical value	5% critical value	10% critical value
$F(1\|0)$	6.90	7.68	5.74	4.91
$F(2\|1)$	4.01	8.42	6.47	5.70
$F(3\|2)$	2.36	8.86	7.01	6.14
$F(4\|3)$	3.51	9.34	7.42	6.45
$F(5\|4)$	3.58	9.59	7.64	6.74

#	Index	Date	95% confidence interval	
			Lower	Upper
1	71	2009m1	-8.5e+06	8.5e+06

Notes: Number of observations: 204. SSR: 0.23. Trimming parameter: 0.15. The sequential test detects one break at the 5% and 10% levels, but not at the 1% level. The estimated confidence interval is not informative and should be interpreted with caution.

Table 21: Structural break test and estimated break dates: Cambodia

Test	Statistic	1% critical value	5% critical value	10% critical value
$F(1\|0)$	2.71	7.68	5.74	4.91
$F(2\|1)$	12.85	8.42	6.47	5.70
$F(3\|2)$	10.00	8.86	7.01	6.14
$F(4\|3)$	10.06	9.34	7.42	6.45
$F(5\|4)$	10.07	9.59	7.64	6.74

#	Index	Date	95% confidence interval	
			Lower	Upper
1	31	2005m9	-91300	9659m9
2	61	2008m3	1762m5	2254m1
3	92	2010m10	-39747	5373m10
4	123	2013m5	1967m9	2059m1
5	155	2016m1	-1.1e+05	1.1e+05

Notes: Number of observations: 204. SSR: 1.01. Trimming parameter: 0.15. The sequential test detects five breaks at the 1%, 5%, and 10% levels. Several confidence intervals are extremely wide and should be interpreted with caution.

8.6 Abnormal shocks

Table 22: Abnormal international shocks identified from the 95% reference band

Date	Shock ($zINT$)	Lower bound	Upper bound
2004m3	0.1163	-0.0972	0.0972
2008m2	0.1983	-0.0972	0.0972
2008m3	0.1421	-0.0972	0.0972
2008m4	0.3319	-0.0972	0.0972
2008m5	-0.1811	-0.0972	0.0972
2008m6	-0.1060	-0.0972	0.0972
2008m10	-0.1202	-0.0972	0.0972
2009m11	0.1163	-0.0972	0.0972
2014m3	-0.0974	-0.0972	0.0972
2017m7	-0.1223	-0.0972	0.0972

Notes: The table reports the dates at which the estimated international rice-price innovation lies outside the 95% confidence interval for the Thai 5% broken rice price. These observations are classified as abnormal international shocks and are used to structure the shock-specific discussion in the empirical analysis.

8.7 Regression Outputs

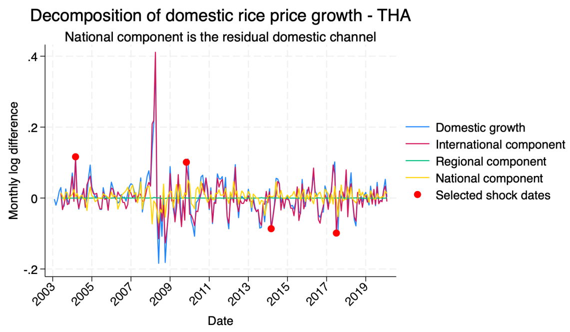
Table 24: Price transmission with selected breaks: recursive AR(1) decomposition

	IND	THA	BGD	PHL	KHM
$L.\Delta p_{c,t}$	–	0.374***	0.180**	0.103	–
		(0.031)	(0.081)	(0.086)	
$zINT_t$	0.047	0.992***	0.193**	0.212***	0.006
	(0.045)	(0.045)	(0.078)	(0.074)	(0.148)
$L.zINT_t$	–	–	–	–	0.378**
					(0.185)
$L2.zINT_t$	–	–	–	–	0.189*
					(0.107)
$zREG_{c,t}$	0.278	0.223	0.131	0.047	-0.001
	(0.204)	(0.922)	(0.094)	(0.222)	(0.262)
$L.zREG_{c,t}$	–	–	–	–	-0.372
					(0.461)
$L2.zREG_{c,t}$	–	–	–	–	0.127
					(0.286)
Constant	0.003	0.003**	0.001	0.003	0.003
	(0.002)	(0.001)	(0.003)	(0.002)	(0.005)
Observations	204	201	204	204	202
R^2	0.012	0.880	0.084	0.103	0.084
Root MSE	0.034	0.020	0.049	0.035	0.073
Model p-value	0.181	0.000	0.001	0.023	0.172
AR term test p-value	–	0.000	0.026	0.232	–
International transmission test p-value	0.305	0.000	0.014	0.005	0.073
Regional transmission test p-value	0.175	0.809	0.167	0.834	0.697

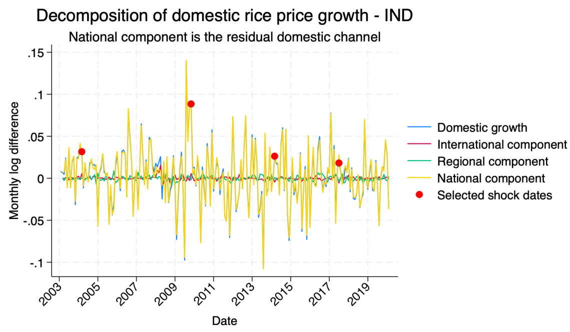
Notes: The dependent variable is monthly domestic rice price growth, $\Delta p_{c,t}$. Robust standard errors are reported in parentheses. For Cambodia, the international and regional transmission tests are joint tests of the contemporaneous, first-lag, and second-lag terms. For India, Thailand, Bangladesh, and the Philippines, the transmission tests correspond to the single contemporaneous coefficient. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

8.8 Figures

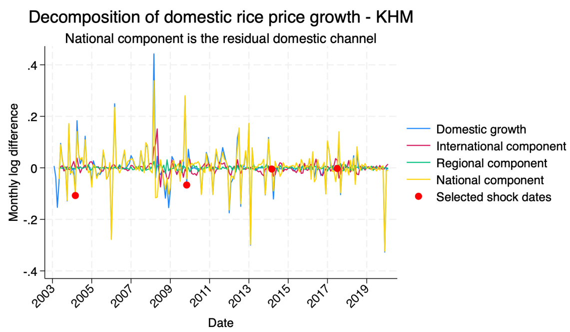
Figure 8: Domestic rice price growth decomposition by country



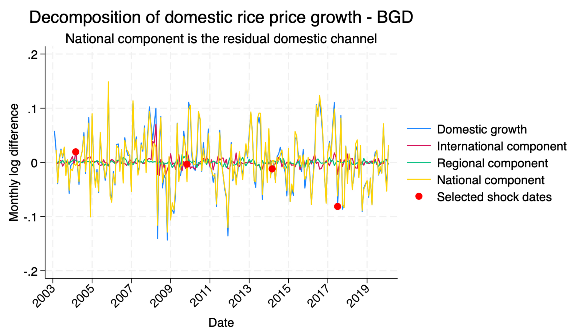
(a) Thailand



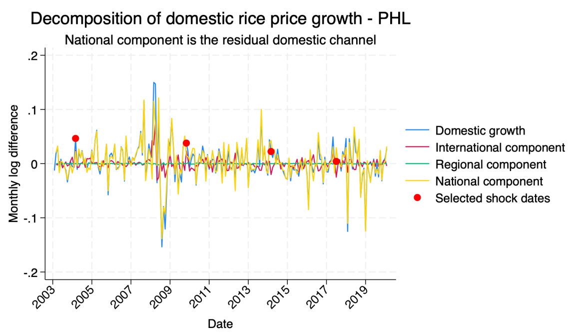
(b) India



(c) Cambodia



(d) Bangladesh



(e) Philippines

Notes: The figure decomposes domestic rice-price growth into international, regional, and national components for each country. It shows whether domestic price movements are mainly associated with international innovations, regional co-movement, or country-specific residual factors.

8.9 Trade and production table

Table 25: Global rice production by market, 2025/2026.

Market	**% of Global Production**	**Total Production (2025/2026, Metric Tons)**
India	28%	152 Million
China	27%	146.33 Million
Bangladesh	7%	37.65 Million
Indonesia	6%	33.6 Million
Vietnam	5%	26 Million
Thailand	4%	20.7 Million
Philippines	2%	12.2 Million
Burma	2%	12 Million
Pakistan	2%	9.4 Million
Cambodia	2%	8.2 Million

Notes: The table reports the main rice-producing markets in 2025/2026. It documents the relative production size of the countries in the sample and supports the distinction between large rice-market actors and smaller producers.

Table 26: Rice exports by country in 2023

Reporter	Year	Trade Value 1000USD	Quantity
India	2023	10,453,280.27	17,865,000,000 Kg
Thailand	2023	5,147,342.77	8,769,040,000 Kg
Vietnam	2023	4,374,646.50	7,746,860,000 Kg
Pakistan	2023	2,860,635.61	4,560,210,000 Kg
United States	2023	2,015,458.87	2,696,880,000 Kg
China	2023	983,750.10	1,625,890,000 Kg
Italy	2023	968,228.35	675,815,000 Kg
Cambodia	2023	815,034.48	1,789,480,000 Kg

Notes: The table reports the main rice exporters in 2023 by trade value and quantity. It highlights the role of India, Thailand, Vietnam, and Cambodia as exporters and helps interpret their exposure to international rice-market conditions.

Table 27: Rice imports by country in 2023.

Reporter	Year	Trade Value 1000USD	Quantity
European Union	2023	1,919,988.43	2,262,770,000 Kg
Indonesia	2023	1,789,023.88	3,062,860,000 Kg
Saudi Arabia	2023	1,683,077.27	1,444,150,000 Kg
Philippines	2023	1,635,577.22	1,477,820,000 Kg
United States	2023	1,422,518.70	1,338,200,000 Kg
China	2023	1,407,227.12	2,596,820,000 Kg
Vietnam	2023	887,787.03	967,776,000 Kg
Malaysia	2023	818,866.04	1,408,210,000 Kg

Notes: The table reports the main rice importers in 2023 by trade value and quantity. It highlights the import dependence of countries such as the Philippines and helps interpret their potential exposure to international price movements.

Table 28: Rice consumption by country in 2022.

Country	**Rice Consumption 2022 (t)**	**Rice Consumption per Capita 2022 (kg/yr)**
China	190,936,000	133.91
India	140,276,000	98.98
Indonesia	51,028,000	185.22
Bangladesh	42,258,000	246.85
Philippines	22,474,000	194.48
Vietnam	22,399,000	228.13
Myanmar	15,115,000	278.97
Thailand	12,823,000	178.85

Notes: The table reports rice consumption and market-position indicators for the countries analysed in the thesis. These statistics help interpret cross-country differences in domestic–international price co-movement by distinguishing major producers, exporters, importers, and consumers.

8.10 Code

The Stata code used for the baseline specification is available in the external appendix: External appendix