Economics Bulletin

Volume 42, Issue 1

Sectoral consumer price synchronization: evidence from an emerging ASEAN economy

Binh Thai Pham
College of Economics, Law and Government, University of Economics Ho Chi Minh City (UEH)

Abstract

This paper assesses spillover effects across ten sectoral consumer price indices, weighted components of the CPI basket, of an emerging ASEAN economy, Vietnam. The findings show a high degree of total connectedness across sectors. Some essential goods and services such as food and beverages, clothing and footwear, housing and utilities exhibit more central roles within the directional price graph. Besides, the time-varying spillover index announces several volatility spikes that correspond to economic turmoil, especially in the current COVID-19 pandemic. Methodological contribution suggests that one should not overlook the cointegration order regarding disaggregated consumer price indices. Robustness analysis by varying the normalization rules and estimating a TVP-VAR model agrees with the main conclusions.

Pham Thai Binh gratefully acknowledges the financial support from the University of Economics Ho Chi Minh City (UEH).
Citation: Binh Thai Pham, (2022) "Sectoral consumer price synchronization: evidence from an emerging ASEAN economy", *Economics Bulletin*, Volume 42 Issue 1 pages 17-29.
Contact: Binh Thai Pham - binhpt@ueh.edu.vn.
Submitted: November 26, 2021. **Published:** February 20, 2022.

1. Introduction

The extant literature has well-documented and analyzed the return volatility transmissions from one asset, market, or commodity to other assets, markets, or commodities. This spillover phenomenon implies twofold. First, it refers to which extent these assets, markets, or commodities are connected or integrated. Second, it poses a relevant question of whether their co-movements eliminate or diminish policy coordination benefits.

It is worthwhile to mention the inflation spillover literature of emerging countries. Osorio and Unsal (2013) claimed that China, the biggest emerging market, seemed to cause and transmit inflation to neighboring countries through commodity and imported product prices because of the high indispensable commodities' weights on the consumer price index (CPI) baskets of many developing Asian economies; and food inflation of these countries is likely sensitive to trade integration, monetary and externality surprises (Blagrave, 2020). Zakaria (2017) also suggested that domestic prices might asymmetrically respond to an oil price shock in developing markets. Besides, a positive network causality between inflation cycles and inflation integration across the ASEAN-5 countries has also been recognized,[1] which complicated inflation targeting policies since it was hard to mitigate external impacts from the neighbors (Kang et al., 2020).

Regarding the Vietnam context, the research on consumer price volatility is scarce since few studies examine the transmissions of world price shocks on the domestic consumption price level. For instance, Pham and Sala's (2020) scrutinization over 1998 – 2018 shows that three disentangled oil price shocks appeared to be the key drivers of the Vietnam price level. Amongst them, oil demand shocks driven by global economic and speculative activities have caused persistent inflation, resulting in adverse effects on macroeconomic stability, which could then resort to a stringent monetary measure. Ngoc (2020) confirms the destructive impacts of high inflation on the Vietnam economy in an asymmetric setting, thus calling for a prudent macroeconomic policy (Bhattacharya, 2014; Pham and Sala, 2020; Hoang and van Anh Nguyen, 2021). In addition, after Abbott et al. (2014) stressed the need to understand how disaggregated sector-level prices influenced the Vietnam economy, it was hardly found further research pursued, except for Vo et al. (2020).

This paper, thus, extends emerging countries' extant literature by vetting how shocks to sectoral consumption prices spillover within a country. We take Vietnam as a case of analysis because she has a full-fledged 19-year disaggregated dataset covering more than ten consumption sectors. To the best of our knowledge, it is the first connectedness study that employs the sectoral-level nominal data of an emerging Asian country. We yield several contributions. First, the overall connectedness of Vietnam sectoral price indices is notably high, as of over 58 percent, and so is the tightness of its directional price network. Second, the time-varying spillovers correctly appreciate price volatility upsurges during 2002 – 2020, especially in the last economic turmoil because of the novel SARS-Cov-2 outbreak. Finally, robustness analyzes show that the spectral normalization brings up the same conclusions and that the cointegration order should not be overlooked regarding disaggregated consumer price indices.

[1] ASEAN-5 countries: Indonesia, Malaysia, The Philippines, Singapore, and Thailand.

We continue as follows. The coming section presents the dataset and methodological issues. Section 3 discusses substantive findings, while the followed-up one checks the robustness. Section 5 concludes.

2. Methodology and Data

2.1 Data description and preliminary tests

In the present study, we employ the latest monthly dataset for the Vietnam disaggregated price indices (2019 = 100) taken from the IMF's International Financial Statistics database. It includes ten sectoral-index series covering the nineteen-year timespan from 2002-Jan to 2020-Dec (228 months), accounting for over 97% of the consumer price basket.[2] Their descriptive statistics are represented in Table 1, whereas Figure 1 illustrates them graphically. A clear pattern scrutinized from Panel A of Figure 1 is that consumption indices in logarithm have gradually risen over time except for a few series exhibiting abrupt changes. In 2012, the HELH series had an exceptional jump in level, whilst the FOOD, HOUS, and TRAN series showed significant increases in economic turmoil during 2008 – 2012 (Bhattacharya, 2014; Pham and Sala, 2020). Additionally, Panel B, depicting monthly log-differenced series, announces a notable synchronization across considering consumption sectors as their variations appear to be high concurrently in the turbulent times.

Panel A: Log-level	LALTO	LCLOT	LCULT	LEDUC	LEQIP	LFOOD	LHELH	LHOUS	LMISC	LTRAN
Mean	4.265	4.234	4.385	3.932	4.316	4.077	3.538	4.132	4.171	4.405
Median	4.379	4.306	4.434	3.857	4.396	4.377	3.266	4.337	4.285	4.465
Maximum	4.626	4.623	4.622	4.671	4.622	4.695	4.628	4.642	4.644	4.738
Minimum	3.747	3.714	4.101	3.339	3.887	3.150	2.625	3.359	3.548	3.987
Std. Dev.	0.306	0.332	0.188	0.473	0.268	0.519	0.660	0.433	0.387	0.249
Obs	228	228	228	228	228	228	228	228	228	228
Panel B: Rate of growth	DALTO	DCLOT	DCULT	DEDUC	DEQIP	DFOOD	DHELH	DHOUS	DMISC	DTRAN
Mean	0.387	0.399	0.205	0.582	0.324	0.676	0.882	0.559	0.481	0.231
Median	0.250	0.322	0.140	0.110	0.250	0.300	0.280	0.470	0.329	0.180
Maximum	2.859	1.951	2.313	11.351	1.518	6.999	21.787	4.287	3.343	8.682
Minimum	-1.715	-0.300	-1.410	-3.459	-0.300	-1.918	-6.032	-4.982	-1.106	-14.923
Std. Dev.	0.551	0.408	0.504	1.574	0.303	1.270	2.322	1.015	0.610	2.133
Obs	227	227	227	227	227	227	227	227	227	227

Note: The prefix L and D denote the logarithm and log-difference operators, respectively.

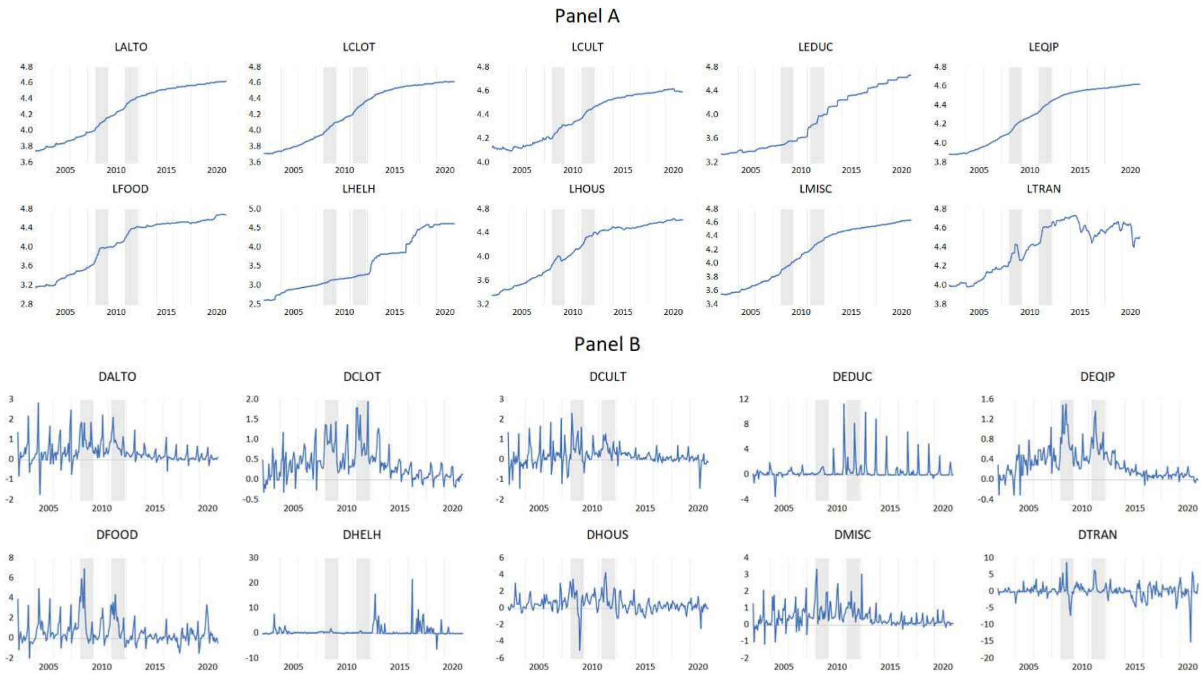
Table 1: Descriptive Statistics (monthly data, 2002:01 – 2020:12)

Since all sectoral indices have steadily grown in almost two decades, we validate that these indices are unarguably non-stationary and jointly cointegrated at order 2 (see Table A2 in the appendix for reported tests). The spillover analysis based on the variance decomposition, thus, has to consider this cointegration order. More insights into statistical characteristics manifest a strong linkage amongst sectors. As seen from Figure 2, the conditional pairwise Granger-causality network of all sectoral indices seems to be dense; eight out of them adequately correlate to each

[2] The ten sectoral consumer price indices are Food and non-alcoholic beverages (FOOD), Alcoholic Beverages, Tobacco, and Narcotics (ALTO), Clothing and footwear (CLOT), Housing, Water, Electricity, Gas and Other Fuels (HOUS), Furnishings, household equipment and routine household maintenance (EQIP), Health (HELH), Transport (TRAN), Recreation and culture (CULT), Education (EDUC), and Miscellaneous goods and services (MISC).

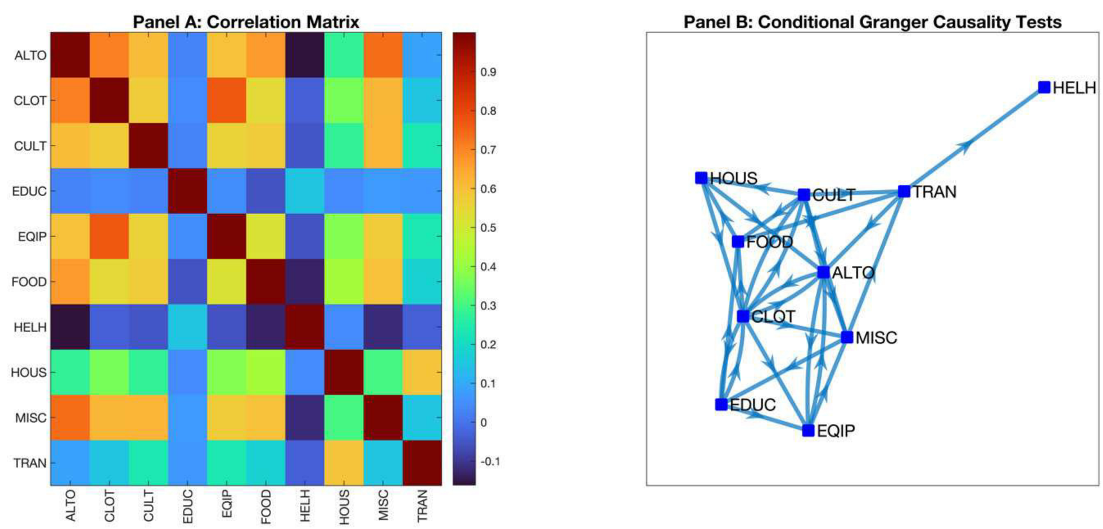
other, say, varying in between 0.3 and 0.8. Contrariwise, health and education sectors have a sign of less-connected sectors in the economy.

Figure 1: Vietnam Consumer Price Indices (2019 = 100)



Note: The prefixes L and D denote the logarithm and log-difference operators, respectively. The shaded bands represent the high inflation episodes.

Figure 2: Pairwise correlations and Conditional Granger causality tests, 2002:01-2020:12



2.2 The measurement of volatility spillover

To explore to what extent a price shock to one consumption sector contaminates other sectors, we adopt the well-known directional spillover measurement of Diebold and Yilmaz (2012, 2014), hereafter DY, which is constructed from the generalized forecast error variance decomposition (GFEVD) of an estimated reduced-form vector autoregression (VAR) model. The GFEVD, however, does not entail the row sum or column sum adding up to one. DY (2012) imposed a row sum normalization, but it is not necessarily a unique rule suggested by Caloia et al. (2019). The latter authors proposed a so-called scalar normalization alternative to assess the robustness of DY's methodology.

Beyond the DY's methodology, several extensions take time-varying VAR models, or TVP-VAR, into account. Antonakakis et al. (2018) and Gabauer and Gupta (2018) are perhaps among the first studies fitting generalized FEVD into a Bayesian TVP-VAR framework. This approach has become more prevalent in recent spillover literature (e.g., Antonakakis et al., 2019; Balcilar et al., 2021).

3. Results and discussions

3.1 The overall patterns

Our analysis begins with the DY's (2012) model estimation. It should be recalled that our system of ten consumer price indices proves to be cointegrated; therefore, to avoid a downward bias stated in DY (2015, Ch. 8), we instead perform the DY's (2012) method to a prescribed VEC (r = 2, q = 3) model, i.e., cointegration rank and AIC lags are selected at 2 and 3, respectively. Table 2 reports the outcome informing an "input-output" decomposition of the overall spillover or total connectedness index.

	ALTO	CLOT	CULT	EDUC	EQIP	FOOD	HELH	HOUS	MISC	TRAN	**FROM**
ALTO	29.74	20.46	1.29	0.23	7.65	17.55	2.98	12.58	6.79	0.73	70.26
CLOT	11.82	30.44	1.23	1.60	6.33	17.26	0.38	25.79	0.79	4.36	69.56
CULT	15.12	17.46	20.68	0.15	11.95	15.26	0.21	9.40	6.71	3.05	79.32
EDUC	3.92	1.85	0.72	64.63	11.54	4.76	2.87	7.20	2.32	0.18	35.37
EQIP	12.75	16.50	1.72	0.05	18.91	19.74	0.75	23.24	4.08	2.26	81.09
FOOD	10.07	10.43	3.97	0.11	2.80	47.56	3.12	12.08	8.59	1.29	52.44
HELH	0.41	0.88	0.33	0.41	2.27	4.24	88.77	0.03	0.12	2.55	11.23
HOUS	6.84	5.17	0.31	0.39	1.74	17.58	0.47	51.19	3.06	13.24	48.81
MISC	21.17	10.03	0.97	0.31	2.77	21.05	1.95	19.41	18.12	4.23	81.88
TRAN	3.45	4.03	1.46	0.60	1.17	5.47	0.12	36.01	1.94	45.74	54.26
TO	85.54	86.82	11.99	3.85	48.21	122.92	12.86	145.74	34.41	31.89	**58.42**
NET	15.28	17.26	-67.33	-31.52	-32.88	70.47	1.63	96.94	-47.48	-22.37	

Note: The FROM column defines *the contribution from others*. The TO row has a similar meaning as *the contribution to others*. Excluding *own variance shares* lying on the top-left ten-by-ten matrix's diagonal, each cell (i, j), *cross variance shares*, represents volatility transmission from variable j to the variable i. Moreover, in boldface font, the overall spillover index or total connectedness à la Diebold and Yilmaz, is located in the most right-bottom.

Table 2: Volatility spillovers across Vietnam sectoral prices (2002:01 – 2020:12)

As can be seen from Table 2, across sectors, the overall price spillover appears to be considerably high; on average, 58.4% of the sectoral forecast error variances come from sectoral spillovers. Specifically, two consumption segments, EQIP and MISC, have remarkably absorbed variations from other sectors within the system, as of 81.1% and 81.9%, respectively. Reading their rows suggests that prices of goods and services in these categories are relatively sensitive to fluctuations in sectors such as ALTO, CLO, FOOD, and HOUS. Meanwhile, except for the health sector, which seems to be disconnected as its own variance share takes up close to 89%, shocks to others have significant contributions to the volatilities of the rest, ranging from 35% to 79.3% of their forecast error variances.

Regarding the directional pairwise connectedness, the highest cross variance share, about 36%, amounts to the pair of HOUS–TRAN, followed by HOUS–CLOT and HOUS–EQIP suits, namely, 25.8% and 23.2%, respectively. Moreover, it is observed that four sectors—ALTO, CLOT, EQIP, and FOOD— have remarkedly connectedness to MISC and each other, implying that price shocks would be easily spread over amongst them.

The NET row of Table 2 reports the result of TO minus FROM measuring the net variance contribution of each variable. Here, we observe two balanced groups of donors and recipients. CULT and MISC sectors have the largest negative values, -67.3% and -47.5%, respectively, showing that they receive much more than giving variance. The rest of the variance donees (EDUC, EQIP, and TRAN sectors) announce a moderate position as their net spillovers are given by -31.5, -32.9, and 22.4%, respectively. In sharp contrast, the HOUS sector registers the highest net variance donor since it gives up to 145.7% row-scaled cross variance shares resulting in 96.9% of net transmission. In a similar vein, a shock to the FOOD sector has significant effects on the consumer price network because of its contribution to others and net spillovers as high as 122.9% and 70.5%, respectively. Notice that the HELH sector has muted in both directions and that both ALTO and CLOT have a trivial net contribution, but the last two sectors seem to diffuse quite a large amount of volatility, as of over 85%.

In general, the static analysis of the full-sample spillover table reinforces our understanding of the conditional Granger-causality network (Panel B of Figure 2). As soon discussed in the network centrality assessment below, it pronounces a notably tight connection across Vietnamese consumption sectors.

3.2 Network centrality analysis

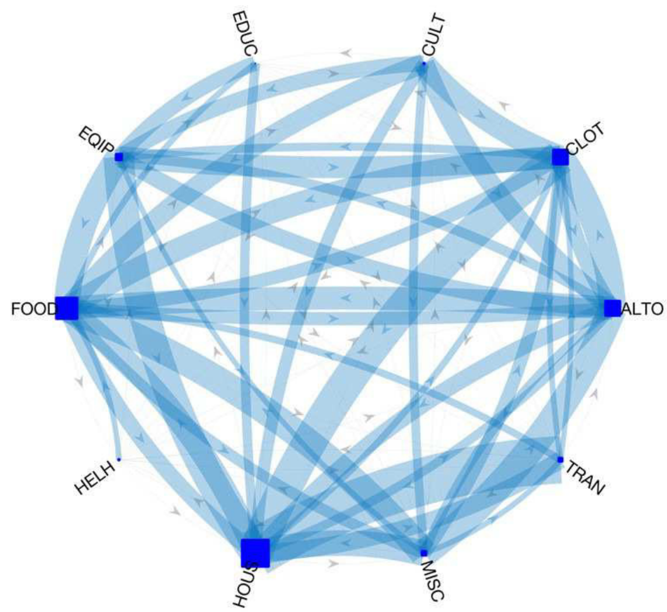
The directional spillover table can be expressed in network topology, as first observed in DY (2014). Figure 3 illustrates a dense network where each node represents a sector, and any directed edge that connects two nodes is considered a directional pairwise connectedness. For the sake of compactness, we plot the bandwidth of some edges whose underlying cross variance shares are greater than 4%. To highlight the importance of each node in the graph, we report four standard centrality measures in Table 3 and depict the Authorities centrality proportion to the node size relatively.

Centrality	ALTO	CLOT	CULT	EDUC	EQIP	FOOD	HELH	HOUS	MISC	TRAN
PageRank	13.13	13.55	3.80	2.20	7.36	19.41	3.57	20.63	7.52	8.83
Authorities	15.41	15.16	1.86	0.63	6.89	21.51	1.84	27.01	5.20	4.49
In-degree	85.54	86.82	11.99	3.85	48.21	122.92	12.86	145.74	34.41	31.89
Out-degree	70.26	69.56	79.32	35.37	81.09	52.44	11.23	48.81	81.88	54.26

Table 3: Network centrality measurements

It may be rewarding to note that directional pairwise spillovers weigh the network; the "In-degree" and "Out-degree" are, thus, corresponding TO and FROM values of Table 2, respectively. Meanwhile, the PageRank and Authorities differ from the two formers and each other by definitions[3]. Still, they refer to the same concept, i.e., how valuable the node in the network based on its weighted links is; hence, PageRank or Authorities' higher value implies the more central node. Our essential conclusion drawn upon the centrality estimation proclaims that four nodes, ALTO, CLOT, FOOD, and HOUS, seem to play a dominant role in the network. There are notable gaps between their PageRank or Authorities values and the remainders' counterparts. Amongst the fours, HOUS and FOOD firmly gain the two most crucial components of the Vietnam consumer price basket as their PageRank and Authorities distance from the rest by at least 6%.

Figure 3: Directed network centrality analysis



Note: The blue square size represents the relative importance of each node within the directed network (the Authorities centrality measure). The width of blue bands highlights the magnitude of pairwise connectedness, i.e., off-diagonal elements of Table 2 are greater than 4%. The arrow indicates the orientation of volatility spillover.

3.3 The dynamics of spillover index

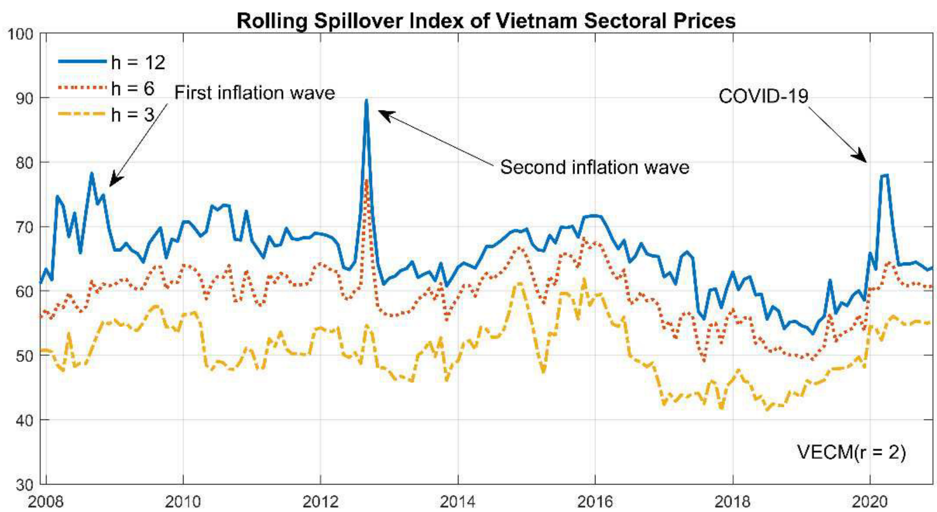
The preceding analysis focuses on the long-run spillover patterns over the 19-year data sample rather than the short-run dynamics, which may provide further insights on the movements of Vietnam inflation and business cycles. In much of what follows, we discuss the fluctuations of total sectoral connectedness based on the setting of VECM (r = 2, q = 1) and the 6-year rolling window. Figure 4 plots the estimated rolling spillovers at different generalized FEVD horizons (*h* = 3, 6, and 12 months).

At a glance, we observe a similar dynamic pattern across horizons, but the longer horizon, i.e., the higher *h*, apparently results in the larger connectedness. The typical 12-month horizon time-varying spillovers (solid curve) provide a clearer image of the evolution of sectoral interdependence over time. It is shown that there are three unprecedented jumps in consumption price volatility, which correspond to two inflation-soaring episodes (Bhattacharya, 2014; Pham & Sala, 2020) and the COVID-19 pandemic. The first high inflation wave happened in 2008 – 2009 due to the consequences of the 2008 global financial crisis and the implemented fiscal stimulus

[3] We refer interested reader to Page and Brin (1998) and Kleinberg (1999) for further details of PageRank and Authorities measures.

package. The second period in 2011 – 2012 resulted from a real estate balloon-burst and the crashed financial system. It is also witnessed the third spike that occurred in March and April of 2020, when Vietnam locked down its economy in April 2020, given the onset of the COVID-19 pandemic.

Figure 4: Time-varying overall spillovers at three FEVD horizons: h = 3, 6 and 12



Several reasons help explain the last price volatility upsurge in Vietnam. First, the first wave of COVID-19 outbreak triggered food hoarding and risk perception giving rise to the temporary price increase in related sectors (Long & Khoi, 2020; Wang & Hao, 2020; Tse et al., 2021). Second, the state-wide locked down in weeks brought on regional supply chain shortages (Inoue et al., 2021; Singh et al., 2021). Finally, social distancing rules could change household consumption behaviors and patterns, leading to significant changes in the consumption basket (Sheth, 2020). For example, people may spend more on food and other essentials with rising inflation than transportation or leisure (Cavallo, 2020).

4. Robustness checks

4.1 Normalization rules

The row sum rule is not unique to normalize the total connectedness index. As an alternative, Caloia et al. (2019) suggest scalar-based rules scaling the generalized FEVD by the max row and max eigenvalue values. The latter is so-called spectral radius normalization, which, to some extent, proves to yield a similar conclusion as the row sum rule (Pham & Sala, 2021). Figure 5 contrasts the dynamics of total connectedness in three different scaling regimes. It is shown that the row sum and spectral spillovers—solid and dashed-dotted curves, respectively—are well to keep track of each other throughout the time. The spectral curve's spikes give notice of three turbulence times correctly, whereas the dotted curve (max row rule) has failed to capture the strong consumption price fluctuations due to the COVID-19 pandemic in early 2020.

Beyond the robustness check of time-varying spillovers, we repeat full-sample estimations concerning two alternative rules (see Table A.3 in the appendix for details). What we learn from this exercise are twofold. First, although the spectral rule slightly inflates the overall spillover, FROM and TO spillovers estimated under this rule seem to be more consistent with the row sum counterparts than the max row scheme. Second, the max row tends to adjust downward the generalized FEVD considerably, resulting in underestimating the strength of the sectoral spillover network.

Figure 5: Time-varying spillovers with different normalizing rules

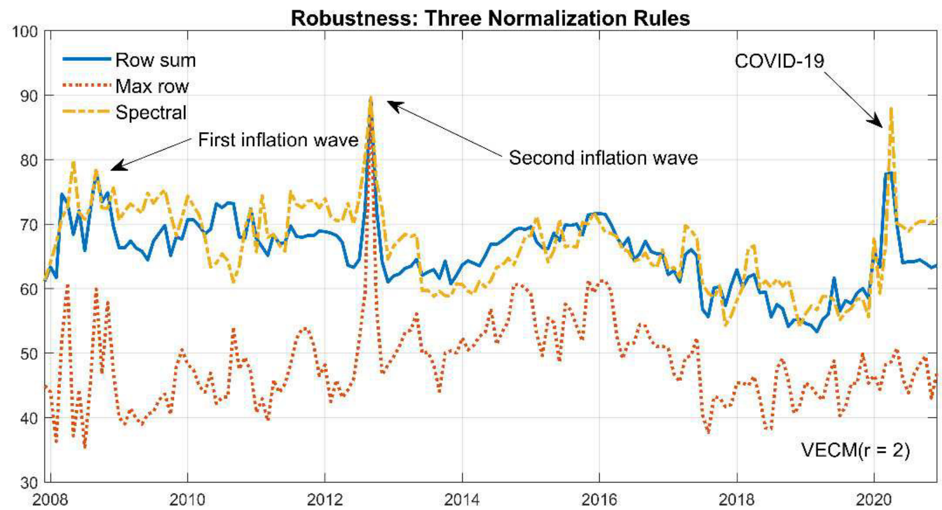
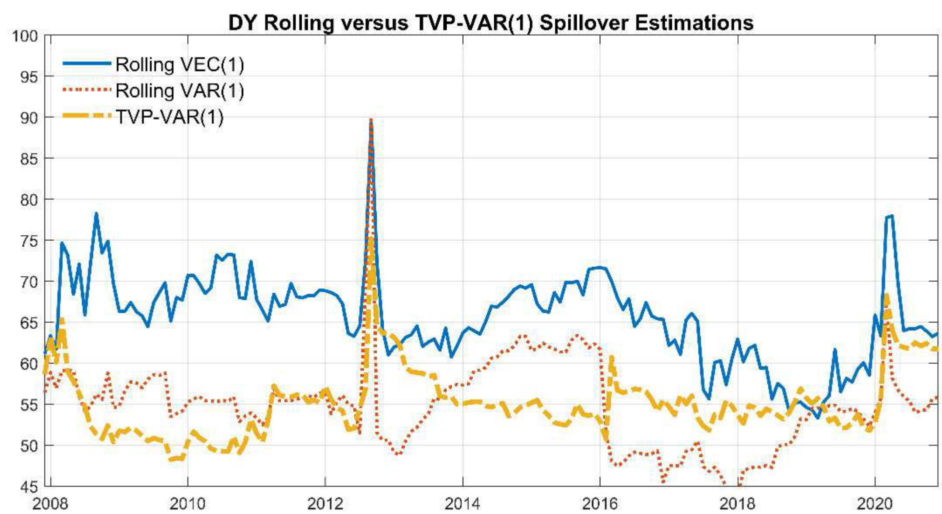


Figure 6: Rolling DY's spillovers and TVP-VAR spillovers



4.2 Time-varying VAR estimation

On the contrary to the rolling procedure of Diebold and Yilmaz, several studies fit the generalized FEVD into a Bayesian TVP-VAR framework (Antonakakis et al., 2018; Gabauer & Gupta, 2018). However, it is unclear how this approach can be applied to an error correction model, which means logarithmic returns must be used for a TVP-VAR estimation.

We closely follow the algorithm described in Antonakakis and Gabauer (2017) and Gabauer and Gupta (2018) to estimate the first order TVP-VAR's spillover along with the VAR(1) 's counterpart for log-differenced series. Figure 6 contrasts the outcomes where we find that the dashed-dotted line—representing the TVP-VAR overall spillover—reasonably tracks down the rolling VECM(1) estimation, the solid line; and that it appears to correctly signal several abrupt volatility escalations, but omitting the cointegration relationship leads to the lower level of time-varying spillover. Simply put, our additional computations suggest that the cointegration relationship should not be overlooked when dealing with disaggregated consumption price indices.

5. Conclusions

We have analyzed in-depth how shocks to Vietnam disaggregated consumption prices circulate within their network. The spillover estimations highlight the centrality roles of essential sectors such as food, (non) alcohol beverages, apparel products, real estate, fuels, and essential utilities as they have remarkably positive net variance contribution to the rest sectors. The time-varying spillovers appreciate precisely three inflation upsurges over 2002 – 2020, especially the last economic turmoil due to the first wave of the SARS-Cov-2 outbreak.

Several implications can be drawn. First, the high degree of sectoral price connectedness suggests that policymakers could manage the headline inflation by stabilizing sectors with net positive variance contributions and high weights in the CPI basket. Second, as claimed in Blagrave (2020), Pham and Sala (2020), and Tram and Thi Thanh Hoai (2021), external surprises could have persistent impacts on Vietnam's price and income levels, so that macro prudence should be considered. Finally, it is worthy of tracking the evolution of disaggregated price networks overtime for a surgical policy of inflation management.

References

Abbott, P., Wu, C., & Tarp, F. (2014). Transmission of world prices to the Vietnamese economy. *Journal of Economic Integration*, *29*(4), 624–656.

Antonakakis, N., Breitenlechner, M., & Scharler, J. (2015). Business cycle and financial cycle spillovers in the G7 countries. *The Quarterly Review of Economics and Finance*, *58*, 154–162.

Antonakakis, N., & Gabauer, D. (2017). Refined measures of dynamic connectedness based on TVP-VAR. *MPRA Paper No. 78282*.

Antonakakis, N., Gabauer, D., & Gupta, R. (2019). International monetary policy spillovers: Evidence from a time-varying parameter vector autoregression. *International Review of Financial Analysis*, *65*.

Antonakakis, N., Gabauer, D., Gupta, R., & Plakandaras, V. (2018). Dynamic connectedness of uncertainty across developed economies: A time-varying approach. *Economics Letters*, *166*, 63–75.

Balcilar, M., Gabauer, D., & Umar, Z. (2021). Crude Oil futures contracts and commodity markets: New evidence from a TVP-VAR extended joint connectedness approach. *Resources Policy*, *73*.

Bhattacharya, R. (2014). Inflation dynamics and monetary policy transmission in Vietnam and emerging Asia. *Journal of Asian Economics*, *34*, 16–26.

Blagrave, P. (2020). Inflation co-movement in emerging and developing Asia: The monsoon effect. *Applied Economics Letters*, *27*(15), 1277–1283.

Caloia, F. G., Cipollini, A., & Muzzioli, S. (2019). How do normalization schemes affect net spillovers? A replication of the Diebold and Yilmaz (2012) study. *Energy Economics*, *84*.

Cavallo, A. (2020). Inflation with Covid Consumption Baskets. *National Bureau of Economic Research Working Paper Series*, *No. 27352*.

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, *28*(1), 57–66.

Diebold, F. X., & Yilmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, *182*(1), 119–134.

Diebold, F. X., & Yılmaz, K. (2015). *Financial and macroeconomic connectedness: A network approach to measurement and monitoring*. Oxford University Press, USA.

Gabauer, D., & Gupta, R. (2018). On the transmission mechanism of country-specific and international economic uncertainty spillovers: Evidence from a TVP-VAR connectedness decomposition approach. *Economics Letters*, *171*, 63–71.

Hoang, T. T., & van Anh Nguyen, T. (2021). The impacts of money policy on growth and inflation in Vietnam: Results from the VAR model. *International Journal of Business and Globalisation*, *27*(3), 293–312.

Inoue, H., Murase, Y., & Todo, Y. (2021). Do economic effects of the anti-COVID-19 lockdowns in different regions interact through supply chains? *Plos One*, *16*(7), e0255031.

Kang, S. H., Lahmiri, S., Uddin, G. S., Arreola Hernandez, J., & Yoon, S.-M. (2020). Inflation cycle synchronization in ASEAN countries. *Physica A: Statistical Mechanics and Its Applications*, *545*.

Kleinberg, J. M. (1999). Hubs, Authorities, and Communities. *ACM Computing Surveys*, *31*, 5. Scopus.

Long, N. N., & Khoi, B. H. (2020). An empirical study about the intention to hoard food during COVID-19 pandemic. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(7), em1857.

Ngoc, B. H. (2020). The asymmetric effect of inflation on economic growth in Vietnam: Evidence by nonlinear ARDL approach. *Journal of Asian Finance, Economics and Business*, *7*(2), 143–149. Scopus.

Osorio, C., & Unsal, D. F. (2013). Inflation dynamics in Asia: Causes, changes, and spillovers from China. *Journal of Asian Economics*, *24*, 26–40.

Page, L., & Brin, S. (1998). The anatomy of a large-scale hypertextual Web search engine. *Computer Networks*, *30*(1–7), 107–117. Scopus.

Pham, B. T., & Sala, H. (2020). The macroeconomic effects of oil price shocks on Vietnam: Evidence from an over-identifying SVAR analysis. *The Journal of International Trade & Economic Development*, *29*(8), 907–933.

Pham, B. T., & Sala, H. (2021). Cross-country connectedness in inflation and unemployment: Measurement and macroeconomic consequences. *Empirical Economics*.

Sheth, J. (2020). Impact of Covid-19 on consumer behavior: Will the old habits return or die? *Journal of Business Research*, *117*, 280–283.

Singh, S., Kumar, R., Panchal, R., & Tiwari, M. K. (2021). Impact of COVID-19 on logistics systems and disruptions in food supply chain. *International Journal of Production Research*, *59*(7), 1993–2008.

Tram, T. X. H., & Thi Thanh Hoai, N. . (2021). Effect of macroeconomic variables on systemic risk: Evidence from Vietnamese economy. Economics and Business Letters, 10(3), 217-228.

Tse, D. C. K., Lau, V. W., Hong, Y., Bligh, M. C., & Kakarika, M. (2021). Prosociality and hoarding amid the COVID-19 pandemic: A tale of four countries. *Journal of Community & Applied Social Psychology*, casp.2516.

Vo, A. T., Ho, C. M., & Vo, D. H. (2020). Understanding the exchange rate pass-through to consumer prices in Vietnam: The SVAR approach. *International Journal of Emerging Markets*, *15*(5), 971–989.

Zakaria, Z. (2017). Crude Oil Price Volatility and Domestic Price Responses in Developing Countries, Accounting for Asymmetry and Uncertainty". Economics Bulletin, 37(4), 2466-2482.

Wang, H. H., & Hao, N. (2020). Panic buying? Food hoarding during the pandemic period with city lockdown. *Journal of Integrative Agriculture*, *19*(12), 2916–2925.

Appendix

Sectoral Price Indices	Short Name	Weight, %
Food and non-alcoholic beverages	FOOD	36.12
Alcoholic Beverages, Tobacco, and Narcotics	ALTO	3.59
Clothing and footwear	CLOT	6.37
Housing, Water, Electricity, Gas and Other Fuels	HOUS	15.73
Furnishings, household equipment and routine household maintenance	EQIP	7.31
Health	HELH	5.04
Transport	TRAN	9.37
Communication	COMM	2.89
Recreation and culture	CULT	4.29
Education	EDUC	5.99
Miscellaneous goods and services	MISC	3.30

Table A1: Weights of Vietnam Consumer Price Index Basket over 2002 – 2020

Panel A: Unit root tests	LALTO	LCLOT	LCULT	LEDUC	LEQIP	LFOOD	LHELH	LHOUS	LMISC	LTRAN
ADF (H0: non-stationary)	0.994	0.958	0.995	0.656	0.979	0.957	0.598	0.992	0.994	0.989
KPSS (H0: stationary)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Panel B: Cointegration test										
	p-r	r	Eigen	Max-Eig	Crit5%	p-value				
	10	0	0.339	92.917	64.505	0.000				
	9	1	0.238	61.041	58.433	0.027				
	8	2	0.173	42.507	52.362	0.350				

Note: The prefixes L and D denote log and log-difference operators, respectively. Numbers in Panel B are expressed in terms of percentage. Unit root tests are applied for log-level data with constant and trend specifications. The cointegration test assumes the time series having a linear deterministic trend and AIC-selected lag length.

Table A2: Unit root and Cointegration Tests

Centrality	ALTO	CLOT	CULT	EDUC	EQIP	FOOD	HELH	HOUS	MISC	TRAN
PageRank	13.13	13.55	3.80	2.20	7.36	19.41	3.57	20.63	7.52	8.83
Authorities	15.41	15.16	1.86	0.63	6.89	21.51	1.84	27.01	5.20	4.49
In-degree	85.54	86.82	11.99	3.85	48.21	122.92	12.86	145.74	34.41	31.89
Out-degree	70.26	69.56	79.32	35.37	81.09	52.44	11.23	48.81	81.88	54.26

Table A.3: Network centrality measurements

	FROM Others				TO Others		
	Row sum	Max row	Spectral		Row sum	Max row	Spectral
ALTO	81.88	47.03	81.14	HOUS	145.74	91.39	157.66
CLOT	81.09	57.83	99.77	FOOD	122.92	78.79	135.93
CULT	79.32	79.32	136.85	CLOT	86.82	61.62	106.30
EDUC	70.26	50.51	87.14	ALTO	85.54	55.73	96.14
EQIP	69.56	38.63	66.64	EQIP	48.21	30.91	53.33
FOOD	54.26	31.96	55.13	MISC	34.41	23.44	40.43
HELH	52.44	30.12	51.96	TRAN	31.89	18.24	31.46
HOUS	48.81	23.82	41.09	HELH	12.86	7.41	12.78
MISC	35.37	13.44	23.19	CULT	11.99	7.08	12.21
TRAN	11.23	4.09	7.06	EDUC	3.85	2.17	3.75
Total Spillover	58.42	37.68	65.00				

Table A4: FROM, TO and Overall Spillovers regarding different normalization rules