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Vertical price transmission dynamics in the fresh tomato value chain in Burkina Faso: an application of the BVAR and TVAR models.

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Abstract

This study investigates the nature of vertical price transmission between farm-gate and retail markets for fresh tomatoes in Burkina Faso. Bayesian Vector Autoregression (BVAR) model and Threshold Vector Autoregression (TVAR) model were applied to annual farm-gate and retail price data obtained from FAOSTAT and the National Institute of Statistics and Demography (INSD), respectively. The findings reveal that price transmission along the fresh tomato value chain is asymmetric. The TVAR results indicate that price transmission is stronger during periods of stable or increasing prices, whereas it is weaker when prices decline. This asymmetry may reflect market imperfections, including the exercise of market power and the highly perishable nature of fresh tomatoes. These findings suggest that improving market transparency, strengthening price information systems, and promoting greater market competition could enhance the efficiency of price transmission throughout the value chain.

Keywords: price transmission, price asymmetry, Bayesian Vector Autoregression, Threshold Vector Autoregression, fresh tomato, value chain, Burkina Faso.

Introduction

In Burkina Faso, the tomato (Solanum lycopersicum L.) is one of the leading market-garden crops, both because of its economic importance and because of the role it plays in food security and in the livelihoods of rural households. It ranks second among market-garden crops in terms of area cultivated and volume produced (MAAHA, 2019). In 2023, national production was estimated at 306,282 tonnes, with an average yield of 17 t/ha (FAOSTAT, 2025). The sector makes a substantial contribution to the national economy, with an estimated turnover of CFAF 78 billion, representing close to 20% of the value of market-garden production (MAAHA, 2019). Tomato exports also generated approximately CFAF 182 million in foreign exchange earnings (Comtrade, 2025), underlining the growing importance of this crop in regional trade.

Despite this economic potential, the tomato sector continues to face numerous structural constraints that limit its efficiency. Production is highly seasonal, with harvests concentrated in the dry season, while the high perishability of the product results in post-harvest losses that can exceed 50% (MAAHA, 2019). Added to this are inadequate storage and processing infrastructure, the absence of contractual arrangements between actors, and difficulties in accessing market information. These constraints encourage substantial price fluctuations and heighten the economic vulnerability of producers, particularly during periods of high supply.

Yet prices are the principal coordinating mechanism of agricultural markets. They convey economic signals between producers, traders and consumers, guiding production, marketing and consumption decisions. The way in which price changes propagate along a value chain is therefore a key indicator of market efficiency. Price transmission refers to the process by which a change observed in one market or at one marketing level is passed through to other markets or to other links in the chain. Meyer & von Cramon-Taubadel (2004) distinguish horizontal transmission, which concerns geographically distinct markets, from vertical transmission, which describes the propagation of price changes between the different levels of a single value chain. Transmission is generally assessed through its magnitude, its speed and its degree of symmetry.

Efficient transmission promotes an efficient allocation of resources and a better distribution of value added among actors. Conversely, incomplete or asymmetric transmission may reflect market imperfections arising in particular from market power, high transaction costs, imperfect information or institutional failures. In such cases, increases in producer prices may be passed on more rapidly than decreases, or vice versa, leading to an unequal distribution of gains between producers, intermediaries and consumers. Earlier work on price transmission shows that transmission is therefore an important indicator of the functioning of agricultural markets (Vavra & Goodwin, 2005). Similarly, Acosta & Valdés (2014) show that the speed of price transmission directly influences the competitiveness of agricultural value chains as well as producer incomes. Rezitis & Pachis (2020) point out that tomato producers in Greece respond mainly to short-run price changes. Etuah et al. (2024) conclude that weak transmission is associated with high transaction costs and with the market power held by intermediaries.

Although vertical price transmission is a key indicator of the functioning of agricultural markets, knowledge remains limited regarding transmission mechanisms in the fresh tomato value chain in Burkina Faso. Existing studies have focused mainly on cereals or on spatial relationships between markets. Thus Bitibale (2021) finds that maize price transmission is asymmetric between the production market and the assembly market. In the same vein, Badolo (2011) concludes that transmission between the different rice markets is asymmetric. Despite the many studies on agricultural price transmission, very few have examined the fresh tomato value chain in Burkina Faso. Moreover, existing studies rely mainly on linear models, which cannot capture the regime shifts that may characterise agricultural markets. Yet the highly perishable nature of the tomato, high transaction costs, information asymmetries and the market power of intermediaries are all likely to generate non-linear and asymmetric behaviour. The absence of such an analysis limits our understanding of how this sector actually operates and complicates the design of effective policies to improve producer incomes. To what extent, then, does vertical price transmission in the fresh tomato value chain in Burkina Faso display asymmetric and non-linear dynamics?

To address this question, the present study combines a Bayesian Vector Autoregressive (BVAR) model, which allows the dynamic interactions between prices to be analysed in a small-sample context, with a Threshold Vector Autoregressive (TVAR) model, which is able to reveal possible asymmetries across market regimes. This approach offers a finer understanding of price transmission mechanisms in the fresh tomato sector in Burkina Faso and provides analytical evidence capable of informing policies aimed at strengthening market transparency, improving coordination between actors and fostering a more equitable distribution of value added.

I. Materials and Methods

1. Study area

The study covers the period 1997–2022 and draws on secondary data from FAOSTAT and from the National Institute of Statistics and Demography (INSD). Tomato producer prices are taken from the FAOSTAT database. However, because the historical producer price series are incomplete, the producer price index was used as a proxy in order to obtain a time series long enough for the analysis.

Retail prices are taken from the INSD database, which produces national statistics based on regular price surveys carried out in the main consumer markets. The observations used correspond to annual average retail prices.

The producer and retail price series were log-transformed in order to reduce their variability, stabilise their variance and facilitate the interpretation of the estimated coefficients in terms of elasticities.

2. Theoretical framework

Vertical price transmission is theoretically grounded in the law of one price, according to which, in a perfectly integrated market and in the absence of frictions, a homogeneous good should command the same price throughout the value chain, apart from transaction costs (Fackler & Goodwin, 2001). Any change in the producer price is thus expected to be passed on to the other links in the chain up to the consumer. In this context, the price differences observed between the various market levels reflect only the costs associated with transport, storage and marketing.

In agricultural value chains, however, transmission is rarely perfect. Meyer and von Cramon-Taubadel (2004) show that vertical price transmission can be analysed along four complementary dimensions, namely the magnitude, the speed, the nature and the direction of

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transmission. Magnitude measures the intensity with which a price shock is passed from one market level to another, whereas speed corresponds to the time required for that adjustment to be completed. These two dimensions depend in particular on transaction costs, adjustment costs, market structure and access to information. The nature of transmission refers to the way prices respond to positive or negative changes. Transmission is said to be symmetric when price increases and decreases are passed on with the same intensity and over the same time horizon. Conversely, it is asymmetric when adjustments differ according to the direction of the price change. According to Peltzman (2000), asymmetry is said to be positive when price increases are transmitted more rapidly or more strongly than decreases, and negative when decreases are passed on more rapidly than increases. In agricultural value chains, empirical studies generally find that price increases are transmitted more rapidly than decreases. Finally, the direction of transmission identifies the way price shocks propagate, either upstream to downstream (from producer to consumer) or downstream to upstream (from the final market to the producer). This dimension provides information on the functioning of the market and on the bargaining power of the different actors in the value chain.

3. Specification

- **BVAR**

The BVAR (Bayesian vector autoregression) model is an extension of the VAR (vector autoregression) model developed by (Sims, 1980) which is a multivariate linear model capable of capturing the joint dynamics of several time series. The BVAR model was developed by (Doan, et al., 1984) . Unlike the standard VAR, the BVAR model reduces over-parameterisation problems when the sample size is small. Given the size of our sample, the BVAR model is more appropriate.

The BVAR(p) model is written as follows:

$$\ln PC_t = \alpha_{10} + \sum_{i=1}^{p} \alpha_{11,i} \ln PC_{t-i} + \sum_{i=1}^{p} \alpha_{12,i} \ln PP_{t-i} + \varepsilon_{1t}$$

$$\ln PP_t = \alpha_{20} + \sum_{i=1}^{p} \alpha_{21,i} \ln PC_{t-i} + \sum_{i=1}^{p} \alpha_{22,i} \ln PP_{t-i} + \varepsilon_{2t}$$

$\ln PC_t$ the logarithm of the retail price

$\ln PP_t$: the logarithm of the producer price

$\alpha_{10}\ et\ \alpha_{20}$ the constants

$\alpha_{11,i}$ and $\alpha_{22,i}$ own autoregressive effects for each variable

$\alpha_{12,i}$ and $\alpha_{21,i}$ transmission effects

However, $\alpha_{ij,i} \sim N\left(\alpha_{ij,i}\, , V_{ij,i}\right)$

$\alpha_{ij,i}$: $denotes\ the\ prior\ mean\ of\ the\ coefficients$

$V_{ij,i}$: denotes the prior variance

$\varepsilon_{1t}$and ε_{2t} the error terms, which must be serially uncorrelated

$$\varepsilon_t \sim N(0, \Sigma\,)$$

$$\Sigma \text{ the variance} - \text{covariance matrix of the errors}$$

The variance-covariance matrix of the errors generally follows an inverse Wishart distribution

$$\Sigma \sim (S_0, \nu_0)$$

The Minnesota prior imposes prior restrictions on the VAR coefficients

Hyperparameter λ controls the strength of the shrinkage

- TVAR

The TVAR model (Threshold Vector Autoregressive) proposed by (Tong, 1978) is an extension of the traditional VAR model. This model combines the advantages of traditional

VAR models and of threshold models in order to describe the asymmetric behaviour of macroeconomic activity. It has the advantage of being able to capture different dynamics between variables according to the economic regime or market state, defined by whether a transition variable crosses a threshold. The TVAR is therefore able to capture asymmetric relationships between economic variables.

The two-regime TVAR model is given as follows:

$$Y_t = lnPC_t = \begin{cases} \alpha_{10} + \sum_{i=1}^{p} \alpha_{11,i} \ln PC_{t-i} + \sum_{i=1}^{p} \alpha_{12,i} \ln PP_{t-i} + \varepsilon_{1t}, & if\ z_{t-d} \leq \gamma \\ \alpha_{10} + \sum_{i=1}^{p} \alpha_{11,i} \ln PC_{t-i} + \sum_{i=1}^{p} \alpha_{12,i} \ln PP_{t-i} + \varepsilon_{1t} & if\ z_{t-d} > \gamma \end{cases}$$

$$lnPP_t = \begin{cases} \alpha_{20} + \sum_{i=1}^{p} \alpha_{21,i} \ln PC_{t-i} + \sum_{i=1}^{p} \alpha_{22,i} \ln PP_{t-i} + \varepsilon_{2t}, & if\ z_{t-d} \leq \gamma \\ \alpha_{20} + \sum_{i=1}^{p} \alpha_{21,i} \ln PC_{t-i} + \sum_{i=1}^{p} \alpha_{22,i} \ln PP_{t-i} + \varepsilon_{2t} & if\ z_{t-d} > \gamma \end{cases}$$

$\alpha_{10}\ et\ \alpha_{20}$ the constants

$\alpha_{11,i}$ and $\alpha_{22,i}$ own autoregressive effects for each variable

$\alpha_{12,i}$ and $\alpha_{21,i}$ transmission effects

$\varepsilon_{1t}$and ε_{2t} the error terms, which must be serially uncorrelated

$\ln PC_t$ the logarithm of the retail price

$\ln PP_t$: the logarithm of the producer price

z_{t-d} transition variable lagged by d periods

γ, the estimated threshold separating the two regimes

Regime 1: $z_{t-d} \leq \gamma$ corresponds to a phase of falling prices

Regime 2: $z_{t-d} > \gamma$ *phase of rising or stable prices*

II. Results

1. Stationarity tests

The results of the ADF (Augmented Dickey-Fuller) tests show that the variables lnpc and lnpp are non-stationary. By contrast, the KPSS test results indicate that lnpc is non-stationary whereas lnpp is stationary. This discrepancy led us to test for unit roots on the differenced series. In first differences, the KPSS and ADF test results converge. The variables lnpc and lnpp are integrated of order I(1). A VAR or VECM model can therefore be used to examine the dynamic evolution of producer and retail prices.

Table 1: Stationarity tests

Series	Test	Statistic	p-value	Interpretation
$lnpc$	ADF	-3.40	0.078	Non-stationary
	KPSS	0.8415	0.01	Non-stationary
$lnpp$	ADF	-1.27	0.852	Non-stationary
	KPSS	0.1945	0.10	Stationary
d_{lnPP}	ADF	-4.04	0.022	Stationary
	KPSS	0.153	0.1	Stationary
d_{lnPC}	ADF	-4.42	0.01	Stationary
	KPSS	0.269	0.1	Stationary

Source *: Author, 2025*

2. Criteria for selecting the optimal lag

The lag order is determined using the AIC, HQ, SC and FPE criteria. The lag order retained is the one that minimises the criterion. Given the sample size and the SC criterion, a lag of 2 is selected (Table 2).

Table 2: Optimal lag selection

AIC(n)	HQ(n)	SC(n)	FPE(n)
4	4	2	4

Source *: Author, 2025*

3. Johansen test results

The Johansen test was used to determine whether a long-run equilibrium relationship exists between producer and retail prices.

H0 = no cointegrating relationship

H1 = at least one cointegrating relationship

For r = 0

10.63<19.96

For r = 1

1.19<9.24

H0 is not rejected

The trace test results indicate that the statistic associated with the hypothesis r = 0 is below the critical value at the 5% level. The null hypothesis of no cointegration therefore cannot be rejected. The same applies to the hypothesis r = 1, for which the test statistic likewise remains below the critical value. These results suggest that producer and retail prices in the fresh tomato value chain do not move together in a long-run relationship.

Table 3: Johansen test

	test	**10%**	**5%**	**1%**
r <= 1	1.19	7.52	9.24	12.97
r = 0	10.63	17.85	19.96	24.60

Source: *Author, 2025*

4. BVAR

The BVAR results estimate the lambda parameter at 1.14.

According to the model estimates, a 1% increase in the retail price in period t-1 translates into a 0.190% rise in the retail price. Prices are not, however, passed through with the same intensity. The adjustment of the retail price to its own past values is therefore gradual rather than immediate: a certain delay is required before prices are fully transmitted.

In year t-2, by contrast, prices respond differently. A 1% increase in the consumer price in year t-2 leads to a 0.79% fall in the retail price. This points to a lag in the transmission of consumer prices, suggesting that changes in producer prices take time to be passed through to the final consumer. In other words, increases observed in the past may be partially corrected over time. This may indicate the existence of an adjustment or correction mechanism following an earlier price rise.

The results also reveal that an increase in the producer price is associated with a 0.250% rise in the retail price. This suggests positive transmission of producer price changes to the consumer in the short run. In other words, prices are transmitted rapidly between the producer and retail levels.

Conversely, over period t-2, retail and producer prices respond with a negative shock. An increase in the producer price in t-2 leads to a 0.050% reduction in the price. In other words, producer and retail prices do not move in the same direction or with the same intensity. This relationship may reflect a differentiated adjustment process in which past changes in the producer price are partially corrected over time.

Equation for d_{LNPC}

Table 4: BVAR results, retail price

Variables	Estimate
Constant	0.029

$d_{lnPCt-1}$	0.190
$d_{lnPPt-1}$	0.250
$d_{lnPCt-2}$	-0.079
$d_{lnPPt-2}$	-0.050

Source : Author, 2025

Equation for d_{LNPP}

$$d_{LNPP} = constant + d_{lnPC\,t-1} + d_{lnPPt-1} + d_{lnPCt-2} + d_{lnPPt-2}$$

Table 5: BVAR results, producer price

Variables	Estimate
Constant	0.004
$d_{lnPCt-1}$	0.087
$d_{lnPPt-1}$	0.137
$d_{lnPCt-2}$	0.146
$d_{lnPPt-2}$	-0.072

***Source** : Author, 2025*

Past retail prices and producer prices move in the same direction but not with the same intensity. A 1% increase in the retail price is associated with a 0.087% rise in the producer price in year t. This may be explained by a dynamic interaction between the two market levels. Similarly, over period t-2, the two prices appear to converge but with different intensities. A 1% increase in the retail price in t-2 has a negative influence of 0.146% on the producer price in period t. Producer prices therefore take longer to respond to increases in retail prices.

The results also indicate that producer prices display differentiated dynamics across periods. In the short run (t-1), current and past producer prices move in the same direction but not with the same intensity. More precisely, a 1% rise in producer prices in t-1 leads to a rise in current prices of 0.137%. These results suggest that past changes tend to be transmitted positively at the production level. Prices adjust partially in the short run.

In period t-2, by contrast, the relationship is reversed. An increase in the producer price two periods earlier tends to reduce the current price by 0.072%. This may be interpreted as a differentiated adjustment mechanism in which past increases eventually generate a price correction after a certain delay.

Overall, these results highlight a dynamic interaction between producer and consumer prices, characterised by lagged effects and gradual adjustment mechanisms.

5. TVAR results

The TVAR model examines the non-linear dynamics that may exist between producer and retail prices for fresh tomatoes.

5.1 Effect of the retail price

The TVAR estimation results reveal two distinct regimes, with a threshold of 0.08. Regime 1, accounting for 73.9% of observations, corresponds to phases of falling retail prices, whereas regime 2, accounting for 26.1% of observations, is characterised by phases of stability or of rising prices.

Regime 1: falling prices

In this regime, the retail price does not respond significantly either to changes in its own past values or to changes in the producer price. In other words, when retail prices fall, vertical transmission is weak. Changes in the retail price are not passed on between the links of the chain.

Dynamics do appear, however, at the producer price level. A 1% rise in the producer price in period t-2 translates into a 0.3% decrease in that price in period t. This means that a certain amount of time is required for the producer price to adjust following an increase.

When retail prices fall, the interactions between prices remain weak, which suggests that vertical transmission is limited. Shocks appear to be absorbed mainly within each link of the chain.

Regime 2 : Rising prices

In regime 2, the dynamics appear mainly at the producer price level. A 1% increase in the retail price in t-1 leads to a 2.5% decrease in the producer price in t. Following a change in the retail price, transmission to the producer price is negative and delayed. This result suggests that price increases tend to be passed on more rapidly than price decreases.

In period t-2, prices adjust. A 1% rise in the retail price in t-2 tends to increase the producer price by 1.33%. These results highlight the existence of a delayed price adjustment mechanism, suggesting that changes in the retail price take some time to be passed through to the producer price.

Furthermore, the current producer price rises by 0.88% following a 1% change in its own past value in t-2. In other words, within the production link, price transmission is gradual.

In sum, these results suggest that positive shocks are transmitted more rapidly than negative shocks. Moreover, producers do not automatically benefit from increases in producer prices when shocks occur.

Table 6: TVAR results

Explanatory variables	Falling prices Regime 73.9%		Rising prices Regime 26.1%	
	Equation d_{LNPC}	Equation d_{LNPP}	Equation d_{LNPC}	Equation d_{LNPP}
Intercept	0.033 (0.03)	0.012 (0.02)	0.08 (0.19)	0.55 (0.14)**
d_{LNPC-1}	-0.32 (0.29)	0.27 (0.21)	-0.03 (0.76)	-2.59 (0.56)***

d_{LNPP-1}	0.03 (0.19)	-0.02 (0.15)	0.94 (0.83)	0.07 (0.61)
d_{LNPC-1}	0.07 (0.21)	-0.12 (0.16)	-0.73 (0.51)	1.33 (0.38)**
d_{LNPP-2}	0.28 (0.19)	-0.31 (0.15)*	-0.74 (0.47)	0.88 (0.35)*
AIC	-203.32			
BIC	-179.48			
SSR	0.23			

Source: Author, 2025

5.2 Hansen test

The Hansen test makes it possible to assess the relevance of the threshold obtained from the TVAR model. It is based on a comparison of the likelihood of the linear VAR model and that of the non-linear TVAR model. The results indicate a likelihood ratio statistic of 55.58 with a p-value of 2.46×10^{-8}. This very low p-value indicates that the linear model hypothesis is rejected in favour of the threshold model. In other words, the TVAR model appears more appropriate for describing price transmission dynamics in the tomato value chain.

Table 7: Hansen test results

LogLik_VAR	LogLik_TVAR	LR_stat	p_value
28.04	56.37	55.58	2.46×10^{-8}

Source : Author, 2025

III. Discussion

The results suggest that the two price series do not appear to converge towards a long-run equilibrium. Consequently, the estimation must be carried out using the BVAR model, which is an extension of the VAR model. This finding corroborates the work of Rezitis & Pachis (2020), who show that tomato producers in Greece react essentially to short-run price variations.

The BVAR model results show that price transmission along the fresh tomato value chain is slow and imperfect. The lagged effects observed suggest the existence of a time lag in price adjustment. This dynamic indicates that price variations are not passed through instantaneously between the different market links. These results are consistent with those of Etuah et al. (2024), who show that price signals in agri-food markets are not fully transmitted along the maize, cowpea and yam supply chains.

The Hansen test confirms that the TVAR model describes price dynamics better than the linear model. The TVAR results reveal two distinct regimes. The first regime, characterised by falling prices, shows weak interaction between producer and retail prices. Vertical transmission is therefore weak during periods of price decline. Conversely, during periods of price increase, vertical transmission is stronger. Price increases are passed through faster than price decreases. This phenomenon, referred to as the "rockets and feathers" effect, is frequently observed in agri-food supply chains. Price transmission along the tomato value chain is therefore asymmetric. According to Peltzman (2000), this asymmetry is positive. This result is similar to that of Jeder et al. (2017), who found the presence of asymmetry in the tomato value chain. It is also in line with Badolo (2011), who highlights the presence of asymmetry in the rice market in Burkina Faso.

This price asymmetry could be explained by a number of factors, such as market power, information asymmetry, market structure, product perishability and adjustment costs. For instance, Etuah et al. (2024) conclude that weak transmission is associated with the presence of high transaction costs and market power. Similarly, Bakucs et al. (2007) showed that asymmetry stems from the market power held by intermediaries in the agri-food value chain. Santeramo & Von Cramon-Taubadel (2016), by contrast, attribute price asymmetry to the highly perishable nature of certain products such as tomatoes. Indeed, perishability limits storage possibilities and leads to slower price adjustment. Similar results are also reported by Kopp & Mishra (2022), who show that market power is more pronounced for highly perishable products. The observed dynamics may also be associated with the existence of information asymmetries between the various actors in the fresh tomato value chain. Raj V. Am (2025) explains that price uncertainty generates price gaps and transaction failures. In line with Akerlof's theory, asymmetry is particularly present in perishable products such as vegetables, where sellers hold private knowledge about the freshness and quality of the products that buyers cannot easily verify at the time of the transaction. Information asymmetry could therefore be a cause of price asymmetry. From an economic standpoint, these results reflect the existence of structural imbalances in the tomato value chain, characterised by the presence of market power and a lack of transparency in price formation.

These findings underline the importance of strengthening mechanisms for transparency and price information dissemination, as well as improving coordination between the different market actors.

Conclusion

This study analyses vertical price transmission along the fresh tomato value chain in Burkina Faso over the period 1997–2022, using data from the INSD and FAOSTAT. The results show that producer and retail prices are linked in the short run.

The BVAR results reveal that transmission is slow and imperfect, possibly suggesting price asymmetry. The Hansen test, however, corroborates the relevance of using the TVAR model to explain non-linear dynamics. The TVAR results reveal the existence of asymmetry in the tomato value chain, characterised by a faster pass-through of price increases than of price decreases. They also show that transmission is stronger from retail prices towards producers.

The presence of asymmetry in price transmission contributes to making the tomato market inefficient. Addressing this requires improving market transparency and regulation through an appropriate information system along the value chain, and strengthening producers' bargaining power through the creation of professional organizations or cooperatives, so as to ensure more equitable transmission.

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Appendices

Post-estimation tests

Tests	Variables	Statistics	df	p-value	Conclusion
Ljung-Box autocorrelation test	d_lnPC BVAR	10.371	12	0.583	No autocorrelation
	d_lnPP BVAR	11.951	12	0.449	No autocorrelation
	d_lnPC TVAR	9.1372	12	0.6912	No autocorrelation
	d_lnPP TVAR	11.664	12	0.473	No autocorrelation
Jarque-Bera test	d_lnPC BVAR	3.5471	2	0.1697	Normal residuals
	d_lnPP BVAR	0.7004	2	0.7046	Normal residuals
	d_lnPC TVAR	4.1026	2	0.1286	Normal residuals
	d_lnPP TVAR	7.0764	2	0.0291	Non-normal residuals
Shapiro-Wilk normality test	W = 0.96173			0.5517	Normal residuals
	W = 0.85257			0.004706	Non-normal residuals
	W = 0.88365			0.01708	Slightly non-normal residuals
Heteroscedasticity (ARCH-LM)	d_lnPC BVAR	4.1862	5	0.5229	No ARCH effects
	d_lnPP VAR	4.5844	5	0.4687	No ARCH effects
	d_lnPC TVAR	6.9464		0.2247	No ARCH effects
	d_lnPP TVAR	10.805		0.05538	Moderate ARCH effect