Improving Volatility Forecasts in Agricultural Commodity Markets using High Frequency Data

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Introduction

- Studies performed in stock and foreign exchange markets suggest that limit order book (LOB) events such as the arrival of orders and trades and the information contained in the bids and asks are important determinants of volatility. However, research performed in agricultural commodities do not take into account such intraday price dynamics that may contain information to predict volatility.
- Intraday volatility can be decomposed into public information shocks and microstructure effects. Little research has been done on public information shocks in agricultural commodities (Adjemian and Irwin 2018 and Bian, Serra and Garcia 2018) but the effect of microstructure effects in these markets has not been explored.

Objective: Assess if the information contained in the LOB is valuable to explain e: intraday volatility.

Data

Limit Order Book (LOB): list of buy/sell limit orders, beyond the best bid and ask quotes, that remain active until matched with another incoming, opposite, limit order. For this study we use:

- Wheat futures market; *market depth* files from the CME Group that contain all the bids, asks, and depth contained in the LOB for the wheat market.
- Period: Nov. 23, 2015 - March 31, 2016.
- Frequency: snapshots of 48-second intervals

Sample LOB at one point in time:
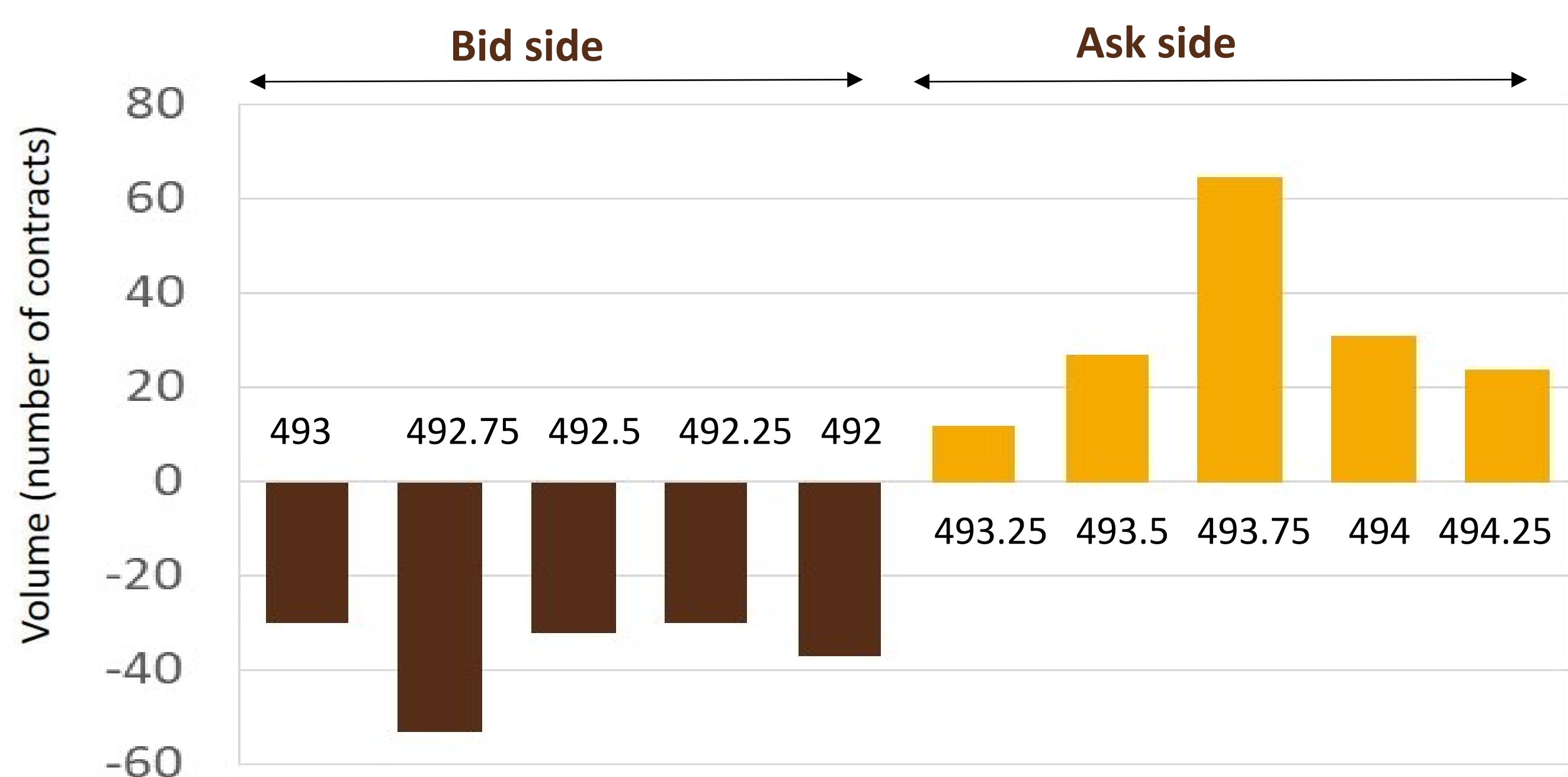
Methods

- Estimate a high frequency VAR model (Hautsch and Huang 2012).

$$\Delta y_t = \mu + \alpha\beta' y_{t-1} + \sum_{i=1}^{p-1} \tau_i \Delta y_{t-i} + \varepsilon_t$$

where $y_t = [a_t, b_t, da_t^1, \ldots, da_t^k, db_t^1, \ldots, db_t^k]'$, a_t and b_t are the best ask and bid quotes; da_t^k and db_t^k for k=1,2,3 denote the depth on the kth best observed quote level on the ask and bid sides, respectively.

- Formulate an impulse response function to estimate the impact of a shock induced by an incoming order on the best bid and ask prices. The long-run impact, which is the permanent effect, is used for volatility estimation.
- Estimate a VAR model using the daily level of price impact and the predicted price volatility coming from from a GARCH model (Jiang et al. 2019)
- Estimate a GARCH-X model to assess the effect of the permanent price impact on volatility.

$$y_t = \mu + \epsilon_t, \qquad \epsilon_t || \Omega_{t-1} \sim D_v(0, \sigma_t^2)$$

$$\sigma_t^2 = \kappa + \beta\sigma_{t-1}^2 + \alpha\epsilon_{t-1}^2 + \gamma_1 PI_{t-1,buy} + \gamma_2 PI_{t-1,sell}$$

where $PI_{t-1,buy}$ and $PI_{t-1,sell}$ are daily aggregates of the permanent price impact induced by a buy and sell incoming order on day t-1, respectively.

Results
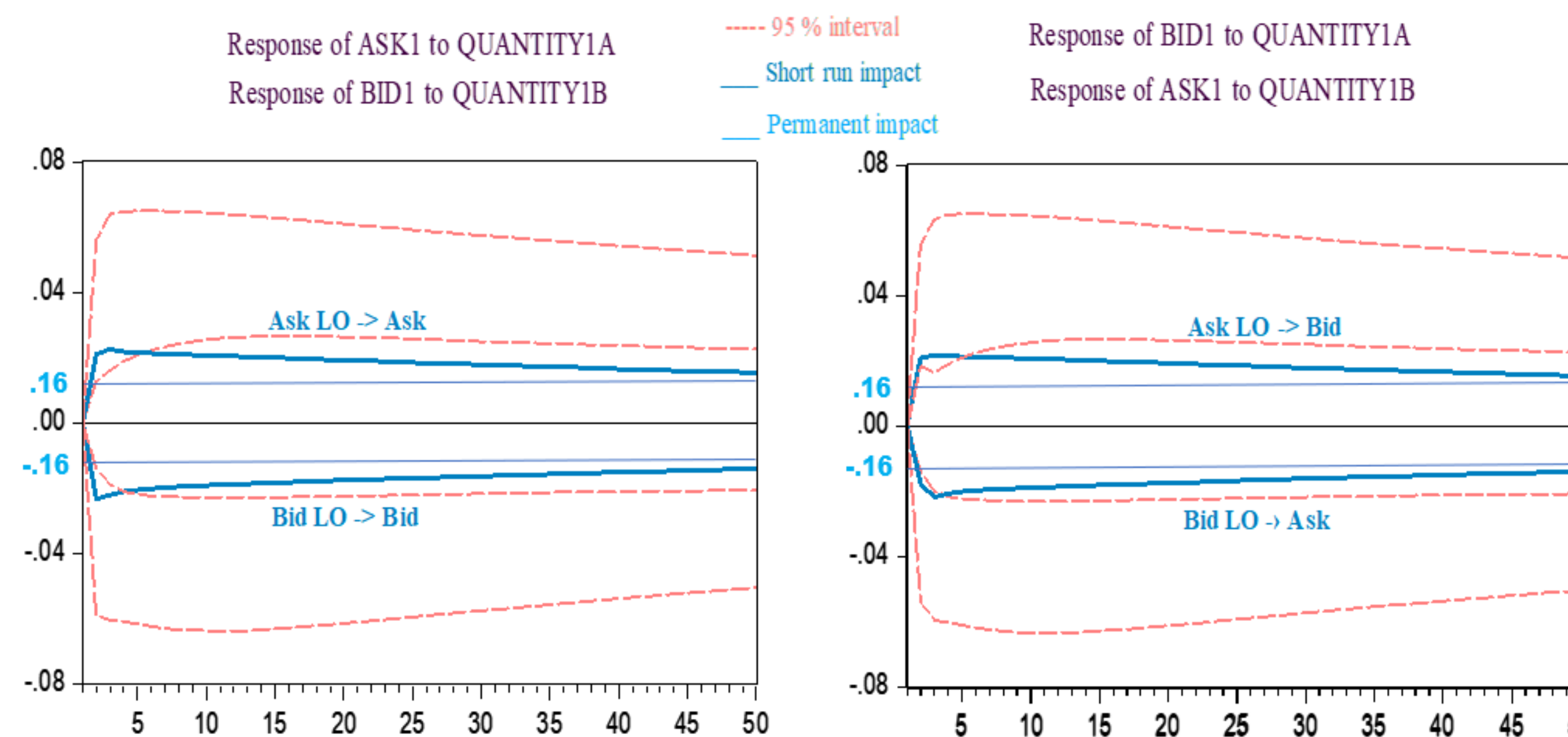
- The incoming limit order placed at the market does not change the ask and bid prices directly, therefore the short run price impact starts from zero, and then starts increasing (decreasing).
- The quotes converge to a permanent level after 50 time periods (the frequency of the data is 48 seconds, so 50 time periods translates to 40 minutes)
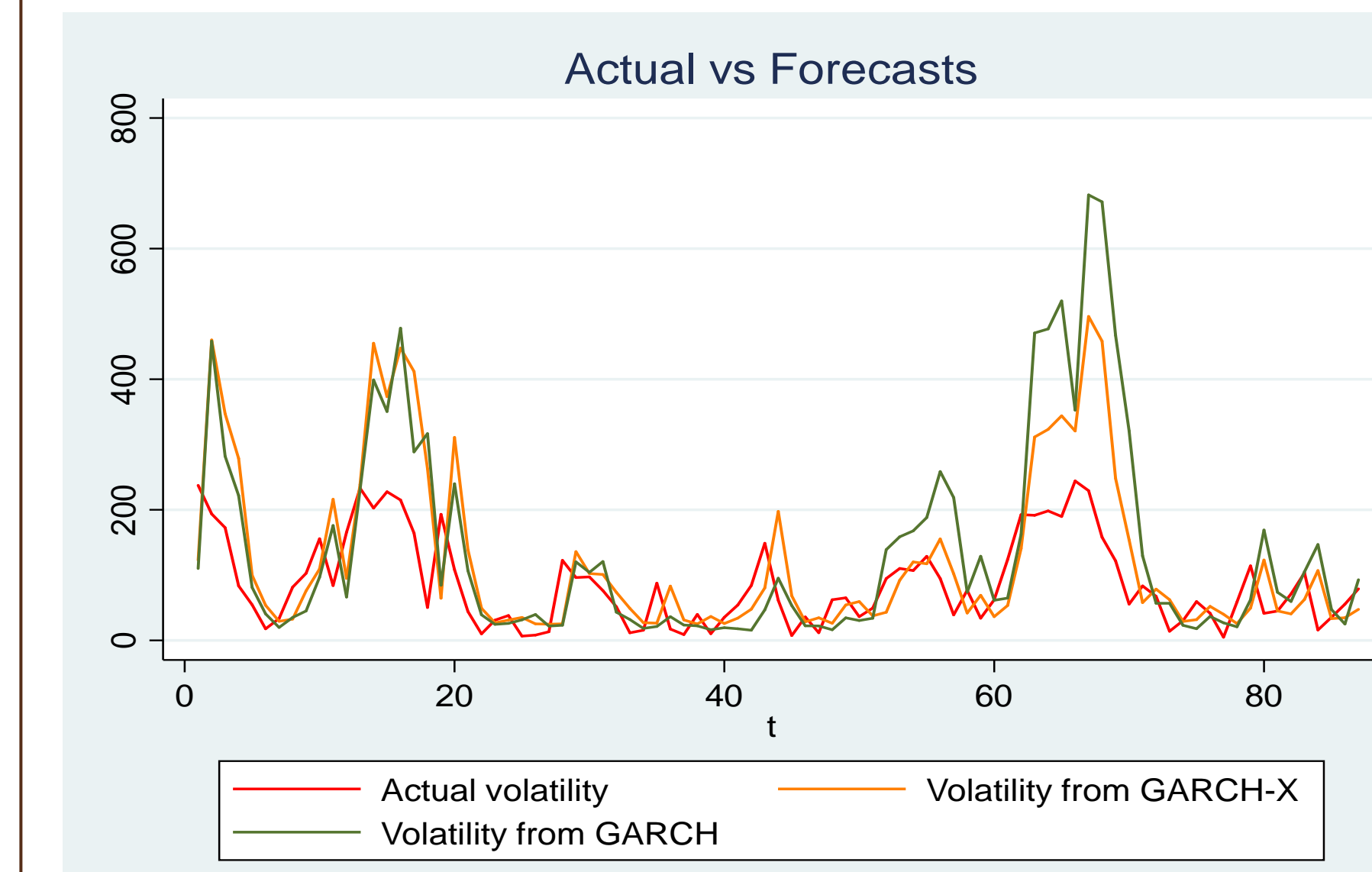
Price impact of a limit order on volatility:
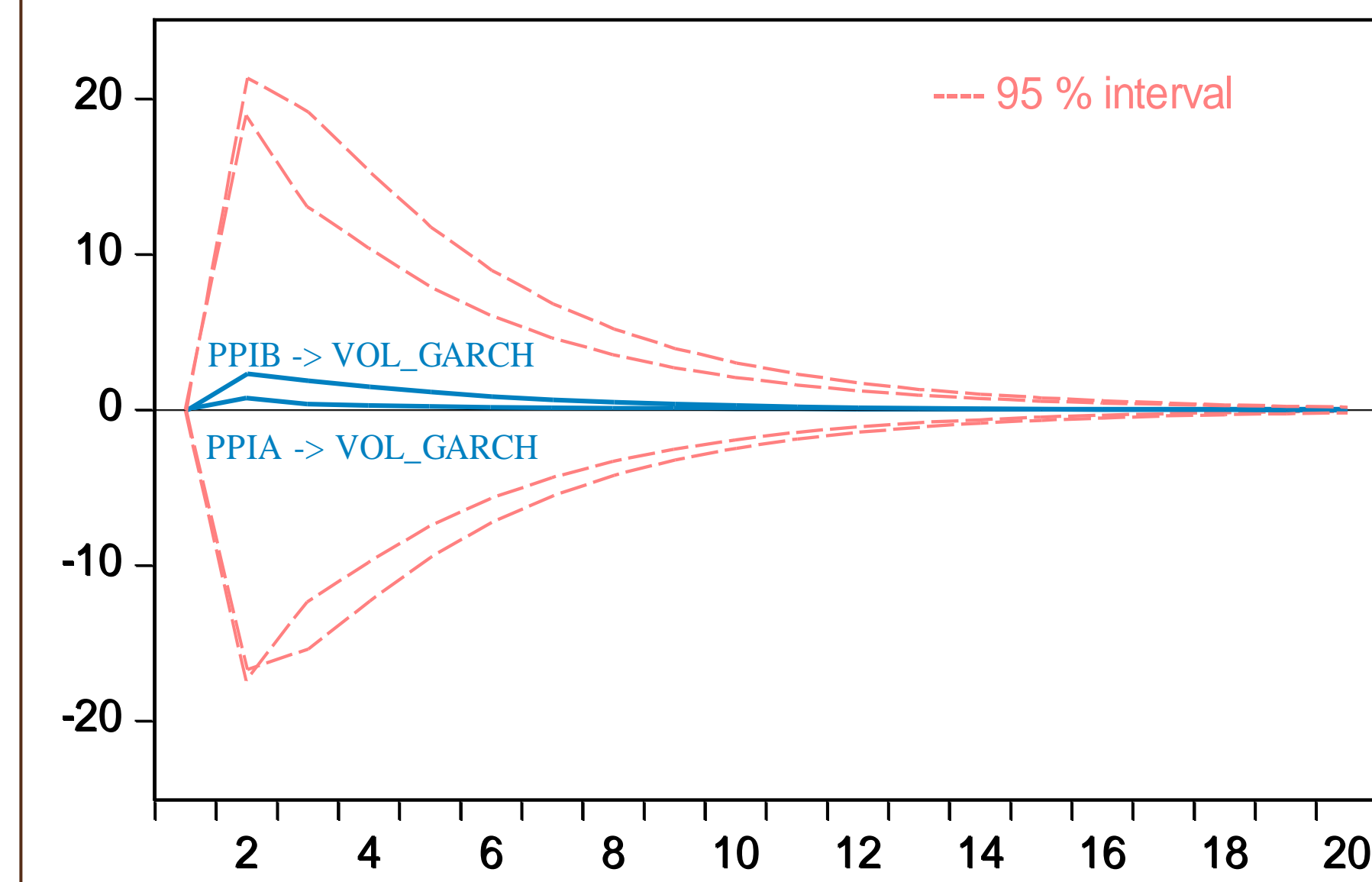
- The bid limit order shows a stronger impact on volatility than the ask limit order.

Accuracy of Volatility Forecast:

- Volatility forecasts were evaluated using the McCracken test and the results show that the augmented GARCH-X model forecasts are mor accurate relative to the traditional GARCH model.

Conclusions

- The information contained in the LOB has useful information that can be used to predict volatility.
- Incoming limit buy and sell orders have a permanent price impact effect that it is significant at the 10% level in explaining daily volatility.
- The augmented volatility model that accounts for the effect of incoming buy and sell orders produces significantly more accurate forecasts.

References

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