Agricultural productivity and price volatility in France: a dynamic stochastic structural estimation

Yu Zheng, Alexandre Gohin

UMR SMART LERECO Rennes

Yu.Zheng@inra.fr, Alexandre.Gohin@inra.fr

The European Union has adopted many reforms of the Common Agricultural Policy (CAP) in the past 25 years. Price support has decreased and decoupled payments were introduced. Accordingly, European agricultural prices become more volatile, in line with the volatility of world prices. While this new context generates many debates on the optimal EU farm policy, critical questions remain on the real impacts of the rising agricultural price volatility on farm decisions. Farmers may have modified their production (such as investment) and financial (such as borrowing) decisions while facing incomplete contingent markets for subsequent production periods. This may have contributed to the observed decline of the farm partial productivity growth (European Commission, 2016).

There are currently mixed empirical evidence on the linkage between price volatility and productivity (either partial or total factor productivity (TFP)). Hu and Antle (1993) indirectly analyze this linkage by assessing the impact of farm policy price supports on the TFP. They find that price support has a negative (resp. positive) impact on TFP when this support is high (resp. low or negative). More recently, Kazukauskas et al. (2010) find a negative effect of price volatility on productivity in Irish dairy farms. On the other hand, Frick and Sauer (2017), Lieu et al. (2017), find a positive relationship on the German and Norwegian dairy sectors.

In our paper, we estimate the link between output price risks and TFP in a dynamic stochastic farm decision model. A representative producer makes production, consumption, investment, and financial decisions and face production (climate), output price and interest rate risks. We allow for structural changes in the drift term and the standard deviation of the shocks in the output price processes before and after the CAP reform.

We originally contribute to the literature in three main aspects. First, the accuracy of the input data, especially the problematic capital data series, has severe impacts on the TFP estimation (Griliches and Jorgenson 1966, Andersen et al. 2011). We treat the capital data series as a latent variable and estimate it from the observed decision variables. The depreciation rate, instead of being assumed or calibrated, is a structural parameter to be estimated simultaneously with capital.

Second, we avoid the standard endogeneity problem in the production function estimation by applying a fully structural estimation approach. Indeed, the basic criticism of estimating TFP as a residual of the production function is the endogeneity problem caused by simultaneity. That is, the producers choose the inputs knowing their level of productivity, while productivity is not observed by econometricians. We do not suffer from this problem because we construct a full structural model in which all farm decisions are considered. These choices are decided by state variables such as price, productivity, interest and current capital, while the state variables are decided by last period states and exogenous shocks. The model form is a state-space model and no endogeneity issue is raised from the modeling process. Another well-known approach in solving the endogeneity problem is Olley and Pakes (1996) approach, but they do not correct for the capital measurement issues.

Third, our structural model is similar to the dynamic stochastic general equilibrium (DSGE) models in macroeconomics. The estimation technique for linearized DSGE models is highly developed (e.g. An and Schorfheide 2007). However, the agricultural producers may experience significant production risks from the climate. The increasing agricultural price fluctuations also result in larger price risks for the producers. We take the larger shocks into consideration by developing new nonlinear estimation techniques based on the Generalised Maximum Entropy (Golan et al., 1996).

Econometric estimation is performed on data for farms specialized in COP (cereals, oilseed and protein crops) production, covering the period 1988 to 2015. We account for the heterogeneity of farmers by selecting farmers in three French regions (Centre, Picardie and Pays de la Loire) where crop production is predominant. Our estimation results confirm that there are two regimes for output price: one regime 1988-2002 where the price volatility is low, and the other regime 2003-2015 where the price volatility is extremely high. We show that the estimated TFP grows steadily with small fluctuations in the first regime when prices were declining. The growth pattern becomes much more volatile following the increase in price volatility, and the upward trend in TFP growth become insignificant in the second regime. Above all, we find a negative causality between the price volatility and TFP evolution. Regarding the structural parameter estimation, we find a relatively higher level depreciation rate in agriculture (around 9-10%) compared to that in macroeconomics (2 – 3%). Our estimation also shows evidence on the existence of a medium level risk aversion for the farmers in these three regions.

Overall, price risk does have an impact on productivity in the way that when farmers are exposed to high price risks, they alter their decisions and production incentives, which in term affect negatively on the realized productivity. These new, preliminary, results add another level of complexity for the definition of the optimal CAP.

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