Report on UK Manufacturing Productivity

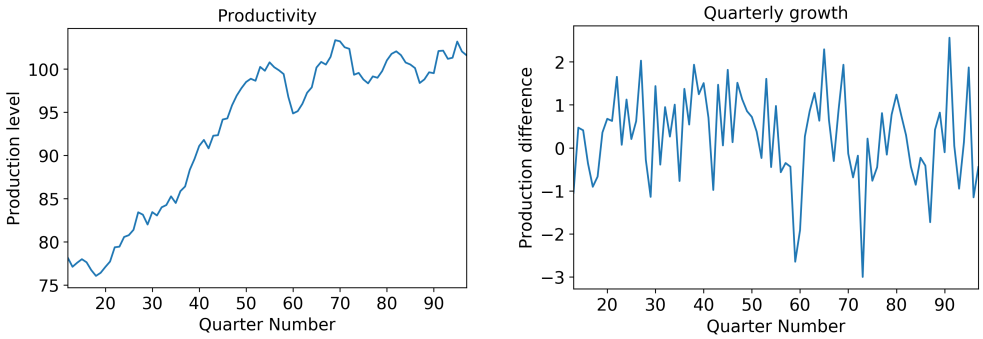
Lingyi Yang (based on reports by Renyuan Xu and Victor Wang)

December 9, 2020

Abstract

In this report, we investigate the possible autoregressive structure of the growth in manufacturing productivity in the UK ranging from 1997 Q1 to 2018 Q2. The goal is to analyse the trend and autoregressive structure of the quarterly productivity data, understand the impact from the financial crisis in 2008, and give predictions for the increase in productivity over 2019-20. We find that productivity is not stationary over time, there is no obvious autoregressive structure in the growth, and the growth behaviour is statistically different before and after the crisis.

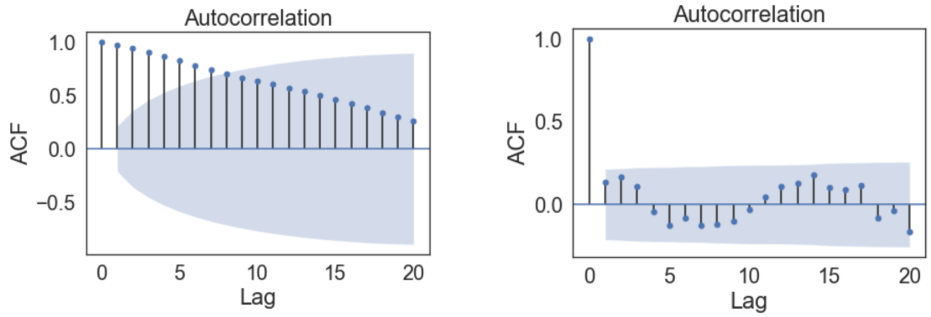
Data. We collected historical quarterly manufacturing productivity index from http://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/timeseries/a4ym/prdy during the period of 1997 Q1 – 2018 Q2.



(a) Quarterly Productivity. (b) Quarterly Growth.

Figure 1: Time series data of manufacturing productivity and its quarterly growth.

Stationarity. From Figure 1, we see a clear trend in the productivity time series hence it is non-stationary, but its first order difference looks stationary. A simple check is to look at the ACF plot in Figure 2. There appears to be unit roots in the productivity time series as its ACF is persistent across lags (otherwise its ACF should decay exponentially). We can test this formally checking for the presence of unit roots with the Augmented Dicky-Fuller test (with null hypothesis as the existence of unit root). We find that the productivity time series fails to reject the null at any conventional confidence level while the growth time series rejects the null at 99% confidence level. This is supported by the KPSS test.



(a) Quarterly Productivity.

(b) Quarterly Growth.

Figure 2: ACF of productivity and its growth (20 Lags).

Model Choice. Consider the ARMA(p,q) model family. We search over ARMA(p,q) models with $p \leq 6$ and $q \leq 6$ using the the `arma_order_select_ic` function. Both the AIC and BIC are used for model selection. The model ARMA(0,0) has the lowest AIC and BIC score. This seems to suggest that there is no significant autoregressive structure present in the time series. This agrees with what we see from the ACF (for choosing q) and PACF (for choosing p) plots.

Prediction. For the ARMA(0,0), the prediction is straightforward - the best guess would be the sample mean 0.276. How good is this prediction? The residuals series fails to reject the null hypotheses of both Ljung–Box test (the model does not exhibit lack of fit) and Jarque–Bera test (residuals do not violate normality assumption).

Global Financial Crisis. From Figure 1, we observe very different behaviours before (1997 Q1–2007 Q4) and after (2008 Q1–2018 Q2) the 2008 financial crisis. The growth becomes slower and more volatile. Is this difference statistically significant? We partition the time series into 2, prior and post the crisis given by the above ranges. We find the growth and check that the ARMA(0,0) model is still the best for each subset by BIC (note the AIC suggests ARMA(1,0) for post-crisis). We fit the ARMA(0,0) model to the two subsets and get sample means of 0.5261 and 0.0335 respectively. To test if they are statistically different, we use a 2-sample t-test. The test statistic is computed to be 2.170, which follows a t-distribution with 73 degrees of freedom (by the Welch–Satterthwaite approximation). The p-value is 0.0332, so we reject the null hypothesis (the two mean are the same) at 95% confidence level. Therefore, we conclude that the drift of the growth after the crisis is significantly lower than that before the crisis. The data is telling us, unfortunately, that the productivity growth in the UK has not yet been recovered from the shadow of the financial crisis after ten years.

Conclusion. To summarise, we find the productivity during 2007 Q1–2018 Q2 is not stationary, there is no obvious autoregressive structure among the growth, and the growth behaviour is statistically different before and after the 2008 financial crisis.