



Tsoukalas, J. and Görtz, C. (2018) Sectoral TFP news shocks. *Economics Letters*, 168, pp. 31-36. (doi:[10.1016/j.econlet.2018.03.001](https://doi.org/10.1016/j.econlet.2018.03.001))

This is the author's final accepted version.

There may be differences between this version and the published version. You are advised to consult the publisher's version if you wish to cite from it.

<http://eprints.gla.ac.uk/160982/>

Deposited on: 20 April 2018

Enlighten – Research publications by members of the University of Glasgow

<http://eprints.gla.ac.uk>

Sectoral TFP News Shocks*

Christoph Görtz
University of Birmingham

John D. Tsoukalas
University of Glasgow

March 2018

Abstract

We document a strong similarity in the macroeconomic effects of consumption-specific and investment specific TFP news shocks. This co-linearity suggests a diffusion channel of technological innovations from the investment to the consumption sector that forecast future changes in aggregate TFP. This finding connects two views of the literature on news shocks: aggregate TFP news and investment specific news.

Keywords: News shocks, Business cycles, VAR, Sectoral TFP.

JEL Classification: E2, E3.

*We thank Pierre-Daniel Sarte and an anonymous referee for very constructive comments. We also thank Hashmat Khan, Lilia Karnizova, Thomas Lubik, Felipe Schwarzman, Mark Watson and Tony Yates for extremely helpful comments and suggestions. We thank seminar and conference participants at the Richmond Fed, Carleton University, Canadian Economic Association (Ottawa 2016), European Economics Association (Geneva, 2016), American Economic Association (Boston, 2015). All remaining errors are our own. Christoph Görtz gratefully acknowledges financial support from a British Academy Small Grant and John Tsoukalas gratefully acknowledge financial support from Leverhulme Trust Research Project Grant RPG-2014-255. Görtz: University of Birmingham, Department of Economics, Email: c.g.gortz@bham.ac.uk. Tsoukalas (corresponding author): University of Glasgow, Adam Smith Business School/Economics, Email: john.tsoukalas@glasgow.ac.uk.

1 Introduction

Shocks to future aggregate TFP have been proposed by Beaudry and Portier (2006) as important sources of U.S. business cycles. This contrasts with a different view articulated by Ben Zeev and Khan (2015) which suggests a shift of focus from aggregate to investment-specific news shocks.¹ However, aggregate TFP is by construction a weighted average of investment specific and consumption specific TFP and hence shocks to the latter cannot be dismissed *a-priori* as an influential source of business cycle fluctuations.²

This paper provides new evidence on the macroeconomic effects of consumption- and investment-specific TFP news shocks that can synthesize both views. We document that VAR-identified news shocks to aggregate, investment-, and consumption-specific TFP exhibit qualitatively and quantitatively very similar dynamics on prices, quantities and asset prices. Specifically, each of these shocks, independently identified, is associated with a broad based increase in economic activity, the stock market and consumer confidence, as well as a decline in the relative price of investment (RPI), inflation and a credit spread indicator.

The timing of the responses to the sectoral shocks provides further insights into their propagation. We find that the statistically significant response of consumption-specific TFP occurs with a considerable delay (and is smaller in magnitude) compared to the statistically significant response of investment-specific TFP. Such a delayed pattern is also evident in the responses of the RPI. Specifically, while the RPI declines immediately following the investment-specific TFP news shock, it declines statistically significant in response to a consumption-specific news shock with a delay. Importantly, the timing of this decline coincides with the statistically significant increase in consumption-specific TFP. These timing patterns suggest diffusion of technologies from innovations that take place in equipment producing industries (investment sector) to faster TFP growth in equipment using industries (consumption sector).

¹For further work highlighting the importance of aggregate and investment specific TFP news shocks see the review by Beaudry and Portier (2014) and the references therein.

²The weights in the construction of aggregate TFP are the sectoral shares of value added which are (on average) 0.23/0.77 for the investment/consumption series. More detailed information on the weights is provided in Section 3.

Basu et al. (2013) provide new evidence on sector specific TFP shocks. They document that unanticipated consumption and investment specific shocks can have different macroeconomic effects. To the best of our knowledge, the only other studies concerned with sectoral TFP news shocks are Nam and Wang (2014) and Vukotic (2016). Nam and Wang (2014) demonstrate that the decomposition of aggregate TFP into its sectoral components matters for the interpretation of the effects of news shocks. Vukotic (2016) documents responses to TFP news shocks in the durables and non-durables industries in the US manufacturing sector, suggesting that an aggregate TFP news shock reveals information about future TFP of the durable manufacturing sector. Both studies broadly support the notion that future growth shocks that emanate in the durables sector are quite important for understanding aggregate TFP news shocks. These studies differ however in the identified economic effects of news shocks; while Nam and Wang (2014) find that investment specific news (which nests the durables sector) are key contributors to economic fluctuations, Vukotic (2016), provides evidence against this finding. Our study provides new valuable evidence on the propagation of news shocks by focussing on the diffusion of technology from the investment to the consumption sector and aggregate TFP.

The remainder of the paper is organized as follows. Sections 2 and 3 discuss data and econometric methodology. Section 4 reports results and section 5 concludes.

2 Data and estimation

We estimate the VAR using quarterly U.S. data for the period 1983:Q1–2017:Q1. We focus on the post Great Moderation era (mid-1980s onwards), informed by a wide body of evidence that points to important structural changes (including nature of shocks) in the economy, and evidence that suggests a proliferation of technological innovations in the 1980s and 1990s (see e.g. Basu et al. (2003)). We identify (i), an aggregate, (ii), a consumption specific (iii), an investment specific TFP news shock, one at a time, from the VAR model, adopting the Max Share identification method proposed by Francis et al. (2014). Our analysis will apply the method seeking for a news shock that maximizes its contribution to the

forecast error variance (FEV) of the aggregate or a sector specific TFP measure at a specific horizon (forty quarters) and does not move the respective TFP measure on impact.³ The aggregate, consumption, and investment specific utilization-adjusted TFP are provided by Fernald (2014) and serve as observable measures for technology.⁴ We estimate two different seven-variable VAR specifications for our analysis. Each specification will be used to separately identify each of the three news shocks explained above. Specification I uses one indicator of utilization adjusted TFP (either the aggregate or one of the two sectoral series), real per capita GDP, real per capita consumption (services and non-durables), per capita hours worked, BAA corporate bond spread, inflation and the Michigan consumer confidence indicator (E5Y). Specification II uses one indicator of utilization adjusted TFP (either the aggregate or one of the two sectoral series), real per capita GDP, real per capita investment (fixed private investment and consumer durables), per capita hours worked, relative price of investment (ratio of investment to consumption deflator), S&P 500 index and the E5Y. To estimate the VAR model we use three lags and a Minnesota prior. Consistent with the treatment in the empirical VAR literature (see e.g. Beaudry and Portier (2014)) time series in the VAR are used in levels.⁵

3 Properties of aggregate and sectoral TFP measures

The growth rate of aggregate TFP is an expenditure share-weighted average of the growth rates of TFP in equipment and consumer durables (the investment goods producing sector) and TFP in non-equipment business output (the consumption goods producing sector), where weights are the sectors' shares in value added (see Fernald (2014)). Table 1 reports statistics on aggregate and sectoral TFP growth measures. Not surprisingly, investment sec-

³We provide additional details and show robustness of our results using alternative identification methodologies in an online appendix available on the authors' websites, section B.1.

⁴In contrast to the related study by Nam and Wang (2014), we use a shorter sample, but importantly also the latest 2017 vintage for utilization-adjusted TFP which contains — unlike previous vintages — significant corrections on utilization from industry data following Basu et al. (2013).

⁵The VAR approach and the time series used are standard in the literature. Further details on time series construction and VAR estimation can be found in the online appendix, sections A and C. This appendix also shows that our results are robust to alternative maximization horizons of the variance in the news shock identification (section B.2) and alternative lag specifications in the VAR (section B.3).

tor TFP growth is both higher on average and more volatile compared to consumption sector TFP growth. The weak correlation (0.31) between the sectoral TFP growth rates points to a weak co-movement between the two series and therefore suggests that changes in aggregate TFP cannot be interpreted as a single homogeneous technological indicator (see also Basu et al. (2013) for corroborating evidence). Moreover, since the weight on investment sector TFP (0.23) is relatively small, by construction, moments of the aggregate TFP growth rate are largely determined by the properties of the consumption sector series. This dominance is also reflected in the correlation statistics: the aggregate TFP growth rate co-moves more closely with the growth rate of consumption-specific TFP (0.88) than the growth rate of investment-specific TFP (0.73), further suggesting that movements in the growth rate of aggregate TFP should be influenced significantly by the growth rate in consumption-specific TFP.

Table 1: Statistics on utilization-adjusted TFP data. Sample is 1983Q1-2017Q1.

	moments		correlations of growth rates	
	mean	stdev	I-sector TFP	C-sector TFP
Investment sector TFP growth rate	2.93	5.85	1	0.31
Consumption sector TFP growth rate	0.26	2.55	0.31	1
Aggregate TFP growth rate	0.91	2.72	0.73	0.88
I-sector TFP weight in aggregate	0.23	0.01		

4 Findings

Figure 1 displays impulse responses (IRFs) from specification I to an aggregate, investment-specific and consumption-specific TFP news shock. Quite strikingly, the dynamics induced by the aggregate or sectoral TFP news shocks are extremely similar to each other. Aggregate and sectoral TFP rises in a delayed fashion, and it becomes significantly different from zero

after several years.⁶ Each of the independently identified TFP news shocks creates a boom today: output, consumption, and hours increase significantly on impact, and they display hump-shaped dynamics. The BAA corporate bond spread declines significantly, suggesting that corporate bond markets anticipate movements in future TFP, consistent with the findings by Görtz et al. (2016) who highlight the importance of frictions in financial markets for the propagation of TFP news shocks. Moreover, confidence indicator (E5Y) increases in anticipation of the future rise in TFP, and inflation exhibits a short lived decline.

Figure 2 displays IRFs for VAR specification II confirming the striking similarity discussed above. Variables that are common in specifications I and II exhibit IRFs that are qualitatively and quantitatively similar. The response of investment is consistent with the overall broad-based rise in activity, and it rises significantly in response to good news about future TFP. The S&P 500 index also rises significantly in anticipation of the future rise in TFP, consistent with the evidence reported in Beaudry and Portier (2006). The RPI declines significantly in response to an aggregate or either sectoral TFP news shock. The investment specific news shock can be thought of as a supply of capital shifter and hence can theoretically generate a decline in the RPI. The surprising finding is that the consumption specific news shock, which can be thought as a capital demand shifter, is associated with a decline in the RPI. We provide an interpretation for this finding below.

Overall, these *a-priori* different sectoral shocks are qualitatively and quantitatively very similar to each other. Moreover, as evident from figures 1 and 2 the IRFs to the sectoral TFP news shocks are largely within the confidence bands of the IRF to the aggregate news shock. The only difference arises in the case of sectoral TFP, where the long-run response of the investment-specific TFP measure is larger compared to the long-run responses of either aggregate or consumption-specific TFP measures, a consequence of the significantly higher average TFP growth in the sample (see Table 1).⁷

⁶The initial drop in the median response of TFP, most notably in the consumption sector, may be rationalised by complementary investment that usually accompanies general purpose technologies and has a short run depressing effect on measured TFP. Evidence for this is provided in Basu et al. (2003).

⁷Appendix B.4 reports shares of FEV accounted for by sector specific and aggregate TFP news shocks derived from VAR specification II. We find that, beyond the first year, aggregate TFP news shocks account for over 20% and for most variables 40% of the FEV in all horizons, supporting their significance as a driving force of the business cycle.

Figures 3 and 4 display IRFs with confidence bands for the sectoral TFP news shocks discussed above. Two additional robust findings are worth highlighting: (i) in the short run, the expansion of investment-specific TFP is faster and larger in magnitude than the expansion of the consumption-specific TFP. For example, in Figure 4, investment-specific TFP rises significantly above zero after seven quarters whereas consumption-specific TFP rises significantly above zero after fourteen quarters. (ii) the decline of the RPI to the consumption-specific news shock becomes significant with a delay (see Figure 4), and this timing roughly coincides with the timing of the statistically significant increase in consumption-specific TFP. Since consumption-specific TFP largely determines the path of aggregate TFP, this pattern of long run co-movement between the RPI and consumption-specific TFP is consistent with the evidence of co-integration between aggregate TFP and the RPI reported in Schmitt-Grohe and Uribe (2011).⁸

Figure 5 confirms the strong co-linearity of sector-specific TFP news shocks. It displays scatter plots of sector-specific news (top panels) and unanticipated (bottom panels) shock time series for the two specifications of the VAR model.⁹ The top panels suggest a very strong correlation between sector-specific news shocks across the different specifications of the VAR model (0.97 and 0.97).¹⁰ By contrast, the bottom panels point to a weak correlation between sector-specific unanticipated TFP shocks across the different specifications of the VAR model (0.29 and 0.31), consistent with the weak correlation between the two sectoral TFP growth rates reported in Table 1.¹¹

The strong collinearity between sector-specific TFP news shocks in combination with

⁸In the on-line Appendix B.5 we report results from VAR specification II that includes both sectoral TFP measures at the same time. These VAR specifications allow us to examine more closely how a news TFP shock in one sector impacts TFP in the other sector. The findings suggest that TFP in the consumption sector always lags behind the significant increase TFP in the investment sector and therefore support the finding of technological diffusion from the latter to the former.

⁹Our identification method identifies the unanticipated TFP shock as the reduced form innovation of the TFP equation in the VAR. The TFP news shock is then identified as the linear combination of all the other reduced form innovations except the TFP reduced form innovation.

¹⁰The correlation between the sectoral and aggregate news shocks is also very strong, ranging between 0.90 and 0.95.

¹¹The weak correlation between sectoral unanticipated TFP shocks is consistent with the evidence in Basu et al. (2013) who argue for separate sector-specific technologies. We also tested for Granger causality to investigate whether there is evidence for a direction of causation between sector-specific TFP news shocks. We cannot reject the null of no Granger causality for all the different pairs of sectoral TFP news shocks identified from the VAR model.

the findings (i) and (ii) described above, favors an interpretation of technological spillovers, that is, innovations in new capital equipment produced by the investment sector that are adopted on a large scale basis by the consumption sector. This spillover is consistent with the delayed long-run decline in the RPI and the delayed increase in consumption sector TFP (in comparison to responses to the investment sector news shock). Basu et al. (2003) have documented, using detailed industry data, this type of spillover which typically characterizes general purpose technologies. They establish that innovations in information and communication technologies (ICT) in a set of equipment-producing industries, coincided with a decline in the price of ICT, and were associated with a strong TFP acceleration in industries that used ICT technologies in the 1990s. The majority of the ICT using industries were service-oriented, comprising a large fraction of the consumption sector.

5 Conclusion

We show that VAR identified sector specific TFP news shocks are highly collinear. We identify timing patterns in the sectoral TFP and RPI responses that are consistent with diffusion of innovations from the investment sector that materialize in higher TFP in the consumption sector and the aggregate economy. Our findings can therefore reconcile two views of the news shocks literature, namely, the importance of both aggregate and investment-specific TFP news shocks for U.S. business cycle fluctuations. In an important study, Basu et al. (2013) report that unanticipated consumption specific shocks have expansionary effects on economic activity consistent with our findings on consumption specific news shocks. However, they find that unanticipated investment specific shocks have depressing effects on economic activity, whereas we find that investment specific news shocks behave very much alike consumption specific news. A direct and close examination is beyond the scope of the paper but we note a key difference.¹² Our findings suggest that news TFP shocks predict a slow and widespread build up in TFP across both sectors in the future, a pattern which seems to be absent from the unanticipated technology shocks in Basu et al. (2013).

¹²It is important to stress that there are many parameters that differ between our study and theirs, namely, sample period, econometric methods, and frequency of sampling to allow a close comparison.

Our finding that news shocks may involve significant spillover across sectors indicates interesting directions for future research. Enriching theoretical models — which typically imply orthogonality across shocks — with a mechanism for technological diffusion and spillovers across sectors, may allow isolating the mechanisms through which expected innovations in one sector diffuse and enhance the expected productive efficiency of other sectors and the overall economy.

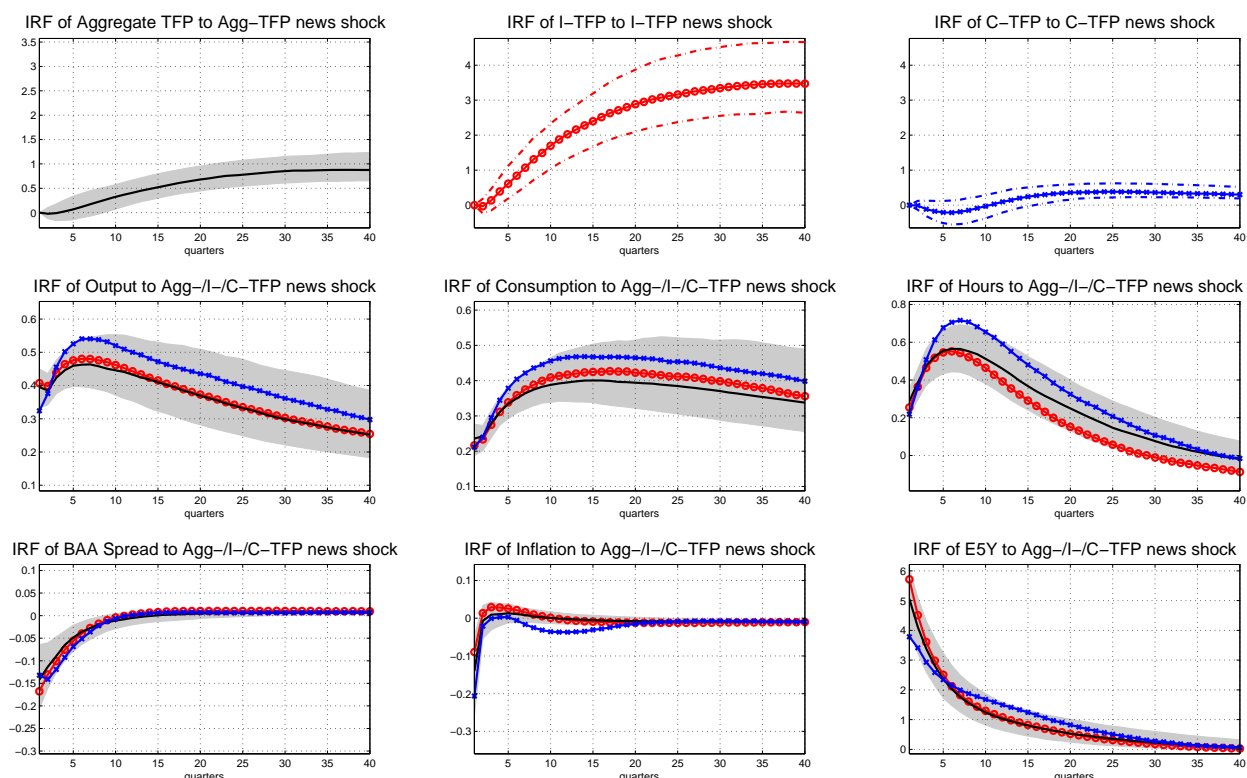


Figure 1: **Responses to aggregate and sector-specific TFP news shocks from 7-variable VAR, specification I.** Median responses to an aggregate (solid line), consumption- (blue line with crosses) and investment-specific (red line with circles) TFP news shock from a seven variable VAR. The shaded gray areas are the 16% and 84% posterior bands generated from the posterior distribution of VAR parameters corresponding to the specification with the aggregate TFP measure. The units of the vertical axes are percentage deviations.

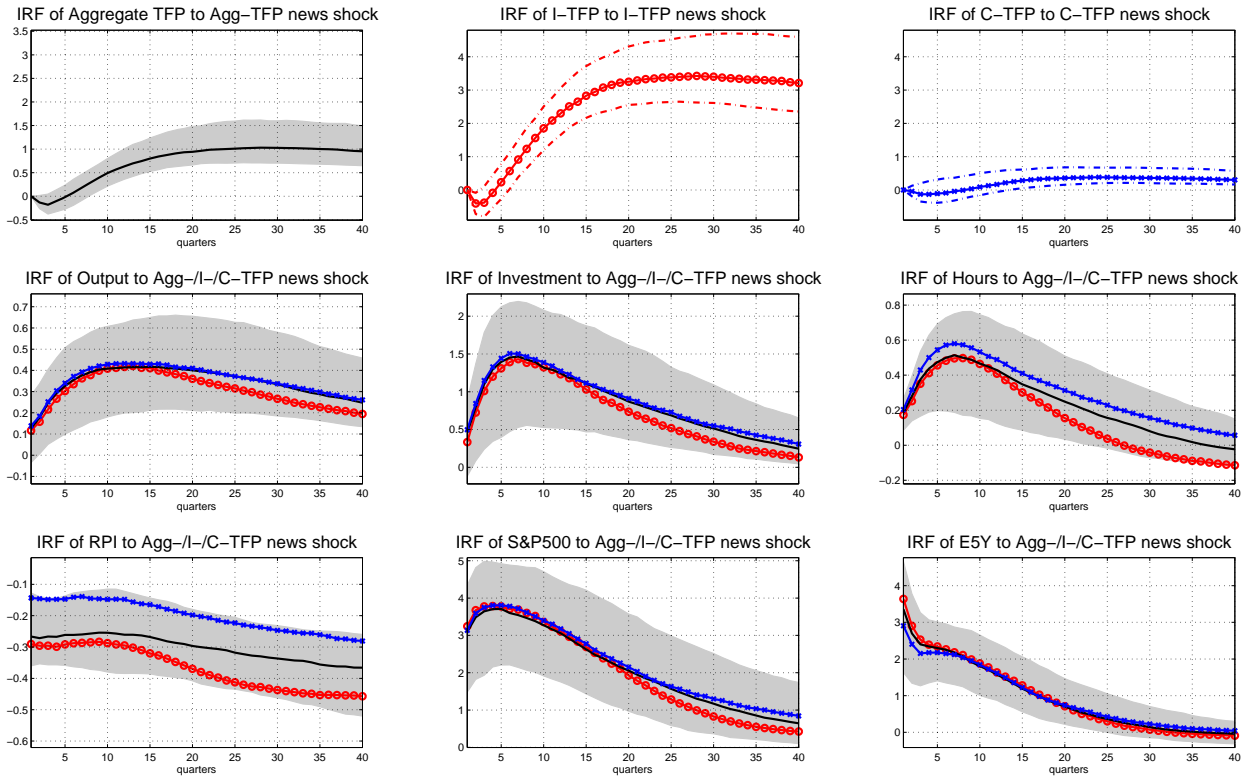


Figure 2: **Responses to aggregate and sector-specific TFP news shocks from 7-variable VAR, specification II.** Median responses to an aggregate (solid line), consumption- (blue line with crosses) and investment-specific (red line with circles) TFP news shock from a seven variable VAR. The shaded gray areas are the 16% and 84% posterior bands generated from the posterior distribution of VAR parameters corresponding to the specification with the aggregate TFP measure. The units of the vertical axes are percentage deviations.

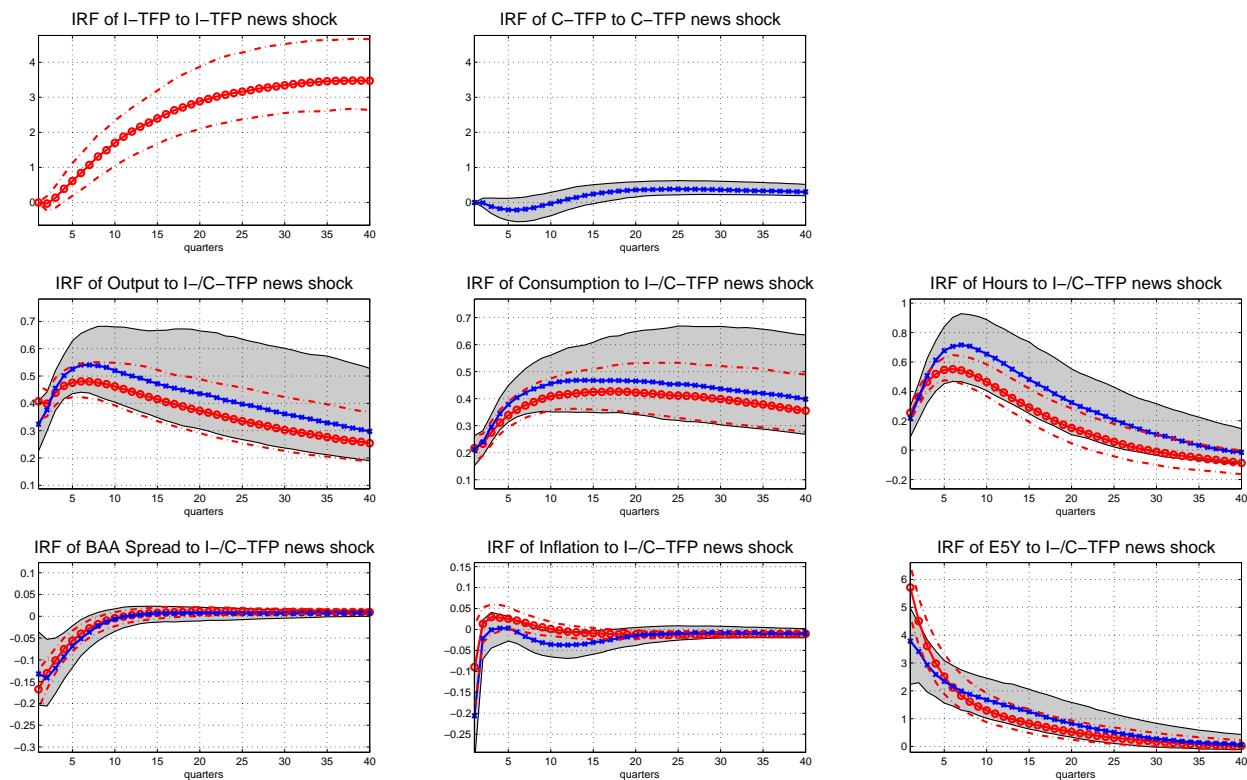


Figure 3: **Responses to sector-specific TFP news shocks from 7-variable VAR, specification I.** Median responses to a consumption- (blue line with crosses) and investment-specific (red line with circles) TFP news shock from a seven variable VAR. The shaded gray areas (red dash-dotted lines) are the 16% and 84% posterior bands generated from the posterior distribution of VAR parameters corresponding to the specification with the consumption sector (investment sector) TFP measure. The units of the vertical axes are percentage deviations.

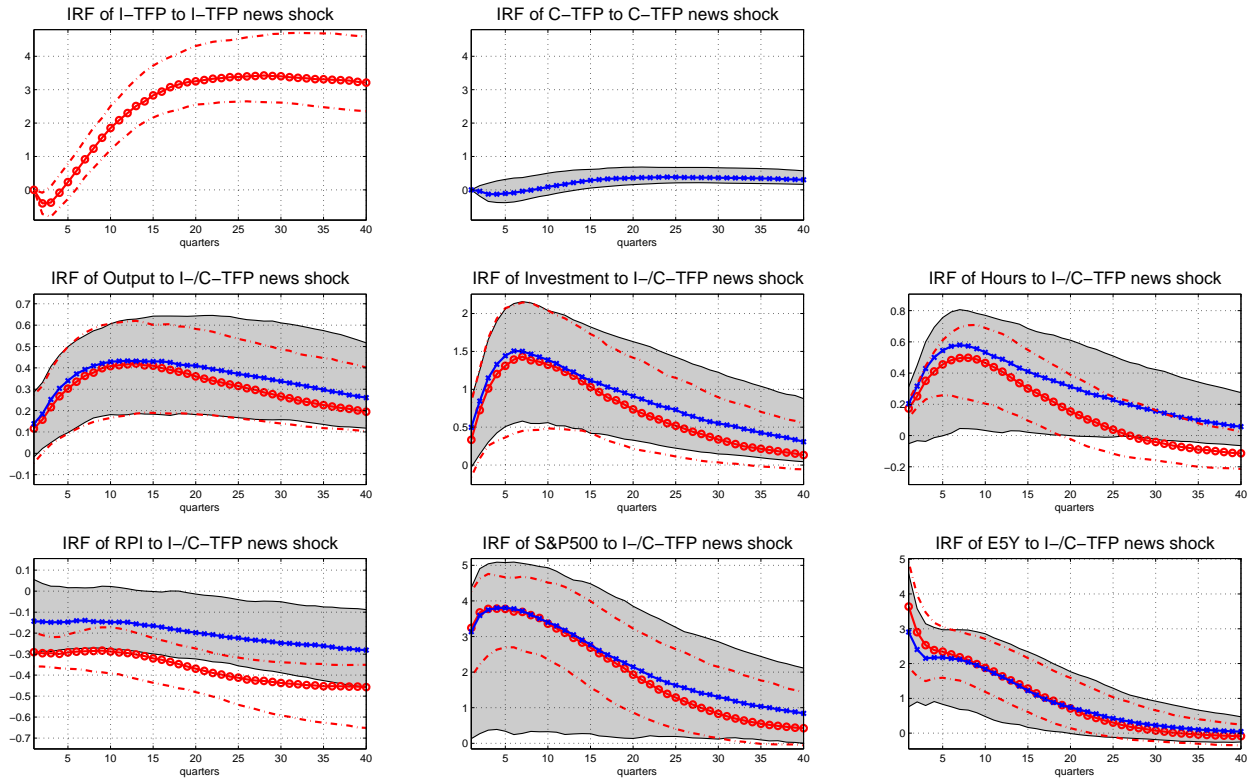


Figure 4: **Responses to sector-specific TFP news shocks from 7-variable VAR, specification II.** Median responses to a consumption- (blue line with crosses) and investment-specific (red line with circles) TFP news shock from a seven variable VAR. The shaded gray areas (red dash-dotted lines) are the 16% and 84% posterior bands generated from the posterior distribution of VAR parameters corresponding to the specification with the consumption sector (investment sector) TFP measure. The units of the vertical axes are percentage deviations.

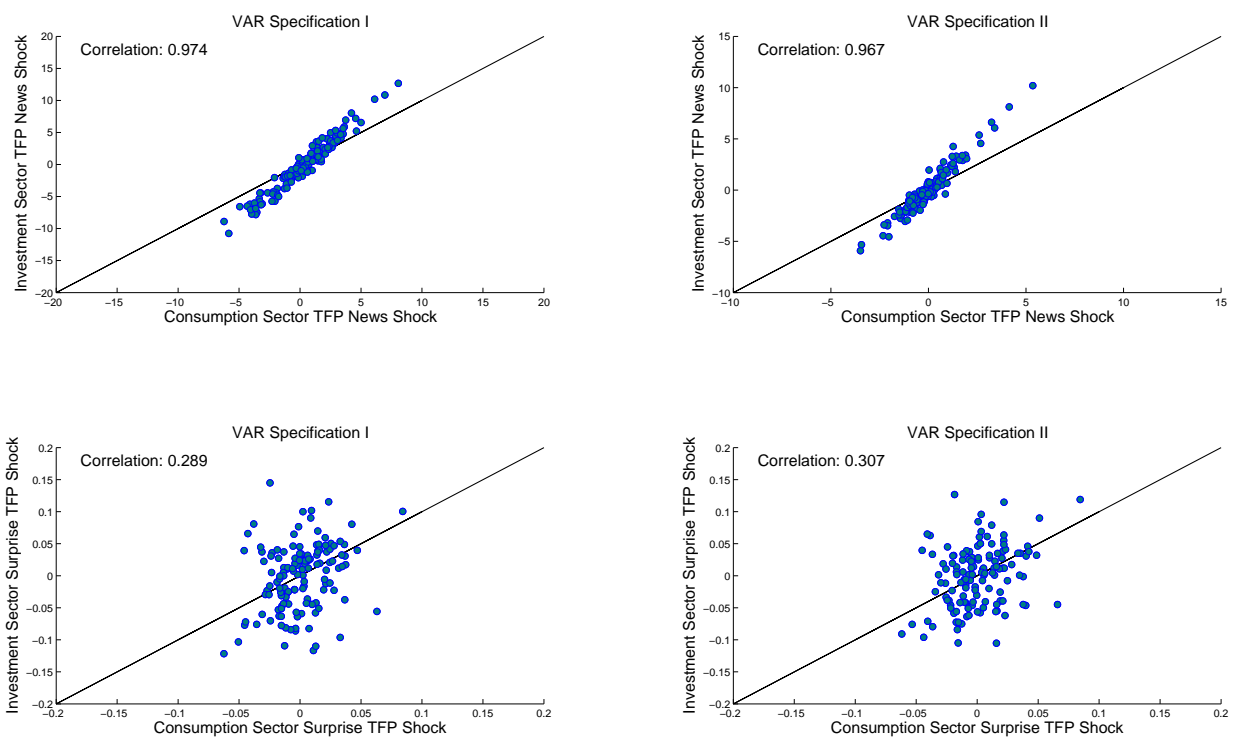


Figure 5: Scatter plots of the sectoral TFP news shocks from the VAR model (top panels) and sectoral TFP surprise shocks (bottom panels) for specifications I and II.

References

- Basu, S., Fernald, J., Fisher, J., and Kimball, M. (2013). Sector specific technical change. *Mimeo*.
- Basu, S., Fernald, J., Oulton, N., and Srinivasan, S. (2003). The case of the missing productivity growth: Or, does information technology explain why productivity accelerated in the United States but not the United Kingdom? *NBER Macroeconomics Annual*.
- Beaudry, P. and Portier, F. (2006). News, stock prices and economic fluctuations. *The American Economic Review*, 96(4):1293–1307.
- Beaudry, P. and Portier, F. (2014). News driven business cycles: Insights and challenges. *Journal of Economic Literature*, 52(4):993–1074.
- Ben Zeev and Khan, H. (2015). Investment Specific News Shocks and U.S. Business Cycles. *Journal of Money, Credit and Banking*, 47(8):1443–1464.
- Fernald, J. (2014). A quarterly, utilization–adjusted series on total factor productivity. *Working Paper*, (2012-19).
- Francis, N., Owyang, M., Roush, J., and DiCecio, R. (2014). A flexible finite-horizon alternative to long-run restrictions with an application to technology shocks. *Review of Economics and Statistics*, 96:638–647.
- Görtz, C., Tsoukalas, J., and Zanetti, F. (2016). News shocks under financial frictions. *University of Glasgow Working Paper*.
- Nam, D. and Wang, J. (2014). Are predictable improvements in TFP contractionary or expansionary? implications from sectoral TFP. *Economics Letters*, 124(2):171–175.
- Schmitt-Grohe, S. and Uribe, M. (2011). Business cycles with a common trend in neutral and investment-specific productivity. *Review of Economic Dynamics*, 14:122–135.
- Vukotic, M. (2016). Sectoral Effects of News Shocks. *mimeo*, University of Warwick.