NEWS SHOCKS, PRECAUTIONARY SAVINGS AND THE LABOUR MARKET

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Abstract

Recessions typically feature deteriorations in both economic expectations and consumption. This paper links the two by providing a transmission mechanism for TFP news shocks via a heightened precautionary savings motive. With the crucial feature of frictional labour markets, bad news reduces the vacancy posting incentive of firms which worsens the employment prospects of households. They then hedge against this by hoarding safe, liquid assets and reducing their spending, triggering a recession which exacerbates the labour market downturn. Robust evidence for this channel is presented through local projections and local projection-IVs. Results are consistent with a heterogeneous agent New Keynesian model.

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1 Introduction

The idea that expectations matter for equilibrium outcomes has been a central doctrine in macroeconomics dating back at least to the work of Pigou and Keynes in the early 20th century. From the former originates the concept of Pigovian cycles, where good news about the future creates an increase in economic activity today, as forward-looking agents modify their current behavior in response. This news-induced expansion is distinctly absent from the standard Real Business Cycle (RBC) model, which explains aggregate fluctuations through unanticipated innovations to productivity. As Figure 1 illustrates, the Great Recession - the longest and most extreme drop in economic activity since the Great Depression - provoked a renewed interest in the importance of Keynes' animal spirits which inherently refer to swings in expectations. It also illustrates that, using a measure of identified news shocks which will be a focus of this paper, the Great Recession featured a particuarly momentous negative news shock[1] in 2008Q4 - in fact, the most negative over the entire shock series 1948-2015. Another key feature of this recession was a significant decline in household consumption, which fell by around 4% in real per capita terms between 2008 and 2009. One source of such a decline is an increase in precautionary savings, where risk averse households, who fear future idiosyncratic employment risk, save more of their income today in order to accumulate a buffer against these shocks and enable consumption smoothing. As highlighted by Carroll et al. (2019), support for this idea comes from the dynamics of the personal savings rate, which rose by unprecedented amounts in the 2007-09 recession compared to its average deviation during downturns.

Precautionary saving is clearly a forward-looking concept, producing a natural connection with news shocks. This paper investigates the former as a transmission mechanism for the latter, with the labour market acting as the intermediary between the two. I first show, through the lens of local projections and local projection-IVs, that

[1] The news shock is the Beaudry and Portier (2006) shock identified in a bivariate VECM with impact restrictions.

labour market aggregates exhibit a strong contractionary response to 'bad news' shocks about total factor productivity (TFP), and these can explain a substantial proportion of business cycle fluctuations in these variables. Vacancy posting is a form of durable investment, and as such, bad news about the future induces firms to cut back on their vacancy posting due to the lower expected return. This worsens the labour market prospects of households and increases the level of idiosyncratic income risk as unemployment spells become more likely. Real non-durable consumption and real GDP also decrease sharply. Results of variance decomposition exercises suggest that news shocks can explain a large fraction of volatility in these aggregate variables over business cycle frequencies, especially vacancies and unemployment. While previous theoretical models, e.g. Jaimovich and Rebelo (2009), feature the supply side as the primary transmission process for news shocks via labour supply effects and adjustment costs, survey-based evidence suggests that the demand side is of prime importance which aligns with a consumption-centric mechanism. This set of findings is shown to be robust to a number of extensions and robustness tests.

Second, I present evidence which suggests that the precautionary savings channel encapsulates the transmission mechanism of news to aggregate fluctuations. I demonstrate this by examining the response of the price of volatile stocks - a proxy for aggregate precautionary saving. This drops immediately and substantially following bad news. I also examine the response of the AAA-BAA corporate bond spread, which captures movements in the premium investors are willing to pay for safety. The spread widens after a bad news shock, indicative of a general flight to safety that is associated with higher precautionary saving motives.

Finally, I reconcile these results in a heterogeneous agent New Keynesian (HANK) model with incomplete markets and frictional labour markets (Ravn and Sterk, 2017; 2018). In the model, a 'bad news' shock causes firms to post fewer vacancies, as they expect matches to be less profitable in the future, resulting in a lower chance of unemployed workers finding a job in the present. These worsening labour market conditions result in increased precautionary saving, as households cannot purchase state-contingent insurance contracts and only have the option of government-provided unemployment benefits which are well below the market wage. Price rigidity then causes declining goods demand to spillover to the firm-side as they cut back further on the number of vacancies posted and unwittingly amplify the shock further. The eventual result of a bad news shock is a large drop in output before the change in TFP is actually realised. This slump in output is also demonstrated to occur following a noise shock, despite TFP never actually changing. Crucially, it is shown that the contractionary response is greatly alleviated when markets are complete (eliminating the precautionary motive) and/or when labour markets do not feature search-and-matching frictions.

1.1 Related literature

The seminal work of Beaudry and Portier (2004; 2006) marks a natural starting point when looking at the modern literature on news shocks. They exploit the well-documented property that stock price innovations represent changes to the discounted sum of future profits and hence can be used as a mechanism to gain information about TFP news shocks. A vector error correction model (VECM) with TFP and stock prices is estimated with two different methods used to determine TFP news shocks - long- and short-run restrictions. Their results suggest significant anticipation effects are present, running contrary to the view of 'surprise' technology shocks emphasized in the canonical RBC model. Results also suggest that total hours and consumption both rise in response to these TFP news shocks and they can produce aggregate fluctuations. In fact, roughly half of the output variance can be explained by the Beaudry-Portier shocks at the ten quarter forecast horizon which indicates that they are a highly important determinant of business cycles. I use the Beaudry-Portier shocks as the measure of identified news shocks throughout Sections 2 and 3.

Barsky and Sims (2011) use a different identification strategy to attempt to recover news shocks. Their scheme utilises the maximum forecast error variance approach, identifying news shocks as those which are orthogonal to current changes in TFP and explain the highest proportion of TFP variance in the future. They estimate a SVAR with TFP, output, consumption and hours included. They find a contractionary impact response of hours and investment to a 'good news' shock, in contrast with Beaudry and Portier (2006) and more in line with the predictions of the standard RBC model. However, Beaudry and Portier (2014) show that, when stock prices are also included in the VAR, the expansionary response of hours, consumption and output re-emerges once again and closely mirrors those in Beaudry and Portier (2006). Ramey (2016) notes that the correlation between the Barsky-Sims and Beaudry-Portier shocks is very low at just 0.25, suggesting that each identification scheme recovers fundamentally different types of shock. Other papers which have demonstrated expansionary effects of news shocks include Beaudry and Lucke (2009), Beaudry et al. (2011) and Miranda-Agrippino et al. (2018).

This paper also dovetails with the work of Angeletos and La'O (2013) and Angeletos et al. (2018), who study the role of expectations via the diffusion of optimistic and pessimistic sentiment waves. They concentrate on the case where these changes to expectations occur independently of underlying fundamentals in the economy, which captures the idea of animal spirits in a form most literally alluded to by Keynes. Chahrour and Jurado (2018) prove an important observational equivalence result between news and noise, implying that the models with news shocks can be rearranged into an environment where agents receive noise-plagued signals about future economic fundamentals, highlighting the close link between the news shock and beliefs literature. Jurado (2016) finds a significant and roughly equal role for both news and noise in explaining output fluctuations in a rich estimated DSGE model which correctly distinguishes between the two[2]. Noise shocks are considered in the framework of the

[2]In Chahrour and Jurado (2018), it is shown that previous studies which attempted to do this such as Schmitt-Grohe and Uribe (2012) underestimated the quantitative importance of noise shocks.

theoretical model in Section 6.

News-induced expansions (Pigovian cycles) have been studied in other environments previously. As Beaudry and Portier (2004) illustrate, the standard RBC model cannot generate Pigovian cycles, as a 'good news' shock causes labour supply to contract contemporaneously because the current period becomes a relatively inefficient time in which to work, as agents anticipate that the returns to labour will be higher in the future. This causes output to contract from the production function. Several papers have outlined conditions under which Pigovian cycles are possible. Jaimovich and Rebelo (2009) show that with variable capital utilization, investment adjustment costs and a form of preferences which allows the strength of the wealth effect, through which the aforementioned labour supply contraction operates in standard RBC models, to be parameterised. They also examine a model extension where labour adjustment is costly, which is similar in spirit to the search-and-matching frictions I include. Den haan and Kaltenbrunner (2009) and Faccini and Melosi (2018) both study news shocks in models with search-and-matching frictions modeled explicitly, and both find that these environments are capable of generating expansionary movements in the labour market in response to a 'good news' shock. The output effects in Faccini and Melosi (2018) are negligible in the periods prior to the TFP increase realising however. This does not fit the estimated impulse response functions shown in Section 2, as these feature a much smoother change in output upon the arrival of the news. Markets are complete in all three of the preceding models also, and the precautionary savings channel is not examined as a channel for news shocks to feed through to real activity as is the case in the model presented in Section 4.

Several other papers emphasise the precautionary savings mechanism as being fundamental in amplifying different types of shocks. Ravn and Sterk (2017) focus on the impact of a shock to the job loss rate and show that the increased threat of becoming unemployed spurs employed workers to reduce their consumption, which triggers a contraction in economic activity when wages and prices are inflexible. Den haan et al. (2018) look at a similar feedback mechanism between the goods market and the labour market which occurs via precautionary saving as a result of unemployment risk. Guerrieri and Lorenzoni (2017) develop a model where a tightening of credit causes a substantial recession via heightened precautionary saving and consequent depressed aggregate demand. Beaudry et al. (2018) show that excess capital accumulation[3] can cause a precautionary savings motive to emerge as a liquidation in the durable goods sector spills over into the non-durable goods sector, with the labour market acting as the transmission mechanism as it does in my model. Heathcote and Perri (2018) look at the effects of liquid wealth levels on precautionary savings, and find that the effects of an expectations shock become strengthened when liquid wealth is low. The expectations shock is modeled through perfect foresight however, rather than being explicitly part of the environment as is the case in my model. Other papers such as McKay and Reis (2016; 2018), Ravn and Sterk (2018) and Bayer et al. (2019) also feature similar incomplete markets models with heterogeneous agents but focus instead on exploring different issues. Berger, Bocola, and Dovis (2019) provide a synthesis of the imperfect risk-sharing literature, demonstrating that the precautionary motive of households was an important contributing factor in the large drop in output between 2009 and 2010.

The rest of the paper proceeds as follows: Section 2 presents empirical evidence on the response of key macroeconomic variables to news shocks. Section 3 contains further evidence on the precautionary savings channel of news shocks. Section 4 describes the model, with its calibration described in Section 5 and results presented in Section 6. Section 7 concludes.

[3] News shocks, which end up not materialising, are briefly discussed as a potential source of the over-accumulation.

2 Empirical Evidence

In this section, I provide baseline results for the effects of news shocks on key labour market variables, output, consumption, inflation and the Federal Funds rate in order to assess the proposed transmission mechanism. Firstly, I examine the response of each variable in the set to a news shock through the lens of Jorda's (2005) local projection method. While Beaudry and Portier (2006, BP) examine the response of hours worked to news shocks, the response of additional labour market variables is not considered.[4] Focusing solely on hours worked gives a somewhat incomplete summary of the labour market as it ignores the inherent dynamics of the bilateral matching process between searching workers and firms and abstracts from the extensive margin of labour adjustment. Investigating the response of vacancies and employment can shed light on the transmission mechanism of news shocks to the labour market and the real economy. Secondly, I perform a variance decomposition exercise as I attempt to assess the contribution of news shocks to explaining business cycle fluctuations in the set of aggregate variables. Results of various robustness tests are also discussed.

2.1 Local Projections and Local Projection-IVs

In order to assess either the effect of news shocks on the variable set or their relative importance over the business cycle, a measure of identified news shocks are necessary. I focus primarily on the Beaudry-Portier shock identified with short-run restrictions (denoted as BPSR henceforth). This identification scheme captures news shocks by imposing an impact restriction on a VECM with TFP and stock prices, and so identifies a news shock as the change in stock prices orthogonal to current economic conditions. Long run restrictions are also used as an alternative means of identification (denoted as BPLR henceforth). As Ramey (2016) finds, both of the estimated BP shocks

[4] They find a significant, hump-shaped increase in hours worked in response to both the shocks which reaches a peak after roughly 5 quarters and persists for 10 to 12 quarters

exhibit neither serial correlation nor are Granger-caused by macroeconomic variables, suggesting that the shocks are unanticipated and are indeed news, meriting their choice in the estimation procedure that follows. While Beaudry and Portier (2006) also report an identification scheme where consumption is included as a third variable and a VECM is used, Kurmann and Mertens (2014) highlight issues with this system being unidentified. Beaudry and Portier (2014) show that the results of the bivariate specification are robust to the addition of additional variables, and provide an extensive discussion of the identification scheme. The series of both news shocks is extended beyond its original sample period of 1948:I - 2000:IV to end in 2015:III for the purposes of all further analysis.

To ascertain how variables respond to news shocks, I follow Jorda (2005) and estimate the impulse response functions (IRFs) directly over a range of horizons. While a VAR is often used to both identify the shock and produce the IRF, it can be advantageous to divorce the two procedures. This separation is particularly applicable in the case of the identification strategy considered here, as it is desirable to investigate the response of a large number of variables to a news shock without applying the restrictions that are necessary in the typical Cholseky identification of a VAR. The local projection (LP) method offers a means of estimating the IRFs for a large number of variables once a series of identified shocks has been obtained. An alternative strategy would be to estimate a trivariate SVAR with TFP, stock prices and a rotating third variable, impose a Cholesky identification scheme, and then estimate the IRFs. The disadvantage of this is that the shocks recovered in each specification would differ from each other, making results harder to compare across variables. It would also impose the additional identifying restriction that shocks to the third variable do not contemporaneously affect stock prices, which is not credible. As such, I choose to work with a consistent shock series and use the local projection method. There can be a potential tradeoff in the form of sacrificing the degree of precision in the estimates, as standard errors are often higher in a local projection relative to using a VAR, resulting in wider confidence intervals in the IRF (Ramey (2016), Miranda-Agrippino and Ricco (2018)).

Let ε_t denote the identified news shock in period t (the BPSR shock in the baseline specification), Y_i the relevant variable of interest and h the horizon length. The LP is then:

$$Y_{i,t+h} = C_i^h + \alpha_i^{h'} X_t + \beta_i^h \varepsilon_t + \sum_{k=1}^{4} \gamma_k t^k + \omega_{i,t+h}$$

The $h+1$ equations are then estimated by OLS for each variable in the set, with β_i^h giving the estimated impulse response of Y_i, h periods after a shock to ε_t. The parameter estimates are then plotted as a function of h to produce the IRF. $\upsilon_{i,t+h}$ is the error term, which will be serially correlated and thus necessitates the use of Newey-West standard errors with the autocorrelation lag in each individual equation chosen by the automatic bandwidth selection procedure of Newey and West (1994). X_t is a vector of controls, consisting of four lags of the following variables: the shock (ε_t), the dependent variable (Y_i), log real GDP and log real stock prices.[5]A quartic trend is also included. It may be tempting to be concerned about the generated regressor problem here, but as Pagan (1984) shows, generated residuals do not pose any complications for inference under the null hypothesis that the coefficients are equal to zero, meaning there is no need for an adjustment to the standard errors[6]. I set $h = 20$ and work with quarterly data. The variables of interest I choose to investigate initially are vacancies, measured as Barnichon's (2010) composite Help Wanted Index, unemployment, TFP, real non-durable consumption, real GDP, the CPI inflation rate and the Federal Funds rate. All variables, except the last two, are included in logs. Further labour market variables are then considered in Section 2.3. The sample period is 1951:I - 2015:III, and all data (apart from vacancies) is taken from the Federal Reserve Bank of St Louis (FRED), with monthly data transformed to quarterly frequency when necessary.

[5]Other studies using the local projection method, such as Coibion et al. (2017), merely include lags of the dependent variable as a control.

[6]I thank Matthew Read for useful discussions about this issue.

As a second specification, I also investigate a local projection instrumental variable (LP-IV) framework following Stock and Watson (2018), Fieldhouse et al. (2018)and Ramey and Zubairy (2018). Here, the BP shock is treated as an instrument for the true news shock in our estimation, which is advantageous for a number of reasons. Firstly, it allows for the BP shock to contain measurement error as long as it is correlated with the true news shock and uncorrelated with other shocks. Secondly, it allows us to directly examine the relevance of the instrument which is important for valid inference. Thirdly, as will become evident, this specification creates a clear link between the news shock and the subsequent change in TFP. Finally, it enables us to use the information contained in both the BPSR and BPLR shocks. The LP-IV is implemented via 2SLS in a procedure that follows Fieldhouse et al. (2018), who estimate the impacts of news shocks to federal housing agency purchasing activity. The first stage is given by:

$$TFP_{t+3} = \mu + \theta_S \varepsilon_t^S + \alpha \widetilde{X}_t + \sum_{k=1}^{4} \gamma_k t^k + u_{t+3}$$

Here we utilise the BPSR and BPLR news shocks to produce an instrument for future TFP at the three-quarter horizon by extracting the first principal component of the two shocks, denoted by ε_t^S . This is motivated by the fact that each shock provides separate information about future TFP, but they are quite highly correlated which makes a multiple instrument approach unattractive due to collinearity. Using this instrument yields a Newey-West robust F-statistic of 16.8 for the three quarter horizon - where it takes its maximal value. Results are not meaningfully different when either of the shocks are individually utilised as instruments or when similar horizons for future TFP are chosen. Figure 3A plots the robust F-statistic for the first stage regression for a range of horizons for TFP. Similar impulse response estimates are ultimately obtained for a range of other horizons around one year. $\widetilde{X_t}$ contains four lags of TFP and real GDP. The second stage regression then takes the form:

$$Y_{i,t+h} = C_i^h + \delta_h \widehat{TFP}_{t+3} + \alpha_i^{h'} \widetilde{X}_t + \sum_{k=1}^{4} \gamma_k t^k + \omega_{i,t+h}$$

Where we use the predicted values of forecasted TFP in three quarters from the first stage as a regressor and the controls include those used in the first stage with the addition of four lags of the dependent variable. The above regression estimates the h-quarter ahead response of variables Y_i to a time 0 TFP news shock. I rescale the coefficients such that the impact response of stock prices is equal in the LP and LP-IV specifications, allowing for direct comparability.

For expositional clarity, given the precautionary savings mechanism of interest, the impact of negative news shocks are displayed in the IRFs. With the Beaudry-Portier (BP) identification scheme, a 'bad news' shock amounts to a decrease in stock prices orthogonal to contemporaneous TFP. The shocks are also standardized in the LP case so that the IRFs represent a one standard deviation negative news shock. The results of the baseline LP specification are presented in Figure 2. The first two panels clearly illustrate the identification strategy, as stock prices fall on impact while TFP does not respond contemporaneously but gradually decreases over the subsequent quarters. It is clear that a 'bad news' shock generates a contraction in the labour market, as firms respond by cutting back on their vacancy posting, while more workers flow into unemployment. The responses of both variables is strong and precisely estimated, with meaningfully tight confidence intervals over the first 5 quarters following the shock. This is in spite of the previously noted tendency of IRFs computed from local projection to yield higher standard errors relative to using a VAR to estimate the IRF. The hump-shaped response of both variables is akin to the response of hours worked evident in the BP results. The timing is also very similar here as the peak of the shock's effect occurs after roughly 5 quarters - the point where BP find the response of TFP reaches its maximum. The increase persists for 10-12 quarters and, after this point, the response of both variables is not significantly different from zero.

Non-durable consumption and output also display a sizeable decrease, albeit in less of a parabola shape, with narrow confidence intervals. Interestingly, non-durable consumption responds immediately upon impact of the news shock, as the t statistic for $\beta^0_{nondurcons}$ is -3.38 with a corresponding p-value of 0.001. This suggests that the consumption-saving decisions of households are very sensitive to news, providing initial evidence of the precautionary saving channel of news at work. The β^0_i coefficient is also significant at the 5% level for vacancies which adds credence to the idea that firms adjust their vacancy posting in a highly forward-looking manner in line with the key mechanism highlighted in the theoretical model of Section 4. The fall in output is clearly larger than the fall in TFP, illustrating the general equilibrium effects of the news shock. The shock leads to a fall in the Federal Funds rate of around 20 bps at 3 quarters, while the response of inflation is not significantly different from zero over any of the short run horizon. Appendix A contains impulse responses estimated using the BPLR shock, and these remain extremely similar qualitatively.

Figure 3B presents IRFs for the LP-IV specification. Ultimately, results are robust to the alternative approach, with the contractionary response still very much present, and are extremely similar. Consumption exhibits a significant decline upon the realisation of the bad news, which again speaks to its relevance in the transmission mechanism. Unemployment and output both respond in a contractionary manner upon impact also as a downturn results. Vacancies decline to a slightly stronger degree than in the LP specification. The only variable which displays a significantly different response is the CPI, for which the IRF is entirely flat and imprecisely estimated in the LP-IV specification. Results from both specifications clearly show that a bad news shock leads to a significant contraction that is particularly pronounced in the labour market and in consumption.

2.2 Variance Decompositions

To quantify the overall importance of news shocks in explaining business cycle movements in the set of endogenous variables, I perform a forecast error variance decomposition (FEVD). I follow Ramey (2016) and perform this in a VAR with the BPSR shock, log real GDP and log real stock prices as a control. A quartic trend is included, four lags are used[7], and the shock is ordered first.

Figure 4 shows the results of the forecast error variance decompositions for each variable in the endogenous set, with bootstrapped confidence intervals computed for 500 repetitions. These demonstrate that news shocks are a powerful driver of fluctuations in both unemployment and vacancies - close to 55% and 50% respectively at business cycle frequencies. It therefore appears that the labour market is particularly sensitive to news. A considerable fraction of the forecast error variance of output (non-durable consumption) can be apportioned to the news shock also, as the shock explains roughly 35% (20%) over the same business cycle horizon. The shock is not an important factor in contributing to price level movements or Fed Funds rate variation.

Taken together, the results of the IRFs and FEV decompositions are illustrative of two key points. First, it provides evidence that the vacancy posting decision firms make comprises a strong forward-looking element and, as such, adjustments to expectations about the future are an important factor in explaining aggregate vacancy fluctuations. Second, the results suggest that the labour market is a key conduit for news shocks to ultimately impact on levels of real activity in the economy. The next section will further explore precautionary savings as a key component of the shock's transmission mechanism.

The robustness of these baseline results are tested with respect to a shorter sample length and an alternative identification of news shocks. Full details, including IRFs

[7] This is based upon results of lag selection tests using the Hannan-Quinn information criterion.

and FEV decomposition results, can be found in Appendix A. Results are ultimately shown to be robust to all of these. The effect of a confidence shock is also considered.

2.3 Labour market flows

To further examine the effect of news shocks on the labour market, I now consider the response of a set of labour market variables which are integral to capturing fluctuations in unemployment. For all of these I convert the monthly data from Elsby et al. (2015) to a quarterly frequency[8].

The first variable I consider is the flow hazard from unemployment to employment - the job finding rate. Standard search-and-matching models predict that a fall in vacancies posted should decrease the probability that workers are able to successfully match with employers, meaning we should expect to see a marked decrease in the job finding rate in response to a 'bad news' shock. As postulated by Elsby et al. (2009), fluctuations in unemployment outflows alone do not offer a full account of unemployment increases in recessions.

While the rate of unemployment inflow is assumed to be constant in the majority of the literature, this paper argues that movements in the rate of layoffs are key to understand cyclical unemployment fluctuations. Furthermore, Ravn and Sterk (2017) show that many salient features of the Great Recession can be explained by the rise in job losses which primarily occurred in 2008 and 2009. In light of this, I investigate the job loss rate as the second additional labour market variable. The final two transition rates I look at are flows from unemployment to nonparticipation, and vice versa. Elsby et al. (2015) stress the importance of a stock-flow approach to the participation rate, which subsequently yields a substantial implied role for this participation margin in

[8] They extend the time series of CPS data back to 1967 and implement several adjustments for various forms of measurement error.

contributing to unemployment fluctuations, with the two flow probabilities selected being of utmost importance.

The same structure is retained in the local projection which yields the estimated IRFs, while for the variance decompositions the shock is ordered first in the VAR with four lags and real stock prices as well as real GDP once again included as controls.

Figure 5 displays the IRFs produced from the local projections. The upper right panel clearly illustrates that the job finding rate displays a pronounced decrease after a 'bad news' shock is realised. This would be expected given the contractionary response of vacancies in Figure 3, as a looser labour market lowers the probability that a searching worker is able to match with a firm. The increase in the job loss rate depicted in the upper left panel would not necessarily be expected purely following previous results, however, as firms react to pessimism about future fundamentals by increasing the number of workers they layoff. Also of note is the response of the job loss rate on the shock's impact, as it is significantly different from zero (p=0.05), implying that firm's layoff decisions are particularly responsive to news. Recessions typically exhibit a sharp increase in the number of job losses at their onset, and the results here suggest that consequently news could play a crucial role in contributing to the early parts of economic downturns. The combined effect of a higher job loss probability and a lower job finding probability combine to result in a large spike in income risk, as unemployment spells become more likely.

The two nonparticipation margins display the cyclical movements which Elsby et al. (2015) allude to. After receiving bad news about the future, more workers enter the labour force as unemployed workers, while fewer unemployed workers flow out of the labour force. One possible theoretical explanation Elsby et al. give, and find some empirical support for, is the idea of the added worker effect. This refers to the tendency for nonparticipant individuals within a given household to look for a job in response to another member of the household losing theirs. If workers anticipate job losses following a news shock, it could be the case that this added worker effect kicks in prior to the job losses actually occurring. Regardless of the precise mechanism, the IRF results certainly suggest that the participation decision has a strong forward-looking component to it, mimicking the dynamics of the job loss and job finding rates.

Variance decomposition results are found in Appendix A. Over business cycle frequencies, news shocks contribute to a considerable proportion of variance in all four flows - around 20-25%. These results reinforce the idea that news shock produce a significant response in the flow transition rates, and are an important source of fluctuations in the labour market over the business cycle.

2.4 Survey-based measures

A key distinction between the proposed transmission mechanism presented here and others outlined in the literature is that the demand side is crucial, whereas the supply channel is normally the key conduit for news. For example, in Jaimovich and Rebelo (2009) bad news shocks are shown to generate recessions in a model which is an extension of the RBC framework to include three additional supply side factors: variable capital utilisation, investment adjustment costs and preferences which allow the wealth effect on labour supply to be calibrated. Any kind of demand channel is conspicuously absent and consumption only falls as a product of general equilibrium rather than as a direct response to the shock. It is essentially firms rather than households for whom the news is most relevant.

In order to provide empirical evidence on the relevance of the demand side of the macroeconomy for news shocks, I look at the response of a survey-based measures of household expectations. The Michigan Survey of Consumers is a US-wide, representative survey of 500 respondents each month, who are each asked 50 questions pertaining to their attitudes towards current and future economic conditions. The forward-looking element makes it well-suited to the context of news shocks, and a number of the questions asked have particular relevance to the concepts of precautionary saving and attitudes towards labour market conditions. First, I include the consumer expectations index in the local projection framework, which is a broad index compiled from the answers to multiple questions in the survey and gauges attitudes about future economic conditions. I then include the responses to a question in the Michigan survey regarding whether or not the respondent would consider the present period a good or bad time to purchase durable goods[9]. This is particularly informative about the demand channel, as spending on durables often represents larger purchases by households, while declines in durable consumption often represent a large component of the output loss in recessions[10]. Next, I include the unemployment expectations index, constructed in the same way as Carroll and Dunn (1997) - the share of surveyed consumers who believe unemployment will rise over the next year minus the share who anticipate it falling. This provides a useful measure of labour market expectations. The sample period is governed by when each of the questions were included in the survey, and is 1965:III-2015:III for the broad expectations index, and 1978:I-2015:III for the unemployment expectations index and durable purchase sentiment measure.

Figure 6 displays the estimated impulse responses for these three survey-based variables in response to a negative news shock. All three respond upon impact to the news, with all three measures becoming more pessimistic and the impact coefficients all significant at the 1% level. Consumers correctly anticipate higher unemployment in the subsequent year - recall from the benchmark results that unemployment rises in a gradual fashion and peaks around 5 quarters after the shock. This change in expectations is a key part of the transmission mechanism, as consumers are clearly unsurprised by the eventual deterioration of labour market conditions when this does

[9] The wording of the question is: "About the big things people buy for their homes--such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or bad time for people to buy major household items?"

[10] Berger and Vavra (2015) show that the decline in durable spending accounted for 24% of the 33% decline in real GDP between 2007-2009.

occur. The more general expectations index follows the same pattern, illustrating that the ensuing bout of pessimism is not limited to beliefs about the state of the labour market. While the response of the two expectations variables would be expected to some degree given the nature of the shock, the immediate change in the durable purchase sentiment measure is perhaps a little more surprising. Consumers immediately believe that the current period becomes a worse time to make durables purchase, indicative of a fall in demand. These sizeable responses from these surveys are suggestive of two things: expectations respond strongly to the news and household demand adjusts substantially.

3 The Precautionary Saving Channel of News Shocks

The results of the preceding section illustrate that the labour market is an important transmission mechanism for news shocks, while the expansionary response of output and consumption is also demonstrated. However, apart from the sharp impact response of consumption to a news shock, the results so far neither support nor rule out precautionary savings as a conduit.

In order to address this, asset markets are investigated - specifically the response of the excess return on safer assets and the price of volatile stocks - as movements in these variables can be illuminative of the mechanism.

3.1 Precautionary saving and asset markets

First, I examine a measure of the 'safety premium' from Krishnamurthy and Vissing-Jorgensen (2012), who use the spread between returns on BAA- and AAA-rated corporate bonds. The motivation behind this comes from the equal liquidity of the two assets, meaning that differences in their returns are solely driven by their differing levels of safety. The empirical default rate over a 10-year period is 8 percent for a BAA-rated bond and only 1 percent for the AAA-rated equivalent over the 1920-2004 period. An integral part of the precautionary motive comes in the form of a heightened desire for safe assets in response to a negative shock, as these more effectively enable risk-averse agents to smooth their consumption. A testable prediction which emerges consequently - if the precautionary mechanism truly is operative - is that bad news about the future should trigger an immediate rise in the safety premium. I include the BAA-AAA corporate bond spread from Moody's in the standard local projection framework, with sample period 1953:II-2015:III.

Next, I directly examine the response of a proxy for precautionary savings in the aftermath of a news shock. Pflueger et al. (2020) measure the level of aggregate precautionary savings by looking at the price of volatile stocks (PVS). They exploit the fact that, when perceived levels of risk are high, the subsequent precautionary savings motive pushes down the price of high-volatility stocks relative to low-volatility ones, and thus this price ratio can be informative for our purposes. Under our identification strategy, real stock prices change on the impact of a news shock by construction and a concern may therefore be that a news shock is also likely to move PVS by construction. However, the correlation between real stock prices and PVS is not statistically significant at any conventional level, so movements in the latter after a news shock can be considered to be genuinely informative about the precautionary savings motive. The same is true for the AAA-BAA corporate bond spread, for which we also cannot reject the null hypothesis of no correlation with stock prices[11]. Notably, there is also a distinct lack of correlation between the spread and the PVS measure. Note that lagged stock prices are also included as a control variable in the local projection,

[11] The correlation between real stock prices and the AAA-BAA corporate bond spread is -0.10. The p-value from a test of the zero-correlation null hypothesis is 0.13. The correlation between real stock prices and the PVS measure is -0.08. The p-value from a test of the zero-correlation null hypothesis is 0.30. The correlation between the AAA-BAA corporate bond spread and the PVS measure is -0.12. The p-value from a test of the zero-correlation null hypothesis is 0.11.

which further mitigates this concern. The PVS variable and the shock are once again included in the local projection and the sample period is 1970:II-2015:III.

The left panel of Figure 7 illustrates that the theorised rise in the safety premium after a bad news shock is present empirically, and occurs immediately upon the arrival of news. We can reject the null hypothesis that the impact coefficient on the spread is zero at the 10% significance level. This flight to safety results in a peak increase in the spread of 12 basis points one quarter after the shock. The IRFs estimated in the right panel of Figure 7 show that PVS exhibits a sharp and immediate decline in response to the shock ($p(\beta_0^{PVS} = 0) = 0.003$) as the precautionary savings motive is triggered, remaining depressed over the next 6 quarters before returning to its steady state value. Confidence intervals are once again tightly estimated.

The message of these two results taken together is clear: asset markets provide salient evidence that a bad news shock causes a significant and prolonged rise in the demand for safer assets and a fall in the demand for more volatile ones. Both of these features are consistent with a rise in precautionary saving.

4 Model

The model is a heterogeneous agents model with search-and-matching frictions in the labour market, nominal rigidities in the goods market and financial market frictions in the form of incomplete markets (Ravn and Sterk, 2017).

Households. There is a unit continuum of single-member households, indexed by $i \in (0, 1)$, who are risk averse, have an infinite horizon, and are either employed or unemployed in a given period t. Their objective is to maximise the expected present value of their utility streams according to their discount factor β. They gain utility from consumption and disutility from working.

If a household is employed, they earn a real wage W_t and lose their jobs with an exogenous probability ρ in each period. Unemployed individuals produce ζ units of the aggregate consumption good via home production. This is strictly less than the real wage, and so unemployed workers seek employment by searching in the frictional labour market. An unemployed worker successfully finds a job with endogenous probability η_t.

At the start of each period, new matches are formed between unemployed workers and vacant firms as hiring takes place. Production and consumption then occur. Following this, a fraction (ρ) of employed workers lose their jobs, and this constitutes the source of idiosyncratic income risk. It is not possible to purchase insurance against unemployment, and households must self-insure via government bonds in order to smooth consumption. Let $B_t(i)$ denote worker i's holding of government bonds in period t. The worker maximises utility subject to a budget constraint and a borrowing constraint in each period. The full household problem is then:

$$\max E_t \sum_{t=0}^{\infty} \beta^t [\tfrac{C_t(i)^{1-\sigma}}{1-\sigma} - \vartheta N_t(i)]$$

s.t.

$$C_t(i) + B_t(i) \leq N_t(i)W_t + (1 - N_t(i))\zeta + \frac{R_{t-1}}{\pi_t} B_{t-1}(i)$$

$$B_t(i) \geq B^{limit}$$

Substituting into the budget constraint:

$N_t(i) = 0$ if worker i is unemployed in period t,

$N_t(i) = 1$ if worker i is employed in period t.

The borrowing limit is given by B^{limit}, the gross nominal interest rate by R and finally the net inflation rate by π. $C_t(i)$ represents a CES aggregator of differentiated consumption goods:

$$C_t(i) = \left(\int_j (C_t(i,j))^{1-1/\gamma} dj \right)^{\frac{1}{1-1/\gamma}}$$

The elasticity of substitution between varieties of the consumption goods is given by γ and is strictly greater than one.

The problem of both employed and unemployed worker's can be summarised by a Bellman equation for each group. The Bellman equation for employed workers is:

$$V^e(B(i),\Gamma) = \max_{C(i),B'(i)} \left\{ U(C(i),N(i)) + \beta E(1-\rho(1-\eta'))V^e(B'(i),\Gamma') + \beta E\rho(1-\eta')V^u(B'(i),\Gamma') \right\}$$

subject to the budget constraint and borrowing constraint with $N_t(i) = 1$. Γ is the aggregate state vector. The Bellman equation for unemployed workers is:

$$V^u(B(i),\Gamma) = \max_{C(i),B'(i)} \left\{ U(C(i),N(i)) + \beta E\eta'(i)V^e(B'(i),\Gamma') + \beta E(1-\eta')V^u(B(i)',\Gamma') \right\}$$

subject to the budget constraint and borrowing constraint with $N_t(i) = 0$.

Production. There is a continuum of capitalists, indexed by $j \in (0,F)$, $F < 1$, who are risk neutral and own firms which operate in monopolistic competition. Entrepreneurs have the same discount factor as households and are the only agents entitled to the firm's earnings. They also consume and save, but face the same borrowing constraint as households. Firms produce a differentiated good with linear production technology:

$$Y_t(j) = A_t N_t(j)$$

where $Y_t(j)$ is the output of firm j in period t, A_t is aggregate TFP and $N_t(j)$ is the number of workers employed by firm j in period t. Aggregate TFP is exogenous and stochastic, with anticipated and unanticipated components. It follows the stochastic process:

$$log(A_t) = \phi_A log(A_{t-1}) + \Psi_t^A$$

$$\Psi_t^A = \varepsilon_t^A + \varepsilon_{t-4}^A + \varepsilon_{t-8}^A$$

where $\phi^A \in (-1, 1)$, $\varepsilon_{t-k}^A \sim N(0, \sigma_k^2)$ for $k = 0, 4, 8$. Following Chahrour and Jurado (2018), this can be re-written in an observationally equivalent noise formulation. In this framing, agents receive three signals, $s_{8,t}^A$, $s_{4,t}^A$ and $s_{0,t}^A$ about future realisations of the TFP shock, which are contaminated with noise:

$$s_{8,t}^A = \Psi_{t+8}^A + \upsilon_{8,t}^A$$

$$s_{4,t}^A = \Psi_{t+4}^A + \nu_{4,t}^A$$

$$s_{0,t}^A = \Psi_t^A$$

The noise shocks are denoted by $\upsilon_{8,t}^A$ and $\upsilon_{4,t}^A$. The response of the endogenous variables to both news and noise shocks will be considered in the model results.

The firm's employment evolves according to the law of motion:

$$N_t(j) = (1-\rho)N_{t-1}(j) + H_t(j)$$

with $H_t(j)$ denoting firm j's hires in period t. In order to hire workers, firms choose their number of vacancies, $v_t(j)$, which have a positive unit cost of κ. Any given vacancy is filled with endogenous, time-varying probability η_t^v and firms are large enough that this corresponds to the proportion of vacancies which result in hires. This leads to the following condition:

$$H_t(j) = v_t(j)\eta_t^v$$

Real marginal costs for firm j are given by:

$$MC_t = \left(\frac{1}{A_t}\right)\left(W_t + \frac{\kappa}{\eta_t^v} - \beta E_t\left[(1-\rho)\frac{\kappa}{\eta_{t+1}^v}\right]\right)$$

Price and wage setting. It is costly for firms to adjust the price of their good, $P_t(j)$, as they face Rotemberg-style quadratic price adjustment costs. Prices are set such as to maximise:

$$\max E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{P_t(j)}{P_t} Y_t(j) - W_t N_t(j) - \kappa v_t(j) - \frac{\theta}{2}\left(\frac{P_t(j) - P_{t-1}(j)}{P_{t-1}(j)}\right)^2 Y_t\right]$$

s.t

$$Y_t(j) = A_t N_t(j)$$

$$Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\gamma} Y_t$$

$$N_t(j) = (1-\rho)N_{t-1}(j) + H_t(j)$$

where P_t is the aggregate price level, $Y_t = \left(\int_j Y_t(j)dj\right)$ is aggregate output and W_t is the real wage. The parameter θ determines the extent of nominal rigidities present. The demand constraint emerges from the consumer's decision problem.

In symmetric equilibrium, relative prices are equal to 1 and marginal cost is equal across all firms, meaning the j index can now be dropped. The first-order condition for the firm's problem is:

$$1 - \gamma + \gamma MC_t = \theta\pi_t(1+\pi_t) - \theta\beta E_t\pi_{t+1}(1+\pi_{t+1})\frac{Y_{t+1}}{Y_t}$$

Wages are set in a Nash bargaining process between households and firms. The two parties bargain cooperatively with bargaining power which may be unequal. The problem is given by:

$$\max[V_t^e(i) - V_t^u(i)]^\chi (S_t^f)^{1-\chi}$$

where:

$$V_t^e(i) = \frac{C_t^e(i)^{1-\sigma}}{1-\sigma} - \vartheta + \beta E_t(1-\rho(1-\eta_{t+1}))V_{t+1}^e(i) + \beta E_t\rho(1-\eta_{t+1})V_{t+1}^u(i)$$

$$V_t^u(i) = \frac{C_t^u(i)^{1-\sigma}}{1-\sigma} + \beta E_t(1-\eta_{t+1})V_{t+1}^u(i) + \beta E_t\eta_{t+1}V_{t+1}^e(i)$$

$$S_t^f = \frac{\kappa}{\eta_t^v}$$

with $C_t^e(i)$ and $C_t^u(i)$ denoting the optimal consumption level chosen by an employed and unemployed worker respectively. The expression for S_t^f follows from the fact that, should the bargaining process fail, the firm would have to incur hiring costs of $\frac{\kappa}{\eta_t^v}$ to replace the worker. The first order conditions for the problem give the solution:

$$(1-\chi)[V_t^e(i) - V_t^u(i)] = \chi\left(\frac{\kappa}{\eta_t^v}\right)$$

Entrepreneur consumption-saving. The entrepreneur's Bellman equation that pins down their consumption-saving decisions solves:

$$V^{ent}(B^{ent}(j), N(j), \Gamma) = \max_{d(j), b^{ent'}(j), h(j)} \left[D(j) + \beta E V^{ent}(B^{ent'}(j), N^{'}(j), \Gamma^{'})\right]$$

s.t

$$D(j) + B^{ent'}(j) + WN(j) + \kappa v(j) = \frac{P(j)}{P}Y(j) - \frac{R_{-1}}{1+\pi}B^{ent}(j)$$

$$Y(j) = AN(j)$$

$$B^{ent}(j) \geq B^{limit}$$

where $D(j)$ and $B^{ent}(j)$ are the consumption and bond holdings of entrepreneur j respectively.

Labour market matching. The labour market features matching frictions a la Diamond-Mortensen-Pissarides. Timing is as follows in each period:

1. The aggregate labour market shocks realise.

2. Unemployed workers match with firms who post vacancies.

3. Production and consumption occur.

4. Job separations take place.

This timing structure implies that workers have the opportunity to search for a new job immediately after being separated from their previous one. Aggregate hires are determined by a Cobb-Douglas matching function:

$$M(u_t, v_t) = u_t^{\alpha} v_t^{1-\alpha}$$

with $\alpha \in (0,1)$, $v_t = \left(\int_j v_t(j)dj\right)$ and $u_t = 1 - \left(\int_j N_t(j)dj\right)$. The job finding rate and vacancy filling rate are given by:

$$\eta_t = \frac{M(u_t, v_t)}{u_t} = (\frac{v_t}{u_t})^{1-\alpha}$$

$$\eta_t^v = \frac{M(u_t, v_t)}{v_t} = (\frac{v_t}{u_t})^{-\alpha}$$

Monetary policy. Monetary policy follows a standard inflation-targetting Taylor rule:

$$R_t = \overline{R}\left(\frac{1+\pi_t}{1+\overline{\pi}}\right)^{\delta}$$

where $\overline{R}$ and $\overline{\pi}$ denote the steady state interest rate and inflation target respectively, while δ is a parameter reflecting how responsive the monetary authority is to inflation.

Equilibrium. Following Ravn and Sterk (2017), Heathcote and Perri (2018), McKay and Reis (2016) and much of the literature, the following borrowing constraints are imposed:

$$B_t(i) \geq 0 \forall i$$

$$B_t^{ent}(j) \geq 0 \forall j$$

These constraints imply that bonds are in zero net supply and the wealth distribution is degenerate. In equilibrium, both households and entrepreneurs live hand-to-mouth and simply consume their income in each period, implying there is no heterogeneity between households of the same employment status, allowing the i subscript to be dropped. The following conditions hold in equilibrium:

$$C_t^e = W_t$$

$$C_t^u = \zeta$$

The full set of equilibrium equations can be found in Appendix B. Four key equations characterise the model's equilibrium:

$$W_t^{-\sigma} = \beta E_t \frac{R_t}{1+\pi_t} \left\{ (1 - \rho(1-\eta_{t+1})) W_{t+1}^{-\sigma} + \rho(1-\eta_{t+1}) \zeta^{-\sigma} \right\}$$

$$MC_t = \left(\frac{1}{A_t}\right)\left(W_t + \frac{\kappa}{\eta_t^v} - \beta E_t\left[(1-\rho)\frac{\kappa}{\eta_{t+1}^v}\right]\right)$$

$$1 - \gamma + \gamma MC_t = \theta\pi_t(1+\pi_t) - \theta\beta E_t\left[\pi_{t+1}(1+\pi_{t+1})\frac{Y_{t+1}}{Y_t}\right]$$

$$R_t = \overline{R}\left(\frac{1+\pi_t}{1+\overline{\pi}}\right)^{\delta}$$

The first of these is the household's Euler equation for bonds. Idiosyncratic income risk shows up through the labour market variables which feature in the equation, meaning that deteriorating labour conditions stimulate precautionary savings[12]. While this does not show up in realised saving, due to the zero net supply of bonds, it does operate via adjustment in the real interest rate which then subsequently leads to changes in other endogenous variables. The second equation is the firm's real marginal cost and the third is its FOC for price setting. The presence of nominal rigidities mean that it is costly for firms to adjust prices and causes them to adjust real marginal cost by instead varying their hiring levels in response to changing demand conditions. The final equation is the Taylor rule, which pins down the nominal interest rate and ensures there is a unique, stable equilibrium.

5 Calibration

The time frequency in the model is quarterly to facilitate direct comparison with the empirical results. The model is calibrated to either match a steady-state target or

[12] Further discussion of the endogenous earnings risk wedge present in the Euler equation can be found in Ravn and Sterk (2018), who discuss conditions under which earnings risk is pro- and counter-cyclical. The presence of wage rigidity in the model means that earnings risk is counter-cyclical here, which Ravn and Sterk find to be the plausible case empirically.

according to microeconomic evidence. The discount factor, β, is set at 0.99, which implies a subjective discount rate of 4 percent per annum. The steady-state interest rate is below $\frac{1}{\beta}$ due to the presence of idiosyncratic income risk. The monetary authority targets a stable price level, resulting in $\overline{\pi} = 0$. The semi-elasticity of the nominal interest rate to deviations of inflation from target, δ, is set at 1.5, which is standard.

The coefficient of relative risk aversion is set to 1.5, and the vacancy posting κ is set to 0.19 as in Ravn and Sterk (2017). A key parameter in the model is ζ, as this determines the amount by which consumption decreases upon the transition from employment to unemployment. Chodorow-Reich and Karabarbounis (2016) estimate this decrease to be 21 percent empirically, while other studies have estimated it to be closer to 13 percent. I calibrate the parameter such that the average consumption drop falls in this range, at 18 percent. The price adjustment parameter, θ, is set to 58.7, which implies that prices adjust on average every 4 quarters. The elasticity of substitution,γ, is set at 6 which produces a steady-state markup of 20%. The elasticity of the matching function (with respect to unemployment) is set at 0.65 which falls in the upper part of the range estimated by Pissarides and Petrongolo (2001). The worker's bargaining parameter, χ, is set to 0.04 following Hagedorn and Manovskii (2008). This implies a realistic wage elasticity to TFP of roughly 0.34. The disutility of work parameter, ϑ, is set to target a steady-state unemployment rate of 6%. The TFP persistence parameter, ϕ^A, is set to 0.95, which is a standard value. The separation rate, ρ, is set to 0.044 which corresponds to a monthly unemployment inflow rate of approximately 1.5% from the CPS. Table 1 provides a full summary of the model's calibrated parameters.

6 Results

Baseline results. The model is solved numerically with a standard first-order perturbation method and IRFs for a -1% shock to ε_{t-4} and ε_{t-8} are computed. As Figure

8 shows, news shocks of both anticipation horizons cause a contraction in output. The mechanism is as follows: a drop in expected future productivity causes firms to post fewer vacancies. Hiring is a form of forward-looking investment, and lower expected TFP induces firms to curtail this, as the marginal benefit of posting a vacancy is lowered. This fall in vacancies decreases the probability of finding a job once unemployed. From the Euler equation, this generates a precautionary savings motive amongst households due to lower expected income. The desire to smooth consumption places downward pressure on nominal interest rates, and inflation consequently from the interest rate rule. From the New Keynesian Phillips curve, and as a result of nominal rigidities, marginal costs fall by further cutbacks in vacancy posting. This serves to deteriorate labour market conditions further, amplifying the shock. Before TFP changes, output falls due to the reduction in employment - a Pigovian cycle. The movement of output, is in line with the empirical results as it exhibits an immediate, hump-shaped decline as the news shock arrives. The response of unemployment, vacancies, consumption and the nominal interest rate also echo the movement pattern seen in the estimated IRFs. The only variable which does not match up is inflation, which declines following a bad news shock in the model but is more or less unmoved in the empirical results.

The role of precautionary savings and labour market frictions. In order to isolate the precise roles of precautionary savings and frictional labour markets, it is instructive to look at two counterfactual economies. In the first, there is complete markets which eliminates all idiosyncratic risk, while search frictions remain present in the labour market. In the second, there is a spot labour market where the transition rates between emplోment and unemployment are fixed and exogenous, but markets are incomplete. Full details of these models can be found in the Appendix C, but the respective Euler equations are:

$$C_t^{-\sigma} = \beta E_t \frac{R_t}{1+\pi_{t+1}} C_{t+1}^{-\sigma}$$

$$W_t^{-\sigma} = \beta E_t \frac{R_t}{1+\pi_t} \left\{ (1-p^{eu})) W_{t+1}^{-\sigma} + p^{eu} \zeta^{-\sigma} \right\}$$

In the first economy, there is full risk-sharing, which means that deteriorating labour markets do not directly affect the consumption-saving decision. In the second economy, idiosyncratic risk is entirely exogenous (p^{eu} denotes the probability of job loss a worker faces each period), meaning there is still a precautionary savings motive but firms and workers can match with other in a frictionless manner each period.

Figure 9 compares the IRFs for consumption and output in these two economies to the baseline results. In the complete markets economy, labour market frictions mean that firms still have a reduced incentive to post vacancies after a bad news shocks, as their labour demand falls in response to poor expected future conditions. This leads to a lower level of employment, reducing output and consumption via general equilibrium effects. The shock is not amplified beyond the firm's vacancy posting decision, as the lower job finding rate does not have a spillover effect on the consumption-saving decision of households as they are insured against the risk of joblessness. For this reason, the magnitude of the output drop is dramatically lower than in the baseline economy. These results dovetail with the results in Section 3, which show that, when levels of wealth are lower in the economy and households are less insured against income losses, news shocks have higher potency.

In the economy which features frictionless labour markets but retains idiosyncratic risk, the sign of the output response is reversed as a bad news shock leads to a counterfactual boom in the periods prior to TFP changing. This is because the effect the shock has on labour supply - bad news makes today a relatively efficient time for households to work, shifting the labour supply curve outwards. This increases employment and output subsequently from the production function. As firms are able to hire and fire workers costlessly each period, the labour demand decision is not forward-looking and is not influenced by expectations of future productivity. It is not until TFP actually falls that firms reduce their labour demand and output falls. This lack of an immediate downturn in the labour market means that levels of idiosyncratic risk do not change for households, and the strength of the precautionary motive stays constant.

Noise shocks. As illustrated in Section 4, the news shocks can be re-framed as noise shocks in an observationally equivalent manner following Chahrour and Jurado (2018). Figure 10 presents the IRFs for output, consumption, unemployment and vacancies following a -1% noise shock relating to TFP 4 quarters ahead. These show that the expectation that TFP will be lower in the future causes the same contractionary response upon the realisation of the shock as in the news framework. When firms realise that their pessimistic expectations have not been borne out in reality, they restore their level of vacancy posting slightly above its steady state level to compensate for the workers they have foregone due to paused hiring. The presence of search-and matching frictions in the labour market mean that unemployment adjusts sluggishly, taking an additional 6 quarters to return to its steady-state value. This leads to a depressed job finding rate which persists, producing a heightened precautionary savings motive amongst employed workers. This causes consumption and output to also take an extended period of time to return to their normal levels. These results highlight that pure 'animal spirits' shocks can produce a deep recession and slow recovery via the interaction of the two key mechanisms in the model, and could potentially be informative as to why the US economy experienced such a sluggish transition back to normal employment levels following the Great Recession. They also closely match the estimated IRF of a confidence shock investigated in the Appendix (Figure A6).

7 Conclusion

Evidence has been presented to suggest that news shocks are a key feature of business cycles. The key message of this paper is that two ingredients are key to the considerable impact of news: precautionary savings and frictional labour markets. After a bad news shock, the labour market experiences a pronounced downturn, operating through the forward-looking vacancy channel. Empirical results suggest that a large fraction of volatility in vacancies and unemployment can be attributed to news shocks. This increase in uninsurable unemployment risk causes households to hedge against the anticipated loss of expected income by reducing consumption immediately. Asset market evidence point towards the existence of this precautionary savings transmission mechanism. The theoretical heterogeneous agent New Keynesian model presented was able to generate responses of key variables which echo those seen in the data. The combination of incomplete markets and labour market frictions were shown to be crucial for news to generate aggregate fluctuations. Noise shocks were shown to induce a persistent slump in unemployment, consumption and output despite the anticipated TFP decrease never being realised.

These empirical and theoretical results have clear policy implications. Automatic stabilisers, namely the extension of unemployment benefits, operate upon the realisation of depressed labour market conditions. When all shocks are unanticipated, this stabilisation mechanism may be effective at propping up the spending of those who *experience* job loss. However, if shocks are anticipated, households may respond to bad news about the future by cutting back on their spending for precautionary reasons as they *fear* job loss.

Results presented suggest this mechanism is indeed prevalent, and could hamstring automatic stabilisers as they are triggered belatedly - too late to prevent a drop in consumption. This can then induce firms to cut back on their hiring, setting in motion a dangerous contractionary feedback mechanism. Stabilisation policies which react to the news directly and aggressively can help to nip this propagation in the bud.

This paper opens up several areas for possible future exploration. While the model was kept simple and tractable in order to clearly illustrate the key mechanism at play, several salient features could be added in order to further understand how news affects agents' behaviour. Firstly, the model abstracted from the zero lower bound on interest rates, which was a defining characteristic of the Great Recession. As both the empirical and theoretical results demonstrate, bad news puts substantial downward pressure on interest rates due to the inter-temporal substitution by households and the central bank's abidance by a Taylor rule. This acts as a dampener on the shock. When rates cannot fall any further and this shock absorber is not active, the magnitude of the impacts would be greater. In the future, I plan to investigate this quantitatively in a DSGE model estimated with Bayesian methods in order to shed light on the exact contribution of news and noise in the Great Recession. Secondly, the model does not incorporate an explicit role for firm entry and exit. An abundance of recent research, e.g. Sedlacek and Sterk (2017) has shown that this is an important element of the business cycle. Intuitively, there are many reasons to believe that the firm entry/exit decision has a strong forward-looking component to it. Its sensitivity to news and noise would be an interesting avenue to explore in further research.

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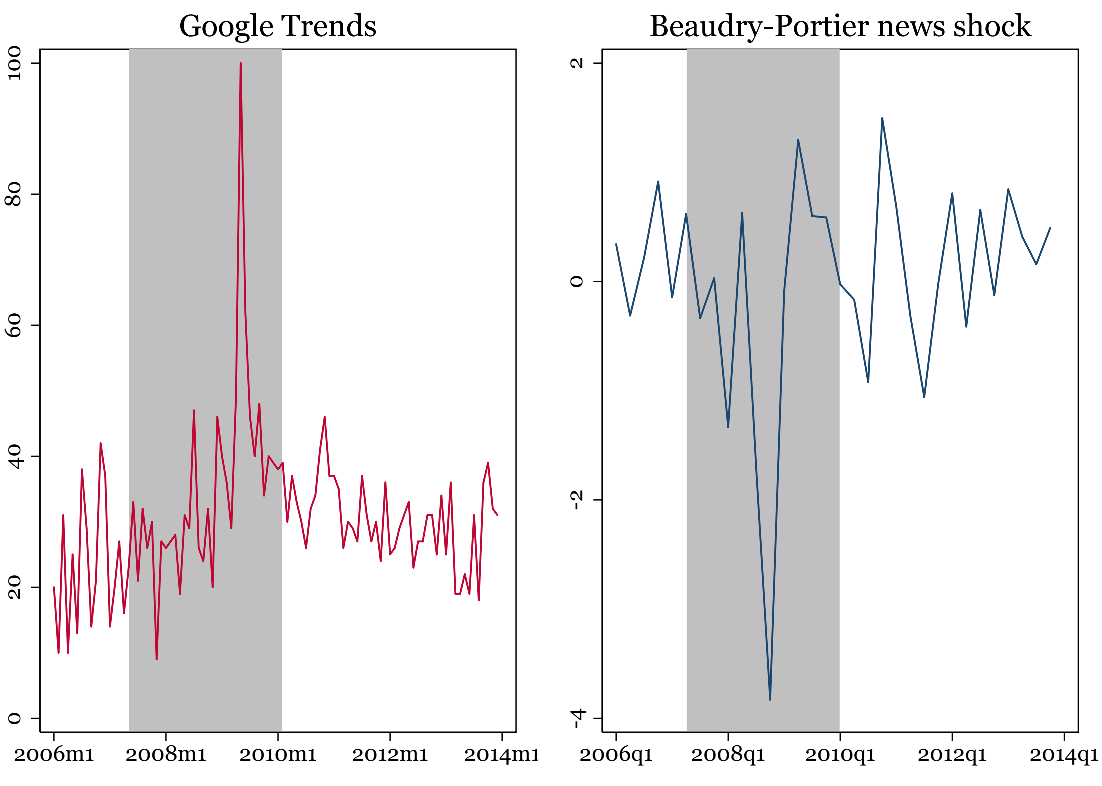
Table 1: Parameter values

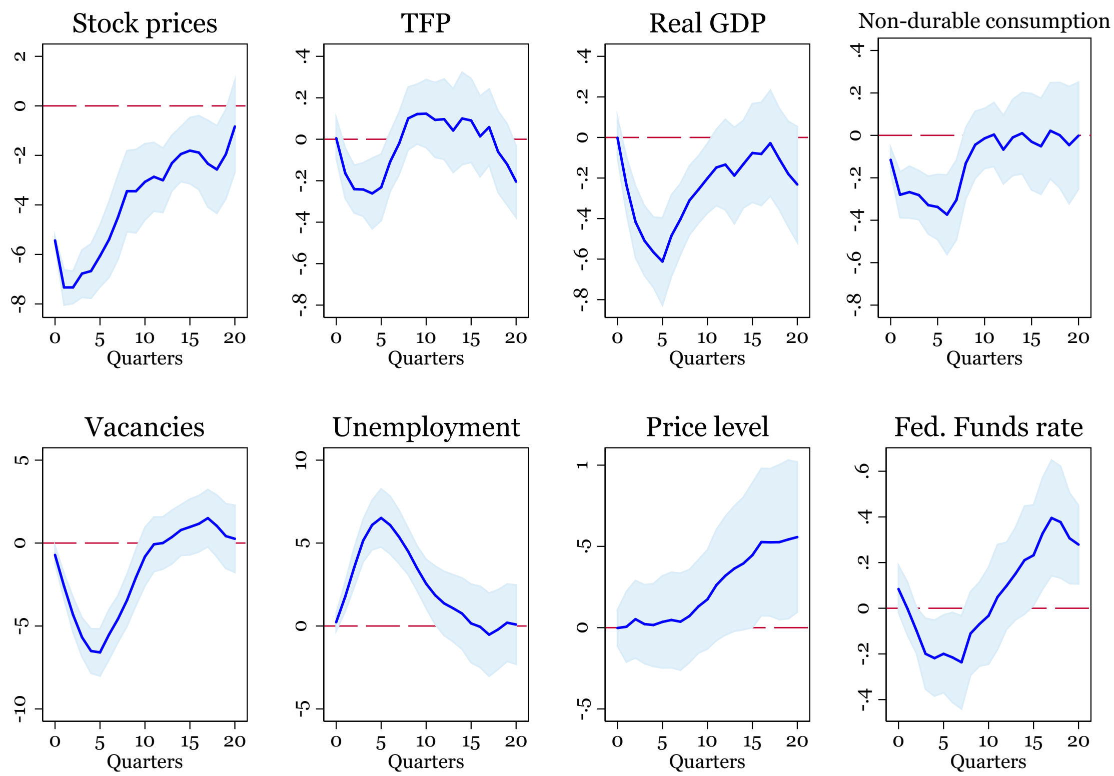
Parameter	Value	Target/Source
β	0.99	Subjective discount rate of 4% per year
σ	1.5	Ravn and Sterk (2017)
ζ	0.68	Consumption loss of 18% upon unemployment,
		Chodorow-Reich and Karabarbounis (2016)
θ	58.7	Average price duration of 4 quarters
γ	6	Steady-state markup of 20%
κ	0.19	Ravn and Sterk (2017)
ρ	0.044	Monthly unemployment inflow rate of 1.5% from CPS
ϑ	0.225	Steady-state unemployment rate of 6%
χ	0.04	Hagedorn and Manovskii (2008)
α	0.65	Pissarides and Petrongolo (2001)
δ	1.5	Standard value
$\overline{R}$	1.005	Steady state annualised nominal interest rate of 2%
$\overline{\pi}$	0	Zero steady-state inflation
ϕ^A	0.95	Standard value

Figure 1: The index of Google searches for the term 'animal spirits' 2006-2014 (left hand panel) and the standardised series of news shocks 2006-2014 (right hand panel)



Note: The grey bar denotes an NBER recession. Source for left hand panel: Google Trends data. The standardised series of news shocks are the Beaudry and Portier (2006) shocks identified with short run restrictions on a bivariate VECM.

Figure 2: Estimated IRFs from a local projection for the initial set of dependent variables to a negative Beaudry-Portier news shock.



Note: The light blue shaded area denotes the 90% confidence intervals.

Figure 3A: Newey-West robust f-statistics from the first stage of the lp-iv by horizon of tfp.

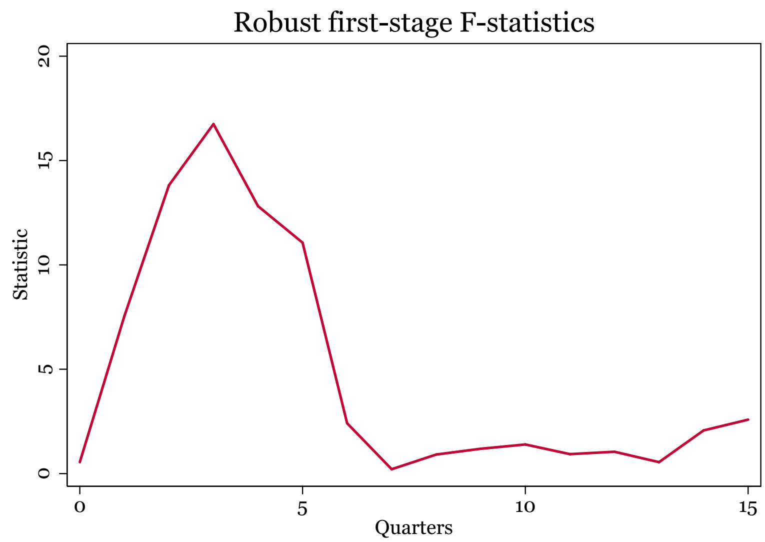
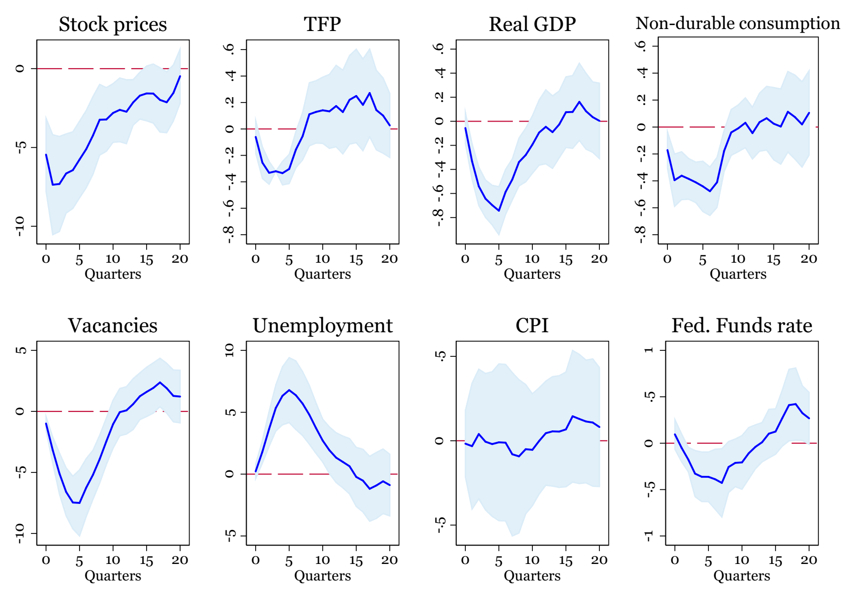


Figure 3B: Estimated IRFs from the lp-iv variables to a negative Beaudry-Portier news shock.

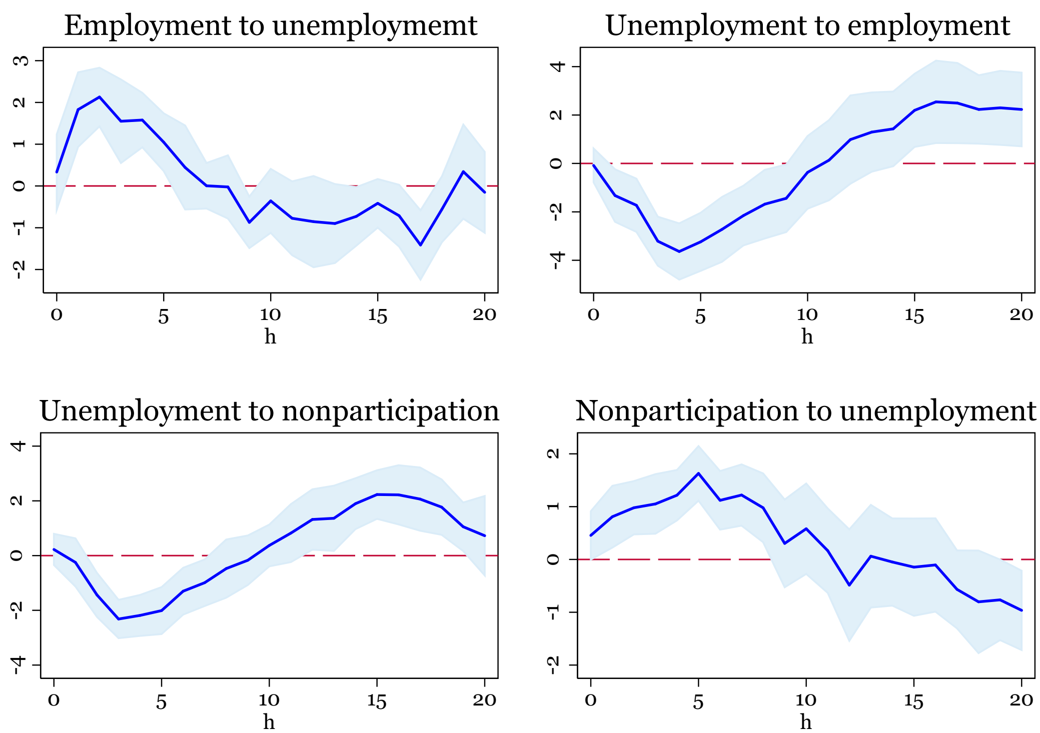


Note: The light blue shaded area denotes the 90% confidence interval at each horizon.

Figure 4: Results of forecast error variance decompositions.

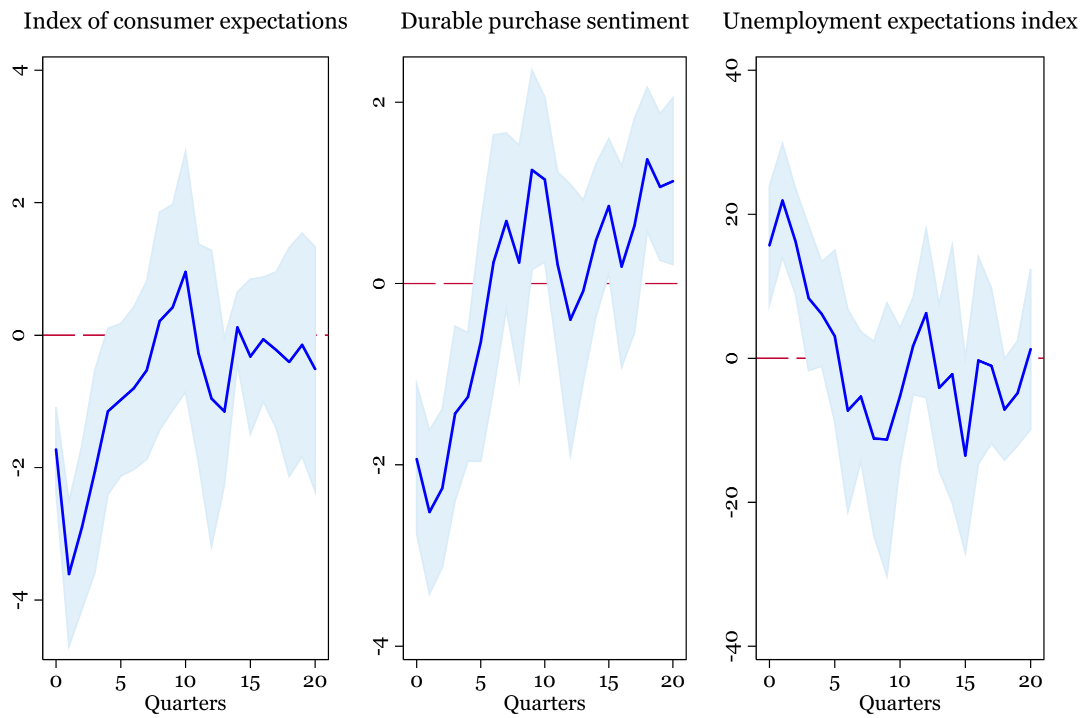
Note: The light red bands denote the 68% confidence intervals computed from a bootstrap procedure.

Figure 5: Estimated IRFs from a local projection for the four labour market flow variables to a negative Beaudry-Portier news shock.



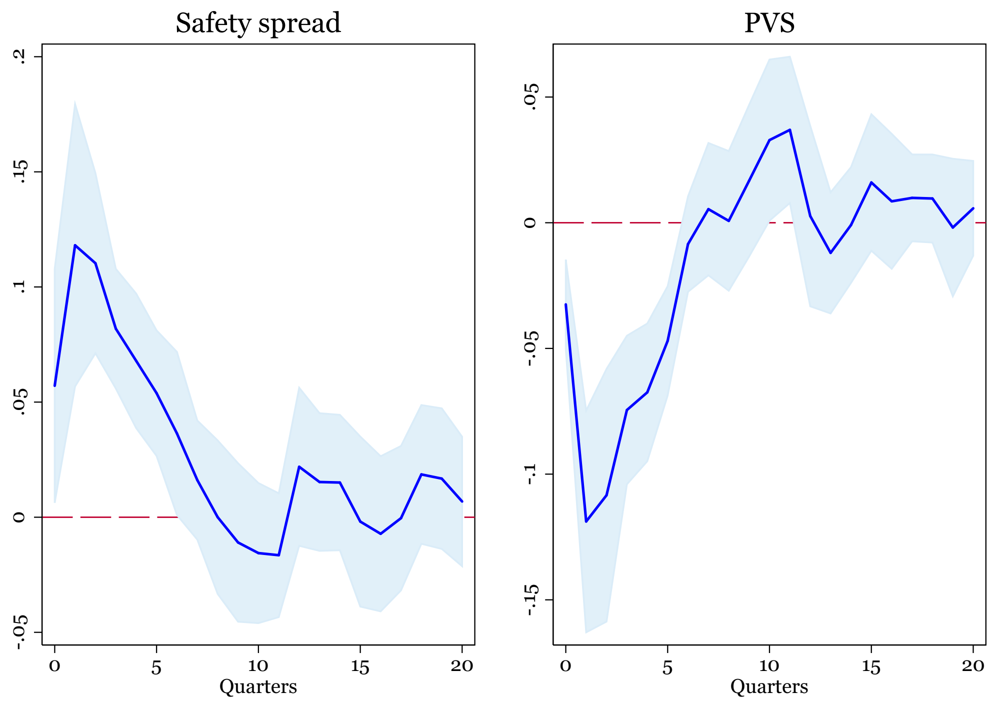
Note: The light blue shaded area denotes the 90% confidence interval at each horizon.

Figure 6: Estimated IRFs from a local projection for the three survey-based variables to a negative Beaudry-Portier news shock.



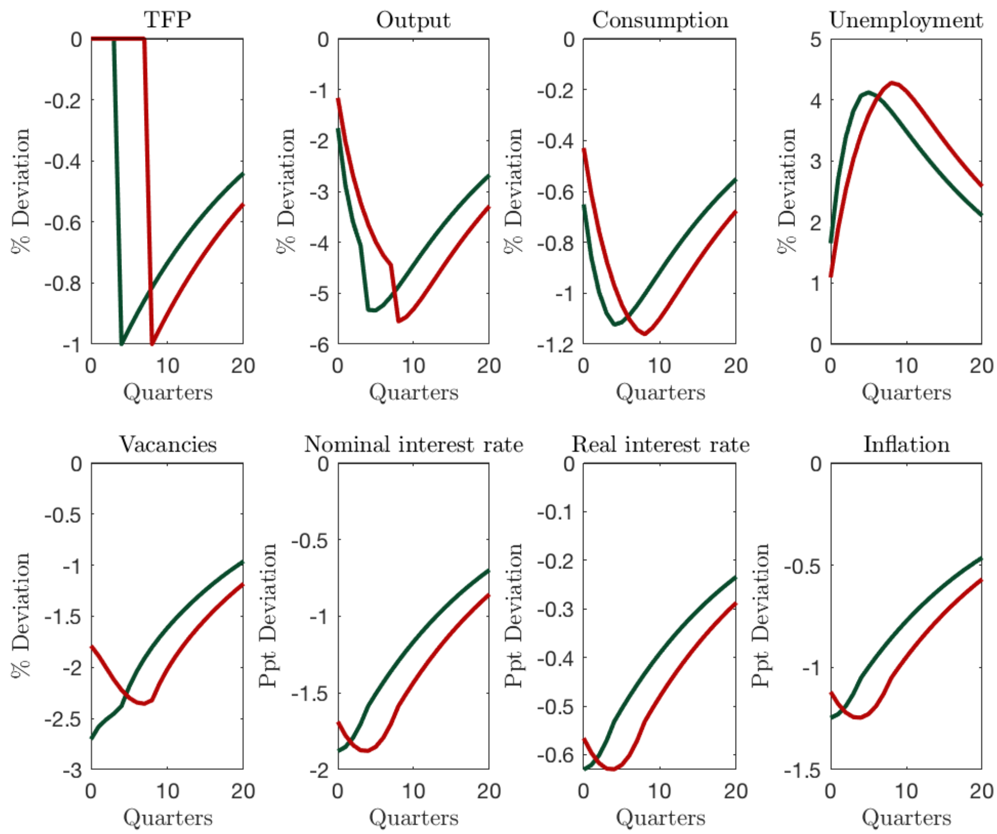
Note: The light blue shaded area denotes the 90% confidence interval at each horizon.

Figure 7: Estimated IRFs from a local projection for the aaa-baa corporate bond spread and the Pflueger et al. (2020) price-of-volatile stocks (PVS) series to a negative Beaudry-Portier news shock.



Note: The light blue shaded area denotes the 90% confidence interval at each horizon.

Figure 8: Model IRFs for a -1% shock to ε_{t-4} and ε_{t-8}.



Note: The green line denotes the IRF for ε_{t-4} and the red line denotes the IRF for ε_{t-8}.

Figure 9: Comparison of the IRFs of output to a -1% shock to ε_{t-4} in the baseline economy and two counterfactual economies.

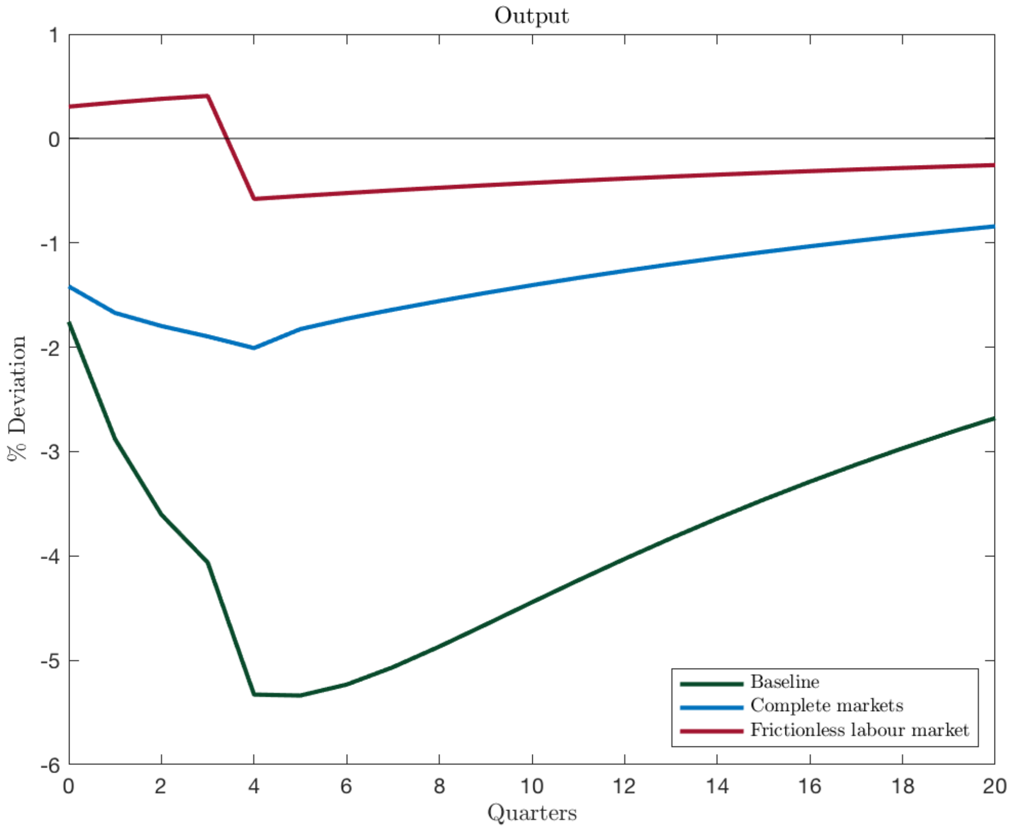
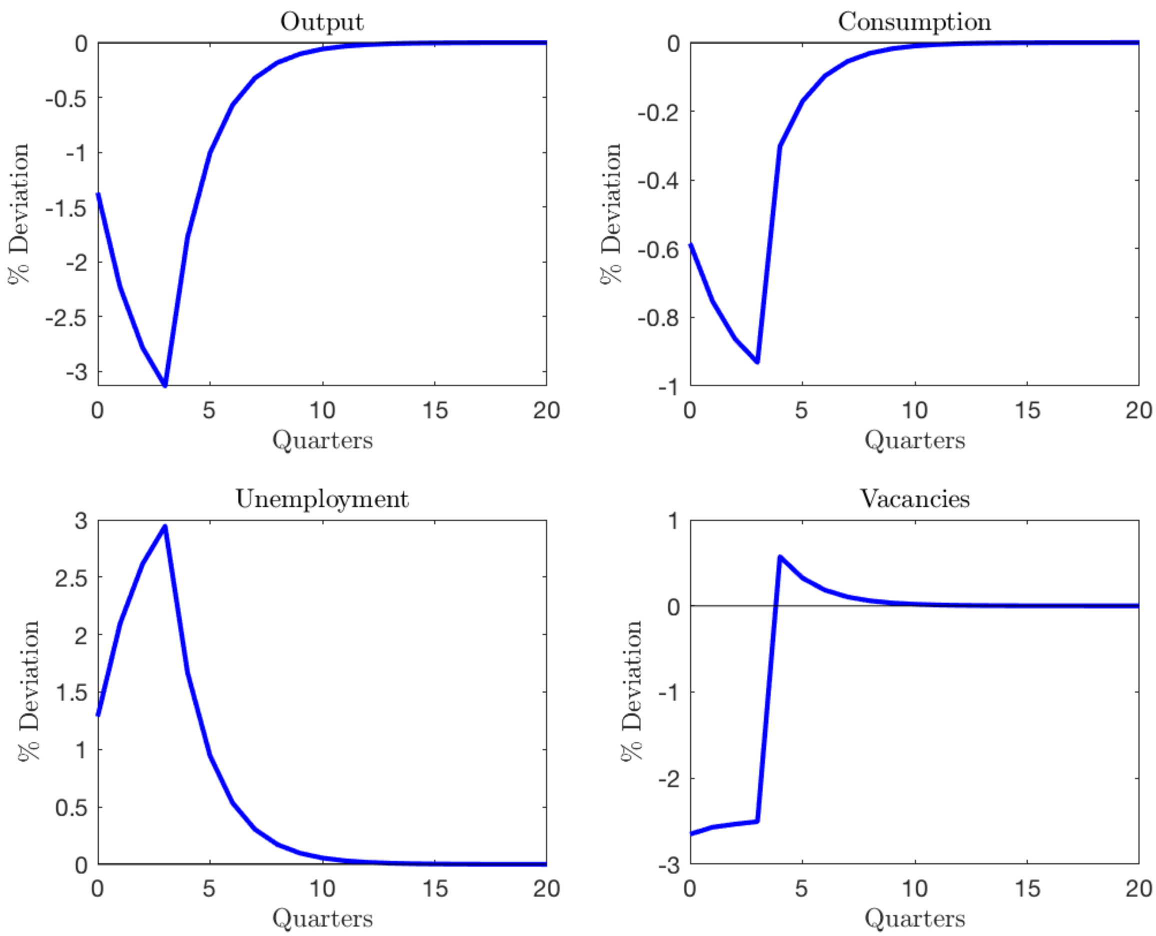


Figure 10: IRFs for a -1% noise shock pertaining to TFP 4 quarters ahead.



Appendix A

Figure A1: Variance decompositions for the labour market flow variables.

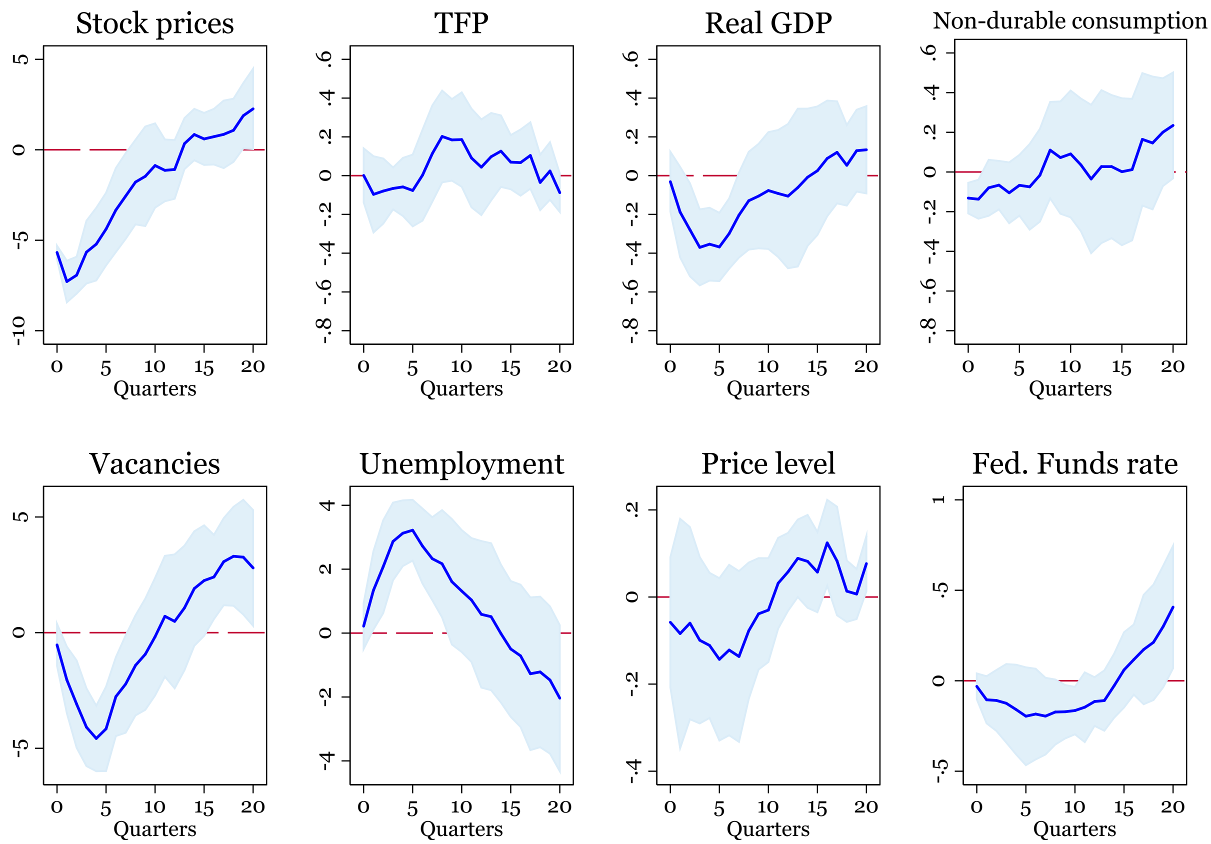
Note: The light red bands denote the 68% confidence intervals computed from a bootstrap procedure.

Robustness tests for the local projection results and confidence shocks

Shorter sample

Barakchian and Crowe (2013) highlight the sensitivity of estimates of the effect of monetary shocks to the chosen sample period across a range of identification schemes. This issue is investigated here in the context of news shocks, as I re-estimate the Beaudry-Portier shocks for a shortened, more recent sample. The baseline sample period is 1951:I - 2015:III, which includes the period prior to the Volcker monetary regime when monetary policy is largely viewed as being a source of instability which could perhaps skew the results for the estimated effects of news shocks. Taking this into account, the shocks are re-estimated for the period 1980:I - 2015:III. Besides the wider confidence intervals, which one would expect given the abbreviated sample, the estimated IRFs remain substantively unchanged. Hence, these results are not driven by the lengthy nature of the baseline sample period. Figure A3 shows that the shock accounts for a slightly lower proportion of variance in consumption relative to the baseline sample period, but roughly the same proportion for all other variables.

Figure A2: Estimated IRFs from a local projection with the shortened sample 1980-2015.



Note: The light blue shaded area denotes the 90% confidence intervals.

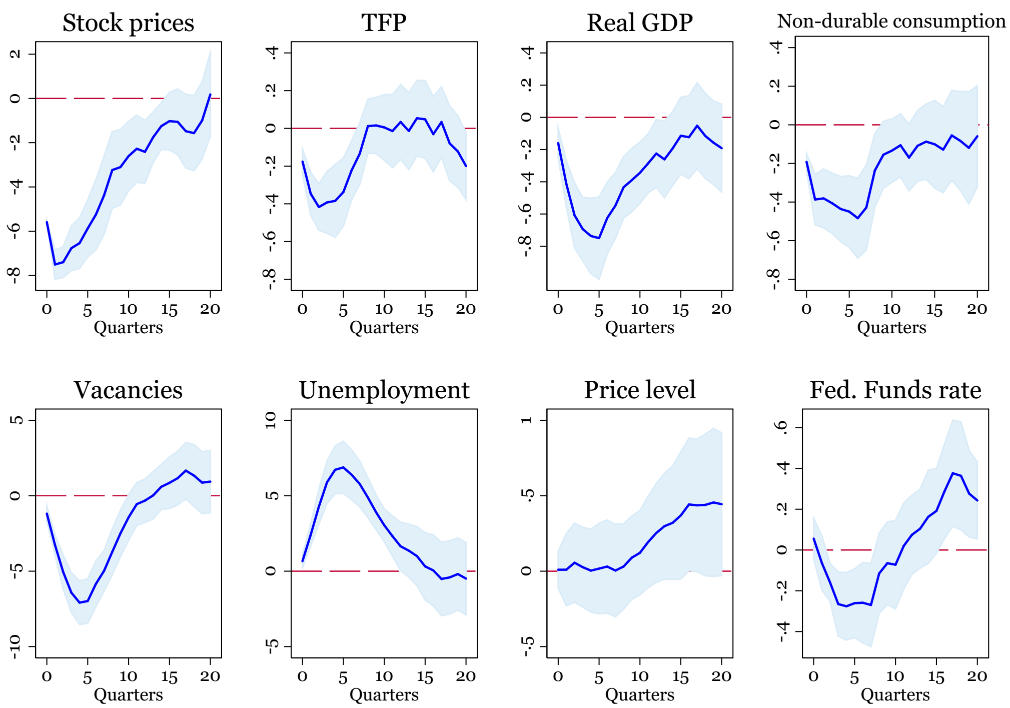
Figure A3: Variance decompositions for the shortened sample 1980-2015.

Note: The light red bands denote the 68% confidence intervals computed from a bootstrap procedure.

News shocks identified with long-run restrictions on a SVAR

Beaudry and Portier (2006) also identify news shocks by imposing the restriction that a news shock has no long-run effect on TFP, and show that this shock is almost perfectly correlated with the shock identified via an impact restriction. This shock is included in the local projections and VAR for the FEV decompositions as an additional robustness test. Ultimately, the shock illicits a stronger response in many of the endogenous variables, including vacancies, non-durable consumption and output. Relevant to the precautionary savings channel, consumption also responds strongly and immediately upon the shock's impact. The FEV decompositions show that the news shock identified with long run restrictions can explain an even greater portion of fluctuations in all of the endogenous variables (apart from inflation) over business cycle frequencies.

Figure A4: Estimated IRFs from a local projection with the Beaudry-Portier shocks identified with long-run restrictions.



Note: The light blue shaded area denotes the 90% confidence intervals.

Figure A5: Variance decompositions for the Beaudry-Portier shock identified with long-run restrictions.

Note: The light red bands denote the 68% confidence intervals computed from a bootstrap procedure.

Confidence shocks

Beaudry et al. (2011) and Angeletos et al. (2018) propose the idea that business cycles may be driven by confidence shocks, of which news shocks are a subset. To investigate the effect of these confidence shocks on the labour market variables, I estimate a two variable structural VAR with the Michigan index of consumer expectations and TFP.

The structural expectation shock is obtained by performing a Cholesky decomposition on the variance-covariance matrix of the reduced form residuals, with the identifying assumption that TFP does not respond contemporaneously to an expectation shock. The expectations shock is, therefore, the part of the expectations index which is orthogonal to TFP, lags of TFP and lags of itself. Four lags are used in the SVAR. The identified shock is then standardised and included in the standard local projection and VAR frameworks to estimate the IRFs and FEV decompositions respectively. The sample period is 1965:I-2015:II. The IRFs for this shock look similar to those in the baseline results, despite the shocks only being mildly correlated[13]. Non-durable consumption again exhibits a significantly negative response on the shock's realisation. The expectations shock less variation in most of the six endogenous variables, especially unemployment and vacancies. Consumption is the only variable for which the expectations shock seems to be as important as the news shock at business cycle frequencies.

[13]The correlation between the expectations shock and the Beaudry-Portier news shock is 0.22

Figure A6: Estimated IRFs from a local projection with the confidence shock.

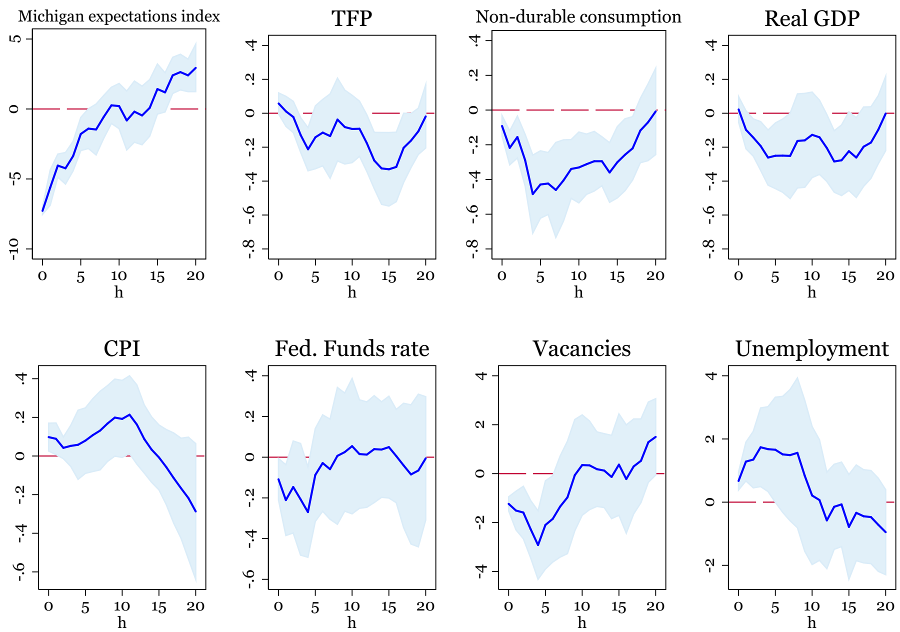


FIGURE A7: VARIANCE DECOMPOSITIONS FOR THE CONFIDENCE SHOCK.

Note: The light red bands denote the 68% confidence intervals computed from a bootstrap procedure.

Appendix B

Equilibrium conditions for the model

1) Euler equation

$$W_t^{-\sigma} = \beta E_t \frac{R_t}{1+\pi_t} \left\{ (1-\rho(1-\eta_{t+1}))W_{t+1}^{-\sigma} + \rho(1-\eta_{t+1})\zeta^{-\sigma} \right\}$$

2) Marginal cost

$$MC_t = (\frac{1}{A_t})(W_t + \frac{\kappa}{\eta_t^v} - \beta E_t \left[(1-\rho)\frac{\kappa}{\eta_{t+1}^v} \right])$$

3) Optimal price setting condition

$$1-\gamma+\gamma MC_t = \theta\pi_t(1+\pi_t) - \theta\beta E_t \left[\pi_{t+1}(1+\pi_{t+1})\frac{Y_{t+1}}{Y_t} \right]$$

4) Matching function

$$M_t = u_t^{\alpha} v_t^{1-\alpha}$$

5) Job finding rate

$$\eta_t = (\frac{v_t}{u_t})^{(1-\alpha)}$$

6) Vacancy filling rate

$$\eta_t^v = (\frac{v_t}{u_t})^{-\alpha}$$

7) Employment law of motion

$$N_t = (1-\rho)N_{t-1} + M_t$$

8) Unemployment

$$u_t = 1 - N_t$$

9) Production function

$$Y_t = A_t N_t$$

10) Taylor rule

$$R_t = \overline{R}\left(\frac{1+\pi_t}{1+\overline{\pi}}\right)^{\delta}$$

11) Employed worker value function

$$V_t^e = \frac{W_t^{1-\sigma}}{1-\sigma} + \beta E_t \rho(1-\eta_{t+1})V_{t+1}^u + \beta E_t[1-\rho(1-\eta_{t+1})]V_{t+1}^e$$

12) Unemployed worker value function

$$V_t^u = \frac{\zeta^{1-\sigma}}{1-\sigma} + \beta E_t(1-\eta_{t+1})V_{t+1}^u + \beta E_t(1-\eta_{t+1})V_{t+1}^e$$

13) Bargaining solution

$$(1-\chi)[V_t^e - V_t^u] = \chi\left(\frac{\kappa}{\eta_t^v}\right)$$

14) Stochastic process for TFP

$$log(A_t) = \phi_A log(A_{t-1}) + \varepsilon_t + \varepsilon_{t-4} + \varepsilon_{t-8}$$

15) Household consumption

$$C_t^H = N_t W_t + u_t \zeta$$

Appendix C

Model with complete markets

Households are organised as large families, meaning they are insured against idiosyncratic unemployment risk and labour market conditions do not directly influence the consumption-saving decision. They maximise expected discounted lifetime utility subject to budget and borrowing constraints:

$$\max E_t \sum_{t=0}^{\infty} \beta^t [\frac{C_t^{1-\sigma}}{1-\sigma} - \vartheta N_t]$$

s.t.

$$C_t + B_t \leq N_t W_t + (1 - N_t)\zeta + \frac{R_{t-1}}{\pi_t} B_{t-1}$$

$$B_t \geq B^{limit}$$

where N_t is the fraction of the household who are employed. The first order conditions for C_t and B_t yield the standard complete markets Euler equation:

$$C_t^{-\sigma} = \beta E_t \frac{R_t}{1 + \pi_{t+1}} C_{t+1}^{-\sigma}$$

The absence of the job finding and job loss rates from the right hand side of this equation illustrate the lack of idiosyncratic risk in the economy, which causes the precautionary savings motive of household to disappear. Labour market frictions remain present, however. The remainder of the model is the same as the baseline, and equilibrium is therefore characterised by the above condition, equations 2 - 14 in Appendix B as well as the following goods market clearing condition:

$$C_t + \kappa v_t + \frac{\theta}{2}\pi_t^2 Y_t = Y_t$$

All calibrated parameters remain the same as in Table 1, with a zero-borrowing limit imposed which generates a degenerate wealth distribution. The model is again solved with a first-order perturbation method around the deterministic steady state.

Model with frictionless labour markets

Households are single-membered and can be either employed or unemployed in each period. Employed households face an exogenous probability of becoming unemployed each period (p^{EU}), meaning there is idiosyncratic risk which they face. This labour market risk is exogenous due to there being a spot labour market, with no search-and-matching frictions. The households maximise expected discounted lifetime utility subject to a budget and a borrowing constraint:

$$\max E_t \sum_{t=0}^{\infty} \beta^t [\tfrac{C_t(i)^{1-\sigma}}{1-\sigma} - \vartheta_0 \tfrac{N_t(i)^{1+\vartheta_1}}{1+\vartheta_1}]$$

s.t.

$$C_t(i) + B_t(i) \leq N_t(i) W_t + (1 - N_t(i))\zeta + \frac{R_{t-1}}{\pi_t} B_{t-1}(i)$$

$$B_t(i) \geq B^{limit}$$

setting $N_t(i) = 1$ if the household is employed and $N_t(i) = 1$ if they are unemployed. The employed household Bellman equation is:

$$V^e(B(i),\Gamma) = \max_{C(i),N(i),B'(i)} \left\{U(C(i),N(i)) + \beta E(1-p^{EU})V^e(B'(i),\Gamma') + \beta E p^{EU} V^u(B'(i),\Gamma')\right\}$$

This leads to the following Euler equation in equilibrium given $B^{limit} = 0$ and the subsequent implication of households consuming their income each period:

$$W_t^{-\sigma} = \beta E_t \frac{R_t}{1+\pi_t}\left\{(1-p^{eu}))W_{t+1}^{-\sigma} + p^{eu}\zeta^{-\sigma}\right\}$$

The condition for household labour supply pins down the real wage:

$$W_t^{1-\sigma} = \vartheta_0 W_t^{\vartheta_1}$$

Firms produce a good with the production function:

$$Y_t(j) = A_t N_t(j)$$

where A_t follows the same stochastic process as in the baseline model:

$$log(A_t) = \phi_A log(A_{t-1}) + \varepsilon_t^A + \varepsilon_{t-4}^A + \varepsilon_{t-8}^A$$

Real marginal costs for firm j are given by:

$$MC_t = (\frac{1}{A_t})(W_t)$$

Each firms face Rotemberg price adjustment costs. Prices are set such as to maximise:

$$\max E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{P_t(j)}{P_t} Y_t(j) - W_t N_t(j) - \frac{\theta}{2} \left(\frac{P_t(j) - P_{t-1}(j)}{P_{t-1}(j)} \right)^2 Y_t \right]$$

s.t

$$Y_t(j) = A_t N_t(j)$$
$$Y_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\gamma} Y_t$$

The first order condition for this problem is:

$$1 - \gamma + \gamma MC_t = \theta\pi_t(1 + \pi_t) - \theta\beta E_t \left[\pi_{t+1}(1 + \pi_{t+1}) \frac{Y_{t+1}}{Y_t} \right]$$

Monetary policy follows the same inflation-targetting framework:

$$R_t = \overline{R} \left(\frac{1 + \pi_t}{1 + \overline{\pi}} \right)^{\delta}$$

Aggregate output in symmetric equilibrium is given by:

$$Y_t = A_t N_t$$

The parameters β, σ, δ, γ, ζ and θ are kept the same is in Table 1. The parameter ϑ_1, the inverse Frisch elasticity, is set to one following much of the literature, while ϑ_0 is set to 1.155 to target a 6% steady state unemployment rate as in the baseline calibration. The parameter p^{EU} is set to 0.044, again following the baseline parameter value. Equilibrium is characterised by seven equations in seven unknowns. These are the household Euler equation, the labour supply condition, the real marginal cost equation, the first order condition for price setting, the aggregate production function, the interest rate rule and finally the stochastic process for TFP. The model is solved with a first-order perturbation method around the deterministic steady state.