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Ambiguous Economic News and Heterogeneity: What Explains Asymmetric Consumption Responses?

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Abstract

We study information and consumption and whether consumers respond symmetrically to good and bad news. We define a news variable and show that it has explanatory power. We, then, test the hypothesis that consumers react more to bad news than to good news using the PSID to analyze the response of households' consumption to news about aggregate future income. We find that our news variable helps one predict households' consumption change and that consumption responses are larger following negative (bad) news than positive (good) news and suggest that observed asymmetric consumption responses could be due to agents' aversion to ambiguous information.

Keywords: Consumption, Asymmetry, Expectations, Noisy Information.

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1 Introduction

Heterogeneity in consumption responses to income shocks has been widely discussed in the empirical literature: For instance, Fagereng et al. (2016) document heterogeneity in households' responses to unanticipated income shocks, identified through lottery prizes using data from tax and income records of Norwegian households; Jappelli and Pistaferri (2014), using the 2010 Italian Survey of Household Income and Wealth, show that marginal propensity to consume is substantially higher for households with low cash-on-hand than affluent households.

One of the interesting empirical finding in the literature is consumption responses being asymmetric in the sense that the marginal propensity to consume (MPC) following negative income shocks is larger than that following positive ones (see, for example, Bunn et al., 2017). Asymmetric consumption responses may be attributed to a number of complementary factors. According to Carroll (1992), Carroll (1994), and Caballero (1990), the precautionary saving motive induces households not to react as much as they otherwise would following positive income changes. Given uncertainty regarding their future income, households choose to create a precautionary buffer to smooth out income shocks.

Similarly, with imperfect credit market accessibility, financially constrained consumers are not able to perfectly smooth out consumption following negative income changes. For example, as in Deaton (1992), if households are unable to substitute consumption across time due to their imperfect access to credit markets, when negative income shocks come along, households are unable to smooth out consumption and will have to reduce consumption substantially, delivering a large marginal propensity to consume. There are also transaction costs on borrowing or dis-saving, which may also generate asymmetric responses in consumption (Jappelli and Pistaferri, 2014). Accordingly, the buffer stock theory predicts an important relationship between consumption in nominal terms and total liquid financial resources of consumers, i.e., cash-on-hand. In fact, if there is a positive income shock, even households with low levels of cash-on-hand might be able to save, generating a smaller consumption response than in the case of a negative shock.

In this paper, we examine an additional source of asymmetric consumption behavior due to information processing. We study whether consumers are neutral to the favorability of information they receive. Specifically, in an environment where permanent income consumers receive information about their long-run income, we show that consumption responses are asymmetric in that the size of consumption responses are larger following negative (bad) information about the future than positive (good) one. We focus on the information other than lagged and current income, and we label such perceived information about future income as *news*. To construct this news variable, we follow the imperfect information literature where agents receive noisy news about the future as in Lorenzoni (2009) , Blanchard et al. (2013), and Cao and L'Huillier (2018) among others. Specifically, we use the methodology discussed in L'Huillier and Yoo (2017) and Yoo (2017) to decompose the effects of observing multiple signals on consumption fluctuations.

For our theoretical discussion, we consider a simple consumption model that hinges on a particular form of information structure and agents' preferences. Specifically, we assume that information is ambiguous, so households' attitudes toward ambiguity play a crucial role in determining consumption spending.[1] When households exhibit aversion toward ambiguity, they reduce spending more with negative information than they increase it with positive information. On the contrary, if consumers are ambiguity loving, they tend to increase spending more when receiving good information than they reduce consumption spending after receiving bad information.

Analysis of Panel Survey of Income Dynamics (PSID) data shows that (*i*) our news variable helps one predict the change of households' consumption and that (*ii*) households' consumption responses to news are asymmetric as they react more to bad news than good news, where good and bad news respectively refer to information that induce positive and negative consumption changes. That is, the data suggests that the average household in the PSID sample is ambiguity averse.

The rest of the paper is organized as follow. Section 2 presents the model. Section 3 describes our identification strategy and discuss quantitative results. Section 4 concludes.

2 A Simple Model

Information is ambiguous if agents do not have a belief about the probability measure of all random variables. So agents who believe that a disturbance must fall in some range, but has no opinion about probability densities within that range face ambiguity. Without a complete set of subjective probabilities, agents cannot maximize expected welfare – agents think they can predict a range of possible outcomes but not the probability distribution within that range. Ambiguity averse (loving) agents maximize the minimum (maximum) of the range of possible welfare.

Ambiguity aversion implies an asymmetry in responses to ambiguous information. If agents receive a signal and do not know the quality of the signal, ambiguity averse agents will interpret the accuracy of negative signals (bad news) to be the maximum possible and will interpret the accuracy of positive signals (good news) to be the minimum possible. In each case, the ambiguity averse agents assume that the unknown variable takes the worst possible value. This implies an asymmetric response to ambiguous signals with a larger response to negative than to positive signals.[2]

We consider the following wage equation:

$$w_{i,t} = X_{i,t}^{'}\beta + z_{i,t} + x_{i,t}, \tag{1}$$

where $w_{i,t}$ is a log of hourly wage.

We assume that $z_{i,t}$ is a transitory income process summarized by an $AR(1)$ process:

$$z_{i,t} = \rho_z z_{i,t-1} + \epsilon_{i,t}^{z},$$

where $\epsilon_{i,t}^{z}$ is a Gaussian shock with variance $\sigma_{\epsilon^z}^2$, and that $x_{i,t}$ is a permanent income process which has a unit root:

$$\Delta x_{i,t} = \rho_x \Delta x_{i,t-1} + \epsilon_{i,t}^{x},$$

[1] We use the terms, "households", "consumers", and "agents", interchangeably.

[2] Similar logic holds for ambiguity loving agents such that they react more to positive than to negative signals.

where $\epsilon^x_{i,t}$ is a Gaussian shock with variance $\sigma^2_{\epsilon^x}$.

From Equation (1), we define $\tilde{w}_{i,t}$ as the wage net of its expected value given observables:

$$\tilde{w}_{i,t} \equiv w_{i,t} - X'_{i,t}\beta = z_{i,t} + x_{i,t},$$

and impose the following informational assumptions. First, we cannot separately identify the two income processes. In addition, all households receive news about aggregate future income:

$$s_t = x_t + \nu_t, \tag{2}$$

where ν_t is a Gaussian shock with variance σ^2_ν and $x_t = \int_0^1 x_{i,t}di$. A crucial assumption we impose here is that the noisy signal s_t is ambiguous:

$$\sigma^2_\nu \in [\underline{\sigma}^2_\nu, \bar{\sigma}^2_\nu],$$

which implies that households do not know the true variance of this noise shock. Instead, they only know roughly how precise this shock is – they know the lower and upper bound of this variance. Therefore, the larger the gap between this upper and lower bound, the more ambiguous this noisy information is perceived to be.

It may be more useful to assume that agents receive news about their own future income:

$$s_{i,t} = x_{i,t} + \nu_{i,t},$$

where $\nu_{i,t}$ is an idiosyncratic $i.i.d$ shock. Obviously, as we will show later it is not a trivial exercise to identify this unobservable noisy signal for each household i. Furthermore, in addition to this practical complication, we believe that assuming households receive identical news about aggregate future income and that this aggregate news affect households' consumption spending is not so unreasonable. First, households' own income process in Equation (1) already contains information about their own future income. Second, households are likely to consider the future state of the aggregate economy when predicting their own future income. Finally, in our quantitative exercise where we use a sample of households, it may useful to consider the aggregate news which is obtained from the whole population.

Once we control for other factors, the residual wage $\tilde{w}_{i,t}$ can be decomposed into permanent and transitory shocks. If households behave as if they are permanent income consumers, they would form an expectation about their permanent income, denoted by $\mathbb{E}^i_t[x_{i,t}]$ and choose consumption spending as a function of this expectation (for notational convenience, we remove the individual superscript i for expectation from now on).

Specifically, households would choose consumption equal to their long-run expectation of income:

$$c_{i,t} = \mathbb{E}_t[x_{i,t+\infty}] + X'_{i,t}\beta,$$

which, by solving the appropriate signal extraction problem, can be expressed as:

$$c_{i,t} = x_{i,t|t} + X'_{i,t}\beta,$$

where $x_{i,t|t} = \mathbb{E}_t[x_{i,t}]$, and we define $x_{i,t|t}$ as the non-deterministic component of consumption, $\tilde{c}_{i,t}$.

The additional complication of our informational structure, the fact that information is not only noisy but also ambiguous, requires that we model households' preferences regarding ambiguity, and we assume that households exhibit either ambiguity aversion or ambiguity loving attitudes. As we will see, this behavioral alteration generates a kinked consumption response (to income shocks) due to pessimistic versus optimistic evaluation of ambiguous information.

Consider the logic that hinges on this particular form of information structure and agents' preferences: households receive a noisy information about their future income where a quality of such information is assumed to be *ambiguous*. Since information is ambiguous, households' attitudes toward ambiguity play a crucial role in determining consumption spending. When households exhibit aversion toward ambiguity, they react more to negative information than positive information and reduce spending more with negative information than they increase it with positive information. On the contrary, if consumers are ambiguity loving, they tend to increase spending more when receiving good information than they reduce consumption spending after receiving bad information.

Households' consumption problem for the non-deterministic consumption component can be solved by filtering the wage process $\tilde{w}_{i,t}$ and the noisy signal s_t. Since this signal extraction problem can be solved sequentially, consumption can be represented by:

$$\tilde{c}_{i,t} = \tilde{c}_{i,t|\tilde{w}_{i,t}} + \kappa(s_t - x_{i,t|\tilde{w}_{i,t}}),$$

where $x_{i,t|\tilde{w}_{i,t}}$ and $\tilde{c}_{i,t|\tilde{w}_{i,t}}$ are the expectations about the permanent productivity component and consumption spending updated with a contemporaneous wage observation $\tilde{w}_{i,t}$, respectively. The gain term κ depicts a relative gain of observing the noisy signal on updating belief which depends on the underlying parameters of the model, and it can be shown that $0 \leq \kappa \leq 1$.

We are also assuming that households treat the aggregate noisy signal s_t in Equation (2) as valuable information about their own permanent income $x_{i,t}$.

In addition, assuming that the quality of information is ambiguous suggests complete uncertainty regarding the value of κ:

$$\kappa \in \left[\underline{\kappa}, \overline{\kappa}\right],$$

where $0 \leq \underline{\kappa} < \overline{\kappa} \leq 1$. Regardless of the type of consumers, asymmetric consumption responses are delivered as they attach relatively less (more) weights to good information realized by a noisy signal s_t than to bad information if they are ambiguity averse (loving). Another prediction of this model is that in addition to different reactions to positive and negative news, consumption responses to positive and negative income (productivity) shocks are also different. However, in this paper, we keep our focus on consumption responses to news rather than to income shocks.

3 Empirical Evidence

Our conjecture is that households exhibit asymmetric responses in response to new information. Here, we examine whether we could observe such asymmetric consumption responses in the data. Specifically, we attempt to test our hypothesis that households' consumption response to macroeconomic news on their long-run income is asymmetric using U.S. micro data by following a two-stage estimation process. First, we extract the news series ($\texttt{news}_t$) using aggregate expenditure data. We, then, attempt to identify whether this news variable contains important information which affects households' consumption decisions and separately estimate the magnitude of consumption responses for positive and negative news, and whether the size of the responses are statistically different for the two cases. The macroeconomic news here refers to the information that affects households' beliefs about their permanent income. To obtain this series, we structurally estimate the simple permanent income consumption model with imperfect information using the aggregate U.S. time series and extract this news series. Putting it bluntly, this news series contains the information outside of households' income process that affects their consumption decisions.

Once we obtain this news series, we conduct a panel regression analysis with household-level survey data to verify whether the response of consumption is asymmetric to the sign of this news variable after controlling for individual socio-demographic characteristics and for the presence of any liquidity constraints.

3.1 Estimating News

To verify that consumption responses to news are (a)symmetric, our empirical specification is given by:

$$c_{it} = \phi \times \texttt{controls}_{it} + \kappa \times \ \texttt{news}_{it} + \epsilon_{it},$$

which allows us to examine whether the estimated values of κ are statistically different for the *positive* and *negative news*. Thus, the very first step of our analysis consists in obtaining the news series – information about future income not contained one's own income data that affect consumption spending decisions.

However, identifying idiosyncratic news for each household is not technically feasible as it requires structurally estimating each household's consumption model separately. Given the small sample size in the time dimension and the large number of households in the sample, we are unable to extract the variable $\texttt{news}_{it}$, and we instead opt to identify the aggregate news series $\texttt{news}_t$ using the aggregate expenditure data and estimate the following empirical model:

$$c_{it} = \phi \times \texttt{controls}_{it} + \kappa \times \ \texttt{news}_{t} + \epsilon_{it}.$$

Specifically, in order to extract this news series, we consider a simple permanent income consumption set-up where consumers receive signals about future income and choose spending accordingly as in Blanchard et al. (2013) and L'Huillier and Yoo (2017). When we construct the news series, we implicitly assume that the representative consumer has a subjective probability distribution – that is, we do not consider possible ambiguity. Under the null hypothesis that consumers do not consider information to be ambiguous, the news variable (calculated implicitly assuming this) should have a simple direct symmetric effect on household's consumption. Our principle aim is to test this null hypothesis.

Consumers are assumed to observe an imperfect signal about their long-run income, denoted by a_t:

$$a_t = x_t + z_t,$$

where x_t and z_t are permanent and transitory components of income process a_t. The permanent and transitory income processes are defined as:

$$\Delta x_t = \rho_x \Delta x_{t-1} + \epsilon_t^x,$$

$$z_t = \rho_z z_{t-1} + \epsilon_t^z,$$

where ϵ_t^x and ϵ_t^z are *i.i.d.* shocks with mean zero and variances $\sigma^2_{\epsilon^x}$ and $\sigma^2_{\epsilon^z}$, respectively.

Consumers are unable to separately observe the income processes x_t and z_t. Considering that consumers have more information than merely their income, we assume that consumers have access to an additional source of information, and that they observe a noisy signal of the permanent component of income:

$$s_t = x_t + \nu_t,$$

where ν_t, a noise shock, is a third source of fluctuations in this economy and is an *i.i.d.* shock with mean zero and variance σ_ν^2.

Given this information structure, permanent income consumers choose their current spending by setting it equal to the long-run expectation of income:

$$c_t = \mathbb{E}_t\big[a_{t+\infty}\big]. \tag{3}$$

From a signal extraction point of view, we can show that:

$$c_t = c_{t|a_t} + \Delta c_{t|s_t}, \tag{4}$$

where $c_{t|a_t}$ is consumption consumers would have spent without observing a noisy signal s_t, and $\Delta c_{t|s_t}$ is consumption changes due to observing the noisy signal. The variable $\Delta c_{t|s_t}$ is determined by:

$$\Delta c_{t|s_t} = \kappa \times \big(s_t - x_{t|a_t}\big),$$

where κ is a non-negative constant bounded by one,[3] which depends on the signal-to-noise ratio, and we define *news* as the difference between noisy information and the ex-ante belief about future income:

$$\texttt{news}_t = (s_t - x_{t|a_t}),$$

where $x_{t|a_t} = \mathbb{E}_t[x_t|a_t, s_{t-1}, a_{t-1}, \ldots]$, positive news is associated with positive consumption changes and negative news induce consumers to reduce spending from $c_{t|a_t}$. When $s_t > x_{t|a_t}$, we consider this noisy signal delivers good news and when $s_t < x_{t|_{a_t}}$, we call it a bad news.

Solving the model for Equation (3) and Equation (4) is a direct implementation of a sequential signal extraction. From Equation (3) consumers form expectations about future income and choose spending: consumers would estimate the permanent income component via a signal extraction problem. This is because *unobserved* long-run income is driven by permanent shocks to income and not by transitory ones. However, we are not just interested in solving the model for consumption itself but need to solve the model for consumption changes due to observing a noisy signal $\Delta c_{t|s_t}$ as our aim is to extract the news series, which depends on this signal. Therefore, we solve this signal extraction problem by assuming that consumers sequentially form expectations and disentangle

[3] Unless this noisy signal is completely useless, i.e., $\sigma_\nu \to \infty$

consumers' expectations updated with income signals from the ones updated with noisy signals.[4] Appendix D in L'Huillier and Yoo (2017) discusses the solution procedure in detail.

Subtracting both sides of Equation (4) by c_{t-1}, we have our testable consumption equation:

$$\begin{aligned}\Delta c_t &= \Delta c_{t|a_t} + \Delta c_{t|s_t}, \\ &= \Delta c_{t|a_t} + \kappa \times \left(s_t - x_{t|a_t}\right),\end{aligned}$$

where $\Delta c_t = c_t - c_{t-1}$, $\Delta c_{t|s_t} = c_t - c_{t|a_t}$, and $\Delta c_{t|a_t} = c_{t|a_t} - c_{t-1}$, and $\left(s_t - x_{t|a_t}\right)$ is our news series households receive at period t. We assume that $\Delta c_{t|a_t}$ is controlled by the observable characteristics and focus on estimating κ.

Given the consumers' sequential Kalman filter, the dynamics of the model can be represented in a state-space form with the appropriate observation equations. We assume that the econometrician's information set include the income variable a_t and the consumption variable c_t.[5] While the econometrician does not directly observe noisy signals s_t, consumers' consumption choices contain sufficient information for estimation. As consumers' expectations become part of the unobserved state vector of the econometrician, the econometrician's Kalman filter can be used to construct the likelihood function and to estimate the underlying parameters of the model. Once we estimate the underlying model parameters and state variables, we can proceed to smooth estimate the news series. Appendix A.1 contains a detailed derivation of the econometrician's filtering.

The News Series

Our data set includes series on real GDP, real consumption expenditure, employment, and population. We use quarterly data. The series were obtained from the U.S. Bureau of Economic Analysis and the U.S. Bureau of Labor Statistics. We construct the series for productivity by dividing Real Gross Domestic Product (ID GDPC1) by Employment (ID LNS12000000Q) and taking logs. Similarly, the consumption series is obtained by taking the log of per capita consumption – Real Consumption Expenditure (ID PCECC96) divided by Population (ID LNS10000000Q). The sample is from 1976-2015.[6]

Table 1 reports the estimation results.[7] The results show that the persistence parameter for productivity is estimated highly persistent at 0.959. Due to this high persistence, the standard deviation for permanent productivity shocks is very small, 0.02%. On the contrary, the standard deviation for noisy shocks is estimated to be very large at 1.40%.

[4] Essentially, there are two subperiods at any given time t, and at subperiod 1, consumers observe an income signal a_t and at subperiod 2, they observe a noisy signal s_t. Consumers then choose spending at the end of subperiod 2. Since all shocks are assumed to be Gaussian, whether consumers update beliefs sequentially or simultaneously does not matter as long as they first update beliefs with an unambiguous signal, which is an income signal a_t in this case.

[5] For estimation, we use productivity in lieu of the income variable.

[6] The estimation is robust when considering data until 2007 (see Table 12 in Appendix A.2).

[7] Regarding the productivity process, we assume that $\rho_x = \rho_z = \rho$, and the variances satisfy the restriction $\rho\sigma_\epsilon^2 = (1-\rho)^2\sigma_\eta^2$. As discussed in Blanchard et al. (2013), this restriction ensures that the univariate productivity process a_t is a random walk that satisfies the following conditions: $\rho_\epsilon^2 = (1-\rho)^2\sigma_u^2$ and $\sigma_\eta^2 = \rho\sigma_u^2$. Thus, instead of directly estimating both the variances σ_ϵ^2 and σ_η^2, one can estimate the variance σ_u^2 and recover σ_ϵ^2 and σ_η^2.

Table 1: Parameter Estimates, U.S. 1976-2015

Parameter	Description	Median	s.e.
ρ	Persistence productivity	0.9590	0.0077
σ_u	Std dev. productivity	0.0061	0.0003
σ_ϵ	Std dev. permanent shock (implied)	0.0002	–
σ_η	Std dev. transitory shock (implied)	0.0059	–
σ_ν	Std dev. noise shock	0.0142	0.0042

Note: σ_ϵ and σ_η are recovered from the estimated ρ and σ_u based on the random walk productivity assumption. As they are indirectly recovered, no standard errors are given.

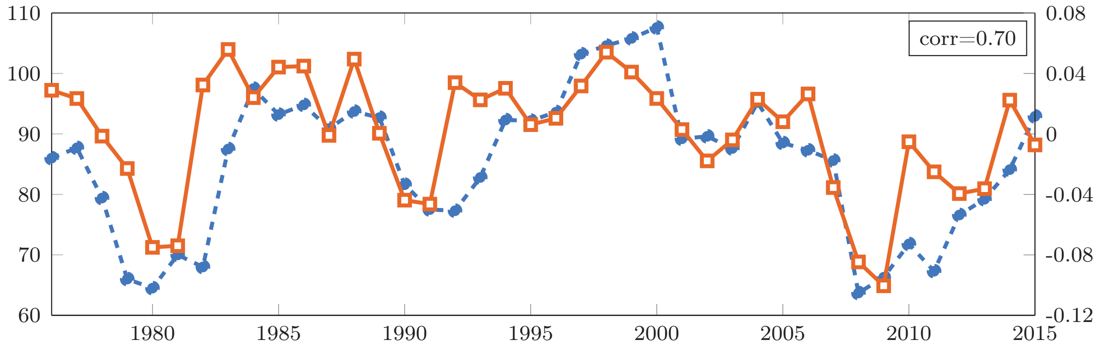

Figure 1: News and the Index of Consumer Sentiment: 1976-2015

Note: The blue-dashed line denotes the Index of Consumer Sentiment (ICS) from the Michigan Survey of Confidence whereas the orange-solid line denotes the estimated news series in the sample. The ICS corresponds to the left y-axis and the estimated news series to the right y-axis. *corr* denotes the correlation coefficient between the ICS and the estimated news series.

Figure 1 shows the estimated news series along with a measure of consumer confidence, the Index of Consumer Sentiment available from the University of Michigan Survey of Consumers. It shows a clear association between the two, supporting the view that the news series produced by the estimated model actually captures shocks that impact consumers' views about the economy. The correlation between the two is strictly positive ($corr = 0.70$) and statistically significant at the 1% level (p-val < 0.01).

Our interpretation of this news series is that it represents information (or confidence) of others not available in their own income. Thus, this information is orthogonal to information contained in income processes in terms of affecting consumers' spending decision.

3.2 PSID Data

We use data from the 1977-2011 PSID. It is the most representative longitudinal household survey in the U.S. economy. The data was collected annually until 1996 and biennially from 1997. For total consumption we use the estimated variable in Attanasio and Pistaferri (2014) since the original PSID dataset only provides consumption components from 1999. Thus, we impute total consumption to the PSID families files before 1999 using consumption data available from 1999 onward.[8] We drop the SEO,[9] Latino and Immigrant subsamples. Next, we only keep households where the head is older than 25 or younger than 65. Finally, after setting some observations to missing, our sample consists of 88,977 observations. Since the questions used to construct variables in the PSID are retrospective – in the 1982 survey the households are asked to report their characteristics for 1981 – we annualize our quarterly proxy of TFP news for the same time span of the PSID dataset. Table 2 summarizes the main PSID variables used in the paper. We notice that total consumption is less volatile than family income where standard deviation of these variables are respectively estimated at 0.46 and 0.78. The average number of children is almost one. House owner is a dummy variable that takes value one if the family owns the house where they live and zero otherwise. In the rest of the socio-demographic variables we refer to the family head. For instance, the mean age is more than 41 years old; there are more male (81%) than female (19%) heads of families; and the proportion of self-employed heads is 12% with respect to non-self-employment. Those reporting health limitations are 13% of the sample.[10]

Table 2: Descriptive Statistics

Variables	Mean	S.D.
Total consumption (log)	8.42	0.46
Family income (log)	9.27	0.78
Self-employment	0.12	0.33
Health limitation	0.13	0.34
House owner	0.67	0.46
White	0.88	0.31
Age	41.56	11.27
Male	0.81	0.38
Number of children	0.96	1.16
Real house price	10.76	0.85
Observations	88,977	

Note: *Self-employment* refers to the proportion of self-employed heads with respect to non-self-employment; *Health limitation* refers to the proportion of those reported to have health limitations; *Real house price* refers to house prices over CPI.

Figure 2 plots the relationship between the TFP news and changes in income, changes in housing wealth and change in consumption. Panel A plots the relationship between change in consumption and TFP. Panel B shows the relationship between change in consumption and change in income. Finally panel C shows the relationship between change in consumption and change in non-human wealth. Overall consumption decisions are closely linked both to changes in current income, to news about future income captured by the

[8] For a detailed explanation, we refer the reader to Attanasio and Pistaferri (2014). In the surveys of 1988, 1989 and 1990 there is no consumption data available

[9] Considering the 1968 family interview number available in the individual-level files (variable ER30001) we drop the SEO (Survey of Economic Opportunity) and retain the SRC (Survey Research Center) sample families. SRC families have values less than 3,000 while SEO sample families have values greater than 5,000 and less than 7,000. For further information, see `https://psidonline.isr.umich.edu/guide/faq.aspx`.

[10] For further details about the questionnaires: `https://psidonline.isr.umich.edu`.

TFP series and to changes in non-human wealth. The correlation of change in consumption with TFP news is 0.37, with income change is 0.25 and with real house price change (measured as a fraction of lagged consumption) is 0.66. All the correlations are significant at 1% level (p-$val < 0.01$).

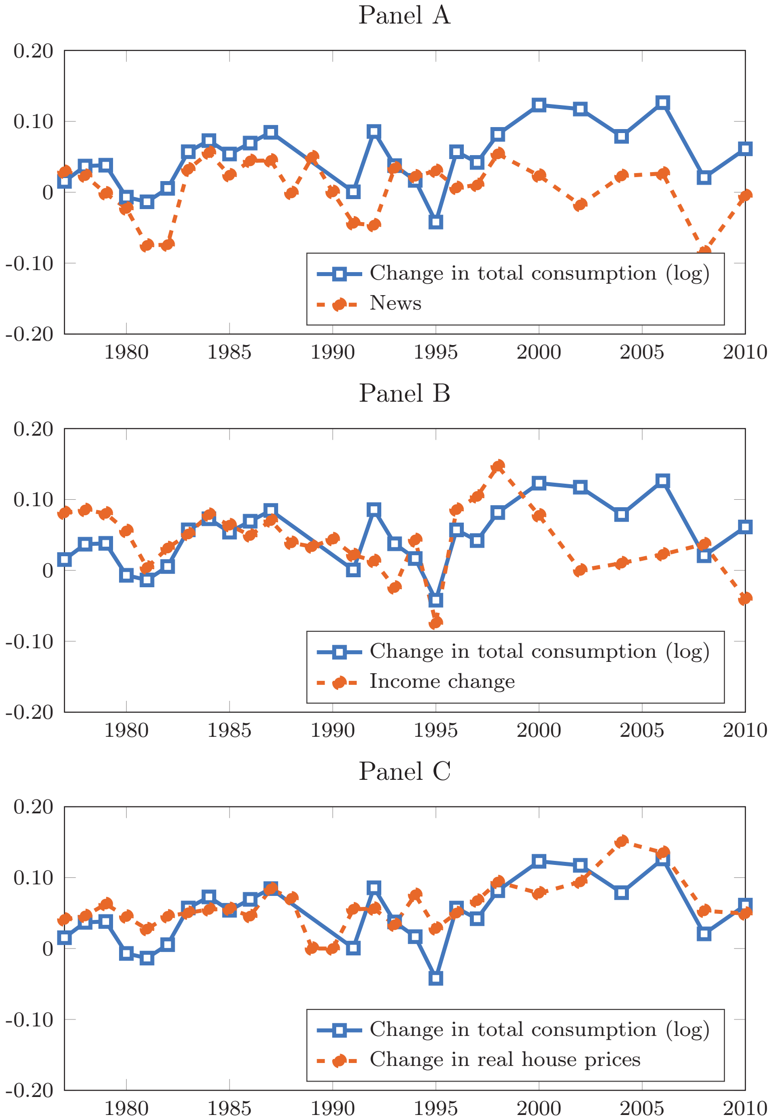

Figure 2: News and Consumption Growth: 1977-2010

Note: The observations are biannual after the year 1998. Correlation between change in total consumption (log) and news: 0.37 (Panel A). Correlation between change in total consumption (log) and income change: 0.25 (Panel B). Correlation between change in total consumption (log) and real house price change (as a fraction of lagged consumption): 0.66 (Panel C).

3.3 Results

For our benchmark estimation, we consider the effects on change in log consumption ($\Delta c_{i,t}$) of (i) changes in income ($\Delta y_{i,t}$) and (ii) news about future income ($\texttt{news}_t$) where news is characterized by information available to consumers not contained in the income signal, and our empirical model is given by:

$$\Delta c_{i,t} = \alpha \times \Delta y_{i,t} + \phi \times \texttt{controls}_{i,t} + \kappa \times \texttt{news}_t + v_i + \epsilon_{i,t},$$

where v_i is the individual fixed effect and $\epsilon_{i,t}$ an idiosyncratic term.

We consider the following research questions. First, we ask if consumers care about something more than the information in their own income such that we test whether news about future income is useful in forecasting the change in household consumption even when controlling for the growth of household income. We control for the growth of household income to verify if there are violations of the permanent income hypothesis (PIH) due to liquidity constraints. We instrument changes in income, Δy, as it contains information not available to the consumer when the consumer chose spending in the past. Under the PIH, the null is that the effect of expected changes in income is zero, so the coefficient on Δy instrumented with information available at time $t-1$ should be zero. Second, we ask whether consumption responds differently to positive (good) and negative (bad) news. In other terms, we separately estimate the magnitude of consumption responses for positive and negative news, i.e., whether the coefficient κ is significant when $news > 0$ or $news < 0$, and we also test whether the size of the responses are statistically different for the two cases.

For our estimation exercise, we use (*i*) a pooled OLS, (*ii*) a panel fixed effect estimation, and (*iii*) instrumental variables panel fixed effect specification (Panel IV-GMM). The OLS specification clusters standard errors by household. The fixed effect specification (Panel FE) removes the influence of time invariant household characteristics related to income changes. We also control for other observable time varying household characteristics that may be related to income changes (home ownership, self-employment, health limitation, age, employment status, marital status, number of children, state of residence). Finally, we exploit the panel structure of the PSID by using an instrumental variables fixed effect (Panel IV-GMM) estimation by instrumenting the variable Δy with lags from 2 to 28.

Table 3: Benchmark PSID

	Pooled OLS Δc	Panel FE Δc	Panel IV-GMM Δc
`news`	0.390*** (0.06)	0.419*** (0.08)	0.383*** (0.07)
Δy	0.295*** (0.00)	0.292*** (0.00)	0.359*** (0.01)
`constant`	-0.270*** (0.03)	-0.326*** (0.04)	-0.266*** (0.04)
`controls`	Yes	Yes	Yes
N	31,011	31,011	31,011

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, martial status, number of children, and states. Panel IV-GMM: Δy is instrumented with lags 2 to 28. Sargan Test: 31.70 (0.203). Hansen Test: 18.16 (0.870). Significance level: * 10%, ** 5%, *** 1%.

Table 3 reports our benchmark estimation to identify whether the news variable is useful to predict consumption growth: for all our model specifications, coefficients on news variables are estimated to be positive and statistically significant so it contains important information that affect households' consumption decisions. The positive sign suggests that when the consumer receives negative (positive) news he will react by decreasing (increasing) consumption. The result holds when we account for households' fixed effects (Panel FE) and when we instrument income (Panel IV-GMM). By instrumenting current income with past income changes we find that there are violations of the PIH due to liquidity constraints. So for any 1% increase in income, consumption will increase by 0.29% in the fixed effect specification and by 0.36% in the instrumental variables fixed effect specification. The Sargan and Hansen tests do not reject the null hypothesis that the excluded instruments are exogenous and therefore independent of the error process.[11]

Table 4 considers our second research question, i.e., whether households' consumption decision is asymmetric to the type of news they receive. We consider the following specification:

$$\Delta c_{i,t} = \alpha \times \Delta y_{i,t} + \phi \times \texttt{controls}_{i,t} + \kappa^{+} \times (\texttt{news}_t > 0) + \kappa^{-} \times (\texttt{news}_t < 0) + v_i + \epsilon_{i,t},$$

where we estimate how consumption changes respond to positive news ($\texttt{news}_t > 0$) and negative news ($\texttt{news}_t < 0$). The results show that negative news is a very useful variable whereas the coefficient on positive news is not statistically significant. The result holds when we include households' fixed effects (Panel FE) and when we instrument income (Panel IV-GMM). By instrumenting changes in income we find that there are violations of the PIH due to liquidity constraints.

Table 4: Separately Estimating Positive and Negative News

	Pooled OLS	Panel FE	Panel IV-GMM
	Δc	Δc	Δc
$\texttt{news} < 0$	0.661*** (0.13)	0.620*** (0.15)	0.666*** (0.14)
$\texttt{news} > 0$	-0.069 (0.18)	0.077 (0.21)	-0.102 (0.19)
Δy	0.295*** (0.00)	0.292*** (0.00)	0.361*** (0.01)
`constant`	-0.257*** (0.03)	-0.316*** (0.04)	-0.252*** (0.04)
`controls`	Yes	Yes	Yes
N	31,011	31,011	31,011

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. Panel IV-GMM: Δy is instrumented with lags 2 to 28. Sargan Test: 24.20 (0.508). Hansen Test: 17.83 (0.850). Significance level: * 10%, ** 5%, *** 1%.

There could be other constraints, i.e., the effect of collateral constraints, that affect households' consumption behavior. Here, we not only consider the effects on consumption of changes in income (Δy) but also include changes in non-human wealth (ΔHousePscaled) for our model specification, where changes in non-human wealth are defined by changes in real house prices between time t and time $t-1$ over consumption in $t-1$. Table 5 reports the estimation results when instrumenting both changes in income and non-human wealth, and it shows that negative news are still very useful to explain households' consumption decisions while positive news are not, even controlling for income and wealth effects. Also, as in our other estimation results, the permanent income hypothesis is violated as changes in income (Δy) are estimated to be positive and statistically significant at the 1% level, although their magnitude is lower since we also consider wealth effects,

[11]Under the null hypothesis that all instruments are uncorrelated with the error term, the test has a large-sample $\chi^2(r)$ distribution where r is the number of over-identifying restrictions.

which are estimated positive and statistically significant. So for any 1% increase in income, consumption will increase by 0.25% in the fixed effect specification and by 0.30% in the instrumental variables fixed effect specification.

Table 5: Controlling the Signs of Income and Wealth

	Pooled OLS Δc	Panel FE Δc	Panel IV-GMM Δc
`news` < 0	0.528*** (0.13)	0.475*** (0.15)	0.482***(0.18)
`news` > 0	0.013 (0.18)	0.165 (0.20)	0.009 (0.19)
Δy	0.257*** (0.00)	0.253*** (0.00)	0.304*** (0.01)
Δ`HousePscaled`	0.010*** (0.00)	0.011*** (0.00)	0.015 (0.01)
`constant`	-0.202*** (0.03)	-0.245*** (0.04)	-0.170*** (0.06)
`controls`	Yes	Yes	Yes
N	30,678	30,678	30,678

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. Panel IV-GMM: Δy is instrumented with lags 2 to 28. Sargan Test: 21.29 (0.621). Hansen Test: 17.45 (0.829). Significance level: * 10%, ** 5%, *** 1%.

As shown in Figure 1, the behavior of our news variable is highly correlated with the dynamics of consumer sentiments depicted by the Index of Consumer Sentiment (ICS).[12] Given the high correlation between our news variable and the ICS, we attempt to estimate our model with the ICS in lieu of the news variable used in the last section. The results reported in Table 6 show that for the ICS there is evidence of an asymmetric effect on consumption, although with a lower magnitude. So for a unitary decrease in the ICS index, consumption falls by 0.110. The reduction in consumption after the arrival of negative news on productivity is, instead, larger and equal to 0.475. The Index of Consumer Sentiment is based on how consumers view three things: (*i*) their own financial situation, (*ii*) the short-term general economy, and (*iii*) the long-term general economy. So the impact of perceptions about the long-term general economy, which is gathered in the survey, may be diluted in the more general index generating a lower impact on consumption changes.

Finally, in Table 7 we find gender heterogeneity in the response to news. The results show that female headed households are more uncertainty averse: the interaction between positive news and male suggests that male headed households react more to positive news while the coefficient on the interaction of negative news with male is not statistically different from zero. Our results corroborate the empirical evidence on gender attitudes towards ambiguity. For example, Schubert et al. (1999) find that women are more ambiguity averse than men in an investment context while Powell and Ansic (1997) report that women are both more risk averse and ambiguity averse.

[12]Each month at least 500 telephone interviews are conducted of a continental United States sample (Alaska and Hawaii are excluded). The index is normalized to have a value of 100 in December 1964.

Table 6: News and the Index of Consumer Sentiment

	Panel FE	Panel FE
	Δc	Δc
`news` < 0	0.475*** (0.15)	–
`news` > 0	0.165 (0.21)	–
ΔICS < 0	–	0.110** (0.05)
ΔICS > 0	–	-0.020 (0.02)
Δy	0.253*** (0.00)	0.253*** (0.00)
Δ`HousePscaled`	0.011*** (0.00)	0.011*** (0.00)
`constant`	-0.245*** (0.04)	-0.244 (0.04)
`controls`	Yes	Yes
N	30,678	30,678

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. Significance level: * 10%, ** 5%, *** 1%.

Table 7: News Interaction with Gender

	Panel FE	Panel IV-GMM
	Δc	Δc
`news` < 0	0.769** (0.35)	0.627** (0.32)
`news` > 0	-0.630 (0.51)	-0.654 (0.46)
`male*news`< 0	-0.365 (0.38)	-0.200 (0.34)
`male*news`> 0	0.979*(0.56)	0.826 (0.51)
Δy	0.253*** (0.01)	0.297*** (0.02)
Δ`HousePscaled`	0.011*** (0.00)	0.016*** (0.00)
`controls`	Yes	Yes
N	30,678	30,678

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. Panel IV-GMM: Δy is instrumented with lags 2 to 28. Sargan Test: 61.41 (0.151). Hansen Test: 43.75 (0.754). Significance level: * 10%, ** 5%, *** 1%.

3.4 Robustness check

In this section we implement further robustness checks concerning the presence of (*i*) asymmetric income effects, (*ii*) asymmetric income effects, separately estimating positive and negative news, and (*iii*) asymmetric income and wealth effects, separately estimating positive and negative news.

Table 8 shows the effect on consumption of asymmetric changes in income, giving us an estimate of the marginal propensity to consume. Under the assumption of perfect credit markets, current income plays a marginal role in the determination of consumption decisions. Nevertheless, this is not a realistic hypothesis: often individuals do not have access to the credit market, or have limited access to it. The inability to borrow, observed in reality, implies a failure for the life cycle and permanent income models. In particular, Zeldes (1989) and Deaton (1992) made fundamental contributions to the discussion of the role of liquidity constraints in the determination of consumption decisions. Furthermore, liquidity constraints give rise to asymmetrical responses of consumption to income changes of opposite sign. As a matter of fact, if the liquidity constraint is binding, a negative income change prevents households from saving and implicates a large consumption response. Instead, with positive shocks, it is likely that the constraint is relaxed and that households are able to save, so that the consumption response is smaller. The results when we instrument asymmetric income changes (Panel IV-GMM) show that a decrease by 1% in income reduces consumption by 0.49% while an increase in income by 1% increases consumption only by 0.25% validating the hypothesis that negative income changes imply, indeed, a larger consumption response.

Table 8: Asymmetric Income Effects

	Pooled OLS	Panel FE	Panel IV-GMM
	Δc	Δc	Δc
`news`	0.392*** (0.06)	0.422*** (0.08)	0.369*** (0.07)
$\Delta y < 0$	0.266*** (0.01)	0.263*** (0.01)	0.492*** (0.15)
$\Delta y > 0$	0.321*** (0.01)	0.319*** (0.01)	0.256** (0.12)
`constant`	-0.291*** (0.03)	-0.346*** (0.04)	-0.176 (0.11)
`controls`	Yes	Yes	Yes
N	31,011	31,011	31,011

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. Panel IV-GMM: $\Delta y \lessgtr 0$ is instrumented with lags 2 to 28. Significance level: * 10%, ** 5%, *** 1%.

Table 9: Asymmetric Income and News Effects

	Pooled OLS	Panel FE	Panel IV-GMM
	Δc	Δc	Δc
`news` < 0	0.658*** (0.13)	0.615*** (0.15)	0.709*** (0.15)
`news` > 0	-0.058 (0.18)	0.094 (0.21)	-0.258 (0.23)
$\Delta y < 0$	0.266*** (0.01)	0.264*** (0.01)	0.649*** (0.17)
$\Delta y > 0$	0.321*** (0.01)	0.319*** (0.01)	0.139 (0.14)
`constant`	-0.277*** (0.03)	-0.336*** (0.04)	-0.053 (0.12)
`controls`	Yes	Yes	Yes
N	31,011	31,011	31,011

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. Panel IV-GMM: $\Delta y \lessgtr 0$ is instrumented with lags 2 to 28. Significance level: * 10%, ** 5%, *** 1%.

When we consider asymmetric income effects by separately estimating positive and negative news, the results reported in Table 9 further show an amplification effect of negative news (about long-run income) and of negative changes in current income. The results obtained when we instrument asymmetric income changes show that a 1% reduction in current income decreases consumption by 0.64%. In our final robustness check in Table 10 we consider both income and wealth effects, separately estimating positive and negative news. The results obtained by instrumenting both asymmetric income and wealth changes show that a 1% increase in changes in non-human wealth (ΔHousePscaled) increases consumption by 0.028%. This could be evidence of a pure wealth effect for homeowners (which we control for in the estimation) or of a collateral effect for credit constrained households; in this case the increase in the house value relaxes the borrowing constraint, raising consumption.

Table 10: Asymmetric Income, News and Wealth Effects

	POLS Δc	Panel FE Δc	Panel IV-GMM Δc
`news` < 0	0.555*** (0.13)	0.502*** (0.15)	0.603***(0.12)
`news` > 0	0.030 (0.18)	0.186 (0.20)	-0.077 (0.23)
$\Delta y < 0$	0.263*** (0.01)	0.263*** (0.01)	0.669*** (0.18)
$\Delta y > 0$	0.260*** (0.01)	0.253*** (0.01)	0.059 (0.15)
Δ`HousePscaled` < 0	0.002 (0.01)	0.001 (0.01)	-0.022 (0.03)
Δ`HousePscaled` > 0	0.012*** (0.01)	0.013*** (0.01)	0.028** (0.01)
`constant`	-0.225*** (0.03)	-0.272*** (0.04)	-0.022 (0.15)
`controls`	Yes	Yes	Yes
N	30,678	30,678	30,678

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. Panel IV-GMM: $\Delta y \lesseqgtr 0$ and Δ`HousePscaled` $\lesseqgtr 0$ are instrumented with lags 2 to 28. Significance level: * 10%, ** 5%, *** 1%.

Table 11: Controlling for Habit formation and Real Interest Rate

	Habit Formation Δc	Interest Rate Δc	Habit Formation + Interest Rate Δc
`news` < 0	0.486*** (0.14)	0.633*** (0.15)	0.653***(0.16)
`news` > 0	0.055 (0.19)	-0.147 (0.20)	-0.141 (0.21)
Δy	0.290*** (0.01)	0.296*** (0.02)	0.286*** (0.02)
Δc_{-1}	-0.015 (0.02)	–	-0.021 (0.02)
`rffr`	–	0.003*** (0.00)	0.003** (0.001)
Δ`HousePscaled`	0.014*** (0.00)	0.016*** (0.00)	0.014*** (0.00)
`constant`	-0.202*** (0.03)	-0.181*** (0.04)	-0.182*** (0.04)
`controls`	Yes	Yes	Yes
N	26,279	30,678	26,279

Note: Standard errors in parentheses. Controls include home ownership, gender, race, self-employment, health limitation, age, employment status, marital status, a number of children, and state. The variable `rffr` stands for the real federal funds rate. Estimation by Panel IV-GMM: Δy and `rffr` are instrumented with lags 2 to 28. Significance level: * 10%, ** 5%, *** 1%.

Finally, the specification of the consumption equation estimated here does not allow for the hypothesis of habit formation. There is a debate on the relevance of habits in consumption, with Fuhrer (2000) pointing to the need of modeling them to replicate stylized facts related to monetary policy shocks and aggregate consumption, and Dynan (2000) pointing to lack of evidence when working with micro data. To this end, we introduce the growth rate of consumption lagged one period to the RHS of the estimated equation. Furthermore, one of the variables typically used to model consumption in business cycle models is the real interest rate, which is responsible of the intertemporal substitution motive. Again, we check for the (aggregate, for simplicity) real interest rate by placing it on the RHS. Table 11 shows that, in both cases, our main results survive. It is also important to notice that our findings confirm the conclusions in Dynan (2000) since the coefficient associated to Δc_{-1} is not statistically different from zero.

4 Conclusion

We have shown that news about aggregate future income can be helpful to predict households' consumption change. Moreover, households react more to bad news than good news such that they reduce consumption spending more after receiving bad news than increase spending when receiving good news. We suggest that these observed asymmetric consumption responses could be explained by information being ambiguous and agents' aversion to ambiguity.

Our results are robust to using the Index of Consumer Sentiment (ICS) in lieu of the estimated news series such that consumption responses are larger following a unitary decrease in the ICS than a unitary increase although the responses are smaller when estimated with the ICS. This can be explained by the fact that the ICS is an aggregation of consumers' financial situations, their perceptions about the short-term economy, and about the long-term general economy: since households are permanent income consumers, their consumption decision depends on perceptions about the long-term general economy, and the impact on consumption (of perceptions about the long-term general economy) may have been weakened in the aggregation of the survey.

Our results also shed light on gender attitudes towards uncertainty: female headed households exhibit a stronger aversion toward uncertainty. Specifically, male headed households seem to be more reactive than females to positive news and tend to increase their consumption on the arrival of a positive news on future income levels. Our general results confirm the importance of the arrival of new information when households set their consumption decisions. We provide evidence that ambiguous information on future income levels generates asymmetric and heterogeneous consumption responses across households that can spillover into the macroeconomy.

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A Appendix

A.1 Estimating the News Series

Since all the exogenous shocks are Gaussian, we can safely assume that consumers can sequentially update beliefs: first processing information contained in productivity and then processing information available in the noisy signal. Consumers' Kalman filter can then be constructed as follows:

$$\mathbf{X}_{t|a_t} = \begin{bmatrix} x_{t|a_t} \\ x_{t-1|a_t} \\ z_{t|a_t} \end{bmatrix} = A \begin{bmatrix} x_{t-1|t-1} \\ x_{t-2|t-1} \\ z_{t-1|t-1} \end{bmatrix} + H \begin{bmatrix} 1+\rho & -\rho & -\rho \end{bmatrix} \begin{bmatrix} x_{t-1} \\ x_{t-2} \\ z_{t-1} \end{bmatrix} + H\epsilon_t + H\eta_t, \quad (5)$$

where $\mathbf{X}_{t|a_t}$ is consumers' beliefs updated with information contained in the productivity signal (a_t) and the matrices A and H depend on the underlying parameters of the model.

Conditional on $\mathbf{X}_{t|a_t}$, consumers' second stage belief updating with the noisy signal is given by:

$$\begin{bmatrix} x_{t|t} \\ x_{t-1|t} \\ z_{t|t} \end{bmatrix} = \begin{bmatrix} x_{t|a_t} \\ x_{t-1|a_t} \\ z_{t|a_t} \end{bmatrix} + G \begin{bmatrix} 1+\rho & -\rho & 0 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ x_{t-2} \\ z_{t-1} \end{bmatrix} + G\epsilon_t + G\eta_t + G\nu_t, \quad (6)$$

where the matrix G depends on the underlying parameters of the model.

We let $\mathbf{X}_t^E$ to represent the econometrician's beliefs:

$$\mathbf{X}_t^E = (x_t,\ x_{t-1},\ z_t,\ x_{t|t},\ x_{t-1|t},\ z_{t|t})', \quad (7)$$

and the dynamics of $\mathbf{X}_t^E$ can be characterized by:

$$\mathbf{X}_t^E = Q\mathbf{X}_{t-1}^E + R(\epsilon_t,\ \eta_t,\ \nu_t)'. \quad (8)$$

The matrices Q and R depend on the underlying model parameters and are given respectively by:

$$Q = \begin{bmatrix} A & \mathbf{0} \\ \mathbf{Q} & \mathbf{A} \end{bmatrix},$$

$$R = \begin{bmatrix} B \\ \mathbf{R} \end{bmatrix},$$

$$A = \begin{bmatrix} 1+\rho & -\rho & 0 \\ 1 & 0 & 0 \\ 0 & 0 & \rho \end{bmatrix},$$

$$B = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix},$$

where $\mathbf{Q}$, $\mathbf{R}$, and $\mathbf{A}$ are given by:

$$\mathbf{Q} = B \begin{bmatrix} 1+\rho & -\rho & \rho \\ 1+\rho & -\rho & 0 \end{bmatrix},$$

$$\mathbf{R} = B \begin{bmatrix} 1+\rho & 0 & 0 \\ 1+\rho & 0 & 0 \end{bmatrix} + B \begin{bmatrix} 1+\rho & 0 & 0 \\ 1+\rho & 0 & 0 \end{bmatrix} + B \begin{bmatrix} 1+\rho & 0 & 0 \\ 1+\rho & 0 & 0 \end{bmatrix},$$

$$\mathbf{A} = \left[I - HC_1\right] \left[I - GC_2\right] A.$$

As the econometrician's information set includes consumption (c_t) and productivity series (a_t), the observation equation is given by:

$$(a_t,\, c_t) = T\mathbf{X}_t^E, \tag{9}$$

where

$$T = \begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1/\left(1-\rho\right) & \rho/\left(1-\rho\right) & 0 \end{bmatrix},$$

We then can build the state space representation of the model using Equation (5), Equation (6), Equation (8) and Equation (9) and structurally estimate the model to recover the news series.

A.2 Parameter Estimates: Excluding the Great Recession

Table 12: Parameter Estimates, U.S. 1976-2007

Parameter	Description	Median	s.e.
ρ	Persistence productivity	0.9430	0.0124
σ_u	Std dev. productivity	0.0061	0.0003
σ_ϵ	Std dev. permanent shock (implied)	0.0003	–
σ_η	Std dev. transitory shock (implied)	0.0060	–
σ_ν	Std dev. noise shock	0.0156	0.0039

Note: σ_ϵ and σ_η are recovered from the estimated ρ and σ_u based on the random walk productivity assumption. As they are indirectly recovered, no standard errors are given.

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