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What Is Consumer Confidence?*

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Abstract

This paper offers a structural interpretation of survey-based measures of consumer confidence. To this end, we consider a simple consumption model based on permanent income logic and estimate it using national accounts. In our framework, consumers receive noisy information about the future and make consumption decisions. Based on this setup, we construct a model-implied measure of consumer confidence and extract it from the data. We show that the model-implied measure corresponds well to fluctuations in confidence survey data for the U.S. and a host of European countries. Our analysis provides an informational mechanism to interpret these widely used confidence indices.

Keywords: Aggregate spending, confidence indices, noisy information

JEL Classification Codes: E21, E32, E66

The views expressed are those of the authors and do not necessarily represent the official views of Eesti Pank or the Eurosystem.

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Non-technical Summary

We ask, from a structural perspective, what consumer confidence measures and what it reflects about economic conditions. While consumer confidence indicators are frequently discussed in the media and used to address the state of the economy, there is lack of a clear understanding of what these survey indicators truly reflect. We develop an information-based interpretation of consumer confidence based on a simple consumption model with noisy information about future income. In this framework, households choose how much to spend based on expectations of their future income. Yet consumers do not perfectly foresee the economy; rather, they receive a mixture of informative *news* and uninformative *noise*. Because spending decisions depend on beliefs about the future, we argue that observing how consumption responds to new information may allow us to infer movements in confidence. This allows us to construct a model-based confidence index directly from national accounts. For the U.S., our index closely matches the Index of Consumer Sentiment, especially after smoothing. Applying the same method to 14 European countries produces similar correspondence, though with varying strength across nations.

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1 Introduction

Measuring the degree of optimism consumers feel about the overall state of the economy, consumer confidence is widely discussed in the popular press and in economic commentaries.[1] While unambiguously reflecting prevailing economic and business conditions perceived by survey respondents, how to interpret "consumer confidence" has been the subject of discussion in the academic literature.[2] On the one hand, consumer confidence is considered to be an important prognostic factor to understand the business cycle fluctuations. To the other extreme, there is a view that expectations held by consumers are little more than uninformed guesses. At any rate, we observe a close relationship between aggregate trends in the measure of confidence with the corresponding trends in the aggregate quantities. It is then natural to ask if we can characterize the mechanism by which consumers' attitudes influence aggregate fluctuations.

In this paper, we evaluate what consumer confidence represents from the lens of estimated business cycle models. We emphasize the role of information and expectation formation to identify and understand consumer confidence. Specifically, we provide an informational mechanism to interpret consumer confidence measurements using national accounts.[3]

In Section 2, we lay out a foundation to measure *model-based* consumer confidence. We assume that consumers cannot perfectly forecast the future and proceed to estimate confidence given a structural interpretation of the economy. Our simple learning model based on Blanchard, L'Huillier, and Lorenzoni (2013) and L'Huillier and Yoo (2017) captures the idea that waves of optimism and pessimism are related to the dynamics of spending (relative to productivity). There, agents' perception of the future changes due to fundamentals and due to information *unrelated* to present (or past) fundamentals.

[1] See, for example, Smith (2025) and Buchwald (2025).

[2] These survey-based indices include the Index of Consumer Sentiment (ICS), produced by the Survey Research Center of the University of Michigan, and the Consumer Confidence Index, issued by the Conference Board among others. Appendix A provides a more detailed description of these indices.

[3] Since its inception in 1953, the System of National Accounts constitutes, in principle, an internationally consistent and coherent measure of activity. Thus, a structural method based on national accounts could provide a measure for consumer confidence that is internationally consistent.

Our method to estimate consumer confidence relies on two assumptions. First, agents' information structure is given by the combination of the permanent-transitory productivity decomposition and the signal on the permanent component. Second, a structural model describing agents' consumption behavior follows the permanent income logic. Productivity is determined exogenously by a combination of a permanent and a temporary shock. Consumers receive noisy signals about the permanent productivity of the economy. According to the permanent income hypothesis, consumers choose spending based on their expected future income. Thus, estimating the parameters of the model and making inferences is feasible by looking at productivity and consumption trends. We, as econometricians, are able to estimate consumers' beliefs about the future and underlying structural shocks as well as *model-based* consumer confidence, which is defined as a function of consumers' beliefs and shocks.

Our set of assumptions and approach can reasonably achieve our goals for the following reasons. First, our model fits the data well, based on results in L'Huillier and Yoo (2019). Second, the simple model achieves identification. Third, the information structure captures well the role of belief-driven fluctuations. (We elaborate on these points in Section 2.2.)

While incorporating noisy news in a standard model has recently been discussed,[4] our focus is on extracting the evolution of agents' perception about the state of the economy. We isolate the contribution of noisy signals to current consumption, effectively capture the role of agents' additional information beyond the fundamental, which we call our *model-based consumer confidence index.*

Having estimated consumer confidence, we proceed to compare it with a survey-based confidence index in Section 3. We use U.S. national accounts data to obtain the model-based consumer confidence index and compare it with the Index of Consumer Sentiment (ICS). A key contribution of our paper is to propose a structural interpretation of consumer confidence under imperfect information and learning. We also show that model-based consumer confidence matches the ICS quite well, with a statistically significant ($< 1\%$) correlation of 0.52 between the two. Smoothing out high-frequency noise using a band-pass filter delivers a higher correlation with the ICS (0.79).

[4]See, for example, Blanchard et al. (2013), Boz, Daude, and Durdu (2011), and Cao and L'Huillier (2018).

We also compare our model-based consumer confidence with the Consumer Confidence Index (CCI) in fourteen European countries in Section 4. Our results show that model-based measures are estimated to be highly correlated with the survey-based measure for nine out of fourteen countries in our sample (even if we do not use the survey measures as an input).

At the same time, there exists a great deal of heterogeneity such that for countries like Austria, Belgium, Germany, Finland, and Sweden, our measure fails to match the CCI. We show that, to some degree, this observed heterogeneity is driven by the survey measure not being able to track observed consumption contemporaneously.

1.1 Relation to the Literature

The crucial ingredient of our model is an information structure where agents receive noisy information of permanent productivity of the economy, discussed in Boz, Daude, and Durdu (2011), Lorenzoni (2009), Blanchard, L'Huillier, and Lorenzoni (2013), Cao and L'Huillier (2018), and Rousakis (2013), among others. While sharing similar information structures, we solve a signal extraction problem sequentially, as in L'Huillier and Yoo (2017) and Yoo (2019), disentangling the effects of different signals on aggregate fluctuations.

Using consumer confidence to forecast aggregate quantities, Batchelor and Dua (1998) show that paying attention to the sharp fall in consumer confidence would have helped predict the 1991 recession. However, consumer confidence would have not been helpful in forecasting recessions in other years. Howrey (2001) shows that the U.S.'s ICS is a statistically significant predictor for forecasting the near-term probability of a recession when used independently or in conjunction with other indicators.[5] In addition, Lahiri, Monokroussos, and Zhao (2015) consider a more realistic and general context to analyze the predictive power of consumer confidence by using monthly and real-time data along with a large number of explanatory variables and show that measures of consumer confidence provide a positive contribution in forecasting consumption expenditure. Barsky and Sims (2012) use structural estimation to assess the impact of consumer confidence in a

[5] These indicators include the spread between long and short-term interest rates, the New York Stock Exchange composite price index, and the Conference Board index of leading indicators.

model that features signal extraction.

Our modeling approach originates in the contributions by Beaudry and Portier (2004, 2006). They were the first to point out that news shocks offer a useful interpretation of macroeconomic data. Schmitt-Grohé and Uribe (2012) also investigated the impact of news shocks in a structural model. More recently, Chahrour and Jurado (2018, 2021) have made important advances in the identification of this type of shocks.

Other parallel strands of the literature investigate the impact of swings in private sector confidence but use very different models. For example, Ilut and Schneider (2014) use ambiguity. Angeletos and La'O (2013) use shocks akin to sunspots that operate in unique equilibrium models. Angeletos, Collard, and Dellas (2018) use a tractable form of higher order belief dynamics. Ilut and Saijo (2021) use a tractable heterogeneous-firm model where firms face Knightian uncertainty about their profitability and learn through production. To the best of our knowledge, none of these strands of the literature has taken a similar focus on survey data as we do.

2 Confidence in a Simple Consumption Model

We extract consumer confidence from a simple consumption model in which consumers form beliefs about the unobserved future path of productivity. In this framework, consumers continuously receive information about the future, some of which represents genuine news, while some is merely noise. Consumers accordingly choose spending. When the information turns out to be news, the economy gradually adjusts to a new level of activity; when it proves to be noise, the economy reverts to its original state.

Our choice of this simple consumption model is motivated by the observation that general equilibrium effects are almost entirely absent for consumption in the class of DSGE models under a standard calibration, as shown in L'Huillier and Yoo (2019). Thus, our simple model provides a good approximation to richer, standard DSGE specifications.

2.1 The Model

In this economy, consumption is the only endogenous variable and the behavior of consumption is described by a random walk:

$$c_t = \mathbb{E}_t[c_{t+1}|\mathcal{I}_t]$$

Blanchard et al. (2013) show that this model can be obtained from first principles, and it can be expressed as the limit of an economy with very sticky prices and hence negligible interest rate volatility.

There is no capital, and output is completely determined by the demand side where consumption is the only determinant of demand:

$$y_t = c_t$$

Simplifying the supply side, we assume that the role of labor input is to adjust to the current productivity level a_t and to produce output y_t:

$$n_t = y_t - a_t$$

Given that the output in the long-run returns to its natural level

$$\lim_{j\to\infty} \mathbb{E}_t[c_{t+j} - a_{t+j}] = 0$$

current spending c_t is defined by

$$c_t = \lim_{j\to\infty} \mathbb{E}_t[a_{t+j}] \tag{1}$$

such that Equation (1) suggests consumption depends on the consumers' long-run productivity expectation.

We consider a single, representative information set by Blanchard et al. (2013) where fundamentals are stochastic processes describing exogenous changes in productivity or income summarized by a_t. Productivity is characterized by the sum of two components - a permanent component x_t and a transitory component z_t:

$$a_t = x_t + z_t \tag{2}$$

where two components are respectively defined by

$$\Delta x_t = \rho_x \Delta x_{t-1} + \epsilon_t$$
$$z_t = \rho_z z_{t-1} + \eta_t$$

The permanent component x_t follows a randomly changing trend due to a permanent shock ϵ_t, and the transitory component follows the stationary process with a transitory shock η_t. Two productivity shocks ϵ_t and η_t are assumed to be i.i.d. Gaussian with variances σ_ϵ^2 and σ_η^2. The coefficients ρ_x and ρ_z are in [0, 1).

We assume that the univariate process for a_t is a random walk:

$$\mathbb{E}[a_{t+1}|a_t, a_{t-1}, ...] = a_t \tag{3}$$

Blanchard et al. (2013) show that this random walk representation is analytically convenient and is also broadly in line with actual productivity data. This implies that

$$\rho_x = \rho_z = \rho$$

Also, the variances need to satisfy the restrictions:

$$\sigma_u^2 = \frac{(1-\rho)^2}{\rho_\epsilon^2} \tag{4}$$

and

$$\sigma_u^2 = \frac{\rho}{\sigma_\eta^2} \tag{5}$$

where σ_u is the standard deviation of Δa_t. Appendix E relaxes these parametric restrictions.

A key assumption regarding the productivity processes is that while agents observe productivity a_t as a whole, they do not observe the components x_t and z_t separately. This informational assumption is important since agents choose their current spending using their expectations about future productivity.[6] Since the transitory productivity process $z_{t+\infty}$ dies out in the long-run, just observing the whole productivity process a_t is not sufficient to predict the future state of the

[6]For the rest of the paper we use the terms *agents* and *consumers* interchangeably.

economy. Thus, agents would need to update their expectations about the future productivity. We assume they do so using the Kalman filter.

Considering the idea that agents have more information than merely about productivity, agents observe a noisy signal s_t about permanent productivity:

$$s_t = x_t + \nu_t \tag{6}$$

where ν_t is an i.i.d Gaussian shock with mean zero and variance σ_ν^2, and the shock ν_t is a noise shock because it affects agents' beliefs but is independent of fundamentals. This noisy signal denotes the additional informative signal that agents receive which is a straightforward interpretation of Equation (6). Ultimately, the presence of this noisy information helps the econometrician make inferences about the (unobserved) long-term productivity trend by looking at the behavior of consumption.

2.2 Validity of This Simple Approach

Our model assumptions are reasonable and useful for the application at hand for the following reasons.

First, this model fits the data well. Chahrour and Jurado (2018) show that their version of Blanchard et al. (2013) fits better than alternative specifications according to the Bayesian information criterion (BIC).[7] In addition, more complex models need a fixed interest rate to fit consumption data, as shown in L'Huillier and Yoo (2019). The general equilibrium effects of real interest rate changes on consumption are almost entirely neutralized in the class of medium-scale DSGE models that are most often used in quantitative macroeconomic work. Hence, we can reliably base our inference on a simpler permanent income model obtained as the limit of a general equilibrium model in which the volatility of the interest rate goes to zero. This insight simplifies and makes our inference more transparent, providing a cleaner interpretation of consumer confidence data. (Please see L'Huillier and Yoo 2019 for the full argument regarding the role of interest rate volatility.)

Second, our simple model is identified, as a number of recent works have demon-

[7]See Table 4 and the subsequent discussion on pp. 1731-1732 of Chahrour and Jurado (2018).

strated (see Blanchard et al. 2013, L'Huillier and Yoo 2017, Cao and L'Huillier 2018, among others).

Third, the information structure captures the role of belief-driven fluctuations. Combined with the forward-looking consumption decision, it generates empirically realistic co-movement patterns in response to a noise shock, as empirically evident by Chahrour and Jurado (2018).

Overall, our economic mechanism and information structure provide a good approximation of consumption behavior and effectively capture the role of belief-driven fluctuations, both of which are essential for our application to estimate consumer confidence. Moreover, the estimation based only on the assumption of permanent income behavior using consumption and productivity data is less likely to be subject to misspecification than is the estimation of bigger models using more data.

2.3 Solving the Model

Solving the model for consumption is a direct implementation of the Kalman filter to solve a signal extraction problem for the long-run productivity expectation, $a_{t+\infty}$. First, solving Equation (1), we get

$$c_t = \frac{1}{1-\rho}\left(x_{t|t} - \rho x_{t-1|t}\right) \tag{7}$$

where $x_{t|t} \equiv \mathbb{E}[x_t|\mathcal{I}_t] \equiv \mathbb{E}_t[x_t]$ and $x_{t-1|t} \equiv \mathbb{E}[x_{t-1}|\mathcal{I}_t] \equiv \mathbb{E}_t[x_{t-1}]$ represent agents' beliefs about current and lagged permanent productivity, respectively. Here, the agents' information set at time t, $\mathcal{I}_t$, includes current productivity, a_t, a noisy signal, s_t, and lagged information, $\mathcal{I}_{t-1}$:

$$\mathcal{I}_t = (a_t, s_t, \mathcal{I}_{t-1})$$

where $\mathcal{I}_0 = (a_0, s_0)$.

Second, agents' beliefs about the permanent state of the economy ($x_{t|t}$ and $x_{t-1|t}$) can be obtained by solving a signal extraction problem where an unobservable state vector $\mathbf{x}_t$ is given by $\mathbf{x}_t = (x_t,\ x_{t-1},\ z_t)'$, and an observable vector is given by $\mathbf{s}_t = (a_t,\ s_t)'$:

$$\mathbf{x}_{t|t} = \left[I - \kappa \times C\right] A\mathbf{x}_{t-1|t-1} + \kappa \times \mathbf{s}_t \tag{8}$$

where $\mathbf{x}_{t|t} = (x_{t|t},\ x_{t-1|t},\ z_{t|t})'$ and $\mathbf{x}_{t-1|t-1} = (x_{t-1|t-1},\ x_{t-2|t-1},\ z_{t-1|t-1})'$ are agents' beliefs about $\mathbf{x}_t$ at time t and $\mathbf{x}_{t-1}$ at time $t-1$ respectively, κ is a vector of steady-state Kalman gains, A and C are the functions of underlying parameters of the model, and I is the 3×3 identity matrix.

Thus, substituting $x_{t|t}$ and $x_{t-1|t}$ obtained in Equation (8) onto Equation (7), we can easily solve the model for consumption.[8]

2.4 A Mechanism to Extract Consumer Confidence

To measure consumer confidence in this framework, we exploit "additional information beyond fundamentals" conveyed to consumers. This additional information is useful to understand what consumer confidence is.

To begin with, we exploit the fact that the signal extraction problem discussed in the last section can also be solved sequentially as in L'Huillier and Yoo (2017) and Yoo (2019). By doing so, we disentangle the effects of two signals, productivity a_t and a noisy signal s_t, on consumption fluctuations.

The following procedure details how we obtain our measure of consumer confidence. Denote agents' expectations about a state vector $\mathbf{x}_t$ with current productivity and lagged information by

$$\mathbf{x}_{t|a_t} = \mathbb{E}[\mathbf{x}_t|\Omega_t]$$

where $\Omega_t = (a_t, \mathcal{I}_{t-1})$ such that $\Omega_t \in \mathcal{I}_t$ and $\Omega_t \cup s_t \equiv \mathcal{I}_t$.

Conditional on agents' beliefs at time $t-1$, $\mathbf{x}_{t-1|t-1}$, where agents' information set includes only productivity a_t (other than those available at time $t-1$), the belief updating is given by

$$\mathbf{x}_{t|a_t} = A\mathbf{x}_{t-1|t-1} + H(a_t - a_{t|t-1}) \tag{9}$$

where $\mathbf{x}_{t|a_t} = (x_{t|a_t}, x_{t-1|a_t}, z_{t|a_t})'$ and H is the steady state Kalman gain for ob-

[8] See Appendix C.1 for a detailed derivation of the model solution.

serving productivity a_t.

Moreover, conditional on agents' beliefs $\mathbf{x}_{t|a_t}$, updating beliefs with the noisy signal s_t leads to

$$\mathbf{x}_{t|t} = \mathbf{x}_{t|a_t} + G(s_t - s_{t|t-1})$$

To study the role of information unrelated to present (or past) fundamentals in consumption dynamics, we consider the level of spending agents would have chosen with the information set Ω_t denoted by $c_{t|a_t}$:

$$c_{t|a_t} = \frac{1}{1-\rho}\left(x_{t|a_t} - \rho x_{t-1|a_t}\right)$$

Here, without observing a noisy signal s_t, agents choose spending as a function of their beliefs about the current and lagged permanent productivity with the information set Ω_t.

We further define $\Delta c_{t|s_t}$ as consumption changes at time t due to information unrelated to present (or past) fundamentals:

$$\Delta c_{t|s_t} = \left(\frac{1}{1-\rho}\left(G^1 - \rho G^2\right)\right)\left(s_t - x_{t|a_t}\right)$$

where G^1 and G^2 are the first and second components of the steady-state Kalman gain G and represent respectively the gain of observing noisy signals on x_t and x_{t-1}. Thus, when s_t is greater than $x_{t|a_t}$, $\Delta c_{t|s_t}$ would be positive. Intuitively, when agents receive good information about the state of the economy ($s_t > x_{t|a_t}$), they would be willing to increase spending. (In other words, consumers increase their spending when they anticipate higher future income, as signaled by $s_t - x_{t|a_t}$.)

It is straightforward to show that

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

We can also define $\Delta c_{t|a_t}$, consumption changes at time t from the previous period's consumption due to fundamentals:

$$\Delta c_{t|a_t} = c_{t|a_t} - c_{t-1}$$

From Equation (9) and the definition of c_{t-1}, we have

$$\Delta c_{t|a_t} = \left(\frac{1}{1-\rho} \left(H^1 - \rho H^2 \right) \right) \left(a_t - x_{t|t-1} \right)$$

where H^1 and H^2 are the first and second components of the steady-state Kalman gain H and represent respectively the gain of observing productivity on x_t and x_{t-1}. Whenever a_t is greater than $x_{t|t-1}$, the last period's forecast on the permanent productivity component, $\Delta c_{t|a_t}$ is positive and vice versa: When agents receive good information compared to a benchmark (in this case, the last period's estimate on x_t), they would increase spending.

We have thus successfully disentangled changes in consumption into changes due to fundamentals and changes due to information unrelated to present (or past) fundamentals:

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

such that we can decompose the rate of consumption growth into two subcomponents.

We define our measure of consumer confidence as follows.

Definition 1 The *Model-Based Consumer Confidence Index* (MB-CCI) at time t is given by

$$\text{Model-Based Consumer Confidence Index}_t = \left(\hat{s}_t - \hat{x}_{t|a_t} \right)$$

where $\hat{s}_t$ and $\hat{x}_{t|a_t}$ are the estimated noisy signal and beliefs about the permanent productivity component conditional on productivity at time t. Both of these series are estimated using the Kalman smoother.

The Model-Based Consumer Confidence Index (MB-CCI) retrieves the contribution of additional information unrelated to present (or past) fundamentals on actual consumption changes. Our interpretation of consumer confidence emphasizes that it is a relative measure. Confidence is inherently related to agents' information, but we are being careful to distinguish the sources of information when measuring confidence.[9]

Throughout the paper, we also consider the medium-frequency MB-CCI, which we obtain by applying a band-pass filter at 32-200 frequencies. The main purpose of exploiting this medium frequency measure is to clearly visualize the slow-moving dynamics of MB-CCI, which is highly volatile due to the presence of noise shocks in our model.

In the next section, we estimate the MB-CCI and compare it against the survey-based counterpart for the U.S.

3 Results for the U.S.

As discussed in the previous section, we solve the model sequentially and proceed to estimation. As econometricians, we can represent the dynamics of the model in a state-space form with the appropriate observation equations, which in this case includes productivity and consumption. Consumers' expectations are part of the unobserved state vector of the econometrician. The econometrician's Kalman filter is used to construct the likelihood function and to estimate the parameters of the model. The model is estimated by maximum likelihood. In Appendix C.2 we show how to compute the likelihood function for a general representative-agent model with signal extraction where the signal is delivered sequentially.

We first solve the consumers' Kalman filter. We then build the econometrician's filter taking into account consumers' expectations. (Consumers' expectations are included in the list of unobservable state variables.) Our estimation includes the demeaned first differences of the logarithm of labor productivity and of the logarithm of per-capita consumption as observables. The simplicity of this model allows extracting a significant amount of information using only these two series. We use a Kalman smoother to estimate the shocks to the permanent and the transitory component of productivity, the noise shock, and the unobservable state variables. Our sample is given by the period 1976:II–2019:III, which includes the recent Great Recession.

[9]Our confidence index is not simply related to news-type ingredients (a long-run productivity innovation ϵ_t or a long-run productivity process x_t) nor to the animal spirit-type ingredients (a pure noise shock ν_t or a noisy signal s_t). Rather, our confidence measure is related to additional information available to consumers beyond the information pertained in productivity/income.

3.1 Data

Our dataset includes series on labor productivity and per capita real consumption expenditure. To construct a series for labor productivity (real GDP divided by the labor input), we use a quarterly real gross domestic product (GDPC1) from the U.S. Bureau of Economic Analysis and employment (LNS12000000Q) from the U.S. Bureau of Labor Statistics. Similarly, to construct a series for per capita real consumption expenditure (real consumption expenditure divided by the total population), we use a quarterly real personal consumption expenditure (PCECC96) and population (LNS10000000Q) where the first series was taken from the Bureau of Economic Analysis and the second series from the U.S. Bureau of Labor Statistics. Recession indicators for the United States are based on NBER-defined recessions. For the consumer confidence index, we use the Index of Consumer Sentiment (ICS) from the University of Michigan.

3.2 Model Estimation

We first present the estimation results for the model in Section 2. Table 1 reports the estimation results. The results show that the persistence parameter ρ is estimated to be highly persistent. Due to this high persistence, the standard deviation for permanent productivity shocks is very small. The standard deviation for noisy shocks is estimated to be large.

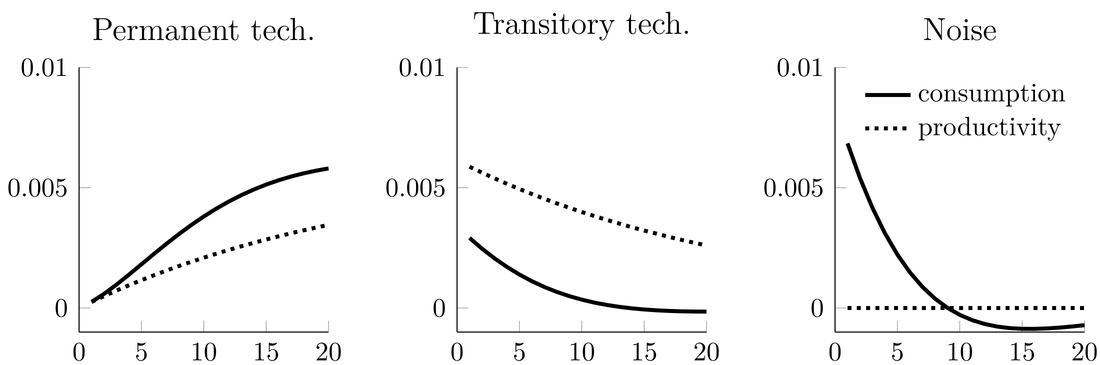
Table 1: Parameter Estimates, US 1976:II–2019:III

Parameter	Description	Value	s.e.
ρ	Persistence productivity	0.9613	0.0068
σ_u	Std dev. productivity	0.0058	0.0002
σ_ϵ	Std dev. permanent shock (implied)	0.0002	-
σ_η	Std dev. transitory shock (implied)	0.0057	-
σ_ν	Std dev. noise shock	0.0121	0.0036

Notes: The parameter σ_u defined by the standard deviation of Δa_t. Given the random walk Assumption (3) for a_t, σ_ϵ and σ_η are determined by ρ and σ_u. As they are indirectly recovered, no standard errors are given.

Figure 1 reports impulse responses of productivity and consumption following three exogenous shocks. We use the estimated parameters in Table 1. Due to a high productivity persistence, productivity gradually builds up (in the case of permanent technology shock) and slowly declines after an initial increase (in the case of transitory technology shock). A noise shock does not affect productivity. Following a permanent productivity shock, consumption gradually increases. Due to large volatilities in transitory and noise shocks, consumers cannot immediately recognize the permanent shock and adjust consumption slowly. In response to a transitory productivity shock, consumption initially increases but returns to normal over time. Following a noise shock, consumption initially increases and slowly declines.

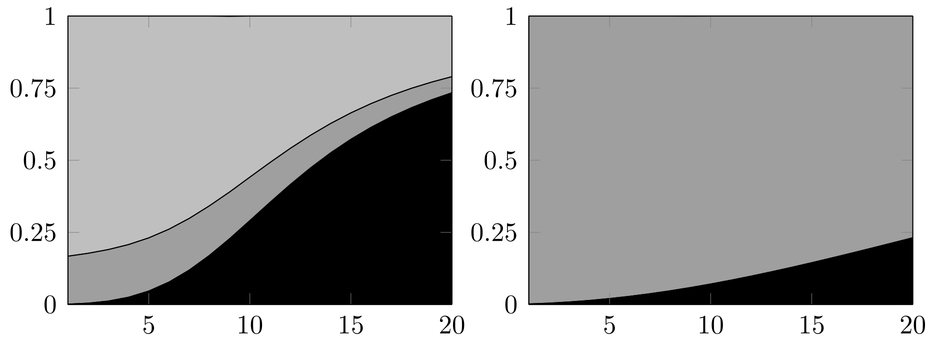
Figure 1: Impulse Responses



Notes: Productivity does not respond to a noise shock. The x-axis represents quarters.

Figure A8 reports the implications of the estimated parameters in Table 1 for the variance decomposition of consumption, summarizing the contribution of the three shocks to the forecast error variance. We observe that noise shocks are a very important source of short- to medium-run volatility, explaining more than 60% of consumption volatility at a one-year horizon (light gray areas). On the contrary, both permanent (black areas) and transitory productivity (gray areas) shocks explain a much smaller fraction of consumption fluctuations, having almost no effect on quarterly volatility (permanent) and explaining less than 20% (transitory) at a one-year horizon.

Figure 2: Variance Decomposition: Consumption (left) and Productivity (right)



Notes: The *black* areas, the *gray* areas, and the *light gray* areas respectively represent a contribution of *permanent technology shocks*, *transitory technology shocks*, and *noise shocks* to consumption fluctuations over different time horizons. The x-axis represents quarters.

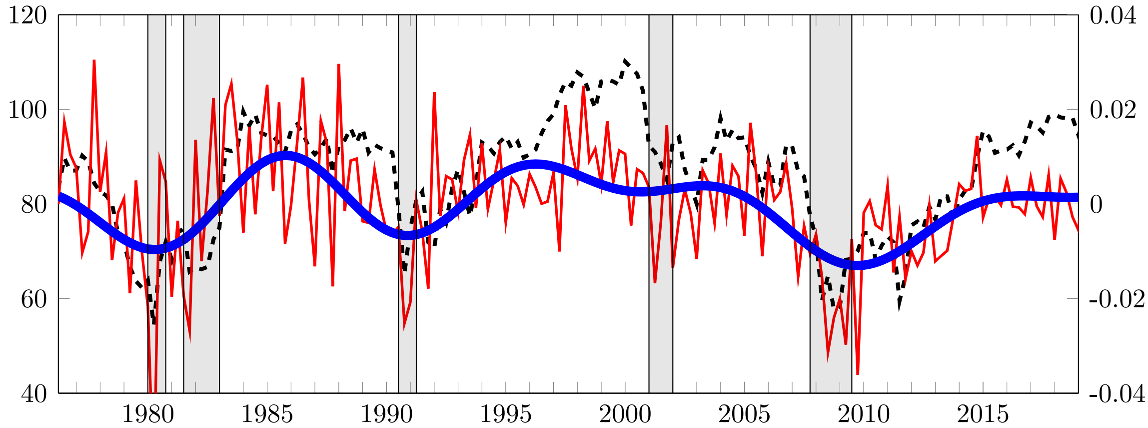
3.3 Model-based Consumer Confidence for the U.S.

We now follow the procedure discussed in the last section and extract MB-CCI by smooth-estimating structural shocks and state variables. The solid lines in Figure 3 denote our model-based measures estimated for the sample period, and to compare our model-based consumer confidence to survey-based one, we also plot the Index of Consumer Sentiment (the thin and dashed, black line). The high-frequency measure (thin and full, red line) denotes our confidence measure as defined in Definition 1, and the medium frequency measure (thick and full, blue line) is the one isolating medium-run dynamics using a band-pass filter at 32-200 frequencies.

Our result shows that the correlation between the two indices is strictly positive (0.52) and statistically significant at the 1% level. For the medium frequency confidence measure the correlation is estimated at 0.79. In addition, most of U.S. recessions are characterized by preceding downward shifts and subsequent recovery in consumer confidence in both measures. Our approach to extracting consumer confidence does a good job of mimicking the dynamics of the survey-based confidence index for the U.S. data.[10]

[10]The Index of Consumer Sentiment (ICS) has two separate components - *Expected Index* and *Current Index*. *Expected Index* is aggregated using the answers to the forward-looking questions, whereas *Current Index* to the questions regarding the current situation. Separately estimating the correlation between these indices and our measure of consumer confidence, the correlation between *Expected Index* and our measure is 0.51 and the one between *Current Index* and our

Figure 3: Model-Based Consumer Confidence Index (solid), and the (Survey-Based) Index of Consumer Sentiment (dashed)



Notes: Shaded areas indicate U.S. recessions. The red and thin solid line denotes the MB-CCI (blue and thick solid for the medium frequency MB-CCI), whereas the black and thin dashed line denotes the ICS. The ICS corresponds to the left y-axis and the MB-CCI to the right y-axis.

In order to justify our focus on what we have defined as MB-CCI, we also consider all other estimated series of beliefs, shocks, and states in our model. We compute their correlation with the survey-based consumer confidence measure. Table 2 reports the results. While some have a positive, statistically significant correlation with the survey-based confidence, namely beliefs about the long-run ($corr$ = 0.37), permanent TFP ($corr$ = 0.16), noisy signals ($corr$ = 0.23), and noise shocks ($corr$ = 0.26), our confidence measure exhibits a higher correlation than any other series of beliefs, shocks and states.

The finding that the MB-CCI is the measure that correlates the most with the ICS is of independent interest for the news shocks literature. Ex-ante, it is unclear why this measure ought to have the highest correlation, and not, for example, beliefs about the long run ($\hat{a}_{t+\infty|t}$) or the noisy signal ($\hat{s}_t$). This offers a theoretical window to interpret what lies behind fluctuations in the ICS: Most of the fluctuations represent fluctuations in beliefs that go beyond the beliefs that are implied by the observation of fundamentals as productivity or income.

To conclude, our main empirical contribution is to establish that the MB-

measure is 0.49.

Table 2: Estimated Unobserved Shocks and States and the Survey-Based Confidence

	Description	Correlation	p-val
$\hat{s}_t - \hat{x}_{t\|a_t}$	Our confidence measure (MB-CCI)	0.52	0.0001
	Our confidence measure (MB-CCI, medium frequency)	0.79	0.0001
$\hat{a}_{t+\infty\|t}$	Beliefs about the long-run	0.37	0.0001
$\hat{\nu}_t$	Noise shocks	0.26	0.0006
$\hat{s}_t$	Noisy signals	0.23	0.0022
$\hat{x}_t$	Permanent component	0.16	0.0397
$\Delta c_{t\|a_t}$	Consumption change due to fundamentals	0.13	0.0920
$\hat{z}_{t\|t}$	Beliefs about transitory component	0.08	0.2979
$\hat{x}_{t\|t}$	Beliefs about permanent component	0.05	0.5387
$\hat{\eta}_t$	Transitory productivity shocks	0.05	0.4956
$\hat{\epsilon}_t$	Permanent productivity shocks	0.03	0.6722
$\hat{x}_{t-1\|t}$	Beliefs about lagged permanent component	0.03	0.7146
$\hat{x}_{t\|a_t}$	Beliefs about permanent component (with info. set Ω_t)	0.02	0.8287
$\hat{z}_t$	Transitory component	-0.10	0.1743

Notes: Correlation and *p-val* report the Pearson correlation coefficient and the associated p-value between the survey-based consumer confidence and the estimated variable of interest.

CCI we have defined above closely mimics the ICS. We emphasize that this is achieved out-of-sample (the ICS is not used in the model estimation.) Therefore, conceptually, this establishes a bridge between the survey measure, and the news and noise model of consumer beliefs. Next, we will apply this insight to a cross-country exploration.

4 Consumer Confidence in Europe

In this section, we extract model-based consumer confidence for fourteen selected European countries and make a comparison with European consumer confidence indices. (Below we explain our focus on these countries.) Similar to the observation in the U.S., recent economic crises have been associated with deteriorating consumer confidence in Europe as well.

4.1 Model Estimation

We first present the estimation results for the model discussed in Section 2. The sample is from 1995:II–2019:III. The model is estimated by maximum likelihood. Our dataset includes series on labor productivity and per capita real consumption expenditure, and our sample includes fourteen European countries: the five founding member states of the EU - Belgium (BEL), France (FRA), (West) Germany (DEU), Italy (ITA), and the Netherlands (NLD) - along with nine other member states who joined the EU on or before January 1995 - Austria (AUT), Denmark (DNK), Finland (FIN), Greece (GRC), Ireland (IRL), Portugal (PRT), Spain (ESP), Sweden (SWE), and the United Kingdom (GBR). We focus on these fourteen countries in part due to data availability. Harmonized consumer surveys are conducted by the Directorate General for Economic and Financial Affairs for the European Union (EU) and the applicant countries.[11] However, for some countries, the harmonized survey is only available from 2001 (Bulgaria, Cyprus, Latvia, Lithuania, Poland, and Romania), 2002 (Luxembourg and Malta), 2005 (Croatia), 2007 (Turkey), 2012 (Montenegro and North Macedonia), 2013 (Serbia), and 2016 (Albania). Thus, we do not include these countries along with other countries who became member states of the EU in the fourth wave of the enlargement in 2004.

To construct a series for labor productivity (real GDP divided by the labor input), we use a quarterly Real GDP from the OECD contained in the measure VORBASA and Total Employment from the Eurostat in the measure Total Employment - Domestic Concept. Both series are seasonally adjusted. Similarly, to construct a series for per capita real consumption expenditure (real consumption expenditure divided by the total population), we use a quarterly Private Final Consumption Expenditure from the OECD contained in the measure VORBASA and Total Population from the Eurostat in the measure Total Population. Both series are seasonally adjusted. For the survey-based measure, we use the Consumer Confidence Index (CCI) from the OECD. Since it is published in monthly frequency, we change it to quarterly frequency by computing the quarterly arithmetic average at every quarter.

[11] The full list includes Belgium, Bulgaria, the Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, the Slovak Republic, Finland, Sweden, the United Kingdom, Montenegro, North Macedonia, Albania, Serbia, and Turkey.

The estimation results show that the persistence parameter ρ is estimated to be high for all countries. Due to this high persistence, the standard deviation for permanent productivity shocks is very small. The estimates of the standard deviation for noisy shocks are, in general, large, but vary considerably across countries.[12]

4.2 Model-based Consumer Confidence in Europe

We extract consumer confidence by estimating the series of structural shocks and state variables using a Kalman smoother. We then use the same procedure described above and used for the U.S.

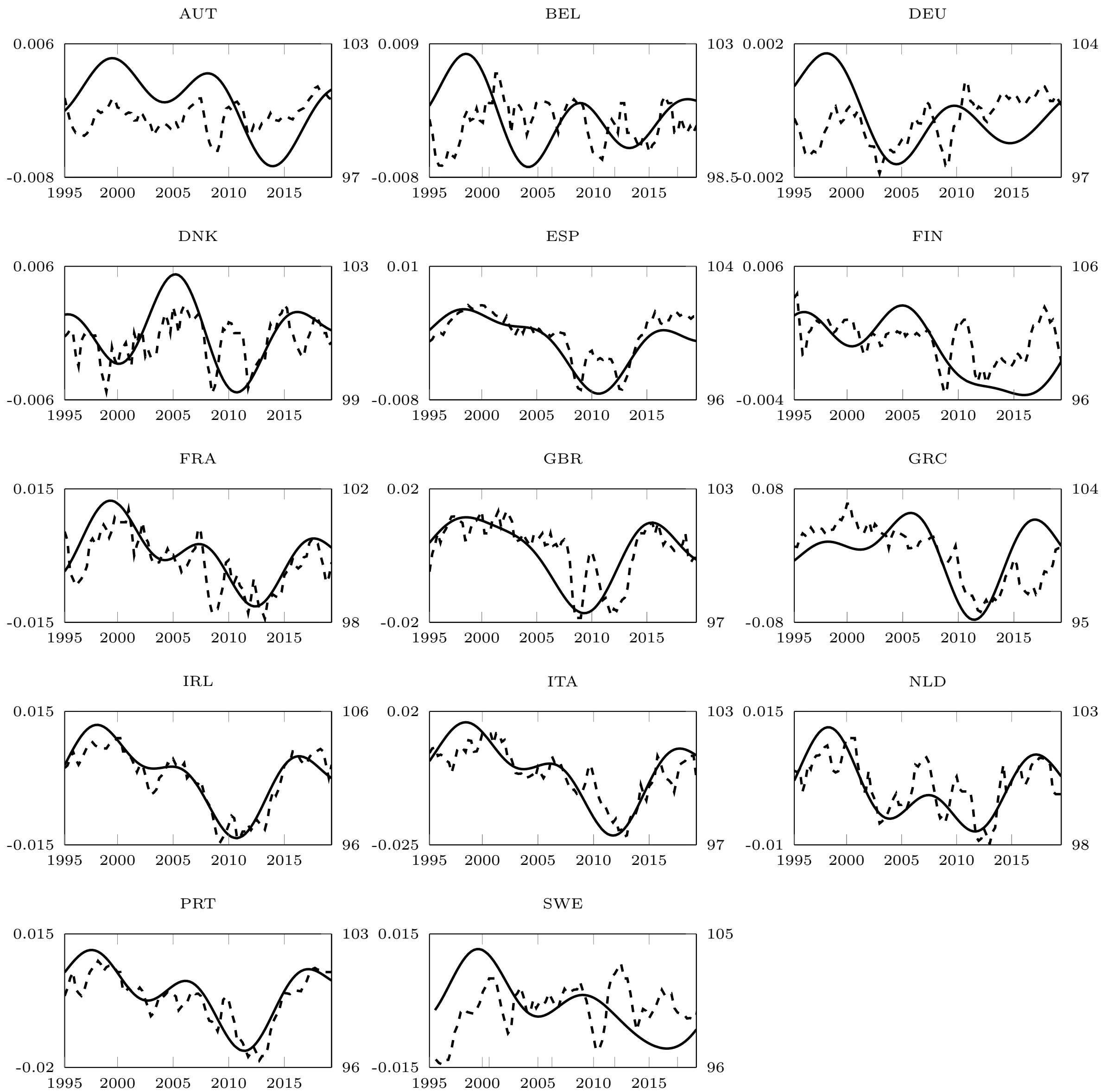
We first present a figure comparing the MB-CCI and the CCI for each country. Among the high- and medium-frequency measures of MB-CCI, the medium-frequency measure allows for a clearer visual comparison to the CCI, and therefore we present this one here in the body. (See Figure A7 in Appendix G for the other one.) See Figure 4. It plots the MB-CCI using solid lines, and the CCI from OECD using dashed lines.

As it is clear from the figure, most countries exhibit sizable fluctuations in confidence according to both measures. Consumer confidence appears to be persistent. In several cases, there is a decline of confidence that is contemporaneous to or lags the global financial crisis of 2008. We observe that there is an extended period of lack of consumer confidence for many countries, which corresponds well to the slow and anemic recovery from the Great Recession across Europe. As one would expect, this decline in confidence is more protracted for periphery countries as Portugal and Greece. Portugal and most countries exhibit high confidence in the early part of the sample, which presumably is related to widespread optimism regarding the European Economic and Monetary Union in the late 1990s.

Another interesting observation is that both measures seem to correlate strongly for some countries (as Italy), but less so for other countries (as, for instance, Germany). In other to look more deeply at this aspect, we compute the correlation between both measures and report it in Table 3. The table reports the correlation between our confidence measure and the survey-based counterpart. We report this correlation both for our high-frequency MB-CCI and for our medium-frequency MB-CCI. As explained in Section 2.4, the high-frequency MB-CCI corresponds

[12] Table A1 in Appendix D reports the estimation results.

Figure 4: Model-Based Consumer Confidence Index (at Medium Frequency), and the OECD (Survey-Based) Consumer Confidence Index



Notes: The solid lines denote the MB-CCI (medium frequency) isolated with the band-pass filter at 32-200 frequencies. The dashed lines denote the (quarterly) Consumer Confidence Index (CCI) available from the OECD. Since it is published in monthly frequency, we change it to quarterly frequency by computing the quarterly arithmetic average at every quarter. The MB-CCI is plotted against the right y-axis, and OECD consumer confidence against to the left y-axis. For Sweden, the CCI is available only from 1995:IV (SWE).

simply to the measure obtained as in Definition 1. The medium-frequency MB-CCI corresponds to the resulting series after using a band-pass filter at 32-200 frequencies.

We find that, for most countries, the correlations between the two indices are strictly positive and statistically significant at the 1% level: for Spain, Italy, Portugal, the UK, Netherlands, Ireland, France, and Greece, for example, the correlations are estimated to be around 0.4 or greater, showing a clear correlation between the two indices. For some countries like Spain, Italy, Portugal, or the U.K., the degree of correlation is remarkable: higher than 0.70 in the case of the medium-frequency MB-CCI. At the same time, there are cases in which the correlations are quite small, as in the case of Austria, Belgium, or Sweden.

Table 3: Correlation between Our Model-Based Confidence Measure and OECD Consumer Confidence Index (14 European Countries)

	Correlation			
	High frequency	p-val	Medium frequency	p-val
ESP	0.63	0.0001	0.85	0.0001
ITA	0.54	0.0001	0.85	0.0001
PRT	0.53	0.0001	0.87	0.0001
GBR	0.49	0.0001	0.71	0.0001
NLD	0.48	0.0001	0.76	0.0001
IRL	0.46	0.0001	0.93	0.0001
FRA	0.41	0.0001	0.77	0.0001
GRC	0.39	0.0001	0.52	0.0001
DNK	0.25	0.0119	0.52	0.0001
SWE	0.15	0.1384	0.04	0.7087
DEU	0.07	0.5159	-0.03	0.7522
FIN	0.02	0.8108	0.39	0.0001
BEL	0.01	0.9680	-0.13	0.1893
AUT	-0.05	0.6497	0.08	0.4443

Notes: Correlation and *p-val* report the Pearson correlation coefficient and the associated p-value. *The high-frequency measure* denotes the smoothed-estimated confidence as in Definition 1, and *the medium frequency measure* is the one isolating medium-run dynamics using a band-pass filter at 32-200 frequencies.

We draw two main conclusions from these results.

First, considering the high correlation of the MB-CCI with the CCI produced by the OECD based on a survey, the MB-CCI does seem like a valid approach to measure consumer confidence. This is more clearly the case for countries that exhibit a high correlation (top rows on Table 3), which is most European countries (these tend to be countries for which there appear to have been larger confidence swings, as we will discuss below.) Moreover, given the solid theoretical basis of the MB-CCI and how easily it can be obtained from national accounts data, it is, at the very least, a complementary measure to the CCI in the case of all the other countries.

Second, there is a striking amount of heterogeneity in the correlation between the MB-CCI and CCI. Indeed, this correlation behaves like in the U.S. for some countries (high and statistically significant correlation, as in the case of Spain with a correlation of 0.63), and with the opposite pattern for other countries (as in the case of Belgium, with a correlation of 0.01). This is a puzzling observation given that the input used to obtain the MB-CCI is obtained from uniformly constructed data, with an identical model and estimation procedure for all countries. Moreover, the CCI survey is conducted by the same institution, and as far as we can tell from studying its description, it is based on a uniform set of questions and procedures.[13] Hence, an obvious question is to what extent one can shed light on this finding. We briefly look at this next.

4.3 What Could Explain the Heterogeneity across Countries?

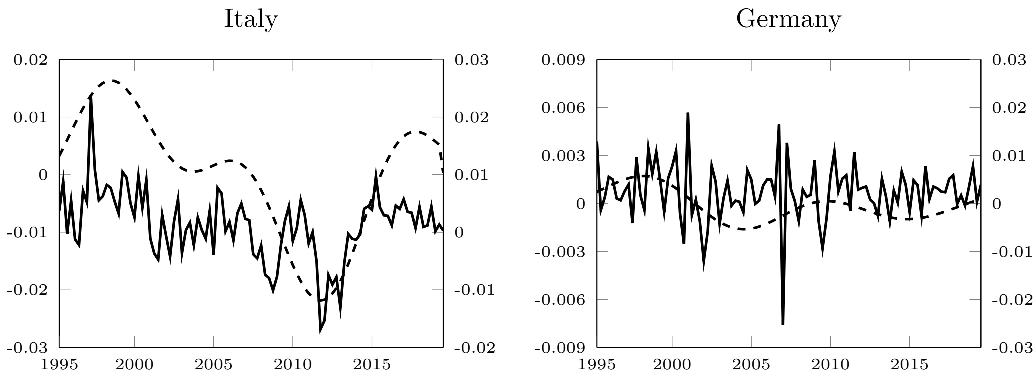
As shown earlier, we observe a surprisingly high amount of heterogeneity in the relation of MB-CCI and the CCI of the OECD. What accounts for such observed heterogeneity?

In our sample, the high correlation countries include the U.K., Netherlands, France, and the GIIPS countries, i.e., Greece, Ireland, Italy, Portugal, and Spain. One possibility from this observed pattern is the presence of large fluctuations, particularly during the 2008 global financial crisis and its aftermath in Europe.

[13] The CCI survey is part of regular harmonized surveys conducted by the Directorate General for Economic and Financial Affairs for different sectors of the economies in the European Union (EU) and in the applicant countries. The methodology of the survey including national questionnaires, partner institutes, and guidelines are available from the following link: https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/business-and-consumer-surveys/methodology-business-and-consumer-surveys_en.

To illustrate this point, consider Figure 5, plotting the MB-CCI and annualized quarterly consumption growth rates for two different countries, Italy and Germany. Italy was hard hit by the European debt crisis, and this generated a protracted consumption recession starting. Instead, consumption recovered quickly after 2008 in the case of Germany. As a result, the swings in consumer confidence in Italy are more dramatic. Accordingly, the correlation between the MB-CCI and the CCI is high for Italy (0.54), and low for Germany (0.07).

Figure 5: Model-Based Consumer Confidence (dashed) and Consumption Growth Rates (solid): Italy (left) and Germany (right)



Notes: The solid lines denote annualized quarterly consumption growth rates. The dashed lines denote the MB-CCI (medium frequency) isolated with a band-pass filter at 32-200 frequencies. The consumption growth rates correspond to the right y-axis and the MB-CCI to the left y-axis.

To make this point more precisely, we consider this heterogeneity from a statistical perspective. Let the MB-CCI, $s_{1,t}$, be the sum of true unobservable confidence, κ_t and a disturbance term $e_{1,t}$:

$$s_{1,t} = \kappa_t + e_{1,t}$$

where $e_{1,t}$ is an i.i.d. Gaussian disturbance. Similarly, let the CCI, $s_{2,t}$, be the sum of true confidence and a different disturbance term $e_{2,t}$:

$$s_{2,t} = \kappa_t + e_{2,t}$$

where $e_{2,t}$ is an i.i.d. Gaussian disturbance and $e_{1,t} \perp e_{t+j}$ for all t and j.

The disturbance terms could be interpreted as measurement errors. For the survey measure of confidence, there is the problem of sampling the population. Also, each participant answers the survey on a particular day while consumption and productivity are averages over quarters. This adds measurement error to the survey. In contrast, the model-based measure of confidence is very simple and clearly imperfect. It is correlated with survey confidence, but we would not claim it is true confidence measured without error.

As shown by this Equation (10)

$$\text{Corr} = \frac{var(\kappa)}{\big((var(\kappa) + var(e_1))(var(\kappa) + var(e_2))\big)^{1/2}} \tag{10}$$

the correlation between s_1 and s_2 is an increasing function of the variance of true confidence κ_t. Thus, if the differences across countries are mostly $var(\kappa)$, that is, the variance of true confidence, the correlation between MB-CCI and CCI should be high.

Let us take the survey confidence measure itself to compute its volatility. Table 4 suggests that the correlation between the two measures of consumer confidence is related to the volatility of the survey confidence measure: a high correlation between two measures of consumer confidence is related to a larger volatility of the survey index.

Table 4: The Volatility of Confidence Index and Correlation between the Two Confidence Measures

	Correlation		Volatility
	High frequency	Medium frequency	
Whole sample	0.31	0.51	1.213
High correlation	0.49	0.78	1.363
Low correlation	0.08	0.15	1.012

Notes: Correlation denotes the average correlation coefficients between the model-based and survey-based consumer confidence in the sample, and *Volatility* denotes the average standard deviation of the survey-based consumer confidence in the respective sample. The first sub-sample (high correlation) contains those countries with the correlation between the model-based and survey consumer confidence higher than 0.39 and includes Spain, Italy, Portugal, the UK, Netherlands, Ireland, France, and Greece; the second sub-sample (low correlation) contains those with the correlation smaller than 0.25 in absolute terms and includes Austria, Belgium, Finland, Germany, and Sweden.

The most plausible explanation for the observed heterogeneity, though, is the degree to which the survey measure of consumption tracks actual consumption fluctuations. For those countries exhibiting a low correlation between our model-based index and the survey-based confidence measure, we also observe a low correlation between the survey-based one and observed consumption: Austria (0.05), Belgium (0.09), Germany (0.17), Finland (0.18), and Sweden (0.26). This finding is in stark contrast to the countries where the fit between two confidence measures is highly correlated (with the average correlation of 0.51 between the survey measure of confidence and actual consumption). It appears that when the survey measure does not replicate observed consumption dynamics, our model-based index cannot match it well as our measure is obtained using observed consumption and productivity.

5 Final Remarks

We have shown how to extract consumer confidence using aggregate macroeconomic data based on a structural framework with imperfect information. We view ours as a viable approach to study consumer confidence, which is based on a standard consumer theory and the state-of-the-art macroeconomic toolbox. Not only do our efforts provide a theoretical interpretation to survey measures of confidence, but they also offer an internationally consistent measure of confidence grounded on the System of National Accounts.

We compare our measure of confidence with its survey-based counterpart by calculating the correlation between the two measures of consumer confidence. We have shown that the correlation between the two measures is remarkable for the U.S. and a range of European countries, which is especially noteworthy given that the survey measure was not used in estimating the model and constructing our model-based confidence measure.

Our methodological approach relies on a particular economic mechanism (the permanent income model) and information structure (the combination of the permanent/transitory decomposition and the signal on the permanent component). They are analytically convenient and, more importantly, reasonable for the application at hand, as discussed in Section 2.2. Considering its simple nature, the model's actual performance in generating filtered confidence and matching the survey-based counterpart is striking and somewhat surprising. Nevertheless, an obvious next step is to explore more complex models. We leave this to future work.

References

Angeletos, G.-M., F. Collard, and H. Dellas (2018). Quantifying confidence. *Econometrica 86*(5), 1689–1726.

Angeletos, G.-M. and J. La'O (2013). Sentiments. *Econometrica 81*(2), 739–780.

Barsky, R. B. and E. Sims (2012). Information, animal spirits, and the meaning of innovations in consumer confidence. *American Economic Review 102*(2), 1343–1377.

Batchelor, R. and P. Dua (1998). Improving macro-economic forecasting: The role of consumer confidence. *International Journal of Forecasting 14*(1), 71–81.

Beaudry, P. and F. Portier (2004). An exploration into Pigou's theory of cycles. *Journal of Monetary Economics 51*, 1183–1216.

Beaudry, P. and F. Portier (2006). Stock prices, news and economic fluctuations. *American Economic Review 96*(4), 1293–1307.

Blanchard, O. J., J.-P. L'Huillier, and G. Lorenzoni (2013). News, noise, and fluctuations: An empirical exploration. *American Economic Review 103*(7), 3045–3070.

Boz, E., C. Daude, and C. B. Durdu (2011). Emerging market business cycles: Learning about the trend. *Journal of Monetary Economics 58*(6), 616–631.

Buchwald, E. (2025, 13 Sep). Americans are feeling a lot worse about the state of the economy. *CNN*. Available at: `https://edition.cnn.com/2025/09/12/economy/september-consumer-sentiment` (Accessed: November 11th, 2025).

Cao, D. and J.-P. L'Huillier (2018). Technological revolutions and the three great slumps: A medium-run analysis. *Journal of Monetary Economics 96*, 93–108.

Chahrour, R. and K. Jurado (2018). News or noise? The missing link. *American Economic Review 108*(7), 1702–1736.

Chahrour, R. and K. Jurado (2021). Optimal foresight. *Journal of Monetary Economics 118*, 245–259.

European Commission. The Joint Harmonised EU Programme of Business and Consumer Surveys. User Guide (Updated 4 July 2017).

Fernald, J. (2012). A quarterly, utilization-adjusted series on total factor productivity. *Federal Reserve Bank of San Francisco Working Paper 2012-19*.

Howrey, E. P. (2001). The predictive power of the index of consumer sentiment. *Brookings Papers on Economic Activity 2001*(1), 175–207.

Ilut, C. and H. Saijo (2021). Learning, confidence, and business cycles. *Journal of Monetary Economics 117*, 354–376.

Ilut, C. and M. Schneider (2014). Ambiguous business cycles. *American Economic Review 104*, 2368–2399.

Lahiri, K., G. Monokroussos, and Y. Zhao (2015). Forecasting consumption: The role of consumer confidence in real time with many predictors. *Journal of Applied Econometrics 31*, 1254–1275.

L'Huillier, J.-P. and D. Yoo (2017). Bad news in the Great Depression, the Great Recession, and other U.S. recessions: A comparative study. *Journal of Economic Dynamics and Control 81*, 79–98.

L'Huillier, J.-P. and D. Yoo (2019). Where is the GE? Consumption dynamics in DSGEs. *Journal of Money, Credit and Banking 51*(6), 1491–1502.

Lorenzoni, G. (2009). A theory of demand shocks. *American Economic Review 99*(5), 2050–84.

Rousakis, M. (2013). Expectations and fluctuations: The role of monetary policy. *Mimeo*.

Schmitt-Grohé, S. and M. Uribe (2012). What's news in business cycles. *Econometrica 80*(6), 2733–2764.

Smith, C. (2025, 14 Mar). U.s. consumer sentiment drops as inflation anxiety soars. *The New York Times*. Available at: `https://www.nytimes.com/2025/03/14/business/inflation-consumer-sentiment.html?searchResultPosition=1` (Accessed: November 11th, 2025).

Yoo, D. (2019). Ambiguous information, permanent income, and consumption fluctuations. *European Economic Review 119*(C), 79–96.

A Data Appendix

A.1 The Index of Consumer Sentiment

The Index of Consumer Sentiment (ICS) is produced by the Survey Research Center of the University of Michigan. The ICS is calculated by computing the relative scores for each of the five index questions on past and future financial, business, and macroeconomics conditions. Specifically, for each index question (Q_i), you subtract the percent giving unfavorable replies from the percent giving favorable replies, then add 100 to compute the relative score X_i:

$$ICS = \frac{X_1 + X_2 + X_3 + X_4 + X_5}{\text{base score}} + 2.0$$

where $X_1, ..., X_5$ denote the relative scores computed for each of the five index questions, *base score* refers to the 1966 base period total of 6.7558, and 2.0 on the second term on the RHS is a constant to correct for sample design changes from the 1950s.

The five index questions are as follows:

Q_1 : "We are interested in how people are getting along financially these days. Would you say that you (and your family living there) are better off or worse off financially than you were a year ago?"

Q_2 : "Now looking ahead–do you think that a year from now you (and your family living there) will be better off financially, or worse off, or just about the same as now?"

Q_3 : "Now turning to business conditions in the country as a whole–do you think that during the next twelve months we'll have good times financially, or bad times, or what?"

Q_4 : "Looking ahead, which would you say is more likely–that in the country as a whole we'll have continuous good times during the next five years or so, or that we will have periods of widespread unemployment or depression, or what?"

Q_5 : "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?"

The Index is available at http://www.sca.isr.umich.edu/tables.html.

A.2 Consumer Confidence Index

The consumer confidence indicator is calculated by computing the simple arithmetic average of the seasonally adjusted balances of answers to questions on the financial situation of households, the general economic situation, unemployment expectations, and savings over the next 12 months.

The questions relevant for computing the consumer confidence indicator are chosen from the full set of questions in the individual survey and are given as follows:

Q_2 : "How do you expect the financial position of your household to change over the next 12 months? "

Q_4 : "How do you expect the general economic situation in this country to develop over the next 12 months?"

Q_7 : "How do you expect the number of people unemployed in this country to change over the next 12 months?"

Q_{11} : "Over the next 12 months, how likely is it that you save any money?"

For each questions, there are six possible answers, i.e., strongly positive, positive to neutral, negative, and strongly negative, as well as "don't know."

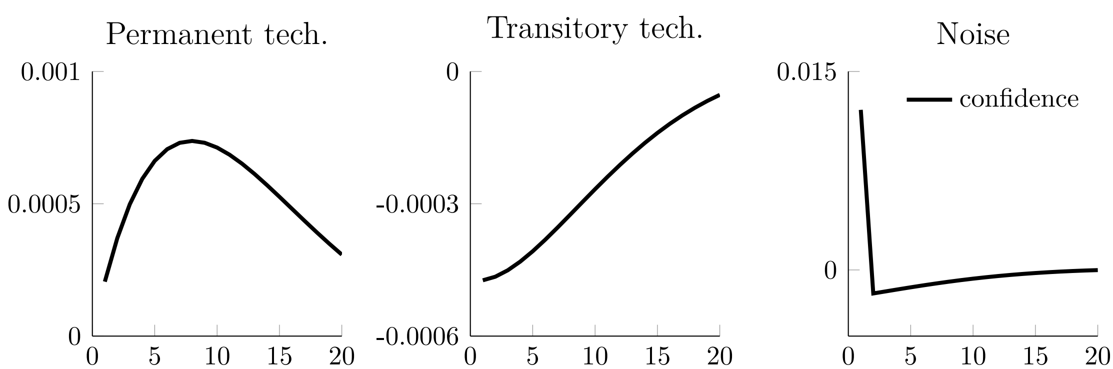
More details are available from the European Commission Directorate-General For Economic and Financial Affairs (European Commission).

B Consumption and Confidence in the Model

In this section, we look at how consumption and MB-CCI comove (in the model). Figure A1 shows the dynamics of consumption and confidence following alternative structural shocks affecting the economy: Specifically, we consider the impulse responses of consumption and confidence following one standard deviation negative shock to permanent productivity, transitory productivity, and the signal. In our description, we focus mainly on the sign of the responses.

With a permanent decrease in productivity, consumption slowly decreases to its new long-run level while confidence does not get affected by much. A (negative) transitory shock generates an initial decrease in consumption, but consumption returns to its original level. On the contrary, confidence initially moves in the opposite direction of consumption and returns to its original level in the long run. Following a negative noise shock, consumption behaves qualitatively similar to the response to a negative transitory shock. However, the response of confidence is much greater on impact as it moves in the same direction with consumption. After the first period, the behavior is qualitatively similar to the ones with a transitory shock. Quantitatively, we can see that the dynamics of confidence are mostly driven by noise shocks.

Figure A1: Impulse Responses: Confidence and Consumption



Notes: We use parameter values estimated in Table 1 to deliver impulse responses following one standard deviation positive shocks.

C Solution

C.1 Solving the Model

Consider the dynamic system:

$$\mathbf{x}_t = A\mathbf{x}_{t-1} + B\mathbf{v}_t$$
$$\mathbf{s}_t = C\mathbf{x}_t + D\mathbf{v}_t$$

and $\mathbf{x}_t = (x_t,\ x_{t-1},\ z_t)'$, $\mathbf{v}_t = (\epsilon_t,\ \eta_t,\ \nu_t)'$, $\mathbf{s}_t = (a_t,\ s_t)'$,

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

Conditional on observing current productivity a_t, consumers' beliefs $\mathbf{x}_{t|a_t}$ are given by

$$\begin{aligned} \mathbf{x}_{t|a_t} &= A\mathbf{x}_{t-1|t-1} + H(a_t - a_{t|t-1}) \\ &= [I - HC_1]A\mathbf{x}_{t-1|t-1} + Ha_t \end{aligned} \tag{11}$$

where H is the Kalman gain for observing productivity,

$$a_t = C_1\mathbf{x}_t + D_1\mathbf{v}_t$$

and $C_1 = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix},\ D_1 = \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$.

Then, observing a noisy signal s_t consumers' beliefs $\mathbf{x}_{t|t}$ are given by

$$\begin{aligned} \mathbf{x}_{t|t} &= \mathbf{x}_{t|a_t} + G(s_t - s_{t|a_t}) \\ &= [I - GC_2]\mathbf{x}_{t|a_t} + Gs_t \end{aligned} \tag{12}$$

where G is the gain of observing new information s_t,

$$s_t = C_2\mathbf{x}_t + D_2\mathbf{v}_t$$

and $C_2 = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$, $D_2 = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$.

Substituting $\mathbf{x}_{t|a_t}$ from Equation (11) into Equation (12), we consumers' expectations $\mathbf{x}_{t|t}$ are given by

$$\mathbf{x}_{t|t} = [I - GC_2][I - HC_1]A\mathbf{x}_{t-1|t-1} + [I - GC_2]Ha_t + Gs_t$$

Once consumers' expectations are formed, consumption can be solved:

$$\begin{aligned} c_t &= \lim_{j\to\infty} \mathbb{E}_t \left[a_{t+j}\right] \\ &= \lim_{j\to\infty} \mathbb{E}_t \left[x_{t+j} + z_{t+j}\right] \end{aligned}$$

where the right-hand side can be simplified to:

$$\lim_{j\to\infty} \mathbb{E}_t \left[x_{t+j} + z_{t+j}\right] = \lim_{j\to\infty} \mathbb{E}_t \left[\Delta x_{t+j} + \Delta x_{t+j-1} + \cdots + \Delta x_{t+1} + x_t + z_{t+j}\right]$$

Taking out the last two terms on the right-hand side, we have

$$\lim_{j\to\infty} \mathbb{E}_t \left[x_{t+j} + z_{t+j}\right] = \lim_{j\to\infty} \mathbb{E}_t \left[\rho^j \Delta x_{t+1} + \rho^j \Delta x_t + \cdots + \Delta x_{t+1}\right] + \lim_{j\to\infty} \mathbb{E}_t[x_t] + \lim_{j\to\infty} \mathbb{E}_t \left[\rho^{j+1} z_t\right]$$

from which, we get the following simplification:

$$\lim_{j\to\infty} \mathbb{E}_t \left[x_{t+j} + z_{t+j}\right] = \rho \lim_{j\to\infty} \mathbb{E}_t \left[(1 + \rho + \cdots + \rho^j)\Delta x_t\right] + x_{t|t}$$

Therefore, consumers choose consumption spending as a function of their beliefs:

$$\begin{aligned} \lim_{j\to\infty} \mathbb{E}_t[a_{t+j}] &= \frac{\rho}{1-\rho} \mathbb{E}_t[\Delta x_t] + x_{t|t} \\ &= \frac{\rho}{1-\rho} \left(x_{t|t} - x_{t-1|t}\right) + x_{t|t} \\ &= \frac{1}{1-\rho} \left(x_{t|t} - \rho x_{t-1|t}\right) \end{aligned}$$

C.2 Estimating the Model

While the econometrician does not observe noisy signals, her information set includes productivity signals, assumed to be publicly available, and consumption observations. Thus, she extracts consumers' beliefs using all available information with the following Kalman filter:

$$\mathbf{x}_{t|a_t} = \begin{bmatrix} x_{t|a_t} \\ x_{t-1|a_t} \\ z_{t|a_t} \end{bmatrix} = A \begin{bmatrix} x_{t-1|t-1} \\ x_{t-2|t-1} \\ z_{t-1|t-1} \end{bmatrix} + H \begin{bmatrix} 1+\rho & -\rho & -\rho \end{bmatrix} \begin{bmatrix} x_{t-1} \\ x_{t-2} \\ z_{t-1} \end{bmatrix} + H\epsilon_t + H\eta_t \tag{13}$$

Conditional on $\mathbf{x}_{t|a_t}$, $\mathbf{x}_{t|t}$ is given by

$$\begin{bmatrix} x_{t|t} \\ x_{t-1|t} \\ z_{t|t} \end{bmatrix} = \begin{bmatrix} x_{t|a_t} \\ x_{t-1|a_t} \\ z_{t|a_t} \end{bmatrix} + G \begin{bmatrix} 1+\rho & -\rho & 0 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ x_{t-2} \\ z_{t-1} \end{bmatrix} + G\epsilon_t + G\eta_t + G\nu_t \tag{14}$$

We let $\mathbf{x}_t^E$ to represent the state vector of the econometrician where

$$\mathbf{x}_t^E = \left(x_t,\ x_{t-1},\ z_t,\ x_{t|t},\ x_{t-1|t},\ z_{t|t}\right)'$$

then, $\mathbf{x}_t^E$ follows

$$\mathbf{x}_t^E = Q\mathbf{x}_{t-1}^E + R\left(\epsilon_t,\ \eta_t,\ \nu_t\right)' \tag{15}$$

The matrices Q and R, which depend on the underlying parameters of the model, are given respectively by

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

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

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

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

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

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

The observation equation is given by

$$(a_t,\, c_t) = T\mathbf{X}_t^E \tag{16}$$

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 (13), (14), (15) and (16) and structurally estimate it.

D Estimation Results for the European Countries

Figures A2 and A3 report impulse responses of productivity and consumption following three exogenous shocks for the fifteen countries in the sample. We use the estimated parameters in Table A1. Due to a high productivity persistence, productivity in general gradually builds up (in the case of permanent tech shock) and slowly declines after an initial increase (in the case of transitory tech shock). A noise shock does not affect productivity.

Figure A3 shows that consumption slowly increases following a permanent tech shock. This is because the large volatilities in transitory productivity and noise shocks prohibit agents from immediately recognizing the permanent productivity change. Thus, they adjust consumption slowly. Similarly, it takes time for consumers to recognize a temporal change in productivity or a noisy disturbance and reduce consumption after an initial impulse following a transitory tech. shock or

Table A1: Parameter Estimates (14 European Countries), 1995:II-2019:III

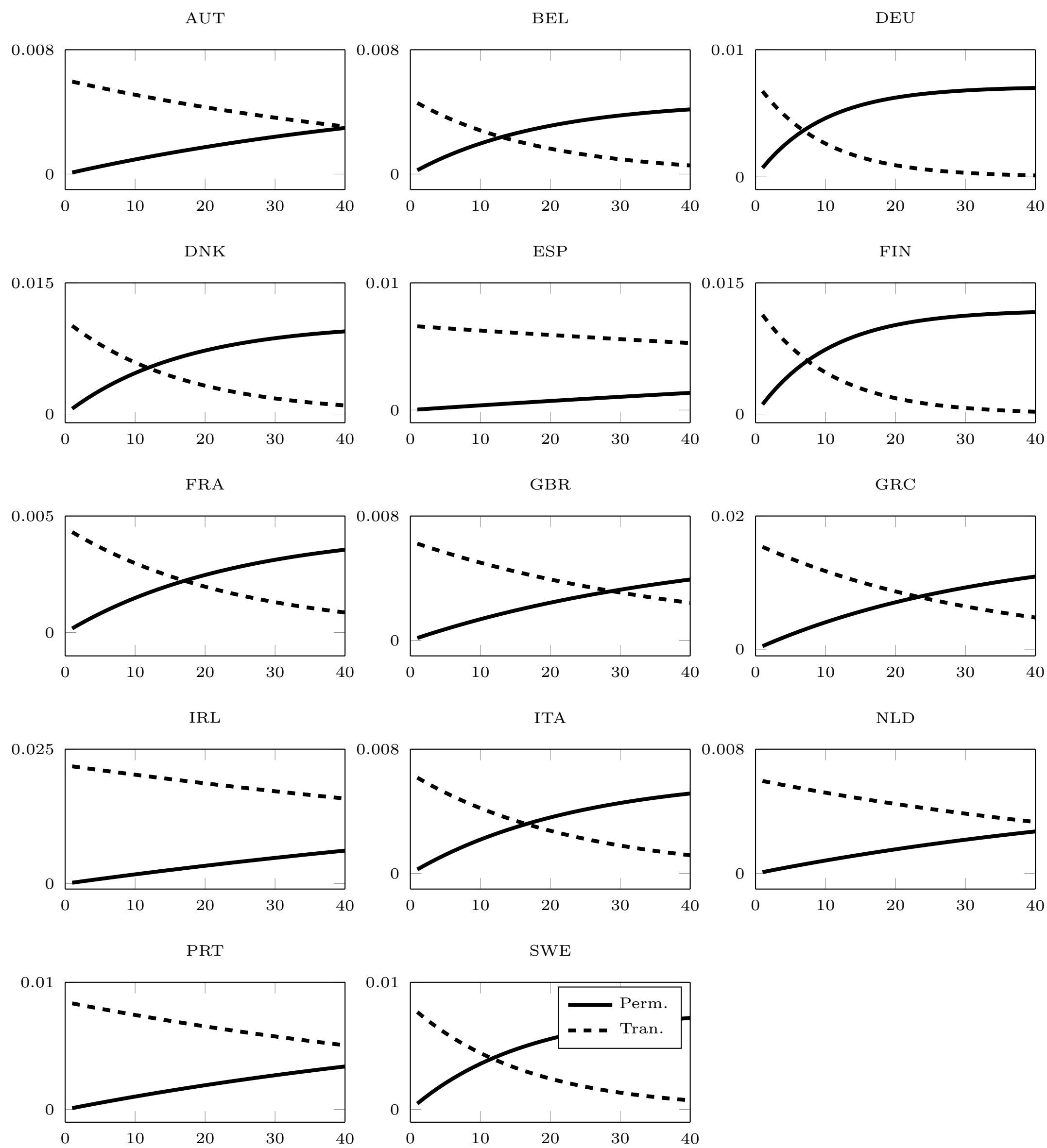
	Persistence (ρ)	Std. Perm. (σ_ϵ)	Std. Tran. (σ_η)	Std. Noise (σ_ν)
AUT	0.9825 (0.0082)	$\leq$0.0001	0.0052	0.0119 (0.0061)
BEL	0.9511 (0.0137)	0.0002	0.0044	0.0112 (0.0046)
DEU	0.9067 (0.0338)	0.0007	0.0069	0.0041 (0.0026)
DNK	0.9312 (0.0283)	0.0007	0.0099	0.0084 (0.0048)
ESP	0.9942 (0.0021)	$\leq$ 0.0001	0.0068	0.0039 (0.0015)
FIN	0.9185 (0.0455)	0.0009	0.0111	0.0144 (0.0087)
FRA	0.9630 (0.0095)	0.0002	0.0041	0.0155 (0.0050)
GBR	0.9748 (0.0069)	0.0001	0.0058	0.0153 (0.0052)
GRC	0.9713 (0.0074)	0.0004	0.0142	0.0716 (0.0213)
IRL	0.9868 (0.0082)	0.0003	0.0230	0.0283 (0.0204)
ITA	0.9658 (0.0086)	0.0002	0.0061	0.0190 (0.0083)
NLD	0.9693 (0.0085)	0.0002	0.0080	0.0124 (0.0053)
PRT	0.9720 (0.0118)	0.0003	0.0091	0.0130 (0.0089)
SWE	0.9388 (0.0169)	0.0005	0.0076	0.0233 (0.0072)

Notes: The parameter σ_u defined by the standard deviation of Δa_t. Given the random walk Assumption (3) for a_t, σ_ϵ and σ_η are determined by ρ and σ_u. As they are indirectly recovered, no standard errors are given.

a noise shock. How fast the adjustment takes place and how large the magnitude of adjustments depends on the estimated volatilities of the shocks.

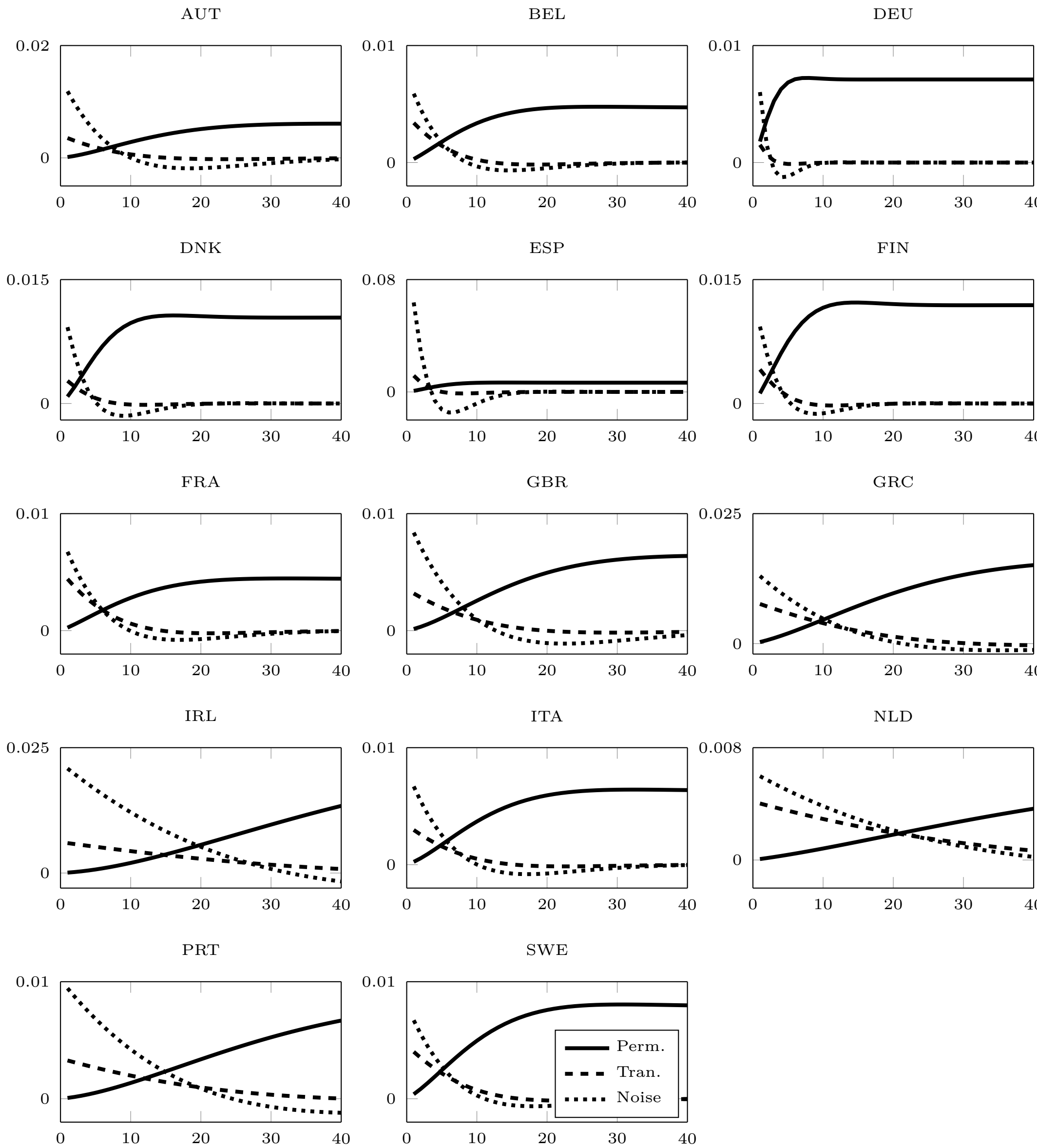
Figure A4 reports the implications of the estimated parameters in Table A1 for the variance decomposition of consumption, summarizing the contribution of the three shocks to the forecast error variance. We observe that across countries noise shocks are a very important source of short to medium run volatilities, explaining more than 60 to more than 90% of consumption volatility at a one-year horizon. On the contrary, both permanent and transitory productivity shocks explain a much smaller fraction of consumption fluctuations, having almost no effect on quarterly volatility (permanent) and explaining less than 20% (transitory) for most countries at a one-year horizon. At the same time, we observe heterogeneity across countries. For example, noise shocks are still an important source of consumption fluctuations even at a ten-year horizon for countries such as Greece, Ireland, Netherlands, Portugal, Spain, and the UK.

Figure A2: Impulse Responses: Productivity



Notes: Plots correspond to the impulse responses of productivity following technology shocks of one standard deviation. The solid lines correspond to the impulse responses of permanent productivity shocks; the dashed lines to those of transitory productivity shocks. Productivity does not respond to a noise shock.

Figure A3: Impulse Responses: Consumption

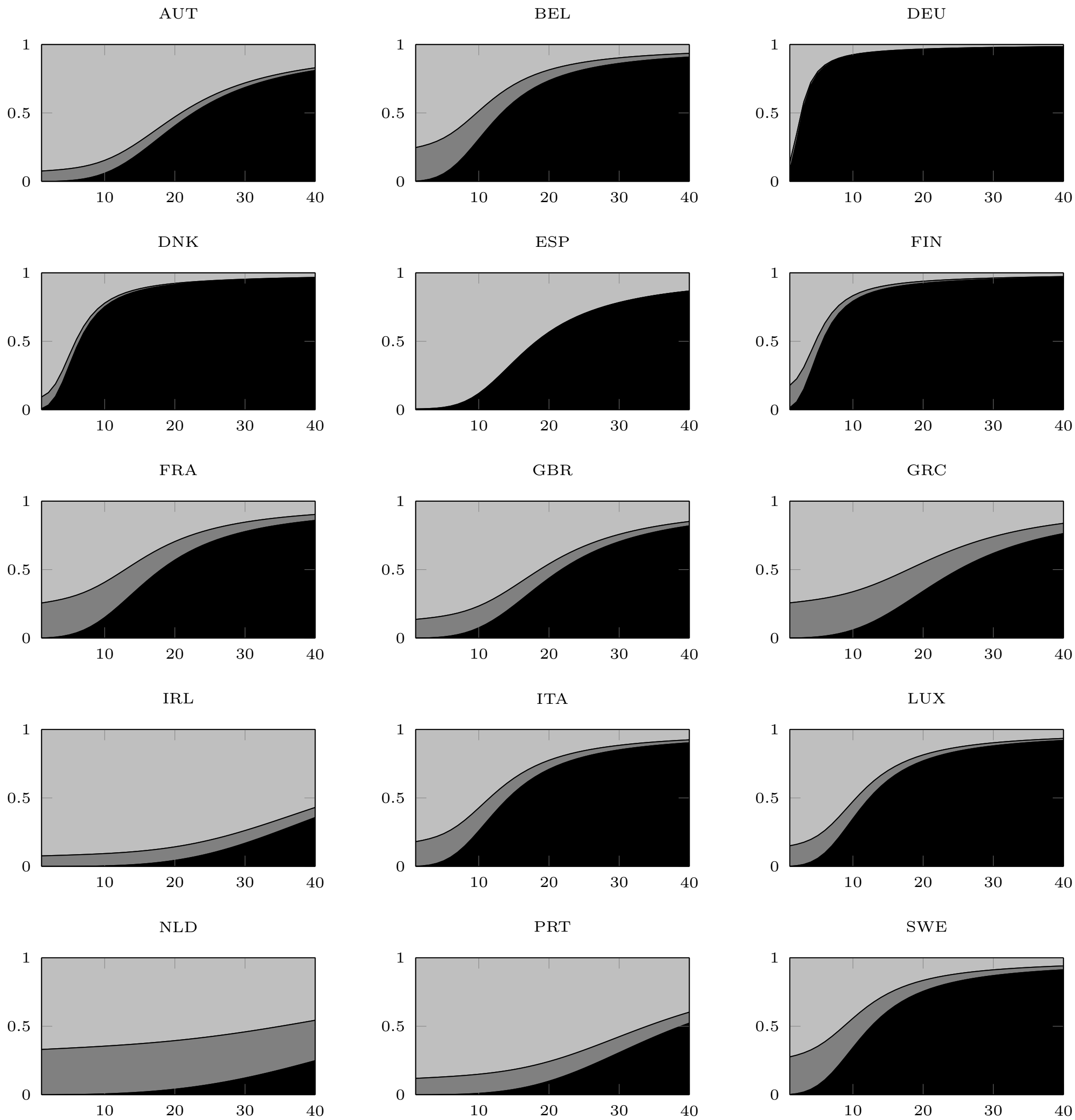


Notes: Plots correspond to the impulse responses of consumption to three shocks of one standard deviation. The solid lines correspond to the impulse responses of permanent productivity shocks; the dashed lines to those of transitory productivity shocks; the dotted lines to those of noise shocks.

E The Alternative Productivity Process Specification and Estimated Consumer Confidence

We relax the parameter restrictions from Equations (4) and (5) and present the estimation results for the model in Section 2. We jointly estimate a set of pa-

Figure A4: Variance Decomposition, 1995:II-2016:III



Notes: The *black* areas, the *gray* areas, and the *light gray* areas respectively represent a contribution of *permanent technology shocks*, *transitory technology shocks*, and *noise shocks* to consumption fluctuations over different time horizons.

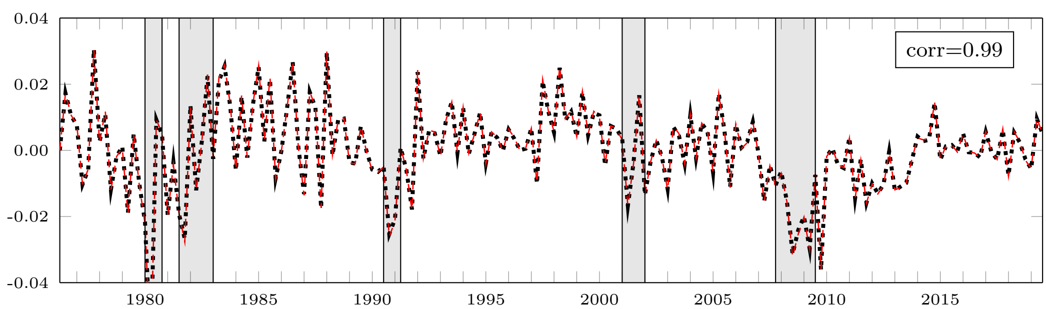
rameters $(\rho_x, \rho_z, \sigma_\epsilon, \epsilon_\eta, \sigma_\nu)$. Table A2 reports the estimation results. Figure A5 depicts estimated consumer confidence. As shown in the figure, these parametric conditions are not restrictive in the sense that our estimated consumer confidences are very similar irrespective of whether we impose such restrictions or not.

Table A2: Parameter Estimates, US 1976:II–2019:III

Parameter	Description	Value	s.e.
ρ_x	Persistence permanent productivity	0.9612	0.0021
ρ_z	Persistence transitory productivity	0.9611	0.0027
σ_ϵ	Std dev. permanent shock	0.0002	0.0000
σ_η	Std dev. transitory shock	0.0058	0.0003
σ_ν	Std dev. noise shock	0.0122	0.0037

Notes: The parameter σ_u defined by the standard deviation of Δa_t. Given the random walk Assumption (3) for a_t, σ_ϵ and σ_η are determined by ρ and σ_u. As they are indirectly recovered, no standard errors are given.

Figure A5: Estimated Model-Based Consumer Confidence Index: 1976:II–2019:III



Notes: Shaded areas indicate U.S. recessions. The dashed line denotes the MB-CCI estimated with parameters in Table 1 whereas the solid line denotes the MB-CCI estimated with parameters in Table A2. *corr* denotes the correlation coefficient between them.

F TFP

In this section, we show that our main results are robust to the use of TFP series. One may argue that TFP instead of labor productivity is the main driver of aggregate per capita income in the long run. In other words, the process a_t in (2) may be better described by the evolution of TFP (in logs). We estimate the model using TFP and extract the model-based consumer confidence index for the U.S. For the TFP variable, we use the utilization adjusted quarterly TFP series from Fernald (2012). It measures the business section TFP less utilization of capital and labor.

Table A3 reports the estimation results using TFP and consumption series as observables. The estimation result using TFP is very close to the one using labor productivity (Table 1).

Table A3: Parameter Estimates, US 1976:II–2019:III

Parameter	Description	Value	s.e.
ρ	Persistence productivity	0.9746	0.0075
σ_u	Std dev. productivity	0.0066	0.0003
σ_ϵ	Std dev. permanent shock (implied)	0.0002	-
σ_η	Std dev. transitory shock (implied)	0.0065	-
σ_ν	Std dev. noise shock	0.0060	0.0021

Notes: The parameter σ_u defined by the standard deviation of Δa_t. Given the random walk Assumption (3) for a_t, σ_ϵ and σ_η are determined by ρ and σ_u. As they are indirectly recovered, no standard errors are given. Our observables include consumption and TFP series.

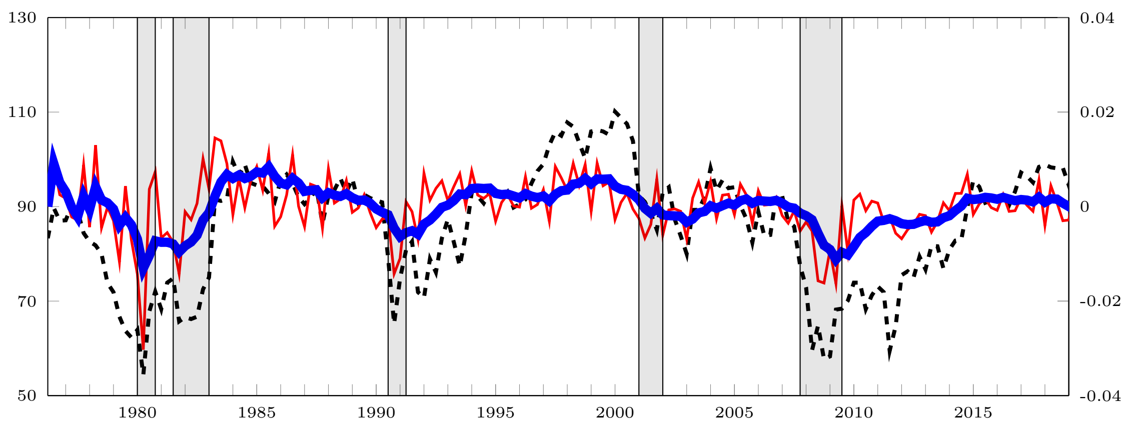
More importantly, our result also shows that the correlation between the model-based consumer confidence index and the survey-based measure is strictly positive (0.50) and statistically significant at the 1% level. For the medium frequency confidence measure the correlation is estimated at 0.80. The estimated correlation coefficients here are comparable to the ones measured in Section 3.3. Figure A6 denote our model-based consumer confidence to survey-based one.

G Extra Figures

Figure A7 plots our consumer confidence estimated for the sample period (solid lines) along with Consumer Confidence Index from OEDC (dashed lines).

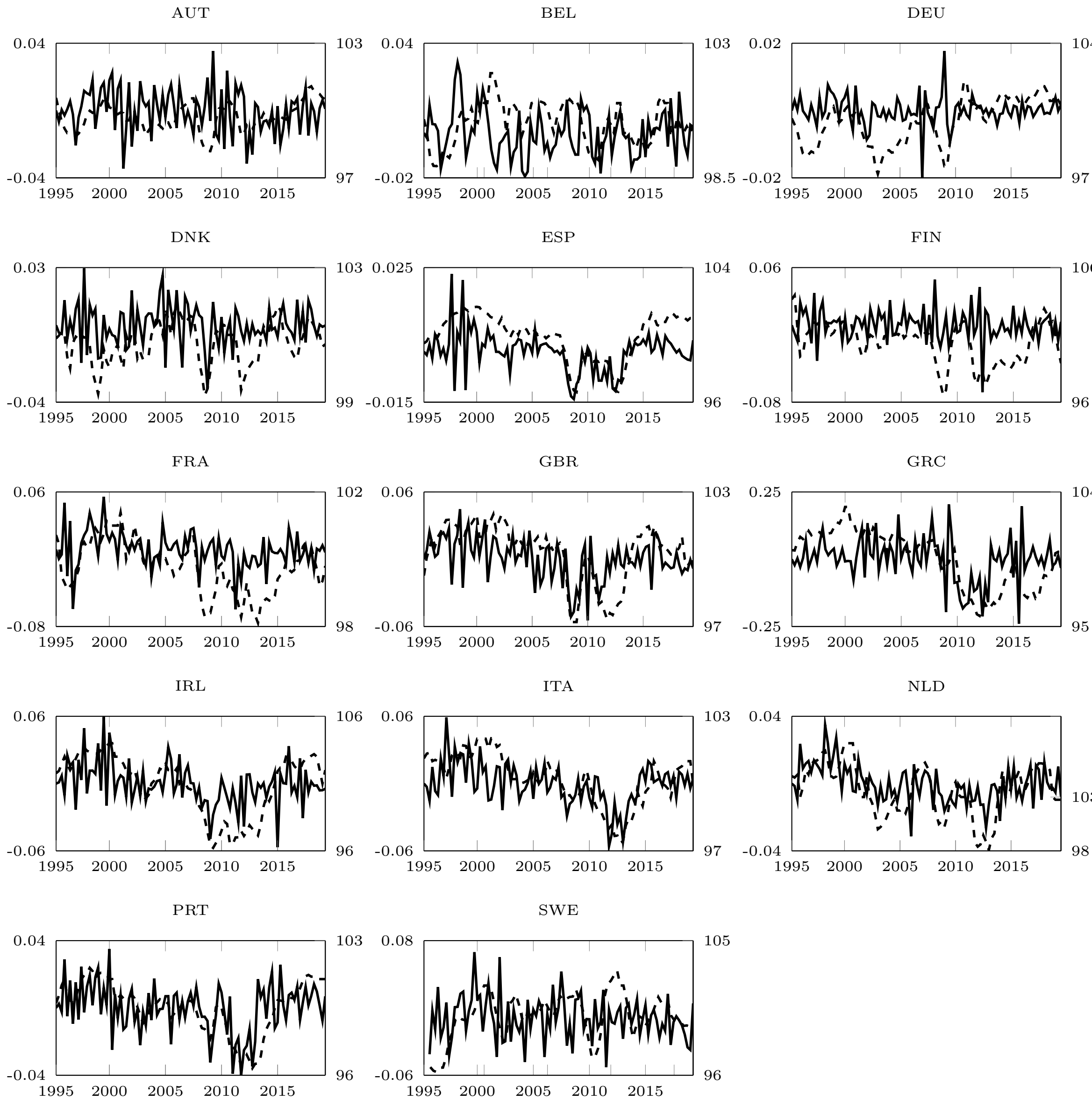
Figure A8 reports the implications of the estimated parameters in Table 1 for the variance decomposition of consumption, summarizing the contribution of the three shocks to the forecast error variance. We observe that noise shocks are a very important source of short- to medium-run volatility, explaining more than 60% of consumption volatility at a one-year horizon (light gray areas). On the contrary, both permanent (black areas) and transitory productivity (gray areas) shocks explain a much smaller fraction of consumption fluctuations, having almost no effect on quarterly volatility (permanent) and explaining less than 20% (transitory) at a one-year horizon.

Figure A6: Model-Based Consumer Confidence Index (solid), and the (Survey-Based) Index of Consumer Sentiment (dashed)



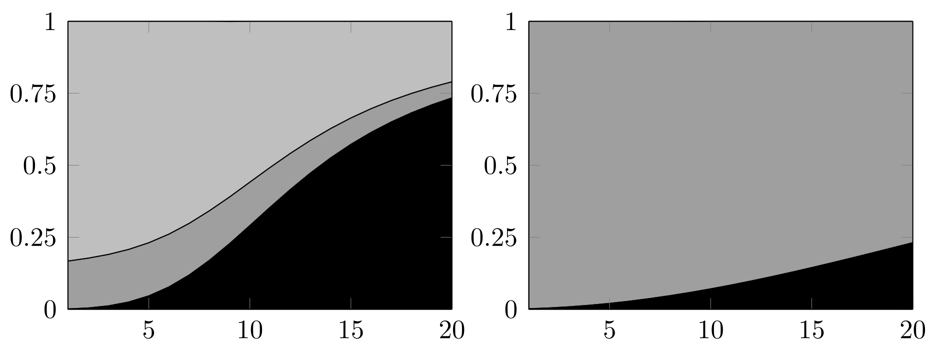
Notes: Shaded areas indicate U.S. recessions. The red and thin solid line denotes the MB-CCI (blue and thick solid for the medium frequency MB-CCI), whereas the black and thin dashed line denotes the ICS. The ICS corresponds to the left y-axis and the MB-CCI to the right y-axis. We use TFP and consumption series as observables.

Figure A7: Consumer Confidence and OECD Confidence Index



Notes: The dashed lines denote the (quarterly) Consumer Confidence Index (CCI) available from the OECD. Since it is published in monthly frequency, we change it to quarterly frequency by computing the quarterly arithmetic average at every quarter. The solid lines denote the MB-CCI. OECD consumer confidence corresponds to the right y-axis and the MB-CCI to the left y-axis. For Sweden, the CCI is available only from 1995:IV (SWE).

Figure A8: Variance Decomposition: Consumption (left) and Productivity (right)



Notes: The *black* areas, the *gray* areas, and the *light gray* areas respectively represent a contribution of *permanent technology shocks*, *transitory technology shocks*, and *noise shocks* to consumption fluctuations over different time horizons.

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