DO THE UNEMPLOYED PAY LOWER PRICES? A REASSESSMENT OF THE VALUE OF UNEMPLOYMENT INSURANCE

Rodolfo G. Campos
Banco de España

Iliana Reggio
Goethe University Frankfurt

Abstract
It is well known that transitions from employment to unemployment reduce consumption expenditure, but is this fall mainly driven by quantities or by prices? Using panel data on expenditure and quantities from the Spanish consumption survey we find that the unemployed pay prices that are, on average, 1.5% lower, and that this difference in prices accounts for roughly one sixth of the gap in consumption expenditure between the employed and the unemployed. The reduction in prices estimated with panel data is considerably lower than the existing estimates for the United States, which rely on cross-sectional comparisons. Based on our estimates, and using economic theory, we reassess the value of providing unemployment insurance and show how the social value of providing unemployment insurance can be decomposed into a consumption-smoothing component and a component that depends on prices. (JEL: D12, J64, H11)

1. Introduction

Economic theory indicates that the consumption-smoothing benefits of unemployment insurance can be inferred from the gap in consumption between the employed and the unemployed. The measurement of this gap has received considerable attention and has been estimated, for example, by Cochrane (1991), Gruber (1997), Browning and Crossley (2001), and Stephens (2001). Because of data limitations, the consumption gap is usually estimated using consumption expenditure (price times quantity) rather than consumption (quantity).

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E-mail: rodolfo.g.campos@gmail.com (Campos); reggio@safe.uni-frankfurt.de (Reggio)

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The use of consumption expenditure as a proxy variable for consumption is not innocuous. For instance, in a series of empirical papers, Aguiar and Hurst (2005, 2007) find that workers that are either retired or not employed pay lower prices, and that therefore changes in expenditure exaggerate changes in consumption. This finding has implications for optimal unemployment insurance, as shown by Campos and Reggio (2016): if the static model of Baily (1978) and Chetty (2006) is generalized to include price search, then the "sufficient statistics" formula that determines the optimal degree of unemployment insurance depends crucially on the magnitude of the difference in prices paid by the employed and the unemployed.

Prior evidence on prices paid by the unemployed, and how they compare to prices paid by the employed relied on either purely cross-sectional data or data sets in which unemployment cannot be separated from other forms of nonemployment. In this paper we study the issue using a panel of Spanish households in which the unemployed can be distinguished from the nonemployed. We estimate the impact of unemployment on expenditure and prices and then use our estimates to assess the social value provided by unemployment insurance using a model that links observed expenditure and price changes to changes in the marginal rate of substitution of a representative unemployed worker.

To interpret our empirical measurements in terms of economic theory, we derive the expression for the marginal welfare gain provided by unemployment insurance in an environment representative of a wide class of models incorporating moral hazard and asymmetric information. We show that the value of unemployment insurance is composed of two parts: a consumption-smoothing component, which depends on the curvature of the utility function, and a price component, which takes into account the return of transferring resources across different states of the world. If a CRRA utility specification is assumed, then the marginal benefit of unemployment insurance can be expressed as an additively separable function of these two components. With CRRA preferences it is possible to calculate the value of unemployment insurance as a weighted average of two semielasticities: the log-difference of consumption expenditure and the log-difference of prices between employed and unemployed states, which can be estimated if appropriate data are available.

We estimate the log-difference of consumption expenditure and the log-difference of prices between the employed and unemployed using data from the Spanish consumption survey, which is ideally suited for this purpose. There are three advantages of using these data. First, the Spanish consumption survey contains detailed household data on expenditure and quantities, a necessary requirement to disentangle consumption expenditure changes from price changes. Second, in this data set unemployment is precisely distinguished from other forms of nonemployment, which is rarely the case in surveys with information on prices or quantities. Third, the survey contains repeated observations on the same household. Therefore, we are able to improve on existing studies that rely exclusively on cross-sectional data.

We find that unemployed households experience a large drop in total consumption expenditure of 8.9% whereas consumption expenditure of food items drops by 6.4%. Using the household-specific price index proposed by Aguiar and Hurst (2007), we find that unemployed households pay prices that are 1.5% lower than prices paid by employed households. This finding implies that roughly one-sixth of the reduction in household expenditure at unemployment can be attributed to lower prices rather than to a change in quantities. Prices play a larger role in the case of food items consumed at home. Food prices paid by the unemployed are 2.0% lower, so that roughly one third of the change in food expenditure can be explained by prices.

The fraction of expenditure explained by price changes is considerably smaller than that implied by prior estimates (e.g., Aguiar and Hurst 2005). The reason for this difference is that with panel data we are able to control for unchanging unobservable characteristics of the household through a fixed-effects estimation. In contrast, the evidence of Aguiar and Hurst (2005) relies on a comparison between employed and nonemployed households in a cross-section of US households. In their data set, it is not possible to observe the same household before and after the unemployment shock. We also compare our results to pooled regressions to diagnose by how much the change in prices is overestimated in the absence of panel data. We find that pooled regressions overestimate the changes in prices associated to unemployment by a factor of between two and three.

Using the expression derived from our stylized model, we combine our estimates of the relationship between unemployment and consumption expenditure and prices to recover the value of providing unemployment insurance. For standard levels of risk-aversion, we find that the bulk of the value of unemployment insurance is due to consumption-smoothing. According to a simple back-of-the envelope calculation for Spain, the cost of providing unemployment insurance exceeds the value provided by the unemployment insurance scheme, meaning that the prevailing level of unemployment insurance exceeds the optimal level unless very high levels of risk-aversion are assumed.

The paper proceeds as follows. In Section 2 we review the relevant empirical literature. In Section 3 we discuss our empirical strategy and data and exhibit our basic empirical findings. In Section 4 we present the stylized static model we use to interpret our results and derive an expression for the value of unemployment insurance that can be estimated given an appropriate data set. We also show that the expression obtained in the static model is a good approximation of the value of unemployment insurance in more general dynamic models. In Section 5 we discuss how our results relate to the value of unemployment insurance. We conclude in Section 6.

2. Related Empirical Literature

To our knowledge, the relationship between unemployment and prices paid at the household level has not been studied for Spain so far. The effect of unemployment shocks on household consumption *expenditure* in Spain has been studied by Castillo et al. (1998) and by Bentolila and Ichino (2008). Both studies use expenditure data from the *Encuesta Continua de Presupuestos Familiares Base 1985* (ECPF85), a survey that was administered between the first quarter of 1985 and the first quarter of 1997, and interpret their findings in terms of risk-sharing. The evidence on risk-sharing from these two studies is inconclusive. Castillo et al. (1998) find a drop of consumption expenditure in response to unemployment that, while being smaller than for Portugal, is statistically significant, which implies a rejection of full risk-sharing whereas Bentolila and Ichino (2008), who perform a comparative study including data from Italy, Spain, United Kingdom, and the United States, find that the drop of consumption expenditure in response to an unemployment shock is smallest in Spain and, in fact, not significantly different from zero.

Recent research argues that declines in consumption expenditure may, in part, be due to a reduction in prices rather than reductions in quantities. The evidence suggests that the availability of time that can be used for shopping and searching for bargains plays an important role in lowering prices. Using supermarket scanner data, Aguiar and Hurst (2007) verify that increases in time used for shopping lowers the price paid for grocery items while maintaining quality constant in the general US population.

Retirement and unemployment are the two transitions out of employment that allow for a sharp increase in the amount of time available for shopping, allowing individuals to secure lower prices. The first of these labor market transitions, retirement, is the focus of the study by Aguiar and Hurst (2007), who find that retired households pay lower prices in the United States. Luengo-Prado and Sevilla (2013) obtain similar results in the case of Spain.[1] Unemployment, the second labor market transition that frees up time available for shopping, initially received less attention but the onset of the Great Recession increased the interest. For the United States, there is evidence that nonemployed households devote more time to shopping: using time use surveys, Aguiar et al. (2013) find that roughly 7% of the time freed up by market hours of work is dedicated to activities such as shopping for groceries and other household items, comparison shopping, coupon clipping, and buying goods online. Using the Nielsen Homescan Dataset, Nevo and Wong (2015) find that purchases of sale items, coupon usage, buying generic products and large sized items, and shopping at discount increased during the Great Recession, and that the rise in these activities led to lower prices. Scanner data have the advantage of providing quantity information at the UPC level.

Focusing specifically on the individual employment status of households, Aguiar and Hurst (2005) find that consumption by those out of work falls less than expenditure, suggesting a reduction in the price paid per unit of consumption. Closer to the methodology used in our paper, Kaplan and Menzio (2015) use the price index of Aguiar and Hurst (2007) and find that households in the Kilts-Nielsen Consumer Panel Dataset with members that are not employed pay lower prices than those that are employed in a cross-sectional comparison.

As stated by Nevo and Wong (2015), a shortcoming of the Nielsen data set used in the US studies is that it is not possible to distinguish between consumers who

1. The conclusion of these empirical studies is that the surprisingly large drop in expenditure observed at retirement (the retirement puzzle) can, in part, be explained by lower prices.

become unemployed and those who leave the labor force. It is also not possible to exclude self-employed individuals.[2] Whereas the difference between employment and nonemployment is the relevant distinction for some purposes, questions related to unemployment insurance require to distinguish unemployment from other forms of nonemployment. Because the unemployed cannot be distinguished from the nonemployed in the Nielsen scanner data, the existing studies for the United States do not answer the question posed in our title: whether the unemployed pay lower prices. That is why, acknowledging its limitations, we use data from Spain to answer the question.

3. Empirical Strategy and Empirical Results

3.1. Data

Our household data are obtained from the EPF (*Encuesta de Presupuestos Familiares. Base 2006*). This yearly survey provides detailed information on consumption, unemployment, and socioeconomic characteristics at the household level. Households are interviewed in two consecutive periods. The EPF provides expenditure data and also quantities purchased for several consumption items. The data in the EPF is of higher quality than prior Spanish ECPF surveys due to a substantial increase in sample size, a lengthening of the period in which households complete a diary, and improvements in the data collection process (INE 2008). Consumption expenditure in the EPF accounts for 87% of Spanish aggregate consumption expenditure (Campos and Reggio 2015).

In addition to the availability of quantity data, the Spanish EPF also compares favorably to sources from other countries on the expenditure side. For example, it has a number of advantages over the Consumer Expenditure Survey (CEX) in the United States. It is well known that consumption measured in the CEX has important discrepancies with Personal Consumption Expenditure (PCE), the aggregate consumption series in the United States (Slesnick 1992; Garner et al. 2006; Heathcote et al. 2010). In particular, consumption measured in the CEX is less procyclical than aggregate consumption. Campos et al. (2013) show that consumption measured from the CEX underestimates the cyclical correlation of aggregate consumption (PCE) with GDP by 40%. It is therefore likely that consumption measured from the CEX underestimates its comovement with unemployment, which is a very cyclical variable. In contrast, consumption expenditure in the EPF tracks aggregate consumption very well.

2. An additional critique of the Nielsen Homescan Dataset is that, because it is not a random sample, selection issues arise. Moreover, Einav et al. (2010) report results from a validation study of the Nielsen Homescan consumer panel data. Although measurement error is comparable to other surveys, they find that recording errors lead to discrepancies that are largest for the price variable. Moreover, in the case of female heads of household, the quality of recording is influenced by employment status.

Information on quantities is available for a subset of the goods and services. In total there are 80 consumption categories in the survey with quantity information. We list them in the Online Appendix. Consumption items in the EPF are classified using the COICOP/HBS classification. Our measure of consumption expenditure is defined as expenditure on nondurable consumption goods and services, excluding rent (which is imputed for homeowners). We obtain real household consumption expenditure by adjusting for inflation using the Spanish consumer price index (*IPC Base 2006*). As is usual in the literature, we adjust household consumption by using the OECD equivalence scale to take into account possible economies of scale in consumption.[3]

3.2. Sample Selection

Our panel data cover the period 2006–2014. We focus on the working-age population and restrict the sample to households in which the primary earner is aged 25–64. We exclude households with heads who are self-employed or inactive and those who report zero expenditure on food. Our final sample consists of 100,754 observations (household-year). For the fixed effects estimation we further restrict the sample to those households observed twice in which the identity of the primary earner does not change from one year to the other. We have a balanced panel of 31,697 households. For our computations using physical quantity data our sample is reduced by 118 households for which quantity data are missing, leaving us with a total of 31,579 households.

3.3. Price Index

Following the methodology in Aguiar and Hurst (2007), we define an index to measure whether a household is paying more or less than the average household. For each good j (where $j = 1, \ldots, J$) we compute $\hat{p}_{ijt}$, the unit value paid by household i ($i = 1, \ldots, N$) at time t, as the ratio of expenditure on j to the quantity of j:

$$\hat{p}_{ijt} = \frac{\tilde{c}_{ijt}}{q_{ijt}}. \tag{1}$$

Using these household-specific unit values $\hat{p}_{ijt}$ we construct a weighted average price $\bar{p}_{jt}$ that was paid for good j at time t, using quantities purchased q_{ijt} as weights:

$$\bar{p}_{jt} = \frac{\sum_i \hat{p}_{ijt} q_{ijt}}{\sum_i q_{ijt}}. \tag{2}$$

The price index measuring how much a household overpaid or underpaid for its consumption basket is then obtained by dividing true expenditure by the cost of the

3. Our conclusions do not rely on this adjustment.

TABLE 1. Characteristics of households in our final sample.

	All		Employed		Unemployed	
	Mean	SD	Mean	SD	Mean	SD
Individual characteristics						
Female	0.25	(0.43)	0.25	(0.43)	0.25	(0.43)
Age	45.10	(9.02)	44.93	(8.93)	46.56	(9.63)
No education	0.11	(0.31)	0.09	(0.29)	0.22	(0.42)
Primary education	0.31	(0.46)	0.29	(0.46)	0.46	(0.50)
Secondary education	0.21	(0.41)	0.21	(0.41)	0.17	(0.38)
Tertiary education	0.37	(0.48)	0.40	(0.49)	0.15	(0.35)
Household characteristics						
Couple	0.79	(0.41)	0.80	(0.40)	0.68	(0.47)
Household size	3.13	(1.22)	3.14	(1.20)	3.02	(1.40)
Num. of kids	0.97	(0.97)	0.98	(0.96)	0.88	(1.01)
Expenditure	8,661.63	(4,855.07)	8,994.70	(4,857.37)	5,824.19	(3,793.01)
Relative price	1.00	(0.14)	1.01	(0.14)	0.94	(0.14)
Obs.	63,158		56,523		6,635	

Notes: The table shows the mean and standard deviation (SD) for households in the estimation sample that includes all households with nonmissing variables in the relevant variables (including data on quantities). Individual characteristics refer to the characteristics of the head of the household. Summary statistics are also shown separately according to whether the head of the household is employed or unemployed.

bundle valued at average prices:

$$\tilde{p}_{it} = \frac{\sum_{j=1}^{J} \hat{p}_{ijt} q_{ijt}}{\sum_{j=1}^{J} \bar{p}_{jt} q_{ijt}}. \tag{3}$$

As Aguiar and Hurst (2007), we normalize this price index to have mean one in every year:

$$p_{it} = \frac{\tilde{p}_{it}}{\frac{1}{N} \sum_i \tilde{p}_{it}}. \tag{4}$$

This normalization implies that $\log p_{it}$ measures log-deviations from the average across households, indicating whether households pay lower prices for the goods in their household basket relative to the average.

3.4. *Characteristics of Households in the Sample*

The summary statistics for the sample consisting of 63,158 household-year observations with nonmissing values for all the variables are presented in Table 1. For the household head, the mean age is around 45, and 75% of household heads are male. Mean household size is around 3, and there is less than one child per household on average, both for unemployed and employed households. As expected, there are important differences between the employed and unemployed for some variables. Employed individuals show higher levels of education, higher levels of consumption expenditure, and pay higher prices than unemployed individuals. In the sample there are 4,938 observations in which there is a transition between employment and unemployment. Employed and unemployed households used in the estimations are very similar to the households in the whole sample along the dimensions shown in the table.

3.5. Specification

We estimate the relationship between unemployment and the two outcomes of interest—consumption expenditure and prices—by relating the log of each of these two variables to a dummy variable U_{it} indicating whether the primary earner is unemployed:

$$\log \tilde{c}_{it} = \lambda^c U_{it} + x'_{it}\theta^c + \delta^c_t + \alpha^c_i + \eta^c_{it} \tag{5}$$

and

$$\log p_{it} = \lambda^p U_{it} + x'_{it}\theta^p + \delta^p_t + \alpha^p_i + \eta^p_{it}. \tag{6}$$

The vector x contains time-varying household characteristics, δ^c_t and δ^p_t are time dummies, and α^c_i and α^p_i are time-invariant household-specific effects. A pooled OLS specification corresponds to a special case of (5) and (6) in which we set $\alpha^c_i = \alpha^c$ and $\alpha^p_i = \alpha^p$ for all households i.

All our specifications include time dummies δ_t to capture aggregate shocks that account for arbitrary changes affecting all households, such as the macroeconomic environment. Other controls x_{it} consist of standard demographic variables likely to affect the level of consumption and the consumption profile. Our control variables include dummy variables for household size and the number of kids below 16 or dependents below 25, dummies for educational attainment, gender, and a polynomial in the age of the primary earner to capture life-cycle effects. We also include regional dummies to control for systematic geographic differences in consumption expenditure and prices across regions.

Because our sample includes urban and rural households, we include a dummy for rural households who may, in principle, obtain their consumption from non-market sources or derive a substantial part of their income from agricultural activities. We also include the number of adults employed other than the primary earner as an additional control to capture differences in the exposure to individual unemployment shocks. We also experimented with restricting the sample to couples and, in that case, added the unemployment status for the spouse as an additional control.

Wealth information in the survey is relatively coarse. We use home ownership as a proxy for wealth and include dummies for owning a primary home or a secondary home as additional controls. We also control for whether the household has a mortgage. Having a mortgage proxies for access to credit and, since households with a mortgage are a subset of those who own a home, it also allows for a more flexible relationship between home ownership and consumption.

TABLE 2. Consumption expenditure by employment status of the primary earner.

Variables	Whole sample Pooled OLS (1)	Panel sample Pooled OLS (2)	Panel sample Fixed effects (3)
U_{it}	−0.314***	−0.313***	−0.089***
	(0.007)	(0.009)	(0.011)
Observations	100,754	63,394	63,394
R-squared	0.339	0.335	0.859

Notes: Coefficients in columns (1) and (2) are obtained from a pooled OLS estimation, the coefficient in column (3) from a fixed-effects estimation. The dependent variable is the log of total real expenditure on nondurables and services and U_{it} is a dummy variable taking the value one when the primary earner is unemployed. Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional, and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

To address the dual nature of the Spanish labor market we include a dummy for when the primary earner has an indefinite labor contract. Previous research has argued that the dual structure of labor contracts is a key characteristic of the Spanish labor market that explains much of the evolution of unemployment (Costain et al. 2010; Bentolila et al. 2012), and also affects a household savings (Barcelo and Villanueva 2016).

3.6. Main Empirical Findings

We discuss the results separately for expenditure and prices and then combine them to evaluate the change in consumption associated with unemployment. In all the estimations we include the control variables described in Section 3.5. In our tables we report the coefficient on U_{it}, a dummy variable taking the value one if the primary earner is unemployed and zero if employed.[4]

We present the main results about the relationship between unemployment and consumption expenditure in Table 2. The first column pools all years and does not make use of the panel dimension. Therefore, the coefficient shown captures the difference in consumption expenditure between a household whose primary earner is unemployed and a similar household whose primary earner is employed. The average estimated drop in consumption expenditure associated to unemployment in this case is extremely large: around 31%. The second column in Table 2 shows the result of running this same pooled regression but only for the sample of households that are observed twice (households for which we can perform a fixed effects estimation). Despite the substantial drop in

4. It might be the case that agents anticipate that they will become unemployed. To the extent that this is true, the coefficients reported in this section can be interpreted as a lower bound of the true effect of unemployment on consumption expenditure and prices.

TABLE 3. Food expenditure by employment status of the primary earner.

Variables	Whole sample Pooled OLS (1)	Panel sample Pooled OLS (2)	Panel sample Fixed effects (3)
U_{it}	−0.169***	−0.174***	−0.064***
	(0.009)	(0.012)	(0.018)
Observations	100,754	63,394	63,394
R-squared	0.106	0.101	0.725

Notes: Coefficients in columns (1) and (2) are obtained from a pooled OLS estimation, the coefficient in column (3) from a fixed-effects estimation. The dependent variable is the log of total real expenditure on food and U_{it} is a dummy variable taking the value one when the primary earner is unemployed. Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

sample size, we estimate a coefficient practically identical to the one in the first column. This evidence indicates that differences between pooled and fixed effects estimates are not due to a selected sample of households. Finally, in the third column of Table 2 we report the coefficient from the fixed effects estimation, our preferred specification. This coefficient represents the change in consumption expenditure associated with a change in the employment status of the head of the household. In this case, unemployment is related to a consumption expenditure drop of 8.9%, 22 percentage points less than in the pooled regressions.

In Table 3 we perform a similar comparison between pooled OLS and fixed-effects estimations for expenditure on food.[5] Again, comparing the third column with the other two, we observe that a pooled regression overestimates the relationship between unemployment and food expenditure. The estimated coefficient drops by about two thirds once we control for time-invariant unobserved household heterogeneity (a difference of 11 percentage points): we find that unemployment is related to a food expenditure drop of 6.4%.

The differing results between expenditure on food and on wider definitions of nondurables is documented in the literature. For example, Browning and Crossley (2009) show that expenditure on food and on clothing respond differently to changes in unemployment benefits and explain it with the differing durability of the consumption items. It is also likely that work-related expenditure decreases by more when a person becomes unemployed owing to nonseparabilities with time use. Expenditures that are complementary with work (e.g., clothing, transport, and food outside of the home) are more likely to drop upon unemployment than others, such as food at home.

5. Much of the prior literature has relied on expenditure on food, although the implicit assumption of separability between food and other consumption items has been questioned (e.g., Attanasio and Weber 1995).

TABLE 4. Prices by employment status of the primary earner.

Variables	Whole sample Pooled OLS (1)	Panel sample Pooled OLS (2)	Panel sample Fixed effects (3)
U_{it}	– 0.037***	– 0.038***	– 0.015***
	(0.002)	(0.003)	(0.004)
Observations	100,443	63,158	63,158
R-squared	0.161	0.164	0.744

Notes: Coefficients in columns (1) and (2) are obtained from a pooled OLS estimation, the coefficient in column (3) from a fixed-effects estimation. The dependent variable is the log of the price index p_{it} and U_{it} is a dummy variable taking the value one when the primary earner is unemployed. Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

TABLE 5. Prices of food items by employment status of the primary earner.

Variables	Whole sample Pooled OLS (1)	Panel sample Pooled OLS (2)	Panel sample Fixed effects (3)
U_{it}	– 0.055***	– 0.056***	– 0.020***
	(0.003)	(0.004)	(0.006)
Observations	100,405	63,118	63,118
R-squared	0.155	0.157	0.751

Notes: Coefficients in columns (1) and (2) are obtained from a pooled OLS estimation, the coefficient in column (3) from a fixed-effects estimation. The dependent variable is the log of the price index p_{it} and U_{it} is a dummy variable taking the value one when the primary earner is unemployed. Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

In sum, the results for consumption expenditure highlight the importance of using panel data rather than relying on cross-sectional data to estimate the effects of unemployment. Both for nondurable consumption and food expenditures, not controlling for unobserved heterogeneity induces a significant overestimation of the effect of unemployment. In addition, the drop of consumption expenditure in the cross-sectional specifications in the first two columns in Table 2 is implausibly large compared to the international evidence. The 8.9% drop in the fixed effects estimation, on the other hand, is comparable to the international evidence, which generally reports estimates of 10% or smaller (e.g., Cochrane 1991).

In Tables 4 and 5 we present the results for prices. In Table 4 we use an index with all prices available in our data as the dependent variable and in Table 5 we use only prices on food items. We perform the same comparison between pooled and fixed-effect estimates as we did for expenditures. Again, coefficients in the first two columns in each table capture the average conditional difference between households with unemployed primary earners versus households with employed primary earners for the whole sample and for the sample with panel information, controlling for the set of observable characteristics explained before.

As was the case with expenditure, we find major differences when comparing columns (3) to columns (1) and (2), and practically no differences between column (1) and column (2). Looking at the first columns, we find that a household with an unemployed primary earner pays average prices that are 3.7% lower than a similar household with an employed primary earner, and pays food prices that are 5.5% lower.

Our preferred estimates are those in the third column in Tables 4 and 5. Once time-invariant unobserved household characteristics are taken into account, both point estimates become significantly smaller. They drop by more than half, from 3.8% to 1.5% for all available prices, and from 5.6% to 2.0% for food prices.

Combining our results so far, we can compute the difference between the drop in expenditure and the drop in prices to obtain an estimate of the drop in consumption associated with unemployment. Relying on our pooled regressions, the first columns in our tables, the estimated drop in consumption associated to unemployment is about 27.7%, much higher than the 7.4% we obtain when exploiting the panel dimension of the data (if we use food consumption the figures are 11.8% against 4.4%).

We can compare our results with previous findings. Aguiar and Hurst (2005), who focus on food in the United States using cross-sectional data, find that the unemployed experience a 19% decline in expenditure and a 5% decline in consumption, suggesting that almost three-quarters of the drop in expenditure are due to lower prices. However, their estimate of a 19% drop in food expenditure due to unemployment is large compared to the usual estimates, which hover around 10% (e.g., Stephens 2001). Assuming that the consumption index of Aguiar and Hurst (2005) is correctly estimated but that the decline in expenditure is actually lower, at 10%, yields an estimated drop in prices of 5%. This drop is more than double of what we find for food prices in the fixed effects estimation (2%) but close to the cross-sectional estimate of 5.6%.

Kaplan and Menzio (2015) also study how prices paid are affected by employment status, although the main focus of their paper is on price dispersion. They use the Kilts Nielsen data set for the United States, that does not distinguish unemployed individuals from nonparticipants. They control for age, household size, and education but do not report fixed-effects estimates. They consider alternative definitions of a good but are agnostic about which one they prefer. The definition of a good that is closest to ours is the one they term "*Brand and Size Aggregation*". With this definition of a good, they find that the nonemployed pay prices that are 2.6% lower than employed households in the case of one-head households. For two-head households they find that, relative to a household with two employed heads, prices paid are 1.5% lower if one head is not employed and 4.6% lower if both heads are not employed.

These effects on prices are slightly larger than the ones we found for Spain. However, they are not as large as we would have expected given that the results by Kaplan and Menzio (2015) rely on a cross-sectional estimation. This might in part be explained by the fact that they cannot distinguish between the unemployed and those

TABLE 6. Expenditure and prices by employment status of the primary earner.

Variables	Expenditure All (1)	Expenditure w/quantities (2)	Price index (3)	Food w/quantities (4)	Price index Food (5)
Nonemployed	− 0.076***	− 0.063***	− 0.010***	− 0.047***	− 0.013***
	(0.009)	(0.010)	(0.004)	(0.014)	(0.005)
Observations	78,159	78,159	78,159	78,136	78,136
R-squared	0.860	0.781	0.749	0.738	0.757

Notes: All columns correspond to fixed-effects estimations. The dependent variable is the log of real expenditure on nondurables and services in column (1), the log of real expenditure on nondurables and services for which quantity data are available in column (2), the log of the price index p_{it} in column (3), the log of real expenditure on food items in column (4), and the log of the price index p_{it} restricted to food items in column (5). The coefficient shown corresponds to a dummy variable taking the value one when the primary earner is not employed. Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

who are out of the labor force. In Table 6 we estimate the response of consumption expenditure and prices for all goods and for food but replacing the unemployment dummy with a nonemployment dummy. We find much lower effects on prices when unemployment is proxied by nonemployment.

The difference between our results for Spain and those for other countries may also in part be explained by idiosyncratic factors. For example, in Spain the margin for reducing prices may also be more limited than in other advanced economies because certain household members may already be specialized in shopping and home production. For instance, the labor force participation of women in Spain has hovered around 40% in the past years, compared to 53% in the United States and around 48% on average in OECD countries.

Taken together, our results, both for expenditure and prices, provide a strong case for preferring panel data fixed-effects estimates. In all cases we find that relying on cross-sectional data produces a sizable overestimation of the effect of unemployment. We also find that prices paid by the unemployed are not that much smaller once time-invariant unobserved heterogeneity is controlled for and that prices play a smaller role than that suggested by previous estimates using cross-sectional data.

3.7. *Additional Analysis: Couples, Long-Term Unemployed, Business Cycle*

3.7.1. Couples. Because households with couples potentially have two earners, they may be in a better position to smooth a job loss by the primary earner. To study whether this is the case, we restrict the sample to couples, who account for almost 80% of the sample, and perform the estimation for this restricted sample. The results for consumption expenditure appear in Table 7 and those for prices in Table 8. The

TABLE 7. Consumption expenditure by employment status of the primary earner for couples.

	Consumption expenditure		
Variables	Whole sample Pooled OLS (1)	Panel sample Pooled OLS (2)	Panel sample Fixed effects (3)
U_{it}	− 0.272*** (0.007)	− 0.268*** (0.009)	− 0.079*** (0.011)
Observations	77,897	49,370	49,370
R-squared	0.364	0.354	0.860

Notes: Coefficients in columns (1) and (2) are obtained from a pooled OLS estimation, the coefficient in column (3) from a fixed-effect estimation. The dependent variable is the log of total real expenditure on nondurables and services and U_{it} is a dummy variable taking the value one when the primary earner is unemployed. Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, unemployment status of the spouse, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

TABLE 8. Prices by employment status of the primary earner for couples.

	Prices		
Variables	Whole sample Pooled OLS (1)	Panel sample Pooled OLS (2)	Panel sample Fixed effects (3)
U_{it}	− 0.032*** (0.002)	− 0.031*** (0.003)	− 0.008** (0.003)
Observations	77,663	49,194	49,194
R-squared	0.183	0.188	0.759

Notes: Coefficients in columns (1) and (2) are obtained from a pooled OLS estimation, the coefficient in column (3) from a fixed-effect estimation. The dependent variable is the log of the price index p_{it} and U_{it} is a dummy variable taking the value one when the primary earner is unemployed. Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, unemployment status of the spouse, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%, **Significant at 5%.

large difference between the pooled OLS estimates and the fixed effects estimation remains.

When controlling for fixed effects, the point estimate of the relationship between unemployment by the primary earner and consumption expenditure is only slightly lower than for the full sample, whereas for prices the fixed effects estimate is cut roughly in half when compared to the full sample. The relatively smaller impact on prices may be explained by the presence of a spouse who is already specialized in obtaining goods and services, and who does not vary the amount of search effort to obtain these consumption goods at lower prices upon unemployment of the main

TABLE 9. Consumption expenditure and long-term unemployment.

	Expenditure		Prices	
	Option 1	Option 2	Option 1	Option 2
Variables	(1)	(2)	(3)	(4)
U_{it}	– 0.207***		– 0.027***	
	(0.012)		(0.004)	
Always unemployed	– 0.174***	– 0.392***	– 0.017***	– 0.046***
	(0.016)	(0.011)	(0.005)	(0.003)
Unemployed one period		– 0.177***		– 0.022***
		(0.009)		(0.003)
Observations	63,394	63,394	63,189	63,189
R-squared	0.338	0.340	0.165	0.165

Notes: The dependent variable in columns (1) and (2) is the log of total real expenditure on nondurables, and the log of the price index p_{it} in columns (3) and (4). U_{it} is a dummy variable taking the value one when the primary earner is unemployed. Always unemployed refers to those workers unemployed in both periods, and unemployed one period to those workers unemployed in one of the two waves. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

earner. The evidence is supportive of this hypothesis. In the Online Appendix we report estimates that distinguish between couples in which the partner is continuously employed and those in which not. According to these estimates, the response of prices to unemployment is larger in couples in which the partner works than in those couples where this is not the case.

3.7.2. The Long-Term Unemployed. It is possible that part of the difference between the OLS and fixed effects estimations is related to the inclusion in the unemployed category of different types of workers. This is in fact another drawback of using a pooled estimation. To address this issue we define three categories of workers: those unemployed in both periods ("Always unemployed"), those unemployed in one of the two waves ("Unemployed one period"), and those employed in both periods ("Always Employed"), our base category in the regressions in this section. In column (2) in Table 9, we add to the baseline equation the "Always Unemployed" dummy, that can be considered an approximation to the long-term unemployed. This dummy now captures the effect of long-term unemployment, and its coefficient represents the additional change in the dependent variable for those always unemployed. We find that "Always Unemployed" workers experience an additional 17% drop in expenditure, on top of the 20% drop for the short-term unemployed (represented by our dummy U_{it}). These workers also pay lower prices than the rest, an additional 1.7% drop with respect to short-term unemployed.

In a second estimation, we consider the three categories defined before, leaving Always Employed as the base category. Each coefficient now represents the conditional difference in expenditure or prices between the corresponding category and workers employed in both periods. We find that the expenditure of those unemployed in both periods is almost 18% lower than that of the short-term unemployed and 39% lower

TABLE 10. Consumption expenditure and prices by employment status of the primary earner.

Variables	Expenditure Fixed effects (1)	Prices Fixed effects (2)	Food expenditure Fixed effects (3)	Food prices Fixed effects (4)
U_{it}	−0.091***	−0.015***	−0.063***	−0.021***
	(0.011)	(0.005)	(0.019)	(0.006)
$U_{it}\times$ precrisis	0.011	0.001	−0.001	0.006
	(0.035)	(0.011)	(0.053)	(0.019)
Observations	63,394	63,158	63,394	63,118
R-squared	0.859	0.744	0.725	0.751

Notes: All columns correspond to fixed-effects estimations. The dependent variable is the log of real expenditure on nondurables and services in column (1), the log of the price index p_{it} in column (2), the log of total real expenditure on food in column (3), and the log of the price index for food items in column (4). Our estimations include household size, the number of kids below 16 or dependents below 25, the number of adults employed other than the primary earner, primary and secondary home ownership, a mortgage dummy, a rural dummy, regional and time dummies, and for the primary earner: educational attainment, gender, a polynomial in age, and a dummy for indefinite contracts. Sample period 2006–2014. Panel-robust standard errors in parentheses. ***Significant at 1%.

than that of the "Always Employed" workers. Therefore, the differences between employed and unemployed uncovered by the pooled cross-sectional analysis is clearly influenced by the long-term unemployed.

3.7.3. Stability Along the Cycle. An additional question is whether the results depend on whether the economy is in a recession or not. The data cover the years 2006–2014, which includes the period of the Great Recession. Prior studies, for example, Blundell et al. (2008) and Campos and Reggio (2014) for the United States and Casado (2011, 2012) for Spain found that transitory versus permanent shocks have different effects on consumption expenditure. If the onset of the recession shifted the perceived persistence of an income shock implied by a job loss, then the response of consumption expenditure, and also the decomposition into consumption and prices, may differ between recessions and expansions.

To address this question, we repeat the fixed-effects regressions for expenditure and prices adding the interaction of unemployment status with a dummy variable for observations in the precrisis period 2006–2008. The results from these regressions, which are collected in Table 10, show an economically small and statistically insignificant coefficient on the interaction between unemployment status and the precrisis dummy variable, suggesting that the relationship between unemployment and expenditure and prices is stable across recession and nonrecession years.

4. Theory

In order to interpret our findings, in this section we model how unemployment insurance affects the decision problem of an unemployed worker. We first consider a static version of the model and then generalize our results by turning to a dynamic version of the model. In the model, in addition to searching for a job, workers exert effort to search for lower prices. The opportunity cost of searching for lower prices may differ depending on whether the decision maker is employed or unemployed, as in the model of Campos and Reggio (2016), which generalizes the static Baily–Chetty environment to include price search. In this paper, we generalize that model to obtain results that can be applied to a wider set of stylized environments: we allow for the decision maker to take any countable number of additional decisions that impact household income. Our results do not require that we specify the exact relationship between these actions and income. Moreover, our characterization of the marginal value of unemployment insurance does not depend on how unemployment insurance is financed and the benefits of unemployment insurance can be studied in isolation from the costs. Once we turn to the dynamic model, we prove that the marginal value of unemployment insurance in this more general model can be approximated by the expression derived from the simpler static model.

4.1. The Static Model

Environment. The model is static and time consists of one period.[6] During that period an individual agent who starts out unemployed becomes employed with probability π and stays unemployed with probability $1-\pi$. As in the standard Baily–Chetty setting, we assume that individuals can deterministically control π, the probability of finding a job. Individuals choose consumption in the event of being employed, c_e, and consumption in the event of being unemployed, c_u. They deterministically control prices paid per unit of consumption in the employed state, p_e, and in the unemployed state, p_u. This implies that in the background there are choices that are left unmodeled of how individuals allocate their time to alternative uses, such as leisure, searching for a job, searching for goods (shopping), and so forth.[7]

In addition to these choices, individuals also choose a vector x, which stands for variables such as labor effort, spousal labor supply, and saving or future consumption. Choices (p_e, p_u, π, x) are restricted to lie in a compact choice set that may be shaped by technology, time constraints, market structure, and existing forms of formal and informal insurance.

Budget Constraints. The budget constraint in the employed state is given by

$$p_e c_e = \Upsilon_e(x) - \tau \tag{7}$$

and in the unemployed state it is

$$p_u c_u = \Upsilon_u(x) + b. \tag{8}$$

6. In Section 4.5 we consider the dynamic version of the model.

7. The relationship between choice variables and time use, which is left in the background for presentation purposes is made explicit in Appendix A where we carefully model time use in the static environment.

The functions $\Upsilon_e(\cdot)$ and $\Upsilon_u(\cdot)$ are general ways of mapping the arbitrary actions contained in the vector x into income that is available for consumption in the employed and unemployed state. Unemployment insurance is captured by the pair (τ, b). Through unemployment insurance, income available for consumption is reduced in the employed state by a tax τ that is imposed on those working and incremented in the unemployed state by a benefit level b that accrues to those unemployed. The product of prices and consumption on the left hand side of the budget constraints (7) and (8) is consumption expenditure. For later use, we explicitly introduce notation for consumption expenditure: $\tilde{c_s} = p_s c_s$ for $s \in \{e, u\}$.

Preferences. Agents choose their actions optimally for any given pair (τ, b). Letting u and v represent preferences for consumption in the unemployed and employed state, the expected utility of an insurance policy pair (τ, b) is then given by

$$U(\tau, b) = \max_{(p_e, p_u, \pi, x)} \pi v(c_e(p_e, x; \tau)) + (1-\pi)u(c_u(p_u, x; b)) - \Psi(\pi, p_e, p_u, x), \tag{9}$$

where $\Psi(\pi, p_e, p_u, x)$ is a term that implicitly embeds the impact of leisure, of time spent shopping, and of any of the variables in the vector x on utility. We do not assume any specific functional form for $\Psi(\pi, p_e, p_u, x)$ other than that it leads to a well-behaved maximization problem.[8] In Appendix A we show how the function $\Psi(\pi, p_e, p_u, x)$ can be derived from time constraints if the utility function is separable in consumption and leisure. State-specific preferences v and u are smooth functions only of consumption in each state and satisfy $u' > 0, u'' < 0$ and $v' > 0, v'' < 0$. Through the budget constraints (7) and (8) consumption depends on the vector x and also on (τ, b), the parameters describing unemployment insurance.

The description of the environment given so far is very general. It encompasses the worker's decision problem in the static models of Baily (1978) and Chetty (2006) adapted to include prices p_e and p_u as additional choice variables. In particular, the problem solved by workers in the textbook version of the Baily–Chetty model (e.g., Chetty and Finkelstein 2013, Section 3, Chap. 3), is obtained in the special case in which $p_e = p_u = 1$.[9]

4.2. *The Marginal Value of Unemployment Insurance*

Assume that the maximization problem in (9) has a unique solution. By the Envelope Theorem, the impact of varying the parameters governing unemployment insurance

8. It is usual, however, to assume that $\Psi(\pi, p_e, p_u, x)$ is an increasing and strictly convex function of π. Because obtaining lower prices requires the use of time for shopping it is also reasonable to assume that $\Psi(\pi, p_e, p_u, x)$ is strictly increasing in prices.

9. The setup of Chetty and Finkelstein (2013, Chap. 3) is obtained exactly by further specializing $\Upsilon_e(x) = A + w_e$ and $\Upsilon_u(x) = A + w_u$, where A is the level of exogenously determined assets and w_e and w_u is the individual's exogenous income in the employed and unemployed state, and letting $\Psi(\pi, 1, 1, x) = \psi(\pi)$ depend only on the probability of reemployment.

on maximized utility will be given by a relatively simple expression:

$$dU = \pi v'\left(c_e\right)\frac{\partial c_e}{\partial \tau}d\tau + (1-\pi)u'\left(c_u\right)\frac{\partial c_u}{\partial b}db, \tag{10}$$

where π, c_e, and c_u are at the optimal values chosen by the agent and the partial derivatives $\partial c_e/\partial \tau$ and $\partial c_u/\partial b$ are evaluated at the optimum. The Envelope Theorem allows us to focus only on the direct effect of b and τ on utility. Indirect effects through the other choice variables (p_e, p_u, π, x) do not appear in the expression because $U(\tau, b)$ is already maximized over these variables. In fact, the Envelope Theorem does not even require an interior solution for these variables.

From the budget constraints (7) and (8), it is immediate that $\partial c_e/\partial \tau = -1/p_e$ and $\partial c_u/\partial b = 1/p_u$, so that the utility impact of a marginal increase of unemployment insurance can be re-expressed as

$$dU = -\pi\frac{1}{p_e}v'(c_e)d\tau + (1-\pi)\frac{1}{p_u}u'(c_u)db, \tag{11}$$

where p_e and p_u are also at the optimal levels chosen by the agent. Rearranging (11), variations in unemployment insurance are locally welfare-improving, and increase expected utility ($dU \geq 0$), if and only if

$$\frac{p_e}{p_u}\frac{u'(c_u)}{v'(c_e)} \geq \left(\frac{\pi}{1-\pi}\right)\frac{d\tau}{db}. \tag{12}$$

This expression compares the marginal value of unemployment insurance to its marginal cost. The left hand side is the ratio of marginal state utilities adjusted by state-prices. It measures the benefit of transferring consumption from the employed to the unemployed state in terms of utility. The right hand side is the cost per dollar of benefits of the insurance scheme ($d\tau/db$) taking into account the proportion of employed to unemployed workers ($\pi/(1-\pi)$).

We will empirically measure the marginal benefit of providing unemployment insurance on the left hand side of (12), which can be estimated in isolation of the marginal cost. In fact, deriving an exact expression for the marginal cost of providing insurance, on the right hand side of (12), requires specifying further details that need to be assumed about the economic environment. Although it is not necessary for the empirical exercise, for later use, we consider two cases here. The first case is an environment without frictions that serves as a benchmark and in the second case we allow for moral hazard. In Appendix B we also consider a third case with asymmetric information.

4.3. The Cost of Providing Unemployment Insurance

4.3.1. Frictionless Benchmark. We first consider the case without moral hazard or adverse selection. In this case, individuals cannot affect π. Also, π is common to all and known by the insurer. A self-financing insurance scheme requires that

$$\pi\tau = (1-\pi)b. \tag{13}$$

By differentiating this expression, we arrive at the cost of insurance per dollar of benefits:

$$\frac{d\tau}{db} = \frac{1-\pi}{\pi}, \tag{14}$$

which implies actuarially fair insurance pricing. From (12), if unemployment insurance is priced in this way, then it has a positive impact on utility if and only if

$$\frac{p_e}{p_u}\frac{u'(c_u)}{v'(c_e)} \geq \left(\frac{\pi}{1-\pi}\right)\left(\frac{1-\pi}{\pi}\right) = 1. \tag{15}$$

In the first best, a benevolent planner who maximizes the agent's expected utility in (9) subject to a balanced budget in (13) increases unemployment insurance, and closes the gap in marginal utilities, up to the point at which (15) holds with equality:

$$\frac{p_e}{p_u}\frac{u'(c_u)}{v'(c_e)} = 1. \tag{16}$$

In this frictionless benchmark insurance is priced at the actuarially fair value and by driving (15) to equality the planner equates the value of providing one dollar in the unemployed state with the value of one dollar in the employed state.

4.3.2. Moral Hazard and Optimal Public Insurance. The case with moral hazard has been studied extensively in the literature on optimal unemployment insurance. In the sufficient statistics literature, Baily (1978) and Chetty (2006) are the benchmark models that study the optimal provision of public unemployment insurance in the presence of moral hazard.

The pair (τ, b) is again constrained by the condition

$$\pi\tau = (1-\pi)b \tag{17}$$

that says that benefits are exactly financed by revenue generated by taxing workers and is therefore fiscally neutral.

Because with moral hazard the probability of transitioning out of unemployment π will be affected by the generosity of benefit levels b, that is, $d\pi/db < 0$, differentiating the planner's budget constraint in this case yields

$$\frac{d\tau}{db} = \frac{1-\pi}{\pi} + \left[\frac{d\left(\frac{1-\pi}{\pi}\right)}{db}\right] b. \tag{18}$$

After taking the derivative and collecting terms, this expression becomes

$$\frac{d\tau}{db} = \frac{1-\pi}{\pi}\left(1 + \frac{\varepsilon_{1-\pi,b}}{\pi}\right), \tag{19}$$

where $\varepsilon_{1-\pi,b} > 0$ is the elasticity of the probability of unemployment with respect to the benefit level b:

$$\varepsilon_{1-\pi,b} \equiv \frac{b}{1-\pi}\frac{d(1-\pi)}{db}. \tag{20}$$

Therefore, the optimal provision of public unemployment insurance under moral hazard implies that (12) becomes

$$\frac{p_e}{p_u}\frac{u'(c_u)}{v'(c_e)} \geq 1 + \frac{\varepsilon_{1-\pi,b}}{\pi}. \tag{21}$$

A benevolent planner maximizes expected utility (9) subject to the balanced budget constraint in (17) and increases unemployment insurance up to the point at which (21) holds with equality:

$$\frac{p_e}{p_u}\frac{u'(c_u)}{v'(c_e)} = 1 + \frac{\varepsilon_{1-\pi,b}}{\pi}. \tag{22}$$

This is a version of the well-known "sufficient statistics" formula in the Baily–Chetty model adapted to include prices. Because of moral hazard the gap in the ratio of marginal utilities chosen by the planner is larger than in the frictionless benchmark, which implies that the optimal level of insurance is lower.

4.4. Consumption-Smoothing and Prices

After discussing the marginal cost of providing unemployment insurance, we now return to the marginal benefit on the left hand side of (12). This ratio measures the willingness to pay for an additional unit of unemployment insurance. By taking the natural logarithm it can be expressed as a markup μ:

$$\mu \equiv \log\left(\frac{p_e}{p_u}\frac{u'(c_u)}{v'(c_e)}\right). \tag{23}$$

Because the natural logarithm of 1 is zero, the markup μ measures the gap in marginal utilities relative to the frictionless benchmark expressed in relative terms (measured in log percentage points). From the point of view of the agent, μ can also be interpreted as the agent's willingness to pay for additional unemployment insurance (Hendren 2017). The value of unemployment insurance μ is a function of consumption, prices, and preferences. To give μ empirical content it is necessary to specify preferences. A particularly appealing choice for preferences, and one that is frequently used in practice, is that of constant relative risk-aversion.

ASSUMPTION 1 (CRRA). *The utility function is of the CRRA form* $u'(c) = v'(c) = c^{-\gamma}$, *with* $\gamma > 0$.

For CRRA preferences with risk-aversion parameter γ, the value provided to the agent by unemployment insurance can be expressed as a linear function of the gap in log-consumption and the gap in log-price between employed and unemployed individuals:

$$\mu = \gamma \Delta \log c + \Delta \log p. \tag{24}$$

The log-differences are defined as $\Delta \log c \equiv \log c_e - \log c_u$ and $\Delta \log p \equiv \log p_e - \log p_u$. Thus, the value of unemployment insurance has two components: the relative gap in consumption between the employed and the unemployed state, which is scaled by the risk-aversion parameter, and the relative gap in prices between the employed and the unemployed state.[10]

The first term on the right-hand-side measures the value due to consumption smoothing: $\gamma\Delta \log c$ is the relative gap in consumption between those employed and unemployed, which is scaled by relative risk-aversion to translate this gap into utility terms. The second term, $\Delta \log p$ (that turns out to be positive empirically) represents an additional reason for valuing unemployment insurance, a reason that does not stem from the preference to smooth consumption across states of the world. Instead, prices govern how individuals participating in an insurance scheme convert monetary payments into consumption. For any fixed level of insurance, a larger gap in prices implies that the same dollar buys more consumption in the unemployed state than in the employed state. Therefore, larger gaps in prices lead to a desire to shift income from the employed to the unemployed state, and therefore to increase the level of unemployment insurance.

In Assumption 1 we have not only specified a CRRA form, but also forced the utility function to be the same in the two states. This is usual in empirical exercises. Specifying different utility functions is also possible. For example, consider a case in which marginal utilities in the employed and unemployed state are related through a (household-specific) preference shifter so that $v'(c) = \exp(\beta' z)u'(c)$, where z is a vector of household characteristics and $u'(c)$ has a CRRA specification. Then the result will be a version of (24) with an additional term on the right hand side involving $\beta' z$.

The expression for μ in (24) contains consumption, which is not directly observable. However, by adding and subtracting $\gamma\Delta \log p$, and collecting terms, it is possible to express the value of unemployment insurance as a function of observable consumption expenditure $\tilde{c}$ and prices:

$$\mu = \gamma\Delta \log \tilde{c} - (\gamma - 1)\Delta \log p. \tag{26}$$

Prior research has estimated the value of unemployment insurance from consumption expenditure alone, omitting prices, that is, as $\mu = \gamma\Delta \log \tilde{c}$. Whether the value of unemployment insurance estimated in this way is overestimated or underestimated depends on two countervailing forces. On the one hand, if prices are lower when unemployed, then it is optimal to shift consumption into that state of the

10. Notice that this result is also obtained without assuming a CRRA specification by following the usual approach (e.g., Chetty 2006) of assuming $u' = v'$ and taking a first order approximation around c_e, $u'(c_u) \approx u'(c_e) + u''(c_e)(c_u - c_e)$. Doing so yields the result:

$$\exp(\mu) \approx 1 + \gamma \frac{\Delta c}{c} + \frac{\Delta p}{p}. \tag{25}$$

Coupling this with the approximation $\mu \approx \exp(\mu) - 1$ delivers a version of (24) expressed in growth rates rather than log-differences. In many cases (e.g., Gruber 1997), the estimation of such an equation will require approximating growth rates with log-differences, which effectively takes us back to the expression in (24) but interpreted as an approximation.

world, leading to a higher value of unemployment insurance. On the other hand, lower prices when unemployed also imply that the gap in expenditure between employed and unemployed agents is an overestimate of the gap in true consumption, and that the value of unemployment insurance is lower than what the change in expenditure reveals.

As shown by (26), with CRRA preferences, which of these two effects dominates depends exclusively on the degree of relative risk aversion: expenditure-based estimates of the value of unemployment insurance will be biased upward if risk aversion is larger than one and downward if it is lower than one. In the special case in which $\gamma = 1$ the elasticity of substitution across states is one and agents choose to expend fixed shares of their income in each state of the world, so that both aforementioned effects cancel out exactly. In the case in which $\gamma > 1$, the agent's desire to smooth consumption across states is higher, meaning that the willingness to substitute across states of the world is smaller. In this case, the second effects wins out over the substitution effect and the value of unemployment insurance is overestimated if expenditure data alone are used. With $\gamma < 1$ the converse is true.

Re-expressing μ in terms of consumption expenditure makes it very clear that the consumption-smoothing benefits estimated using consumption expenditure, without taking into account prices, will be biased except in the special case in which relative risk aversion $\gamma = 1$. Moreover, because the values assumed for γ in the literature on unemployment insurance usually exceed 1, the bias falls in one direction and the value of unemployment insurance will in general be overestimated if expenditure data are used. Also, unless $\gamma = 1$, at least two pieces of information are needed to properly account for the benefits of unemployment insurance: consumption expenditure and prices. However, the number of surveys that contain information on both is limited.

4.5. A More General Dynamic Model

So far, we derived the marginal value of unemployment insurance in a static environment. It turns out that this expression is also a good approximation of the value of unemployment insurance in more general dynamic models. We show this by extending the dynamic model of Chetty (2006) by including prices for consumption that may depend on whether the agent is employed or not.

Environment and Preferences. In the dynamic model, time is continuous and the length of life is normalized to one unit, so that time $t \in [0, 1]$. We consider the decision problem of a representative agent. A state variable ω_t contains the history up to time t of variables that are relevant for the agent's current employment status and future layoff probabilities. The evolution of ω_t is determined by an arbitrary stochastic process $F_t(\omega_t)$, where F_t is a smooth function and Ω denotes the maximal support of F_t. Contingent on the value of ω_t, the agent chooses consumption $c(t, \omega_t)$ and a vector of M other behaviors $x(t, \omega_t) = (x^1(t, \omega_t), \ldots, x^M(t, \omega_t))$. The vector $x(t, \omega_t)$ also provides a way to introduce multiple consumption goods and proves that the marginal value of unemployment insurance can also be derived when only a subset of consumption goods can be measured. Utility is time-separable and $u(c(t,\omega_t), x(t,\omega_t))$ denotes instantaneous utility.[11]

The full program of state-contingent lifetime choices is denoted by $c = \{c(t,\omega_t)\}_{t\in[0,1],\omega_t\in\Omega_t}$ and $x = \{x(t,\omega_t)\}_{t\in[0,1],\omega_t\in\Omega_t}$. The agent's employment status at date t and in state ω_t is given by $\theta(t,\omega_t,c,x) \in \{0,1\}$. Unemployment corresponds to $\theta = 0$ and employment to $\theta = 1$. Moreover, because θ depends on the random variable ω_t in an arbitrary way, the model allows for uncertainty in unemployment duration lengths. Because the employment status depends on the full history of choices, c and x, the model allows for the possibility of moral hazard.

With this notation, the expected duration of unemployment is given by

$$D(c,x) = E[1-\theta(t,\omega_t)] = \int_0^1 \int_{\omega_t\in\Omega} [1-\theta(t,\omega_t,c,x)]dF_t(\omega_t)dt, \tag{27}$$

whereas mean consumption while employed and unemployed are, respectively,

$$\overline{c_e} = E[c(t,\omega_t)|\theta(t,\omega_t)=1] = \frac{\int_t \int_{\omega_t\in\Omega} \theta(t,\omega_t)c(t,\omega_t)dF_t(\omega_t)dt}{\int_t \int_{\omega_t\in\Omega} \theta(t,\omega_t)dF_t(\omega_t)dt} \tag{28}$$

and

$$\overline{c_u} = E[c(t,\omega_t)|\theta(t,\omega_t)=0] = \frac{\int_t \int_{\omega_t\in\Omega}(1-\theta(t,\omega_t))c(t,\omega_t)dF_t(\omega_t)dt}{\int_t \int_{\omega_t\in\Omega}(1-\theta(t,\omega_t))dF_t(\omega_t)dt}. \tag{29}$$

So far, the description of the model coincides with the dynamic model of Chetty (2006). We extend the setup of Chetty (2006) by including a price $p(x(t,\omega_t))$ paid for consumption. The agent can affect prices for consumption by taking any of the actions in the vector $x(t,\omega_t)$, that may include, for example, time spent on price search. The vector $x(t,\omega_t)$ may also include other actions that are complementary to price search, such as cooking at home.[12] The dynamic budget constraint faced by the agent is

$$\dot{A}(t,\omega_t) = f(x(t,\omega_t)) + \theta(t,\omega_t)(w-\tau) + (1-\theta(t,\omega_t))b - p(x(t,\omega_t))c(t,\omega_t). \tag{30}$$

We assume that $p(x(t,\omega_t)) > 0$ for any $x(t,\omega_t)$ and $\forall t,\omega_t$, that is, consumption is never free. For later use, average prices while employed and unemployed are defined

11. Like Chetty (2006), we assume that the marginal utility of consumption depends just on consumption and write $u'(c(t,\omega_t))$. We later consider the implications of relaxing this assumption.

12. The price paid for consumption may also depend directly on the time and the state (t,ω_t). However, because $x(t,\omega_t)$ is any arbitrary function of (t,ω_t), including them as additional arguments of $p(\cdot)$ is redundant.

in a way analogous to consumption as

$$\overline{p_e} = E[p(x(t,\omega_t))|\theta(t,\omega_t) = 1]$$
$$= \frac{\int_t \int_{\omega_t \in \Omega} \theta(t,\omega_t) p(x(t,\omega_t)) dF_t(\omega_t) dt}{\int_t \int_{\omega_t \in \Omega} \theta(t,\omega_t) dF_t(\omega_t) dt} \tag{31}$$

and

$$\overline{p_u} = E[p(x(t,\omega_t))|\theta(t,\omega_t) = 0]$$
$$= \frac{\int_t \int_{\omega_t \in \Omega} (1-\theta(t,\omega_t)) p(x(t,\omega_t)) dF_t(\omega_t) dt}{\int_t \int_{\omega_t \in \Omega} (1-\theta(t,\omega_t)) dF_t(\omega_t) dt}. \tag{32}$$

As in the setup of Chetty (2006), in addition to the budget constraint, the agent faces N constraints in each state ω_t at each time t:

$$g_{i\omega t}(c,x,b,\tau) \geq \bar{k}_{i\omega t}, \quad i = 1,\ldots N. \tag{33}$$

These constraints may refer to time constraints, borrowing constraints if unemployed, and so forth.[13] Also, assets satisfy a terminal condition $A(1,\omega_1) \geq A_{\text{term}}, \forall \omega_1$.

The agent chooses a program c, x to solve

$$\begin{aligned} V(b,\tau) \equiv \max & \int_t \int_{\omega_t} u(c(t,\omega_t), x(t,\omega_t)) dF_t(\omega_t) dt \\ & + \int_{\omega_1} \lambda_{\omega_1,T}(A(1,\omega_1) - A_{\text{term}}) dF_1(\omega_1) \\ & + \int_t \int_{\omega_t} \lambda_{\omega_t,t}\{f(x(t,\omega_t)) + \theta(t,\omega_t)(w-\tau) \\ & + (1-\theta(t,\omega_t))b - p(x(t,\omega_t))c(t,\omega_t)\} dF_t(\omega_t) dt \\ & + \sum_{i=1}^{N} \int_t \int_{\omega_t} \lambda_{g_i\omega_t,t}(g_{i\omega t}(c,x,b,\tau) - \bar{k}_{i\omega t}) dF_t(\omega_t) dt. \end{aligned} \tag{34}$$

The problem of the planner is formally the same as in the static case: the social planner maximizes $V(b,\tau)$ subject to $\tau(1-D) = Db$.

Assumptions. Chetty (2006) imposes the five regularity assumptions to obtain a solution from first order conditions that we adapt here.

ASSUMPTION 2. *Total lifetime utility is smooth, increasing, and strictly quasiconcave in (c,x).*

ASSUMPTION 3. *The set of choices $\{(c,x)\}$ that satisfy all the constraints is convex.*

13. See Chetty (2006) for examples.

ASSUMPTION 4. *In the agent's optimal program, the set of binding constraints does not change for a perturbation of b in some open interval* $(b - \varepsilon, b + \varepsilon)$.

ASSUMPTION 5. *The function* $\tilde{V}(b) \equiv V(b, \frac{D}{1-D}b)$ *is concave.*

Assumptions 2 and 3 guarantee the existence of a unique global maximum of the agent's problem and, together with Assumption 4, ensure that the Envelope Theorem can be applied. Assumption 5 ensures that the planner's problem can be solved from first order conditions.[14] This assumption is not required in Propositions 1 and 2. Chetty's last assumption is on properties satisfied by the constraints in the agent's maximization problem. This assumption cannot be taken directly from Chetty (2006) but needs to be amended to take into account that the price $p(x(t, \omega_t))$ drives a wedge between the unit of account and consumption. The modified version of the assumption is the following.

ASSUMPTION 6. *The set of feasible choices can be defined using a set of constraints* $g_{i\omega_t}$ *such that* $\forall i \forall t \forall \omega_t$:

$$
\begin{aligned}
\frac{\partial g_{i\omega_t}}{\partial b} &= \frac{-(1-\theta(t,\omega_t))}{p(x(t,\omega_t))}\frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)},\\
\frac{\partial g_{i\omega_t}}{\partial \tau} &= \frac{\theta(t,\omega_t)}{p(x(t,\omega_t))}\frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)},\\
\frac{\partial g_{i\omega_t}}{\partial c(s,\omega_s)} &= 0 \quad \text{if } t \neq s.
\end{aligned} \tag{35}
$$

The first two conditions require that all constraints can be written so that consumption and the unemployment benefit b and the tax τ enter the constraint taking into account that, to convert money into consumption, the price $p(x(t, \omega_t))$ prevailing in each specific state ω_t has to be paid.[15] In the special case in which $\forall t, \forall \omega_t : p(x(t, \omega_t)) = 1$, this last assumption becomes that of Chetty (2006).

This completes the description of the general dynamic model. The setup of the model coincides with that of Chetty (2006) with the exception that prices show up in the budget constraint and that Assumption 6 takes into account prices. The model embeds the model of Chetty (2006), which is obtained as a special case when, $\forall t, \forall \omega_t : p(x(t, \omega_t)) = 1$.

The Marginal Value of Unemployment Insurance in The General Dynamic Model. In the dynamic model, the marginal value of increasing unemployment insurance is only

14. We directly assume that the objective function $\tilde{V}(b)$ is concave. Chetty gives conditions that are sufficient (but not necessary) for the function to be concave.

15. Notice that the budget constraint also satisfies Assumption 6.

slightly more complex than in the static case. The only difference is that the left hand side now consists of expectations over marginal utilities rather than marginal utilities directly.

PROPOSITION 1. *Under Assumptions* 2–4 *and* 6*, an infinitesimal change in the parameters of the UI scheme improve lifetime utility if and only if*

$$\frac{E\left[\frac{u'(c_u)}{p_u}\right]}{E\left[\frac{u'(c_e)}{p_e}\right]} \geq \left(\frac{1-D}{D}\right)\frac{d\tau}{db}, \tag{36}$$

where

$$E\left[\frac{u'(c_e)}{p_e}\right] = \frac{\int_t \int_{\omega_t} \theta(t,\omega_t)\left(\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))}\right) dF_t(\omega_t)dt}{\int_t \int_{\omega_t} \theta(t,\omega_t) dF_t(\omega_t)dt} \tag{37}$$

and

$$E\left[\frac{u'(c_u)}{p_u}\right] = \frac{\int_t \int_{\omega_t} (1-\theta(t,\omega_t))\left(\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))}\right) dF_t(\omega_t)dt}{\int_t \int_{\omega_t} (1-\theta(t,\omega_t)) dF_t(\omega_t)dt}. \tag{38}$$

The proof is in the appendix.

As in the static case, the right hand side in (36) is the cost of raising unemployment insurance and is identical with the right hand side of (12).[16] As already mentioned, the left hand side of (36) looks similar to the static case but marginal utilities are inside expectations. It turns out however, that the value of unemployment insurance in the dynamic model can be approximated by the value of unemployment insurance in the static model. We show this in Proposition 2 by taking a Taylor expansion of the left hand side of (36) around $(\overline{c_e}, \overline{c_u}, \overline{p_e}, \overline{p_u})$.

PROPOSITION 2. *The marginal value of unemployment insurance in the dynamic model can be approximated with the marginal value of unemployment insurance in the static model.*

(1) *According to a first-order approximation:*

$$\frac{E\left[\frac{u'(c_u)}{p_u}\right]}{E\left[\frac{u'(c_e)}{p_e}\right]} \approx \frac{\overline{p_e}}{\overline{p_u}}\frac{u'(\overline{c_u})}{u'(\overline{c_e})}. \tag{39}$$

(2) *According to a second-order approximation:*

$$\frac{E\left[\frac{u'(c_u)}{p_u}\right]}{E\left[\frac{u'(c_e)}{p_e}\right]} \approx \frac{\overline{p_e}}{\overline{p_u}}\frac{u'(\overline{c_u})}{u'(\overline{c_e})}\kappa, \tag{40}$$

16. Notice that in the static case, the duration of unemployment is $D = 1-\pi$, so that $\frac{1-D}{D} = \frac{\pi}{1-\pi}$.

where $\kappa = \frac{(1+\frac{1}{2}\gamma\rho s_u^{cc}+\frac{1}{4}s_u^{pp}-\frac{1}{2}\gamma s_u^{cp})}{(1+\frac{1}{2}\gamma\rho s_e^{cc}+\frac{1}{4}s_e^{pp}-\frac{1}{2}\gamma s_e^{cp})}$, $s_e^{xy} = E\left[\frac{(x-\overline{x_e})}{\overline{x_e}}\frac{(y-\overline{y_e})}{\overline{y_e}}|\theta = 1\right]$, *and* $s_u^{xy} = E\left[\frac{(x-\overline{x_u})}{\overline{x_u}}\frac{(y-\overline{y_u})}{\overline{y_u}}|\theta = 0\right]$.

The proof is in the appendix.

In the first-order approximation, the value calculated for μ in the dynamic model can be directly approximated with the expression derived for the static model:

$$\mu^{\text{dynamic}} \equiv \log\left(\frac{E\left[\frac{u'(c_u)}{p_u}\right]}{E\left[\frac{u'(c_e)}{p_e}\right]}\right) \approx \log\left(\frac{\overline{p_e}}{\overline{p_u}}\frac{u'(\overline{c_u})}{u'(\overline{c_e})}\right) \equiv \mu^{\text{static}}. \tag{41}$$

The second-order approximation incorporates an adjustment factor κ that takes into account the relative variability of consumption and prices in the employed and unemployed state. In this case, μ^{static}, the willingness to pay for an additional unit of unemployment insurance (expressed as a markup) can be inferred from μ^{static} up to an additive constant:

$$\mu^{\text{dynamic}} \equiv \log\left(\frac{E\left[\frac{u'(c_u)}{p_u}\right]}{E\left[\frac{u'(c_e)}{p_e}\right]}\right) \approx \mu^{\text{static}} + \log\kappa. \tag{42}$$

In the Online Appendix, we report results from a simulation of how good these approximations are in practice using the empirical results of Section 3.6 as a basis for the parameterization. We compare the exact values from Proposition 1 to the approximations derived in Proposition 2 (Equations (39) and (40)). We find that for a level of relative risk aversion $\gamma = 2$, the error of using the first order approximation ranges from 0.34% to 0.48%, depending on how quickly prices in the employed and unemployed state adjust. The second order approximation is always closer to the exact value, with the error ranging between 0.06% and 0.20%.[17]

5. Estimation of the Value of Unemployment Insurance

5.1. The Value of Unemployment Insurance

From our model, the value of unemployment insurance μ can be recovered from combining estimations of the effect of unemployment on consumption expenditure and on prices. Conditioning on observable household characteristics X:

$$E[\mu|X] = \gamma E[\Delta\log\tilde{c}|X] - (\gamma-1)E[\Delta\log p|X]. \tag{43}$$

17. The complete description of the simulation exercise and its results can be found in the Online Appendix.

Although $E[\Delta \log \tilde{c}|X]$ and $E[\Delta \log p|X]$ could be estimated separately, even from different surveys, there are clear advantages from using the same survey, covering the same households, to estimate the relationship of consumption expenditure and prices with employment status.

The point estimate of the value of unemployment insurance μ is given by

$$\hat{\mu} = \gamma(-\hat{\lambda^c}) - (\gamma - 1)(-\hat{\lambda^p}), \tag{44}$$

where $\hat{\lambda^c}$ and $\hat{\lambda^p}$ are the point estimates obtained from regressing (5) and (6) on the same sample of households (there are negative signs in front of $\hat{\lambda^c}$ and $\hat{\lambda^p}$ because we defined the dummy variable U_{it} to take value one if unemployed rather than if employed).

Identification of the parameters of interest, λ^c and λ^p, does not require any assumption on the covariance between η_{it}^c and η_{it}^p. Because data correspond to the same households the error terms in both equations, η_{it}^c and η_{it}^p, are likely to be correlated. This is not problematic because the same right-hand-side variables appear in both equations, so that estimating the system of equations is equivalent to estimating these equations separately (Zellner 1962). However, in order to construct confidence intervals around the estimated value of unemployment insurance, the correlation between the estimated coefficients $\hat{\lambda^c}$ and $\hat{\lambda^p}$ is informative and joint estimation of (5) and (6) will be useful: the standard error of $\hat{\mu}$ is given by

$$\text{se}(\hat{\mu}) = \sqrt{\gamma^2 \text{var}(\hat{\lambda^c}) + (\gamma - 1)^2 \text{var}(\hat{\lambda^p}) - 2\gamma(\gamma - 1)\text{cov}(\hat{\lambda}^c, \hat{\lambda}^p)}. \tag{45}$$

To obtain an estimate of $\text{cov}(\hat{\lambda}^c, \hat{\lambda}^p)$ we take advantage of the fact that our regressions are estimated on the same households and estimate both equations simultaneously in order to obtain a variance–covariance matrix for all estimates. Because our panel data cover two periods, the joint estimation can be performed by first-differencing our level equations (and therefore effectively converting our equations into a cross-section form), and then estimating a system of otherwise standard seemingly unrelated-regression (SUR) equations. We obtain standard errors and the covariance of interest by performing a bootstrap with 1,000 repetitions.

5.2. *Estimation of the Value of Unemployment Insurance*

Using the expression derived from our model, we combine our estimates of the relationship between consumption expenditure and prices to recover the value of providing unemployment insurance using the formula in (44). The value of unemployment insurance depends on the assumed level of relative risk aversion. Values used in practice hover around $\gamma = 2$, although it is common to present results for a range of values.

In Figure 1 we exhibit the value of unemployment insurance calculated for levels of risk-aversion between 0 and 3. The bars on the left (in black and gray) correspond to our calculations and the bars on the right (in white) show the result that would be obtained by erroneously attributing the whole change in expenditure to consumption.

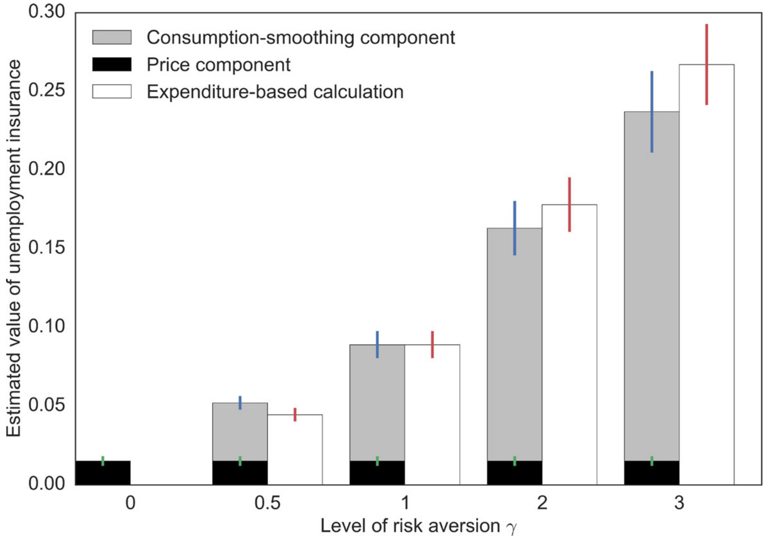


FIGURE 1. Decomposition of the value of insurance into a consumption and price component. Standard errors represented by the lines on top of each bar.

In the figure, we have also decomposed the value of unemployment insurance into the two components uncovered in Section 4: the consumption-smoothing component (in gray) and the price component (in black). The vertical bars at the top of each bar indicate estimated standard errors. For example, given the impact of unemployment on expenditure of 0.089 reported in the third column in Table 2 and the impact on prices of 0.015 reported in the third column of Table 4, for $\gamma = 2$, the value of unemployment insurance is $\hat{\mu} = 2 \times 0.089 - (2-1) \times 0.015 = 0.163$, according to the formula in (44). Of this value, the price component amounts to 0.015 and the remainder, $2 \times (0.089 - 0.015) = 0.148$ corresponds to the consumption-smoothing component.[18] To interpret these numbers it is useful to remember that the value of unemployment insurance μ measures a gap in marginal utilities in log-point deviations from the frictionless benchmark. In the next section we show how this number can be compared to the cost of providing unemployment insurance in order to gauge whether unemployment benefits are at their optimal level.

Figure 1 shows that the value of unemployment insurance calculated exclusively from expenditure data underestimates the true value if $\gamma < 1$ and overestimates it if $\gamma > 1$. In the special case $\gamma = 1$ the value of unemployment insurance calculated from expenditure data happens to be the correct one, albeit for the wrong reasons: whereas the expenditure-based calculation assigns the whole value of unemployment insurance

18. In contrast, the expenditure-based results pictured in white bars are based on a calculation in which the whole change in expenditure is assumed to be a change in consumption and pretending that prices did not move, that is, for $\gamma = 2$, this calculation yields $\hat{\mu} = 2 \times 0.089 = 0.178$.

to consumption-smoothing, the theoretical result in Section 4 shows that part of this value is due to the price effect.

The conceptual mistake from expenditure-based calculations becomes particularly clear in the boundary case where $\gamma = 0$. In this case, agents in the model do not value consumption-smoothing. Therefore, consumption-smoothing benefits are zero. But even in this case, the social value of providing unemployment benefits is not zero because a dollar in the hands of an unemployed buys more consumption because they obtain consumption goods at lower prices.

Overall, the total value of providing unemployment benefits in the correct calculation and the expenditure-based calculation as measured from the total heights of the bars in Figure 1 in the case of Spain are not so different. This is a stark difference with the calibration results presented by Campos and Reggio (2016) for the United States. The main reason for this is that our estimates for price changes are significantly smaller than those obtained for the United States. We find that prices make up for only one-sixth of the difference in expenditure between employed and unemployed households. In a calibration for the United States, Campos and Reggio (2016) use smaller price changes than those implicit in the findings of Aguiar and Hurst (2005) but still assume that prices explain 50% of the fall in expenditures. Our empirical findings in Section 3.6 strongly suggest that the use of cross-sectional data in the existing studies for the United States leads to an overestimation of the role of prices.

The gap between the calculation that takes into account price changes and the expenditure-based calculation is larger if food items are used. Proposition 2 proves that the value of unemployment insurance can be calculated using data on either total consumption expenditure or on consumption of just some subcategory, such as food expenditure, provided the appropriate curvature parameter of the utility function is used.[19] In Figure 2 we repeat the decomposition exercise but using the estimates for food items in Tables 3 and 5. For any given level of γ prices explain a larger share of the variation in expenditure and the gap becomes larger. However, standard errors estimated for food items are, in general, larger.

The point estimates for the value of unemployment insurance (the height of the bars) are lower in Figure 2 than in Figure 1 but this may simply reflect that agents are more risk-averse when it comes to food consumption. An additional factor that may bring the values estimated from food and nondurable goods closer together is related to the presence of complementarities in the utility function.[20] In Appendix C we show that the approximation to marginal utility requires an adjustment factor if marginal utility of consumption depends on additional arguments in the utility function. Because total nondurable consumption contains consumption items such as transportation, clothing, and food outside of the home that are complementary with work, this adjustment factor

19. Formally, this is because the final formula is not influenced by the presence of an additional vector of choice variables x, which may contain additional consumption items.

20. We thank an anonymous referee for pointing this out.

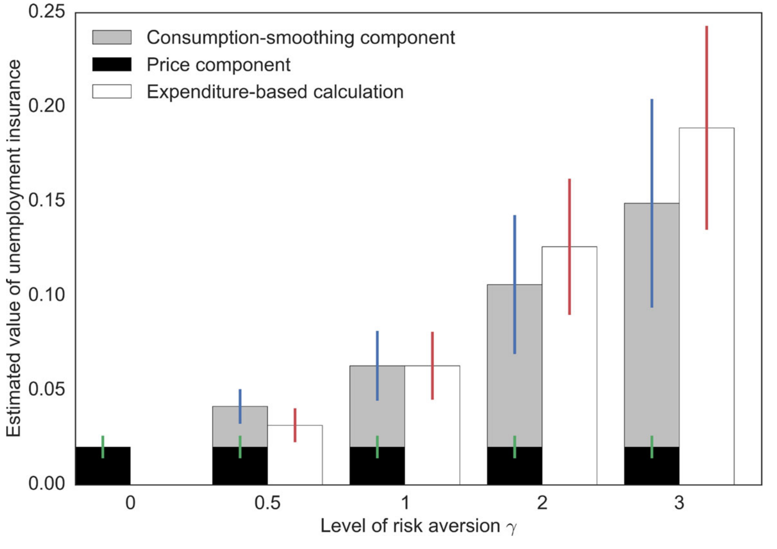


FIGURE 2. Decomposition of the value of insurance into a consumption and price component using food expenditure. Standard errors represented by the lines on top of each bar.

can be shown to be negative, leading to a smaller value of unemployment insurance in the case of nondurable consumption.[21]

5.3. *Optimal Unemployment Insurance*

We now turn to the optimal level of public unemployment insurance implied by our estimates for μ. The value of unemployment insurance μ needs to be compared to an expression for the cost of providing unemployment benefits. The appropriate "sufficient statistics" formula in the case of moral hazard is given by (21). A benevolent planner would choose to increase unemployment benefits up to the point where

$$\mu = \log\left(1 + \frac{\varepsilon_{1-\pi,b}}{\pi}\right). \tag{46}$$

This expression can be confronted with data. If the left hand side is larger than the right hand side, then benefits are too low, if the left hand side is smaller than benefits are too high. Only if the equation holds with equality, then benefits are at their optimal level.

The value of unemployment insurance depends on the level of risk aversion that is assumed; for example, it is $\hat{\mu} = 0.163$ for a level of risk aversion of $\gamma = 2$ and $\hat{\mu} = 0.237$ for a level of risk aversion of $\gamma = 3$. In order to ascertain

21. An argument is given in Appendix C for the case of consumption that is complementary with leisure time. For consumption that is complementary with working time, an analogous argument can be made by reversing the sign.

whether unemployment insurance is optimal, these values need to be compared to $\log(1 + \varepsilon_{1-\pi,b}/\pi)$, the marginal cost of providing unemployment benefits. We calibrate π to a long-run value of $\pi = 0.9$ (the fraction of time spent in employment is π and the time spent in unemployment is $1 - \pi$). This implies that, for the current level of unemployment insurance in Spain to be at the optimal level, the value of the elasticity of unemployment duration with respect to the level of benefits $\varepsilon_{1-\pi,b}$ should be between 0.16 (if $\gamma = 2$) and 0.24 (if $\gamma = 3$). For values higher than that unemployment benefits are too high. However, available estimates for Spain range from 0.86 (Rebollo-Sanz and Rodríguez-Planas forthcoming) to values above 1.00 (Campos et al. 2017), suggesting that the low values of $\varepsilon_{1-\pi,b}$ required for optimality are unrealistic in the case of Spain.[22] Therefore, benefits at the current implicit level of unemployment insurance fall short of the cost, meaning that unemployment benefits in Spain are too generous.

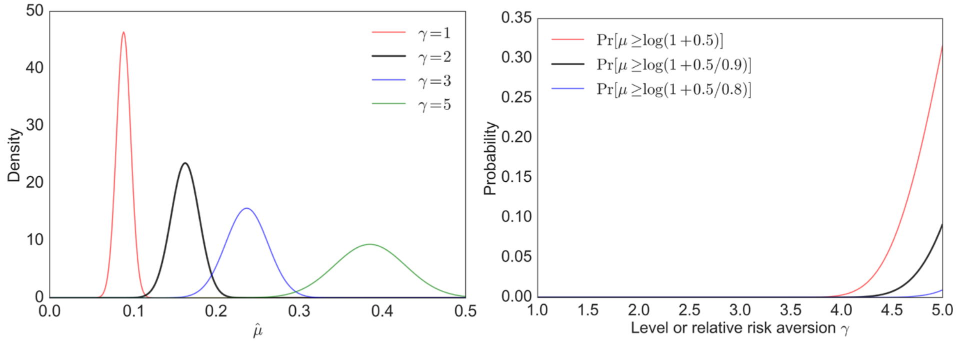
This calculation does not take into account uncertainty around the estimated value of μ, which is something that we can address with our estimation procedure. Estimation uncertainty implies that despite a low point estimate of μ relative to the marginal cost, there is some probability that μ is actually larger than the right hand side in (46), and therefore, that there is some probability that unemployment benefits are optimal or even too low rather than too high. One of the advantages of our methodology is that we obtain not only the point estimate but also the standard error of $\hat{\mu}$, that we can use to measure the probability that unemployment benefits are too low.[23]

From our bootstrapping procedure we obtain an estimate for the covariance $\mathrm{Cov}(\hat{\lambda^c}, \hat{\lambda^p}) = 4.34 \times 10^{-6}$, which given estimated standard deviations, implies a correlation coefficient of 0.166. This positive correlation implies that confidence intervals around the central point estimate $\hat{\mu}$ are narrower than those that we would have obtained by (mistakenly) assuming independence across equations.

In Figure 3 we use our estimate of the dispersion around the point estimate of the value of unemployment insurance to make probabilistic statements about whether the level of unemployment insurance in Spain is close to optimal for a given elasticity of unemployment duration with respect to unemployment benefits. In panel (a) we plot the density around point estimates for different levels of risk-aversion using an asymptotically normal distribution of errors. In panel (b) we graph the probability that the value of unemployment insurance exceeds its cost for different levels of π. For this figure, we take the value $\varepsilon_{1-\pi,b} = 0.5$ used for US data, the value most favorable for finding that an increase in the level of unemployment benefits is optimal. If benefits were at their optimal level, given the symmetry of the normal distribution, we would

22. For the United States the value that is usually assumed is $\varepsilon_{1-\pi,b} = 0.5$, based on the survey by Krueger and Meyer (2002).

23. Methodologically, here we are implicitly reinterpreting our results obtained by frequentist methods in Bayesian terms. As is well known, in regular estimation problems the Bayesian posterior distribution is asymptotically the same as the repeated sample distribution. So, for example, a 95% central posterior interval for a parameter will cover the true value in 95% of the cases under repeated sampling for any fixed true parameter (Arellano 2016).



(a) Density around $\hat{\mu}$

(b) $\Pr\left[\mu \geq \log\left(1+\frac{\varepsilon_{1-\pi,b}}{\pi}\right)\right]$

FIGURE 3. Uncertainty around $\hat{\mu}$ and optimal unemployment insurance.

expect the density of $\hat{\mu}$ to be centered around $\log(1+\varepsilon_{1-\pi,b}/\pi)$, so that

$$\Pr\left[\mu \geq \log\left(1+\frac{\varepsilon_{1-\pi,b}}{\pi}\right)\right] = 1 - F\left(\log\left(1+\frac{\varepsilon_{1-\pi,b}}{\pi}\right)\right) = 0.5, \tag{47}$$

where $F(\cdot)$ represents the cumulative density function (CDF) of $\hat{\mu}$.

The densities in Figure 3(a) show that as the level of risk-aversion increases, not only does the point estimate of the value of unemployment insurance increase, but also the uncertainty regarding this value. From (45), and given the relatively small covariance term, the standard deviation of $\hat{\mu}$ increases with γ in an approximately linear way. This implies that for larger values of risk-aversion the probability that unemployment benefits are at the optimal level increases for two reasons: because the point estimate of the value of unemployment insurance increases and because the density of likely values around this point estimate becomes larger. However, Figure 3(b) shows that even after taking into account the uncertainty involving our estimates it is unlikely that unemployment benefits are at their optimal level except for degrees of risk-aversion that are much higher than those usually assumed. This holds even though we have assumed a value for $\varepsilon_{1-\pi,b}$ that is lower than recent estimates for Spain.

5.4. Concerns about Quality

One concern about our results is that the change in prices induced by unemployment might be masking a change in the quality of goods purchased by the unemployed. Although the itemized consumption categories that we use are fairly detailed, we do not observe whether households change brands or switch to products within the same class of goods that they perceive to be as lower quality. For example, we observe the quantity of eggs purchased but not whether these eggs are from caged hens, free-range eggs, organic eggs, and so forth.

From a normative point of view, changes in quality can affect the value of unemployment insurance. In Appendix C we consider the case in which utility $u(c, q)$

depends on consumption c and the level of quality q of this consumption, which is potentially a choice variable. In its most general form, utility is given by a function $u(c, q)$. In this case, we show that an extra term appears in the expression for the value of unemployment insurance, and

$$\mu \approx \frac{\Delta \bar{p}}{\bar{p}} + \gamma \frac{\Delta \bar{c}}{\bar{c}} + \varepsilon_{u',q} \times \frac{\Delta \bar{q}}{\bar{q}}, \tag{48}$$

where $\varepsilon_{u',q} = -\partial \log u' / \partial \log q$ is an elasticity that measures the sensitivity of the marginal utility of consumption to changes in quality and $\Delta \bar{q}/\bar{q} \geq 0$ is the relative change in the quality of consumption between the employed and unemployed state of the world. If consumption and the quality of consumption are additively separable, then quality does not affect the marginal utility of consumption, $\varepsilon_{u',q} = 0$, and the formula is the same as without quality changes. If, on the other hand, quality raises the marginal utility of consumption, then $\varepsilon_{u',q} < 0$. A reduction in the quality of consumption then implies that $\varepsilon_{u',q} \times \Delta \bar{q}/\bar{q} < 0$. Because higher quality raises the marginal utility of consumption in the employed state relative to that of the unemployed state, the gap between marginal utility in the employed and unemployed state is lower and the value of unemployment insurance is reduced. In this case, an overestimated price change due to changes in quality would unambiguously lead to an overestimate of the value of unemployment insurance: the value of $\Delta \bar{p}/\bar{p}$ in (48) would need to be adjusted downward and the last term in (48) is strictly negative, leading to an unambiguously lower true value of μ. In this sense, the value of unemployment insurance estimated without taking into account quality changes can be thought of as an upper bound of the true value.

From a descriptive point of view, the drop in prices related to unemployment is unlikely to be entirely due to a switch to lower quality items. Motivated by the evidence by Aguiar et al. (2013), who show a negative relationship between time employed for shopping activities and prices paid by a household in the United States, we used the Spanish time use survey (*Encuesta de Empleo del Tiempo*, EET) to verify whether the unemployed increase the time used for shopping (which would imply that they obtained lower prices). The EET was conducted in the year 2009, which is roughly in the middle of the period we consider. We classified individual activities into three mutually exclusive aggregate activities: home production, activities related to home ownership, and obtaining goods and services. Home production activities include all time spent on meal preparation, cleaning up, doing laundry, ironing, and activities related to the organization of the household. Home ownership activities include all time spent on household repairs, on exterior cleaning and repairing. Obtaining goods and services includes all time spent on shopping activities, and buying commercial and personal services.

In the first two columns of Table 11 we show the number of average weekly hours spent on each aggregate activity by employed and unemployed individuals. Employed individuals spend on average 3.9 hours on activities related to obtaining goods and services whereas unemployed individuals spend on average 5.6 hours on these activities. In the third column we exhibit the coefficient from regressing

TABLE 11. The time allocation of employed and unemployed individuals.

	Sample average weekly hours		Conditional difference
	Employed	Unemployed	
Home production	11.04	17.63	6.089*** (0.346)
Home ownership	0.875	1.607	0.780*** (0.167)
Obtaining goods and services	3.878	5.586	1.989*** (0.210)

Notes: Coefficients in columns (1) and (2) show the average hours per week spent on each activity by employed and unemployed individuals. Coefficients in column (3) exhibit the difference between unemployed and employed individuals after controlling for a set of dummy variables for region of residence, education, age, household composition, gender, health status, quarter of the interview, and day of the week. Robust standard errors in parentheses. ***Significant at 1%.

the hours spent on each activity on a dummy variable for being unemployed plus additional controls: dummy variables for region of residence, education, age, household composition, gender, health status, quarter of the interview, and day of the week. Conditioning on these variables, unemployed individuals devote almost two more hours to shopping activities.

Time use for home production and home ownership activities is also significantly larger for unemployed individuals. These activities are probably complementary with shopping. For example, the unemployed could buy raw unprocessed food (obtaining goods and services) in order to cook these raw materials at home (home production). The resulting meal would not necessarily be of an inferior quality than a pre-processed meal but would most likely cost less per unit of consumption. In this line, Griffith et al. (2016) show that during the Great Recession households in the United Kingdom adjusted their shopping behavior and while their real food expenditure dropped, the number of calories purchased and their nutritional quality did not.

In conclusion, although a fraction of the change in prices could conceivably be explained by a change in varieties within a consumption category, the increase of time spent shopping (and of complementary activities) suggests that the unemployed do pay lower prices. In any case, the main point we stress about our findings is that, once individual fixed effects are taken into account, the drop in prices associated with unemployment becomes smaller. If part of this drop is due to a change in quality, then the true drop in prices would be even lower, reinforcing the point that price drops are smaller than what the prior literature suggests.

6. Concluding Remarks

We have derived a formula for the marginal welfare gain provided by unemployment insurance in an environment that is general in that it encompasses a wide class of models incorporating moral hazard and asymmetric information. The formula we use is exact in the case of CRRA preferences but can also be interpreted as an approximation in the case of other utility functions, or of a dynamic model. This formula allows us to decompose the value of unemployment insurance into a consumption-smoothing component and a price component. For standard levels of risk-aversion, we find that the bulk of the value of unemployment insurance is due to consumption-smoothing.

On the empirical side we find that transitions to unemployment have a sizable impact on household expenditure. We find evidence that prices paid by the unemployed are lower, so that the response to unemployment of expenditure overstates the response of actual consumption: consumption is more stable than expenditure. However, we find that prices play a smaller role than that suggested by previous estimates using cross-sectional data for the United States. We find that differences in prices paid between households with employed and unemployed households are mostly due to time-invariant unobservable household characteristics and that the gap in prices becomes significantly smaller once this unobserved heterogeneity is accounted for. This also implies that the marginal benefit of unemployment insurance estimated exclusively from expenditure data is not that different from the correct value that takes into account price changes.

We show how estimates of prices and expenditure can be combined to obtain an estimate of (and confidence interval for) the marginal value of unemployment insurance. In a simple back of the envelope calculation for Spain, our estimation implies that the marginal benefit of unemployment is small relative to the moral hazard costs induced by providing insurance. Although the value of unemployment insurance could be affected by additional factors that we do not consider, such as the role that unemployment insurance plays in allowing for better job matches, our streamlined model allows us to make a simple point. We expect that in models that are enriched with details covering additional benefits and costs of unemployment insurance, the decomposition of the marginal value of unemployment insurance into a consumption and price component will be of relevance, and that our methodological contribution and empirical findings will be informative for these more general settings.

More generally, the evidence that consumption may diverge from expenditure highlights the importance of considering other decisions of members of the household that influence consumption. In particular, economists need to be aware of non-market activities, such as the choice that households have to devote time to price search. An increased emphasis to include shopping, and also house work, into economic models may prove fruitful. The recent availability of time use surveys will allow to do so systematically. We expect that careful modeling of the additional margins available to households will allow to shed light on the value of social insurance and, more generally, on how income fluctuations impact welfare.

Appendix A: Derivation of the Function Ψ in the Utility Function

For simplicity in the exposition, in this section, we model the period as a day. At the beginning of the day agents search for a job and use up a fraction t^{π} of their total time on this activity. The time remaining after job search is $1 - t^{\pi}$ and agents find a job with probability π, which depends on t^{π} in a deterministic way: $\pi = \delta(t^{\pi})$. If they find a job, then they spend a constant fraction of the day $\bar{t}$ working. Whether employed or not, agents can search for lower prices. Time spent searching for lower prices t_s^p in state $s \in \{e, u\}$ maps into prices according to a deterministic (and possibly state-dependent) function $p_s = \sigma_s(t_s^p)$. We assume that prices are bounded away from zero and that the functions δ and σ_s are continuous and invertible. Any time not spent on job search, price search, or working is devoted to leisure ℓ.

The time constraint if the agent finds a job is

$$\bar{t} + t_e^p + \ell_e = 1 - t^{\pi}. \tag{A.1}$$

If the agent remains unemployed, then the time constraint is

$$t_u^p + \ell_u = 1 - t^{\pi}. \tag{A.2}$$

Using the assumption that δ, σ_e, and σ_u are invertible, and solving for leisure in both states, yields expressions for leisure that are functions of the probability of finding a job and prices:

$$\ell_e(\pi, p_e) \equiv 1 - \delta^{-1}(\pi) - \sigma_e^{-1}(p_e) - \bar{t} \tag{A.3}$$

and

$$\ell_u(\pi, p_u) \equiv 1 - \delta^{-1}(\pi) - \sigma_u^{-1}(p_u). \tag{A.4}$$

We assume that state utility functions are separable in consumption and leisure: $\hat{v}(c_e, \ell_e) = v(c_e) + g(\ell_e)$ and $\hat{u}(c_u, \ell_u) = u(c_u) + h(\ell_u)$. Expected utility is given by

$$\begin{aligned} U &= \pi \hat{v}(c_e, \ell_e) + (1 - \pi)\hat{u}(c_u, \ell_u) \\ &= \pi v(c_e) + (1 - \pi)u(c_u) + \pi g(\ell_e) + (1 - \pi)h(\ell_u) \\ &= \pi v(c_e) + (1 - \pi)u(c_u) - \Psi(\pi, p^e, p^u) \end{aligned} \tag{A.5}$$

where

$$\Psi(\pi, p^e, p^u) = -\pi g\left(\ell_e(\pi, p_e)\right) - (1 - \pi)h\left(\ell_u(\pi, p_u)\right). \tag{A.6}$$

In the main text we allow the function Ψ to also depend more generally on the vector x.

Appendix B: Asymmetric Information and the Provision of Private Insurance

The provision of private unemployment insurance is hindered if individuals have private information on their probabilities of becoming unemployed, because only those with high probabilities will self-select into the insurance scheme. Hendren (2013) studies this problem and shows how the presence of private information leads to empirically testable no-trade theorems that imply that private insurance markets do not exist.

Hendren (2017) then applies these no-trade results to unemployment insurance and shows that the markup required for the existence of a private insurance market cannot be reconciled with the consumption-smoothing benefits it provides.

In the model of Hendren (2017) agents start out employed rather than unemployed. However, in the static model this distinction is irrelevant because the initial state is not used anywhere to derive (12). They transition into unemployment with individual probability $1-\pi$, which is privately known to the agent but not known to the insurer. If only agents with high probabilities of becoming unemployed buy insurance, then insurance can be profitably sold if and only if

$$\frac{d\tau}{db} \geq \frac{E[1-\tilde{\pi}|\tilde{\pi} \leq \pi]}{E[\tilde{\pi}|\tilde{\pi} \leq \pi]}. \tag{B.1}$$

The expression resembles the cost of providing an additional monetary unit of benefits in the frictionless benchmark in (14) but with π and $1-\pi$ replaced with their conditional expectations because of the self-selection problem.[24]

Plugging this result into the expression in (12) yields

$$\frac{p_e}{p_u}\frac{u'(c_u)}{v'(c_e)} \geq T(\pi) \equiv \left(\frac{\pi}{1-\pi}\right)\frac{E[1-\tilde{\pi}|\tilde{\pi} \leq \pi]}{E[\tilde{\pi}|\tilde{\pi} \leq \pi]}. \tag{B.3}$$

Therefore, with asymmetric information, the right hand side is also larger than one, indicating that full insurance will again not be possible.

Appendix C: Complementarity in the Utility Function

Approximation when Marginal Utility Depends Only on the Level of Consumption. Proposition 2 shows that even in the dynamic model the value of unemployment insurance μ can be approximated by

$$\mu^{\text{static}} \equiv \log\left(\frac{\overline{p_e}}{\overline{p_u}}\frac{u'(\overline{c_u})}{u'(\overline{c_e})}\right). \tag{C.1}$$

We retain the notation using bars above the variables to indicate averages from the dynamic model in Section 4.5. The results that follow also apply in the static version of the model in Section 4.1, and in this case the bars above the variables can be removed.

24. With asymmetric information only those with a high probability of unemployment (i.e., low π in our notation) self-select into unemployment insurance. Hendren (2017) assumes uni-dimensional heterogeneity in the type-space. If so, expected profits to a private insurer are given by

$$\text{Profits} = E[\tilde{\pi}|\tilde{\pi} \leq \pi]\tau - E[1-\tilde{\pi}|\tilde{\pi} \leq \pi]b. \tag{B.2}$$

In order to earn positive profits on the first dollar of insurance, and for a private insurance market to exist, the condition in (B.1) must hold.

In order to estimate μ using consumption and price data the following approximation of marginal utility is used: $u'(\overline{c_u}) \approx u'(\overline{c_e}) + u''(\overline{c_e})(\overline{c_u} - \overline{c_e})$. Then,

$$\begin{aligned}
\exp(\mu) &\approx \left(\frac{\overline{p_u} + \overline{p_e} - \overline{p_u}}{\overline{p_u}}\right)\left(\frac{u'(\overline{c_e}) + u''(\overline{c_e})(\overline{c_u} - \overline{c_e})}{u'(\overline{c_e})}\right) \\
&= \left(1 + \frac{\overline{p_e} - \overline{p_u}}{\overline{p_u}}\right)\left(1 + \frac{-\overline{c_e}u''(\overline{c_e})}{u'(\overline{c_e})}\frac{(\overline{c_e} - \overline{c_u})}{\overline{c_e}}\right) \\
&= \left(1 + \frac{\Delta\bar{p}}{\bar{p}}\right)\left(1 + \gamma(\overline{c})\frac{\Delta\overline{c}}{\overline{c}}\right) \\
&= 1 + \frac{\Delta\bar{p}}{\bar{p}} + \gamma(\overline{c})\frac{\Delta\overline{c}}{\overline{c}} + \frac{\Delta\bar{p}}{\bar{p}} \times \gamma(\overline{c})\frac{\Delta\overline{c}}{\overline{c}} \\
&\approx 1 + \frac{\Delta\bar{p}}{\bar{p}} + \gamma(\overline{c})\frac{\Delta\overline{c}}{\overline{c}},
\end{aligned} \tag{C.2}$$

where the approximation in the last line assumes that the product $\Delta\bar{p}/\bar{p} \times \Delta\overline{c}/\overline{c}$ is negligible. Using this approximation, and taking logs, an expression that can be taken to the data is obtained:

$$\mu \approx \log\left(1 + \frac{\Delta\bar{p}}{\bar{p}} + \gamma(\overline{c})\frac{\Delta\overline{c}}{\overline{c}}\right) \approx \frac{\Delta\bar{p}}{\bar{p}} + \gamma(\overline{c})\frac{\Delta\overline{c}}{\overline{c}}. \tag{C.3}$$

This approximation for marginal utility assumes, as Chetty (2006) does, that marginal utility of consumption is unaffected by leisure or any other additional variables subsumed into the vector $x(t, \omega_t)$. If this is not the case, then the above expression requires an adjustment.

Approximation when other Variables Affect the Marginal Utility of Consumption If marginal utility of consumption depends on any element x^i, then we have $\partial u'(c, x^i)/\partial x^i \neq 0$, and the approximation used before is no longer valid. The Taylor expansion used for the approximation in this case becomes

$$\begin{aligned}
u'(\overline{c_u}, \overline{x_u}) &\approx u'(\overline{c_e}, \overline{x_e}) + u''(\overline{c_e}, \overline{x_e})(\overline{c_u} - \overline{c_e}) \\
&\quad + \frac{\partial}{\partial x^i}u'(c, x^i)|_{(c,x^i)=(\overline{c_e},\overline{x_e})}(\overline{x_u} - \overline{x_e}),
\end{aligned}$$

where $\overline{x_e}$ and $\overline{x_u}$ are the average values of x^i while employed and unemployed. Notice that the partial cross-derivative of $u'(c, x^i)$ with respect to x^i in the approximation can be re-expressed as

$$\begin{aligned}
&\frac{\partial}{\partial x^i} u'(c, x^i)|_{(c,x^i)=(\overline{c_e},\overline{x_e})}(\overline{x_u} - \overline{x_e}) \\
&\quad = \frac{\frac{\frac{\partial}{\partial x^i} u'(c,x^i)|_{(c,x^i)=(\overline{c_e},\overline{x_e})}}{u'(\overline{c_e},\overline{x_e})}}{\frac{1}{\overline{x_e}}} \frac{(\overline{x_u} - \overline{x_e})}{\overline{x_e}} u'(\overline{c_e}, \overline{x_e}) \\
&\quad = \frac{\partial \log u'(c, x^i)}{\partial \log x^i}|_{(c,x^i)=(\overline{c_e},\overline{x_e})} \frac{(\overline{x_u} - \overline{x_e})}{\overline{x_e}} u'(\overline{c_e}, \overline{x_e}) \\
&\quad = -\varepsilon_{u',x}(\overline{c_e}, \overline{x_e}) \frac{(\overline{x_u} - \overline{x_e})}{\overline{x_e}} u'(\overline{c_e}, \overline{x_e}),
\end{aligned} \tag{C.4}$$

where

$$\varepsilon_{u',x}(\overline{c_e}, \overline{x_e}) \equiv -\frac{\partial \log u'(c, x^i)}{\partial \log x^i}|_{(c,x^i)=(\overline{c_e},\overline{x_e})}$$

is an elasticity measuring the magnitude of the impact of any variable x^i on the marginal utility of consumption at the point $(\overline{c_e}, \overline{x_e})$. For later reference, notice the negative sign in the definition of this elasticity.

Following the same steps as in the approximation before, and defining $\Delta\overline{x}/\overline{x} \equiv (\overline{x_e} - \overline{x_u})/\overline{x_e}$, the approximate expression for μ becomes

$$\begin{aligned}
\exp(\mu) &\approx 1 + \frac{\Delta \bar{p}}{\bar{p}} + \gamma(\overline{c}, \overline{x}) \frac{\Delta \overline{c}}{\overline{c}} + \varepsilon_{u',x}(\overline{c}, \overline{x}) \frac{\Delta \overline{x}}{\overline{x}}, \\
\Rightarrow \mu &\approx \frac{\Delta \bar{p}}{\bar{p}} + \gamma(\overline{c}, \overline{x}) \frac{\Delta \overline{c}}{\overline{c}} + \varepsilon_{u',x}(\overline{c}, \overline{x}) \frac{\Delta \overline{x}}{\overline{x}}.
\end{aligned} \tag{C.5}$$

This means that if an additional choice variable x^i affects marginal utility, and $\varepsilon_{u',x}(\overline{c}, \overline{x}) \neq 0$, then the expression for the value of unemployment insurance contains an additional additive term. If, for example, x^i denotes leisure and time devoted to leisure is higher during unemployment, then $\frac{\Delta\overline{x}}{\overline{x}} < 0$. If leisure is complementary with consumption and makes a marginal unit of consumption more valuable, then $\varepsilon_{u',x}(\overline{c}, \overline{x}) < 0$ (recall that we included a negative sign in the definition of the elasticity), so that the additional term is positive: $\varepsilon_{u',x}(\overline{c}, \overline{x})\Delta\overline{x}/\overline{x} > 0$. In this example, the assumed non-separability between consumption and leisure widens the gap between the marginal utility of consumption when employed and unemployed, and increases the value of providing unemployment insurance. Intuitively, because consumption is lower in the unemployed state of the world, marginal utility in that state is higher. If, in addition, the complementarity with leisure raises marginal utility in the unemployed state even further, then there is an additional reason to transfer resources from the employed to the unemployed state of the world.

It is possible to think of further examples of variables that affect the marginal utility of consumption. For example, the marginal utility of consumption could also be affected by the fact that effort was spent on shopping or by the joy of cooking at home. In any case, our empirical implementation makes use of the usual assumption that marginal consumption is unaffected by other variables.

Quality in the Utility Function. The approximation in (C.5) can also be used to discuss the influence of changes in the quality of consumption on the value of unemployment insurance. Let q be a measure of the quality of consumption, which is a choice variable of the agent and that potentially differs when employed or unemployed. The expression $\Delta\overline{q}/\overline{q}$ measures the relative change in average quality between the employed and the unemployed state if the world. The agent obtains utility from the consumption-quality bundle $u(c, q)$. Using the approximation in (C.5), for the specific case $x^i = q$, the value of unemployment insurance can be expressed as

$$\mu \approx \frac{\Delta \bar{p}}{\bar{p}} + \gamma \frac{\Delta \overline{c}}{\overline{c}} + \varepsilon_{u',q} \times \frac{\Delta \overline{q}}{\overline{q}}, \tag{C.6}$$

where $\varepsilon_{u',q}$ is the elasticity of marginal utility with respect to quality. If consumption and the quality of consumption are additively separable in the utility function, and quality does not affect the marginal utility of consumption, then $\varepsilon_{u',q} = 0$. In this case, although utility depends on quality, the value of unemployment insurance is not affected by it. An alternative assumption is that, for example, higher quality increases the marginal utility of consumption, so that $\varepsilon_{u',q} < 0$ (recall the negative sign in the definition of the elasticity). If the quality of consumption is lower in the unemployed state of the world, then $\Delta\overline{q}/\overline{q} \equiv (\overline{q_e} - \overline{q_u})/\overline{q_e} > 0$, and the last term in (C.6), $\varepsilon_{u',q} \times \Delta\overline{q}/\overline{q}$, is negative. The reduction in quality experienced during unemployment lowers marginal utility when unemployed and reduces the gap between marginal utility in the employed and unemployed state of the world, leading to a lower value of smoothing consumption across states of the world. With $\varepsilon_{u',q} > 0$ the opposite result is obtained. The magnitude of this additional component of the value of unemployment insurance depends on the relative variation in quality $\Delta\overline{q}/\overline{q}$ and on the elasticity $\varepsilon_{u',q}$, which measures the sensitivity of marginal utility with respect to changes in quality.

Appendix D: Proofs

Proof of Proposition 1. By the Envelope Theorem, the total differential of maximized utility is

$$\begin{aligned} dV = &-\left(\int_t \int_{\omega_t} \left[\lambda_{\omega_t,t}\theta(t,\omega_t) - \sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial \tau}\right] dF_t(\omega_t) dt\right) d\tau \\ &+ \left(\int_t \int_{\omega_t} \left[\lambda_{\omega_t,t}(1-\theta(t,\omega_t)) + \sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial b}\right] dF_t(\omega_t) dt\right) db \end{aligned} \tag{D.1}$$

The first two conditions of Assumption 6 imply that $\forall t, \omega_t$,

$$\sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial \tau} = \frac{\theta(t,\omega_t)}{p(x(t,\omega_t)))} \sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)}$$
$$\sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial b} = \frac{-(1-\theta(t,\omega_t))}{p(x(t,\omega_t))} \sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)} \tag{D.2}$$

Therefore, the total differential can be written as

$$dV = -\left(\int_t \int_{\omega_t} \left[\theta(t,\omega_t) \left(\lambda_{\omega_t,t} - \frac{\sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)}}{p(x(t,\omega_t))} \right) \right] dF_t(\omega_t) dt \right) d\tau$$
$$+ \left(\int_t \int_{\omega_t} \left[(1-\theta(t,\omega_t)) \left(\lambda_{\omega_t,t} - \frac{\sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)}}{p(x(t,\omega_t))} \right) \right] dF_t(\omega_t) dt \right) db \tag{D.3}$$

By the third part of Assumption 6, the marginal utility of consumption in each state is a function of multipliers only at time t, and

$$u'(c(t,\omega_t)) = p(x(t,\omega_t))\lambda_{\omega_t,t} - \sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)} \tag{D.4}$$

Because $p(x(t,\omega_t)) > 0$, this implies that $\forall t, \forall \omega_t$:

$$\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))} = \lambda_{\omega_t,t} - \frac{\sum \lambda_{g_i \omega t} \frac{\partial g_{i\omega_t}}{\partial c(t,\omega_t)}}{p(x(t,\omega_t))} \tag{D.5}$$

Substituting this expression into the total differential yields

$$dV = -\left(\int_t \int_{\omega_t} \left[\theta(t,\omega_t) \left(\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))} \right) \right] dF_t(\omega_t) dt \right) d\tau$$
$$+ \left(\int_t \int_{\omega_t} \left[(1-\theta(t,\omega_t)) \left(\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))} \right) \right] dF_t(\omega_t) dt \right) db, \tag{D.6}$$

Substituting the definitions of $E\left[\frac{u'(c_e)}{p_e}\right]$ and $E\left[\frac{u'(c_u)}{p_u}\right]$ into this expression,

$$dV = -(1-D)E\left[\frac{u'(c_e)}{p_e}\right] d\tau + DE\left[\frac{u'(c_u)}{p_u}\right] db. \tag{D.7}$$

Therefore, lifetime utility improves ($dV \geq 0$) if and only if the expression in the Proposition is satisfied. □

Proof of Proposition 2. The proof follows directly from calculating the first-order and second-order approximations to the terms inside the expectations.

(1) A first-order approximation around $(\overline{c_e}, \overline{p_e})$ and $(\overline{c_u}, \overline{p_u})$ yields

$$E\left[\frac{u'(c_e)}{p_e}\right] \approx \frac{u'(\overline{c_e})}{\overline{p_e}} \tag{D.8}$$

and

$$E\left[\frac{u'(c_u)}{p_u}\right] \approx \frac{u'(\overline{c_u})}{\overline{p_u}} \tag{D.9}$$

To verify this take a first-order Taylor expansion around $(\overline{c_e}, \overline{p_e})$.

$$\begin{aligned}\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))} &\approx \frac{u'(\overline{c_e})}{\overline{p_e}} + \frac{u''(\overline{c_e})}{\overline{p_e}}(c(t,\omega_t) - \overline{c_e}) \\ &\quad + \frac{u'(\overline{c_e})}{-\overline{p_e}^2}(p(x(t,\omega_t)) - \overline{p_e})\end{aligned} \tag{D.10}$$

Taking conditional expectations, from the definitions of $\overline{c_e}$ and $\overline{p_e}$ the last two terms drop out, so that:

$$E\left[\frac{u'(c_e)}{p_e}\right] = E\left[\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))}|\theta = 1\right] \approx \frac{u'(\overline{c_e})}{\overline{p_e}}. \tag{D.11}$$

For the unemployed case, the proof is analogous.

(2) A second-order approximation around $(\overline{c_e}, \overline{p_e})$ and $(\overline{c_u}, \overline{p_u})$ yields

$$E\left[\frac{u'(c_e)}{p_e}\right] \approx \frac{u'(\overline{c_e})}{\overline{p_e}}\left(1 + \frac{1}{2}\gamma\rho s_e^{cc} + \frac{1}{4}s_e^{pp} - \frac{1}{2}\gamma s_e^{cp}\right) \tag{D.12}$$

and

$$E\left[\frac{u'(c_u)}{p_u}\right] \approx \frac{u'(\overline{c_u})}{\overline{p_u}}\left(1 + \frac{1}{2}\gamma\rho s_u^{cc} + \frac{1}{4}s_u^{pp} - \frac{1}{2}\gamma s_u^{cp}\right) \tag{D.13}$$

where

$$s_e^{xy} = E\left[\frac{(x - \overline{x_e})}{\overline{x_e}}\frac{(y - \overline{y_e})}{\overline{y_e}}|\theta = 1\right] \tag{D.14}$$

and

$$s_u^{xy} = E\left[\frac{(x - \overline{x_u})}{\overline{x_u}}\frac{(y - \overline{y_u})}{\overline{y_u}}|\theta = 0\right] \tag{D.15}$$

To verify this take a second-order Taylor expansion around $(\overline{c_e}, \overline{p_e})$.

$$\begin{aligned}\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))} \approx \frac{u'(\overline{c_e})}{\overline{p_e}} + \frac{u''(\overline{c_e})}{\overline{p_e}}(c(t,\omega_t) - \overline{c_e}) \\ + \frac{u'(\overline{c_e})}{-\overline{p_e}^2}(p(x(t,\omega_t)) - \overline{p_e}) \\ + \frac{1}{2}\frac{u'''(\overline{c_e})}{\overline{p_e}}(c(t,\omega_t) - \overline{c_e})^2 \\ + \frac{1}{2}\frac{u'(\overline{c_e})}{2\overline{p_e}^3}(p(x(t,\omega_t)) - \overline{p_e})^2 \\ - \frac{1}{2}\frac{u''(\overline{c_e})}{\overline{p_e}^2}(c(t,\omega_t) - \overline{c_e})(p(x(t,\omega_t)) - \overline{p_e})\end{aligned} \tag{D.16}$$

Taking conditional expectations, the linear terms drop out, and

$$\begin{aligned}E\left[\frac{u'(c_e)}{p_e}\right] &= E\left[\frac{u'(c(t,\omega_t))}{p(x(t,\omega_t))}|\theta = 1\right] \\ &\approx \frac{u'(\overline{c_e})}{\overline{p_e}} + \frac{1}{2}\frac{u'''(\overline{c_e})}{\overline{p_e}}E[(c(t,\omega_t) - \overline{c_e})^2|\theta = 1] \\ &+ \frac{1}{2}\frac{u'(\overline{c_e})}{2\overline{p_e}^3}E[(p(x(t,\omega_t)) - \overline{p_e})^2|\theta = 1] \\ &- \frac{1}{2}\frac{u''(\overline{c_e})}{\overline{p_e}^2}E[(c(t,\omega_t) - \overline{c_e})(p(x(t,\omega_t)) - \overline{p_e})|\theta = 1] \\ &= \frac{u'(\overline{c_e})}{\overline{p_e}}(1 + \frac{1}{2}\gamma\rho\frac{1}{c^2}E[(c(t,\omega_t) - \overline{c_e})^2|\theta = 1] \\ &+ \frac{1}{4}\frac{1}{\overline{p_e}^2}E[(p(x(t,\omega_t)) - \overline{p_e})^2|\theta = 1] \\ &- \frac{1}{2}\gamma\frac{1}{c\overline{p_e}}E[(c(t,\omega_t) - \overline{c_e})(p(x(t,\omega_t)) - \overline{p_e})|\theta = 1]) \\ &= \frac{u'(\overline{c_e})}{\overline{p_e}}\left(1 + \frac{1}{2}\gamma\rho s_e^{cc} + \frac{1}{4}s_e^{pp} - \frac{1}{2}\gamma s_e^{cp}\right)\end{aligned} \tag{D.17}$$

For the unemployed case, the proof is analogous. □

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Supplementary Data

Supplementary data are available at *JEEA* online.