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The Welfare Cost of Business Cycles for Heterogeneous Consumers: A State-Space Decomposition*

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Abstract

The main objective of this paper is to measure welfare costs related to permanent and transitory shocks in heterogeneous class of consumers. We divide consumers into three income groups: Low Class, Middle Class and High Class. For these group of consumers, we consider a model with permanent and transitory shocks. Then, we put our problem in a state-space form and use Kalman Filter to compute some properties of the shocks. For the most of our specifications the welfare costs of economic fluctuations are greater than 1%. Moreover, our finds indicates that low-income consumers are more sensitive to both transitory and permanent shocks that other classes of consumers.

Keywords: Kalman filter; Welfare cost; Business cycle; Heterogeneous agents.
JEL Classification: E32,C32,C53

1 Introduction

Lucas (1987) argues that welfare cost due to business cycles are small, about 0.04% of personal consumption per-capita. Subsequent work measured the cost of business cycles with different methods and data bases. In general, these works have either changed

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the environment of the problem or relaxed Lucas assumptions.[1] Some authors changed the preference utility and achieve high welfare cost, as example we have Van Wincoop (1994), Dolmas (1998) and Tallarini (2000). Although they found great welfare costs, these papers are criticized by Otrok (2001) who says that it is trivial to find big number for the welfare cost when we can choose preferences. Our approach is to relax the assumption of representative consumer keeping CRRA preferences. In our model, consumer are heterogeneous with respect to income. Then, we measure how different class of consumers are willing to pay (in terms of consumption) to eliminate consumption uncertainty.

There are some works that relax the hypothesis of representative consumer and compute the welfare cost of business cycles. Imrohoroglu (1989), Krusell and Smith (1999), De Santis (2007), Krebs (2003, 2007), and others measured the costs of fluctuations in economies where agents are heterogeneous and markets are incomplete. Although one can expect that the costs of fluctuations would be higher, as bad income shocks hurt a few households severely, the typical finding from these studies is that the costs of fluctuations are only slightly higher or even lower than the Lucas benchmark. It is also common in all works of this group the use calibration techniques on some well design economic models, which implies that the individual consumption series is derived from simulations.

The literature that uses econometric tools to estimate the welfare cost of business cycles have important results relaxing some of the assumption of Lucas. Obstfeld (1994) points that, for reasonable calibrations, the costs of fluctuations are small even if consumption is infinitely persistent. However, Reis (2009) relax the assumption that the log of annual *per capita* consumption is serially uncorrelated and finds that the high persistence of consumption in the data severely distorts conventional measures of welfare cost of cycles, and find a cost of fluctuations between 0.5% and 5% of per capita consumption. Issler et al. (2008) and Issler et al. (2014) split off the cost in welfare costs due to permanent and transitory shocks and finds even negative numbers for the costs of fluctuations. It is common in all those works the assumption of representative agent.

Our contribution to the literature is to measure the welfare costs related to permanent and transitory shocks in heterogeneous class of consumers using microdata. For the best of our knowledge, we are the first work to use data from individual consumers to estimate the welfare cost of business cycles.[2] Our approach is similar to Issler et al. (2014) estimation of a structural time-series models with long-run constraints. We assume a structural time-series model, where the unobserved components are assumed to be normal and uncorrelated, as in Harvey (1985) and Koopman et al. (2009). We put our problem in a state-space form and use Kalman Filter to compute the likelihood

[1] Lucas made three basic assumption: (1) there is a representative consumer, (2) the welfare function is time-separable and iso-elastic (3) the log of annual per capita consumption is serially uncorrelated and normally distributed around a linear trend.

[2] Although our primary data is from individual, we agreggate consumers within income groups to proceed our estimations.

function through the one-step prediction error decomposition to estimate the transitory and permanent components of our model.

We find evidence that consumers have a higher costs due to permanent shocks (that are assumed to be common to all classes of consumers) than the costs due to transitory shocks. Also, low-income consumers have higher costs with business cycles than other income-classes of consumers. Moreover, our results indicates that the total costs of economic fluctuation are higher than the related literature that explores heterogeneous consumers suggests. More related to this paper is Issler et al. (2014), that also classify the shock on consumption between transitory and permanent ones, but they find a lower welfare cost. One possible explanation is the relaxation of the assumption of representative consumer we make here. In general, works that keeps the representative consumer hypothesis use aggregate consumption data, which may hide part of the variation in the consumption of individual (or groups of) consumers.

This paper is divided as follows: Section 2 provides a theoretical framework to evaluate the welfare costs of business cycles and of economic growth variation. Section 3 presents how we put our problem in state-space form using Kalman Filter to estimate our key parameters. Section 4 describes data. In Section 5 we present our estimated parameters and computed welfare costs. Section 6 concludes the paper.

2 Model

We consider a economy where there is a large number of individual indexed by $i = 1, 2, \dots N$. All individuals have the same utility function:

$$u(c_{t,i}) = \frac{c_{t,i}^{(1-\phi)} - 1}{1-\phi}.$$

where t represents the period of consumption and ϕ is the relative risk aversion of an agent. Each person lives forever and discount future utility at the rate $\beta \in (0, 1)$. Individuals maximize the following objective function:

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t u(c_{t,i}) \right\} \tag{1}$$

Lucas (1987) supposes that consumption of each consumer is log-normally distributed around a deterministic trend:

$$c_{t,i} = \alpha_{0i}(1 + \alpha_{1i})^t exp(-\frac{1}{2}\sigma_{zi}^2) z_{t,i}, \tag{2}$$

where $\ln(z_{t,i}) \sim$ N$(0,\sigma_{zi}^2)$ is the stationary and ergodic stochastic component of consumption. Lucas (1987) estimate the welfare effects of business cycle in a counter-factual exercise, where c_t is the consumption sequence and c_t^* is the cycle free consumption sequence

$$c_{t,i}^* = \mathbb{E}(c_{t,i}) = \alpha_{0i}(1 + \alpha_{1i})^t. \tag{3}$$

More precisely, the exercise consist in calculate λ such that:

$$\mathbb{E}\left\{\sum_{t=0}^{\infty}\beta^t u((1+\lambda)c_t)\right\} = \sum_{t=0}^{\infty}\beta^t u(c_t^*). \tag{4}$$

Following Issler et al. (2014), we decompose $ln(c_{t,i})$ as the sum of a deterministic term, a martingale trend and a stationary and ergodic cycle:

$$ln(c_{t,i}) = ln(\alpha_{0,i}) + ln(1+\alpha_{1,i})t - \frac{\omega_{t,i}^2}{2} + \sum_{j=1}^{t}\epsilon_j + \sum_{k=0}^{t-1}\psi_k\mu_{t-k,i} \tag{5}$$

where, $\ln\left(\alpha_{0,i}(1+\alpha_{1,i})^t \cdot \exp(-\frac{\omega_{t,i}^2}{2})\right)$ is the deterministic term of log-consumption, ϵ_t represents an permanent shock, that is common for all consumers, and $\mu_{t,i}$ is a stationary shock for individual i. The former shock is a aggregate one, that represents an source of variation in the consumption of all individuals. We use a common stochastic trend for all consumer to model a source of variation in consumption due to some uncertainty about economic growth. In addition, we use individual transitory shocks (cycles) to model a possible difference in how different consumers perceive the business cycles. Then, the total macroeconomic uncertain in consumption of an individual comes part from a source that is common for all individuals, but there is an idiosyncratic part, i.e., a part which depends on how individuals perceive economic cycles.

Here, we make an assumption to allow us to use the Kalman filter to estimate properties of those shocks: we suppose that shocks are uncorrelated and have a bivariate Normal distribution:

$$\begin{pmatrix}\epsilon_t \\ \mu_{t,i}\end{pmatrix} \sim i.i.d.\mathcal{N}\left(\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}\sigma_{11} & 0\\ 0 & \sigma_{22,i}\end{pmatrix}\right) \tag{6}$$

Considering the uncorrelated shocks hypothesis, the unconditional variance of $\ln(c_{i,t})$ is $\omega_{t,i}^2 = \sigma_{11,i}t + \sigma_{22,i}\sum_{k=0}^{t-1}\psi_k^2$. Giving that the marginal distribution of a multivariate normal distribution is also normal distributed, we have that

$$\epsilon_t \sim \mathcal{N}(0,\sigma_{11}); \tag{7}$$
$$\mu_{t,i} \sim \mathcal{N}(0,\sigma_{22,i}). \tag{8}$$

Then, we can turn off either permanent or transitory shock and calculate counterfactual log-consumtion exposed to only one kind of those shocks.

In order to find a consumption sequence only exposed to permanent shock, $c_{t,i}^P$, we tun off transitory shock and obtain the following sequence of log-consumption:

$$ln(c_{t,i}^P) = ln(\alpha_{0,i}) + ln(1+\alpha_{1,i})t - \frac{\sigma_{11,i}}{2}t + \sum_{j-1}^{t}\epsilon_j. \tag{9}$$

With $c_{t,i}^P$, we can measure welfare cost associated to transitory shocks. Similar to Lucas (1987), we find $\lambda_{P,i}$ comparing the conditional expected utility from the sequence of consumption exposed only to permanent shock and the consumption exposed to all macroeconomic uncertainty, i.e, solves the following equality

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u((1+\lambda_{P,i})c_{t,i}\right] = \mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u(c_{t,i}^P)\right]. \tag{10}$$

Then, $\lambda_{P,i}$ represents *the welfare cost of cycles* for consumer i in terms of consumption. Following the algebra in Issler et al. (2014), we get the following expression:

$$\lambda_{P,i} = \begin{cases} exp\left(\frac{\phi\tilde{\sigma}_{22,i}}{2}\right) - 1 & \text{for } \phi \neq 1 \\ exp\left(\frac{\tilde{\sigma}_{22,i}}{2}\right) - 1 & \text{for } \phi = 1 \end{cases}, \tag{11}$$

where $\tilde{\sigma}_{22,i} = \sigma_{22,i}\sum_{k=0}^{\infty}\psi_k^2$. We implicit assume that a convergence condition

$$\beta(1+\alpha_{1,i})^{(1-\phi)}exp(-\phi(1-\phi)\frac{\sigma_{11,i}}{2} < 1$$

holds.

Now, turning off the transitory shock, we found consumption exposed only to transitory shock with the following sequence

$$ln(c_{t,i}^T) = ln(\alpha_{0,i}) + ln(1+\alpha_{1,i})t - \frac{\sigma_{22,i}\sum_{k=0}^{t-1}\psi_k^2}{2} + \sum_{k=0}^{t-1}\psi_k\mu_{t-k,i}. \tag{12}$$

Thus, we can measure *the welfare cost of growth variation* by finding $\lambda_{T,i}$ that solves

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u((1+\lambda_{T,i})c_{t,i}\right] = \mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u(c_{t,i}^T)\right]. \tag{13}$$

Assuming the convergence condition $\beta(1+\alpha_{1,i})^{(1-\phi)} < 1$, we have:

$$\lambda_{T,i} = \begin{cases} \left[\frac{(1-\beta(1+\alpha_{1,i})^{1-\phi}exp(-\phi(1-\phi)\frac{\sigma_{11,i}}{2})}{(1-\beta(1+\alpha_{1,i})^{(1-\phi)}}\right]^{\frac{1}{(1-\phi)}} - 1 & \text{for } \phi \neq 1 \\ exp\left(\frac{\beta\sigma_{11,i}}{2(1-\beta)}\right) - 1 & \text{for } \phi = 1 \end{cases}. \tag{14}$$

Finally, we can measure the combined effect of both shocks. In this case we turn off ϵ_t and $\mu_{t,i}$. We have $ln(c_{t,i}^D) = ln(\alpha_{0,i}) + ln(1+\alpha_{1,i})t$. The welfare cost associated with both shocks, $\lambda_{D,i}$ solves:

$$\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u((1+\lambda_{D,i})c_{t,i}\right] = \mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t u(c_{t,i}^D)\right] \tag{15}$$

Which give us:

$$\lambda_{D,i} = \begin{cases} \left[\frac{(exp(\phi(1-\phi)\frac{\sigma_{22,i}}{2})(1-\beta(1+\alpha_{1,i})^{1-\phi} exp(-\phi(1-\phi)\frac{\sigma_{11,i}}{2}))}{(1-\beta(1+\alpha_{1,i})^{(1-\phi)}} \right]^{\frac{1}{(1-\phi)}} - 1 & \text{for } \phi \neq 1 \\ exp\left(\frac{\beta\sigma_{11,i} + (1-\beta)\tilde{\sigma_{22,i}}}{2(1-\beta)} \right) - 1 & \text{for } \phi = 1 \end{cases} \tag{16}$$

Here we need that the convergence condition $\beta(1 + \alpha_{1,i})^{(1-\phi)} < 1$ holds. Following Alvarez and Jermann (2004), we can calculate marginal welfare cost of trend and business cycle. The idea is take a convex combination of cycle free consumption,$c^*_{t,i}$ and consumption $c_{t,i}$; $(1-\alpha)c_{t,i} + \alpha c^*_{t,i}$. Differentiating in α the equivalent variation in consumption, we obtain the marginal welfare costs as exposed below.

$$\lambda'_{P,i}(0) = \begin{cases} exp\left(\phi\tilde{\sigma}_{22,i}\right) - 1 & \text{for } \phi \neq 1 \\ exp\left(\tilde{\sigma}_{22,i}\right) - 1 & \text{for } \phi = 1 \end{cases} \tag{17}$$

$$\lambda'_{T,i}(0) = \begin{cases} \frac{(1-\beta(1+\alpha_{1,i})^{1-\phi} exp(-\phi(1-\phi)\frac{\sigma_{11,i}}{2})}{(1-\beta(1+\alpha_{1,i})^{1-\phi} exp(\phi(1+\phi)\frac{\sigma_{11,i}}{2})} - 1 & \text{for } \phi \neq 1 \\ \frac{1-\beta}{1-\beta exp(\sigma_{11,i})} - 1 & \text{for } \phi = 1 \end{cases} \tag{18}$$

$$\lambda'_{D,i}(0) = \begin{cases} \frac{(exp(\phi\tilde{\sigma}_{22,i})(1-\beta(1+\alpha_{1,i})^{1-\phi} exp(-\phi(1-\phi)\frac{\sigma_{11,i}}{2}))}{(1-\beta(1+\alpha_{1,i})^{(1-\phi)} exp(\phi(1+\phi)\frac{\sigma_{11,i}}{2})} - 1 & \text{for } \phi \neq 1 \\ \frac{exp(\tilde{\sigma_{22,i}}(1-\beta))}{1-\beta exp(\sigma_{11,i})} - 1 & \text{for } \phi = 1 \end{cases} \tag{19}$$

3 Estimation

Before we describe the technique used in the empirical work, we brief describe one additional assumption. It is not feasible to estimate parameter for individual consumers in the model above with our panel data (describe in the next section). Then, we make the following assumption. Individuals from the same income group receive the same transitory shock. Then, for a group with $K < N$ individuals, we calculate the average of log-consumption:

$$\frac{1}{K}\sum_{\ell=1}^{K}[ln(c_{t,\ell})] = \frac{1}{K}\sum_{\ell=1}^{K} ln(\alpha_{0,\ell}) + \frac{1}{K}\sum_{\ell=1}^{K}\left[ln(1+\alpha_{1,\ell})t - \frac{\omega^2_{t,\ell}}{2}\right] + \sum_{j=1}^{t}\epsilon_j + \sum_{k=0}^{t-1}\psi_k\mu_{t-k,g} \tag{20}$$

where g represents an income group. Then, the average of $\ln(c_{t,i})$ keeps the same permanent and transitory shocks that individuals receive. Then, we can calculate the λ's described in the last section for groups of individual. It is essential to our empirical approach.

We estimate our models in a state-space form with Normal disturbances, using Kalman Filter. Following Drukker and Gates (2011) we apply the *sspace* to estimate a local-level model. The observation and state equations are, respectively:

$$\begin{aligned} y_t &= \mu_t + \epsilon_t \\ \mu_t &= \mu_{t-1} + \xi_t \end{aligned} \tag{21}$$

Where, $\epsilon_t \sim N(0, \sigma^2_\epsilon)$ and $\xi_t \sim N(0, \sigma^2_\xi)$ and both are independent. The parameters in this model are σ^2_ϵ, σ^2_ξ, and μ_0.

Following Issler et al. (2014), we impose that shocks to consumption are independent, relying on the structural time-series model of Harvey (1985) and Koopman et al. (2009). The idea is to decompose a single integrated series in a trend and a cycle by maximum likelihood, guaranteeing consistent and asymptotically Normal parameter estimates. Applying the local-level model to our trend-cycle decomposition of consumption for different income levels consists in:

$$\begin{aligned} c_{it} &= \bar{c}_t + \epsilon_{it} \\ \bar{c}_t &= \bar{c}_{t-1} + \delta_i + \xi_{it} \end{aligned} \tag{22}$$

Where, c_i is consumption for different income (i) level: low, middle and high; $\bar{c}$ is mean consumption; $\epsilon_{it} \sim N(0, \sigma^2_{\epsilon_i})$ and $\xi_{it} \sim N(0, \sigma^2_{\xi_i})$ and both are independent. Note that we constrained our state variable to have a unit root, and c_i and $\bar{c}$ parameter to be equal one.

Using Kalman Filter in this state-space model we can estimate our key parameters for each income (i) level: ; $\sigma^2_{\epsilon_i}$ is our variance related do cycle ($\sigma_{22,i}$ in the model) and $\sigma^2_{\xi_i}$ variance related to trend ($\sigma_{11,i}$ in the model, invariant to adition of a constant), and we also will estimate a different constant for each i. Where $ln(1+\alpha_1)$ is equal $\mathbb{E}(\Delta\bar{c}_t)$.

4 Data

We use the Consumer Expenditure Survey (CEX) to gather income and expenditure data at household-level. CEX program consists of two different surveys, the Quarterly Interview Survey and the Diary Survey, providing data of American consumers, expenditures, income, and consumer unit (families and single consumers) characteristics. We only look at the Quarterly Interview Survey, which tracks consumer units large expenditures, such as major appliances and cars, and is conducted quarterly with each consumer unit.

A consumer unit appears up to four interviews, spaced three months apart. After its final interview, a new randomly selected household replaces this consumer unit. There are six types of data files organized by quarter. However, we focus only at the FMLI file, also referred to as the Consumer Unit Characteristics and Income file, contains consumer unit characteristics, consumer unit income, and characteristics and earnings of the reference person and of the spouse. The file includes weights needed to calculate population estimates and variances.

Our sample was drawn from CEX data files corresponding to the period 1996:Q1 (earlier data had more significant problems with quality) through 2014:Q4 (the latest quarter available at the time that the paper was written). We use three variables from the FMLI file: (i) Expenditure: total expenditures last quarter[3]; (ii) Income: amount

[3]TOTEXPPQ.

of wage and salary income, before deductions, received by all CU members in past 12 months[4]; and, (iii) Consumer unit replicate weight[5]. To adjust for inflation, we deflate income using implicit price deflators for gross domestic product, and expenditures using implicit price deflators for personal consumption expenditures from the Bureau of Economic Analysis of the U.S. Department of Commerce. The base-year for the deflated variables is 2009.

First, we dropped households whom reported expenditures or income equal zero, keeping 345,587 individuals in our sample. Then, we deseasonalized income and consumption data using dummys for each quarter. Next, for each year quarter we sort the data by income from the lowest to the highest income. Then, we slip the consumers in three income groups keeping the number of consumers closed in each group: Low Class, Middle Class and High Class.[6] All told, we take averages of expenditures logarithms by group to compute our heterogeneous consumption series. At the end, we have three consumption time series with 76 observations.[7]

Figure 1 presents our consumption time series for different income levels and also the mean consumption time series.

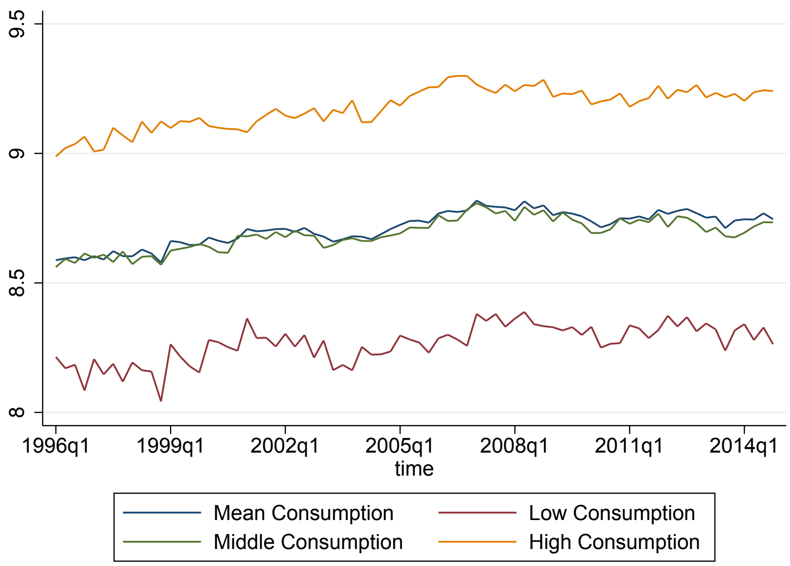

Figure 1: Consumption per income level profile (deseasonalized logs)

[4]FSALARYX.

[5]FINLWT21.

[6]Other possible method to to that is define maximum income as $\bar{y}$, then the first group is composed by consumer that reported income $\in [0, \bar{y}/3)$, the second group is composed by consumer that reported income $\in [\bar{y}/3, 2\bar{y}/3)$ and the third group is composed by consumer that reported income $\in [2\bar{y}/3, \bar{y}]$.

[7]Our main assumptions to use this method is that consumers do not jump from one income group to another.

5 Empirical Results

5.1 State-space model estimation

Table 1 presents the estimated section 2 parameters, employing the state-space approach using Kalman Filter. Figures 2, 3 and 4 plot the results of the trend-cycle decomposition bases using Kalman Filter for Low, Middle, and High income, respectively. For comparison figure 5 plots only consumption (log) and trends for all income levels.

Table 1: Estimated parameters (1996-2014)

Class	$ln(1+\alpha_1)$	σ_{11}	σ_{22}
Low	0.00159	0.000314	0.001536
Middle	0.00213	0.000228	0.000233
High	0.003135	0.000227	0.000416

In figure 5 we can see that low consumption individuals have great shift away their trends. The high consumption individuals have smaller shift than the low consumption groups, however they have a bigger shift than the middle consumption groups. This suggest that middle consumption groups do not have great issues with cycles when we compare with other groups, once their cycle has the smallest amplitude.

5.2 Welfare costs

In order to confirm ours thoughts in last paragraph, in this subsection we measure the welfare cost of trend and business cycle for each group of agents. Remember in section 2 that λ represent how many utility the consumer is willing to give up in order to avoid variation. As we already saw, λ for any case are directly correlated with shock variance. In table 1 we saw that low class show higher variance, so it is expected that this group of agents suffer bigger welfare costs. We can observe that on table bellow.

Low consumption group has the biggest welfare cost due to business cycles. This mean that poorest people tend to be more sensitive to oscillations in economy. In all risk aversion coefficient and future discount rate we see low class with higher cost, on other side, middle class exhibit the smallest cost. We expected that, once we observed on last subsection that low consumption groups show the biggest variation on consumption, and the middle group shows the smallest variations.

Welfare cost are directly correlated with risk aversion coefficient, ϕ, and with future discount rate, β. This is a intuitive result. So, we will always see the biggest welfare cost with $\beta = 0.99$ and $\phi = 10$, a extremely case.[8] The results are in percent of consumption, so, to avoid business cycle a high class individual would give up 0.21%

[8]Despite we follow Issler et al. (2014), we do not measure the welfare cost for $\phi = 20$ because we do not guarantee the convergence conditions exposed in section (2) for low class.

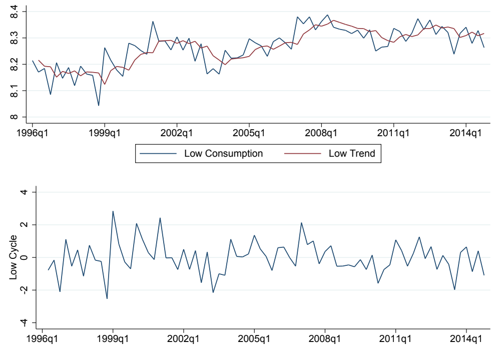

Figure 2: Low Consumption (deseasonalized logs) and Unobsorved-Component Trend and Cycle

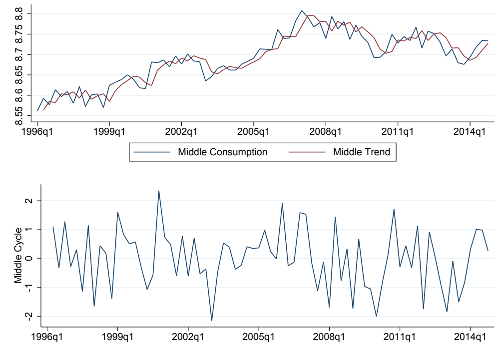

Figure 3: Middle Consumption (deseasonalized logs) and Unobsorved-Component Trend and Cycle

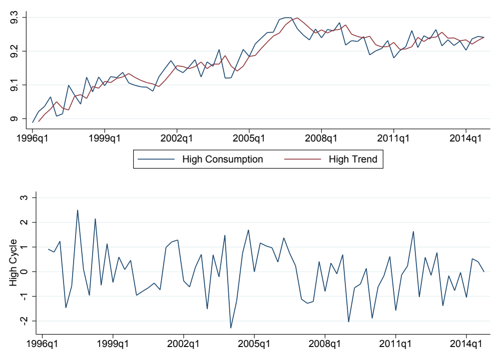

Figure 4: High Consumption (deseasonalized logs) and Unobsorved-Component Trend and Cycle

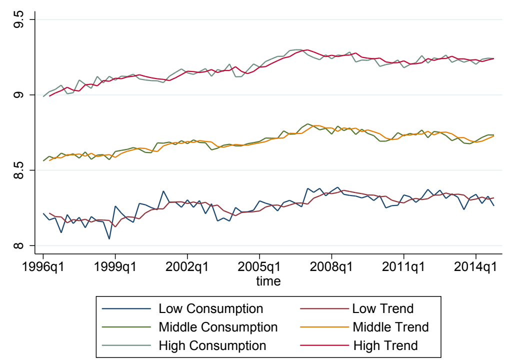

Figure 5: Consumption (deseasonalized logs) and Unobsorved-Component Trends

of his income, similar to Issler et al. (2014) result, while the low class individual is prepared to give up 0.77% of his income. In order to avoid variations due to economic growth, we observe a even bigger desire to give up consumption than in order to avoid variations due to cycles. We observed that when measure the welfare cost associated to economic growth variation, λ_T.

The welfare cost associated to economic growth variation are bigger for low class as we already saw when we analyse the cost due to business cycle. The different here is that we can see a linearity in welfare cost in function of income class. The poorest individuals continues to be more sensitive a variations, now due to economic growth, but the most resilient group is the rich one and not the middle class. We can conclude that middle class has a better adaptation when shock are transitory, but not so a good

Table 2: Welfare Cost of Business Cycle (1996-2014) - % consumption.

	Welfare Cost				**Marginal welfare cost**			
ϕ	1	3	5	10	1	3	5	10
$\boldsymbol{\beta}$**=0.95**								
Low	0.07	0.23	0.38	0.77	0.15	0.46	0.77	1.55
Middle	0.01	0.03	0.05	0.12	0.02	0.06	0.12	0.23
High	0.02	0.06	0.10	0.21	0.04	0.12	0.21	0.42
$\boldsymbol{\beta}$**=0.97**								
Low	0.07	0.23	0.38	0.77	0.15	0.46	0.77	1.55
Middle	0.01	0.03	0.05	0.12	0.02	0.06	0.12	0.23
High	0.02	0.06	0.10	0.21	0.04	0.12	0.21	0.42
$\boldsymbol{\beta}$**=0.99**								
Low	0.07	0.23	0.38	0.77	0.15	0.46	0.77	1.55
Middle	0.01	0.03	0.05	0.12	0.02	0.06	0.12	0.23
High	0.02	0.06	0.10	0.21	0.04	0.12	0.21	0.42

Table 3: Welfare Cost of Economic Growth Variation (1996-2014) - % consumption.

	Welfare Cost				**Marginal welfare cost**			
ϕ	1	3	5	10	1	3	5	10
$\boldsymbol{\beta}$**=0.95**								
Low	0.30	0.85	1.37	2.66	0.60	1.75	2.89	6.34
Middle	0.22	0.60	0.95	1.71	0.44	1.23	1.97	3.82
High	0.22	0.58	0.88	1.48	0.43	1.18	1.72	3.27
$\boldsymbol{\beta}$**=0.97**								
Low	0.51	1.41	2.22	4.23	1.03	2.92	4.81	11.27
Middle	0.37	0.98	1.49	2.55	0.74	2.02	3.15	6.03
High	0.37	0.92	1.34	2.09	0.74	1.89	2.81	4.80
$\boldsymbol{\beta}$**=0.99**								
Low	1.57	3.74	5.42	10.06	3.21	8.26	13.35	44.29
Middle	1.14	2.46	3.30	4.87	2.31	5.25	7.47	13.56
High	1.13	2.14	2.66	3.46	2.30	4.52	5.86	8.70

one when the shock are permanent. We imagine that high class are more resilient from permanent shock due to the more financials opportunities that they are exposed. And the middle class are more resilient from transitory shock due to the facility to consume "worst" goods.

When we analyse the cost associated for all macroeconomic uncertainty, we observe that the cost due to economic growth predominates over cost associate with transitory shock. So, we observe the welfare cost linearity in function of income as observed on economic growth's welfare cost. We can compare the cost on the last table. We found bigger welfare cost than the related literature. This possible occurs due ours estimation methods. In Lucas (1987) and Issler et al. (2014), their result is smaller than ours, and in some cases negative, however they do not consider heterogeneous individuals. Reis (2009) do not consider even, however he founds more similar results than ours, where the authors find with $\phi = 5$ a welfare cost, in some cases, equal to 5%.

Table 4: Welfare Cost of All Macroeconomic Uncertainty (1996-2014) - % consumption.

	Welfare Cost				**Marginal welfare cost**			
ϕ	1	3	5	10	1	3	5	10
$\boldsymbol{\beta}$**=0.95**								
Low	0.38	1.09	1.76	3.45	0.76	2.22	3.68	7.99
Middle	0.23	0.64	1.01	1.83	0.46	1.30	2.08	4.06
High	0.24	0.64	0.99	1.70	0.48	1.30	2.03	3.70
$\boldsymbol{\beta}$**=0.97**								
Low	0.59	1.64	2.61	5.03	1.18	3.40	5.62	12.99
Middle	0.38	1.02	1.55	2.67	0.77	2.09	3.27	6.28
High	0.39	0.99	1.44	2.31	0.78	2.02	3.02	5.24
$\boldsymbol{\beta}$**=0.99**								
Low	1.65	3.98	5.83	10.91	3.37	8.76	14.23	46.52
Middle	1.15	2.50	3.36	4.99	2.33	5.33	7.60	13.83
High	1.15	2.20	2.76	3.67	2.34	4.65	6.08	9.15

A more similar model to ours is the model in Krusell and Smith (1999). The authors analysis the welfare cost of business cycles in a heterogeneous agents environment. In their model agents could be employed, short-term unemployed and long-term unemployed. They found that cost is small for all groups and not significantly different between agents. We, as repeatedly said, found that low income agents tend to be more sensitive a variations in economy, even due to permanent shock and transitory shock. So, although Lucas (1987) suggest that economist does not need to worry about cycles because the cost is small, we believe that business cycle and economic growth variation must be a main issue in economic research due the biggest impact on low income agents. Business cycle and economic growth variation can be a social inequality source.

6 Final Remarks

In this paper, we use data from individual consumers to compute consumption for different group of individuals based on income level. After that, we compute the welfare cost of economic fluctuations. We use a similar method to Issler et al. (2014) that split off the cost in welfare costs due to permanent shocks and due to transitory shocks. Our estimation is based in a state-space model and uses Kalman Filter to identify the different kinds of shocks. We find that for all parameters set, the biggest cost is always associate to low-income consumers. This is not completely unexpected because this class of consumers is more likely to face more problems to smooth consumption.

Although low-income consumers presents a higher welfare cost associate to business cycles and economic growth in our estimations, for all classes of consumers we also find higher welfare cost than previous works with heterogeneus consumers. In general, our results indicate that the welfare cost of macroeconomic variation is higher than 1%. We use data from individual consumers to compute averages for groups of consumers, which contains more variation than the aggregate consumption used in similar empirical works. Even compared to Issler et al. (2014) - our inspiration to split the variation in two kind of shocks - our estimations indicate a higher cost of business cycles and economic growth variation. It is important to notice that they permit a more flexible form for the relation between the economic shock: while they permit correlation between shocks we impose independence to use the Kalman filter.

Future work can benefit from our finds that the assumption of representative consumer is not a neutral one. There is also many of our assumption that can be relaxed in future work, for example: (a) we only use three classes of consumers, maybe with more classes there will be heterogeneity in the welfare cost of business cycles, but we believe that our general finds will keep; (b) the independence assumption can be relaxed in order to explore the correlation between cycles and economic growth.

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