Expenditure Heterogeneity, Nominal Rigidities, and Aggregate Fluctuations*

Benjamín García[†] Mario Giarda[‡] Carlos Lizama[§] Damian Romero[¶]

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Abstract

We study how income heterogeneity affects the dynamics of consumption and GDP over the business cycle through its effect on households' optimal expenditure decisions across different types of goods. Based on household-level consumption data for Chile, we show that expenditure shares systematically vary with income; i.e., preferences are non-homothetic. We build a Heterogeneous Agent New Keynesian (HANK) model with non-homothetic preferences and show how these preferences impact the transmission of monetary and fiscal shocks. We find an amplification of shocks whenever there is a positive relationship between price stickiness and income elasticities. We use Chilean data to empirically validate the model's predictions regarding the response of households' expenditure shares after an income shock.

JEL Codes: D14, D31, E21, E32, E52, E62

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[†]Central Bank of Chile. Email: bgarcia@bcentral.cl

[‡]Central Bank of Chile. Email: mgiarda@bcentral.cl

[§]Central Bank of Chile. Email: clizama@bcentral.cl

[¶]Central Bank of Chile. Email: dromeroc@bcentral.cl

1 Introduction

Since Keynes (1936), Keynesian economists have argued that wages and income play a central role in determining aggregate outcomes. However, the complete market assumption embedded in most neoclassical Real Business Cycle (RBC) models generally rules out the relevance of such a relationship. The importance of income, especially labor income, as a critical driver of consumption fluctuations when financial markets are incomplete has nevertheless been put back into the discussion by a recent strand of the literature on New Keynesian models with heterogeneity (Kaplan et al., 2018; Auclert, 2019). They emphasize the role of income fluctuations, income risk, and income distribution in shaping the business cycle.

In this paper, we analyze the role of income heterogeneity in determining consumption (both aggregate and across different goods) and its impact on the business cycle. First, we provide evidence regarding the allocation of consumption expenditures across the income distribution. We show that different goods' expenditure shares depend on the income level (Cravino and Levchenko, 2017; Cravino et al., 2020). Moreover, because expenditures across the income distribution are not the same for every good, expenditure shares depend on a good-specific income elasticity. Using data for Chile, we show that the fraction of household income spent in the lowest (highest) decile on food is 0.35 (0.13). For services, those shares are 0.46 and 0.69, respectively.[1]

The previous results provide evidence regarding a static relationship between income and expenditure shares. To complement the analysis, we rely on granular microdata on expenditures and income at the municipal level to analyze the dynamic impact of fiscal transfers on expenditure shares. We focus our exercise on fiscal transfers because it directly shocks households' disposable income. Suppose expenditure shares do not respond to income shocks. In that case, the differences in expenditure patterns are static and well represented by a fixed characteristic of households across the income distribution (Clayton et al., 2018; Cravino et al., 2020). We show that the share of services goes up by more than that of manufacturers and food. This result implies that income elasticities affect the pattern of consumption shares in the cross-section of households and generate dynamic effects on consumption through changes in expenditure shares. Therefore, it is crucial to model non-homothetic preferences as a time-varying phenomenon.

Motivated by this evidence, we build a Heterogeneous Agent New Keynesian (HANK) model

[1] Even though this evidence is specialized to Chile, the general patterns associated with differential income elasticities are a more generalized stylized fact. Chile is an appropriate laboratory for this question because it shows similar patterns as the US but delivers more pronounced relationships between consumption shares and income.

(Kaplan et al., 2018) considering non-homothetic (NH) preferences in the spirit of Comin et al. (2021) to study how income determines consumption. NH preferences are essential in determining consumption (intertemporally and intratemporally). For example, a positive income shock implies a rebalance in the composition of expenditures towards more income-elastic goods, which at the same time tend to be more expensive. Therefore, households receiving a more significant windfall tend to consume less of their preferred goods at a higher level of expenditure. However, if the shock is persistent, it is optimal to advance consumption relative to the future to minimize the impact on expenditures. This effect implies a higher level of aggregate consumption today, and we call it *the real rate channel* of NH preferences. At the same time, we also show that in a model with borrowing constraints, NH preferences differentially affect the shadow price of the borrowing constraint, amplifying or dampening the impact of precautionary motives in determining consumption. We call this effect *the financial frictions channel* of NH preferences.

We use the model to study the effect of a monetary policy and a fiscal transfer shock over sectoral and aggregate consumption and inflation. Our quantitative results show that NH preferences significantly change sectoral and aggregate responses. In our baseline calibration with heterogeneous price rigidities, we find that NH preferences amplify the response of aggregate consumption by about 25%, while the response to a fiscal transfer shock more than doubles. Moreover, in sensitivity analysis, we show that the degree of nominal price rigidities across sectors and the persistence of the shocks are crucial to determining NH preferences' amplification effect by changing the relative importance of the real rate channel and the financial friction channel. In particular, we show that in the presence of more persistent transfer shocks, the real rate channel dominates over the financial friction channel, implying more amplification.

The remainder of the paper is organized as follows. First, we present our empirical evidence on expenditure heterogeneity (across the income distribution, as well as the dynamic response of expenditure shares in the business cycle) in Section 2, which motivates the HANK model with non-homothetic preferences of Section 3. We then describe the calibration procedure in Section 4, before presenting our main quantitative results in Section 5. Section 6 concludes.

2 Empirical Evidence

In this section, we document to what extent there is expenditure heterogeneity in consumption across the income distribution. We start by summarizing the data for the analysis to present then our main empirical fact that motivates the theoretical analysis. We then present empirical evidence showing that expenditure shares respond to income shocks, which motivates constructing a model with time-varying non-homothetic preferences.

2.1 Consumption Heterogeneity Across the Income Distribution

2.1.1 Data

For the analysis of consumption expenditures at the household level, we rely on the Consumption Expenditure Survey (*Encuesta de Presupuestos Familiares* in Spanish, or EPF hereafter). It is a cross-sectional survey that provides information about expenditures and household characteristics (demographics and income). The main goal of EPF is to serve as the base for constructing the Consumer Price Index (CPI).[2]

While this is the main source of information for consumption expenditures in Chile, the use of this dataset carries two main issues. First, unlike expenditure surveys in the US, such as the Consumer Expenditure Survey (CEX), we cannot follow individuals or households over time but only construct pseudo-panels to analyze expenditure patterns. Therefore, we can not control for unobservable characteristics that might be important to understand consumption patterns. Second, the dataset is not taken either at business-cycle frequency (i.e., every quarter) or at regular intervals. In particular, the most recent waves of the survey were taken in the years 1996, 2007, 2013, and 2017. Because of the reasons above, we base our analysis on the most recent wave of the data, EPF VIII for 2017, to document the heterogeneity in consumption expenditures and provide robustness of our results in the appendix for previous waves of the data.

Income Measures. EPF VIII provides information on different sources of income, such as labor income, rents from assets and real estate, and imputed rentals for homeowners. Following the literature (Cravino et al., 2020), our baseline classification uses total disposable income per capita at the household level, which is the sum of all income sources net of transfers. We then classify each household according to its percentile in this distribution. In Figure A.1 in the appendix, we show that the general patterns presented below are similar if we use the distribution of labor income instead of total income. Also, using a more narrow classification, such as deciles, does not change the general picture presented in this section.

[2] For this analysis, we follow Romero (2022) closely.

Expenditure Categories. Expenditure in EPF VIII is structured into five different levels of aggregation. From more to less disaggregated, these groups are defined by 1,186 products, 285 subclasses, 126 classes, 59 groups, and 12 divisions. We aggregate the 12 divisions to generate three categories: food and beverages, manufactured goods, and services.[3] Table A.1 gives more details about their components and the expenditure shares across selected percentiles of the income distribution.

2.1.2 Expenditure Patterns

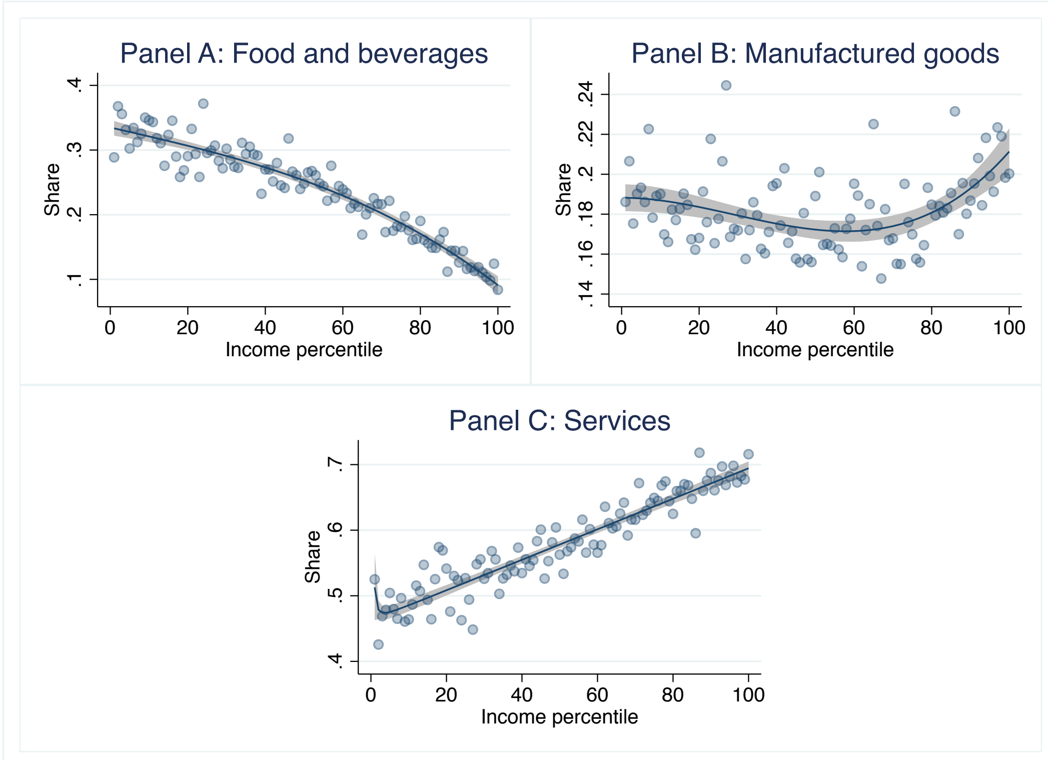
Figure 1 presents our first observation that motivates the theoretical analysis in the following section. Each panel presents the expenditure share for the three aggregate goods (food and beverages, manufactured goods and services) relative to the total expenditures of each percentile. The figure reveals clear patterns of consumption across the income distribution. First, low-income households spent relatively more (35 percent) than wealthy households (13 percent) on food and beverages. In between these two points, there is a monotone decreasing pattern. Second, even though it seems that manufactured goods have a U-shaped form, the pattern of expenditures is relatively constant across the distribution. For example, the lowest decile spent 19 percent on these goods, the same as the top decile and the median household.

Interestingly, note that the expenditure pattern on these goods is more volatile than in the case of food and services. In addition, note that the classification of these goods also considers "industry goods" such as utilities (water, electricity, gas, and other fuels), which tend to have more volatile prices, which can be behind these patterns. Finally, even though services are an essential category for all households in the distribution, there is a clear increasing pattern in expenditures. While the lowest decile spent around 46 percent on these categories, the top decile spent 69 percent. All these patterns are robust to consider a more disaggregated level of the data, as well as other points in the income distribution (see Table A.1).

As mentioned at the beginning of this section, unfortunately, we cannot follow the same household over time to verify how stable these patterns are over time or across the cycle. To partially address this concern, we compare expenditures in these three broad groups of goods for different waves of the EPF survey. We present this evidence in Figure A.2, which compares the baseline distribution of expenditures in EPF VIII with those in waves V (1996), VI (2013), and VII (2013). The figure

[3] We prefer to work with this more coarse classification rather than a granular one in order to (i) use data on prices to estimate key parameters of the model and (ii) be able to compare expenditure patterns over time. See details below.

Figure 1: Aggregate consumption patterns across income distribution



Notes: This figure presents the share in consumption expenditures for households in each percentile of the income distribution, considering three aggregate expenditure groups. On every panel, each dot corresponds to a percentile. The solid line corresponds to the local polynomial fit. The grey area denotes 95% confidence interval.

reveals that the decreasing (increasing) expenditure pattern for food (services) across the income distribution is stable over time, with a high correlation for both measures (above 80 percent). Note that the level of these expenditure shares is also quite similar. Most of the differences, however, come from the comparison between EPF V of 1996 and the baseline wave, EPF VIII of 2017, which can be due to the time difference between these two surveys and the significant changes in technological developments, as well as the changes in income over these 20 years. What is certainly different is the expenditure share in manufactured goods, which is positively but weakly correlated across surveys. This category most likely has changed its components over time, and the prices of the individual goods in each sub-category.

2.2 The Dynamic Response of Expenditure Shares

The previous section presented evidence regarding expenditure heterogeneity in the cross-section of the income distribution. Up to this point, this observation implies that there are structural differences in expenditure patterns, which are given only by income heterogeneity. This is the modeling assumption taken, among others, by Clayton et al. (2018) and Cravino et al. (2020).

In this section, we study if expenditure shares respond differently to income shocks. In that case, it is necessary to consider such dynamic responses in modeling NH preferences. With this goal in mind, we study the effects of fiscal transfers on expenditure shares in Chile during 2018-2022. We use administrative databases of credit card transactions (at the municipal and sector level), income (at an individual level), and fiscal transfers (at the individual level). We run a Local Projection-like exercise in which we study the responses of the expenditure shares at a municipal level, dividing transactions between the three groups of groups we did before.

2.3 Data

Fiscal Support in Chile. Let us first characterize the household support measures in the form of direct transfers from 2018 to 2022 in Chile. The measures considered include the policies undertaken during the COVID-19 pandemic and several other programs starting in 2018. Additionally, we study to what extent these different policies affected consumption differently depending on the level of progressivity they displayed.

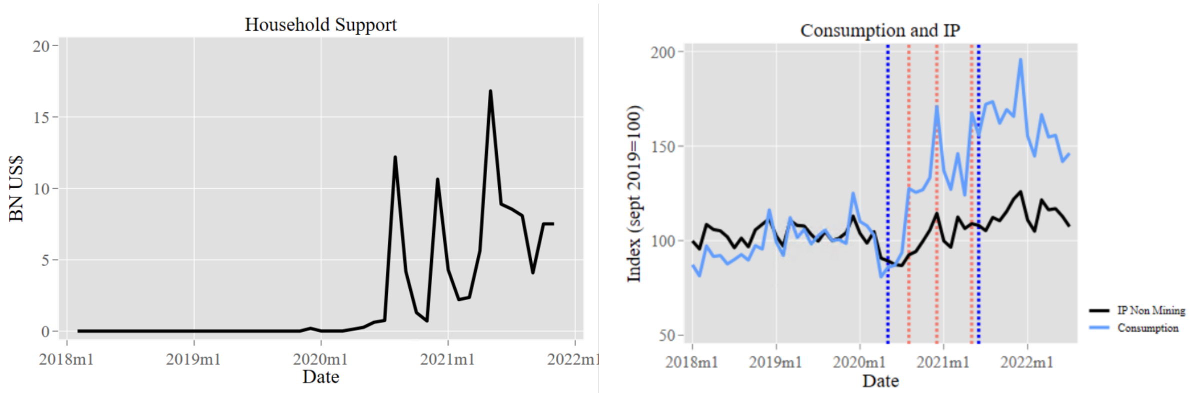
We analyze eleven programs featuring different sizes, timings, cyclicality, and progressivity.[4] The data on the different programs comes from the Ministry of Social Security and the Pensions Regulator. While this data is available at the individual level, for the empirical analysis performed in this section, we aggregate it at a municipal level as it allows us to draw a direct comparison with our measures for consumption, only available up to that level of aggregation.

We show the programs' size and relationship with economic activity in Figure 2. The left panel depicts the total amount of additional liquidity obtained by households thanks to these measures. The right panel, on the other hand, shows how the path of these policies correlated with the evolution of aggregate demand during the period. Later, we focus our analysis on the differentiated impact of fiscal transfers over expenditure shares. In particular, we study the effect of the policies *per unit* of additional liquidity provided to the households.

Expenditures and Additional Data. We use several different data sources, including data on credit and debit card transactions at the municipal level as a proxy of consumption obtained from Transbank, a private firm that processes most of the credit and debit transactions in Chile; data

[4] The twelve programs are (I) Family help check; (ii) Family base check; (iii) Christmas COVID check; (iv) School homework check; (v) Child homework check; (vi) COVID emergency check; (vii) Protection check; (viii) Emergency Income COVID; (ix) Emergency COVID 2020; (x) Guaranteed Minimum Income; and (xi) Universal COVID check.

Figure 2: Total household support and aggregate outcomes



on labor income at the municipal level as a control (to account for heterogeneous fluctuations in income) obtained from the Chilean unemployment insurance administration agency; per municipality total amounts given by the different programs, obtained from the Ministry of Social Security and the Pensions System Regulator; and finally, as some additional controls, we use data on industrial production, CPI, and exchange rates, obtained from the central bank and the national statistic institute to control for business cycle fluctuations.

Our credit and debit card transaction data is available at the municipal level and distinguish between in-person and online purchases. We use the former, as the latter is harder to associate with the buyer's residence. Using this data as a proxy for aggregate consumption has a few shortcomings. First, it only considers card transactions and hence only represents a fraction of the aggregate consumption in the economy, not including cash purchases. Second, although we have access to the firm and place the transactions were made, we do not know who the individual who made the purchase was. Due to these restrictions, we restrict ourselves to carry our analysis at the municipal level.[5]

The aggregation of the more granular fiscal support data down to the municipality level is, as mentioned above, a compromise due to the availability of consumption data. However, it is still an appropriate level of aggregation for our analysis, given the observed heterogeneity across municipalities in all dimensions we are studying: consumption, income, and fiscal support.

[5]The geographical approach is used, for instance, by Mian and Sufi (2009) and Mian et al. (2013) to study the effects of wealth on consumption. This approach is also extensively discussed by Guren et al. (2020) to disentangle general equilibrium from the partial equilibrium effects of these estimates.

2.4 Empirical Approach and Dynamic Responses

We study the differential effects of transfers on consumption shares by exploiting the mentioned heterogeneity. We follow the specification by Misra and Surico (2014), who estimate the effects of 2001 and 2008's rebates in the United States using the Consumer Expenditure Survey.[6] To be able to analyze not only the contemporaneous response of consumption to fiscal transfers shocks but also their dynamics, we estimate the following Local Projection like regression:

$$s_{jit+k} - s_{jit-1} = \alpha_{jk} + \beta_{jk} T_{it} + +\Gamma'_{jk} X_{it} + \epsilon_i + \psi_t + \varepsilon_{jikt}, \tag{1}$$

for $k = 0, \ldots, K$ and $j = \{s, m, f\}$, where s_{jit+k} is log of the consumption share in good j (services, manufactures, and food), at municipality i in time $t+k$; α_{jk} is a constant for projection jk; T_{it} denotes the total amount transfers given to a municipality i in time t; ϵ_i and ψ_t are respectively a municipality and a time fixed-effect; and X_t is a vector of macroeconomic controls that include two lags of industrial production, income growth, CPI, and T_{it}. The estimated coefficients β_{jk} denote the response of the consumption shares response up to period $t+k$ after the household support given in period t.[7]

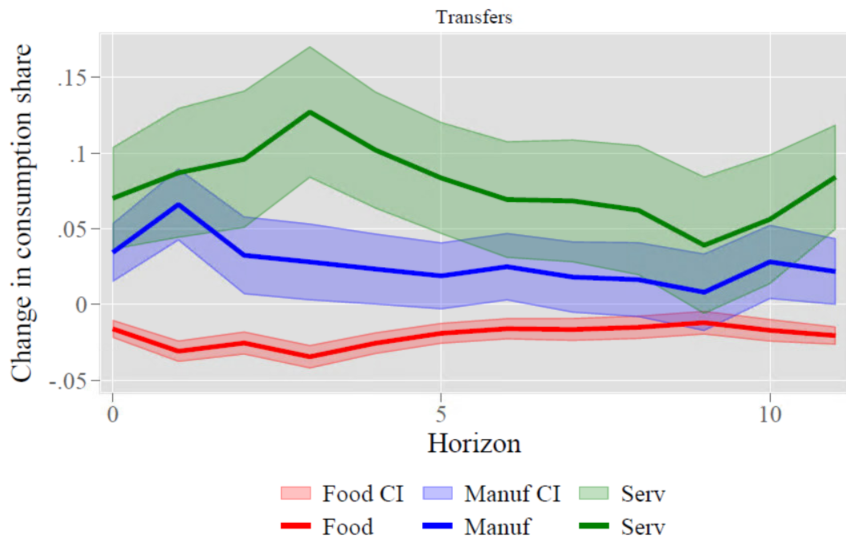
A few remarks are in order. First, these responses do not correspond to consumption responses to exogenous fiscal transfers, even after controlling for other variables, like income or employment, at the municipal level. It may be that consumption decisions anticipate the rise in transfers. Second, these responses are the total effect of fiscal stimulus and do not represent the partial equilibrium effect since we are not identifying it. However, we assume these biases are distributed homogeneously across municipalities and affect all policies equally. In that case, we can still have an unbiased estimation of the differential effect between policies.

We show in Figure 3 the results of estimating Equation (1), where we plot the effect on consumption shares after fiscal transfers. Several results are worth commenting on. Transfers have unequal effects on consumption shares. A rise in transfers at a municipal level raises consumption of services disproportionately more than manufactures and food. This effect is persistent and lasts for more than twelve periods, and the differences between food and the rest are always negative and significantly different for manufactures and services. The response of services is larger than the

[6] Misra and Surico (2014) further studies the heterogeneous effects of those rebates following Johnson et al. (2006) and Parker et al. (2013). A similar approach is also used by Fuster et al. (2020), who use surveys from experiments to study the effects on consumption of raising households' income.

[7] Robustness exercises with four and eight lags yield qualitatively similar results.

FIGURE 3: Response of Consumption to Fiscal Transfers



response of manufactures in all periods.

Our results show that the share of services goes up by more than that of manufactures and food. These results imply that income elasticities affect the pattern of consumption shares in the cross-section of households and generate dynamic effects on consumption through changing the expenditure shares of goods and hence, the bundles they consume.

3 Model

Motivated by the previous evidence, we build a Heterogeneous Agent New Keynesian (HANK) model extended to consider non-homothetic (NH) preferences. We present the main features of the model to then discuss the differences with respect to a homothetic (H) counterpart.

3.1 Households

We assume there is a measure of one of households that differ in wealth b and productivity z. The b-dimension is the endogenous state, and the z-dimension is the exogenous time-varying idiosyncratic shock. We identify the type of households with the pair of indices (b, z).

Households derive utility from consumption and disutility from labor. We assume there are a continuum of $g \in (0, 1)$ labor tasks that each household (b, z) can execute. Hence, household (b, z) maximizes its lifetime utility, time-discounted at a factor $0 < \beta < 1$, given by:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \mathcal{U}\left(c_t(b,z), \{n_t^g(b,z)\}_{g=0}^1\right). \tag{2}$$

Following Galí (2011), we assume a separable utility function of the form:

$$\mathcal{U}(c_t(b,z)\{n_t^g(b,z)\}_{j=0}^1) = \frac{(c_t(b,z)-1)^{1-\gamma}}{1-\gamma} - \chi \frac{\int_0^1 (n_t(b,z))^{1+\varphi} dg}{1+\varphi},$$

where γ is the inverse of the intertemporal elasticity of substitution, χ is the parameter of the disutility of labor, and φ is the inverse of the Frisch elasticity of the labor supply. $c_t(b,z)$ is total consumption and $n_t^g(b,z)$ is hours supplied by workers from household (b,z) to the task g. Workers do not choose their labor supply directly due to labor market frictions. The labor supply is determined by a union that represents labor supplied by households to task g, in order to maximize the average welfare of all households providing those services. We first show the individual problem and in the next subsection, the wage-setting process (the problem of the union). The implication of that assumption is that $n_t^g(b,z) = N_t \ \forall \ (b,z)$. Consequently, nominal wages are common across households and equal to W_t.

Households maximize (2) subject to the following budget constraint:

$$E_t(b,z) + b_{t+1}(b,z) = (1+i_t)b_t + W_t N_t z_t + T_t(b,z) - \tau_t(b,z) + D_t(b,z), \tag{3}$$

where $E_t(b,z) \equiv p_t(b,z)c_t(b,z)$ denotes total expenditures that are also given by

$$E_t(b,z) = \sum_{j=1}^{J} p_{jt} c_{jt}(b,z). \tag{4}$$

In our setting, households consume a bundle of J goods facing a (common) price p_{jt} and consuming a quantity $c_{jt}(b,z)$. We denote by $p_t(b,z)$ the price index at the household level, while $c_t(b,z)$ is the total consumption of household (b,z). As we explain below, our non-homothetic preferences generate household-level price indices. This means that households face individual price indices and different costs of living, despite observing the same sectoral prices.

Households save in a liquid and risk-free asset b_t that returns a nominal interest rate i_t, receive income from labor $W_t N_t z_t$, where $W_t N_t$ is a "common" labor income and z_t is an individual idiosyncratic shock which generates a non-degenerate distribution of income. Households receive a fiscal transfer given by $T_t(b,z)$ and pay lump-sum taxes $\tau_t(b,z)$. Both fiscal instruments can have a progressive or a flat profile. Finally, there are firms' dividends $D_{st}(b,z)$ that can also be distributed unevenly among the different households.

The households' optimization problem can be split into an intratemporal problem, which describes how households distribute consumption among the different goods (which in our setup are nontrivial), and the intertemporal problem, which is also affected by the allocation of resources to the different goods. We study both in turn.

Intratemporal Problem–The Role of Non-homothetic Preferences. Households derive utility from the consumption of the J different goods in the economy. For example, we can think about the consumption basket as composed of food, manufactures, and services. The consumption aggregator of every household is denoted by $c_t(b,z)$ and takes the form of an implicitly additive non-homothetic CES function. It defines total consumption in period t by:[8]

$$1 = \sum_{j=1}^{J} \left(\omega_j \left(c_t(b,z)\right)^{\epsilon_j}\right)^{\frac{1}{\sigma}} \left(c_{jt}(b,z)\right)^{\frac{\sigma-1}{\sigma}}, \tag{5}$$

where $c_{jt}(b,z)$ denotes the consumption of good j by household (b,z) in period t, ω_j is a taste parameter for good j (common across households), σ is the constant elasticity of substitution between sectoral goods, and ϵ_j is the constant elasticity of consumption of sectoral good j with respect to the consumption index $c_t(b,z)$ that allows preferences to be non-homothetic. This latter parameter is also understood as the income elasticity with respect to individual consumption goods.

These preferences were introduced by Hanoch (1975) and recently used in the macroeconomics literature by Comin et al. (2021), Cravino and Sotelo (2019), Matsuyama (2019) and Redding and Weinstein (2019), among others, mostly to analyze trade patterns and structural change. Note that we recover the standard homothetic CES specification in the particular case of $\epsilon_j = 1-\sigma$ for every j.

Given a level of total expenditures $E_t(b,z) = p_t(b,z)c_t(b,z)$, the intratemporal cost minimization optimization problem derives the following conditions:

$$c_{jt}(b,z) = \omega_j \left(\frac{p_{jt}}{p_t(b,z)}\right)^{-\sigma} \left(c_t(b,z)\right)^{\epsilon_j+\sigma} \tag{6}$$

$$s_{jt}(b,z) \equiv \frac{p_{jt}c_{jt}(b,z)}{E_t(b,z)} = \omega_j \left(\frac{p_{jt}}{p_t(b,z)}\right)^{1-\sigma} \left(c_t(b,z)\right)^{\epsilon_j-(1-\sigma)}, \tag{7}$$

[8] Comin et al. (2021) shows that with these preferences the intertemporal and intratemporal allocation problems can be separated, as in the case of standard CES utility function.

where $s_{jt}(b,z)$ is the expenditure share of household (b,z) in good j. The household-specific CPI corresponds to the price index that equalizes $p_t(b,z)c_t(b,z) = \sum_{j=1}^{J} p_{jt}c_{jt}(b,z)$ and is defined by:

$$p_t(b,z) = \left[\sum_{j=1}^{J}(\omega_j p_{jt}^{1-\sigma})^{\vartheta_j}(s_{jt}(b,z)E_t(b,z)^{1-\sigma})^{1-\vartheta_j}\right]^{\frac{1}{1-\sigma}}, \tag{8}$$

with $\vartheta_j \equiv (1-\sigma)/\epsilon_j$. From these expressions is clear that both the expenditure share and the CPI of each household (characterized by different levels of income and access to financial markets) depend on the level of consumption/expenditures in every period. Note again that in the case of homothetic preferences ($\epsilon = 1-\sigma$), the expenditure shares do not depend on the level of consumption, and the CPI is common across households because it only depends on observed prices and not on the level of consumption itself (i.e., $\vartheta_j = 1$ holds). At the same time, with non-homothetic preferences, the demand for each good nonlinearly depends on total consumption through the good-specific income elasticity, ϵ_j. For future reference, denote $\bar{\epsilon}_t(b,z) \equiv \sum_{j=1}^{J} s_{jt}(b,z)\epsilon_j$ as the average (expenditure-weighted) income elasticity. As we will see next, this object plays a crucial role in determining *intertemporal* consumption.

A visual inspection of the individual CPI, Equation (8) suggests that the CPI is an increasing function of total consumption $c_t(b,z)$. This implies that total expenditures increase non-linearly with respect to total consumption. This reflects that households switch consumption from goods with low-income elasticity to goods with high-income elasticity when they can spend one extra dollar. This is one of the crucial distinctions between a model with homothetic preferences and one with non-homothetic preferences.

Intertemporal Problem. The problem of the household can be written in the following recursive formulation, where we drop the time index and define next-period variables with a prime (e.g., x'):

$$V(b,z) = \max_{b',c} u(c(b,z)) + \beta \mathbb{E}_t V(b',z'), \tag{9}$$

subject to

$$p(b,z)c(b,z) + b'(b,z) = (1+i)b + w_s N_s z + T(b,z) - \tau(b,z) + D(b,z)$$
$$b'(b,z) \geq 0$$
$$1 = \sum_{j=1}^{J} (\omega_j (c(b,z)^{\epsilon_j})^{\frac{1}{\sigma}} c_j(b,z)^{\frac{\sigma-1}{\sigma}}.$$

The first order conditions of problem (9) are:

$$V_b(b,z) = \beta(1+r)\mathbb{E}_t V_b(b',z') + \mu(b',z') \tag{10}$$
$$u'(c(b,z)) = \beta \mathbb{E}_t V_b(b',z') \frac{p(b,z)\bar{\epsilon}(b,z)}{1-\sigma}, \tag{11}$$

where $\mu(b,z)$ is the Lagrange multiplier of the financial constraint, $b'(b,z) \geq 0$. Combining (10) and (11), we obtain the following Euler equation:

$$u'(c(b,z)) = \beta \mathbb{E}_t \left[\underbrace{\frac{1+i}{1+\pi(b',z')} \frac{\bar{\epsilon}(b,z)}{\bar{\epsilon}(b',z')}}_{\text{Effective Real Rate}} u'(c(b',z')) \right] + \beta \underbrace{\mu(b',z') \frac{p(b,z)\bar{\epsilon}(b,z)}{1-\sigma}}_{\text{Financial Frictions}}. \tag{12}$$

Equation (12) is the Euler equation of households of type (b,z) determining the consumption-savings decision. In the case of NH preferences, we observe that the *Effective Real Rate* depends on individual variables. In particular, it depends on the expected *individual* inflation and the growth of average elasticity, so the effects of inflation are now heterogeneous across the distribution of households. Since expenditure shares are time-varying, households switch their consumption between goods with different inflation rates. This implies that whenever a household moves to a bundle with higher expected inflation, current consumption rises by more (with $u'[c(b,z)] < 0$). Also, notice that consumption depends on the change in income elasticity out of the steady state. If the bundle becomes more elastic (i.e. if $\frac{\bar{\epsilon}(b,z)}{\bar{\epsilon}(b',z')} < 1$), there is an amplifying effect of shocks. This happens because households reallocate expenditures towards more income-elastic goods and are willing to consume fewer units on impact. However, what matters is the growth of the elasticity between today and tomorrow. Therefore, whenever this average elasticity is expected to grow over time, this implies stronger expenditure reallocation tomorrow than today. To smooth consumption, it is preferred to start consuming more today. Thus, non-homoteticicities contribute to consumption fluctuations through this channel.

On top of the previous channels, NH preferences affect consumption through a financial channel. For some agents, $\mu(b', z')$ is positive, inducing precautionary motives. However, the shadow price of the financial constraint now interacts with the term $p(b, z)\overline{\epsilon}(b, z)$, capturing the effective cost of living of household (b, z). Depending on the value of the latter variables, the magnitude of precautionary motives can be dampened or amplified depending on income level. That would affect the marginal propensities to consume across the income distribution. The intuition of this result is the following. Households now internalize that whenever they change the composition of their consumption bundle, they change their cost of living, $p(b, z)$. This fact also affects the cost of being close to the borrowing constraint given by $\mu(b, z)$ because reallocating to cheaper or less income-elastic bundles implies a lower need to take precautionary savings to keep utility levels high.

The latter fact directly affects the transmission of shocks in the economy: affecting precautionary motives implies distorting the curvature of consumption functions and hence affect the marginal propensities to consume of households. The final effect, though, depends on how the bundle reallocation is distributed across the population. We analyze this in the quantitative section.

Households' distribution. The above consumption-savings problem generates a distribution of households in the space $\mathcal{B} \times \mathcal{Z}$ where $\mathcal{B}$ is determined by the borrowing constraint and $\mathcal{Z}$ by the stochastic process governing z. We denote the distribution of households by $\Psi(b, z)$, which satisfies $\int\int \Psi(b, z)dbdz = 1$. Due to the recursive formulation of the problem, and given the policy functions of households, there is an operator F that maps $\Psi(b, z)$ onto $\Psi'(b, z)$:

$$\Psi'(b, z) = F\left(\Psi(b, z)\right).$$

The mapping $F(\cdot)$ is a key object of our analysis because it keeps track of the distribution of households both in the steady state and along the transition path of the economy.

3.2 Workers' Unions

We assume that for each task g, there is a union that decides wages w_t^g and the labor supplied n_t^g. In this setting, unions have market power as workers' tasks are in monopolistic competition. The union aggregates individual labor such that $n_t^g = \int\int n_t^g(b, z)dbdz$. Then, we assume there is a Dixit-Stiglitz aggregator that determines aggregate labor, given by:

$$N_t = \left(\int_0^1 \left(n_t^g\right)^{\frac{\varepsilon-1}{\varepsilon}} dg \right)^{\frac{\varepsilon}{\varepsilon-1}},$$

where ε is the elasticity of the demand for labor tasks, which is also a measure of the market power of the union. The Dixit-Stiglitz aggregator gives rise to the following demand for each task g:

$$n_t^g = \left(\frac{w_t^g}{w_t} \right)^{-\varepsilon} N_t. \tag{13}$$

We assume nominal wages are sticky and their changes are subject to the following Rotemberg adjustment costs that are measured in utility units:

$$\Gamma\left(\frac{W_t^g}{W_{t-1}^g} - 1 \right) = \frac{\theta_w}{2} \left(\frac{W_t^g}{W_{t-1}^g} - 1 \right)^2, \tag{14}$$

where θ_w is the nominal wage adjustment cost parameter. Then, the problem of the union is to choose the optimal labor, the nominal wage, and the wage inflation rate by solving:

$$\max_{n_t^g(b,z), W_t^g(b,z), \pi_{wt}^g(b,z)} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\int \int \left\{ U\left(c_t(b,z)\right) - v\left(n_t^g(b,z)\right) \right\} \Psi_t(b,z) db dz - \Gamma^s \left(\frac{W_t^g(b,z)}{W_{t-1}^g(b,z)} - 1 \right) \right], \tag{15}$$

subject to (13), and given that wage inflation is defined as $\pi_{wt}^g(b,z) = \frac{W_t^g(b,z) - W_{t-1}^g(b,z)}{W_{st-1}^g}$. After imposing symmetry, this maximization problem leads to:

$$(\pi_{wt}+1)\pi_{wt} = \frac{\varepsilon_w}{\theta_w} n_t \int \int \left\{ v'(n_t) - \frac{\varepsilon_w - 1}{\varepsilon_w} U'(c_t(b,z)) \frac{W_t}{P_{st}(b,z)} \frac{1-\sigma}{\bar{\epsilon}_t(b,z)} \right\} \Psi_t(b,z) db dz + \beta\theta_w(\pi_{wt+1}+1)\pi_{wt+1}, \tag{16}$$

which is the New Keynesian Wage Phillips Curve (NKWPC). Equation (16) relates the nominal wage inflation with hours worked and worker's preferences; it is a version of the wage Phillips curve described by Galí (2013) adapted to heterogeneity, Rotemberg adjustment costs, and non-homoteticities. Due to labor market frictions, all workers supply N_t hours at a real wage w_t. Equation (16) shows that non-homoteticities also enter the labor supply schedule through the average income elasticity of the different households $\bar{\epsilon}_t(b,z)$. This implies that not only fluctuations in total consumption affect the labor supply but the composition of expenditures represented by this elasticity. To be more clear, let us write the labor supply implied by these expressions and our assumed preferences:

$$\psi N_t^{\varphi} = \frac{1}{\mathcal{M}_{wt}} W_t \int\int \left(\frac{(1-\sigma)}{\bar{\epsilon}_t(b,z) \;\; P_t(b,z)(c_t(b,z))^{\gamma}} \right) \Psi_t(b,z) db dz. \tag{17}$$

Equation (17) is the labor schedule in this economy. It has implicit the fact that unions have market power and wages are rigid through the dependence on $\mathcal{M}_{wt}$ which is the wage markup that workers get. We can rewrite this expression by multiplying by aggregate consumption (to the power of γ) to obtain:

$$\mathcal{M}_{wt} \psi N_t^{\varphi} C_t^{\gamma} = \frac{W_t}{P_t} \int\int \left(\frac{(1-\sigma)}{\bar{\epsilon}_t(b,z)} \frac{P_t}{p_t(b,z)} \left(\frac{C_t}{c_t(b,z)} \right)^{\gamma} \right) \Psi_t(b,z) db dz. \tag{18}$$

3.3 Firms

We assume there are J sectors composed of a final good producer and intermediate producers. Final goods are a composite of a measure one of intermediates that operate in monopolistic competition. All sectors demand workers, but at a different levels. We describe the setup and optimality conditions for a given sector, denoted by j.

Final Goods Producers. In a given sector j, a competitive representative firm produces a final good by aggregating a continuum of measure one intermediate good with the following production function

$$Y_{jt} = \left(\int_0^1 {y_{jt}^m}^{\frac{\varepsilon-1}{\varepsilon}} dm \right)^{\frac{\varepsilon}{\varepsilon-1}}.$$

In this setting, the final firm decides how to allocate its demand among the different intermediate goods. After cost minimization, the demand for each intermediate good m, and the sector j price index writes:

$$y_{jt}^m = \left(\frac{p_{jt}^m}{p_{jt}} \right)^{-\epsilon} Y_{jt}, \quad \text{and} \quad p_{jt} = \left(\int_0^1 (p_{jt}^m)^{1-\varepsilon} dm \right)^{\frac{1}{1-\varepsilon}}. \tag{19}$$

Intermediate Goods Producers: Labor Demands. Each intermediate good m in sector j is produced by a monopolistically competitive producer using labor n_{jt}^m according to the production function

$$y_{jt}^m = A_{jt} n_{jt}^{1-\alpha}.$$

Each intermediate producer hires workers at a nominal wage W_t. Therefore, the demand satisfies

$$W_t = mc_{jt}(1-\alpha)N_{jt}^{-\alpha},$$

where N_{jt} is hours worked in sector j and mc_{jt} is the nominal marginal cost of sector j. Moreover, we can define the price markup of sector j as $\mathcal{M}_{jt}^{p} = \frac{p_{jt}}{mc_{jt}}$, which is different from one due to monopolistic competition and fluctuates due to price rigidities.

Intermediate Goods Producers: Price Setting. Each intermediate producer chooses its price to maximize profits subject to Rotemberg (1982) price adjustment costs. These adjustment costs are quadratic in the rate of price change $\frac{p_{jt}^m}{p_{jt-1}^m} - 1$ and are expressed as a fraction of output $p_{jt}^m y_{jt}^m$:

$$\Theta_{jt}^m = \frac{\theta_j^p}{2}\left(\frac{p_{jt}^m}{p_{jt-1}^m} - 1\right)^2 p_{jt}^m y_{jt}^m. \tag{20}$$

Therefore, each intermediate producer chooses $\{p_{ft}^m\}_{t\geq 0}$ to maximize:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \left(\frac{1}{1+r_t}\right)\left\{\Pi_t(p_{jt}^m) - \Theta_t\left(\frac{p_{jt}^m}{p_{jt-1}^m} - 1\right)\right\},$$

with

$$\Pi_{jt}^m(p_{jt}^m) = \left(\frac{p_{jt}^m}{P_{jt}} - mc_{jt}\right)\left(\frac{p_{jt}^m}{P_{jt}}\right)^{-\varepsilon} y_{jt},$$

where we assume that $\left(\frac{1}{1+r_t}\right)$ is the relevant discount factor of the firm, and mc_{jt} is the marginal cost. Given the assumptions above, the inflation rate (after the intermediate firms' optimization) is determined by the following New Keynesian Phillips curve for sector j:

$$(\pi_{jt} - \overline{\pi}_j)\pi_{jt} = \frac{\varepsilon}{\theta_j^p}\left(\frac{mc_{jt}}{p_{jt}} - \frac{\varepsilon - 1}{\varepsilon}\right) + \mathbb{E}_t\left[\left(\frac{1}{1+r_t}\right)(\pi_{jt+1} - \overline{\pi}_j)\pi_{jt+1}\frac{p_{jt+1}y_{jt+1}}{p_{jt}y_{jt}}\right], \tag{21}$$

with $\pi_{jt} = \frac{p_{jt}}{p_{jt-1}}\pi_t$. Intermediate firms generate each period an aggregate amount of profits given by

$$D_{jt} = (1 - mc_{jt})\, Y_{jt} - \frac{\theta_j}{2}\pi_{jt}^2 Y_{jt} + mc_{jt}\alpha Y_{jt}.$$

3.4 Monetary Authority

The monetary authority sets the nominal interest rate i_t according to a Taylor rule:

$$i_t = i^* + \phi_\pi(\pi_t - \overline{\pi}) + \varepsilon_t^{mp},$$

where we denote by ϕ_π the preference parameter for inflation, and ε_t^{mp} is a monetary policy shock that follows an AR(1) process given by:

$$\log(\varepsilon_t^{mp}) = \rho_{mp}\varepsilon_{t-1}^{mp} + u_t^{mp}.$$

Monetary authorities seek a nominal interest rate target in the steady state given by i^* (where $i^* = r + \overline{\pi}$). Given the inflation level and the nominal interest rate, the aggregate real rate is determined by the Fisher equation $r_t = i_t - E_t\pi_{t+1}$.[9]

3.5 Fiscal Policy

The government raises lump-sum taxes $\tau_t(b,z)$ and gives lump-sum transfers $T_t(b,z)$ to households that can be household-specific. In the baseline specification we assume $\tau_t(b,z)$ is progressive, i.e. increasing in b and z: $\frac{\partial\tau_t(b,z)}{\partial b} > 0$, $\frac{\partial\tau_t(b,z)}{\partial z} > 0$, and $T_t(b,z)$ is flat, i.e. $\frac{\partial\tau_t(b,z)}{\partial b} = \frac{\partial\tau_t(b,z)}{\partial z} = 0$. We assume the functions $\tau_t(b,z)$ and $T_t(b,z)$ satisfy $\int\int \tau_t(b,z)\Psi(b,z)dbdz = \tau_t$ and $\int\int T_t(b,z)\Psi(b,z)dbdz = T_t$, for aggregate amounts of taxes τ_t and transfers T_t.

The government also issues debt denoted by B_t^g, which is held by households and pays the real rate. The budget constraint is given by:

$$B_{t+1}^g = T_t - \tau_t + (1 + r_t)B_t^g.$$

3.6 Aggregation

Total consumption expenditures of a workers' group are given by the weighted average of their constrained and unconstrained consumers:

[9] Notice that in an NH setting the Fisher equation no longer represents the real rate relevant to all households, since due to the heterogeneity in prices and inflation rates, the real rate is individually determined. Therefore, with NH, the Fisher equation becomes individually determined: $r_t(b,z) = i_t - E_t\pi_{t+1}(b,z)$.

$$C_t = \int\int p(b,z)c(b,z)\Psi(b,z)dbdz. \tag{22}$$

We define the aggregate price index (CPI), which is the price of aggregate consumption, as $P_t = \left(\sum_j \omega_j P_{jt}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$. We use this expression to normalize prices, and the inflation process associated with this index is the one targeted by the central bank in the case it takes spending shares constant. Note also that such an index would be the one that prevails in a benchmark economy with homothetic preferences.

Then, goods market clearing implies:

$$GDP_t = \sum_{j=1}^{J} P_{jt}Y_{jt} = C_t + \sum_{f=1}^{J} \Theta_{jt},$$

and the market for bonds closes:

$$B_t^g = \int\int b\Psi(b,z)dbdz.$$

4 Calibration

4.1 Estimation of Income Elasticities

As noticed by Comin et al. (2021), the model's predictions for observable variables remain invariant to any scaling of all income elasticities and taste shifters (ϵ_j and ω_j) by a constant factor. Therefore, we can normalize all these parameters relative to a base good. Let $j = v$ denote such base good, which will be normalized to one (i.e., $\epsilon_v = \omega_v = 1$). This implies that we can write the real consumption index as $c_t(b,z) = s_{vt}(b,z)(p_t/E_t(b,z))^{\sigma-1}$. Substituting this expression back in (7) for any $j \neq v$, the expenditure share in good j relative to the base good by household (b,z) in period t can be written as:

$$\log\left(\frac{s_{jt}(b,z)}{s_{vt}(b,z)}\right) = (\epsilon_j - 1)\log(s_{vt}) + (1-\sigma)\log\left(\frac{p_{jt}}{p_{vt}}\right) + (\epsilon_j - 1)(1-\sigma)\log\left(\frac{E_t(b,z)}{p_{vt}}\right), \tag{23}$$

for any $j \neq v$, which defines a $J-1$ system of demand equations. The key element to notice from (23) is that it provides an expression for the consumption shares of all other goods in terms of observable variables. For our empirical estimation, we set manufactures as the baseline good ($v = m$)

and normalized those values to one ($\epsilon_m = \omega_m = 1$).

We estimate this empirical specification with the cross-sectional data presented in Section 2 to replicate the expenditure patterns observed across the income distribution. As Comin et al. (2021), we assign a percentile-specific price for the three goods, which imperfectly captures the fact that different households might not face the same prices. We impose that the parameters are the same across the $J-1$ equations. The estimation is carried out using Feasible Generalized Nonlinear Least Squares (FGNLS) as Herrendorf et al. (2013) and Cravino and Sotelo (2019).[10] As in Comin et al. (2021) and Cravino and Sotelo (2019), the identification assumption is that shocks to income and relative prices are not correlated to changes in demand shifters, ω_j, so preferences do not change over time, other than by the income effect.

Table 1 reports the results. The elasticity of substitution σ is significantly below one and close to zero, implying a high degree of complementarities in consumption. On the other hand, the income elasticity of food is close to zero, while the income elasticity of services is above one. These results indicate that services are more income elastic than manufactures and food.[11]

TABLE 1: Demand system estimates

	Coefficient	Std. Error
σ	0.271***	(0.023)
ϵ_f	0.000	$(\cdot)$
ϵ_s	1.113***	(0.036)
Observations	100	

NOTES: This table presents the estimates of the demand system given by equation (23). σ denotes the elasticity of substitution between goods, while ϵ_j denotes the income elasticity of good $j \in \{f, s\}$. Robust standard errors reported in parenthesis. *, ** and *** denote statistical significance at the 1, 5 and 10% levels, respectively.

4.2 Remainder of Parameters

Households. We set the elasticity of intertemporal substitution equal to one ($\gamma = 1$). We calibrate the disutility of labor to match $N = 1/3$ in steady state, and the Frisch elasticity of labor is equal to one. We calibrate the discount factor β to match an average bond holding equal to 80% of quarterly GDP at an annual interest rate at 5%.[12] This calibration in the NH leads to a share of hand-to-mouth agents, which are consumers with 5% or lower assets holdings, equal to 33%,

[10] For the estimation, we constraint the elasticities to be positive to ensure that the consumption aggregator is concave.

[11] For comparison purposes, note that Comin et al. (2021) finds $\sigma = 0.26$, $\epsilon_f = 0.2$ and $\epsilon_s = 1.65$ for the U.S., using panel data from the Consumption Expenditure Survey (CEX) for the period 1999-2010.

[12] We consider this an upper bound.

while its empirical counterpart is 36%, according to the *Encuesta Financiera de Hogares* 2017, which is the Survey of Consumer Finances for Chile. We calibrate the income risk process to match the cross-sectional variance of the first difference of log income (0.32) and the variance of the log of income (0.74) at a quarterly frequency. We discretize this process in eleven points using the Rouwenhorst method. To estimate the idiosyncratic income process, we use administrative data with information on the universe of formal workers at a quarterly frequency.[13] Finally, we assume workers' unions face an elasticity of substitution equal to $\varepsilon = 10$ and calibrate the adjustment cost to obtain a slope equal to 0.1.

Firms. For consistency with our empirical results, we assume there are three sectors: Food, Manufactures, and Services, indexed by 1, 2, and 3, respectively. For simplicity, we assume all firms face the same elasticity of demand, ε_j, equal to six. In the baseline calibration (where sectors have different price rigidities), we set the adjustment cost parameters to set the slopes of the price Phillips curves given by 0.3, 0.1, and 0.05 for goods one, two, and three, respectively. That implies that in the baseline calibration, there is a monotonic relationship between price rigidity and income elasticities. Additionally, we assume decreasing returns to scale in labor, setting $\alpha = 0.25$.

Monetary and Fiscal Policy. The Taylor rule only responds to inflation. In both the homothetic and non-homothetic cases, it targets the average inflation given by the aggregate price index. We set $\phi_\pi = 1.5$, as is common in this literature.

For fiscal policy, we assume budget balance and finance the transfer to households with progressive lump-sum transfers. This is, we assume that for a given aggregate transfer T_t, distributed evenly across households, the tax level is given by τ_t which is charged in a progressive fashion $\tau_t(b, z) = \tau_t \times f(b, z)$ with $f'(z) > 0$ and $\int f(b, z) = 1$. Budget balance implies $\tau_t = T_t + r_t B_t^g \;\; \forall t$. We consider this specification a lower bound for the effects of a government transfer. When debt-financed, transfers would have a stronger effect due to high MPCs.

Solution Method. To solve this heterogeneous-agent model with borrowing constraints, we follow Auclert et al. (2021). The steady-state equilibrium is obtained by solving the model equilibrium for two parameters and prices. To solve the value function, we use Carroll (2005) endogenous grid method, a fast and accurate algorithm to solve these kinds of problems. Finally, we use a Newton method to solve for β, φ, p_2, and p_3 that satisfy equilibrium in steady-state. To solve the model

[13] This calibration matches well the consumption profile by quintiles.

with aggregate shocks, we follow Auclert et al. (2021) as well, who propose to write the model in its Sequence-Space and linearize it around this system of equations. The method relies on the fact that any model without aggregate uncertainty can be written as a sequence of equations. This is, if we assume shocks are one-time and unexpected (MIT shocks), we can write the system as a sequence of equations in the transitional dynamics. This system of equations given by $T \times M$, with T the horizon of the transition and M the number of equations to solve, can be linearized around the steady state. This linearization leads to jacobians of all variables with respect to others, and a composition of these jacobians delivers the impulse-response functions. This method is based on the result by Boppart et al. (2018) and is fast and accurate relative to methods like Reiter (2009). We refer the reader to the paper for more details on the method.

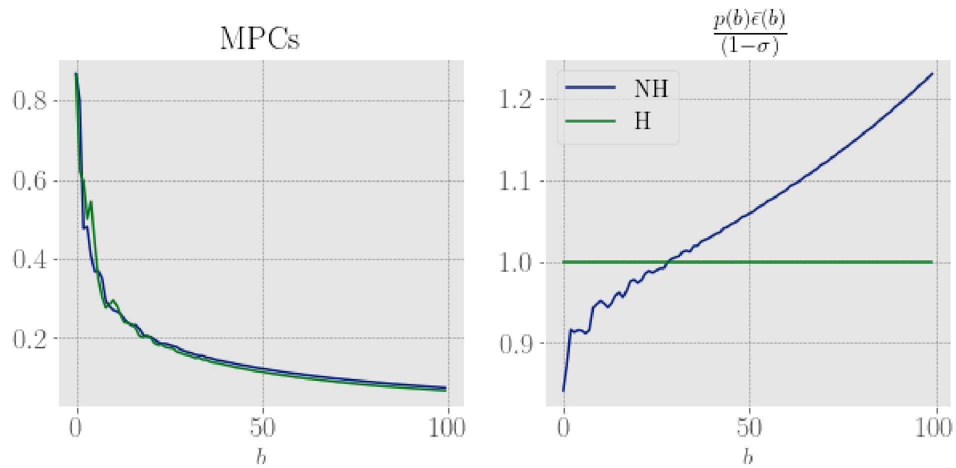
4.3 Steady State Equilibrium

Before turning to the dynamics of our model, let us analyze two important objects delivered by the model. These are the marginal propensities to consume (denoted as MPCs) and the expenditures derivative ($\frac{\partial E(b,z)}{\partial c(b,z)} = \frac{p(b,z)\bar{\epsilon}(b,z)}{(1-\sigma)}$). Figure 4 shows these two objects with respect to the b dimension. As our theory predicts, non-homothetic preferences (denoted as NH) distort the MPCs in the steady state. In fact, the average MPC is lower in NH for low wealth, while for high wealth, it is higher. The reason is the expenditure elasticities, which, as we showed before, affect the extent to which households are financially constrained today or in the future. As the right panel shows, the elasticity is increasing in wealth, meaning that the contemporaneous MPC falls for poor and increases for rich households. In our calibration, on average, these effects are low: the average MPC in the homothetic case (denoted by H) is 0.35, while in the NH case is 0.33. The final effect is ambiguous and depends on the distribution of households.

5 The Transmission of Aggregate Shocks

In this section, we study the transmission of two aggregate shocks: a monetary policy shock and a transfer shock. We study the monetary policy shock because it is pretty neutral in distributive terms in the absence of more assumptions. We analyze a government transfer shock because we would like to study a shock that directly affects the income level. For both shocks, we show two calibrations and highlight the mechanisms implied by NH. We show a case where the persistence of the shock is high, with heterogeneity in price rigidity, and a case where price rigidities are identical

FIGURE 4: MPCs and average elasticities as a function of wealth



NOTES: H and NH denote the homothetic and non-homothetic versions of the model.

across sectors.

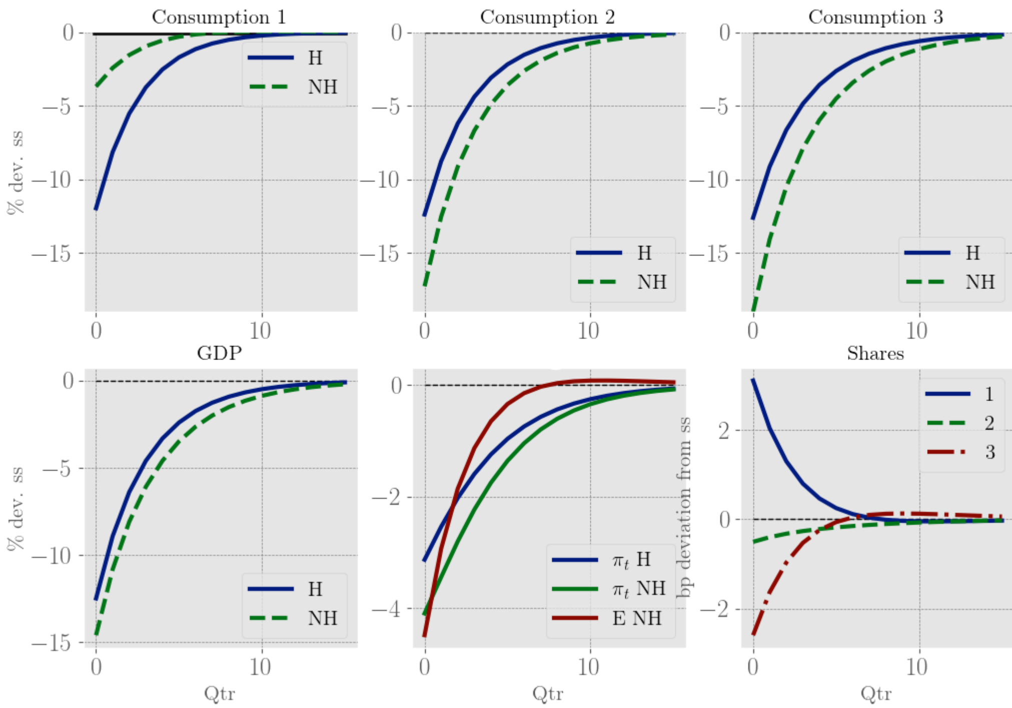
5.1 Monetary Policy Shocks

Figure 5 shows the response of sectoral and aggregate consumption to a monetary policy shock under homothetic (blue-solid lines) and non-homothetic (green-dashed lines) preferences. Our first observation is that for this "symmetric" shock (in the sense that it does not affect consumption shares directly), consumption of the different goods reacts very differently. In fact, in response to the contractionary monetary policy shock, there is a re-balancing in the consumption bundle: the consumption of all goods fall, but the magnitude of the responses follows an order. The larger fall is good with high-income elasticity and stickier prices (good three corresponding to services), and the lower fall is good with low-income elasticity (good one corresponding to food).

The bundle re-balancing can be seen in the lower-right panel, which shows the response of the average consumption shares in the model with non-homotheticities. In response to the contractionary shock, households switch to consume *relatively* more the less elastic good. All of this is not present in the homothetic model. By definition, in the homothetic model (as in a CES or Cobb-Douglas model), expenditure shares are constant since the consumption of each good is proportional to aggregate consumption. In this exercise, even though services (the third good) have more rigid prices, all responses are very similar.

These sectoral responses have aggregate effects as well. The lower-left panel in Figure 5 shows the response of total expenditures. In this case, we observe there is an amplification of the monetary

FIGURE 5: Sectoral and aggregate response of consumption to a monetary policy shock



NOTES: H and NH denotes the homothetic and non-homothetic versions of the model. Goods 1, 2, and 3 correspond to Food, Manufactures, and Services, respectively. Horizontal axes correspond to quarters.

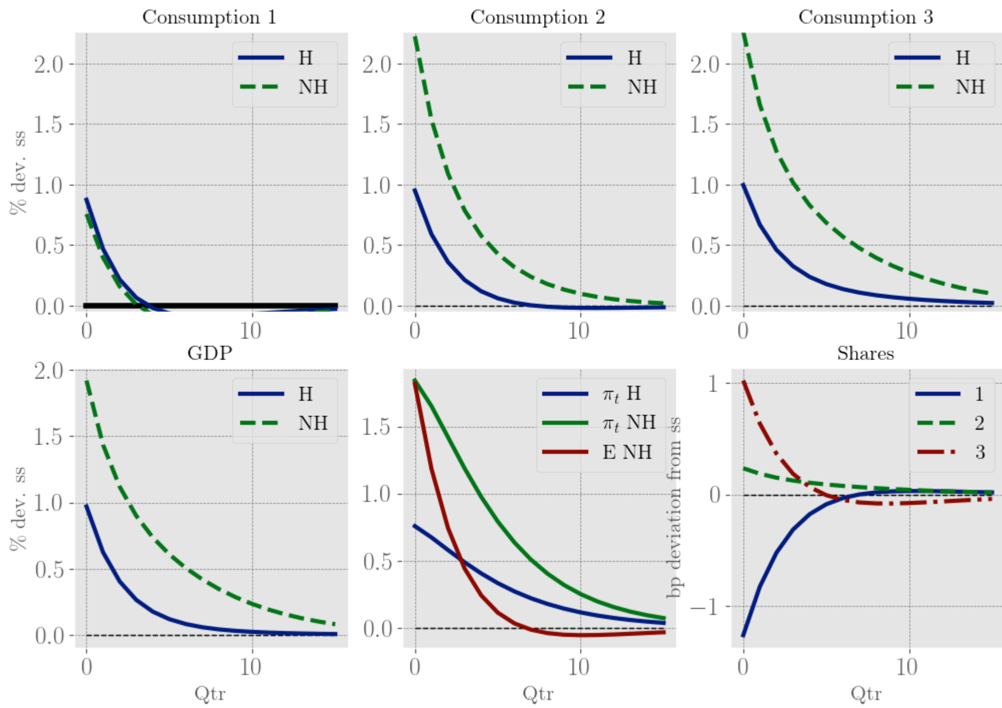
policy shock due to non-homotheticities. The reason for this is that, in this case, consumers with high MPCs are still forward-looking and expect a high average elasticity of income over time. This incentivizes them to cut consumption today by more.

5.2 Fiscal Transfer Shocks

Next, we study the effect of a lump-sum transfer on households. The experiment is as follows. We let the government increase the aggregate lump sum transfer and distribute it evenly among households (i.e., all households receive the same amount), but it is paid by raising progressive taxes (i.e., wealthier households pay a larger lump-sum tax). This gives rise to a progressive fiscal scheme. As in the previous exercise, we compare the results of our NH model with the H model.

Figure 6 shows the consumption response to this transfer shock. In this case, again, there is a different response of the three consumption goods in the NH case. For this calibration, the consumption response is monotonic in each good's income elasticity, with the least elastic responding low while the more elastic responding more strongly. Notice that by definition, in the H case, all

Figure 6: Sectoral and aggregate response of consumption to a fiscal transfer shock



Notes: H and NH denotes the homothetic and non-homothetic versions of the model. Goods 1, 2, and 3 correspond to Food, Manufactures, and Services. Horizontal axes correspond to quarters.

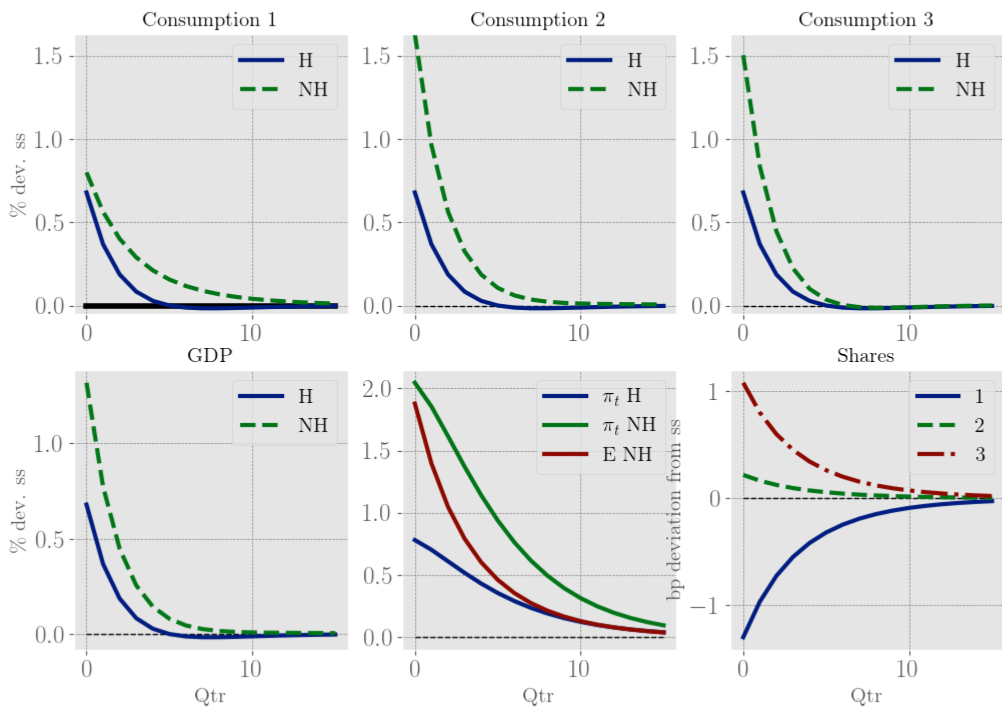
consumption goods respond to the same extent. All of this implies a rebalancing in households' consumption bundle from food (good 1) to manufactures and services (goods 2 and 3).

Like in the case of a monetary policy shock, the response of aggregate consumption in the NH is stronger relative to the H case. Even though this can be a contradictory result, as we explain below, this result is due to the persistence of the shock. In short, even though households have a lower MPC on average, since the average expenditure elasticity is increasing and expected to be high for a long period, households respond by increasing consumption today. This mechanism is also present in the response to the monetary policy shock.[14]

The reasons why there are these big amplification effects in the model with non-homothetic preferences can be studied by shutting off two of the channels through which non-homotheticities operate. Next, we show the effects when price rigidities are the same in all sectors and with a less persistent transfer.

[14] This is a property specific to HANK models with NH because in a HANK (unlike a TANK or even RANK), constrained or about to be constrained households are also forward-looking. This is, households with high MPCs also react to what happens in the future, and they have high *intertemporal* MPCs.

FIGURE 7: Sectoral and aggregate response of consumption to a fiscal transfer shock–Homogeneous price rigidities



NOTES: H and NH denotes the homothetic and non-homothetic versions of the model. Goods 1, 2, and 3 correspond to Food, Manufactures, and Services. Horizontal axes correspond to quarters.

With Homogeneous Price Rigidities. The degree of heterogeneity in price rigidities heavily interacts with NH preferences. As we showed in the calibration section, there is a relationship between income elasticities and price rigidities across sectors: more income-elastic sectors have more rigid prices. In this case, services (good 3) is the most elastic and rigid sector. That is one of the reasons for the differences between the homothetic and the non-homothetic cases. In response to a positive income shock like a fiscal transfer, demand switches between sectors, shifting towards sectors with higher price rigidities, which generate a further increase in *quantities* due to nominal rigidities. These two forces imply a powerful effect not observed in a homothetic version of the model. This is the main result of the paper.

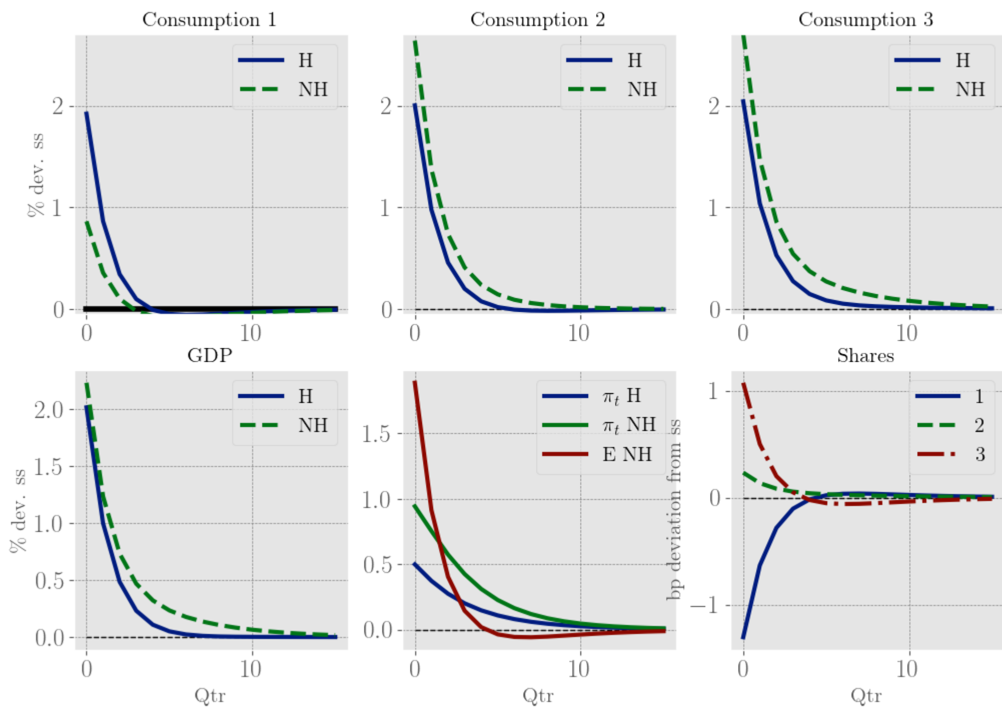
To study the role of heterogeneity in price rigidities, we recalibrate the model assuming that rigidities are homogeneous. Figure 7 shows that case. When prices are equally flexible, there is still amplification of the transfer shock in the NH case, but the amplification is lower and less persistent. This suggests an interaction between NH and nominal rigidities in the presence of high MPCs.

With Lower Persistence. Another feature we found relevant for transmitting disturbances in the NH case is the persistence of shocks. From the Euler Equation (12), we observe that not only contemporaneous expenditure elasticities matter for consumption today, but the whole path of them. This is, in the NH model, unlike the NH, if there is persistence in the response of the expenditure elasticity, we would observe changes in consumption today. This is what we observe if we run the model with a lower persistence of the shock. There is a lower amplification in the NH with respect to H, and a less persistent response of consumption. We attribute that to the anticipation that households have of future high expenditure elasticities. With a more persistent shock, households anticipate they are going to have higher income in the future, a rebalance in their expenditures towards more expensive goods and lower consumption. Therefore, they consume more today because tomorrow is more expensive to do so. They do that along the whole path. Together with the general equilibrium effects of the New Keynesian features, the final effect implies amplification. That is why we have a stronger effect in Figure 6 than in Figure 8. Moreover, if we set the persistence of the shock close to zero, we obtain the opposite effect: NH dampens the effect of the transfer shock. This is because the expenditure elasticity operates only contemporaneously, cutting the average MPCs of the economy.[15]

In summary, we find that NH has an important effect on the consumption dynamics for both a monetary and a fiscal shock. The differences are more pronounced if price stickiness is stronger for more income-elastic sectors. Also, the persistence of the shock plays a role. Due to anticipation of future increases in the cost of changing bundles, households consume more today. In general equilibrium, that generates a stronger response of consumption, implying further amplification.

[15] We also find this pattern for the monetary policy shock. Therefore, the persistence of the shock plays an important role in determining the effects of NH through movements in the expenditure elasticity.

FIGURE 8: Sectoral and aggregate response of consumption to a fiscal transfer shock–Less persistent shock



NOTES: H and NH denotes the homothetic and non-homothetic versions of the model. Goods 1, 2, and 3 correspond to Food, Manufactures, and Services. Horizontal axes correspond to quarters.

6 Conclusion

In this paper, we analyze the role of income heterogeneity in determining consumption. We provide evidence on how expenditures are distributed across the income distribution, showing that richer households spend relatively more on services and less on food and manufacturing. Moreover, we show that these expenditure shares change over the business cycle after income shocks, with stronger responses in the share of services than manufactures or food.

Motivated by this evidence, we build a Heterogeneous Agent New Keynesian model considering non-homothetic preferences (NH) to study how income determines consumption. Our key result is that NH preferences affect consumption both intratemporally (by reallocating consumption towards more income-elastic goods) and intertemporally (through a real interest rate channel and a financial frictions channel). Furthermore, our quantitative results indicate that the degree of sectoral nominal rigidities and the persistence of shocks are crucial to understanding the amplifying effects of NH preferences.

Our paper contributes to a growing literature analyzing the role of income shocks in determining business cycles and how microeconomic responses shape aggregate responses. In particular, we contribute by studying the role of income in determining expenditure shares, the reallocation of consumption baskets, and how these elements shape aggregate responses. We emphasize that pushing this research agenda will deliver important policy implications.

References

Auclert, A. (2019): "Monetary Policy and the Redistribution Channel," *American Economic Review*, 109, 2333–67.

Auclert, A., B. Bardoczy, M. Rognlie, and L. Straub (2021): "Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models," *Econometrica*, 89, 2375—-2408.

Boppart, T., P. Krusell, and K. Mitman (2018): "Exploiting MIT Shocks in Heterogeneous-Agent Economies: The Impulse Response as a Numerical Derivative," *Journal of Economic Dynamics and Control*, 89, 68–92.

Carroll, C. (2005): "The Method of Endogenous Gridpoints for Solving Dynamic Stochastic Optimization Problems," *Economic Letters*, 91, 312–320.

Clayton, C., X. Jaravel, and A. Schaab (2018): "Heterogeneous Price Rigidities and Monetary Policy," *mimeo*.

Comin, D., D. Lashkari, and M. Mestieri (2021): "Structural Change with Long-run Income and Price Effects," *Econometrica*, 89, 311–374.

Cravino, J., T. Lan, and A. Levchenko (2020): "Price Stickiness Along the Income Distribution and the Effects of Monetary Policy," *Journal of Monetary Economics*, 110, 19–32.

Cravino, J. and A. Levchenko (2017): "The Distributional Consequences of Large Devaluations," *American Economic Review*, 107, 3477—-3509.

Cravino, J. and S. Sotelo (2019): "Trade-Induced Structural Change and the Skill Premium," *American Economic Journal: Macroeconomics*, 11, 289–326.

Fuster, A., G. Kaplan, and B. Zafar (2020): "What Would You Do with $500? Spending Responses to Gains, Losses, News, and Loans," *The Review of Economic Studies*, 88, 1760–1795.

Galí, J. (2011): "The Return of the Wage Phillips Curve," *Journal of the European Economic Association*, 9, 436–461.

——— (2013): "Notes For a New Guide to Keynes (i): Wages, Aggregate Demand, and Employment," *Journal of the European Economic Association*, 11, 973–1003.

GUREN, A., A. MCKAY, E. NAKAMURA, AND J. STEINSSON (2020): "What Do We Learn from Cross-Regional Empirical Estimates in Macroeconomics?" *NBER Macro Annual*, 35.

HANOCH, G. (1975): "Production and Demand Models with Direct or Indirect Implicit Additivity," *Econometrica*, 43, 395–419.

HERRENDORF, B., R. ROGERSON, AND A. VALENTINYI (2013): "Two Perspectives on Preferences and Structural Transformation," *American Economic Review*, 103, 2752–2789.

JOHNSON, D. S., J. A. PARKER, AND N. S. SOULELES (2006): "Household Expenditure and the Income Tax Rebates of 2001," *American Economic Review*, 96, 1589–1610.

KAPLAN, G., B. MOLL, AND G. L. VIOLANTE (2018): "Monetary Policy According to HANK," *American Economic Review*, 108, 697–743.

KEYNES, J. M. (1936): *The General Theory of Employment, Interest, and Money*, MacMillan.

MATSUYAMA, K. (2019): "Engel's Law in the Global Economy: Demand-Induced Patterns of Structural Change, Innovation, and Trade," *Econometrica*, 87, 497–528.

MIAN, A., K. RAO, AND A. SUFI (2013): "Household Balance Sheets, Consumption, and the Economic Slump*," *The Quarterly Journal of Economics*, 128, 1687–1726.

MIAN, A. AND A. SUFI (2009): "The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis*," *The Quarterly Journal of Economics*, 124, 1449–1496.

MISRA, K. AND P. SURICO (2014): "Consumption, Income Changes, and Heterogeneity: Evidence from Two Fiscal Stimulus Programs," *American Economic Journal: Macroeconomics*, 6, 84–106.

PARKER, J. A., N. S. SOULELES, D. S. JOHNSON, AND R. MCCLELLAND (2013): "Consumer Spending and the Economic Stimulus Payments of 2008," *American Economic Review*, 103, 2530–53.

REDDING, S. J. AND D. E. WEINSTEIN (2019): "Measuring Aggregate Price Indices with Taste Shocks: Theory and Evidence for CES Preferences*," *The Quarterly Journal of Economics*, 135, 503–560.

REITER, M. (2009): "Solving Heterogeneous-agent Models by Projection and Perturbation," *Journal of Economic Dynamics and Control*, 33, 649–665.

Romero, D. (2022): “Market Incompleteness, Consumption Heterogeneity and Commodity Price Shocks,” *mimeo*.

Rotemberg, J. J. (1982): “Sticky Prices in the United States,” *Journal of Political Economy*, 90, 1187–1211.

A Additional Empirical Results

A.1 Consumption Patterns Across a More Disaggregated Level of Consumption

Table A.1 presents additional evidence for selected percentiles in the income distribution and a more disaggregated level of consumption categories.

TABLE A.1: Consumption expenditure of households

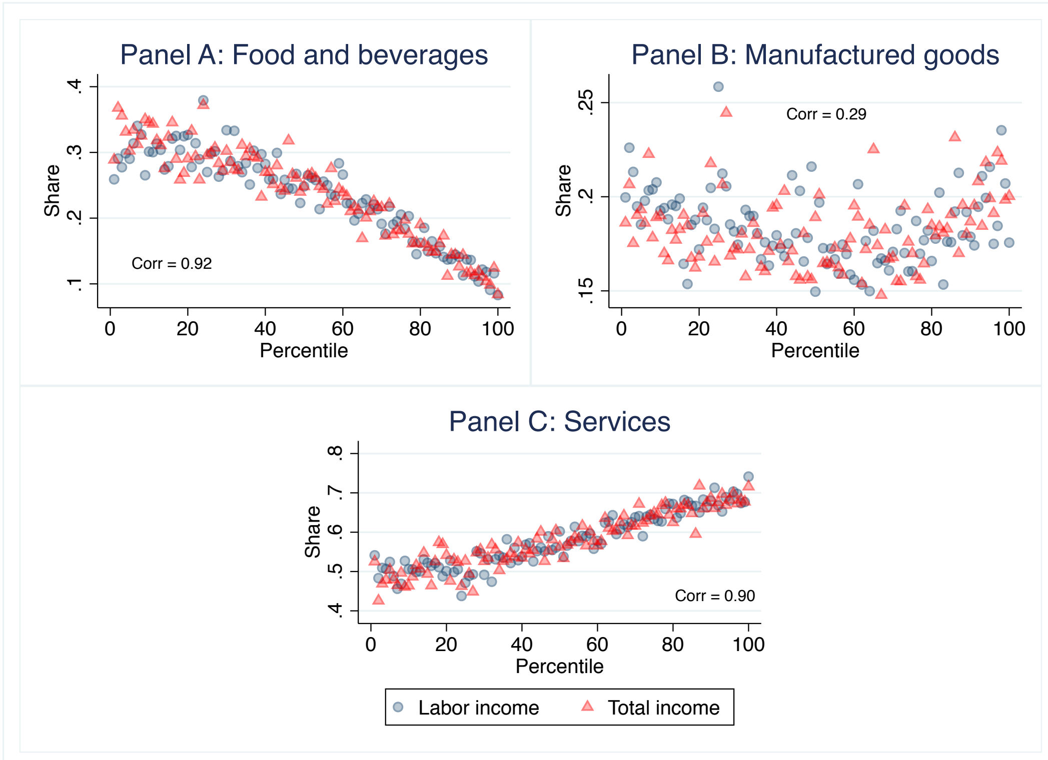
		Income percentile					
Code	Consumption division	P10	P25	P50	P75	P90	Average
Panel A: Food and beverages							
01	Food and non-alcoholic beverages	0.325	0.276	0.232	0.160	0.110	0.186
02	Alcoholic beverages, tobacco	0.021	0.020	0.016	0.021	0.016	0.018
	Total	0.346	0.295	0.248	0.181	0.126	0.204
Panel B: Manufactures							
03	Clothing and footwear	0.047	0.043	0.037	0.032	0.033	0.035
04	Housing, water, electricity, gas and other fuels	0.100	0.098	0.110	0.078	0.068	0.087
05	Furnishings, household equipment	0.043	0.037	0.042	0.060	0.086	0.062
	Total	0.190	0.178	0.189	0.170	0.187	0.185
Panel D: Services							
04.1	Rentals	0.043	0.034	0.035	0.053	0.062	0.053
06	Health	0.036	0.076	0.094	0.072	0.069	0.072
07	Transport	0.093	0.137	0.122	0.165	0.159	0.156
08	Communication	0.050	0.058	0.069	0.063	0.044	0.052
09	Recreation and culture	0.058	0.053	0.064	0.115	0.133	0.086
10	Education	0.088	0.053	0.063	0.032	0.051	0.046
11	Restaurants and hotels	0.045	0.046	0.043	0.069	0.078	0.067
12	Miscellaneous goods and services	0.052	0.070	0.073	0.080	0.090	0.078
	Total	0.464	0.527	0.563	0.649	0.687	0.611

NOTES: This table presents the share in consumption expenditures for households in selected percentiles of the income distribution, considering the 12 division of expenditure groups. Codes corresponds to the 12 divisions in the Classification of Individual Consumption by Purpose (COICOP). Panel A presents the decomposition for Food and Beverages categories. Panel B presents the decomposition for Manufactures, housing and utilities. Panel C presents the decomposition for Services. Each column denotes percentiles 10, 25, 50, 75 and 90, and average consumption, respectively.

A.2 Consumption Patterns Across Labor Income Distribution

Figure A.1 compares consumption expenditures between labor income and total income distributions. As can be seen, both present a similar picture, in which low-income households (measured either by labor income or total income) spent a larger fraction of their income in food and beverages, while richer households spent more on services. While both distributions are closely correlated for those goods (above 90 percent), larger differences are presented for manufactured goods, in which the correlation is just 23 percent.

Figure A.1: Consumption patterns across: aggregate vs labor income distribution



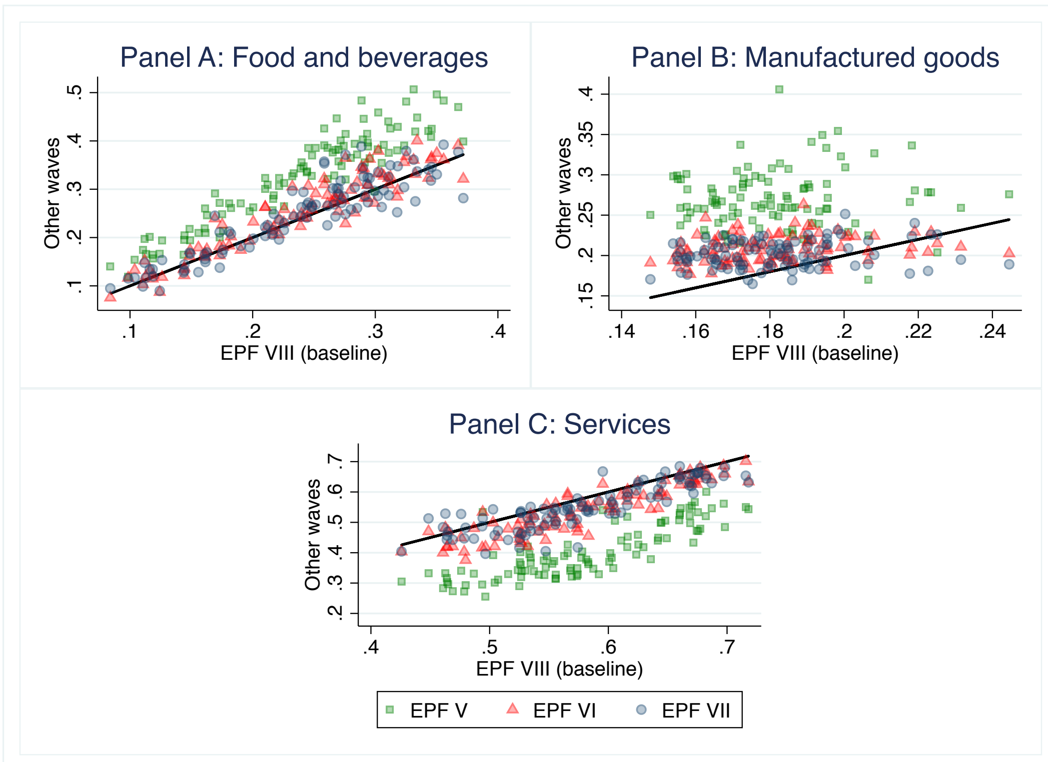
Notes: This figure compares the share in consumption expenditures for households in each percentile of the income distribution vs percentiles in labor income distribution, considering three aggregate expenditure groups. On every panel, each dot/triangle corresponds to a percentile.

A.3 Consumption Patterns Across Different Waves of the Consumption Expenditure Survey

Figure A.2 compares the distribution of consumption expenditures across different waves of the Consumption Expenditure Survey, EPF. The baseline sample corresponds to EPF VIII of the year 2017 (x-axis on each panel), while the alternative samples corresponds to EPF V of 1996 (green squares on each panel), EPF VI of 2006 (red triangles on each panel), and EPF VII of 2014 (blue dots on each panel). On each panel, every point shows the expenditure share in the respective kind of good in EPF VIII against other waves of the survey. As can be seen, with the exception of manufactured goods, the expenditure patterns documented in the main text are relatively stable over time. In the case of food and beverages, correlations with respect to the baseline year are above

0.9, while for services they are above 0.8.[16] Note that the largest differences in levels are observed with respect to EPF V, because of the distance in time with EPF VIII (20 years). In particular, food and beverages account for a greater fraction of expenditures in EPF V, while the opposite happens in services.

FIGURE A.2: Consumption patterns across different waves of the Consumption Expenditure Survey



NOTES: This figure compares the share in consumption expenditures for households in each percentile of the income distribution between different waves of the Consumption Expenditure Survey (EPF). On every panel, each point corresponds to a percentile. Black solid line denotes 90 degree line.

A.4 Consumption Patterns in Other Countries

In this section we present additional empirical evidence regarding consumption expenditures across the income distribution. In particular, we extend our results for Chile to analyze if those patterns are also observed in other countries.

For this, we rely on data from the OECD about distributional consumption expenditures.[17] This data is an unbalanced panel for 13 countries in the period 1999-2019.[18] Different to the Chilean data,

[16]More precisely, the correlation of food are 0.93, 0.94 and 0.91 for EPF V, EPF VI, and EPF VII, respectively. For services, those correlations are 0.83, 0.91 and 0.86.

[17]See the section of Annual National Accounts at https://stats.oecd.org.

[18]The list of countries is: Australia, Canada, Czech Republic, France, Ireland, Israel, Mexico, the Netherlands, New Zealand, Slovenia, Sweden, United Kingdom, and the United States.

we only observe expenditures (in domestic currency) for the (equivalized) disposable income quintiles and not at the household level. To make progress, we define a dummy variable Q_k taking value equal to one for observations corresponding to quintil $k = 1, \ldots, 5$, and zero otherwise. As in the Chilean data, we observe expenditures for the 12 divisions in the Classification of Individual Consumption by Purpose (COICOP) (see Table A.1 for details) and we aggregate into our three-goods classification to have the expenditure share in food, manufactures and services. Those goods are indexed by j.

To study the expenditure patterns across the income distribution for different countries and periods, we run the following regression:

$$s_{jkit} = \alpha + \sum_{k=2}^{5} \beta_k Q_k + \delta X_{it} + \varepsilon_{jit},$$

for every $j = 1, \ldots, 3$. In the previous specification, the dependent variable s_{jkit} denotes the expenditure share of quintile k group of country i-period t in good j, and X_{it} denote controls that vary acorss country and time. Because the previous specification excludes the effect of the first quintile, the coefficients of interest, β_k denote expenditure shares in goods j relative to the lowest share of the population.

Table A.2 presents the results, where we control for GDP per capita as well as country and year fixed effects. Column (1) presents the results for expenditures on food. Similar to the Chilean case, our results show a decreasing pattern across the income distribution. For example, households in the second quintile spend 1.3% less than the first quintile, while the highest quintile spends 7.9% less. We observe a similar pattern (and magnitudes) in column (2) for the case of manufactures. Finally, column (3) shows the results for services. As in the case of Chile, expenditures in services are increasing in income. The second quintile spends 2.8% more than the first quintile. For the highest quintile this figure is five times larger, with an expenditure share 13.4% higher.

Table A.2: Consumption expenditures in OECD countries

	Food (1)	Manufactures (2)	Services (3)
Quintile 2	-0.013***	-0.015**	0.028***
	(0.004)	(0.005)	(0.003)
Quintile 3	-0.028***	-0.031***	0.060***
	(0.007)	(0.009)	(0.006)
Quintile 4	-0.047***	-0.045***	0.092***
	(0.010)	(0.013)	(0.011)
Quintile 5	-0.079***	-0.055**	0.134***
	(0.017)	(0.019)	(0.019)
Log (GDP pc)	-0.108***	-0.075	0.183***
	(0.007)	(0.055)	(0.058)
Observations	370	370	370
Adj R2-within	0.649	0.471	0.824

Notes: This table presents estimates of the relationship between consumption expenditures and quintiles of the income distribution. All regressions incluede country and year fixed effects. Standard errors clustered at the country and year level. ***, ** and * denote statistical significance at the 1, 5 and 10% levels, respectively.