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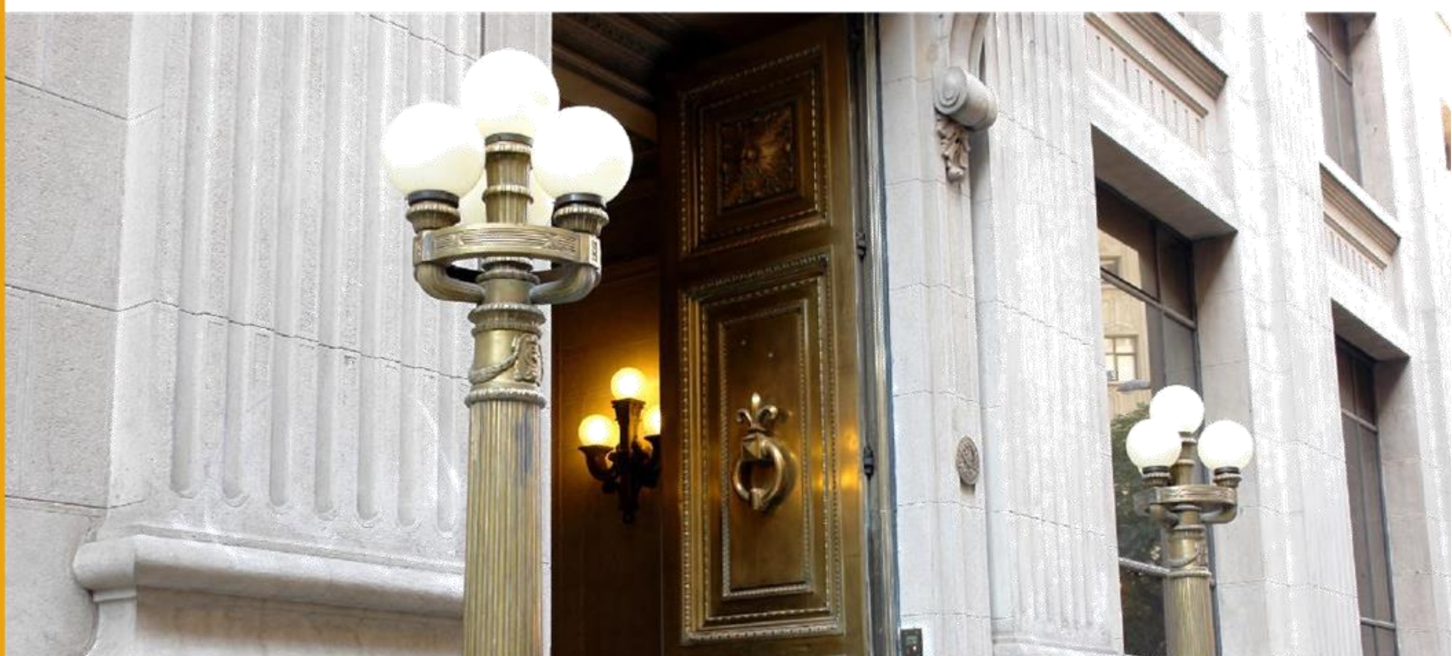

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Market Incompleteness, Consumption Heterogeneity and Commodity Price Shocks*

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Abstract

This paper studies how household heterogeneity shapes the response to commodity price shocks. Using data from Chile and other emerging economies, we document that (i) low/high-income households spend relatively more on food/services, and (ii) more than 40 percent of the population is financially constrained. We build a multi-sector New Keynesian model for a small open economy with household heterogeneity and non-homothetic preferences. Non-homothetic preferences dampen the effect of a commodity price shock by inducing a reallocation in the consumption basket towards more income-elastic goods: an economy with non-homothetic preferences generates aggregate responses 29 percent lower.

Resumen

Este artículo estudia cómo la heterogeneidad de los hogares afecta la respuesta de la economía ante shocks de precios de materias primas (commodities). Usando datos para Chile y otras economías emergentes, mostramos que (i) hogares de bajo/alto ingreso gastan relativamente más en alimentos/servicios y (ii) más del 40% de la población se encuentra restringido financieramente. Construimos un modelo Neo Keynesiano con múltiples sectores para una economía pequeña y abierta, con heterogeneidad en hogares y preferencias no-homotéticas. Estas preferencias amortiguan el efecto de un shock en el precio de commodities al re-balancear la canasta de consumo hacia bienes con una mayor elasticidad-ingreso. En términos agregados, el modelo con preferencias no-homotéticas genera respuestas 29% menores.

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1 Introduction

Commodity prices are a windfall for emerging economies, translating into higher income and consumption. The literature has focused on the aggregate effects of those shocks, either empirically or by studying representative household models. However, we know little about the microeconomic impact of those fluctuations and how they shape aggregate responses. Are the gains induced by increases in commodity prices equally distributed across the population? Can these shocks generate differences in consumption across the income distribution? Are the differences induced by household heterogeneity relevant to understanding aggregate fluctuations?

This paper contributes to the literature by analyzing the role of household heterogeneity in the transmission of commodity price shocks. We analyze household heterogeneity through differential (i) access to financial markets and (ii) consumption expenditures across the income distribution. We use Chilean microeconomic data to document the following fact. While the share of expenditures in manufactured goods is flat across the income distribution, low-income households spent proportionally more of their income on food than high-income households and less on services. This behavior is monotone: there is a decreasing (increasing) pattern of consumption in food (services) across the income distribution. We also document that those patterns are stable over time and the definition of income, and they hold for other emerging economies as well.[1]

Motivated by these observations, we build a model for a commodity-exporting small open economy with household heterogeneity. For tractability, we consider a model with two households that differ in their access to financial markets and ownerships of firms, being these the only sources of income heterogeneity. The first kind of household neither has access to financial markets nor owns firms in the economy. This "hand-to-mouth" household only consumes its labor income every period, and is also denoted as *restricted* or *constrained*. The remaining fraction of the population (the *unconstrained* households) receives profits from firms in the economy and has access to domestic and foreign financial markets.

To model consumption heterogeneity, we follow Comin et al. (2021) and assume that households have non-homothetic (NH) preferences given by an implicitly additive non-homothetic CES func-

[1] Other papers documenting heterogeneity in consumption expenditures across the income distribution, especially in the U.S., are Costa (2001), Hamilton (2001), Almas (2012), Almas and Kjelsrud (2017), Kaplan and Schulhofer-Wohl (2017), Clayton et al. (2018), Dobrew (2018), Cravino and Levchenko (2017) and Cravino and Sotelo (2019), among others. For a recent summary specialized in the consequences for inflation heterogeneity, see Jaravel (2021).

tion.[2] All households have the same preferences over domestic goods, but their expenditure shares are explicitly dependent on their level of income. Consistent with the empirical observations, we estimate that food is less income elastic than manufactures, which at the same time are less elastic than services. Therefore, high-income households spend a relatively larger fraction of their total consumption on services, while low-income households spend a larger fraction on food.

The rest of the model is an extension of the New Keynesian (NK) framework for a multi-sector small open economy with non-homothetic preferences and builds on Romero (2022b). The domestic production side (given by food, manufactures, and services) corresponds to a continuum of monopolistically competitive firms who are subject to heterogeneous price rigidities as in Calvo (1983). Competitive sectoral aggregators combine their output and sell domestically and abroad. There is also a competitive firm producing the commodity goods, taking the international commodity price as given, fully exporting its output. Variations in the international price of the commodity good are the only source of fluctuations in the economy. Finally, the central bank sets the domestic nominal interest rate following a Taylor rule by responding to inflation and output.

We focus on the role of NH preferences and income heterogeneity in aggregate consumption response to the commodity price shock. A positive commodity price shock increases income in the economy. On the theoretical side, NH preferences and market incompleteness (i.e., the fraction of constrained agents) operate differently. With NH preferences, the marginal cost of an additional unit of consumption is given not only by the price of the consumption basket but also by how this extra unit changes its composition. With more income, households shift consumption towards services, which are more income-elastic but also more expensive. This mechanism induces a change in the average income elasticity of households and is not present in a standard model with homothetic (H) preferences. This reaction dampens the consumption response at household and aggregate levels relative to a model with constant income elasticity. On the other hand, market incompleteness implies that a fraction of agents has a higher marginal propensity to consume, so this mechanism amplifies the response of aggregate consumption to the shock.

In line with the theoretical analysis, the model considering household heterogeneity and NH preferences generates an impact-response of aggregate consumption of 0.36 percentage points. In a homothetic counterpart, such response is 0.52. The response under NH (H) preferences in the rep-

[2]Those preferences have been introduced by Hanoch (1975) and used recently in the context of structural transformation and trade (see, for example, Cravino and Sotelo, 2019; Matsuyama, 2019; Redding and Weinstein, 2020; Comin et al., 2021).

resentative agent framework is 0.24 (0.35) percentage points. The minor quantitative role of market incompleteness is due to the assumption of similar labor supplies across households, dampening the response of this transmission channel. Our sensitivity analysis shows that parameters such as the labor supply elasticity and the elasticity of substitution in consumption play a crucial role in the response of the economy, generating responses 27 to 48% larger than our baseline economy.

Related Literature. First, this paper is related to the literature studying the effects of terms of trade shocks in emerging economies. Since the seminal contributions of Mendoza (1995) and Kose (2002), a recent wave of papers analyzes the particular role of commodity prices on aggregate fluctuations (Fernandez et al., 2017) and potential transmission mechanisms for the shock. The literature has studied the interaction between commodity prices and financial frictions (Shousha, 2016), changes in aggregate productivity (Kohn et al., 2020), the role of production networks (Romero, 2022a), the role of monetary policy Catão and Chang (2015); Drechsel et al. (2019) and the role of fiscal policy (Pieschacon, 2012; Caputo and Irarrazaval, 2017). This paper contributes to the literature by analyzing how household heterogeneity and NH preferences affect the transmission of the shock, shaping its aggregate consequences.

This paper is also related to the literature analyzing multi-sector models in the NK framework. Some questions in this literature are related to the network origin of aggregate fluctuations (Pasten et al., 2020), the microeconomic behavior of prices (Carvalho et al., 2020), the flattening of the Phillips curve over time (Höynck, 2020) or the optimal monetary policy design (Castro, 2019; Rubbo, 2020; La'O and Tahbaz-Salehi, 2020).[3] Different from these papers, which model a closed economy, we analyze a multi-sector NK model for a small open economy, in which the driver is the price of commodity goods exported by the country. Also, these papers study models with a representative household and focus on the production side of the economy and its interaction with monetary policy. Our paper analyzes an environment with heterogeneous agents and NH preferences.[4]

Finally, this paper contributes to the literature that analyzes the role of household heterogeneity and the transmission of shocks. Clayton et al. (2018) and Cravino et al. (2020) study the effect of monetary policy shocks across the income distribution, taking into account consumption hetero-

[3]See the seminal contribution of Gali and Monacelli (2005) that studies optimal monetary policy in a NK model for a small open economy. More recently, Wei and Xie (2020) studies optimal monetary policy in an NK model for a small open economy with global value chains.

[4]We also consider input-output linkages and heterogeneous price rigidities. These assumptions are not crucial for the qualitative responses of the economy but improve the comparison with our empirical analysis.

geneity. However, these papers analyze closed economies with consumption heterogeneity given by exogenously different consumption baskets. Instead, our paper studies the consequences of a foreign shock and endogenizes consumption heterogeneity by modeling NH preferences shared across households. Cravino and Levchenko (2017) studies the impact of the Tequila crisis and the devaluation of the Mexican peso in 1994. The authors analyze the distributional consequences of the devaluation by showing that the cost of living of households at the bottom decile of the distribution increased more than for the top decile. Our paper does not focus on a specific event but the systematic consequences of foreign (commodity price) shocks and their distributional consequences measured as relative consumption responses across the income distribution. Cugat (2019) also studies the consequences of the sudden-top associated with the Tequila crisis, considering household heterogeneity through limited asset market participation. We also consider this mechanism but focus on the role of consumption heterogeneity to understand the aggregate and microeconomic consequences of a shock.

Section 2 describes the heterogeneous consumption patterns of Chilean households that motivate the study of this dimension for the transmission of commodity price shocks. Section 3 presents the model. Section 4 analyzes the theoretical properties behind NH preferences and market incompleteness, while Section 5 focuses on the quantitative properties as well as sensitivity analysis. Section 6 concludes.

2 Empirical Motivation

This section presents the main empirical observation that motivates the theoretical analysis about the heterogeneous expenditure patterns across the income distribution of households. We first describe the data and selection criteria to analyze the evidence then.

2.1 Data: Consumption Expenditure Survey

The Consumption Expenditure Survey (*Encuesta de Presupuestos Familiares* in Spanish, or EPF) is a cross-sectional survey that measures consumption patterns across households in the Chilean economy together with households' characteristics (demographics and income). Its most recent version is EPF VIII for 2017, which we use as the baseline for this paper. Previous versions of the survey are from 1996, 2007, and 2013. The main goal of EPF is to serve as the base for constructing the Consumer Price Index (CPI).

To the extent that different households have heterogeneous consumption expenditures, this might affect the microeconomic and aggregate responses to a shock.[5] We use EPF data to characterize consumption expenditure patterns across the income distribution. We start by defining the measure of income, the household classification, and the goods considered in the analysis.

Income Measure. EPF provides information on different sources of income, such as labor income, rents from assets and real estate, and imputed rentals for homeowners. We use the total disposable income per capita of each household and classify each household according to its percentile in this distribution.[6] Appendix A.2 shows that the general patterns presented below are similar by using the distribution of labor income instead. Also, using a more narrow classification, such as deciles, does not change the general picture presented in this section.

Consumption Categories. The consumption structure in EPF considers five levels of aggregation. These groups correspond to 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. Table A.1 gives more details about their components.

2.2 Expenditure Patterns

Main Results. Figure 1 presents the main empirical observation that motivates the analysis of consumption heterogeneity. Each panel shows the expenditure share for the three aggregate goods (food and beverages, manufactured goods, and services) across the income distribution. The figure reveals clear patterns of expenditures across the income distribution. First, low-income households spent relatively more than rich households on food and beverages. While a household in the bottom decile spent 35 percent of their income on food, a household in the top decile spent only 13 percent. In between these two points, there is a monotone decreasing pattern. Second, even though manufactured goods seem to 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

[5] In particular, the interest in this paper is a commodity price shock, which directly represents an increase in income for the overall economy.

[6] Considering imputed rentals of homeowners in the income classification is a standard practice in the literature (Cravino et al., 2020). All results are robust to exclude imputed rentals.

on these goods is more volatile than in the case of food and services.[7] Finally, even though services are an important 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.[8]

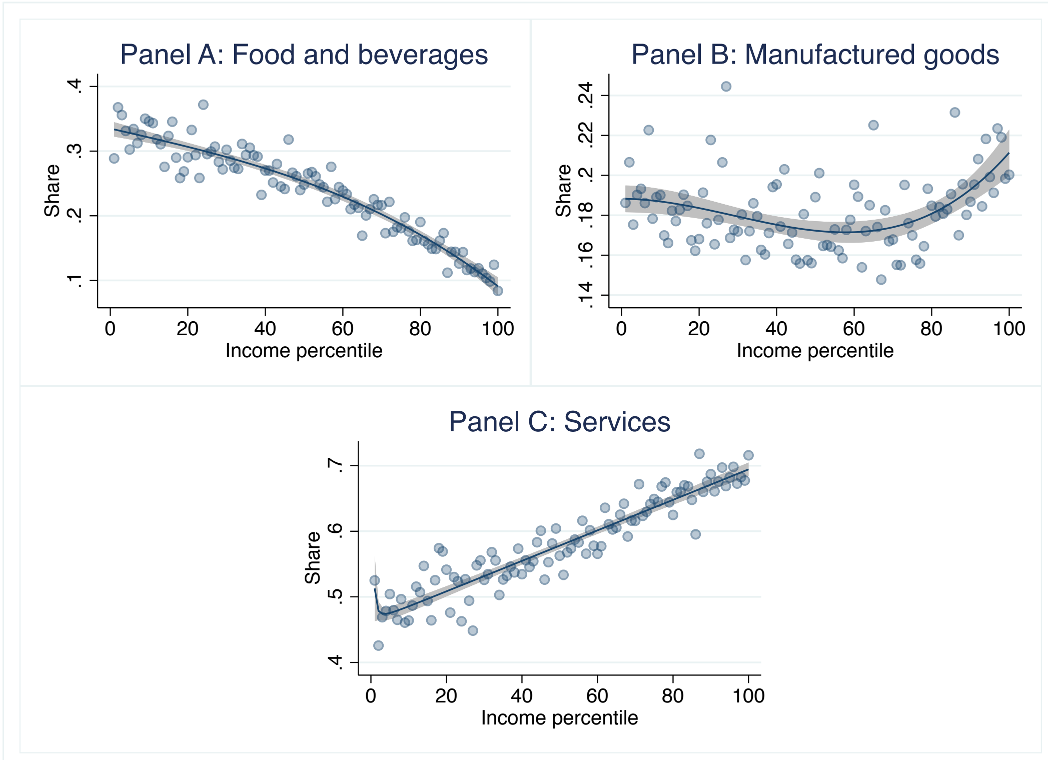
While our evidence uses cross-sectional microeconomic data, it is consistent with aggregate patterns documented in the literature of structural transformation (see, for example, Garcia-Santana et al., 2021). In general, this literature has found (i) decreasing expenditures in agricultural goods, which are proxied by food and beverages in our approach, and (ii) increasing expenditures in services across the level of development (which in our case corresponds to the income percentile). The main difference comes with manufactured goods. While aggregate evidence shows a hump-shaped pattern of expenditures, in our case, the distribution is mainly flat across income.

Evidence over Time. How stable are these patterns across time? Ideally, we would like to observe a panel of households over time to study their consumption expenditure patterns over the cycle in more depth. However, the Chilean data only provides cross-sectional evidence at different points in time. Fortunately, the data allows comparing the aggregate three goods classification used in the baseline analysis, even though the components of each kind of aggregate goods are different primarily due to changes in technological progress that make some goods and services obsolete over time. Figure A.2 compares the distribution of expenditures across different waves of EPF survey. We consider versions V (from 1996) to VII (from 2013). The figure reveals that expenditure patterns across the income distribution are pretty stable over time: the correlation between surveys is above 80 percent, and expenditure shares are also quite similar. However, most of the differences come from the comparison between EPF V of 1996 and the baseline wave, EPF VIII of 2017. An obvious explanation is the time difference between these two surveys and the technological developments and income changes over these 20 years. What is certainly different is the expenditure share in manufactured goods, which correlates positively but weakly across surveys. This category most likely has changed its components and prices of individual goods over time.

[7]Manufactured goods also include expenditures in utilities (water, electricity, gas, and other fuels). Therefore, they correspond to industrial goods.

[8]Table A.1 provides additional details of consumption expenditures across these aggregate categories for selected percentiles. The decreasing (increasing) pattern for food and beverages (services) remains more disaggregated. Therefore, our three main categories capture the behavior of the more microeconomic expenditures categories.

Figure 1. Consumption Expenditures across the Income Distribution



Notes: This figure presents expenditures shares for households in each percentile of the income distribution. Dots correspond to a percentile. Solid line denotes a local polynomial fit. Grey area denotes 95% confidence interval.

2.3 Cross-Country Evidence

How representative are the consumption expenditure patterns of the Chilean economy? In principle, we may be concerned about the possibility that the Chilean economy is special regarding the decreasing (increasing) pattern of consumption in food (services), so the theoretical analysis would be only locally valid. To alleviate this concern, we also study expenditure patterns across the income distribution in other emerging economies, using the World Bank's Global Consumption Database. This dataset combines microeconomic data from different consumption surveys across 90 emerging economies for 2010, containing information about 107 products/services.[9,10] Unfortunately, the data is grouped into four categories of income per capita and not at a more disaggregated level. The lowest income group corresponds to the bottom half of the distribution (50th percentile and below);

[9] All the data is standardized across commodity classifications and compared in PPP terms. Even though there still could be differences in the level of consumption given by income and differences in goods/services available in different countries, this is less of a concern in our context because we are comparing expenditure shares and not levels.

[10] For details of the data see http://datatopics.worldbank.org/consumption/.

the low group to the 51th-75th percentiles; the middle group to the 76th-90th percentiles; and the high group to the 91th percentile and above. We aggregate expenditure shares in a classification consistent with the three goods used for Chile (food, manufactures, and services).

Figure A.3 presents consumption patterns across the income distribution in the pooled data. As we can see, the same patterns presented for Chile in Figure 1 emerge in the group of emerging economies: decreasing (increasing) expenditures in food (services) across the income distribution and flat expenditures in manufactured goods. The main difference with the Chilean case corresponds to the level of these expenditure shares. As Figure A.3 shows, while in Chile the bottom half of the population spends less than 30 percent of their income on food, in other emerging economies this share is close to 60 percent (the opposite for services). The reason is that the data contains information about developing countries in which food expenditures correspond to most of the total expenditures.[11] We can conclude that the heterogeneous consumption expenditure patterns presented for Chile are also a common feature for other economies.

3 Model

This section presents a model for a small open economy that produces commodity goods, building on Romero (2022b). It has three distinctive elements. First, and most important, it considers non-homothetic (NH) preferences to capture the heterogeneity in consumption patterns across different households. Second, to generate income heterogeneity, we assume that the population is composed of two kinds of households who differ in their access to financial markets and ownership of firms. Finally, there are N domestic sectors indexed by j (the commodity sector is indexed by $j = c$) subject to nominal rigidities in setting their prices, giving a more relevant role to demand forces. For future reference, under-scripts denote sectors in the economy, while upper-scripts denote a type of household.

3.1 Households

There are two households in the economy indexed by h. The first household ($h = r$) is financially constrained. It only has access to its labor income; it does not receive profits from firms in the economy and can not borrow/lend in financial markets. Therefore, this household behaves in a

[11] Table A.2 presents descriptive statistics separating between groups of countries (dependent and non-dependent on commodity exports as defined by UNCTAD (2019)). All the qualitative results remain on each subsample.

hand-to-mouth fashion and is denoted as the *restricted* or *constrained.* This household represents a fixed fraction λ of the population. The remaining fraction $1 - \lambda$ corresponds to the *unconstrained* household ($h = u$). In addition to its labor income, this household owns the profits from domestic firms. Also, it can take both domestic and foreign debt, which allows them to smooth consumption over time.

We start by describing the intratemporal problem of a generic household, which decides their consumption and labor supply allocations. Then, we describe the intertemporal problem, which is household-specific. Detailed derivations are presented in Appendix B.1.

3.1.1 Intratemporal Problems

Consumption Allocation. Households derive utility from consumption of the N different mainland goods in the economy (households do not consume the commodity good). Later on, we will think about food, manufactured goods, and services in line with the empirical section. The consumption aggregator of every household is denoted by C_t^h and takes the form of an implicitly additive non-homothetic CES function. It defines total consumption in period t by[12]

$$1 = \sum_{j=1}^{N} (\omega_j (C_t^h)^{\epsilon_j})^{\frac{1}{\sigma}} (C_{jt}^h)^{\frac{\sigma-1}{\sigma}},$$

where C_{jt}^h denote the consumption of good j by household h in period t, ω_j is a taste-shifter parameter for good j, σ is the constant elasticity of substitution between sectoral goods, and ϵ_j is the constant elasticity of consumption of sectoral good j relative to the consumption index C_t^h that allows preferences to be non-homothetic. We interpret it as the income elasticity of individual consumption goods. Hanoch (1975) introduced these preferences and have been used recently in the macroeconomic literature by Cravino and Sotelo (2019), Matsuyama (2019), Redding and Weinstein (2020) and Comin et al. (2021), among others, mostly in the context of trade and structural change. Note that we recover the standard homothetic CES specification in the particular case of $\epsilon_j = 1 - \sigma$ for every j.

For a given level of total expenditures E_t^h, the intratemporal optimization problem derives the following conditions

$$C_{jt}^h = \omega_j \left(\frac{P_{jt}}{P_t^h} \right)^{-\sigma} (C_t^h)^{\epsilon_j + \sigma} \tag{1}$$

[12] Comin et al. (2021) shows that we can separate the intertemporal and intratemporal allocation problems, as in the standard CES utility function.

$$s^h_{jt} \equiv \frac{P_{jt} C^h_{jt}}{E^h_t} = \omega_j \left(\frac{P_{jt}}{P^h_t} \right)^{1-\sigma} (C^h_t)^{\epsilon_j - (1-\sigma)}. \tag{2}$$

Equation (1) corresponds to the household demand for good j. Different to a standard CES specification, the dependance of sectoral demand to aggregate consumption is heterogeneous across goods and given by the term ϵ_j. The higher this term, the more consumption- (hence, income-) elastic is the good. Equation (2) characterizes the expenditure shares, where s^h_{jt} is the fraction of expenditures of household h in good j in period t, and $E^h_t = P^h_t C^h_t$ denotes total expenditures of household h in period t.

Note that these preferences define a household-specific CPI of the form

$$P^h_t = \left[\sum_{j=1}^{N} (\omega_j P_{jt}^{1-\sigma})^{\vartheta_j} (s^h_{jt} {E^h_t}^{1-\sigma})^{1-\vartheta_j} \right]^{\frac{1}{1-\sigma}}, \tag{3}$$

with $\vartheta_j \equiv (1-\sigma)/\epsilon_j$. From equations (2) and (3) is clear that both the expenditure share and the CPI of each household depend on the level of consumption/expenditure on every period. Note again that in the case of homothetic preferences ($\epsilon_j = 1-\sigma$), 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 expenditures ($\vartheta_j = 1$). At the same time, with these non-homothetic preferences, the demand for each good is non-linearly related to aggregate consumption, and such relation depends on the income elasticity of each good, ε_j. For future reference, let $\bar{\epsilon}^h_t \equiv \sum_{j=1}^{N} s^h_{jt} \epsilon_j$ be the average (expenditure-weighted) income elasticity.

As noticed by Comin et al. (2021), the predictions of the model for observables 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 $j = b$ to denote such base good, which will be normalized to one (i.e., $\epsilon_b = \omega_b = 1$). Using (2), this implies that we can write the real consumption index as $C^h_t = s^h_{bt}(P_{bt}/E^h_t)^{\sigma-1}$. Substituting this expression back in (2) for any $j \neq b$, the expenditure share in good j relative to the base good by household h in period t can be written as

$$\log \left(\frac{s^h_{jt}}{s^h_{bt}} \right) = (\epsilon_j - 1) \log(s_{bt}) + (1-\sigma) \log \left(\frac{P_{jt}}{P_{bt}} \right) + (\epsilon_j - 1)(1-\sigma) \log \left(\frac{E^h_t}{P_{bt}} \right), \quad \forall j \neq b, \tag{4}$$

which defines a $N-1$ system of demand equations. The critical element to notice from (4) is that it provides an expression for the consumption shares of all other goods in terms of observables. This property will be the basis for the empirical estimation in the quantitative section of the paper.

Labor Supply. Each household can work in any of the domestic sectors, as well as in the commodity sector. We assume labor mobility is imperfect across sectors. Following Horvath (2000), the aggregator labor bundle is given by

$$N_t^h = \left(\sum_{j,c} N_{jt}^{h \frac{1+\varrho^h}{\varrho^h}} \right)^{\frac{\varrho^h}{1+\varrho^h}} . \tag{5}$$

The parameter ϱ^h is the intratemporal elasticity of substitution and governs the degree of labor mobility across sectors. When $\varrho^h \to 0$ ($\to \infty$), labor is completely immobile (mobile). For $\varrho^h < \infty$, the economy displays limited labor mobility, and sectoral wages differ in equilibrium. Note that the elasticity ϱ^h might be household-dependent, introducing heterogeneity in labor income.

The household's optimization problem maximizes total labor income, given wages, and the labor aggregator. This problem generates the labor supply schedule

$$N_{jt}^h = \left(\frac{W_{jt}}{W_t^h} \right)^{\varrho^h} N_t^h, \tag{6}$$

with $W_t^h \equiv \left(\sum_{j,c} W_{jt}^{1+\varrho^h} \right)^{\frac{1}{1+\varrho^h}}$ being a household-specific wage index. Note that this index satisfies $W_t^h N_t^h = \sum_{j,c} W_{jt} N_{jt}^h$.

3.1.2 Intertemporal Problems

Per-period Utility. The per-period utility function, common across households, is separable in consumption and labor and given by

$$U(C_t^h, N_t^h) = \frac{1}{1-\varsigma} (C_t^h)^{1-\varsigma} - \frac{\kappa^h}{1+\varphi} (N_t^h)^{1+\varphi}, \tag{7}$$

where ς is the household's coefficient of relative risk aversion, φ is the inverse of the Frisch elasticity of labor supply, and κ^h scales the disutility of labor. These parameters are the same for all households, except for the κ^h. The latter assumption allows imposing the same number of total hours worked in the steady-state.[13]

[13] As we discuss in Section 4, non-homothetic preferences induce an additional income effect in the labor supply, beyond the quantity of consumption. To have a better fit of the model, we follow Gali et al. (2012) and eliminate such effects, keeping separable preferences, by defining $\kappa_t^h = \overline{\kappa}^h (C_t^h)^{-\varsigma} \frac{(1-\sigma)}{\overline{\epsilon}_t^h}$.

Unconstrained Households. The mass $1-\lambda$ of unconstrained households u, maximizes their lifetime utility by choosing aggregate consumption and labor supply. As an additional source of income, they receive all the profits in the economy. Also, they have access to financial markets in the form of a domestic bond B_t that pays the (gross) nominal interest rate R_t, and a foreign bond B_t^* paying the (gross) nominal interest rate R_t^*. The former bond pays in domestic currency while the latter pays in units of foreign currency. The latter payments are transformed in domestic currency by the nominal exchange rate, $\mathcal{E}_t$.

Formally, the optimization problem of these households is

$$\max_{C_t^u, N_t^u, B_t, B_t^*} \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t U(C_t^u, N_t^u)$$

subject to the budget constraint

$$E_t^u + \frac{B_t}{1-\lambda} + \mathcal{E}_t \frac{B_t^*}{1-\lambda} = W_t^u N_t^u + R_{t-1} \frac{B_{t-1}}{1-\lambda} + \mathcal{E}_t R_{t-1}^* \frac{B_{t-1}^*}{1-\lambda} + \frac{D_t}{1-\lambda},$$

where E_t^u denotes total expenditures (which is a function of the total consumption of the household), and D_t is the total amount of profits coming from all firms in the economy, which are distributed equally across all unconstrained households.

The solution to this problem is given by

$$1 = \beta R_t \mathbb{E}_t \left\{ \left(\frac{C_{t+1}^u}{C_t^u} \right)^{-\varsigma} \frac{\overline{\epsilon}_t^u}{\overline{\epsilon}_{t+1}^u} \frac{P_t^u}{P_{t+1}^u} \right\} \tag{8}$$

$$1 = \beta R_t^* \mathbb{E}_t \left\{ \left(\frac{C_{t+1}^u}{C_t^u} \right)^{-\varsigma} \frac{\overline{\epsilon}_t^u}{\overline{\epsilon}_{t+1}^u} \frac{P_t^u}{P_{t+1}^u} \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right\} \tag{9}$$

$$\frac{W_t^u}{P_t^u} = \kappa^u (C_t^u)^{\varsigma} (N_t^u)^{\varphi} \frac{\overline{\epsilon}_t^u}{1-\sigma}. \tag{10}$$

Equation (8) denotes the Euler equation for unconstrained households. This expression characterizes the (nonlinear) relationship between real and nominal consumption at different income levels, which the household incorporates in the intertemporal allocation problem. There is a wedge between the marginal cost of real consumption and the aggregate price index. The size of this wedge depends on the average income elasticity across sectors (time-varying and households-specific) and the composition of expenditures. Something similar is observed in equation (9), corresponding to the optimality condition for foreign bonds. The only difference with the previous expression is that now the intertemporal trade-off must also consider the expected nominal depreciation of the domestic currency. Finally, equation (10) characterizes the aggregate amount of labor, which depends on the average wage received. This labor supply depends on a real wage that is household-specific and on the wedge induced by the average income elasticity. Once we have the desired amount of consumption and the total amount of hours supplied, we can recover the sector-specific demands and labor supplies from (1) and (6).

Constrained Households. The mass λ of constrained households have no access to financial markets and do not receive profits from firms. Their optimization problem is static, and they have to choose consumption and labor supply period by period. Formally, they solve

$$\max_{C_t^r, N_t^r} U(C_t^r, N_t^r) \quad \text{subject to} \quad W_t^r N_t^r = E_t^r,$$

where E_t^r denotes total expenditures of the restricted household. The following expression gives the solution to this problem for total hours and consumption expenditures

$$\frac{W_t^r}{P_t^r} = \kappa^r (C_t^r)^{\varsigma} (N_t^r)^{\varphi} \frac{\bar{\epsilon}_t^r}{1-\sigma} \tag{11}$$

$$W_t^r N_t^r = E_t^r. \tag{12}$$

As in the case of the unconstrained household, the characterization of the problem also requires the sector-specific demands for consumption goods and labor supplies given by (1) and (6).

3.2 Production

We separate the problem of production between mainland sectors ($j = 1, \ldots, N$) and the commodity sector ($j = c$). Two layers of production characterize mainland sectors. At the top, there is a representative competitive firm aggregating the output of atomistic producers. This firm sells its output to households and other aggregators. At the bottom, there is a continuum of monopolistically competitive producers subject to nominal rigidities à la Calvo. The commodity sector is composed of a representative and competitive firm. Distinct from other economic sectors, it takes the price from abroad.

3.2.1 Mainland Sectors

Sectoral Aggregator. On each sector, a competitive firm aggregates the output of a continuum of intermediate producers according to

$$Y_{jt} = \left(\int_0^1 Y_{jt}(z)^{\frac{\varepsilon-1}{\varepsilon}} dz \right)^{\frac{\varepsilon}{\varepsilon-1}},$$

where $z \in [0,1]$ denotes the z-th variety of good j. As standard, profit maximization derives the following demand faced by a producer z

$$Y_{jt}(z) = \left(\frac{P_{jt}(z)}{P_{jt}} \right)^{-\varepsilon} Y_{jt}, \tag{13}$$

where $P_{jt} = \left(\int_0^1 P_{jt}(z)^{1-\varepsilon} dz \right)^{\frac{1}{1-\varepsilon}}$ is the price of the final sectoral good j. The output of this sector is used for private consumption, exports, or as an input for other sectors of the economy (see details below).

Sectoral Producers. Each producer $z \in [0,1]$ in sector j, operates in a monopolistically competitive environment. Technology is common to all firms within a sector but differs across sectors. The production function is given by

$$Y_{jt}(z) = \delta_j L_{jt}(z)^{\alpha_j} M_{jt}(z)^{\mu_j} V_{jt}(z)^{\nu_j},$$

where L_{jt}, M_{jt} and V_{jt} denote labor, domestic materials and imports, respectively, and δ_j is a sector-specific constant.

The bundle of materials is sector-specific and given by

$$M_{jt} = \delta_j^m \prod_{i=1}^{N} M_{ijt}^{\gamma_{ij}}, \quad \text{with} \quad \sum_{i=1}^{N} \gamma_{ij} = 1,$$

where M_{ijt} denotes sales of materials from sector i to sector j in period t. The elements $\gamma_{ij} \in \mathbf{\Gamma}$ denote the input-output (IO) matrix of the economy, which establishes the production linkages between domestic sectors. In particular, entry $\gamma_{ij} \geq 0$ denotes the amount of intermediates from sector i necessary to produce \$1 of output in sector j.

Let P_{vt}^* be the foreign price of imports and assume the law of one price holds. Therefore, the domestic price of imports equals the nominal exchange rate times the foreign price, $P_{vt} = \mathcal{E}_t P_{vt}^*$.[14] Because the technology and factor prices are common across producers within a sector, the marginal cost is the same across monopolists. Given this, by cost minimization, the demands for labor, materials, and imports at the *sectoral* level are

[14]Different to Romero (2022b), for simplicity, we abstract from nominal rigidities in importable goods.

$$L_{jt} = \alpha_j \frac{MC_{jt}Y_{jt}}{W_{jt}} \Delta_{jt}, \quad M_{jt} = \mu_j \frac{MC_{jt}Y_{jt}}{P^m_{jt}} \Delta_{jt} \quad \text{and} \quad V_{jt} = \nu_j \frac{MC_{jt}Y_{jt}}{P_{vt}} \Delta_{jt},$$

where $P^m_{jt} = \prod_{i=1}^N P_{it}^{\gamma_{ij}}$ is the sector-specific price of intermediate goods, and MC_{jt} denotes the marginal cost of production. By cost minimization, the demand for materials is given by $M_{ijt} = \gamma_{ij} P^m_{jt} M_{jt}/P_{it}$. In the previous expressions, Δ_{jt} is the sectoral price dispersion which comes from nominal rigidities (see details below).

Nominal Rigidities. Firms face price stickiness à la Calvo, implying that with probability $1-\theta_j$, they can reset their price in any given period, regardless of their last update. With this, a fraction θ_j of producers keep their price unchanged from the last period, while the remaining fraction can set their desired price. We allow for sectoral heterogeneity in this probability.

Firms maximize profits by choosing their desired price subject to the demand of the sectoral aggregator. They take into account that such price can remain over time, which is captured by the probability θ_j[15]

$$\max_{\widetilde{P}_{jt}(z)} \mathbb{E}_t \sum_{\tau=0}^{\infty} (\theta_j \beta)^\tau \left[\widetilde{P}_{jt}(z) Y_{jt+\tau|t}(z) - MC_{jt+\tau} Y_{jt+\tau|t}(z) \right]$$

subject to (13), where $\widetilde{P}_{jt}$ denotes the desired price. In the previous expression $Y_{jt+\tau|t}(z)$ denotes the demand of the sectoral aggregator in period $t+\tau$, conditional on the last price reset of firm z in period t.

The optimality condition is $\widetilde{P}_{jt} = \frac{\varepsilon}{\varepsilon-1}\frac{S_{jt}}{F_{jt}}$, with

$$\begin{aligned} S_{jt} &= Y_{jt} MC_{jt} + \theta_j \beta \mathbb{E}_t[\Pi_{t+1} \Pi^\varepsilon_{jt+1} S_{jt+1}] \\ F_{jt} &= Y_{jt} + \theta_j \beta \mathbb{E}_t[\Pi^\varepsilon_{jt+1} F_{jt+1}], \end{aligned}$$

where Π_t denotes aggregate gross inflation and $\Pi_{jt} = \frac{P_{jt}}{P_{jt-1}} \Pi_t$ denotes sectoral gross inflation. In an abuse of notation, $\widetilde{P}_{jt}$ corresponds to the real sectoral desired prices (i.e., nominal price relative to the price of aggregate consumption), and MC_{jt} is the real marginal cost.

Given the properties of the Calvo pricing, sectoral prices and sectoral price dispersion evolve as

[15] The pricing problem of firms typically considers the stochastic discount factor (SDF) of the household owning firms. However, in an extended version of the model with a continuum of households and NH preferences, deciding which SDF is relevant for the price setting is not direct. For simplicity, and because we solve the model around its steady-state, we consider only the common deterministic discount factor β as the relevant element for pricing.

$$1 = (1-\theta_j)\left(\frac{\widetilde{P}_{jt}}{P_{jt}}\right)^{1-\varepsilon} + \theta_j \Pi_{jt}^{\varepsilon-1}$$

$$\Delta_{jt} = (1-\theta_j)\left(\frac{\widetilde{P}_{jt}}{P_{jt}}\right)^{-\varepsilon} + \theta_j \Pi_{jt}^{\varepsilon}\Delta_{jt-1}.$$

3.2.2 Commodity Sector

The commodity sector ($j = c$) is characterized by a representative firm that produces with Cobb-Douglas technology similar to the one in mainland sectors

$$Y_{ct} = \delta_c (L_{ct})^{\alpha_c}(M_{ct})^{\mu_c}(V_{ct})^{\nu_c},$$

where δ_c is a constant term. We assume that the law of one price also holds for the commodity prices, implying that the domestic price is $P_{ct} = \mathcal{E}_t P_{ct}^*$.

The commodity sector is competitive, so profit maximization derives the following demands for factors

$$L_{ct} = \alpha_c \frac{P_{ct}Y_{ct}}{W_{ct}}, \quad M_{ct} = \mu_c \frac{P_{ct}Y_{ct}}{P_{ct}^m}, \quad \text{and} \quad V_{ct} = \nu_c \frac{P_{ct}Y_{ct}}{P_{vt}}.$$

As in the case of mainland sectors, materials take a Cobb-Douglas form

$$M_{ct} = \delta_c^m \prod_{j=1}^{N} M_{jct}^{\gamma_{jc}}, \quad \text{with} \quad \sum_{j=1}^{N} \gamma_{jc} = 1.$$

Cost minimization implies a demand for specific sectors of the form $M_{jct} = \gamma_{jc} P_{ct}^m M_{ct}/P_{jt}$, with the price of materials given by $P_{ct}^m = \prod_{j=1}^N P_{jt}^{\gamma_{jc}}$.

As mentioned before, the commodity sector takes the international price as given. We assume this follows an autoregressive form, and its the only source of fluctuations in the economy

$$\log(P_{ct}^*) = (1-\rho_c)\log(P_c^*) + \rho_c \log(P_{ct-1}^*) + \eta_t^c.$$

3.3 Exportable Good

A competitive firm combines inputs from different mainland sectors to produce an exportable good sold abroad. The technology of this sector is given by $Y_t^x = \delta_x \prod_{j=1}^N (Y_{jt}^x)^{\psi_j}$, where δ_x is a constant term and $\sum_{j=1}^N \psi_j = 1$ holds. The price of exports and the demand for inputs from each sector are given by

$$P_t^x = \prod_{j=2}^{N} P_{jt}^{\psi_j} \qquad \text{and} \qquad Y_{jt}^x = \psi_j \frac{P_t^x}{P_{jt}} Y_t^x.$$

The foreign demand for the exportable good takes the form $Y_t^x = \omega^x \left(\frac{P_t^x}{\mathcal{E}_t P_t^*}\right)^{-\eta^*} Y_t^*$, where P_t^* and Y_t^* denote the foreign CPI and the foreign level of output, respectively.

3.4 Aggregation, Monetary Policy and Market Clearing

Numeraire, Aggregation and Monetary Policy. Total consumption expenditures are the sum of consumption of the restricted and unconstrained households

$$P_t C_t = \lambda P_t^r C_t^r + (1-\lambda) P_t^u C_t^u.$$

The numeraire of the economy is aggregate consumption. Consistent with usual practice among statistical agencies, we assume (i) that the CPI index is a weighted average of sectoral prices and (ii) weights do not change regularly over time. These assumptions translate in the normalization $P_t = \sum_j \omega_j P_{jt}^{1-\sigma}$ for the price of aggregate consumption. The latter is the same expression that would hold in a world with CES homothetic preferences. Working the previous expressions, total consumption can also be written as $C_t = \sum_j (P_{jt}/P_t) C_{jt}$, with $C_{jt} = \lambda C_{jt}^r + (1-\lambda) C_{jt}^u$ being total sectoral consumption.

Total exports are given by the value of commodity goods plus the value of the exportable good, $X_t = P_{1t} Y_{1t} + P_t^x Y_t^x$. On the other hand, total imports are given by the sum of sectoral imports, $V_t = \sum_{j=1}^{N} V_{jt}$. Combining these expressions, the trade balance is given by $TB_t = X_t - P_{vt} V_t$, while Gross domestic product (GDP) is defined as the sum of aggregate consumption and the trade balance, $\text{GDP}_t = C_t + TB_t$.

Finally, the central bank sets the domestic nominal rate by using a Taylor rule

$$\frac{R_t}{R} = (\Pi_t)^{\phi_\pi} \left(\frac{\text{GDP}_t}{\text{GDP}_{t-1}}\right)^{\phi_y},$$

where R is the long-run value of the gross nominal rate and Π_t is the CPI inflation.

Market-clearing. For equilibrium, we have to impose market clearing conditions in labor markets and for every sectoral good

$$L_{jt} = \lambda N_{jt}^r + (1-\lambda) N_{jt}^u$$

$$Y_{jt} = C_{jt} + Y_{jt}^x + \sum_{i=1}^{N} M_{jit}.$$

By combining the different market-clearing conditions of the model, the domestic bond market clearing ($B_t = 0$), as well as the aggregate resource constraint (given by the combined budget constraints of different households), the financial position of the economy is given by

$$\mathcal{E}_t B_t^* = TB_t + \mathcal{E}_t R_{t-1}^* B_{t-1}^*. \tag{14}$$

To close the model, we consider the following specification for the foreign interest rate

$$R_t^* = R_t^w \times \exp\left[\phi_b \left(\bar{b} - \frac{\mathcal{E}_t B_t^*}{GDP_t}\right)\right], \tag{15}$$

where $\phi_b > 0$ and R_t^w is the world interest rate and the term $\exp[\cdot]$ is a risk premium that the country pays over the risk-free rate. This premium is affected by the deviations of the country's total debt (relative to GDP) to a long-run determined value, $\bar{b}$. This closing device guarantees the stationarity of the model (Schmitt-Grohe and Uribe, 2003).

4 Theoretical Results

What is the role of NH preferences and market incompleteness in propagating the shock? First, we analyze the general details of the optimization problem and the implications in terms of consumption and hours for an individual household. Then we analyze the effect of hand-to-mouth agents on aggregate consumption.

Consumption Decision. When making consumption decisions, households equalize the marginal utility of an extra unit with its marginal cost. In general terms, the trade-off for a generic household h is characterized by

$$U_C(C_t^h, N_t^h) = \lambda_t^h \frac{\partial E(C_t^h)}{\partial C_t^h},$$

where $U_C(\cdot)$ denotes the marginal utility of consumption, $\frac{\partial E(C_t^h)}{\partial C_t^h}$ is the marginal effect of consumption over expenditures and λ_t^h is the household specific Lagrange multiplier capturing the shadow value of wealth. The second term can be written as $\frac{\partial E(C_t^h)}{\partial C_t^h} = P_t^h \frac{\bar{\epsilon}_t^h}{1-\sigma}$, where, as mentioned before, $\bar{\epsilon}_t^h = \sum_{j=1}^{N} s_{jt}^h \epsilon_j$ denotes the average income elasticity and s_{jt}^h is the expenditure share in good j for household h (see Appendix B.1.1 for derivations). Note that this average elasticity is household-specific and time-varying because it depends on the consumption expenditures shares.

In models with homothetic preferences, the marginal effect of an extra unit of consumption over expenditures is given only by the price of the consumption basket. Because the composition of the consumption basket does not change with the level of consumption, the income elasticity of each good is common and equal to $1-\sigma$. Therefore, in such case, $\frac{\partial E(C_t^h)}{\partial C_t^h} = P_t$, which is the aggregate (and common) price of consumption. However, with non-homothetic preferences, the income elasticity is good-specific (ϵ_j), and the average income elasticity is not trivial. Conceptually, this term reflects that one extra unit of consumption changes the allocation among different goods, which affects the marginal effect of consumption over expenditures. In particular, as total consumption grows, this additional unit is allocated towards more income elastic goods (i.e., services), and the cost of living changes nonlinearly. In what follows, we analyze how this elasticity differentially affects each household, depending on their access to financial markets.

Unconstrained Household. The Euler equation (8) determines consumption of the unconstrained. Taking a log-linear approximation around the steady-state, this equation can read as

$$c_t^u = \underbrace{\mathbb{E}_t\{c_{t+1}^u\} - \varsigma^{-1}(r_t - \mathbb{E}_t\{\pi_{t+1}\})}_{\text{Standard Euler}} + \underbrace{\varsigma^{-1}\mathbb{E}_t\{\Delta\widehat{\epsilon}_{t+1}^u\}}_{\text{Income elasticity}} - \underbrace{\varsigma^{-1}\mathbb{E}_t\{\pi_{t+1} - \pi_{t+1}^u\}}_{\text{Expected inflation}}, \tag{16}$$

where lowercase letters denote log-deviations with respect to steady-state and $\widehat{\epsilon}_t^h \equiv \overline{\epsilon}_t^h - \overline{\epsilon}^h$. The previous expression contains three arguments on the right-hand side. The first term corresponds to the standard expression for the Euler equation. Consumption today is positively associated to consumption tomorrow and negatively to the real interest rate ($r_t - \mathbb{E}_t\{\pi_{t+1}\}$). This latter term is the standard intertemporal substitution effect for consumption, in which a larger real rate provides incentives to increase savings and postpone consumption.

On top of that, the model with non-homotheticities changes the response of consumption of the unconstrained in two ways. On the one hand, the second term on the right-hand side captures the effect of changes in the income elasticity over consumption decisions. An increase in such elasticity today reduces current consumption by changing the composition of expenditures. One extra unit of consumption changes the cost of living by its direct price effect and the compositional effect of the consumption basket, which is moving towards more income elastic and expensive goods. In this sense, when the household expects the average income elasticity to decrease over time (i.e., the average income elasticity increases today), it is optimal to postpone consumption. On the other hand, the last term captures a differential in the expected inflation for tomorrow. When the unconstrained experiences higher inflation than the aggregate, it is optimal to advance consumption for today.

How does labor supply react? Approximating (10) around the steady-state, gives the expression

$$n_t^u = \frac{1}{\varphi}(w_t^u - p_t^u) - \frac{\varsigma}{\varphi} c_t^u - \frac{1}{\varphi}\widehat{\epsilon}_t^u.$$

As usual, labor supply is increasing in the real wage, which in the case of non-homotheticities considers the household-specific CPI ($w_t^u - p_t^u$). On top of that, there is the standard income effect of labor supply, given by c_t^u, which reduces hours. In the non-homothetic model, the compositional effect given by changes in the income elasticity operates as an additional income effect by reducing hours even further.

Constrained Household. The case of the restricted household shares the dampening features of the problem of the unconstrained given by the non-homothetic preferences. We can get expressions for consumption and hours in closed form by solving (11)-(12), which can be approximated as

$$\begin{aligned} c_t^r &= \frac{1+\varphi}{\varphi+\varsigma}(w_t^r - p_t^r) - \frac{1}{\varphi+\varsigma}\widehat{\epsilon}_t^r \\ n_t^r &= \frac{1-\varsigma}{\varphi+\varsigma}(w_t^r - p_t^r) - \frac{1}{\varphi+\varsigma}\widehat{\epsilon}_t^r. \end{aligned}$$

Consumption of the restricted household increases with its real wage, but the compositional effect captured by the average income elasticity dampens the effect. The same happens for hours supplied. Interestingly, hours will respond to fluctuations even in the log-utility case ($\varsigma = 1$) where labor supply does not depend on wages, which is a standard assumption in models with constrained agents (Bilbiie, 2008). Therefore, non-homothetic preferences not only modify the intertemporal elasticity of substitution, as in the case of the unconstrained household, but has intratemporal consequences as well.

From Micro to Macro. We can combine consumption at the household level to get an expression for aggregate consumption. Recall that aggregate consumption corresponds to a weighted average between expenditures of each household. Following Debortoli and Gali (2018), define $\gamma_t \equiv (P_t^u C_t^u - P_t^r C_t^r)/(P_t^u C_t^u)$ as an index of average expenditures gap between constrained and unconstrained households, capturing the heterogeneity between the two groups.[16] Using the definition of total consumption expenditures, we can write $C_t = (1-\lambda\gamma_t)P^u_t C^u_t$. This expression shows that total consumption directly depends on the degree of inequality within the economy captured by λ and γ_t.

Up to a first-order, consumption reads as

$$c_t = p^u_t + c^u_t - \frac{\lambda}{1-\lambda\gamma}\widehat{\gamma}_t,$$

where $\widehat{\gamma}_t = \gamma_t - \gamma$ denotes deviations of the expenditure gap with respect to steady-state. Finally, combining with (16), we get an expression for aggregate consumption

$$c_t = \underbrace{\mathbb{E}_t\{c_{t+1}\} - \varsigma^{-1}(r_t - \mathbb{E}_t\{\pi_{t+1}\})}_{\text{Standard Euler}} + \underbrace{\varsigma^{-1}\mathbb{E}_t\{\Delta\widehat{\epsilon}^u_{t+1}\}}_{\text{Income elasticity}} + \underbrace{\frac{\lambda}{1-\lambda\gamma}\mathbb{E}_t\{\Delta\widehat{\gamma}_{t+1}\}}_{\text{Heterogeneity}} - \varsigma^{-1}\mathbb{E}_t\{x_{t+1}\}, \tag{17}$$

with $x_{t+1} \equiv \pi_{t+1} - (1-\varsigma)\pi^u_{t+1}$. Equation (17) characterizes the behavior of aggregate consumption in the economy and the different transmission channels. The main distinction relative to (16) is the component associated with heterogeneity in the form of the expenditure gap. In this model, total income comes from labor income and profits, and the commodity price shock will generate reallocation between these two sources. With the presence of hand-to-mouth agents, this force changes the relative purchasing power of each household. Because the restricted household has a larger marginal propensity to consume relative to the unconstrained, any change in favor of the latter will reduce total consumption in the economy. Finally, note that when preferences are homothetic ($\widehat{\epsilon}_t = 0$) and there is no inequality ($\lambda = 0$), (17) collapses to the familiar standard Euler equation for a representative agent. In what follows, we focus the analysis on the quantitative response of aggregate consumption and the role played by each channel.

5 Quantitative Results

This section explores the quantitative properties of the model. First, we describe the calibration strategy for the Chilean economy, focusing on the demand system estimates. Then, we analyze the impact of commodity price shocks in the context of non-homothetic preferences and heterogeneity.

[16] Note that income, hence expenditures, of the unconstrained are larger than its counterpart among restricted households. Therefore, in steady-state $\gamma = (P^uC^u - P^rC^r)/(P^uC^u) \in [0,1]$ holds.

5.1 Calibration

A period in the model is a quarter, and the number of mainland sectors is $N = 3$. In particular, the economy is composed of the sectors of food and beverages ($j = f$), manufactured goods ($j = m$), and services ($j = s$), besides the commodity sector ($j = c$). To parameterize the economy, we partition the parameter space into three groups. First, there is a subset of predetermined parameters which are standard in the literature or taken from the Chilean data and govern the steady-state of the model. The second set of parameters, which are related to the demand system of households, is estimated in order to match the features presented in Section 2. Finally, we choose the third group of parameters to improve the model's fit to an empirical commodity price shock. Here we focus on the demand system estimates and the calibration of the fraction of hand-to-mouth agents. Appendix C.1 provides further details.

Demand System Estimation. To estimate the parameters associated with the demand system (2), recall that the predictions of the model remain invariant to any scaling of the elasticities ϵ_j and the taste parameters ω_j as shown in Equation (4). We set manufactures as the baseline good and normalized those values to one ($\epsilon_m = \omega_m = 1$). The demand system reads as

$$\log\left(\frac{s_j^h}{s_m^h}\right) = (\epsilon_j - 1)\log(s_m) + (1-\sigma)\log\left(\frac{P_j}{P_m}\right) + (\epsilon_j - 1)(1-\sigma)\log\left(\frac{E^h}{P_m}\right) + \nu^h, \tag{18}$$

for $j \in \{f, s\}$ and where s_{jt}^h denotes the expenditure share of household h in good j, and E_t^h denotes total expenditures of household h. We estimate this empirical specification with the cross-sectional data presented in Section 2 in order 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 notion that different households might not face the same prices. The previous expression denotes a system of $N - 1$ equations, and we impose that the parameters are the same across them. The estimation uses Feasible Generalized Nonlinear Least Squares (FGNLS) as Herrendorf et al. (2013) and Cravino and Sotelo (2019).[17] As in Cravino and Sotelo (2019) and Comin et al. (2021), 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

[17] We constrain the elasticities to be positive to ensure that the consumption aggregator is concave.

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.[18]

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 estimates of the demand system given by equation (18). 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.

Market Incompleteness. The fraction of hand-to-mouth agents in the economy captures the notion of market incompleteness. To account for this, we compare the degree of earnings and total income to the use of financial services following two approaches. For details, see Appendix C.1.

Table 2 presents the share of financially constrained households in Chile using data from the Household Financial Survey (*Encuesta Financiera de Hogares* in Spanish, or EFH). Column 1 presents results using the measure proposed by Zeldes (1989) by comparing total net worth with earnings. Column 2 uses the measure proposed by Kaplan et al. (2014) distinguishing by the degree of liquidity of net worth. The distinction between total and liquid net worth makes a big difference in market incompleteness. In particular, when using liquid net worth, the fraction of hand-to-mouth agents is 2.5 times larger on average. Also, both measures remain stable over time, even though they show a slight decreasing pattern over time. All in all, the degree of financial constraints for households in the SOE are significant and stable over time, implying that market incompleteness is an important structural feature of the economy. For our baseline calibration, we use $\lambda = 0.42$, corresponding to the average measure computed *à* la Kaplan et al. (2014).

[18]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.

Table 2. Share of Hand-to-Mouth Agent

Net Worth	2011	2014	2017	Average	Std. Dev.
Total	0.198	0.174	0.160	0.177	0.019
Liquid	0.436	0.436	0.387	0.420	0.028

Notes: This table presents the share of financially constrained households using data from the Chilean EFH survey.

5.2 The Role of Heterogeneity and Non-homothetic Preferences

As shown in the analytical results of Section 4, consumption and hours worked of both households are lower in the case with non-homothetic preferences due to the consumption basket reallocation and the additional income effect that generates. At the same time, market incompleteness in the form of financial constraints should increase the response and persistence of consumption because of the presence of agents with a higher marginal propensity to consume.

We investigate the relative importance of each mechanism by focusing on the response of aggregate consumption to a commodity price shock. For this, we compare the evolution on its response for different calibrations of the model.[19] As mentioned before, this exercise considers a version of the model without income-effect of labor supply (see footnote 13 for details). Figure 2 shows the response to a 10% commodity price shock under four specifications of the model. For future references, the TANK (RANK) denotes the model with two agents (representative agent), while NH (H) denotes the model with non-homothetic (homothetic) preferences. From the previous theoretical discussion, we expect that NH preferences dampen the response of aggregate consumption while market incompleteness amplifies it.

Figure 2 presents two results. First, in line with the theoretical analysis, there is a clear order in the impact-response of consumption: economies with heterogeneous agents generate larger responses than representative agent models, while non-homothetic preferences dampen such responses. In particular, the impact response of the baseline TANK-NH model is 0.36 percentage points, while its homothetic counterpart TANK-H is 0.52 percentage points. At the same time, the impact-response in the RANK-NH model is 0.24, and the RANK-H version is 0.35 percentage points.

Second, aggregate responses depend on both mechanisms. In particular, note how consumption's shape and persistence changes when comparing economies with or without hand-to-mouth agents,

[19] Appendix C.2.1 provides additional analysis for other aggregate variables.

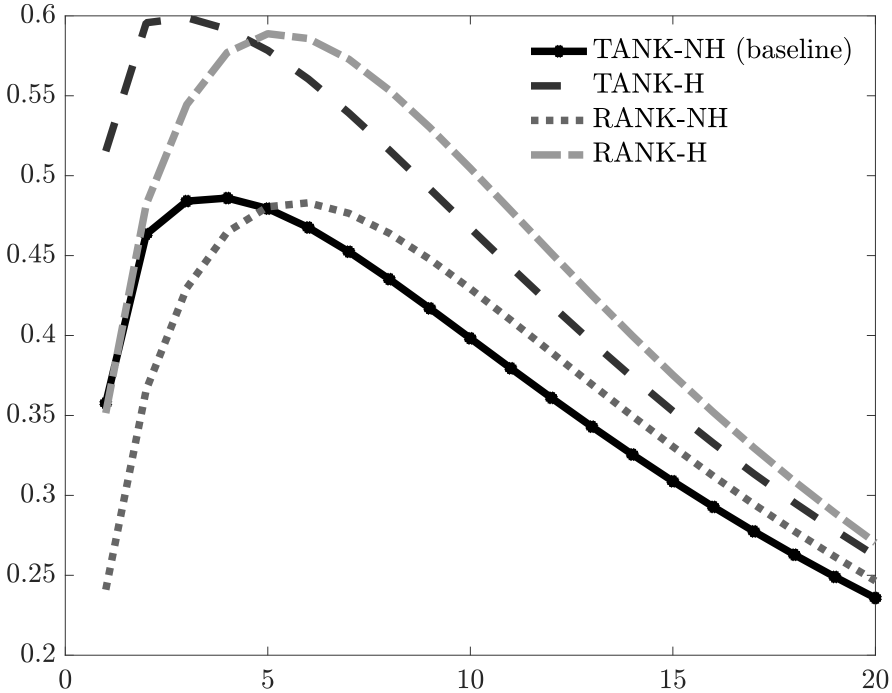
conditional on the degree of non-homotheticities. We make two observations about this. First, the response peak is the same between RANK and TANK models, conditional on non-homotheticities. For example, the TANK-NH model generates a peak-response of 0.48 percentage points, the same as the RANK-NH model. Something similar happens when comparing the TANK-H and the RANK-H models, with a response at the peak of 0.59 percentage points. Note, however, that such a peak occurs two quarters before in the NH model. Our second observation is related to the latter point: the response in models with hand-to-mouth agents is less persistent over time, which has implications over the cumulative consumption response. For example, in a horizon of 20 quarters, the cumulative response of the TANK-NH (RANK-NH) model is 7.48 (7.52), while for the TANK-H (RANK-H) is 8.92 (8.97) percentage points. Therefore, for our calibration, the main difference (in cumulative terms) comes from non-homotheticities and not expenditures inequality. This result is because of the assumption of equal labor aggregator of both households, such that differences in income are minor.

Are the differences induced by non-homothetic preferences too large? In a different context, Ravn et al. (2006) documents similar gaps between a homothetic and a non-homothetic model. Their paper studies a closed economy model subject to a technology shock, in which non-homothetic preferences are modeled as "deep habits". The representative household has Stone-Geary preferences at the goods level (and not at the level of aggregate consumption), implying that each good has different subsistence levels and income elasticity. Their setup found that (i) a positive technology shock in a world with homothetic preferences generates a consumption response four times larger than the non-homothetic case, and (ii) these differences are persistent over time.

5.3 Understanding the Mechanisms

In what follows, we study the microeconomics behind the response of aggregate consumption. Figure 3 compares the cases of homothetic and non-homothetic preferences for the different propagation channels in the TANK model. Panels (a)-(c) present the response of expenditure shares for the two agents. Note that expenditure shares only depend on prices in the homothetic model; hence, they respond equally for both households. As we can see, the relative importance of food decreases for both households, regardless of non-homotheticities. However, the magnitude of those changes dramatically changes in the non-homothetic model, especially for the restricted household, with responses three to six times larger. Something different happens in the case of manufactured goods and services, which increase their importance on impact. Non-homothetic preferences amplify such

Figure 2. Aggregate Consumption under Different Specifications



Notes: This figure compares the impulse-response function of aggregate consumption under different specifications of the model. TANK-NH (black-solid line) corresponds to the baseline specification with two agents and non-homothetic preferences. TANK-H (dashed line) corresponds to a model with two agents and homothetic preferences. RANK-NH (dotted line) corresponds to a model with a representative agent and non-homothetic preferences. RANK-H (grey-dashed line) corresponds to a model with a representative agent and homothetic preferences. All responses are in percentage deviations with respect to steady-state.

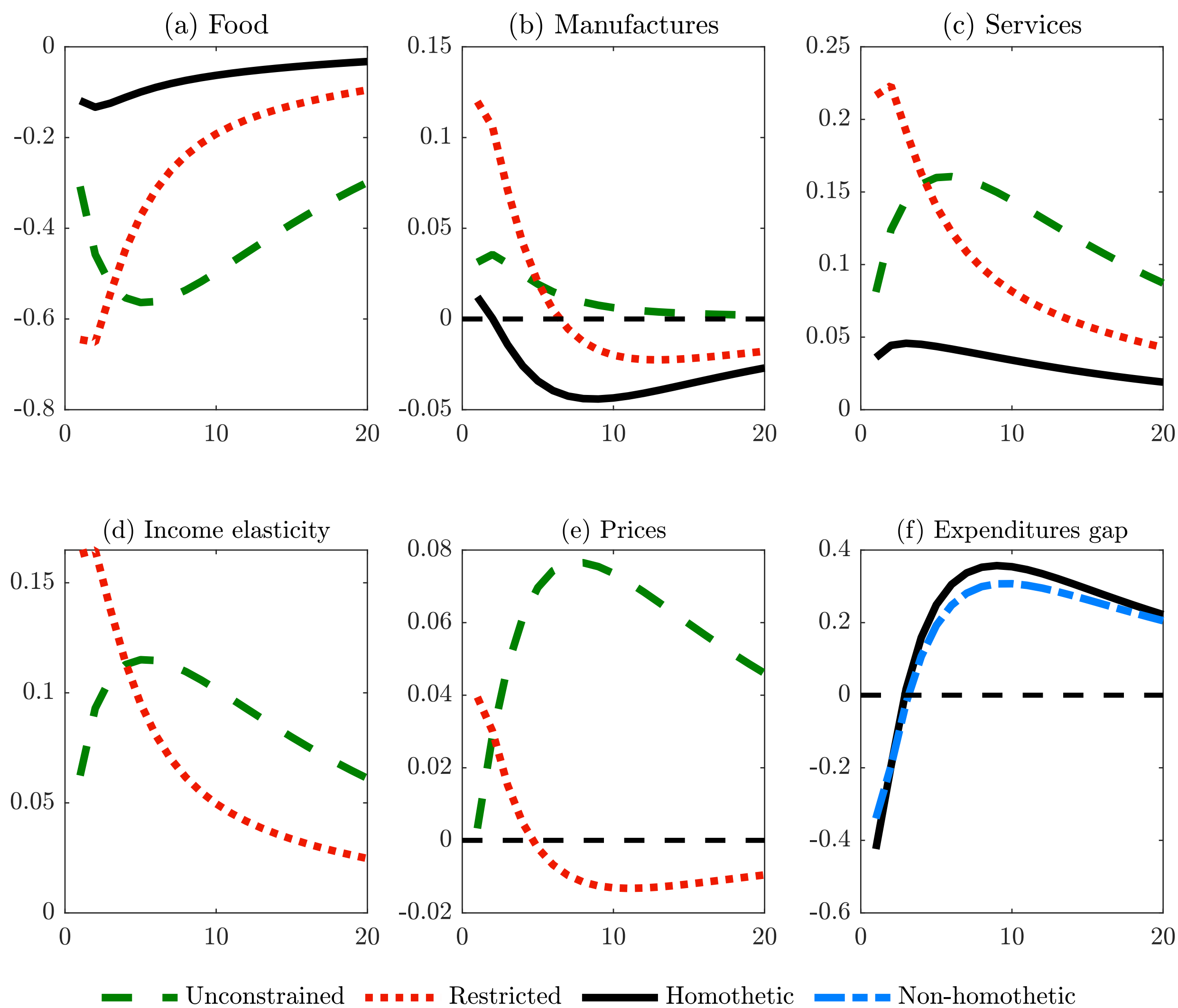
responses. The fact that constrained households have a higher marginal propensity to consume explains why their response is more pronounced.

The logic behind these results comes from the income elasticity associated with each good, in which food has a lower elasticity than manufactures and services. Therefore, the increase in income associated with the commodity price shock reallocate expenditures toward more income elastic goods like services. The response of the average income elasticity in panel (d) summarizes these forces. In the homothetic model, such variable is constant and equal to one for every agent, but not in the non-homothetic economy, which is household-specific. The average income elasticity increases for both households due to the reallocation effect of NH preferences, with a response three times larger for hand-to-mouth agents.

Such reallocation has implications for the cost of living of different agents, as shown in Equation (3). As panel (e) shows, the price index of each household increases on impact, but the dynamic response is different for each household. The CPI of the hand-to-mouth quickly decreases over time because their expenditure shares converge sooner to the steady-state. The opposite happens for unconstrained agents. Because they smooth consumption over time and their expenditure shares react sluggishly, their cost of living increases over time.

Finally, panel (f) compares the expenditures gap between the homothetic and non-homothetic models. As we can see, the response of this variable is similar in both cases because households have the same labor aggregator, hence the same aggregate wage. The response on impact decreases in both cases because constrained agents react more. Later on, the response of this variable is positive because the unconstrained reaction persists over time.

FIGURE 3. Propagation Channels in the TANK Model



NOTES: This figure presents the response of different microeconomic channels to the commodity price shock. All variables in deviations with respect to steady-state. Prices are in percentage deviations with respect to steady-state.

5.4 Sensitivity Analysis

This section studies the sensitivity of the main results to key parameters in the model. As in the previous section, we focus on the response of aggregate consumption to a commodity price shock, considering different parameter configurations. In particular, we analyze the role of labor mobility of households, the degree of market incompleteness (captured by the fraction of restricted agents in the economy), the elasticity of substitution among goods in the consumption aggregator, and the income elasticity of services.[20] Figure 4 presents the results.

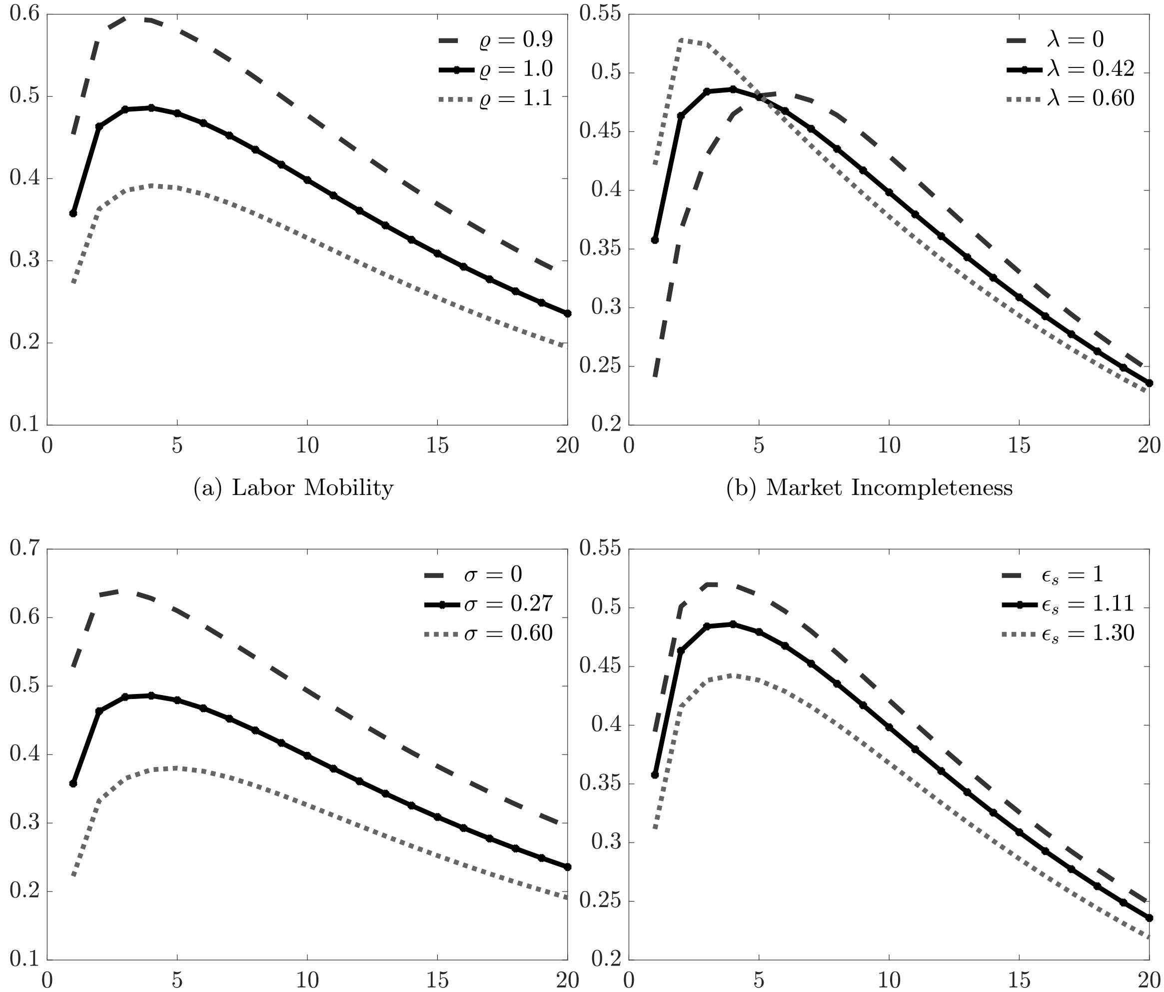
Labor Mobility. Panel (a) compares the responses under different values of the degree of labor mobility, ϱ. As in the baseline scenario, we assume this parameter is common across households in every counterfactual. As we can see, the lower the degree of labor mobility (smaller value of ϱ), the higher the response of consumption. After the commodity price shock, all sectors want to increase hirings to satisfy the higher demand. Lower mobility reduces the reallocation of workers because the labor supply is now more inelastic. Therefore, firms offer higher wages in equilibrium, resulting in higher income and more consumption. Going from the baseline value of $\varrho = 1$ to $\varrho = 0.9$, generates a response 27% larger.

Market Incompleteness. The fraction of agents in the economy having no access to financial markets and no consumption smoothing captures the degree by which markets are incomplete. As discussed previously, this corresponds to the fraction of restricted agents, λ: the larger this value, the higher the degree of market incompleteness. Panel (b) shows the effect of changing the fraction of hand-to-mouth agents. In line with Figure 2, a higher fraction of constrained agents imply an impact response 18% larger relative to the baseline calibration of $\lambda = 0.42$, with a sharp decrease over time. When comparing the cumulative consumption response, we find that the initial gain of more income inequality compensates for the final loss. Hence, both consumption responds the same in both scenarios.

Elasticity of Substitution. Panel (c) presents results of changing the elasticity of substitution between the three goods consumed by households. Reducing such elasticity implies that food, manufactures, and services are gross complements. The lower σ, the more sensitive are expenditure shares to changes in prices and lesser to changes in income. In such a case, expenditure shares

[20] Additional analysis for other aggregate is presented in Appendix C.2.2.

Figure 4. Aggregate Consumption under Different Specifications–Sensitivity



(a) Labor Mobility

(b) Market Incompleteness

(c) Elasticity of Substitution

(d) Income Elasticity of Services

Notes: This figure compares the impulse-response function of aggregate consumption under alternative calibrations of the TANK-NH model. All responses are in percentage deviations with respect to steady-state.

respond positively to prices, implying a higher reallocation in the consumption basket (a higher average income elasticity) towards goods that increase their price. Those forces imply that when $\sigma = 0$, the response of consumption is 48% higher relative to the case with $\sigma = 0.42$.

Note, however, that the opposite case is also possible if the labor supply does respond to income. Recall that the increase in the average income elasticity implies a stronger wealth effect (see Section 4). In this scenario, hand-to-mouth agents reduce their labor supply after the shock, reducing their consumption, and the lower elasticity of substitution would reduce aggregate consumption. Therefore, to understand the overall effect of changes in the elasticity of substitution of the consumption basket, it is key to account for (i) the degree of hand-to-mouth agents in the economy; and (ii) the way that labor supply reacts to wealth effects.[21]

Income Elasticity of Services. Finally, we explore the consequences of changes in the income elasticity of specific goods. We focus on the case of services because they are the more important in terms of weight in the consumption basket and the more income-elastic. An increase in such elasticity makes services more sensitive to increments in income and generates a larger difference in terms of valuation relative to manufactures and food. Therefore, in a world with a higher income elasticity, the expenditure share of services (manufactures) increases (decreases) by more, implying an increase in the average income elasticity of households. As discussed in Section 4, this variable is key to understanding the role of consumption over time because it represents an additional cost for consumers. Therefore, we expect to observe a decrease in the response of both household-specific and aggregate consumption expenditures. Panel (d) confirms this intuition: a higher income elasticity of services going from $\epsilon_s = 1.11$ to $\epsilon_s = 1.3$, reduces the response of aggregate consumption in 10%.

6 Conclusions

This paper analyzes the role of household heterogeneity in the transmission of commodity price shocks, analyzing a novel channel of adjustment: consumption heterogeneity. Using data from Chile and other emerging economies, we document that low-income households spend relatively more on food while high-income households spend more on services.

Motivated by these observations, we build a model for a commodity-exporting economy with non-homothetic preferences, in which expenditure shares are endogenous and depend on the level of income. In the model, households have differential access to financial markets, so not all of them can smooth consumption, inducing heterogeneity in income and expenditures. After a positive commodity price shock, every household increases their income and consume more. However, the gains are biased towards agents who have access to financial markets and profit from firms. In terms of the mechanisms, non-homothetic preferences dampen the microeconomic and aggregate impact of the shock because they induce a reallocation effect on the consumption basket towards more income elastic goods (services). At the same time, heterogeneity amplifies the responses by giving a more relevant role to a fraction of agents with a higher marginal propensity to consume.

[21] By the same arguments, the response of aggregate consumption hardly changes with the elasticity of substitution in a RANK model.

These findings contribute to our understanding of the effects and transmission of trade and commodity price shocks to small open economies and the role that heterogeneity (either in terms of income or consumption) plays in shaping the response to those shocks.

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A Empirical Appendix

A.1 Expenditures Across the Income Distribution–Disaggregation

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 Expenditures Across the Income Distribution–Disaggregation

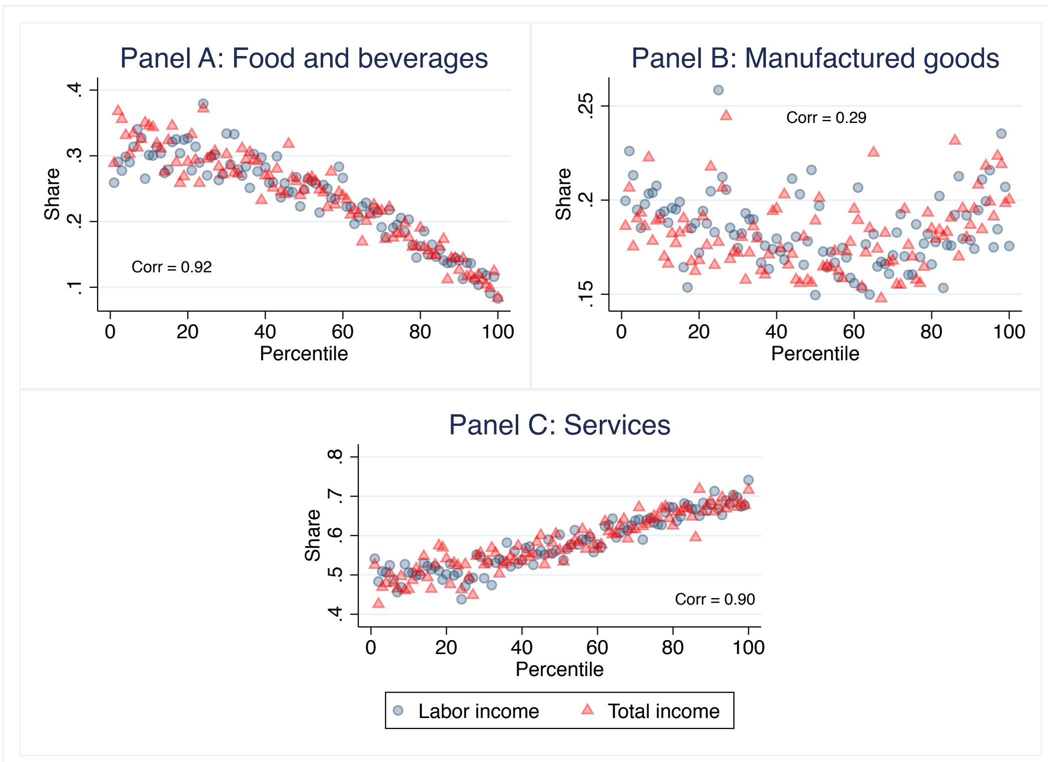
		Income Percentile					
Code	Consumption Division	P10	P25	P50	P75	P90	Average
Panel A: Food and Beverages							
01	Food and non-alcoholic beverages	0.325	0.276	0.232	0.160	0.110	0.186
02	Alcoholic beverages, tobacco	0.021	0.020	0.016	0.021	0.016	0.018
	Total	0.346	0.295	0.248	0.181	0.126	0.204
Panel 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 expenditures shares 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). Each column denotes percentiles 10, 25, 50, 75 and 90, and average consumption, respectively.

A.2 Expenditures Across the Labor Income Distribution

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

FIGURE A.1. Consumption Expenditures Across the Labor Income Distribution

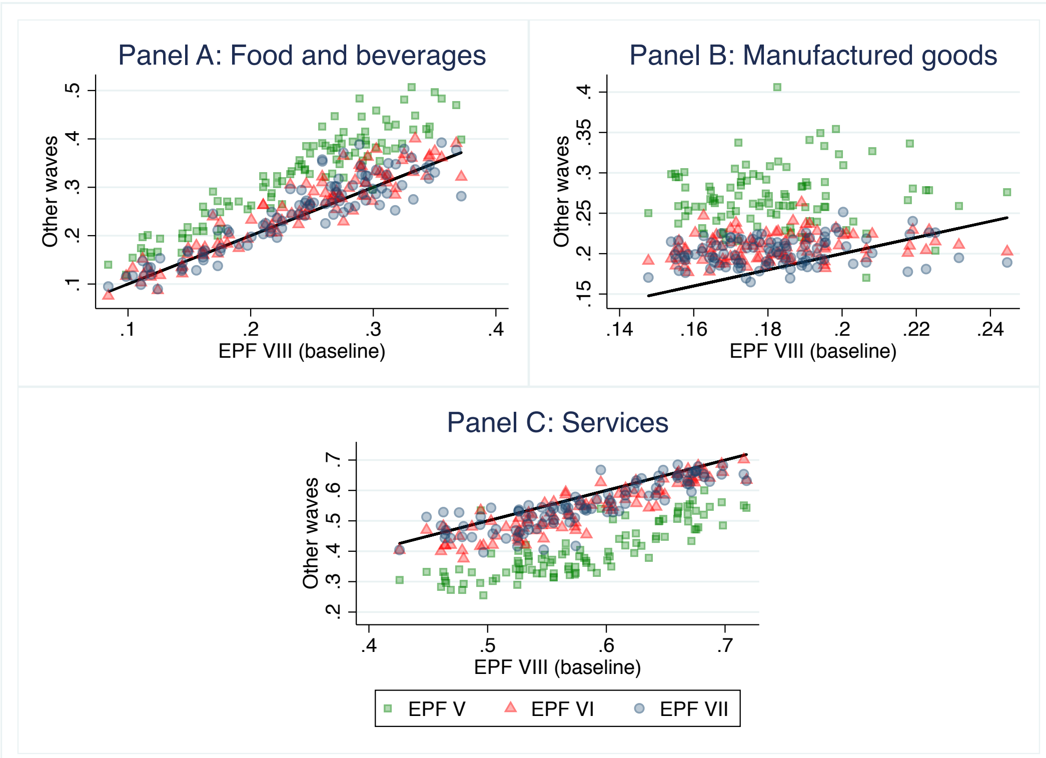


NOTES: This figure compares expenditure shares for households in each percentile of the income distribution vs percentiles in labor income distribution. On every panel, each dot/triangle corresponds to a percentile.

A.3 Expenditures Across the Income Distribution–Comparison Across Waves

Figure A.2 compares the distribution of consumption expenditures across different waves of the Consumption Expenditure Survey, EPF. The baseline wave (EPF VIII of the year 2017) is on the x-axis on each panel, while the alternative waves correspond 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) are on the y-axis. On each panel, every point shows the expenditure share in the respective kind of good in EPF VIII against other survey waves. As can be seen, except for manufactured goods, the expenditure patterns documented in the main text are relatively stable over time. For example, in the case of food and beverages, the correlations with the baseline year are above 0.9, while for services they are above 0.8.[22] Note that the most considerable differences in levels are with EPF V because of the distance in time with EPF VIII (20 years). In particular, food and beverages account for a more significant fraction of expenditures in EPF V, while the opposite happens in services.

Figure A.2. Comparison Across Waves of the Consumption Expenditures Survey



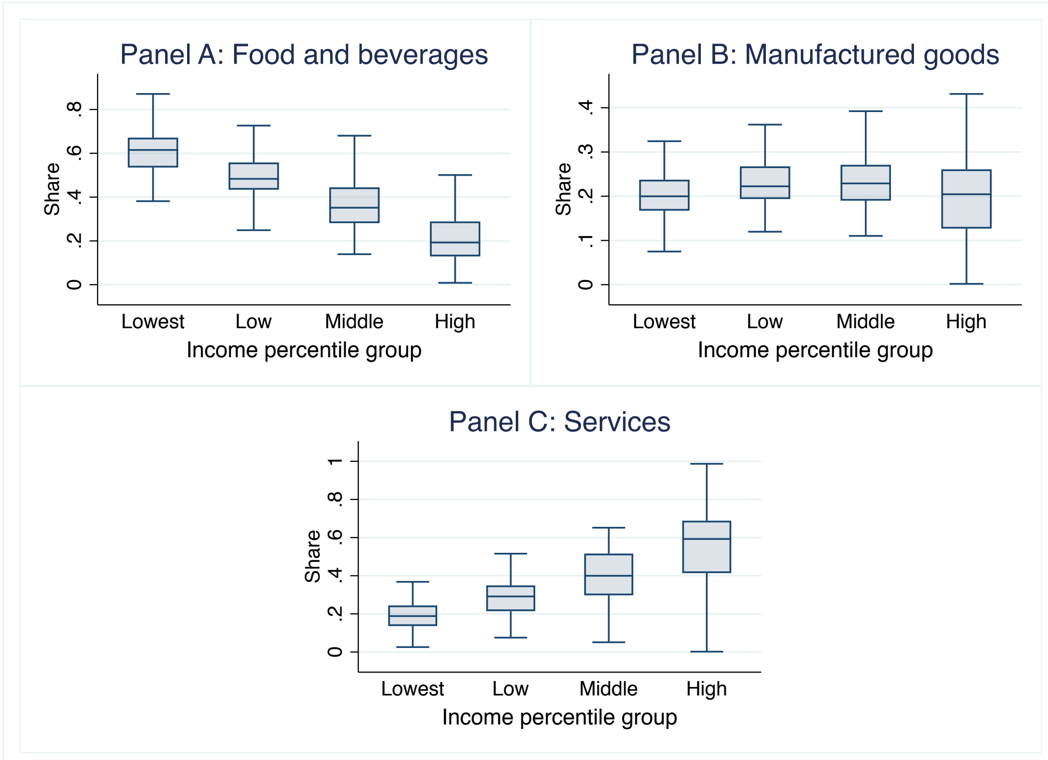
Notes: This figure compares expenditure shares for households in each percentile of the income distribution between different waves of the Consumption Expenditure Survey (EPF). On every panel, each point corresponds to a percentile. The black solid line denotes 90-degree line.

A.4 Expenditures Across the Income Distribution–Other Emerging Economies

Figure A.3 presents expenditure patterns across the income distribution in 90 emerging economies. As in the case of Chilean data, there is a decreasing pattern for food and beverages, a flat pattern for manufactured goods, and an increasing pattern for services.

[22]More precisely, the correlation of food is 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.

FIGURE A.3. Consumption Expenditures in Emerging Economies



NOTES: This figure presents expenditure shares across the income distribution in 90 emerging economies. Each figure shows the expenditure share across the income distribution according to the World Bank's Global Consumption Database. The lowest consumption segment corresponds to the bottom half of the global distribution, or the 50th percentile and below; the low consumption segment to the 51th-75th percentiles; the middle consumption segment to the 76th-90th percentiles; and the higher consumption segment to the 91st percentile and above. Each box presents the median and interquartile range.

Table A.2 presents descriptive statistics on consumption expenditures across the income distribution in 90 emerging economies, separating by groups of countries. Panel A shows statistics for the full set of countries. Panel B shows statistics for commodity-dependent economies (55 countries) defined by UNCTAD (2019), while Panel C shows statistics for non-dependent economies (35 countries). As can be noticed, the decreasing (increasing) patterns in consumption expenditures in food (services) across the income distribution is stable across these different sets of countries.

Table A.2. Consumption Expenditures in Emerging Economies–Disaggregation

	Food and Beverages				Manufactures				Services			
	Lowest	Low	Middle	Higher	Lowest	Low	Middle	Higher	Lowest	Low	Middle	Higher
Panel A: All Countries												
Mean	0.600	0.491	0.372	0.242	0.206	0.226	0.232	0.211	0.194	0.283	0.396	0.547
Median	0.615	0.483	0.352	0.193	0.200	0.222	0.229	0.205	0.188	0.291	0.400	0.593
Std. Dev.	0.106	0.111	0.140	0.179	0.062	0.058	0.072	0.121	0.083	0.096	0.138	0.200
Panel B: Commodity Dependent Countries												
Mean	0.605	0.488	0.370	0.232	0.208	0.231	0.234	0.198	0.186	0.281	0.395	0.570
Median	0.616	0.479	0.348	0.178	0.210	0.229	0.233	0.191	0.183	0.292	0.406	0.625
Std. Dev.	0.097	0.110	0.151	0.193	0.063	0.060	0.074	0.113	0.071	0.092	0.139	0.201
Panel C: Non-commodity Dependent Countries												
Mean	0.593	0.494	0.374	0.255	0.202	0.219	0.229	0.230	0.205	0.286	0.397	0.515
Median	0.612	0.485	0.357	0.223	0.196	0.206	0.209	0.210	0.206	0.291	0.391	0.547
Std. Dev.	0.121	0.112	0.123	0.160	0.062	0.055	0.069	0.129	0.100	0.104	0.139	0.198

Notes: This table presents descriptive statistics on the consumption expenditure shares across the income distribution in 90 emerging economies. Each column presents expenditure shares in food and beverages, manufactured goods, and services. Each consumption group is separated across the income distribution according to the World Bank's Global Consumption Database: the lowest consumption segment corresponds to the bottom half of the global distribution, or the 50th percentile and below; the low consumption segment to the 51th-75th percentiles; the middle consumption segment to the 76th-90th percentiles; and the higher consumption segment to the 91st percentile and above.

B Theoretical Appendix

B.1 Households' Problem

This section summarizes the optimization problems of households and their optimality conditions.

B.1.1 Intratemporal Consumption Allocation

The expenditure minimization problem of household h is

$$\min_{C^h_{jt}} \sum_{j=1}^{N} P_{jt} C^h_{jt} + \lambda^h_t \left[1 - \sum_{j=1}^{N} (\omega_j (C^h_t)^{\epsilon_j})^{\frac{1}{\sigma}} (C^h_{jt})^{\frac{\sigma-1}{\sigma}} \right],$$

where the Lagrange multiplier λ^h_t is household specific.

The first order condition for any good j reads as

$$P_{jt}C_{jt}^h = \lambda_t^h \left(\frac{\sigma-1}{\sigma}\right)(\omega_j (C_t^h)^{\epsilon_j})^{\frac{1}{\sigma}}(C_{jt}^h)^{\frac{\sigma-1}{\sigma}}.$$

Using this condition and the definition of the consumption aggregator, total expenditures are

$$E_t^h = \sum_{j=1}^N P_{jt}C_{jt}^h = \lambda_t^h \left(\frac{\sigma-1}{\sigma}\right),$$

so the expenditure share of good j for household h is

$$s_{jt}^h \equiv \frac{P_{jt}C_{jt}^h}{E_t^h} = (\omega_j (C_t^h)^{\epsilon_j})^{\frac{1}{\sigma}}(C_{jt}^h)^{\frac{\sigma-1}{\sigma}},$$

which implies that each summand in the consumption aggregator corresponds to the equilibrium expenditure share.

Using the latter expression, we can get the demand for each sectoral good and its expenditure share

$$\begin{aligned} C_{jt}^h &= \omega_j \left(\frac{P_{jt}}{P_t^h}\right)^{-\sigma} (C_t^h)^{\epsilon_j+\sigma} \\ s_{jt}^h &= \omega_j \left(\frac{P_{jt}}{P_t^h}\right)^{1-\sigma} (C_t^h)^{\epsilon_j-(1-\sigma)}, \end{aligned}$$

where we use the fact that P_t^h is the relevant price index for household h in period t, such that $E_t^h = P_t^h C_t^h$.

By replacing this demand in the aggregator, the price index for the household is defined by

$$P_t^h = \left[\sum_{j=1}^N \omega_j P_{jt}^{1-\sigma}(C_t^h)^{\epsilon_j+\sigma-1}\right]^{\frac{1}{1-\sigma}}.$$

Defining $\vartheta_j \equiv \frac{1-\sigma}{\epsilon_j}$, a more intuitive expression for the price index, that only depends on observables, can be written as follows

$$P_t^h = \left[\sum_{j=1}^N (\omega_j P_{jt}^{1-\sigma})^{\vartheta_j}(s_{jt}^h {E_t^h}^{1-\sigma})^{1-\vartheta_j}\right]^{\frac{1}{1-\sigma}}$$

On the other hand, the expenditure function reads as

$$E_t^h = \left[\sum_{j=1}^{N} \omega_j P_{jt}^{1-\sigma} (C_t^h)^{\epsilon_j}\right]^{\frac{1}{1-\sigma}}$$

Importantly, note that the elasticity of expenditure with respect to aggregate consumption is

$$\eta_C^E \equiv \frac{\partial E_t^h}{\partial C_t^h}\frac{C_t^h}{E_t^h} = \frac{1}{1-\sigma}\sum_{j=1}^{N} \epsilon_j \omega_j \left(\frac{P_{jt}}{E_t^h}\right)^{1-\sigma} (C_t^h)^{\epsilon_j} = \frac{1}{1-\sigma}\sum_{j=1}^{N} s_{jt}^h \epsilon_j = \frac{\bar{\epsilon}_t^h}{1-\sigma}, \tag{B.1}$$

where the third equality comes from the definition of the expenditure share (using expenditures instead of the aggregate price), and where $\bar{\epsilon}_t^h \equiv \sum_{j=1}^{N} s_{jt}^h \epsilon_j$ is the expenditure-weighted average of income elasticity, which is time-varying and household-dependent.

For comparison, note that in the homothetic case, $\epsilon_j = 1-\sigma$ for every j, and all the previous conditions collapse to the familiar CES demand system, in which the expenditure share of each good and the CPI do not depend on the level of consumption. Also, note that expenditure elasticity equals one in every period and for every household.

B.1.2 Intertemporal Problem for the Unconstrained Household

The Lagrangian of this problem can be written as

$$\mathcal{L} = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \Bigg\{ \frac{1}{1-\varsigma}(C_t^u)^{1-\varsigma} - \frac{\kappa^u}{1+\varphi}(N_t^u)^{1+\varphi} + \lambda_t^u \Bigg[W_t^u N_t^u + R_{t-1}\frac{B_{t-1}}{1-\lambda} + \mathcal{E}_t R_{t-1}^* \frac{B_{t-1}^*}{1-\lambda} + \frac{D_t}{1-\lambda} - E_t^u - \frac{B_t}{1-\lambda} - \mathcal{E}_t \frac{B_t^*}{1-\lambda} \Bigg] \Bigg\},$$

where λ_t^u is the Lagrange multiplier. The first order conditions of this problem are

$$C_t^u: \qquad (C_t^u)^{-\varsigma} = \lambda_t^u \frac{\partial E_t^u}{\partial C_t^u}$$

$$B_t: \qquad \lambda_t^u = \beta R_t \mathbb{E}_t[\lambda_{t+1}^u]$$

$$B_t^*: \qquad \lambda_t^u = \beta R_t^* \mathbb{E}_t\left[\lambda_{t+1}^u \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}\right]$$

$$N_t^u: \qquad \kappa^u (N_t^u)^{\varphi} = \lambda_t^u W_t^u.$$

From equation (B.1) and the fact that $E_t^h = P_t^h C_t^h$, we get $\frac{\partial E_t^h}{\partial C_t^h} = P_t^h \frac{\bar{\epsilon}_t^h}{1-\sigma}$, which implies that the Lagrange multiplier can be written as $\lambda_t^u = (C_t^u)^{-\varsigma}\left(\frac{1-\sigma}{\bar{\epsilon}_t^u}\right)\frac{1}{P_t^u}$. Replacing in the rest of optimality conditions we get

$$1 = \beta R_t \mathbb{E}_t \left\{ \left(\frac{C^u_{t+1}}{C^u_t} \right)^{-\varsigma} \frac{\overline{\epsilon}^u_t}{\overline{\epsilon}^u_{t+1}} \frac{P^u_t}{P^u_{t+1}} \right\}$$
$$1 = \beta R^*_t \mathbb{E}_t \left\{ \left(\frac{C^u_{t+1}}{C^u_t} \right)^{-\varsigma} \frac{\overline{\epsilon}^u_t}{\overline{\epsilon}^u_{t+1}} \frac{P^u_t}{P^u_{t+1}} \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right\}$$
$$\frac{W^u_t}{P^u_t} = \kappa^u (C^u_t)^{\varsigma} (N^u_t)^{\varphi} \frac{\overline{\epsilon}^u_t}{1-\sigma},$$

as in the main text.

B.1.3 Intertemporal Problem for the Restricted Household

As mentioned in the main text, the restricted household must solve for consumption and labor supply in a period-by-period basis. The Lagrangian is

$$\mathcal{L} = \frac{1}{1-\varsigma}(C^r_t)^{1-\varsigma} - \frac{\kappa^r}{1+\varphi}(N^r_t)^{1+\varphi} + \lambda^r_t \Big[W^r_t N^r_t - E^r_t \Big].$$

The first order conditions are

$$C^r_t: \qquad (C^r_t)^{-\varsigma} = \lambda^r_t \frac{\partial E(C^r_t)}{\partial C^r_t}$$
$$N^r_t: \qquad \kappa^r (N^r_t)^{\varphi} = \lambda^r_t W^r_t.$$

As in the unconstrained problem, the Lagrange multiplier can be expressed as $\lambda^r_t = (C^r_t)^{-\varsigma} \left(\frac{1-\sigma}{\overline{\epsilon}^r_t} \right) \frac{1}{P^r_t}$, so the labor supply equation is

$$\frac{W^r_t}{P^r_t} = \kappa^r (C^r_t)^{\varsigma} (N^r_t)^{\varphi} \frac{\overline{\epsilon}^r_t}{1-\sigma}.$$

Together with the budget constraint, this equation characterize the optimality conditions of the constrained household.

C Quantitative Appendix

C.1 Calibration

Predetermined Parameters. Table C.1 summarizes the set of predetermined parameters of the model. The parameter of risk aversion is set to one, while the Frisch elasticity is to 0.54 (Chetty et al., 2011). The discount factor is to get a domestic interest rate of 5.8 percent at a yearly frequency, in line with Garcia-Schmidt and Garcia-Cicco (2020). The demand taste shifters are set to match steady-state consumption shares of 0.20, 0.19, and 0.61 for food, d goodsand services, respectively (see Table A.1). In the baseline analysis, labor supply elasticity is set equal to 1 for both households ($\varrho^r = \varrho^u = 1$), implying limited labor mobility across sectors and the same wage index, which minimizes the role of income heterogeneity.

For sectors, the elasticity of substitutions across varieties is set to 10, implying a steady-state level of sectoral profits close to 11 percent, among the values of the New Keynesian literature. The parameters associated with the production functions of mainland and commodity sectors come from the Input-Output (IO) table for Chile of the year 2017. In line with the empirical application of Section 2, we aggregate the 111 sectors in the IO table to get the same sectors (food, manufactures, and services).[23] Services are more labor-intensive than the rest of the sectors ($\alpha_s = 0.48$), while food is the sector that uses less labor ($\alpha_f = 0.17$). On the other hand, the usage of imports for production is more intensive in the food sector and significantly less relevant for services. This is consistent with the notion that services are non-tradable, while food and manufactures are tradable.

To calibrate the level of price rigidities, we follow Pasten et al. (2020) and compute the average frequency of price adjustment for goods in the different categories. Then, using the microdata underlying the construction of the official Chilean CPI for 2010-2018, we compute the ratio between the number of price changes over the total number of periods available for each product. Then, we aggregate at the three-sector classification level to get the behavior of food, manufactures, and services. Finally, the level of price rigidity is one minus the obtained level. With this procedure, we obtain values of $\theta_f = 0.27$, $\theta_m = 0.46$, and $\theta_s = 0.59$, implying that the price of food and beverages are relatively more flexible than the price of manufactures and services.

The values for the monetary policy rule are standard in the literature, with a central bank reacting aggressively to movements in inflation. The world interest is taken from Garcia-Schmidt and Garcia-Cicco (2020) and set to 4.5 percent in annual terms. We set the long-run value of foreign bonds to match a ratio of trade balance-to-GDP of 8 percent in the steady-state. Finally, the persistence of the autoregressive process for the commodity price is 0.7123.

Other Parameters. The final set of parameters corresponds to the foreign demand shifter and elasticities of demand (ω^x and η^*), and the risk-premium of the interest rate (ϕ_b). We normalize $\omega^x = 1$. We run an empirical structural VAR (SVAR) with one lag to choose the remaining

[23] The commodity sector corresponds to all mining activities in the economy. We exclude agriculture and fishing.

parameters. The model includes the real value of copper (dollars deflated by US CPI) as the relevant commodity price for Chile, gross domestic product, consumption, the trade balance to GDP ratio, inflation, and the real exchange rate. We estimate the model with quarterly data between 1996 and 2018. The identifying assumption is that the commodity price does not react to domestic conditions. To estimate the model parameters, we minimize the distance between the empirical and the model-implied responses for consumption and the trade balance to GDP, using as a weighting matrix the inverse of the interquartile range used to compute the confidence interval of the empirical response. Figure C.1 compares the empirical SVAR and the theoretical model. This procedure delivers the following values: $\eta^* = 3.01$ and $\phi_b = 0.013$.

Market Incompleteness. To calibrate the fraction of hand-to-mouth agents in the economy, we rely on data from the Household Financial Survey (*Encuesta Financiera de Hogares* in Spanish, or EFH). EFH is a survey about financial assets and debts of Chilean households that the Central Bank of Chile has implemented since 2007. Currently, there are seven waves (2007, 2008, 2009, 2010, 2011, 2014, and 2017) in which waves 2007 and 2011-2017 are representative at the national level, while the rest is representative at the level of Santiago Metropolitan area.

We follow two approaches to identify the fraction of hand-to-mouth agents in the economy. (See Aguiar et al. (2021) for a summary.) Following Zeldes (1989), our first measure denotes a household as financially constrained if its *total* net worth is less than two months of labor earnings. Note that the previous measure considers the total amount of assets and liabilities, with no distinction on their degree of liquidity. To account for these differences, following Kaplan et al. (2014), we construct a second measure of market incompleteness by using a notion of *liquid* net worth. In this case, a household is financially constrained if its liquid net worth is less than 30% of aggregate income. Such measure captures the idea that a relevant fraction of households have little or no liquid wealth to use for consumption expenditures, even if they have large amounts of illiquid wealth (carrying a transaction cost). Table 2 in the main text presents the results.

To compute both measures, we use the following variables

- Labor earnings: main source per household member, including additional income related to the main occupation and income from secondary occupations.

- Total net worth: is the sum of total income plus total assets, net of total liabilities. Income comes from labor income, transfers, and imputed household rent. Total assets include housing, other real estate, vehicles, machinery and other real assets, financial assets (variable and fixed income), and checking and saving balances. Finally, liabilities is the sum of the (net present value of) mortgage debt, credit card debt, banking loans, and other loans and debts.

- Liquid net worth: is the sum of fixed income assets, variable income assets, and checking and saving balances, net of total non-mortgage debt. The latter includes credit card debt, banking loans, and other loans.

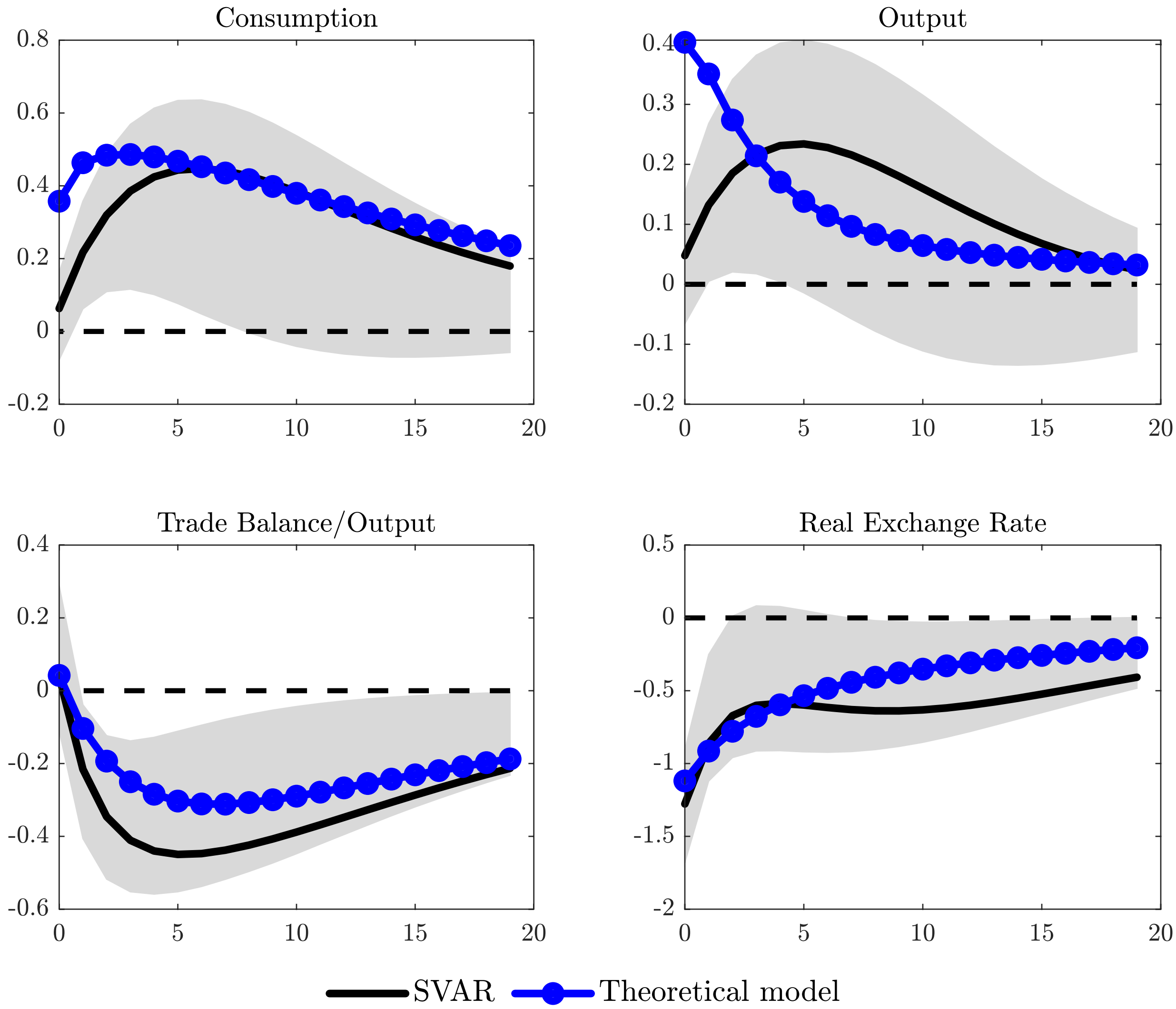
How do these figures compare with other countries? Unfortunately, as in the case of expenditure patterns, analyzing the degree of market incompleteness across countries is a difficult task because of data availability and comparison scope. However, we can compare with some country-specific cases. For example, using data from the Panel Study of Income Dynamics (PSID) in the U.S., Aguiar et al. (2021) finds that 17.3% of the population is hand-to-mouth by using the liquidity measure of net worth. Kaplan et al. (2014), using liquid net worth for comparison, finds that 31% of the population is financially constrained in the U.S. They find similar figures compared with other developed countries (Australia, Canada, France, Germany, Italy, and United Kingdom). More recently, Almgren et al. (forthcoming) documents that the fraction of hand-to-mouth agents in the Euro Area ranges from 10% in Malta to 65% in Latvia.

In the case of emerging economies, there is more scarce evidence. One particular exception is Cugat (2019). Using data from Mexico in 1994, she documents that 58% of the population is financially constrained. On the other hand, Anand et al. (2015) uses data from the World Bank's Global Findex Database about access to formal financial services. The authors document that 58 percent of the population is financially constrained in the median developing country. Therefore, Chile lives in between the cases of developed and emerging economies.

Table C.1. Predetermined Parameters

Variable	Parameter	Value
Panel A: Households		
ς	Risk aversion	1
φ	Frisch elasticity	1/0.54
β	Discount factor	$R = 1.058$
ω_j	Taste shifter	Avg. consumption expenditures
λ	Share constrained agents	0.42
ϱ^h	Elasticity of substitution (labor)	1
χ_j^h	Labor supply shifter	1
Panel B: Sectors		
ε	Elasticity of substitution (varieties)	10
α_j	Labor share	IO (2017)
μ_j	Materials share	IO (2017)
γ_{ij}	Production linkages	IO (2017)
θ_j	Price rigidities (Calvo)	Frequency of price adjustment
α_c	Labor share (commodity)	IO (2017)
μ_c	Materials share (commodity)	IO (2017)
ψ_j	Share on exports	IO (2017)
Panel C: Monetary Policy and Aggregates		
ϕ_π	Weight of inflation	1.25
ϕ_y	Weight of GDP	0.125
R^w	World interest rate	1.045
$\bar{b}$	Interest rate premium	TB/GDP=0.08
ρ_1	Commodity price AR(1)	0.7123

FIGURE C.1. Impulse-response Function to a 10% Commodity Price Shock



NOTES: Each grey area corresponds to the 95% confidence intervals computed with bootstrap with 100,000 replications. The SVAR model includes, as exogenous controls, a constant term and linear and quadratic time trends. Horizontal axes in quarters. Vertical axes correspond to percentage deviations with respect to trend (for empirical model) and percentage deviations with respect to steady-state (for model-implied responses), except for trade balance/GDP (in deviations).

C.2 Additional Quantitative Results

C.2.1 Macroeconomic Aggregates

Table C.2 presents the response (on impact and in a horizon of 20 quarters) of macroeconomic aggregates to a 10 percent commodity price shock for different calibrations of the model. As can be noticed, inflation and the real interest rate react the most in the TANK model, especially with NH preferences. Something similar happens for the real exchange rate. The output response reflects a partial counteraction of the trade balance and consumption across models.

Table C.2. Macroeconomic Aggregates under Different Specifications of the Model

	Output	Consumption	Inflation	Real Interest Rate	Trade Balance	Real Exchange Rate
Panel A: TANK-NH						
Impact	0.403	0.358	0.105	0.127	0.042	-1.119
Cumulative	2.370	7.477	3.843	0.161	-4.698	-9.036
Panel B: TANK-H						
Impact	0.539	0.515	0.081	0.114	0.022	-1.040
Cumulative	3.678	8.921	2.836	0.111	-4.823	-8.035
Panel C: RANK-NH						
Impact	0.373	0.241	0.073	0.103	0.121	-1.059
Cumulative	2.274	7.524	1.792	0.076	-4.829	-9.279
Panel D: RANK-H						
Impact	0.477	0.351	0.047	0.085	0.115	-0.979
Cumulative	3.593	8.971	0.929	0.031	-4.947	-8.247

Notes: This table compares the impact and cumulative response of macroeconomic aggregates under different specifications of the model. TANK (RANK) denotes the model with two agents (representative agent). H (NH) denotes the model with homothetic (non-homothetic) preferences. All responses are in percentage deviations with respect to steady-state, except for the trade balance (in deviations and relative to GDP).

C.2.2 Sensitivity

Table C.3 presents the impact response of macroeconomic aggregates to a 10 percent commodity price shock for different calibrations of the TANK-NH model. Most macroeconomic aggregates move in the same direction of consumption for the different sensitivity exercises. Of particular interest are the changes in inflation, real interest, and output response.

Table C.3. Macroeconomic Aggregates–Sensitivity

	Output	Consumption	Inflation	Real Interest Rate	Trade Balance	Real Exchange Rate
Panel A: Labor Mobility						
$\varrho = 0.9$	0.515	0.454	0.115	0.145	0.056	-1.315
$\varrho = 1$	0.403	0.358	0.105	0.127	0.042	-1.119
$\varrho = 1.1$	0.306	0.273	0.097	0.111	0.031	-0.945
Panel B: Market Incompleteness						
$\lambda = 0$	0.373	0.241	0.073	0.103	0.121	-1.059
$\lambda = 0.42$	0.403	0.358	0.105	0.127	0.042	-1.119
$\lambda = 6$	0.415	0.422	0.126	0.140	-0.006	-1.159
Panel C: Elasticity of Substitution						
$\sigma = 0$	0.492	0.528	0.101	0.135	-0.033	-1.187
$\sigma = 0.27$	0.403	0.358	0.105	0.127	0.042	-1.119
$\sigma = 0.6$	0.342	0.222	0.104	0.117	0.110	-1.060
Panel D: Income Elasticity of Services						
$\epsilon_s = 1$	0.427	0.394	0.105	0.130	0.030	-1.121
$\epsilon_s = 1.11$	0.403	0.358	0.105	0.127	0.042	-1.119
$\epsilon_s = 1.3$	0.374	0.312	0.106	0.124	0.057	-1.118

Notes: This table presents the impact response of macroeconomic aggregates in the TANK-NH model under different calibrations. All responses are in percentage deviations with respect to steady-state, except for the trade balance (in deviations and relative to GDP).

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