# Pricing Inequality*

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*Preliminary and incomplete - Do not circulate*

**Abstract**

This paper studies household inequality and product market power in general equilibrium. Heterogeneous households face the standard income fluctuations problem and have idiosyncratic preferences over a continuum of goods. Heterogeneous firms produce these varieties and set their price as oligopolistic competitors given the endogenous distribution of demand. We show how households' savings motives and incomplete insurance endogenously lead to variation in household-level price elasticities with wealth and income, and that this is consistent with recent empirical evidence. In the stationary equilibrium, firms' market power varies as households with different price-sensitivities differentially select into high- and low-price varieties by wealth and income. Under standard preferences, high quality firms sell high marginal cost goods at higher prices to richer households, endogenously face less elastic demand, and set higher markups. Quantitatively, we show that a one-time fiscal transfer to households leads to a medium run decline in TFP due to two effects (i) poor households trade up to higher marginal cost goods, (ii) these goods' markups increase as poor households' demand becomes less elastic.

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# 1. Introduction

Since the start of 2021, the US economy experienced large increases in the prices for goods and services. Simultaneously, a multitude of shocks affected the US economy: supply-side disruptions, large scale fiscal stimulus, and gains in housing (and stock market) wealth. These observations provoke questions about how these shocks feed through into prices and for whom. Who feels the burden of higher prices as supply shocks pass-through the economy? What role do fiscal transfers and wealth shocks play in the rise in inflation over the past two years?

This paper develops, tests and applies a framework where household inequality determines how shocks (e.g. productivity, wealth, fiscal transfers) pass-through to prices versus quantities. The framework we develop is a general equilibrium model in which (i) a central outcome is household heterogeneity in price elasticities of demand (ii) heterogeneous firms strategically price their products given the equilibrium composition of households they sell to. This provides a laboratory we can apply to study macro- and micro-responses of (i) household consumption and saving, (ii) firm pricing and production, to various shocks on either the demand side (e.g. fiscal transfers of wealth) or supply side (e.g. idiosyncratic or sectoral shocks) of the economy.

Recent empirical findings motivate the core ideas in the paper and allow us to test our theory. Auer, Burstein, Lein, and Vogel (2022) find low income households are more price sensitive than high income households by studying substitution patterns in response to an unexpected appreciation of the Swiss Franc. Stroebel and Vavra (2019) find that across regions in the US, when house prices increases, markups on local retail goods also increase. In totality, this evidence suggests a role for consumer heterogeneity in income and wealth in determining how firms price their products.

Our framework builds on several canonical models in economics. On the demand side, heterogeneity is introduced through the standard incomplete markets tradition (Huggett, 1993; Aiyagari, 1994). We interact this with a nested-logit demand system where households make a discrete choice over different varieties of consumption. This delivers heterogenous elasticities of demand and differential sorting of households across the product space. In a nutshell, low income / low wealth households strongly value the resources left over after purchasing a good, making them more sensitive to prices when deciding which product to buy, leading them to sort into relatively cheaper varieties.

The supply side interacts non-trivially with demand as heterogenous firms set prices strategically given the distribution of demand they face and competitors' prices. These strategic motives are also shaped by household heterogeneity as in a departure from "nested-CES" settings (e.g. Atkeson and Burstein, 2008), a firm's market power depends not on its overall size, but how large it is in the basket of the consumers it sells to.[1] We further characterize a firm's *super-elasticity*—a core object determining how a firm's price responds to changes in marginal cost—and connect it to strategic motives and the marginal propensities to consume of the customers the firm faces.

[1]Dollar General in the US is a good example of this tension. They typically face poor / high price elastic consumers, which is a force toward a low markup. But it operates in rural locations with few competitors and, thus, has a lot of market power with respect to them.

**Overview.** The rest of this paper proceeds as follows. Section 2 describes the model environment, defines an equilibrium, and provides a set of propositions characterizing demand elasticities, sorting and pass-through. Section 3 calibrates the model. Section 4 studies the quantitative properties of the model in steady-state. Section 5 shows how the model qualitatively and quantitatively replicates Auer et al. (2022) and Stroebel and Vavra (2019). Section 6 studies the transition dynamics of the economy following a lump-sum fiscal transfer. Section 7 concludes.

# 2. Model

In Section 2.1 we describe the model, Section 2.2 defines general equilibrium across markets and Nash equilibrium within markets, Section 2.3 provides analytical characterizations of key model objects.

## 2.1. Environment and decision problems

Time is discrete. The economy contains three different types of agents: a continuum of firms, a continuum of households and a government. Firms are heterogeneous in the goods they produce and their productivity. Households are heterogeneous in their assets, labor productivity and preferences for goods. Fiscal policy is passive: the government taxes labor income to fund government spending and interest payments on debt, which is held by households.

**Goods, Varieties, and Firms.** Two types of goods are characterized by heterogeneity in production and preferences, implying different competitive structures. A "homogenous good" is produced by many homogeneous firms, hence product markets are competitive. A "differentiated good" is produced by many heterogeneous firms. Many sectors produce differentiated goods, with a finite number of firms in each sector, hence product markets are oligopolistic.

**Competitive Good.** The homogeneous good, which we also call the *competitive good*, is produced by firms with a linear technology. We consider a representative firm, with output and profits:

$$Y_c = Z_c N_c \quad , \quad \Pi_c = P_c Y_c - W N_c.$$

where subscripts denote the sector. Output depends on total factor productivity $Z_c$ and efficiency units of labor $N_c$, hired in a competitive labor market at price $W$.[2] Competition implies price equals marginal cost:

$$P_c = MC_c \quad , \quad MC_c = W/Z_c. \tag{1}$$

We choose $P_c$ as the numeraire and normalize it to one, thus, all other prices are relative to the price of the competitive good. Infinitely elastic demand for labor in the competitive sector implies $W = Z_c$ in all periods.

**Differentiated Goods.** We split varieties into $m \in \{1, \ldots, M\}$ markets. Within each market there are $j_m \in \{1, \ldots, J_m\}$ firms producing a unique variety, hence a firm, varieties, and goods

[2] Labor is freely mobile across sectors, so $W$ is independent of sector.

are synonymous. The total number of markets $M$ is so large, that firms within a market view themselves as infinitesimal with respect to all other markets. However, the number of competitors $J_m$ within a market is finite and firms understand that they have influence over their competitors within the market. These firms also operate a linear technology, hiring $n_{jm}$ efficiency units of labor:

$$y_{jm} = Z_m z_{jm} n_{jm} \quad , \quad \pi_{jm} = p_{jm} y_{jm} - W n_{jm} \, , \tag{2}$$

where $z_{jm}$ is a firm specific and $Z_m$ controls market $m$ productivity.

**Differentiated Goods Firms' Problem.** Here we describe the problem of the firm in the differentiated goods sector. The first step is an assumption about what the game is and what the firm perceives it can influence.

**Assumption 1** *Firms play a static game of price competition. Specifically, each firm $jm$ chooses its price, taking as given the prices of its competitors in the market $\boldsymbol{p}_{-jm}$, as well as the aggregates that we gather in $\boldsymbol{S} = \{W, R, P_c\}$. Each firm in market $m$ recognizes that market $m$ quantities and prices vary when that firm changes its price.*

This assumption is as in Atkeson and Burstein (2008) but with price competition.

The firm chooses its price and labor inputs to maximize profits $\pi_{jm}$, given its perceived demand curve $x(p_{jm};\, \boldsymbol{p}_{-jm}, \boldsymbol{S}\,)$:

$$\pi_{jm} = \max_{p_{jm}, n_{jm}} \; p_{jm} x\big(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S}\,\big) - W n_{jm}, \quad \text{subject to} \quad x\big(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S}\,\big) = Z_m z_{jm} n_{jm}. \tag{3}$$

Firm $jm$'s perceived demand curve is a function of it's product at price $p_{jm}$, aggregates $\boldsymbol{S}$ and the vector of prices at the firm's competitors' in market $m$, denoted $\boldsymbol{p}_{-jm}$. The firm's profit maximizing price can be expressed a markup over marginal cost:[3]

$$p_{jm} = \mu_{jm} \times mc_{jm} \quad , \quad \mu_{jm} = \frac{\varepsilon_j(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S})}{\varepsilon_j(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S}) - 1} \quad , \quad mc_{jm} = \frac{W}{Z_m z_{jm}} \quad , \tag{4}$$

where $\varepsilon(p_{jm};\, \boldsymbol{p}_{-jm}, \boldsymbol{S})$ is the elasticity of demand for firm $jm$'s product, defined as

$$\varepsilon(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S}) := -\frac{\partial x(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S}\,)/x(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S}\,)}{\partial p_{jm}/p_{jm}}\bigg|_{\boldsymbol{p}_{-jm}}. \tag{5}$$

Here the Bertrand-Nash structure of the market equilibrium is already being assumed. All firms take their competitors prices $\boldsymbol{p}_{-jm}$ as given, and choose their single-shot best response $p_{jm}$.

**Key contribution.** The core idea of this paper is to explore a world where $\varepsilon_j(p_{jm};\, \boldsymbol{p}_{-jm},\, \boldsymbol{S})$ depends on the distribution of demand from an economy of endogenously wealthy and poor households choosing their consumption of goods, and savings while subject to idiosyncratic, aggregate and policy shocks.

This is in contrast to economies where there is, say, a representative consumer and preferences "technologically" determine $\varepsilon_j(p_{jm};\, \boldsymbol{p}_{-jm})$. As an example, with CES and monopolistic

[3]The assumption of constant marginal cost is not for computational tractability. We have solved and analyzed the case with increasing marginal cost ($y_{jm} = Z_m z_{jm} n_{jm}^{\alpha},\ \alpha < 1$), which we have found to impose no additional computational burden given the fixed point in $p_{jm}$ that we already solve. We discuss this in Section 2.

competition, the markup simply reflects the representative consumer's elasticity of substitution. With 'Kimball' demand and monopolistic competition, markups are richer, but elasticities still are independent of the distribution of households. With nested CES and Assumption 1, markups endogenously depending upon a firm's size as in Atkeson and Burstein (2008), but what is still missing is some notion about how pricing connects with the types of consumers a firm endogenously faces. This is where next section enters. We describe the consumer side of the model and how a firm's pricing decision depends upon the distribution of demand.

**Households.** A unit mass of households is indexed by $i$. Each period, $t$, household $i$ consumes a continuous amount of the competitive good and purchases one unit of the differentiated good from a single producer $jm$. The differentiated good is unit demand, but the competitive good is not and it features an intensive margin. Preferences over streams of consumption of both goods are given by:

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\beta^t \sum_{m\in M}\sum_{j\in J_m}\widetilde{u}^i_{jmt}\right] \quad , \quad \widetilde{u}^i_{jmt} = \begin{cases} u\big(c^i_t\big) + \psi_{jm} + \zeta^i_{jmt} & \text{, if purchase good } jm \\ 0 & \text{, otherwise} \end{cases} \tag{6}$$

Households' period utility function is of the random utility class. The term $u\big(c^i_t\big)$ describes the mapping from consumption of the competitive good into utils. The term $\zeta^i_{jmt}$ gives utils from consuming one unit of the differentiated good $jm$, and is an idiosyncratic random component *iid* across time and households. The term $\psi_{jm}$ reflects heterogeneity in permanent quality differences across goods, and common to all consumers.[4] Taking stock, firms are permanently heterogeneous in quality and marginal cost: $(\psi_{jm},\, mc_{jm})$.

We assume that the vector of idiosyncratic tastes of individual $i$ at date $t$ is $iid$ over time and individuals, and distributed according to a Generalized Extreme Value distribution with parameters $\eta$ and $\theta$:

$$F\big(\boldsymbol{\zeta}^i_t\big) = \prod_{m\in M}\exp\left\{-\left(\sum_{jm\in J_m} e^{-\eta\zeta^i_{jmt}}\right)^{\theta/\eta}\right\} = \underbrace{\prod_{m\in M}\prod_{jm\in J_m}\exp -\left\{e^{-\eta\zeta^i_{jmt}}\right\}}_{\text{If } \theta=\eta\text{, then } \sum_m J_m \text{ independent draws}} \tag{7}$$

This is sometimes described as a *nested-logit* with an outer nest of markets $m$ and inner nest of varieties $jm$. This approach allows us to mimic properties of nested CES (Verboven, 1996) and in turn oligopoly pricing behavior similar to Atkeson and Burstein (2008).

Figure 1 describes how the parameters $\eta$ and $\theta$ change the distribution of preference draws. A consumer has preferences over two markets $m \in \{\text{Ski-wax},\ \text{Dog food}\}$, with five firms in each market. With $\eta > \theta$, the draw of preferences for one good—in this case Ski-wax—are around a mean that is shifted away from that of Dog food. Within each good, preferences are similar but still dispersed. Unless the price of one of the Dog food firms is very low, this particular consumer will closely compare the prices of different Ski-waxes, and buy from one weighing price against tastes. A higher value of $\eta$—Panel B—compresses the dispersion in preferences within each market, while a higher value of $\theta$ compresses preferences across markets. Hence $\theta$ and $\eta$ naturally map into

[4] To match data on market shares and prices, heterogeneity in quality is a necessary addition (Hottman et al., 2016).

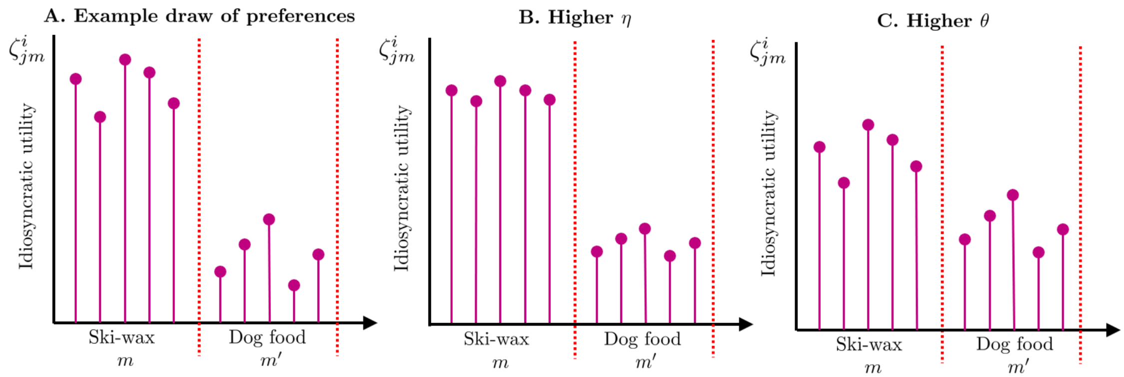


Figure 1: Example of preference draws for an individual across two markets

Notes: In each panel the pink dots represent draws of individual utilities $\zeta^i_{jm}$ for each of 5 goods $j \in \{1, \ldots, J_m\}$ in two markets $m \in \{\text{Ski-wax}, \text{Dog food}\}$. In Panel B, $\eta$ is larger, delivering higher correlation within each market, across goods. In Panel C, $\theta$ is larger, delivering higher correlations between markets.

within- and between-market elasticities of substitutions (Verboven, 1996). For this formulation to be well behaved, we assume $\eta \geq \theta$: varieties within market are more substitutable (less dispersion in tastes) than across markets (more dispersion in tastes across markets). When $\eta = \theta$ varieties within and across markets are equally substitutable. Dynamically, since shocks are $iid$, and there are a large $M$ markets, an individual will buy from different markets and producers each period.

A household's labor productivity is stochastic and evolves according to a Markov process. Let $e_i$ be a household's efficiency units and $\mathcal{P}(e_i, e')$ describe the transition density to $e'$. We assume $\mathcal{P}$ is well behaved in the necessary ways. After paying proportional labor income taxes to the Government, net labor income is $(1-\tau)We_i$

Households can save or borrow in a non-state contingent asset $a$ that pays a gross return $R$ next period. An exogenous debt limit $\underline{a}$ constrains borrowing so $a^i_{t+1} \geq \underline{a}$. Finally, households are the owners of the firm and receive equal shares of aggregate profits $\Pi_t$.

Given the above, we can obtain household $i$'s budget constraint. Conditional on choosing variety $jm$, and focusing on a stationary setting where prices are constant we have

$$c^i_t + p^i_{jm} + a^i_{t+1} \quad \leq \quad R_t a^i_t + (1-\tau)W_t e^i_t + \Pi_t \,. \tag{8}$$

The first part is expenditure on the competitive good, next is expenditure on the (unit demand) of the differentiated good, then asset purchases. The value of expenditures must be less than or equal to asset payments, net labor income, and profits.

**Government.** The Government collects fraction $\tau$ of labor income, giving aggregate tax revenues $T_t$. Taxes are used for expenditure $\overline{G}$, which is not valued by the household, is in units of the competitive good, and is a parameter of the economy. Taxes also finance interest payments on outstanding debt. The Government issues one period, non-state contingent, interest bearing debt, which is held by households. While $\tau$ and $\overline{G}$ are fixed, debt is endogenous. The Government budget constraint is therefore

$$\overline{G} + R_t B_t = T_t + B_{t+1} \,. \tag{9}$$

If we were to extend our economy to include capital, the downward sloping demand for assets would be due to firms' first order conditions. In our simpler economy with only labor, government demand for assets fills this role. In steady-state, the fiscal surplus generates a demand for household saving: $B = (T - \overline{G})/r$, where $r = R - 1$.[5]

**The Household Problem.** The state variables of a household are its asset holdings and efficiency units. For brevity we detail a stationary economy. When we later study transition dynamics following an unforeseen shock, we describe how we extend the model.

Let $v(a, e, \boldsymbol{\zeta})$ be the expected present discounted value of lifetime utility of a household with assets $a$, productivity $e$ and vector of idiosyncratic tastes $\boldsymbol{\zeta}$. This value is given by:

$$v\Big(a, e, \boldsymbol{\zeta}\Big) = \max_{jm} \Big\{ \, v_{jm}(a, e) + \phi_{jm} + \zeta_{jm} \, \Big\}. \tag{10}$$

This is the maximum across the values associated with the discrete choices of different varieties. The value conditional on choosing variety $jm$, net of quality $\phi_{jm}$ and idiosyncratic utility $\zeta_{jm}$, is:

$$\begin{aligned} v_{jm}(a, e) = \quad & \max_{a'} \Big\{ u\Big(c_{jm}(a, e)\Big) + \beta \, \mathbb{E}\Big[ v\Big(a', e', \boldsymbol{\zeta}'\Big)\Big]\Big\} \\ \text{subject to} \quad & \text{borrowing constraint } a' \geq \underline{a} \text{ and budget constraint (8)} \end{aligned} \tag{11}$$

where households choose asset holdings. Consumption of the competitive good $c_{jm}(a, e)$ is residually determined through the budget constraint and is indexed by $jm$, since it depends on $p_{jm}$. The continuation value in (11) is an expectation with respect to future efficiency units $e'$ and taste shocks $\boldsymbol{\zeta}'$.

The solution includes an asset policy function $g_{jm}(a, e)$ that maps states into asset holdings tomorrow $a'$ contingent upon the choice $jm$. For consumption choices, the household chooses **how** much of the competitive good to consume to maximize (11) conditional on a market/variety choice, and then the maximum across market/varieties in (10) determines **which** market and variety.

**Choice probabilities.** The distribution of taste shocks lead to the following choice probabilities for each differentiated good. Without loss of generality let quality $\psi_{jm} = \eta^{-1} \log \phi_{jm}$. Conditional on purchasing from $m$, the probability variety $jm$ is chosen is

$$\rho_{jm|m}(a, e) = \phi_{jm} \frac{\exp\left\{\eta \, v_{jm}(a, e)\right\}}{\exp\left\{\eta \, \widetilde{v}_m(a, e)\right\}} \quad \text{where} \quad \widetilde{v}_m(a, e) := \frac{1}{\eta} \log\Bigg[ \sum_{jm' \in J_m} \phi_{jm'} \exp\left\{\eta \, v_{jm'}(a, e)\right\}\Bigg], \tag{12}$$

The term $\widetilde{v}_m(a, e)$ is equal to the value that—prior to drawing preference shocks—an individual would expect from consuming the value maximizing choice in market $J_m$. This expected value term plays a similar role to a CES price-index in summarizing the value of all options within market $m$. The probability that market $m$ is chosen is

$$\rho_m(a, e) = \frac{\exp\left\{\theta \, \widetilde{v}_m(a, e)\right\}}{\exp\left\{\theta \, \overline{V}(a, e)\right\}}, \quad \text{where} \quad \overline{V}(a, e) := \frac{1}{\theta} \log\Bigg[ \sum_{m' \in M} \exp\left\{\theta \, \widetilde{v}_m(a, e)\right\}\Bigg]. \tag{13}$$

[5] We could remove the government and study a Hugget (1994) economy, in which aggregate asset demand is inelastic at zero. Computationally, the stability of the economy with a downward sloping asset demand condition is appealing, while maintaining the realism of a richer model with capital.

The term $\overline{V}(a,e)$ represents the expected value across all markets. Putting these together, the total probability that good $jm$ is chosen across all varieties in all markets is:

$$\rho_{jm}(a,e) = \rho_{jm|m}(a,e) \times \rho_m(a,e) = \phi_{jm} \frac{\exp\left\{\eta\, v_{jm}(a,e)\right\}}{\exp\left\{\eta\, \widetilde{v}_m(a,e)\right\}} \times \frac{\exp\left\{\theta\, \widetilde{v}_m(a,e)\right\}}{\exp\left\{\theta\, \overline{V}(a,e)\right\}} \tag{14}$$

Demand depends on the value of buying from $jm$ relative to the average value of the market, and the average value of the market relative to all other markets. If $\eta$ is large, then small differences in the value of $jm$ relative to the market strongly reallocates spending. Under a high $\eta$, the dispersion of idiosyncratic tastes is small, so quantities respond strongly to prices.[6]

**Euler equation.** We can derive an Euler Equation for competitive good consumption. Away from the borrowing constraint, the household equates marginal utility today to discounted expected marginal utility tomorrow. In this economy, the discount factor reflects choice probabilities over varieties tomorrow, which weight marginal utilities conditional on each potential variety:

$$u'\Big(c_{jm}(a,e)\Big) = \beta R\, \mathbb{E}_{e'} \left[ \sum_{m \in M} \sum_{jm' \in J_m} \rho_{jm'}(a',e') u'\Big(c_{jm'}(a',e')\Big) \right]. \tag{15}$$

## 2.2. Aggregation and equilibrium

**Aggregation.** Determining firm demand requires aggregation, which requires a stationary distribution $\Lambda(a,e)$ of households across the individual states. Here, the mass of households with $(a,e) \in \mathcal{A} \times \mathcal{E}$, evolves according to:

$$\Lambda(\mathcal{A},\mathcal{E}) = \int_a \int_e \sum_{m \in M} \sum_{jm \in J_m} \mathbf{1}\left[g_{jm}(a,e) \in \mathcal{A}\right] \mathcal{P}(e,\mathcal{E}) \rho_{jm}(a,e) \Lambda(a,e)\, da\, de. \tag{16}$$

A mass $\rho_{jm}(a,e)\Lambda(a,e)$ chooses variety $jm$. Of this, a fraction $\mathcal{P}(e,\mathcal{E})$ transits to $e' \in \mathcal{E}$, and $g_{jm}(a,e)$ captures transitions to asset holdings $a' \in \mathcal{A}$.

Given the distribution $\Lambda(a,e)$, all other aggregates follow. Aggregate demand of variety $jm$ is

$$x_{jm} = \int_a \int_e \rho_{jm}(a,e) \Lambda(a,e)\, da\, de. \tag{17}$$

Reflecting on (17) and the firm's problem, this is the demand curve firm $j$ faces for its variety. Given demand, aggregate profits are obtained by summing differentiated goods producers:

$$\Pi = \sum_{m \in M} \sum_{jm \in J_m} \Big( p_{jm} x\left(p_{jm}\right) - W N_{jm} \Big). \tag{18}$$

Aggregate consumption of the competitive good and private assets integrate over consumption

[6]A useful benchmark is demand under nested CES preferences. One would obtain demand curve for good $jm$ of

$$x_{jm} = \left(\frac{p_{jm}}{\widetilde{p}_m}\right)^{-\eta} \left(\frac{\widetilde{p}_m}{\overline{P}}\right)^{-\theta} = \frac{\exp\left\{-\eta \log p_{jm}\right\}}{\exp\{-\eta \log \widetilde{p}_m\}} \frac{\exp\left\{-\theta \log \widetilde{p}_m\right\}}{\exp\{-\theta \log \overline{P}\}} \quad , \quad \log \widetilde{p}_m = \frac{1}{1-\eta} \sum_{jm \in J_m} \exp\Big\{(1-\eta) \log p_{jm}\Big\}.$$

where $\widetilde{p}_m$ is the market $m$ price index, and $\overline{P}$ is the aggregate price index, and $\eta$ and $\theta$ are the within- and across-market elasticities of substitution.

and asset choice conditional on the differentiated good variety, weighted by choice probabilities $\rho_{jm}(a,e)$:

$$C = \int_a \int_e \sum_{m\in M} \sum_{jm\in J_m} c_{jm}(a,e)\rho_{jm}(a,e)\Lambda(a,e)\, da\, de\,, \tag{19}$$

$$A' = \int_a \int_e \sum_{m\in M} \sum_{jm\in J_m} g_{jm}(a,e)\rho_{jm}(a,e)\Lambda(a,e) da\, de. \tag{20}$$

Government tax revenues are given by aggregate payments to labor times the tax rate:

$$T = \int_a \int_e \tau W e \Lambda(a,e) da\, de. \tag{21}$$

**Equilibrium.** Below we define the Stationary Recursive Competitive Equilibrium. Private market participants take prices as given and solve their problems, the distribution of households is stationary, prices are consistent with market clearing, and the Government respects its budget constraint. Importantly, a consistency condition requires that a firms' perceived demand curve to consistent with the demand curve induced by household behavior, and given the finiteness of firms within each market, prices constitute a Nash equilibrium in each market.

A *Stationary Recursive Competitive Equilibrium* is a government policy $\{G, B, \tau\}$, household value functions, asset policy functions, and variety choice probabilities $\{v_{jm}(a,e), g_{jm}(a,e), \rho_{jm|m}(a,e), \rho_m(a,e)\}$, a probability distribution $\Lambda(a,e)$, aggregate demand functions $x_{jm}(p_{jm}, \boldsymbol{p}_{-jm})$, and prices $\{W, R\}$ and $p_{jm}$ such that

i. Competitive firm prices satisfy the markup condition (1) given $W$;
ii. Differentiated goods firm prices $p_{jm}$ satisfy (4) and (5) given $W$ and their demand curve $x_{jm}(p_{jm}, \boldsymbol{p}_{-jm})$.
iii. The value functions, policy functions, and choice probabilities solve the household's optimization problem in (10) and (11);
iv. The probability distribution $\Lambda(a,e)$ induced by the policy functions, choice probabilities, and primitives is stationary and satisfies (16);
v. The aggregate demand functions that firms take as given are consistent with household choice probabilities and the distribution of types satisfying (17);
vi. Goods markets clears for the competitive and differentiated goods:

$$Y_c - C - G = 0 \quad \text{and} \quad Y_{jm} - X_{jm} = 0, \quad \forall jm; \tag{22}$$

vii. Government budget constraint holds

$$\overline{G} + RB = T + B' \tag{23}$$

viii. Bond market clears

$$A' = B'. \tag{24}$$

This is the model. In a nutshell, firms have some market power and the demand curve that they face in (17) is composed of heterogenous consumers where heterogeneity is induced by productivity and taste shocks plus their limited ability to completely insure the shocks away. Below, we work through some properties of the demand curve and show how they connect with the household side of the model.[7]

### 2.3. Properties of the model: Elasticities, Sorting, Super-Elasticities

We now link households and firms through explicit expressions for firms' own-price elasticity of demand, and their super-elasticity, i.e., how the own-price elasticity changes with a change in price. Broadly, given a shock that impacts firms' marginal costs, we need to understand (i) who does it affect (*sorting of households across firms*), (i) how does it affect prices (*pass-through*)?, and (iii) how do quantities respond to prices (*demand elasticities*)? We then show how the aggregate response of the economy, say to a productivity shock or lump-sum transfer, is summarized by these elasticities and the behavior of firms and households behind them.

**A. Own-Price Elasticity of Demand.** The firm's own price elasticity, $\varepsilon(p_{jm})$ is central: it connects how a firm sets its price in (4) and (5) with household behavior, and will show up repeatedly, e.g., in the super-elasticity and various shock calculations. We proceed in several steps. For clarity we suppress $p_{jm}$ as an argument, for example writing $\varepsilon_{jm}$ instead of $\varepsilon(p_{jm}, \boldsymbol{p}_{-jm}, \boldsymbol{S})$.

The first step consists of an identity:

$$\varepsilon_{jm} = \int \varepsilon_{jm}(a,e)\,\omega_{jm}(a,e)\,d(a,e) \tag{25}$$

$$\varepsilon_{jm}(a,e) := \underbrace{-\frac{\partial\rho_{jm}(a,e)/\rho_{jm}(a,e)}{\partial p_{jm}/p_{jm}}}_{\text{A. Type }(a,e)\text{ elasticity}} \tag{26}$$

$$\omega_{jm}(a,e) := \underbrace{\frac{\rho_{jm}(a,e)\Lambda(a,e)}{x_{jm}}}_{\text{B. Share of } jm\text{'s sales to }(a,e)\text{ types}} \tag{27}$$

From the perspective of the firm, its elasticity of demand is the sales share weighted average of household type $(a,e)$ demand elasticities $\varepsilon_{jm}(a,e)$. This is quite general. Any model of the household can be inserted into (25) to connect household-level elasticities and market shares with aggregate demand elasticities.

The second step imposes our formulation of the household's problem from Section 2.1. Via the chain rule, household type $(a,e)$ own-price elasticity for good $jm$ can be expressed in two pieces:

$$\varepsilon_{jm}(a,e) = -\frac{\partial\rho_{jm}(a,e)}{\partial v_{jm}(a,e)}\frac{\partial v_{jm}(a,e)}{\partial p_{jm}/p_{jm}} = \underbrace{\left[\eta\Big(1-\rho_{jm|m}(a,e)\Big)+\theta\rho_{jm|m}(a,e)\right]}_{\text{A. Oligopoly}} \times \underbrace{-\frac{\partial v_{jm}(a,e)}{\partial p_{jm}/p_{jm}}}_{\text{B. Wealth}}. \tag{28}$$

The "oligopoly component" reflects the firm's share of market $m$ *for consumers of type* $(a,e)$, and captures how sensitive choices are to the value of the choice. This is multiplied by what we call

[7] Note that optimality in the competitive sector implies that $W = Z_c$. Once can check from the above conditions that the labor market clearing, goods market clearing and government budget constraint conditions all hold when $R$ is such that the asset market clears.

the "wealth component" which reflects the household's marginal valuation of the change in price.

The *oligopoly component* takes on a similar form as in the Bertrand competition version of Atkeson and Burstein (2008), with a key difference. Recall individual demand for good $jm$, and use the superscript $i$ in place of $(a, e)$ to compress these expressions:

$$\rho^i_{jm} = \rho^i_{jm|m}\rho^i_m = \phi_{jm} e^{\eta(v^i_{jm} - \widetilde{v}^i_m)} e^{\theta(\widetilde{v}^i_m - \overline{V}^i)} \quad , \quad \widetilde{v}^i_m = \frac{1}{\eta}\log\left[\sum_{jm\in J_m} \phi_{jm} e^{\eta v^i_{jm}}\right] \quad , \quad \overline{V}^i = \frac{1}{\theta}\log\left[\sum_{m\in M} e^{\theta \widetilde{v}^i_m}\right]$$

If the value of the choice $v^i_{jm}$ is high relative to other firms in the market, then the conditional choice probability $\rho^i_{jm|m}$ is large, but changes in the value $v^i_{jm}$ also change the average value in the market $\widetilde{v}^i_m$. The latter leads to a small change in $\rho^i_{jm|m}$, while the change in $\widetilde{v}^i_{jm}$ shifts $\rho^i_m$. The result is that the elasticity of demand is shaped by the low across market elasticity $\theta$. Firms that represent low value to a customer shift market value very little, so the elasticity is shaped by the within market elasticity $\eta$.[8] In the limit of $J_m \to \infty$, then this term is simply $\eta$. This is similar to Atkeson and Burstein (2008).

The key difference with respect to Atkeson and Burstein (2008) is that the above statements should be restated in terms of the *market for individual* $i$. Rather than overall market share, what shapes the individual elasticity is the share of the firm in the consumption basket of individual $i$, $\rho^i_{jm|m}$. Hence in this model, a firm may have a small overall market share, but represent a large market share of a particular group of customers, and hence face inelastic demand. For example, poorer households may shop mostly at Dollar General, while richer households may shop mostly at Target. While both may have market shares of one half, they represent closer to the entire market share of each household, and hence demand is less elastic. Oligopoly forces are interacting with the endogenous distribution of demand that the firm faces, and hence the model wants to know how concentrated consumption of different groups of households is across firms, which we turn to below when we study sorting.

The *wealth component* reflects how the household's value function—conditional on purchasing good $jm$—changes with price. If value is very sensitive to price, small changes in price will lead the household to switch to another seller, leading to a high elasticity of demand. Conditional on purchasing from $jm$, raising price is the same as removing resources from the household budget constraint, and hence this derivative is captured by the household's Lagrange multiplier on its budget constraint, which measures the marginal value of resources to the household. This can further be written as either the marginal value of wealth, or in terms of competitive good consumption:

$$-\frac{\partial v_{jm}(a,e)}{\partial p_{jm}/p_{jm}} = \Lambda_{jm}(a,e)p_{jm} = u'\big(c_{jm}(a,e)\big)\left(\frac{p_{jm}}{P_c}\right). \tag{29}$$

Decreasing marginal utility implies that poor, high marginal utility consumers are—holding everything else constant—more elastic with respect to price relative to rich consumers. Below we detail how this is verified in recent empirical work. The Bewley model provides a rich theory for the endogenous distribution of the marginal value of wealth, here we have shown how that shows up in firms' demand functions.

[8] Note that since the firm's market $m$ is small relative to $M$, the derivative of $\overline{V}^i$ with respect to its price $p_{jm}$ is zero.

Behind this result are assumptions that have eliminated intertemporal effects. First, the effect of prices on asset choice and continuation value functions in the future equal zero through an envelope condition. Second, firms only differentiate the value function with respect to $p_{jm}$ as it appears in the current period budget constraint—nothing about future purchases. With large $M$ markets, the firm is infinitesimal and has no effect on $\overline{V}(a', e')$ in (13).

Combining the above gives the following representation:

**Proposition 1 (Own-Price Elasticity)** *Firm $jm$'s own price elasticity is:*

$$\varepsilon_{jm} = \int_e \int_a \left[ \eta\Big(1 - \rho_{jm|m}(a,e)\Big) + \theta\rho_{jm|m}(a,e) \right] \times \left[ u'\Big(c_{jm}(a,e)\Big) p_{jm} \right] \omega_{jm}(a,e) \, da \, de \qquad (30)$$

*where $\rho_{jm|m}(a,e)$ is its market share (12) and $\omega_{jm}(a,e)$ is share of firm $jm$ sales to type $(a,e)$ households (25).*

The first bracketed term is as in Atkeson and Burstein (2008) with the new insight that what matters is the firm's market power with respect to the composition of consumers a firm faces. The second bracketed term is the wealth effect picking up the new idea that poor, high marginal utility consumers are more price elastic. In aggregate, what matters is the share $\omega_{jm}(a,e)$ weighted average of these two forces, which itself depends on sorting of households by wealth and income across the price distribution of firms, which describe next.

Before moving on we note that quality $\phi_{jm}$ does not show up directly in these expressions. Quality shifts the demand of each individual but does not affect is shape. However Proposition 1 helps us understand how quality will indirectly shape $\varepsilon_{jm}$ through (i) changing firm market share, and hence market power via the oligopoly term, (ii) changing the composition of buyers, and hence shift the composition term—for example, if high quality goods sell to wealthy households, demand for these goods will be less elastic.

**B. Sorting Across Products by Wealth.** Proposition 1 makes clear that a key determinant of $\varepsilon_{jm}$, and hence markups and output, is the types of consumers a firm faces. We argue that the rich have a higher propensity to choose high price products while the poor choose low price products.

To make this precise, we ask the following question: *Within a market $m$ and given prices, how does firm $jm$'s (log) market share vary with wealth?* Using our previous expressions for $\rho_{jm|m}(a)$, this is answered by

$$\frac{\partial \log \rho_{jm|m}(a,e)}{\partial a} = \eta \left[ \frac{\partial v_{jm}(a,e)}{\partial a} - \sum_{j' \in J_m} \rho_{j'm|m}(a,e) \frac{\partial v_{j'm}(a,e)}{\partial a} \right]. \qquad (31)$$

This is positive if the $jm$-specific value function changes more with respect wealth relative than its (share weighted) average across all other firms in the market.

Because (31) is evaluated at the same point in the state space $(a,e)$, the only source of variation across choices is how the marginal value of wealth varies with the price of the commodity. If $j$ is a high price commodity in $m$, then buying $jm$ tightens the household's budget constraint, implying a high marginal value of wealth relative to the case at all other $j' \in m$. In contrast, if $j$ is a low price commodity in $m$, buying $j$ leaves the household with more left over resources, and hence the marginal value of wealth when buying $j$ will be relatively low. Hence (31) flips sign from *positive* to *negative* when moving from high to low prices within any market. The implication is that among the customers of high priced firms, the share of the firm within the household's basket is increasing up the asset distribution. At the other end, low price firms sell an increasing amount to low wealth individuals.

This pattern of sorting is important because it concentrates different types of consumers on different firms. This naturally gives rise to heterogenous elasticities of demand. For example, a low price firm will face poorer households, with a higher marginal value of wealth and hence from (25) higher demand elasticity. In contrast, if their were no sorting, all firms would face the same type of consumers, leading to no variation in elasticities of demand, markups, and in the monopolistic competition case the model would behave a lot like a constant elasticity of demand world.

Note that sorting occurs without having to assume that poor and rich households have different preferences. We have not assumed non-homotheticity in either form commonly used in work on household heterogeneity: (a) high income households gain more utility from consuming higher quality goods (Handbury, 2021; Comin et al., 2021; Nord, 2023), or (b) complementarity between the level of consumption of the competitive good and quality of the differentiated good (Fajgelbaum et al., 2011). Instead, the Bewley model delivers a marginal value of wealth that is decreasing in wealth and income. Having a lower marginal value of wealth naturally makes richer households less discerning when comparing prices, and hence a customer base of a high priced good is likely to contain more high income, low elasticity households. Avoiding hard-wiring in sorting via preferences also has the advantage that its properties remain endogenous to changes in policy and shocks. Policies that provide resources or insurance to households change the level and dispersion of the marginal value of wealth, which will change sorting and hence firms' demand elasticities, markups and production.

**C. The Super-Elasticity of Demand.** A central question for allocative efficiency is how changes in marginal cost pass-through to prices. In this setting, this is determined by the *super-elasticity of demand*, which answers the question: *If the firm changes its price how would its elasticity of demand change?* In our framework the super-elasticity is not hard-wired in parameterically as in a Kimball model, but instead shaped by both market power forces and the distribution of consumers, and their heterogeneous sensitivity to price changes. Importantly each firm's super-elasticity will respond to idiosyncratic and aggregate shocks as well as changes in policy. It is a living, breathing object.

Our derivation of the super elasticity starts from the observation that—similar to the elasticity identity in (25)—there is an analogous identity relating (a) how micro-level elasticities $\varepsilon_{jm}(a,e)$ and market shares $\omega_{jm}(a,e)$ change, (b) weighted by shares of their product.

$$\varepsilon_{jm} = \int \varepsilon^i_{jm}\omega^i_{jm}\, di \quad , \quad \frac{\partial \varepsilon_{jm}/\varepsilon_{jm}}{\partial p_{jm}/p_{jm}} = \int \left( \frac{\varepsilon^i_{jm}\omega^i_{jm}}{\varepsilon^k_{jm}\omega^k_{jm}\, dk} \right) \left[ \frac{\partial \varepsilon^i_{jm}/\varepsilon^i_{jm}}{\partial p_{jm}/p_{jm}} + \frac{\partial \omega^i_{jm}/\omega^i_{jm}}{\partial p_{jm}/p_{jm}} \right] di$$

Into this identity we can insert our model of household behavior arriving at the following formula.

Here it is useful to recall that the household elasticity is $\varepsilon^i_{jm} = [\eta(1-\rho^i_{jm|m}) + \theta\rho^i_{jm|m}]u'(c^i_{jm})p_{jm}$.

**Proposition 2 (The Super-Elasticity of Demand)** *Firm $jm$'s super-elasticity of demand is:*

$$\frac{\partial\varepsilon_{jm}/\varepsilon_{jm}}{\partial p_{jm}/p_{jm}} = \underbrace{\mathbb{E}\left[\frac{\eta(\eta-\theta)\rho^i_{jm|m}(1-\rho^i_{jm|m})}{\eta(1-\rho^i_{jm|m})+\theta\rho^i_{jm|m}} p_{jm}u'(c^i_{jm})\right]}_{\text{A. Market share effect}} \underbrace{+1+\sigma\,\mathbb{E}\left[\mathtt{mpc}^i_{jm}\left(\frac{p_{jm}}{c^i_{jm}}\right)\right]}_{\text{B. Elasticity effect}} \underbrace{-\mathbb{V}\left[\frac{\varepsilon^i_{jm}}{\varepsilon_{jm}}\right]}_{\text{C. Composition effect}} \tag{32}$$

In Proposition 2 $\mathbb{E}$ and $\mathbb{V}$ are the cross-sectional expectation and variance of these objects across $(a^i, e^i)$, where the expectations are with respect to the elasticity-share-weighted (i.e. $\varepsilon^i_{jm}\omega^i_{jm}$) distribution of households.

The positive *"Market share effect"* arises from the oligopoly forces in the model and again shares elements to a close analog in Atkeson and Burstein (2008). As a firm increases its price, its market share becomes smaller which increases its elasticity demand. What is unique about this, like the discussion around Proposition 1, is that what matters is *for whom* the share is becoming smaller which is why the marginal utility of consumption interacts with this effect. If $\eta = \theta$, then competition can be described as monopolistically competitive. In Atkeson and Burstein (2008), pass-through would be one in this case, and indeed in our model the *Market share effect* would be zero. However, even with $\eta = \theta$, there remain elasticity and composition effects that are missing in a representative household model.

The positive *"Elasticity effect"* picks up the simple idea that as a firm increases its price, it makes consumers more price elastic. The twist is that how much more elastic a consumer becomes depends on what the consumer in response to the price increase. Does the consumer save less and not alter consumption, smoothing out the marginal value of wealth? Or does consumption decline by the amount of the increase in price, increasing the marginal value of wealth? Since a price increase is just like taking a dollar away from an individual, the marginal propensity to consume, $\mathtt{mpc}^i_{jm}$, measures this effect. In the first case, the $\mathtt{mpc}^i_{jm}$ is low and the elasticity effect is small, in the second case the $\mathtt{mpc}^i_{jm}$ is high, and the elasticity effect is large. The parameter $\sigma$ measures how the marginal utility of consumption responds to this change in consumption. Conditional on mpc's, if individuals are more risk averse, the super elasticity is larger.

The negative *"Composition effect"* captures how the type of consumers change as a firm increases its price and takes a simple form: the variance of individual elasticities relative to the firm's elasticity. As a firm increases its price, consumers start switching away from the firm. The most elastic consumers switch out first, leaving less elastic consumers, and hence this term is *negative*. If there's a lot of heterogeneity in wealth among a firm's customers, and hence in the elasticity of demand of its customers, then this effect will be larger. If consumption is highly segregated—firms sell to very similar customers within each good, but very different customers across goods—then this effect will be small. This logic is very similar to the argument in Nakamura and Zerom (2010) who study pass-through in a random coefficients discrete choice model of demand as in Berry, Levinsohn, and Pakes (1995).

**Summary.** The above should make clear that the model does not allow for a clean, parametric separation of elasticities, super-elasticities and sorting. All consumers have some probability of buying all goods. Marginal values of wealth across the income and wealth distribution determine elasticities, which determine sorting, which in turn determines prices, which themselves shape the distribution of wealth. The following provide useful points of departure:

1. **IO** - In the Nevo (2000) interpretation of Berry, Levinsohn, and Pakes (1995), individuals have quasi-linear random utility preferences, and are heterogeneous in income:

$$v(e^i, \boldsymbol{\zeta}^i) = \max_j \left\{ \alpha^i (e^i - p_j) + \psi_j + \zeta^i_j \right\} \quad , \quad \alpha^i = \alpha_0 + \alpha_1 \log e_i$$

Under single nested logit, the elasticity is $\varepsilon^i_j = \eta p_j \alpha^i$. The sensitivity of households to prices is exogenous and cannot depend on shocks or changes to policy. There is sorting, and the *Composition effect* is negative. However, this is largely exogenous, and the *Elasticity effect* is zero, since $\alpha^i$ is parametric. That is, the $\texttt{mpc}^i_{jm}$ term in 32—which is central to thinking about consumption response to policy and economic shocks in heterogeneous household macroeconomic models—is absent.

2. **Macro** - In Boar and Midrigan (2019), households in a Bewley model each have preferences over a continuum of goods due to a Kimball demand aggregator as in Klenow and Willis (2016). Here there is household heterogeneity but firms' demand elasticities and their super-elasticity depend only on their market share, and all households spend the same fraction of their expenditure on each good. The distribution of wealth and income is immaterial for the elasticity of demand that firms face and only *market power* effects are at play. In this case the super-elasticity of demand is invariant to policy and economic shocks.

### 2.4. Computation

A key contribution of the paper is to show that this economy is a feasible laboratory for quantitative work. The equilibrium consists of a Nash equilibrium in every market, where demand elasticities depend on policy functions of households as well as the stationary distribution of households, and firms are arbitrarily heterogeneous in productivity and quality, $(z_{jm}, \phi_{jm})$. Despite this, the structure of the equilibrium can be exploited to maintain a degree of tractability on par with the standard Bewley model. To see this, fix the interest rate $R$ and wage $W$ and consider solving for the Nash equilibrium in all markets.

1. Set $k = 0$. Guess prices at all firms $p^{(k)}_{jm}$.
2. Set $l = 0$. Guess a continuation value function $\overline{V}^{(k,l)}(a, e)$.
3. Solve for $v(a, e, p_n)$ on a grid of points $p_n$.

$$v(a, e, p_n) = \max_{a' \in [\underline{a}, \infty)} u\Big(We + Ra - a' - p_n\Big) + \beta \int \overline{V}(a', e') d\mathcal{P}(e, e')$$

Fit an interpolant to $v(a, e, p_n)$ across $p_n$, and denote this $\widehat{v}(a, e, p)$. Since this problem is so well behaved, small number of points $p_n$ can be used.

4. Interpolate $\widehat{v}(a, e, p)$ on guessed prices $p^{(k)}_{jm}$ to construct average values, which gives an update of $\overline{V}^{(k,l+1)}(a, e)$

$$\widetilde{v}_m(a, e) = \frac{1}{\eta} \log \left[ \sum_{j \in J_m} \phi_{jm} e^{\eta \widehat{v}(a, e, p_{jm})} \right] \quad , \quad \overline{V}^{(k,l+1)}(a, e) = \frac{1}{\theta} \log \left[ \sum_{m \in M} e^{\theta \widetilde{v}(a, e)} \right]$$

5. Iterate on $l$ to convergence of $\overline{V}^{(k,l)}(a, e)$
6. Use the above values to construct choice probabilities $\rho^{(k)}_{jm}(a, e)$, and combine with an interpolant of the asset policy function $\widehat{a}'^{(k)}(a, e, p)$ to solve for the the stationary distribution $\Lambda^{(k)}(a, e)$.

7. Use the stationary distribution, choice probabilities and an interpolant of the consumption policy function $\widehat{c}^{(k)}(a,e,p)$ to compute demand and demand elasticities:

$$
\begin{aligned}
x_{jm}^{(k)} &= \int \rho_{jm}^{(k)}(a,e)d\Lambda^{(k)}(a,e) \quad , \\
\varepsilon_{jm}^{(k)} &= \int \left(\frac{\rho_{jm}^{(k)}(a,e)}{x_{jm}^{(k)}}\right)\left[\eta(1-\rho_{jm|m}^{(k)}(a,e))+\theta\rho_{jm|m}^{(k)}(a,e)\right]u'\left(\widehat{c}^{(k)}(a,e,p_{jm})\right)d\Lambda^{(k)}(a,e)
\end{aligned}
$$

8. Update firms' optimal price.

$$
p_{jm}^{(k+1)} = \frac{\varepsilon_{jm}^{(k)}}{\varepsilon_{jm}^{(k)}+1} \times mc_{jm}^{(k)} \quad , \quad mc_{jm}^{(k)} = \frac{1}{\alpha}\frac{W}{z_{jm}}\left(\frac{x_{jm}^{(k)}}{z_{jm}}\right)^{\frac{1-\alpha}{\alpha}} .
$$

   Here we are more general, allowing potentially for increasing marginal cost, with $y_{jm} = z_{jm}n_{jm}^{\alpha}$, with our benchmark case nested under $\alpha = 1$.

9. Iterate on $k$ to convergence of $p_{jm}^{(k)}$.

A few key observations yield tractability. First, we only have to solve the choice problem on a small set of points in $p$ in Step 3, and can interpolate in Step 4. Second, Step 4 is very fast. Combined, these imply that solving the Bellman equation does not take substantially longer than a usual consumption saving problem. Construction of the stationary distribution is standard (Step 6), and the update of $p_{jm}$ is done in closed form and very fast (Step 7, 8). Third, in our experience, $p_{jm}^{(k)}$ can be updated along with $R$ and $W$. Hence the overall equilibrium takes not much longer than a standard Bewley model to solve.

## 3. Calibration

In this preliminary version of the paper we aim to provide some numerical examples that illustrate the above propositions. To do so we consider a simple calibration of the model. While being simple, the calibration points to an advantage of our framework: it introduces very few free parameters, while delivering a demand system in which the elasticities and super-elasticities of demand that firms face are entirely endogenous and vary across firms and in response to shocks.

Table 1 gives the associated parameters and the small set of current targets. A period is a year. As a starting point we set $\theta = \eta$, which abstracts from oligopoly. Hence we solve the model for a single market ($M = 1$) with infinitely many firms and drop the $m$ subscript in what follows.[9] This corresponds to a *monopolistically competitive* economy. We set $\eta = 11$, which we pick to deliver an average markup of 1.35.[10]

We calibrate firm productivity as follows. We draw $z_j$ from a Pareto distribution, we normalize the location parameter to one, and set the tail parameter to four. We then choose the shifter $\overline{Z}_d$ such that 15 percent of aggregate consumption spending is on the differentiated good. The relative productivity of firms in the competitive and differentiated goods sectors determines their overall share in household expenditure. We normalize $\overline{Z}_c = 1$, which pins down $W = 1$ given infinitely elastic labor demand in the competitive sector.

[9] When solving the model with $\eta > \theta$, we will use heterogeneity across the size distribution of pass-through from marginal cost shocks to prices to separately identify $\theta$ and $\eta$.

[10] Note that in our model the markup is not $\eta/(\eta-1)$ as in CES, since the marginal utility of consumption enters $\varepsilon_{jm}^{i}$ and the full equilibrium distribution of consumers determines how these are weighted in computing $\varepsilon_{jm}$.

| Parameter | | Value | Moment | Data | Model |
|---|---|---|---|---|---|
| **A. Preferences** | | | | | |
| Taste dispersion - Within markets | $\eta$ | 11 | Average markup | 1.35 | 1.35 |
| ... - Across markets | $\theta$ | 11 | Restricted $\theta = \eta$, monopolistic competition | — | — |
| Discount rate | $\beta$ | 0.919 | Total liquid assets / Total income (SCF, 2010) | 0.56 | 0.56 |
| Coefficient of relative risk aversion | $\sigma$ | 1.50 | *No target* | | |
| **B. Worker productivity** | | | | | |
| Productivity persistence | $\rho_P$ | 0.90 | Krueger et al. (2016) | | |
| Persistent shock standard deviation | $\nu_P$ | 0.62 | Krueger et al. (2016) | | |
| Transitory shock standard deviation | $\nu_T$ | 0.72 | Krueger et al. (2016) | | |
| **C. Firm productivity** | | | | | |
| Productivity shifter - Differentiated | $\overline{Z}_d$ | 6 | 15% of spending on diff. goods | | |
| Productivity shifter - Competitive | $\overline{Z}_c$ | 1 | Normalization | | |
| Tail parameter of Pareto | $\kappa_z$ | 4 | *No target* - Implies a std. dev $\log z_j$ of 0.14 | | |
| Marginal cost-Quality elasticity | $(\bar{\phi}, \gamma)$ | (1,1) | *No target* | | |
| **D. Other parameters** | | | | | |
| Income tax rate | $\tau$ | 0.247 | Median income tax (Piketty et al., 2018) | | |
| Interest rate | $r$ | 0.02 | Following Kaplan and Violante (2022) | | |
| Borrowing constraint | $\underline{a}$ | 0 | *No target* | | |

Table 1: Calibration

Notes: In this preliminary version of the paper a number of the parameters are chosen without targeting a particular moment. These are denoted *No target*.

Providing an intuitive approach to calibrating this parameter will be a key step in future revisions of this paper.

On the household side, we parameterize the stochastic process for productivity—$\mathcal{P}(e, e')$—to have a transitory and permanent component. We take the functional form and parameter values from Krueger et al. (2016): In particular we assume that

$$\begin{aligned} \log e_{it+1} &= \log e^P_{it+1} + \varepsilon^T_{it+1} \quad , \quad \varepsilon^T_{it+1} \sim \mathcal{N}\left(-\frac{1}{2}\frac{\nu_T^2}{1+\nu_T}, \nu_T^2\right) \\ \log e^P_{it+1} &= \rho_P \log e^P_{it} + \varepsilon^P_{it+1} \quad , \quad \varepsilon_{it+1} \sim \mathcal{N}\left(-\frac{1}{2}\frac{\nu_P^2}{1+\nu_P}, \nu_P^2\right) \end{aligned}$$

This also implies that $\int e_{it} di = 1$. The borrowing constraint is zero ($\underline{a} = 0$), and we set the CRRA parameter $\sigma$ to $1.5$. Labor income taxes are 24.7 percent ($\tau = 0.247$), reflecting the labor income tax on the median income household in the US (Piketty et al., 2018).

Given the prominence of the marginal propensity to consumer in the super-elasticity in Proposition 2, it is important that the model generates the empirical distribution of $\texttt{mpc}^i$. Absent a liquid and illiquid asset we follow suggestions in Kaplan and Violante (2022). As in their paper, we fix the interest rate $r$ to 2 percent. We then choose the discount rate $\beta$ such that across households the ratio of average assets to average income is $0.56$. This reflects the empirical ratio of *liquid wealth* to income measured in the *Survey of Consumer Finances*. This is much lower than total assets to income, which in the US is more than four, but mostly represents illiquid assets. In the baseline this pins down $\overline{G}$ as a residual, which we then keep fixed over counterfactuals.[11] Figure 2 shows

[11] Given $W = Z_c = 1$, and $N = \int e_i di = 1$, then the government budget constraint in steady-state is $rB = \tau - \overline{G}$. This gives $(\overline{G}/Y) = \tau - r(B/Y)$, where at this point the right-hand side is data. We obtain $\overline{G}/Y = 0.24$. In the US

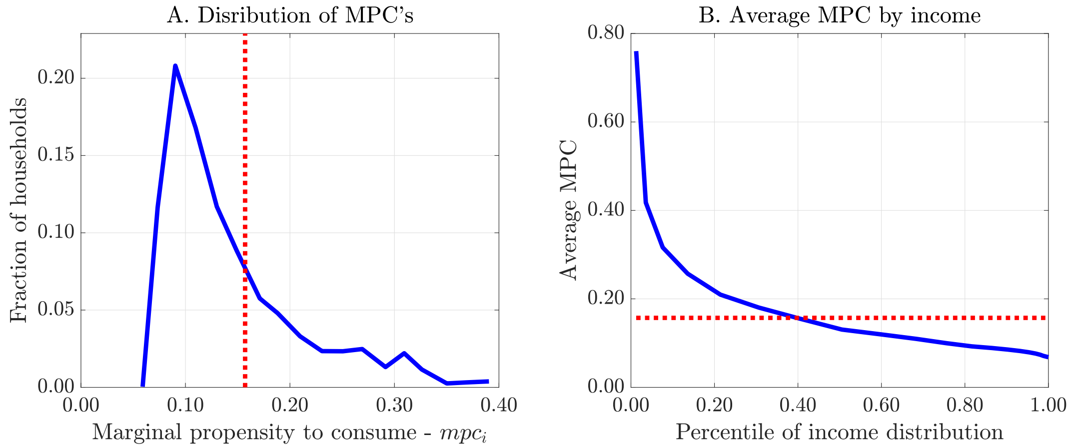


Figure 2: Household heterogeneity in the marginal propensity to consume

Note: The $mpc^i$ is computed out of an unexpected one-time payment of \$500. We measure the counterfactual increase in total consumption expenditure in the quarter after the payment, and divide by the size of the payment.

that the model generates an empirically realistic distribution of $mpc$'s, with an average $mpc$ of 16.9 percent, and a fat tail of households with low income and high $mpc$'s.

We parameterize the relationship between product $jm$ productivity and quality as follows. We assume that marginal cost $mc_{jm}$ and quality $\phi_{jm}$ are perfectly correlated, with the following functional form linking the two:

$$u^i_{jm} = u(c^i_{jm}) + \log \phi_{jm}^{\overline{\phi}/\eta} + \zeta^i_{jm} \quad , \quad \log \phi_{jm} = \gamma \log\left(\frac{mc_{jm}}{\overline{mc}}\right) \quad , \quad mc_{jm} = \frac{W}{\overline{Z}_d z_{jm}} \quad , \quad \overline{mc} = \mathbb{E}\left[\frac{W}{\overline{Z}_d z_{jm}}\right]$$

If marginal cost is above average, then the quality term increases utility with a constant elasticity $\gamma$. This corresponds to the way in which quality and productivity are often linked in representative agent CES models (e.g. in monetary economics, see Midrigan, 2011; Alvarez and Lippi, 2014; Mongey, 2021).[12] The parameter $\overline{\phi} \in \{0, 1\}$ allows us to remove quality differences all together. In this preliminary version of the paper we turn on quality differences ($\overline{\phi} = 1$), and set $\gamma$ to one: higher quality goods have a higher marginal cost (Hottman et al., 2016).

# 4. Quantitative properties

In this section we illustrate the quantitative properties of the model, showing how the previous propositions can be observed in data generated by the model.

## 4.1. Elasticties

Figure 3 provides a sense of how this plays out across households and across two types of firms, a high price and low price firm. The heat map reports a household's elasticity of demand $\varepsilon_{jm}(a, e)$

$G/Y$ is around 30 percent, but the fraction of $G$ financed by purely labor income taxes is lower.

[12] This is the standard result from Anderson et al. (1987), which we have simply extended to have heterogeneous quality. In particular, given the way we have written down the logit preferences, if we removed the competitive good, and introduced an intensive margin of demand for each differentiated good, then total demand for each differentiated good would have the standard CES form: $x_{jm} = \phi_{jm}(p_{jm}/P_m)^{-\eta}(P_m/P)^{-\theta}X$, where $X$ is the nested CES aggregator with a quality shifter $\phi_{jm}^{1/\eta}$.

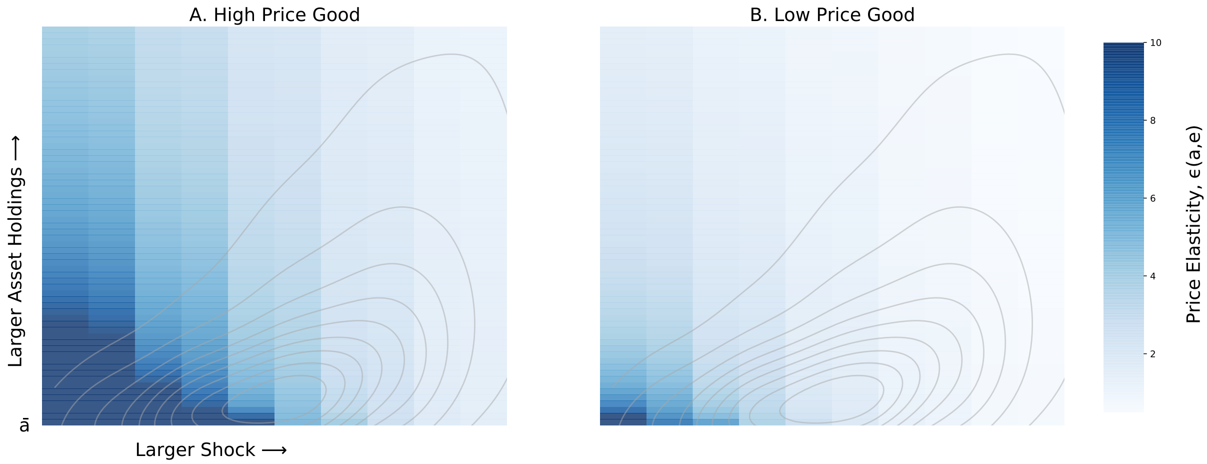


Figure 3: Distribution of household-level elasticities - Low vs. High priced firm customers

with assets on the $y$-axis and earnings on the $x$-axis. Households near the borrowing constraint are toward the bottom of the figure, while lower income households are to the left. Darker (blue) signifies larger price elasticities, lighter signifies smaller price elasticities. The contour plot illustrates the overall stationary distribution $\Lambda(a, e)$ of consumers.

Three observations. First, in both panels, poor consumers—especially those near the borrowing constraint in the southwest corner—have high elasticities of demand. In contrast, as we move northeast, rich consumers' elasticities fall. This is consistent with Auer et al. (2022). Second, both income and assets impact elasticities, some households may be high income but have a high marginal value of wealth due to being asset poor, and hence have high elasticities. Third, elasticities differ between high price and low price firms. For any $(a, e)$, elasticities of demand are relatively larger at the high priced firm. This is the *Elasticity effect* from (32): buying at a high $p_{jm}$ tightens their budget constraint, increasing the marginal value of wealth, and increasing $\varepsilon_{jm}(a, e)$. However this effect is larger for poorer consumers, with much higher elasticities of demand at the high priced firm, where paying a high price eats into available resources, increasing the marginal value of wealth. In contrast, for rich consumers, elasticities of demand are essentially the same as higher prices can be smoothed with savings. Figure 3 confirms that how consumers sort across firms therefore matters for the firm's elasticity of demand $\varepsilon_j$. We turn to this next.

## 4.2. Sorting

Figure 4A shows how households sort across firms. The horizontal axis runs across the distribution of firm prices. As price increases, buyers that are the most elastic substitute away first, leaving only high income households buying from high price firms. We show this by plotting the share of each firm's sales that are to below median income households (red line) At the lowest priced firm more than 80 percent of sales are to below median income households, dropping to less than 20 percent at the highest priced firms.

Figure 4B uses Proposition 1 to show how this sorting shapes the elasticity of demand faced by the firm. Low priced firms sell to poorer households. When comparing products poor households

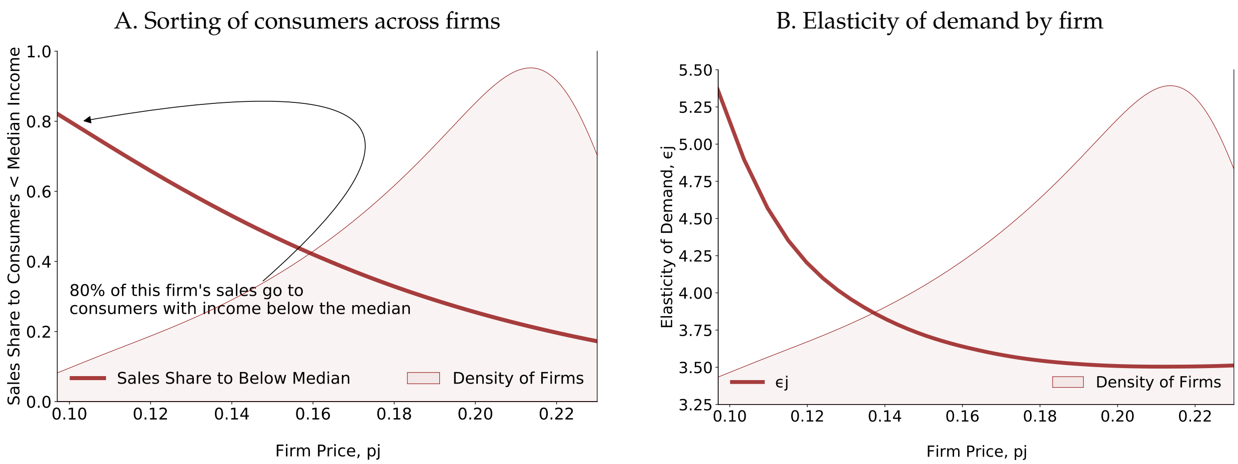


Figure 4: Distribution of households across firms, and firms' elasticity of demand

are highly sensitive to price differences due to a high marginal value of residual wealth after the purchase. This shows up as a high extensive margin elasticity across goods for firms with low prices. High priced firms sell to fewer elastic consumers, and will charger higher markups.

Comparing Figures 3 and 4, two additional quantitative properties of the model emerge. First, there is no contradiction associated with the following observation: conditional on purchasing from a high priced firm, the elasticity of demand of a household of type $(a, e)$ is higher than if it purchased from a low priced firm, however the elasticity of demand faced by high priced firms is lower. This says that the compositional effect dominates, i.e. there are so few low income households at high priced firms. Second, the dominant force shaping price differences across firms remains productivity differences. Consider a low and high priced firm in Figure 4B: $(p_j, \varepsilon_j) \in \{(0.10, 5.30), (0.22, 3.50)\}$. Then $\Delta \log p_j$ can be decomposed into $\Delta \log \mu_j$ and $\Delta \log mc_j$. Doing this we get that 18 percent of the higher price is due to markup differences, while 72 percent is due to marginal cost. The key point of our exercise is that the former piece is endogenous.

### 4.3. Super-elasticity and pass-through

Figure 5A uses Proposition 2 to decompose the super-elasticity of demand into the *Elasticity effect* and *Composition effect*, which we discuss below. In Panel B we plot pass-through. Suppose a firm's marginal cost were to increase slightly, then pass-through measures the elasticity with which its price responds. In any generic model in which $p_j = \mu_j mc_j$, and $\mu_j = \varepsilon_j/(\varepsilon_j+1)$, then pass-through is

$$\varphi_j := \frac{\partial \log p_j}{\partial \log mc_j} = \frac{[\varepsilon_j - 1]}{[\varepsilon_j - 1] + \left\{\frac{\partial \log \varepsilon_j}{\partial \log p_j}\right\}}$$

When the super-elasticity is zero—as is the case with CES—then the markup is constant and pass-through is complete $\varphi_j = 1$. When the super-elasticity is positive then pass-through is less than one. In our current calibration of the model, pass-through is instead *over-shifted*, and greater than one: following an increase in marginal cost, firms raise their prices more than one-for-one.

Why is pass-through over-shifted? In the preliminary calibration of the model, the composition effect is so large as to off-set the elasticity effect which—absent the *Oligopoly effect*—is the only

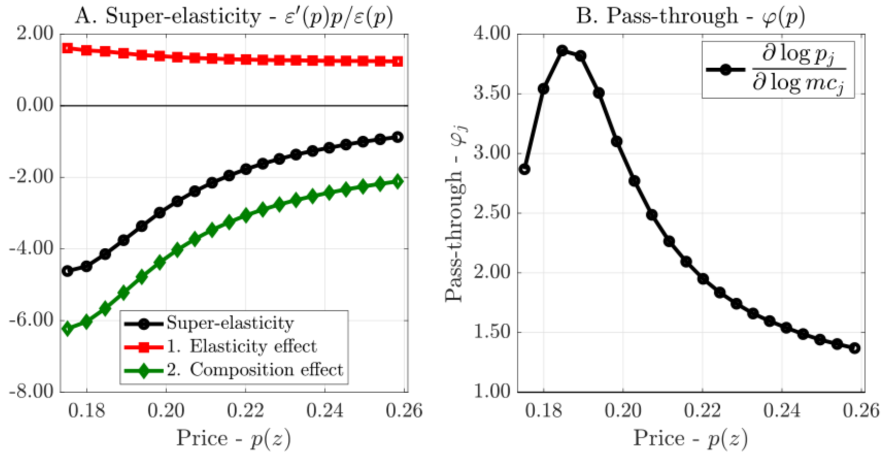


Figure 5: Super-elasticity of demand and pass-through

positive component of the super-elasticity. When marginal cost increases and a firm increases its price, the heterogeneity in elasticities of demand at each firm is so large that the increase in price quickly shifts the mean elasticity upward as low elasticity consumers substitute away to cheaper varieties. The drop in the elasticity leads to further price increases, and so on, implying over-shifted pass-through.[13] While low priced firms sell to poor and rich households, high priced firms sell predominately to rich households. The greater heterogeneity in the customer base of low priced firms leads to a larger composition effect.

The elasticity effect is positive and smaller at higher priced firms. Low priced firms sell more to poorer customers, who have a higher $\mathtt{mpc}^i$, and hence contribute to a larger elasticity effect. Raising prices, makes these customers more elastic. In the current calibration of the model, the heterogeneity in the elasticity effect across firms is minor.

A robust feature of the model is lower pass-through at high priced firms. The weaker elasticity effect at higher prices, and the compressed distribution of customers leading to a weaker composition effect both go in the same direction of a high super-elasticity of demand at higher priced firms, and consequently less pass-through.

Overall, our model gives us a way of uncovering and decomposing the rich underlying forces that determine pass-through from marginal cost into prices. Again, we emphasize that each of these mechanisms is fully endogenous in our model, and not determined by a single parameter.

**Resolving inconsistencies.** Moving forward, the following two inconsistencies of the model with respect to empirical benchmarks can be resolved in the same direction. First, the strong composition effect generates positive pass-through. Second, the relationship between individual elasticities and income is too steep relative to the empirical evidence in Auer et al. (2022). In particular, a regression consistent with their framework yields a coefficient of minus 6.25, relative to

[13] As an aside, note that discussion of firm pricing in the press in early 2023 frequently documented earnings calls in which companys' management describe the positive aspects of keeping prices high—following earlier shocks to marginal cost—and hence selling less to higher income customers at higher margins. This would be consistent with pass-through being over-shifted. See: New York Times - *Is the Entire Economy Gentrifying?*

their estimate of minus 2.19. Reducing heterogeneity in the elasticity of demand by income will flatten out this relationship, and also weaken the composition effect. Additionally, the positive oligopoly effect will reduce pass-through.

## 5. Interpreting empirical studies

A surge of recent empirical work using good level price data from scanner datasets, as well as plausibly exogenous variation in prices or household income / wealth has lead to new evidence on the interaction between household heterogeneity and pricing behavior. Our model is set up specifically to be able to rationalize this evidence. This section validates our quantitative model against two such recent studies: Auer et al. (2022), Stroebel and Vavra (2019). The first establishes that poor households reallocate spending more aggressively than rich households when relative prices change. The second establishes that increases in household wealth are associated with increases in markups.

### 5.1. Auer et al. (2022) - *Unequal Expenditure Switching: Evidence from Switzerland*

**Background.** A key test of our framework is whether it can deliver heterogeneity in substitution patterns across goods that are empirically observed. In a recent paper Auer et al. (2022, henceforth, ABLV) document that poorer households have higher elasticities of substitution. ABLV arrive at this conclusion by studying microdata on Swiss household purchases of Swiss vs. French varieties within the same goods category following exogenous price changes due to the 2015 Swiss Franc appreciation. Subject to the same, exogenous, decrease in prices of French relative to Swiss goods, poor households were found to substitute spending at a significantly higher elasticity. Our model can speak to, and held accountable to this evidence.

**ABLV empirics.** Let $j \in \{M, D\}$ denote i**M**ported or **D**omestic varities of a good of type $m$. The key empirical specification in ABLV is:

$$\log\left(\frac{b^i_{Mt}}{b^i_{Dt}}\right) = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \log\left(\frac{p_{Mt}}{p_{Dt}}\right) + \boldsymbol{\beta}_2 \log e^i \log\left(\frac{p_{Mt}}{p_{Dt}}\right) + \varepsilon^i_t \tag{33}$$

ABLV uses the exchange rate depreciation as an instrument for relative prices, household scanner data to compute budget shares $b^i_{jt}$, and household income $e^i$. Estimated in differences to remove time-invariant quality differences across goods, the key empirical result of ABLV is $\widehat{\boldsymbol{\beta}}_2 = 2.2$. Lower relative prices of imports lead to higher budget shares ($\widehat{\boldsymbol{\beta}}_1 < 0$), but *less so* for richer households ($\widehat{\boldsymbol{\beta}}_2 > 0$).

**Theory.** In this extended model, taking individuals of type $(a, e)$ and aggregating across idiosyncratic preference shocks yields the total share of household type $(a, e)$ spending on good $jm$. We call this the budget share:

$$b_{jm}(a,e) = \frac{p_{jt}\phi_{jt}\exp\left\{\eta v_{jm}(a,e)\right\}}{\sum_{m'\in M}\sum_{j'\in m'}\phi_{j'm'}\exp\left\{\eta v_{j'm'}(a,e)\right\}}$$

Let $i$ denote type $(a, e)$, drop the notation of market $m$. We first take logs of the relative budget shares across-goods $j$ and $k$, within-individuals $i$: $\log(b^i_{jt}/b^i_{jt})$. We then take first order approximations' first with respect to relative prices, second with respect to income. Doing so gives the following comparison of budget shares of individual $i$ and $n$, determined by across-individual variation in income as per ABLV:

$$\log\left(\frac{b^i_{jt}}{b^i_{kt}}\right) - \log\left(\frac{b^n_{jt}}{b^n_{kt}}\right) \approx \underbrace{\left\{\eta u'(c(e^i, p_{kt}))\left(\frac{p_{kt}}{P_{ct}}\right)\right\}\left\{\sigma\right\}\left\{\frac{\partial \log c^i\left(p_{kt}\right)}{\partial \log e^i}\right\}}_{\text{Coefficient estimated in Auer et al (2022)}} \underbrace{\log\left(\frac{e^i}{e^n}\right)\log\left(\frac{p_{jt}}{p_{kt}}\right)}_{\text{Interaction term}}.$$

To see that this is precisely the coefficient estimated by the specification in ABLV, take (33) for individual $i$ and subtract the same equation for individual $n$.

In the model, the ABLV coefficient is unambiguously positive, as per their main empirical result. Given differences in relative prices, poorer households have a higher elasticity of substitution across goods. When is this coefficient larger? Intuitively, this effect is more pronounced if consumption is more sensitive to income and the marginal utility of consumption is more sensitive to consumption (higher $\sigma$).

**Quantitative.** Figure 4B shows the negative relationship between elasticity and income in the calibrated model, qualitatively confirming the findings of ABLV. However, in this preliminary version of the paper, our simple calibration delivers an implied ABLV coefficient that is quantitatively *too large*. That is, the slope in Panel A is *too steep*, relative to the data. In future versions of the paper, we will be able to link our theory to the data more precisely via the ABLV coefficient. Being able to link the theory to data via the coefficient both confirms the theory qualitatively, but will also allow us to discipline the quantitative forces of the model.

**Stone-Geary preferences.** One might think that a promising approach to generating heterogeneity in elasticities of demand by households could be using Stone-Geary-like preferences, and intensive margin demand. However, such a model would be rejected by the evidence in ABLV. Why? Take the simplest case of an individual with preferences over two goods $(x_1, x_2)$, and utility function $u(x_1 - \underline{x}_1, x_2 - \underline{x}_2)$, where $(\underline{x}_1, \underline{x}_2)$ represent subsistence levels of consumption. Rich households consume quantities $x^i_j \gg \underline{x}_j$, while poor households are closer to subsistence consumption. Hence poor households' consumption is *less elastic* with respect to prices, since more of their consumption is dedicated to subsistence. Meanwhile, rich households' consumption can largely ignore subsistence and is free to respond to relative price differences.

### 5.2. Stroebel and Vavra (2019) - *House Prices, Local Demand and Retail Prices*

**Background.** The key finding in Stroebel and Vavra (2019, henceforth SV) is that following an increase in local housing wealth, prices on goods sold locally increase, while marginal costs remain unchanged. SV argues that higher housing wealth reduces homeowners' demand elasticity, leading firms to increase markups in response. Qualitatively, we have already established that such a channel could exist in our model. If a large fraction of households become wealthier—and costs remain the same—then prices will increase as demand becomes less elastic. In this section we want to understand whether the model can (a) replicate their results quantitatively, (b) then be used to unpack the results by exploiting the microdata that is generated by the model, but unobserved to an empiricist.

**Replication.** The idea in Stroebel and Vavra (2019) is to compare changes in markups in areas where there are large changes in wealth to areas in which there are smaller changes in wealth, where disparities across areas are due to the interaction between heterogeneity in changes in house prices and heterogeneity in areas' rate of home ownership. Following a house price increase, owners become richer while renters do not. SV study both the housing boom from 2001-2006 and bust from 2007-2011, we focus on their boom period results.

To mimic their experiment we make $N$ copies of our economy in steady-state, which we denote period $t = 0$. Each copy now corresponds to a different locality, indexed $n$. In each location $n$ we randomly assign a fraction $\varphi_n$ households to be homeowners. Since owners tend to have more wealth than renters, we draw owners from the top 3 quartiles of the distribution of wealth, and renters from the bottom 3 quartiles. In $t = 1$, we increase assets for homeowners by $\Delta_n$ percent, while leaving the assets of renters the same. We then solve the transition of each locality to a new steady-state. Consistent with observations in SV, we keep marginal costs fixed. As each location should be thought of as small, and hence in partial equilibrium, we keep $r$ fixed and drop the asset market clearing condition and the government budget constraint.

We assign $\varphi_n$ and $\Delta_n$ using data from 2000 to 2006. Figure 7A plots the distribution of ownership rates across US ZIP codes in 2000, with $[p25, p50, p75] = [0.69, 0.79, 0.90]$. Figure 7B plots the distribution of ZIP code house price index between 2001 and 2006, with $[p25, p50, p75] = [0.17, 0.28, 0.66]$. Panel C shows that the two are only slightly negatively uncorrelated. We draw $(\varphi_n, \Delta_n)$ from the joint empirical distribution of these statistics.

**Measurement.** Consistent with SV we measure the local price index $P_{nt}$ using consumption expenditure weights computed in the given period:

$$\log P_{nt} = \sum_j \omega_{jnt} \log p_{jnt} \quad , \quad \omega_{jnt} = \frac{p_{jnt} x_{jnt}}{\sum_{m \in M} \sum_{j \in J_m} \sum_k p_{knt} x_{knt}}$$

Given this data, we can compute the main regression in SV (equation 3), which projects the change in log prices on the change in log house prices, the initial home ownership rate, and their interaction. Since all locations in our experiment are ex-ante identical, there is no need for additional controls. We run this regression $\tau = 1, \dots, T$ times, using price index differences between period $\tau \in \{1, \dots, T\}$ and period 0:

$$\log P_{n,\tau} - \log P_{n,0} = \beta_\tau \Delta_n + \gamma_\tau \varphi_n + \delta_\tau \Big( \Delta_n \times \varphi_n \Big) + \varepsilon_n$$

**Results.** The key parameter estimate in SV is the interaction term $\delta_\tau$, with their estimates in a range of 0.10 to 0.23 (SV, Table II, IV, A3).

*To be added.*

## 6. Results

In this preliminary version of the paper we study a single macroeconomic shock: a one time lump-sum fiscal transfer from the government to households. In future versions of the paper we will study the response of the economy to aggregate productivity and demand shocks, and additional policy changes.

### 6.1. Response to a fiscal transfer

A key question following a fiscal policy like lump sum fiscal stimulus checks is how do prices move, for which firms, and to what extent does this choke off expansion in output. To make progress on this question we consider a one time payment to households under a fiscal rule that keeps government debt fixed. Government spending adjusts to finance the transfer and accommodate changes in the government's interest payments on debt.

**Shock.** In period zero the economy is in steady state and households expect this to persist. In period 1, each household receives an unanticipated lump sum transfer $\overline{T}$ equal to one thousand dollars. In periods 1 and $t \geq 2$, the government budget constraints are as follows, where the unit measure of households implies that the total lump sum transfer is $\overline{T}$:

$$G_1 + R_1 B_0 + \overline{T} = W_1 \tau \int e_i \, di + B_1 \tag{34}$$

$$G_t + R_t B_{t-1} = W_t \tau \int e_i \, di + B_t \quad , \quad t \geq 2 \tag{35}$$

The government could keep spending fixed ($G_1 = \overline{G}$), issue debt to pay for $\overline{T}$, raising income taxes in period 1 or in the future. If we were trying to understand the welfare implications of the policy, then this would be an appropriate counterfactual. Here our goal is more modest: to understand the dynamics of household spending across goods and its implication for pricing. Hence we choose a simple fiscal rule: the government keeps debt fixed $B_1 = B_0$, and adjusts $G_1$ to clear (34) given $R_1$. Note $G_2$ will also change due to movements in the equilibrium interest rate $R_2$ given the dynamic effects of the policy on household savings.

Given the shock and associated fiscal policy rule, we solve for the transition of the economy as it returns back to the original stationary equilibrium. This requires solving the transition of the full distribution of prices $p_{jmt}$ and the interest rate $R_t$. Recall that our preliminary version of the economy (Section 3) features $\theta = \eta$ and monopolistic competition. We solve the transition for $J = 50$ firms, under monopolistic competition. When we turn to the transition of the economy with oligopolistic markets, the fact that firms are infinitesimal with respect to continuation values of individuals (discussed in Section 2) and have no state variables—like fixed capital—implies no additional complications in terms of solving the Nash equilibria along the transition.

**Dynamics.** Our main result is that the shock leads to a decline in total factor productivity, which would eat into any desired benefits of the policy. We explain this result in steps in Figure 6.

First, all firms raise their prices. Panel A plots prices for three firms with prices at percentiles

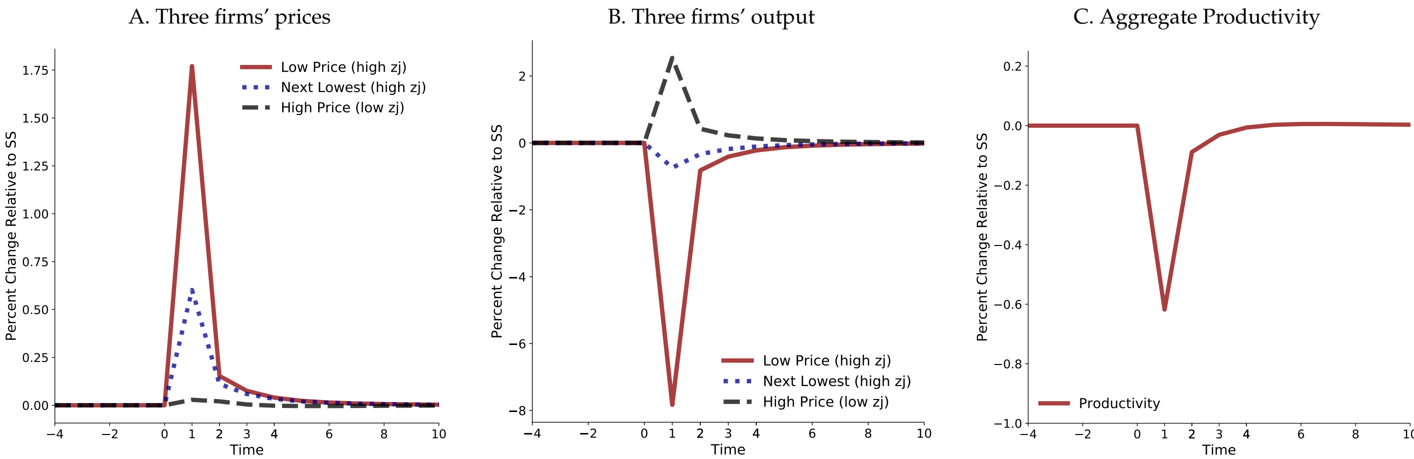


Figure 6: Counterfactual - Response of the economy to a one-time fiscal stimulus payment

25, 50, and 75 of the price distribution. The cash transfer increases the wealth of all customers, making all customers more inelastic. With less inelastic demand and marginal cost unchanged ($W_t = W_0$ for all $t$), firms raise their markups which translate directly into an increase in prices. This is exactly the effect suggested by the empirical evidence in Stroebel and Vavra (2019).

Second, price increases are heterogeneous across firms. The low price firm (red) has the largest increase in its markup, and hence has experienced the largest decline in its elasticity of demand. From our sorting results in Section 2.3, we know that the low price firm sells relatively more to poor households: their elasticity of demand is high (Section 2.3) so they shed quantity quickly when considering moving up the price distribution. (Fig. 4 showed upward of 80 percent of low priced firm sales went to households below median income). The transfer represents a relatively larger increase in wealth for poorer households, and a larger reduction in their marginal utility of consumption. Moreover, rather than saving the transfer like rich households, poorer households spend it, realizing that decline in the marginal utility of consumption immediately. These forces generate a larger drop in the elasticity of demand of poor relative to rich households, and since more poor households consume at the low price firm, its elasticity of demand remains high, but falls by the largest amount. It appropriately increases its price.

Third, while all prices are increasing, the heterogeneous response across firms changes relative prices which reallocates spending. Panel B shows that production is reallocated from the low price firm to firms with higher prices. Even if prices were held fixed, as consumers become less elastic some will trade up to more expensive goods for which they have an idiosyncratic taste. This effect is compounded by the change in relative prices as firms respond to the changing elasticities of demand among their customers.

Fourth, reallocation from low price, high productivity firms to high price, low productivity firms leads to a drop in aggregate productivity. The physical units of goods produced by the differentiated goods sector remains constant—each customer buys a single unit from some producer—but the amount of labor used to produce this measure of goods is now higher as more consumers shop at low productivity firms which use more labor. This reduces the amount of labor available for production in the competitive goods sector, lowering overall output in the economy. Quantitatively TFP falls by 0.6 percent, which is a sizeable decline given the modest transfer.

**Summary.** A key preliminary takeaway is that the cash transfer is not a "free lunch" when viewed from the production side of the economy. By implicitly helping poor households relatively more, the cost of the transfer is (i) higher prices and (ii) a loss in aggregate productivity as resources are reallocated away from the most productive firms. Note the implications for the distributional welfare effects of the policy, as poorer households buy most from the firms that increase prices the most. We will build out discussion of the distributional welfare effects in revisions of this paper.

## 7. Conclusion

In this paper we have put forward a quantitative framework that allows macroeconomists to study how heterogeneity in income and wealth can impact the pricing decisions of firms. The model is shown to be consistent with empirical evidence on how poor versus rich households substitute between goods (Auer et al., 2022), and how firm prices respond to changes in household wealth (Stroebel and Vavra, 2019). We have shown that this behavior can be important for understanding the aggregate effects of a canonical fiscal policy (a lump sum transfer to households), and understanding the distributional effects of shocks that impact different parts of the distribution of firms. The model has limited free parameters, and generates endogenous, policy variant notions of pass-through, sorting of households across prices, elasticities of demand and markups.

Preliminary, related work, provides additional empirical support for the model we have analyzed. First, a key prediction of the exercise in Section 6 is that lower income households are more likely to reallocate spending to higher priced goods within each market. With Jonathan Parker we are testing this result as part of a study into heterogeneity in the spending behavior of households following receipt of 2008 fiscal stimulus payments. Related to Michelacci et al. (2019) who study the addition of new products, we are aiming to understand how expenditure is reallocated across the local price distribution. Second, if firms that sell more to higher income households have a lower elasticity of demand, and additionally productivity was stochastic and there was a menu cost of changing price, then such goods should also exhibit a lower frequency of price adjustment and larger price changes conditional on adjustment. In her job market paper Turk (2023) finds that this relationship holds even when zooming in to variation that exists between goods within the same supermarket and narrow goods category: higher priced goods sell to higher income households and look like they have stickier prices. Hence, heterogeneity in demand elasticities also rationalize cross-sectional facts related to price stickiness.

The broad idea of this paper is (i) the endogenous distribution of wealth shapes the distribution of the marginal value of a dollar, and hence how individuals choose between goods that have different prices, (ii) in imperfectly competitive markets, this affects pricing and hence production decisions. This can be applied more broadly outside of product markets. Consider two examples. First, in labor, Berger et al. (2023) study a Bewley economy with idiosyncratic labor supply disutilities across firms on the extensive margin as well as an intensive margin labor supply decision.

In this environment increased progressivity in income taxes lowers individual elasticities of labor supply on intensive and extensive margins, which when internalized by firms lead to lower wages and employment. Second, in finance, Benetton et al. (2021), study the same general idea in the market for mortgages. The paper proposes that heterogeneity in price sensitivity of borrowers is an important factor in the menu of mortgages offered by lenders, and hence important for monetary policy transmission. Our paper presents these idea in the broadest possible context: a canonical model of household heterogeneity and a canonical model of product choice. It may be specialized in either direction.

Finally, our model has implications for the broader study of business cycles. We are working on a 'TANK' version of the model with stripped back household heterogeneity (i.e. borrower, saver as in Bilbiie (2008), but maintaining logit preferences) and homogeneous firms with Rotemburg price stickiness. This stripped back model is less useful for the discussion of distributive effects of policy, but is more readily amenable to studying business cycle shocks and the effects of monetary policy. Such a model could also be used to help understand the pro-cycality of markups documents by Nekarda and Ramey (2020).[14]

[14]In this framework borrowers have a higher marginal value of wealth and hence are more elastic. Moreover their consumption is more volatile over the business cycle, generating strong counter-cyclicality of their elasticity of demand, and hence pro-cyclicality of markups.

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# Appendix

## A. Additional Figures and Tables

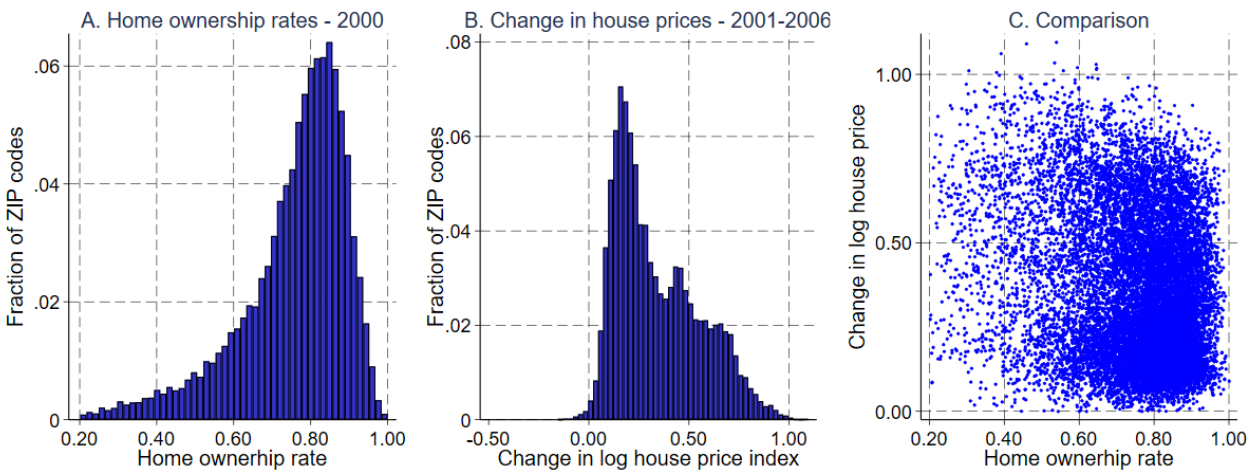


Figure 7: Home ownership rates and changes in house price

Notes: Home ownership rate data from replication package for Stroebel and Vavra (2019), taken from 2000 Census. House price data from *Federal Housing Finance Agency - House Price Index Datasets*.