Online Appendix

Does the Phillips Curve Lie Down as we Age?

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A Derivation of Main Model

For completeness, we start with the foundations of the framework presented in the main text. Recall that each type of person minimizes expenditure subject to the constraint of achieving an overall level of consumption.

$$\min \int_0^1 P_{i,t} c_{i,a,t} di$$
$$\text{subject to } \left(\int_0^1 c_{i,a,t}^{\frac{\sigma_a - 1}{\sigma_a}} di \right)^{\frac{\sigma_a}{\sigma_a - 1}} \geq c_{a,t}.$$

$c_{i,a,t}$ is the consumption of good i of a person of age a at time t. Lower-case letters denote per-capita variables. The first order condition for for good i is

$$P_{i,t} - \lambda_{a,t} c_{i,a,t}^{\frac{-1}{\sigma_a}} c_{a,t}^{\frac{1}{\sigma_a}} = 0 \Leftrightarrow c_{i,a,t} = c_{a,t} P_{i,t}^{-\sigma_a} \lambda_{a,t}^{\sigma_a}$$

where $\lambda_{a,t}$ is the multiplier on the constraint. Substituting the FOC into the constraint (and evaluating it at equality) gives

$$\left(\int_0^1 c_{i,a,t}^{\frac{\sigma_a - 1}{\sigma_a}} di \right)^{\frac{\sigma_a}{\sigma_a - 1}} = \lambda_{a,t}^{\sigma_a} c_{a,t} \left(\int_0^1 P_{i,t}^{1-\sigma_a} di \right)^{\frac{\sigma_a}{\sigma_a - 1}} = c_{a,t} \Leftrightarrow$$
$$\lambda_{a,t} = \left(\int_0^1 P_{i,t}^{1-\sigma_a} di \right)^{\frac{1}{1-\sigma_a}} = P_{a,t}$$

The demand function for a person of age a is

$$c_{i,a,t} = c_{a,t} \left(\frac{P_{i,t}}{P_{a,t}} \right)^{-\sigma_a}.$$

Note that we can write this demand function in aggregate variables as well. Denoting

$C_{i,a,t}$ as the aggregate consumption of good i at time t for all people of age a gives

$$C_{i,a,t} = C_{a,t} \left(\frac{P_{i,t}}{P_{a,t}} \right)^{-\sigma_a}.$$

Assume that people of every age group are part of a large household. The household planner puts equal weight on their utility. Let the number of people of age a be given by ν_a. The intertemporal utility function is given by

$$U = \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left[\sum_{a=1}^{N} \nu_a \frac{\left(c_{a,t}(1-n_{a,t})^{\theta_a}\right)^{1-\gamma}}{1-\gamma} \right]$$

where γ is the coefficient of relative risk aversion, θ_a governs the marginal utility of leisure for a person of age a.

Letting the general price level be P_t, the household's budget constraint in real terms is given by

$$\sum_{a=1}^{N} \nu_a c_{a,t} + B_t = \frac{P_{t-1}}{P_t}(1+i_{t-1})B_{t-1} + w_t \sum_{a=1}^{N} \nu_a n_{a,t} + D_t.$$

B_t is the aggregate quantity of bonds held by the household. Bonds purchased in period t pay a nominal interest rate of i_t. D_t are dividends earned by the firm and rebated to the household.

The first order conditions are given by

$$\begin{aligned} c_{a,t}:\ & c_{a,t}^{-\gamma}(1-n_{a,t})^{\theta_a(1-\gamma)} = \lambda_t \\ n_{a,t}:\ & \theta_a c_{a,t}^{1-\gamma}(1-n_{a,t})^{\theta_a - 1 - \theta_a\gamma} = \lambda_t w_t \\ B_t:\ & \lambda_t = \beta \mathbb{E}_t \lambda_{t+1} \frac{1+i_t}{1+\pi_{t+1}}. \end{aligned}$$

Denote aggregate variables by big letters. Accordingly,

$$\begin{aligned} C_{a,t} &= \nu_a c_{a,t} \\ N_{a,t} &= \nu_a n_{a,t}. \end{aligned}$$

A.1 Firm Side

Firms, indexed by i, produce a differentiated good, $y_{i,t}$. The production function for good i is

$$Y_{i,t} = A_t \sum_{a=1}^{N} N_{a,i,t}$$

The marginal cost of producing another unit of $Y_{i,t}$ is

$$mc_t = \frac{w_t}{A_t}.$$

The output produced by firm i gets sold to consumers of different ages:

$$Y_{i,t} = \sum_{a=1}^{N} C_{i,a,t} = \sum_{a=1}^{N} C_{a,t} \left(\frac{P_{i,t}}{P_{a,t}} \right)^{-\sigma_a}.$$

The dynamic optimization problem for firms entails choosing $P_{i,t}$ and $Y_{i,t}$ to maximize

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \lambda_t \left[\frac{P_{i,t} Y_{i,t}}{P_t} - mc_t Y_{i,t} - \frac{\phi}{2} Y_t \left(\frac{P_{i,t}}{P_{i,t-1}} - 1 \right)^2 \right]$$

subject to the constraint

$$Y_{i,t} = \sum_{a=1}^{N} C_{a,t} \left(\frac{P_{i,t}}{P_{a,t}} \right)^{-\sigma_a}.$$

Let $\mu_{i,t}$ denote the Lagrangian multiplier on the constraint. The first order conditions are

$$Y_{i,t}: \quad mc_t - \frac{P_{i,t}}{P_t} = \mu_{i,t}$$

$$\begin{aligned} P_{i,t}: \quad & \frac{Y_{i,t}}{P_t} - \phi \frac{Y_t}{P_{i,t-1}} \left(\frac{P_{i,t}}{P_{i,t-1}} - 1 \right) \\ & + \mu_{i,t} \sum_{a=1}^{N} \sigma_a C_{a,t} P_{a,t}^{\sigma_a} P_{i,t}^{-\sigma_a - 1} \\ + \beta \mathbb{E}_t & \left[\frac{\lambda_{t+1}}{\lambda_t} \phi Y_{t+1} \frac{P_{i,t+1}}{P_{i,t}^2} \left(\frac{P_{i,t+1}}{P_{i,t}} - 1 \right) \right] = 0. \end{aligned}$$

Next, combine these two equations to eliminate the multiplier.

$$\begin{aligned} &\frac{Y_{i,t}}{P_t} - \phi \frac{Y_t}{P_{i,t-1}} \left(\frac{P_{i,t}}{P_{i,t-1}} - 1 \right) \\ &+ \left(mc_t - \frac{P_{i,t}}{P_t} \right) \sum_{a=1}^{N} \sigma_a C_{a,t} P_{a,t}^{\sigma_a} P_{i,t}^{-\sigma_a - 1} \\ &+ \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \phi Y_{t+1} \frac{P_{i,t+1}}{P_{i,t}^2} \left(\frac{P_{i,t+1}}{P_{i,t}} - 1 \right) \right] = 0. \end{aligned}$$

Focusing on the symmetric equilibrium in which firms choose the same price and quantity implies that the price indexes across different age groups are the same, $P_{j,t} = P_t$). Let $P_{i,t} = P_t$. Inflation is $\frac{P_t}{P_{t-1}} = 1 + \pi_t$. The (non-linear) Phillips curve is:

$$\sum_{a=1}^{N} (\sigma_a - 1) C_{a,t} + \phi Y_t \pi_t (1 + \pi_t) = mc_t \sum_{a=1}^{N} \sigma_a C_{a,t} + \mathbb{E}_t \beta \frac{\lambda_{t+1}}{\lambda_t} \phi \pi_{t+1} (1 + \pi_{t+1}) Y_{t+1}.$$

A.2 Aggregation

Because each firm chooses the same price, they also produce the same level of output. The aggregate production function is therefore given by

$$Y_t = A_t \sum_{a=1}^{N} N_{a,t}.$$

Dividends are given by

$$D_t = Y_t - w_t \sum_{a=1}^{N} N_{a,t} - \frac{\phi}{2} Y_t \pi_t^2.$$

Substituting this into the household budget constraint and assuming that bonds are in zero net supply gives

$$\begin{aligned} \sum_{a=1}^{N} C_{a,t} + B_t &= \frac{P_{t-1}}{P_t} (1 + i_{t-1}) B_{t-1} + w_t \sum_{a=1}^{N} N_{a,t} + D_t \Leftrightarrow \\ \sum_{a=1}^{N} C_{a,t} &= w_t \sum_{a=1}^{N} N_{a,t} + Y_t - w_t \sum_{a=1}^{N} N_{a,t} - \frac{\phi}{2} Y_t \pi_t^2 \Leftrightarrow \\ \sum_{a=1}^{N} C_{a,t} &+ \frac{\phi}{2} Y_t \pi_t^2 = Y_t. \end{aligned}$$

To close the model, assume that the central bank follows the following rule in setting the nominal interest rate.

$$i_t = i_{ss} + \varphi \pi_t$$

with the parameter $\varphi > 1$ satisfying the Taylor principle.

A.3 Summarizing Equilibrium Conditions

The endogenous variables are: $c_{a,t}, n_{a,t}, C_{a,t}, N_{a,t}, \lambda_t, mc_t, w_t, Y_t, \pi_t, i_t$.

$$c_{a,t}^{-\gamma}(1-n_{a,t})^{\theta_a(1-\gamma)} = \lambda_t \tag{1}$$

$$\theta_a c_{a,t}^{1-\gamma}(1-n_{a,t})^{\theta_a-1-\theta_y\gamma} = \lambda_t w_t \tag{2}$$

$$\lambda_t = \beta E_t \lambda_{t+1}\frac{1+i_t}{1+\pi_{t+1}} \tag{3}$$

$$C_{a,t} = \nu_a c_{a,t} \tag{4}$$

$$N_{a,t} = \nu_a n_{a,t} \tag{5}$$

$$mc_t = \frac{w_t}{A_t} \tag{6}$$

$$\sum_{a=1}^{N}(\sigma_a-1)C_{a,t} + \phi Y_t\pi_t(1+\pi_t) = mc_t\sum_{a=1}^{N}\sigma_a C_{a,t} + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\phi\pi_{t+1}(1+\pi_{t+1})Y_{t+1}. \tag{7}$$

$$Y_t = A_t\sum_{a=1}^{N}N_{a,t} \tag{8}$$

$$\sum_{a=1}^{N}C_{a,t} + \frac{\phi}{2}Y_t\pi_t^2 = Y_t \tag{9}$$

$$i_t = i_{ss} + \varphi\pi_t \tag{10}$$

A.4 Rotemberg Pricing: Log-linear approximation

As mentioned, we assume steady-state inflation rate is 0. A couple notes. First, the resource constraint is

$$Y_t = \sum_{a=1}^{N}C_{a,t} + \frac{\phi}{2}\pi_t^2 Y_t.$$

In steady state,

$$Y_{ss} = \sum_{a=1}^{N}C_{a,ss}.$$

Let s_a be the share of output consumed by people of age a in steady state. So

$$C_{a,ss} = s_a Y_{ss}.$$

Second, evaluating the Phillips curve in steady state shows that steady-state marginal cost is

$$mc_{ss} = \frac{\sum_{a=1}^{N}(\sigma_a-1)C_{a,ss}}{\sum_{a=1}^{N}\sigma_a C_{a,ss}}.$$

This can be simplified to

$$mc_{ss} = \frac{\sum_{a=1}^{N}(\sigma_a - 1)s_a}{\sum_{a=1}^{N}\sigma_a s_a}.$$

Noting that $\sum_{a=1}^{N} s_a = 1$ and letting $\sum_{a=1}^{N} s_a\sigma_a = \bar{\sigma}$ be the weighted average of the elasticities, we can write steady-state marginal cost as

$$mc_{ss} = \frac{\bar{\sigma} - 1}{\bar{\sigma}}.$$

We then take the natural log of both sides of the Phillips curve. This gives

$$\begin{aligned} &\ln\left[\sum_{a=1}^{N}(\sigma_a - 1)C_{a,t} + \phi Y_t \pi_t(1+\pi_t)\right] \\ &= \ln\left[mc_t \sum_{a=1}^{N}\sigma_a C_{a,t} + \mathbb{E}_t\beta\frac{\lambda_{t+1}}{\lambda_t}\phi\pi_{t+1}(1+\pi_{t+1})Y_{t+1}\right]. \end{aligned}$$

Now, taking a first-order Taylor series expansion around the steady state gives

$$\begin{aligned} \frac{\sum_{a=1}^{N}(\sigma_a - 1)(C_{a,t} - C_{a,ss}) + \phi Y_{ss}\pi_t}{\sum_{a=1}^{N}(\sigma_a - 1)C_{a,ss}} =& \frac{(mc_t - mc_{ss})\sum_{a=1}^{N}\sigma_a C_{a,ss}}{mc_{ss}\sum_{a=1}^{N}\sigma_a C_{a,ss}} \\ &+ \frac{mc_{ss}\sum_{a=1}^{N}\sigma_a(C_{a,t} - C_{a,ss})}{mc_{ss}\sum_{a=1}^{N}\sigma_a C_{a,ss}} \\ &+ \frac{\beta\phi Y_{ss}\pi_{t+1}^{e}}{mc_{ss}\sum_{a=1}^{N}\sigma_a C_{a,ss}}. \end{aligned}$$

Note that the multipliers completely disappear because we are approximating around an inflation rate of 0. Then, we can write the log-linearized Phillips curve as

$$\frac{\phi\pi_t}{\sum_{a=1}^{N}(\sigma_a - 1)s_a} + A_t = \tilde{mc}_t + B_t + \frac{\beta\phi\pi_{t+1}^{e}}{mc_{ss}\sum_{a=1}^{N}\sigma_a s_a}$$

where $\tilde{mc}_t$ is marginal cost's percent deviation from steady state.[1] Using the steady-state condition for marginal cost, we can write this as

$$\frac{\phi\pi_t}{\sum_{a=1}^{N}(\sigma_a - 1)s_a} + A_t = \tilde{mc}_t + B_t + \frac{\beta\phi\pi_{t+1}^{e}}{\sum_{a=1}^{N}(\sigma_a - 1)s_a}.$$

Doing some cross multiplication yields

$$\pi_t = \frac{\sum_{a=1}^{N}(\sigma_a - 1)s_a}{\phi}\tilde{mc}_t + \beta\pi_{t+1}^{e} + H_t$$

[1] A_t and B_t are given by $A_t = \frac{\sum_{a=1}^{N}(\sigma_a - 1)(C_{a,t} - C_{a,ss})}{\sum_{a=1}^{N}(\sigma_a - 1)C_{a,ss}}$ and $B_t = \frac{\sum_{a=1}^{N}\sigma_a(C_{a,t} - C_{a,ss})}{\sum_{a=1}^{N}\sigma_a C_{a,ss}}$.

where $H_t = \frac{\sum_{a=1}^{N}(\sigma_a - 1)s_a}{\phi}(B_t - A_t)$.

Finally, we can write the Phillips curve as

$$\pi_t = \frac{\bar{\sigma} - 1}{\phi}\tilde{mc}_t + \beta\pi^e_{t+1} + H_t.$$

If σ_a is constant across ages, then $H_t = 0$, and this collapses to the usual log-linearized Phillips curve under Rotemberg pricing:

$$\pi_t = \frac{\sigma - 1}{\phi}\tilde{mc}_t + \beta\pi^e_{t+1}.$$

Returning to our Phillips curve, the slope with respect to marginal cost is

$$\frac{\bar{\sigma} - 1}{\phi}. \tag{11}$$

To the extent that older people have a lower σ_a, an older population will flatten the Phillips curve.

B Menu Cost Pricing

With Rotemberg pricing, a lower elasticity of substitution flattens the Phillips curve. This result is derived in a model in which firms face a quadratic cost of adjustment. With quadratic costs, it is optimal for firms to adjust their price every period, but stop short of the optimal (frictionless) reset price.

The leading alternative to Rotemberg is the Calvo model in which firms get to reset their prices with some exogenous probability. However, under Calvo pricing, the elasticity of substitution parameter does not show up directly in the slope of the Phillips curve. In what follows, we argue that the probability of price adjustment itself likely depends on the value of σ. Specifically, we assume that firms pay a fixed cost, i.e. a menu cost, to update prices. For most parameterizations we find that, for a given menu cost, firms will be more likely to change prices when demand is relatively elastic. As demand becomes more inelastic, firms change prices less frequently which means that prices will be "stickier" *à la* Calvo. So the probability of price adjustment, which is commonly given as a structural parameter in these models, will actually be affected by the age distribution – also consistent with the message in Rubio-Ramirez and Fernández-Villaverde (2007). All else equal, an older population maps to a lower probability of price adjustment which, in the Calvo framework, flattens the Phillips curve.

Consider a monopolist who faces a CES demand curve given by $Q = AP^{-\sigma}$ where $\sigma > 1$ is the price elasticity of demand and A represents market size. Assume a linear cost function,

$$C(Q) = \phi Q.$$

A constant returns to scale production function maps into a linear cost function, so this is without loss of generality. From a firm's perspective, this demand function is equivalent up to a constant of the monopolistic competition demand curve (because the firm takes the aggregate price level and aggregate income as exogenous).

Profit maximization implies an optimal price of

$$P^* = \frac{\sigma}{\sigma - 1}\phi$$

which is the typical markup over marginal cost.

Suppose that the firm comes into the period with a preset price of $\bar{P}$, i.e. the price on the menu that was presumably selected in an earlier period. The firm's profit under $\bar{P}$ is

$$\Pi_{\text{fixed}} = A\bar{P}^{1-\sigma} - \phi A\bar{P}^{-\sigma}.$$

If marginal cost changes between periods (i.e. a productivity shock), then $\bar{P}$ is no longer optimal. Suppose the firm faces a menu cost, f, of adjusting prices. If it pays the adjustment cost, the firm will adjust prices all the way to P^*. In the case that the firm adjusts to the optimal price, profit is given by

$$\Pi^*_{\text{var}} = AP^{*^{1-\sigma}} - \phi AP^{*^{-\sigma}} - f.$$

It follows that the firm will adjust its price if an only if

$$\Pi^*_{\text{var}} > \Pi_{\text{fixed}} \Leftrightarrow AP^{*^{1-\sigma}} - \phi AP^{*^{-\sigma}} - (A\bar{P}^{1-\sigma} - \phi A\bar{P}^{-\sigma}) > f.$$

Define $\hat{f}$ as the menu cost where the firm is indifferent to adjusting prices. Formally,

$$\hat{f} = AP^{*^{1-\sigma}} - \phi AP^{*^{-\sigma}} - (A\bar{P}^{1-\sigma} - \phi A\bar{P}^{-\sigma}).$$

If $\hat{f}$ is increasing in σ then a firm facing a more price-sensitive demand curve will require a larger f to keep its prices the same. That is, for a given f, the firm will be more likely to change the price the larger the elasticity (σ). Intuitively, the more price sensitive is a firm's demand curve the more willing they will be to pay the fixed cost and update prices. The derivative is

$$\frac{\partial \hat{f}}{\partial \sigma} = \frac{\partial \Pi^*_{\text{var}}}{\partial \sigma} - \frac{\partial \Pi_{\text{fixed}}}{\partial \sigma}.$$

Applying the envelope theorem to the first derivative on the right-hand side and simplifying results in

$$\frac{\partial \hat{f}}{\partial \sigma} = AP^{*^{-\sigma}} \ln P^* \left[-P^* + \phi\right] - A\bar{P}^{-\sigma} \ln \bar{P} \left[-\bar{P} + \phi\right].$$

The sign of this derivative is ambiguous. Intuitively, as long as $\bar{P} > \phi$, profits under the optimal price and the fixed price are both decreasing in σ and it is not obvious which profit function decreases faster. Assuming $\bar{P}$ is five percent below the optimal price, Figure 1 shows how $\hat{f}$ depends on σ and ϕ.[2]

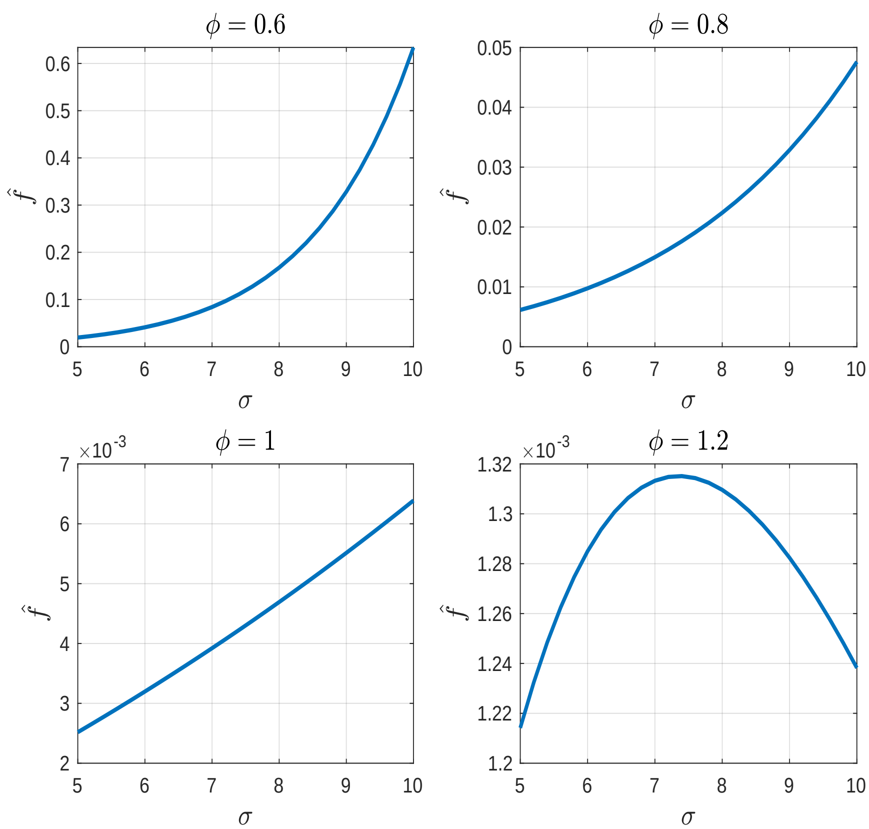

Figure 1: $\bar{P} = 0.95P^*$

Likewise, the Figure 2 shows plot when the $\bar{P}$ is five percent too high.

[2]Because A does not affect the sign of the derivative, we assume $A = 1$ in all of the exercises in this Appendix.

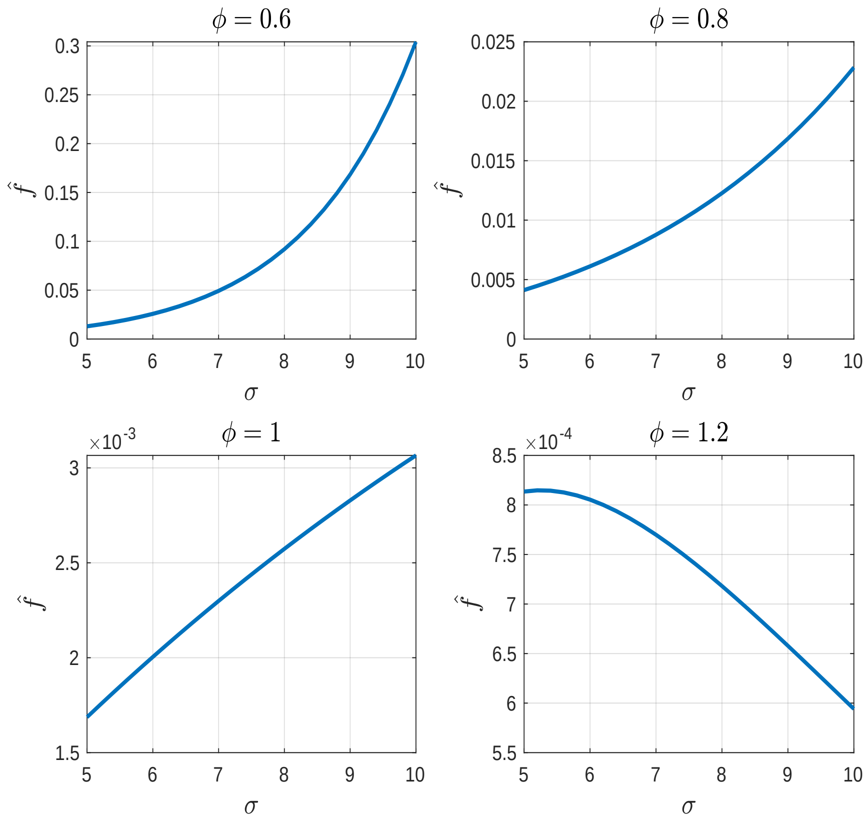

Figure 2: $\bar{P} = 1.05P^*$

We can discipline ϕ to be in a quantitatively relevant range to see the role of σ. When prices are flexible, the profit-to-output ratio reduces to $\phi/(\sigma - 1)$. In the data, profit share of GDP is between 5 and 10 percent. The plot below shows how $\hat{f}$ changes when $\phi = 0.5$ over the range of $6 < \sigma < 11$, the empirically relevant range of σ. The profit share in this case is between 5 and 10 percent. In the empirically relevant range for ϕ, Figure 3 shows that $\hat{f}$ increases with σ for several different values of $\bar{P}$ which is consistent with a flatter Phillips curve.

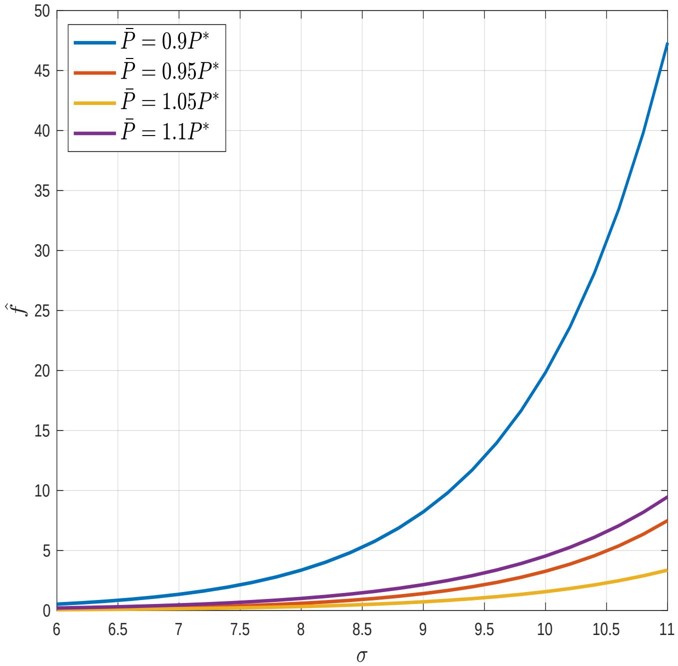

Figure 3: $\hat{f}$ as a Function of σ

C Summary of Data

Table 1 summarizes the NielsenIQ Homescan data sample in the main analysis. Table 2 shows the number of estimated product module σ_ms by age group and by age-income category. In our analysis, we require that at least 20 households purchase a product in each group to be included in the estimation. At younger and lower income households, there are fewer observations that match this criteria and thus there are fewer elasticities estimated within each product module.

Table 1: Summary of Data

Ave. Households per year	57,355
Number of Observations (summed at age-period-barcode)	6,402,134
Number of Product Modules	1,117
Ave. Total Expenditures per year (projection factor weighted)	$314,392,448,666

Table 2: Number of estimated Product Module σ_ms by Group

	by Age	Income and Age lower 50%	Income and Age upper 50%
25-34	378	187	220
35-44	632	383	529
45-54	743	459	667
55-64	768	471	688
65+	742	481	655

C.1 Income groups

One issue with the Homescan data is that incomes are reported in discrete bins at a two-year lag. To estimate relative income, we follow Faber and Fally (2022) to estimate expenditures per capita as a proxy for income group. For this, we obtain per capita expenditures by year regressing log total expenditures on household size dummies and household-level attributes. We then adjust household expenditures by netting our household size dummy coefficients to get per capita expenditure estimates. While expenditures may not accurately measure actual income, they do appear to identify relative income levels. Table 3 regresses the log adjusted per capita expenditures we constructed on income dummies and household size controls for 2004, 2009, 2014, and 2019 (every 5 years in our sample). Note that with only few exceptions, the coefficients on the income dummies are monotonically increasing even though the income bin is reported from 2 years prior. This pattern suggests that the expenditures are monotonically increasing with reported income levels. Thus, estimated expenditures appear to be appropriate for capturing relative income.

Table 3: Per Capita Consumption Estimate and Income Bin

	2004	2009	2014	2019
$5000-7999	-0.0170	-0.0104	-0.0102	-0.0604
	(0.0355)	(0.0351)	(0.0354)	(0.0367)
$8000-9999	0.0156	-0.00577	-0.0405	-0.0782*
	(0.0366)	(0.0352)	(0.0315)	(0.0337)
$10,000-11,999	0.0230	-0.0255	0.0121	-0.0251
	(0.0342)	(0.0323)	(0.0292)	(0.0305)
$12,000-14,999	0.0598	0.0274	0.00461	-0.0434
	(0.0318)	(0.0291)	(0.0265)	(0.0271)
$15,000-19,999	0.0971**	0.0421	0.0246	0.00580
	(0.0304)	(0.0276)	(0.0245)	(0.0249)
$20,000-24,999	0.119***	0.0555*	0.0705**	0.0183
	(0.0299)	(0.0267)	(0.0235)	(0.0236)
$25,000-29,999	0.149***	0.0837**	0.0913***	0.0524*
	(0.0301)	(0.0266)	(0.0234)	(0.0235)
$30,000-34,999	0.171***	0.125***	0.109***	0.0711**
	(0.0299)	(0.0264)	(0.0233)	(0.0232)
$35,000-39,999	0.181***	0.134***	0.146***	0.0991***
	(0.0301)	(0.0266)	(0.0234)	(0.0234)
$40,000-44,999	0.196***	0.143***	0.147***	0.0753**
	(0.0301)	(0.0266)	(0.0236)	(0.0233)
$45,000-49,999	0.235***	0.165***	0.165***	0.104***
	(0.0303)	(0.0266)	(0.0233)	(0.0232)
$50,000-59,999	0.237***	0.193***	0.169***	0.115***
	(0.0296)	(0.0258)	(0.0226)	(0.0223)
$60,000-69,999	0.248***	0.203***	0.189***	0.131***
	(0.0298)	(0.0261)	(0.0229)	(0.0226)
$70,000-99,999	0.290***	0.221***	0.199***	0.143***
	(0.0294)	(0.0254)	(0.0221)	(0.0217)
$100,000 +	0.329***		0.212***	0.177***
	(0.0299)		(0.0223)	(0.0217)
$100,000 - 124,999		0.249***		
		(0.0262)		
$125,000 - 149,999		0.224***		
		(0.0289)		
$150,000-199,999		0.237***		
		(0.0300)		
$200,000+		0.212***		
		(0.0329)		
Household size controls	Yes	Yes	Yes	Yes
N	39,577	60,502	61,554	61,480

Notes: Standard errors in parentheses. * denotes 10%, ** 5%, and *** 1% significance.

C.2 Elasticity of substitution estimates by year and age

Table 4 gives the estimates of the elasticity of substitution within product modules by each age group and each year in our sample.

Table 4: σ estimates by year and age

	Age				
	25-34	35-44	45-54	55-64	65+
2004	6.380	6.101	6.562	6.246	5.642
	(0.088)	(0.056)	(0.061)	(0.081)	(0.046)
2005	6.388	6.108	6.564	6.244	5.656
	(0.092)	(0.055)	(0.060)	(0.084)	(0.046)
2006	6.351	6.066	6.566	6.230	5.665
	(0.094)	(0.053)	(0.060)	(0.081)	(0.045)
2007	9.720	8.554	8.886	8.562	7.153
	(0.149)	(0.113)	(0.106)	(0.114)	(0.090)
2008	10.745	9.231	9.312	9.124	7.769
	(0.156)	(0.121)	(0.111)	(0.120)	(0.100)
2009	10.740	8.916	9.122	8.917	7.735
	(0.157)	(0.118)	(0.108)	(0.118)	(0.099)
2010	11.155	9.306	9.464	9.238	8.135
	(0.161)	(0.122)	(0.110)	(0.119)	(0.104)
2011	11.509	9.721	9.657	9.551	8.611
	(0.162)	(0.127)	(0.112)	(0.121)	(0.110)
2012	8.029	7.257	7.547	7.276	6.460
	(0.131)	(0.089)	(0.084)	(0.095)	(0.070)
2013	7.730	7.168	7.468	7.263	6.458
	(0.132)	(0.088)	(0.082)	(0.093)	(0.069)
2014	7.584	7.166	7.492	7.344	6.573
	(0.127)	(0.087)	(0.083)	(0.093)	(0.072)
2015	7.614	7.173	7.476	7.378	6.702
	(0.125)	(0.087)	(0.083)	(0.093)	(0.075)
2016	7.459	7.176	7.484	7.399	6.716
	(0.118)	(0.085)	(0.083)	(0.092)	(0.075)
2017	7.486	7.211	7.495	7.469	6.817
	(0.119)	(0.086)	(0.083)	(0.093)	(0.076)
2018	7.584	7.284	7.551	7.490	6.799
	(0.122)	(0.088)	(0.084)	(0.094)	(0.076)
2019	7.697	7.322	7.549	7.497	6.792
	(0.128)	(0.089)	(0.084)	(0.094)	(0.075)

Notes: Standard errors in parentheses.

References

Faber, B. and T. Fally (2022): "Firm heterogeneity in consumption baskets: Evidence from home and store scanner data," The Review of Economic Studies, 89, 1420–1459.

Rubio-Ramirez, J. F. and J. Fernández-Villaverde (2007): "How structural are structural parameters?" National Bureau of Economic Research Macroeconomics Annual, 22.