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The Macroeconomics of Aging Consumers: the Competition Channel *

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Abstract

Population aging affects product-market competition through demand composition. A search model of competition, disciplined by evidence on life-cycle differences in substitution behavior and search intensity, predicts non-monotone effects: aging from young to middle age weakens competition, while aging into retirement strengthens it. Consistent with the model, a shift-share IV combining foreign demographic shifts with predetermined sectoral exposure finds that middle-aged demand raises prices and profit shares but lowers output. In a U.S.-calibrated general-equilibrium analysis, this competition channel lowers real GDP by up to 1.2 percent, peaking in the mid-2010s before partly reversing as baby boomers enter retirement.

JEL classification: J11, E21, E23, O47, D43, D83
Keywords: Population Aging, Demand Composition, Product-Market Competition, Secular Stagnation.

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1 Introduction

Advanced economies are undergoing a profound demographic transition, as declining fertility and rising longevity reshape the age distribution of the population. The macroeconomic consequences of this transition have been studied primarily through the supply side, as population aging affects labor markets, innovation, technology, and productivity (Maestas et al., 2023; Aksoy et al., 2019; Jones, 2022; Acemoglu and Restrepo, 2017, 2022; Angelini, 2023; Moreno-Galbis and Sopraseuth, 2014). However, population aging not only affects the age composition of workers but also the age composition of consumers. Since consumption behavior varies over the life cycle, demographic change can alter the way firms compete with potentially relevant macroeconomic implications. We show that this aging demand *competition channel* is quantitatively important.

The mechanism is driven by two life-cycle patterns in consumer behavior. First, young consumers are more willing to substitute across varieties, while middle-aged and older consumers are more brand loyal and display lower elasticities of substitution (Lambert-Pandraud et al., 2005; Lambert-Pandraud and Laurent, 2010; Curtis et al., 2025; Bornstein, 2025). Second, shopping intensity varies over the life cycle with the opportunity cost of time. Working-age consumers devote less time to shopping and price comparison, whereas older consumers search more intensively and tend to pay lower prices for a given good (Aguiar and Hurst, 2005, 2007) as they have a lower opportunity cost of time once retired. Therefore, demand composition disciplines firms' decisions through changes in the intensity of competition within and between goods as consumers age.

We formalize these forces in a model of price competition with consumer search. Within a market, a finite number of firms sell a homogeneous good, compete in prices as in Stahl (1989), and choose productivity-enhancing investment. Consumers differ along two dimensions: search costs and the elasticity of substitution across goods. Demographic change is then represented as a reallocation of demand across consumer types. The model delivers non-monotonic effects of aging on competition. A transition from young to middle-aged consumers leaves search intensity unchanged but lowers the elasticity of substitution across goods, reducing between-market competition and increasing the incentives to increase prices.

Under sufficient conditions, the price distribution shifts upward, potentially contracting demand and, therefore, production. A subsequent transition from middle-aged to old consumers increases the share of consumers who search more intensively for prices, increasing within-market competition. This raises the payoff to undercutting prices, shifting the price distribution downward, boosting demand, and increasing production.

We empirically identify this demand-side channel by exploiting variation in the age composition of foreign demand faced by domestic sectors. We combine the World Input-Output Database (Timmer et al., 2015), which provides sectoral prices, output, profit shares, and global input-output linkages, with the UN World Population Prospects (United Nations, 2022). We interact foreign demographic changes (*shift*) with predetermined country-sector exposure to foreign final demand (*share*), measured through global value-chain linkages. This shift-share design isolates variation in the age composition of demand driven by foreign consumers from that driven by domestic demographics, which also affect sectors through other domestic channels, e.g., labor supply. Because demographic change is partly predictable, we report estimates using two versions of the instrument: one based on actual foreign demographic changes, and one based on revisions in UN demographic projections that isolate the forecast-error component of foreign aging. The latter rests on the weaker exogeneity assumption that unanticipated foreign demographic changes are orthogonal to domestic sectoral shocks.

We find that greater exposure to middle-aged demand is associated with higher average prices and profit shares but lower output. The negative co-movement between prices and quantities supports the competition-shock interpretation. The results are robust to alternative age definitions and different model specifications.

Finally, we quantify the aggregate importance of the mechanism in a multi-market general equilibrium model calibrated to the U.S. economy. Since 1995, demographic changes in the U.S. have lowered real GDP through the demand channel by up to about 1.2 percent. The effect peaks in the mid-2010s and partly reverses thereafter, as baby boomers start entering retirement and search intensity rises.

The paper makes three contributions. First, it identifies an aging demand competition channel of demographic change: as the age composition of consumers shifts, so does the intensity of product-market competition. Aging demand generates a negative co-movement between producer prices and quantities, closer to a competition shock rather than a standard demand shock. We derive this prediction theoretically, document it empirically, and quantify it in a multi-market general equilibrium model. The framework builds on Stahl (1989) and Chen and Zhang (2011) within-market competition search models, adding heterogeneous demand elasticities to capture between-market competition. This channel is distinct from the between-sector reallocation studied in Cravino et al. (2019), and complements its analysis: aging not only affects the industrial composition through changes in consumption patterns but also affects the economy through changes in competition.

Second, the paper reconciles two micro-level sets of evidence with opposite competitive implications. On one side, substitution elasticities fall with age (Lambert-Pandraud et al., 2005; Lambert-Pandraud and Laurent, 2010; Curtis et al., 2025), weakening competition. On the other side, search intensity rises in retirement (Aguiar and Hurst, 2005, 2007), which strengthens it. Embedding both in a single framework, in the spirit of the goods-market frictions literature (Kaplan and Menzio, 2016; Bethune et al., 2020; Nord, 2022; MacKay and Remer, 2024), implies non-monotonic effects of aging on competition over the demographic transition as young-to-middle-aged aging reduces competition, while middle-aged-to-old aging increases it. The closest paper is Bornstein (2025), in which weaker consumer inertia among the young links aging to declining entry, lower competition, and rising profit shares. We differ by introducing heterogeneity in search costs, implying an increase in competition as consumers age into retirement, a mechanism absent from his framework.

Third, the paper offers a demographic interpretation of two long-run trends: the rise in markups and profit shares (De Loecker et al., 2020; Barkai, 2020; Gutiérrez and Philippon, 2017; Decker et al., 2016) and the growth slowdown at the core of the secular-stagnation debate (Summers, 2014). Existing work ties aging to the supply side, through labor and productivity (Maestas et al., 2023; Aksoy et al., 2019; Jones, 2022), technology adoption (Acemoglu and Restrepo, 2017, 2022; Moreno-Galbis and Sopraseuth, 2014; Angelini, 2023), or savings and the natural rate (Eggertsson et al., 2019; Carvalho et al., 2016; Rachel and Summers, 2019). Abstracting from the supply side, our paper theoretically identifies a novel demand-side competition channel through which aging affects the economy, empirically documents it, and quantitatively estimates its relevance in explaining those secular trends.

The rest of the paper is organized as follows: Section 2 presents the theoretical model and derives the effects of the young-to-middle-aged and middle-aged-to-old transitions on prices and production. Section 3 describes the data, empirical strategy, and sector-level evidence on the effects of changes in the age composition of demand. Section 4 embeds the mechanism in a multi-market general equilibrium framework and quantifies its aggregate effect on the U.S. economy. Finally, section 5 concludes.

2 Theoretical framework

We develop a market-level model of price competition with consumer search. Firms sell a homogeneous market good. Consumers differ in search costs and in the elasticity of demand. Search costs determine the cost of sampling additional prices and hence the extent of price comparison across firms. Demand elasticities determine how strongly demand responds to firm prices. We initially take type-specific demand schedules as primitives in the market-level model, which are then disciplined within a multi-market framework. The market-level model, therefore, distinguishes two margins of competition: a within-market competition margin, governed by search costs, and a between-market competition margin, governed by the price elasticity of demand.

2.1 Search model

Consumers. Let $i \in \{h, l\}$ index search costs, where h denotes high search costs and l low search costs, and let $I \in \{H, L\}$ index the elasticity of substitution, where H denotes high elasticity and L low elasticity. The economy is populated by four consumer types, $(i, I) \in \{(h, H), (h, L), (l, H), (l, L)\}$, with population shares $\lambda^{(i,I)} \in [0, 1]$ satisfying $\sum_i \sum_I \lambda^{(i,I)} = 1$. Consumers observe prices sequentially. The first price observation is free. Consumers with high search costs pay a cost $\nu > 0$ for each additional price observation, while consumers with low search costs pay no such cost (they have a search cost of zero).

Given an observed price z, for a consumer with high search costs, the gain from observing an additional price $p < z$ is

$$CS^{(h,I)}(p;z) \equiv \int_p^z D^{(h,I)}(x)\,dx, \tag{1}$$

where $D^{(h,I)}(\cdot)$ denotes the market-level demand of type-(h,I) consumers and is non-increasing in price. Assuming that prices are drawn from the cumulative distribution F, the expected gain from one more search, conditional on the current best price z, is

$$ECS^{(h,I)}(z) \equiv \int_b^z CS^{(h,I)}(p;z)\,dF(p), \tag{2}$$

where b is the lower bound of the price distribution. We define the reservation price $r^{(h,I)}$ by $ECS^{(h,I)}(r^{(h,I)}) = \nu$ whenever a finite solution exists, and set $r^{(h,I)} = +\infty$ otherwise. A type-(h,I) consumer continues searching as long as the lowest observed price exceeds $r^{(h,I)}$ and buys once a price weakly below $r^{(h,I)}$ is observed.

Since consumers with low search costs face zero search costs, they observe all prices and buy from the lowest-priced firm in the market. Therefore, the price faced by low-search-cost consumers is the order statistic $p_{\min} \equiv \min\{p_1, \ldots, p_N\}$, with cumulative distribution $F_{\min}(p) = 1 - (1 - F(p))^N$.

Firms. In each market, a finite number $N \geq 2$ of ex-ante identical firms choose prices and productivity-enhancing investment. Production uses labor according to

$$y^{sup.}(a) = (\bar{a} - a)^{-1}\ell, \tag{3}$$

where $y^{sup.}$ denotes output, ℓ labor input, and $a \in [0, \bar{a})$ is firm-level investment. A higher value of a lowers unit labor requirements, thereby raising output per worker. Equation (3) implies labor demand $\ell = y^{sup.}(\bar{a} - a)$, so total variable cost is $w\,y^{sup.}(\bar{a} - a)$ and marginal cost is $m(a) \equiv w(\bar{a} - a)$, where w denotes the wage. We assume a quadratic investment cost, $z(a) = a^2/2$, which implies diminishing returns to productivity-enhancing investment and keeps the firm's problem tractable.

Equilibrium. Following Stahl (1989), we restrict our attention to symmetric mixed-strategy equilibria. An equilibrium is a collection $\{F(p), a(p), r^{(h,H)}, r^{(h,L)}\}$, where F is the distribution of prices, $a(p)$ is the investment policy conditional on posting price p, and $r^{(h,H)}$ and $r^{(h,L)}$ are reservation prices for high-search-cost consumers. Given F and the reservation rules, firms are indifferent across all prices in the support of F, choosing the associated investment $a(p)$. Given F, high-search-cost consumers follow their reservation rule, while low-search-cost consumers observe all prices and buy from the lowest-price firm.

The game admits no pure-strategy equilibrium: if a positive mass of firms were to set the same price, any one of them could profitably undercut by an arbitrarily small amount and capture all low-search-cost consumers. We, therefore, exclusively consider atomless mixed-strategy equilibria. It implies that ex-ante identical firms adopt heterogeneous strategies ex-post with identical pay-offs.

We also maintain the assumption that no firm can profitably deviate by posting a price in $(\min\{r^{(h,H)}, r^{(h,L)}\}, \max\{r^{(h,H)}, r^{(h,L)}\}]$ and serving only the subset of high-search-cost consumers with the higher reservation price: the gain from targeting a smaller set of consumers at a higher price is outweighed by the loss of low-search-cost demand. Under this condition, the upper bound of the support is

$$\bar{r} \equiv \min\{r^{(h,H)}, r^{(h,L)}, p^{mon.}\}, \tag{4}$$

where $p^{mon.}$ is the monopolistic price. On the equilibrium path, all prices lie in the support $[b, \bar{r}]$. Therefore, high-search-cost consumers always stop searching at the first price observed and purchase from the first sampled firm.

Unlike Stahl (1989), where consumers purchase a single unit, consumers adjust the quantity purchased in response to price differences. For high-search-cost consumers, since firms are ex ante symmetric, each firm is sampled first with probability $1/N$. Since low-search-cost consumers instead observe all prices, they buy from the lowest-pricing firm. Therefore, each firm faces the following expected demand

$$\mathbb{E}\{y^{dem.}(p)\} = \frac{1}{N}\sum_I \lambda^{(h,I)} D^{(h,I)}(p) + [1 - F(p)]^{N-1} \sum_I \lambda^{(l,I)} D^{(l,I)}(p). \tag{5}$$

The first term captures demand from high-search-cost consumers, while the second captures demand from low-search-cost consumers. The probability that a firm charging price p is the lowest-priced seller and captures the entire demand of shoppers is $[1-F(p)]^{N-1}$.

Given expected demand $\mathbb{E}\{y^{dem.}(p)\}$, a firm choosing price p and investment a solves

$$\max_{\{a,p\}} \left\{ \mathbb{E}\{y^{dem.}(p)\}\big(p - m(a)\big) - z(a) \right\}. \tag{6}$$

The first-order condition with respect to investment is

$$z'(a(p)) = w\, \mathbb{E}\{y^{dem.}(p)\}, \tag{7}$$

meaning that firms invest more when expected demand is higher. This equilibrium condition creates a positive (negative) correlation between a firm's size (price) and productivity.

To derive the equilibrium CDF, denote per-consumer revenue by $R^{(i,I)}(p) \equiv D^{(i,I)}(p)\big(p - m(a(p))\big)$. At the upper bound $\bar{r}$, a firm attracts no low-search-cost consumers, $F(\bar{r}) = 1$. Therefore, expected profits at $\bar{r}$ are:

$$\pi^* \;\equiv\; \mathbb{E}\{\pi(\bar{r}, F)\} = \frac{1}{N}\sum_I \lambda^{(h,I)} R^{(h,I)}(\bar{r}) - z(a(\bar{r})). \tag{8}$$

Every equilibrium price in the support must yield the same expected profit π^*, equating expected profits at a generic price $p \in [b, \bar{r})$ to π^* yields the indifference condition:

$$[1-F(p)]^{N-1} = \frac{B(p)}{C(p)}, \tag{9}$$

where, setting $\Delta R^{(i,I)}(p) \equiv R^{(i,I)}(\bar{r}) - R^{(i,I)}(p)$ and $\Delta z(p) \equiv z(a(p)) - z(a(\bar{r}))$, $B(p)$ is the opportunity cost of undercutting and $C(p)$ is the revenue from being the firm with the lowest price.

$$B(p) \equiv \frac{1}{N}\sum_I \lambda^{(h,I)} \Delta R^{(h,I)}(p) + \Delta z(p), \tag{10}$$

$$C(p) \equiv \sum_I \lambda^{(l,I)} R^{(l,I)}(p). \tag{11}$$

We summarize the pricing pressure at price p by defining a competition index $\Theta(p;\lambda) \equiv C(p)/B(p)$, so that:

$$(12) \qquad F(p) \;=\; 1 - \Big[\Theta(p;\lambda)\Big]^{-\frac{1}{N-1}}, \qquad p \in [b, \bar{r}].$$

For a given support and investment policy, a higher $\Theta(p;\lambda)$ implies higher competition and a larger payoff from undercutting prices, shifting the price distribution toward lower prices.

2.2 Aging consumers

We interpret aging as a reallocation of the population across consumer types. Throughout this subsection, we work with three age groups mapped into the model: young consumers $Y \equiv (h, H)$ (high search costs, high elasticity), middle-aged consumers $M \equiv (h, L)$ (high search costs, low elasticity), and old consumers $O \equiv (l, L)$ (low search costs, low elasticity).[1] Aging operates through two margins. A $Y \to M$ reallocation changes the composition of demand elasticities within the consumers with high search costs. An $M \to O$ reallocation changes the share of consumers who compare prices across sellers. These two transitions have opposite effects on competition and market outcomes.

We now characterize the effect of demographic reallocations on prices and production output. We hold fixed the upper support $\bar{r}$ and the investment schedule $a(p)$, and we assume that, conditional on the realized transaction price, market-level demand depends only on the elasticity type.[2] The quantitative analysis recomputes the full equilibrium under alternative demographic shares. We now consider the middle-aged-to-old and young-to-middle-aged transitions in turn.[3]

[1] The mapping reflects two life-cycle patterns. From young to middle age, consumers become less willing to substitute across varieties while remaining time-constrained (Lambert-Pandraud and Laurent, 2010; Bornstein, 2025). From middle age to old age, consumers devote more time to price comparison while retaining low elasticity (Aguiar and Hurst, 2007). The low search cost, high elasticity type plays no role in the aging analysis, and we, therefore, set $\lambda^{(l,H)} = 0$.

[2] Search types therefore differ only in the transaction-price distribution they face. In particular, consumers of types (h, L) and (l, L) share the same demand schedule at a given price, and likewise for (h, H) and (l, H).

[3] Although the demographic transition naturally proceeds from young to middle-aged and then, from middle-aged to old age, we begin with the latter transition because it isolates the search-margin mechanism most transparently.

Proposition 2.1 (Middle-aged to Old)**.** *Consider a marginal reallocation from middle-aged to old consumers, $M \to O$. Holding the equilibrium support and the investment schedule fixed:*

(i) *The equilibrium price distribution shifts towards lower prices in first-order stochastic dominance (FOSD).*

(ii) *Expected market-level production rises.*

Proof in Appendix A.1.

The $M \to O$ reallocation increases the share of consumers observing all prices. As a result, $B(p)$ falls because fewer consumers buy from randomly sampled firms, while $C(p)$ rises because more consumers buy from the lowest-priced seller. Both effects raise $\Theta(p; \lambda)$ pointwise, shifting the equilibrium price distribution toward lower prices. Since demand is non-increasing in price, expected production rises.

We next consider the transition from young to middle-aged.

Proposition 2.2 (Young to Middle-aged)**.** *Consider a marginal reallocation from young to middle-aged consumers, $Y \to M$. Holding the equilibrium support and the investment schedule fixed, the price distribution shifts toward higher prices in the sense of FOSD if:*

$$\Delta R^{(h,L)}(p) \geq \Delta R^{(h,H)}(p) \qquad \textit{for all } p \in [b, \bar{r}]. \tag{13}$$

Proof in Appendix A.2.

The $Y \to M$ reallocation leaves the share of low-search-cost consumers unchanged, while increasing the share of consumers with low elasticity. It operates therefore only through $B(p)$, while $C(p)$ remains unaffected. Condition (13) requires that, at each price in the support, lowering the price from $\bar{r}$ to p entails a weakly larger revenue loss on low-elasticity consumers than on high-elasticity consumers. Intuitively, since demand is less price-sensitive, the reallocation from young to middle-aged consumers raises the opportunity cost of undercutting prices, lowers $\Theta(p; \lambda)$, and shifts the price distribution toward higher prices.[4]

[4] Condition (13) is sufficient, not necessary. With isoelastic residual demand, whether it holds depends on

The effect of the $Y \to M$ transition on production is ambiguous. Two forces operate in opposite directions. The upward shift in prices reduces demand, while the replacement of (h, H) consumers by (h, L) consumers raises demand at a given price when low-elasticity consumers purchase more. Market-level production falls only if the price-induced demand contraction dominates this direct composition effect.[5]

Taken together, the propositions identify two direct pricing forces. The $M \to O$ transition strengthens price comparison and shifts prices downward. Under the revenue condition (13), the $Y \to M$ transition weakens the incentive to undercut and shifts prices upward. The associated production response is unambiguously positive for $M \to O$, but it is ambiguous for $Y \to M$, because the price-induced contraction and the composition effect work in opposite directions.

3 Empirical analysis

The empirical analysis takes the market-level mechanism to country-sector data.[6] We therefore ask whether sectors more exposed to middle-aged demand display patterns associated with weaker competition: higher producer prices, higher profit shares, and lower production output. Changes in the age structure of the domestic population simultaneously affect labor supply, savings, and other aggregate conditions that can move prices and quantities. We isolate demand-side variation using country-sector differences in exposure to foreign markets. The shift-share instrument interacts predetermined exposure to foreign demand with destination-country demographic shifts. Foreign demographic changes reweigh the age-composition of demand faced by a sector, while leaving the domestic age structure unchanged.

the normalization of type-specific demand and on the part of the equilibrium support over which the comparison is evaluated. In the quantitative implementation, the calibrated equilibrium satisfies the condition over the relevant support.

[5] In the calibrated model, this dominance condition holds, so the $Y \to M$ transition lowers production.

[6] The theory is stated at the market level while data are observed at the country-sector level, each of which might comprise many markets. Nevertheless, predictions from Propositions 2.1 and 2.2 extend to the sector level under within-sector symmetry of primitives. Indeed, if markets within a sector face the same demographic composition and demand across markets is governed by a CES aggregator, sector-level price and quantity indexes inherit the signs of the market-level comparative statics. Since the data are observed at the country-sector level rather than at the market level, the estimates should be interpreted as reduced-form evidence on these sectoral implications.

3.1 Data

To measure sectoral exposure to foreign demand, we use the World Input-Output Database (Timmer et al., 2015). It provides sector-level statistics on value added, hours worked, price deflators, and input-output tables covering trade links at the country-sector level. The WIOD covers 35 sectors in 27 European Union countries and 13 other major economies for the period 1995-2009, plus estimates for the rest of the world.[7] Using the input-output tables allows us to track the interdependence arising from the integrated production structure of the world economy, capturing both direct and indirect exposure to each country's final demand. The structure of a world input-output table is illustrated in Figure 1.[8]

Figure (1) The structure of a world input-output table

			Input use & value added							**Final use**			**Total use**
			Country 1			$\cdots$	Country J			Country 1	$\cdots$	Country J	
			Industry 1	$\cdots$	Industry S	$\cdots$	Industry 1	$\cdots$	Industry S				
		Industry 1	Z_{11}^{11}	$\cdots$	Z_{11}^{1S}	$\cdots$	Z_{1J}^{11}	$\cdots$	Z_{1J}^{1S}	F_{11}^{1}	$\cdots$	F_{1J}^{1}	Y_1^1
Intermediate	Country 1	$\cdots$	$\cdots$	Z_{11}^{rs}	$\cdots$	$\cdots$	$\cdots$	Z_{1J}^{rs}	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
		Industry S	Z_{11}^{S1}	$\cdots$	Z_{11}^{SS}	$\cdots$	Z_{1J}^{S1}	$\cdots$	Z_{1J}^{SS}	F_{11}^{S}	$\cdots$	F_{1J}^{S}	Y_1^S
inputs	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	Z_{ij}^{rs}	$\cdots$	$\cdots$	$\cdots$	$\cdots$	F_{ij}^{r}	$\cdots$	Y_i^r
		Industry 1	Z_{J1}^{11}	$\cdots$	Z_{J1}^{1S}	$\cdots$	Z_{JJ}^{11}	$\cdots$	Z_{JJ}^{1S}	F_{J1}^{1}	$\cdots$	F_{JJ}^{1}	Y_J^1
supplied	Country J	$\cdots$	$\cdots$	Z_{J1}^{rs}	$\cdots$	$\cdots$	$\cdots$	Z_{JJ}^{rs}	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
		Industry S	Z_{J1}^{S1}	$\cdots$	Z_{J1}^{SS}	$\cdots$	Z_{JJ}^{S1}	$\cdots$	Z_{JJ}^{SS}	F_{J1}^{S}	$\cdots$	F_{JJ}^{S}	Y_J^S
Value added			VA_1^1	$\cdots$	VA_1^S	VA_j^s	VA_J^1	$\cdots$	VA_J^S				
Gross output			Y_1^1	$\cdots$	Y_1^S	Y_j^s	Y_J^1	$\cdots$	Y_J^S	$\cdots$			

Source: World Input-Output Database

The World Population Prospects (United Nations, 2022) further provide measures of past, current, and predicted demographic compositions for all world countries. We construct measures of unexpected demographic change comparing estimates for the same year reported in two different vintages. These forecast revisions capture the component of demographic change that was not anticipated, and therefore could not have been reflected in firms' earlier trade and investment decisions. We use the 1996 dataset to construct the expected demo-

[7] The 13 non-EU economies are Australia, Brazil, Canada, China, Indonesia, India, Japan, South Korea, Mexico, Russia, Turkey, Taiwan, and the United States.

[8] Rows represent the country-sector supplying the input; columns represent the country-sector purchasing it. Each cell records the corresponding value-added flow. The "Final use" columns record output consumed by each country, decomposed into household consumption expenditure, NPISH consumption, government consumption, gross fixed capital formation, and changes in inventories. Consistent with our focus on consumer demand, we consider exclusively the household consumption expenditure component.

graphic path and the 2019 dataset for the realized one. Differences between the two are the unexpected shifts that form the basis of exogenous variation in our instrument.

3.2 Identification approach

OLS model. We estimate the effect of demand-side aging on sectoral outcomes using the following long-difference fixed-effect specification:

$$\Delta \log Y_i^s = \beta_0 + \beta_1 \cdot \Delta MiddleAgeConsumers_i^s + \beta_2 \cdot ForeignExposure_i^s + \gamma_i + \gamma_s + \epsilon_i^s. \tag{14}$$

The dependent variable $\Delta \log Y_i^s$ is, in turn, the log difference in prices, output, and profit shares between 1996 and 2006 in sector s of country i.[9] For prices, we use the sector-specific value-added price deflator, which captures producer-side price variation and is therefore independent of the expenditure weights underlying consumer price indices. For profitability, we construct sectoral economic profit shares following the accounting approach of Van Vlokhoven (2024).[10]

The regressor of interest, $\Delta MiddleAgeConsumers_i^s$, measures the change in the share of middle-aged consumers (aged 45-64 relative to the population aged 25-79) faced by sector s in country i between 1996 and 2006, weighting country-level demographic shares by the sector's exposure to each country's final demand:

$$\Delta MiddleAgeConsumers_i^s = \sum_j \xi_{i,j,2006}^s \cdot MiddleAge_{j,2006} - \sum_j \xi_{i,j,1996}^s \cdot MiddleAge_{j,1996}. \tag{15}$$

More specifically, exposure weights $\xi_{i,j,t}^s$ measure the share of sector s's value added in country i that ultimately reaches consumers in country j, tracing value added through the full supply chain rather than only direct exports. Following Ferrari (2023), we define it as

$$\xi_{i,j}^s \equiv \frac{F_{i,j}^s + \sum_r \sum_k a_{i,k}^{s,r} F_{k,j}^r + \sum_r \sum_k \sum_g \sum_m a_{i,k}^{s,r} a_{k,m}^{r,g} F_{m,j}^g + \cdots}{Y_i^s}, \tag{16}$$

[9] We use the longest available period in the WIOD 2013 release excluding the recession years from 2007 onward. We begin in 1996 rather than 1995 to align the sample with the first vintage of the UN World Population Prospects, which was published in 1996.

[10] Economic profits are defined as nominal output net of operating expenses and estimated capital costs, and the economic profit share is the resulting residual divided by nominal output.

where $F^s_{i,j}$ is the value added of sector s in country i directly consumed in country j, the second term captures output sold to intermediate producers that ultimately reaches consumers in j, and so on for higher-order terms.[11] Accounting for indirect linkages is important: a German car producer using Italian tires that sells its cars in France creates exposure of the Italian tire sector to French consumer demographics, which a direct-exports measure would miss.

All specifications include country fixed effects γ_i, sector fixed effects γ_s, and the initial-period foreign exposure share $ForeignExposure^s_i \equiv \sum_{j \neq i} \xi^s_{i,j,1996}$ as a control. Sector fixed effects absorb sector-specific average changes or trends in the period considered, such as common growth in health-sector demand associated with global aging. Observations are weighted by country-sector value added, so that $\hat{\beta}_1$ recovers the effect relevant for the aggregate outcome.[12]

Shift-share IV model. The OLS estimates of equation (14) are likely biased: domestic demographic shifts affect not only the age composition of consumers but also the age composition of workers, confounding the demand-side channel with labor-supply and productivity effects. To isolate the demand-side variation, we instrument $\Delta MiddleAgeConsumers^s_i$ with changes in the age composition of foreign demand, weighted by the sector's predetermined exposure to foreign markets. The endogenous regressor measures the age composition of total demand faced by a sector, while the instrument isolates the component induced by foreign destination markets only. The first-stage model is

$$\begin{aligned}(17)\quad \Delta MiddleAgeConsumers^s_i = \alpha_0 + \alpha_1 \cdot \Delta ForeignMiddleAgeConsumers^s_i \\ + \alpha_2 \cdot ForeignExposure^s_i + \gamma_i + \gamma_s + \nu^s_i,\end{aligned}$$

[11] We compute the exposure shares using the Leontief inverse matrix $(I-A)^{-1}$, so that $[\xi^s_{i,j}] = (I-A)^{-1} \cdot [f^s_{i,j}]$, where $[f^s_{i,j}] \equiv [F^s_{i,j}/Y^s_i]$ is the final demand share matrix and $A \equiv [Z^{s,r}_{i,j}/Y^s_i]$ is the input-output matrix.

[12] To see this, note that the aggregate outcome is a value-added weighted average of sector-level outcomes, $\Delta \log Y^{\text{agg}} = \sum_{i,s} \omega_{i,s} \Delta \log Y^s_i$, where $\omega_{i,s} = VA_{i,s}/\sum_{i,s} VA_{i,s}$. Aggregating equation (14) with weights $\omega_{i,s}$ yields $\Delta \log Y^{\text{agg}} = \beta_1 \cdot \Delta\text{MiddleAge}^{\text{agg}} + \ldots$, where $\Delta\text{MiddleAge}^{\text{agg}} = \sum_{i,s} \omega_{i,s} \Delta\text{MiddleAge}^s_i$ is the value-added weighted change in the middle-aged share. Weighting observations by $\omega_{i,s}$ delivers precisely this $\hat{\beta}_1$. Unweighted estimation would instead recover the simple average effect across cells, which does not correspond to the aggregate object of interest.

where the instrument $\Delta ForeignMiddleAgeConsumers_i^s$ is a shift-share constructed by weighting country-level demographic changes (shifts) by the sector's initial exposure to each foreign market (shares):

$$\Delta ForeignMiddleAgeConsumers_i^s \equiv \sum_{j \neq i} \xi_{i,j,1996}^s \cdot DemographicShift_{j,1996}. \tag{18}$$

Following Borusyak et al. (2022), Adão et al. (2019), and Goldsmith-Pinkham et al. (2020), identification requires either exogenous shares or exogenous shifts. Because the exposure weights $\xi_{i,j,1996}^s$ are potentially endogenous, as firms choose which sectors and countries to trade with, we rely on exogenous shifts, requiring that foreign demographic changes are orthogonal to domestic sectoral outcomes conditional on the controls.

The main threat to this condition is that demographic change is predictable: if firms anticipated foreign aging, they may have adjusted their trade exposure in ways that correlate the shares with the shifts. We address this by using, along with actual demographic changes, forecast revisions as our shifts. Hence, we consider two measures of demographic shifts:

$$DemographicShift_{j,1996}^A \equiv age_{j,2006} - age_{j,1996}, \tag{19}$$

$$DemographicShift_{j,1996}^U \equiv age_{j,2006} - \mathbb{E}_{1996}\left(age_{j,2006}\right), \tag{20}$$

where $\mathbb{E}_{1996}(age_{j,2006})$ is the demographic projection for 2006 as published in the 1996 vintage of the UN World Population Prospects. The two shift measures rest on different identifying assumptions. IV^A requires that *actual* foreign demographic changes be orthogonal to domestic sectoral shocks, conditional on country fixed effects, sector fixed effects, and initial foreign exposure. IV^U relies on the weaker condition that the *unexpected* component, the forecast revisions, satisfies the same orthogonality requirement, weakening the concern that initial exposure shares reflect anticipated foreign aging. Figure 2 shows substantial variation in these revisions across countries and age categories. For the baseline middle-aged specifications, the corresponding first-stage statistics reported in Table 1 indicate a strong first stage. Standard errors are clustered by each sector's main exposure country, since sectors selling primarily to the same foreign market are exposed to common demographic shocks.

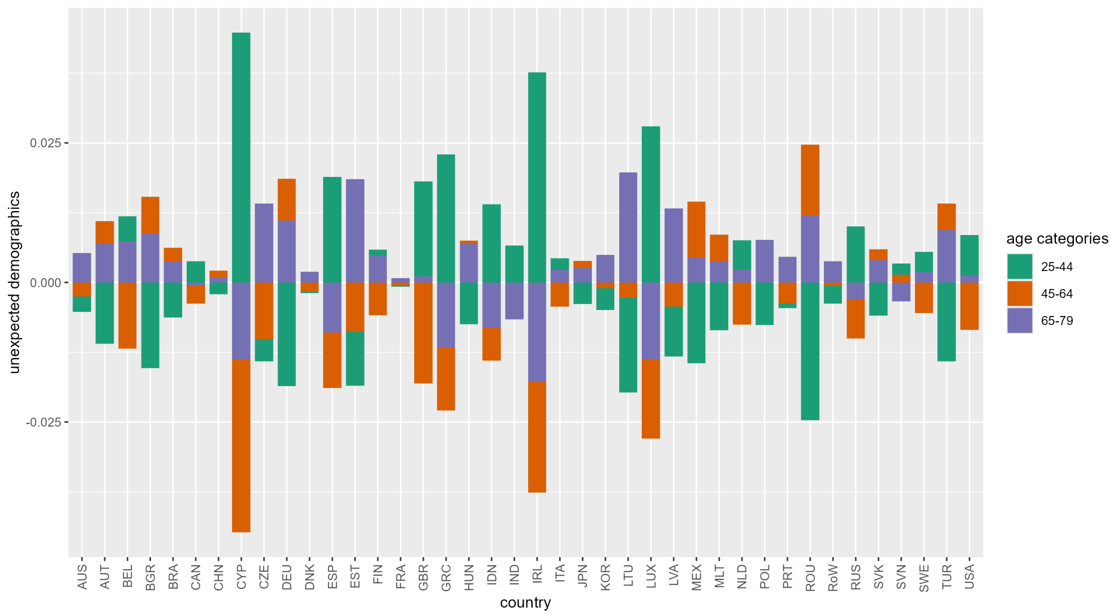

Figure (2) Unexpected demographic changes aggregated in three age categories.

Notes: This figure shows the forecast revisions for the year 2006 computed between the 1996 and 2019 vintages of the UN World Population Prospects. For each age category, we report its share in the total population aged 25-79. Forecast revisions are computed as the 2019-vintage estimate for 2006 minus the 1996-vintage projection for 2006.

3.3 Results

Table 1 summarizes the main empirical results.[13] An increase in the share of middle-aged consumers raises producer prices and profit shares while lowering production. The shift-share IV estimates imply that a one-percentage-point increase in the middle-aged share leads to a yearly increase in prices in the range $[0.43, 0.77]\%$, a reduction in output in the range $[0.36, 0.55]\%$, and an increase in profit shares in the range $[2.13, 5.13]\%$ over the 1996-2006 period.[14]

The sign pattern is the key empirical result. Standard demand shocks tend to move prices and quantities in the same direction. By contrast, shifts toward middle-aged demand raise prices while lowering production output. This negative co-movement is consistent with a competitive shock: demand is reallocated toward consumers whose characteristics weaken

[13] Over the 1996-2006 sample period, the dominant demographic shift in the countries covered is from young to middle-aged consumers, so we interpret the middle-aged regressor as identifying the $Y \rightarrow M$ transition; the relevant theoretical benchmark is Proposition 2.2.

[14] The average annual changes are computed as $100 \times [1 + \%\Delta y/100]^{1/(2006-1996)} - 100$, where $\%\Delta y = 100 \cdot (e^{\hat{\beta}_1 \cdot \Delta x} - 1)$ is the cumulative percentage change, $\hat{\beta}_1$ is the IV$^{v \in \{A,U\}}$ coefficient estimate, and Δx is set to one percentage point.

Table (1) Demand-Composition Aging and Sectoral Outcomes

	Δ log Price			Δ log Production			Δ log Profit		
	OLS	IV^A	IV^U	OLS	IV^A	IV^U	OLS	IV^A	IV^U
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Middle-aged (45-64)	3.162	4.247	7.664	−3.143	−3.647	−5.488	18.744	21.105	50.058
	(0.750)	(2.895)	(4.028)	(0.901)	(2.545)	(2.416)	(3.181)	(12.123)	(17.895)
Initial foreign exposure	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,353	1,353	1,353	1,353	1,353	1,353	917	917	917
R^2	0.885	0.885	0.882	0.582	0.582	0.580	0.297	0.297	0.217
F statistic	-	158.211	148.289	-	158.211	148.289	-	96.872	63.955

Notes: This table reports OLS and shift-share IV estimates of the effect of changes in the share of middle-aged consumers, aged 45–64 relative to the population aged 25–79, on sectoral outcomes over the period 1996–2006. Both IV specifications weight foreign demographic changes by initial sectoral exposure to foreign demand. IV^A uses actual changes in foreign middle-aged shares; IV^U uses unexpected changes, defined as the 2019-vintage estimate for 2006 minus the 1996-vintage projection for 2006. Standard errors are clustered by main exposure country in the IV columns and reported in parentheses. Observations are weighted by country-sector value added. Profit-share regressions use the available trimmed non-agricultural profit-share sample.

firms' incentives to undercut. The increase in the profit share reinforces this interpretation, since profitability rises precisely when prices rise, and output falls.

Robustness. Robustness checks provide further support for this interpretation. For old consumers, the point estimates consistently display the opposite pattern to middle-aged demand: lower prices and profit shares and higher production. The IV estimates for young consumers generally point in the same direction, with lower prices and higher production. The middle-aged results remain robust to alternative age thresholds and alternative forecast horizons for demographic revisions. Appendix B reports the full set of results.

4 Quantitative analysis

We now quantify the aggregate effect of this competition channel of aging demand on the U.S. economy. The quantitative model embeds the market-level mechanism in a multi-market general equilibrium environment in which demographic change affects competition, household expenditure allocation, factor prices, and productivity-enhancing investment. The benchmark exercise isolates the demand-side channel by holding aggregate labor supply fixed and imposing equal per-capita income across cohorts. We then compare this demand-only economy with a full aging exercise that also allows labor supply to vary with age-specific participation rates. Appendix C.1 provides details of the general equilibrium environment.

4.1 Calibration

We calibrate the model to the U.S. economy in 1995 and then hold the structural parameters fixed while feeding the model the observed evolution of demographic shares over time. We discipline age-specific elasticities of substitution in two steps. First, we use Curtis et al. (2025) to discipline the relative elasticity of young consumers relative to older consumers. Their estimates are obtained in retail data, where substitution across closely related products is likely stronger than in aggregate expenditure, so we use them for relative differences across age groups rather than for the absolute level. Second, we set the population-weighted average elasticity to $\bar{\sigma} = 2.9$, following Broda and Weinstein (2006). Under 1995 population shares, this yields $\sigma^Y \approx 3.12$ and $\sigma^M = \sigma^O \approx 2.66$.

The remaining parameters $(\bar{a}, \nu, N)$ are calibrated internally to match three moments. Although all three parameters jointly affect equilibrium prices and quantities, each target is chosen to load most directly on one model margin. The number of firms N governs the strength of competition for low-search-cost consumers: with more firms, the minimum of the price distribution falls further below the average price. We therefore discipline N using the middle-aged-to-old paid-price gap from Aguiar and Hurst (2007), which captures the price advantage of consumers who search more intensively. The investment parameter $\bar{a}$ governs the return to productivity-enhancing investment and is disciplined by innovation intensity, measured as BEA intellectual-property investment relative to compensation of employees (NIPA, 1995). The search-cost parameter ν governs the willingness of high-search-cost consumers to continue searching, and hence the rents firms can extract from captive demand; we discipline it using the 1995 aggregate markup from De Loecker et al. (2020). Table 2 reports the calibration targets and fit. At the calibrated parameters, the sufficient conditions maintained in Section 2.2, the revenue condition (13) and the no-deviation condition, are numerically verified to hold over the entire equilibrium price support, both at the 1995 baseline and under the 2010 counterfactual demography.

Table (2) Calibration targets and baseline fit

Moment	Source	Target	Model	Parameter
Price gap (M/O, tx log -1)	Aguiar and Hurst (2007)	0.0210	0.0211	$N = 2.1804$
Inv./labor	BEA IPP / comp. of employees	0.0540	0.0540	$\bar{a} = 1.2318$
Markup (1995)	De Loecker et al. (2020)	1.3775	1.3444	$\nu = 0.0338$
Objective $\mathcal{L}$	0.0140			

Notes: The table reports targeted moments, model-implied moments at the calibrated parameter vector, and the resulting calibrated parameters. The objective is the root mean squared proportional deviation between model and data moments. The parameter N is interpreted as an effective number of competitors.

4.2 Aggregate implications of the demand-side aging channel

We now use the calibrated model to quantify the aggregate effect of the aging demand competition channel. The model is solved every five years from 1995 to 2020, treating each period as a separate stationary equilibrium. This comparative-static approach is appropriate because the demographic transition unfolds slowly relative to within-period market adjustment, making a sequence of stationary equilibria a reasonable approximation of the transition dynamics.

From sector-level to aggregate effects. Table 3 reports local comparative statics under five-percentage-point demographic reallocations. We compute each shock both in the market partial-equilibrium block and in the multi-market general equilibrium. The partial-equilibrium sign pattern mirrors the theory and the sectoral evidence: a $Y \to M$ transition raises the real price paid relative to the wage and lowers output, while an $M \to O$ transition lowers the real price and raises output. The $Y \to M$ result also verifies that, at the calibrated parameters, the price-induced contraction dominates the direct composition effect.

General-equilibrium feedbacks differ across outcomes. Real-price responses are broadly similar across the partial-equilibrium and general-equilibrium exercises for the $Y \to M$ shock and somewhat amplified for the $M \to O$ shock. Quantity responses, by contrast, are strongly dampened in general equilibrium: because the benchmark holds labor supply fixed, aggregate production is anchored, and the large sector-partial quantity movements are absorbed by price and wage adjustment.[15] The markup response to the $Y \to M$ transition is negli-

[15] This anchoring applies to aggregate physical production; the headline real-output series and its post-2015 partial reversal, reported in Figure 4 as $C + I$ at constant 1995 prices, are not pinned down in the same

gible in partial equilibrium, where the upward shift in prices is offset by the demographic reweighting of transacted prices, and becomes positive only in general equilibrium, while the $M \rightarrow O$ transition lowers markups in both. These patterns illustrate how sector-level elasticities cannot be mechanically rescaled into aggregate effects. The empirical price and quantity estimates correspond more closely to the sector-partial benchmark than to the GE counterfactual, because the shift-share design identifies the effect of *relative* sector exposure to foreign demographic shifts rather than the effect of an economy-wide demographic reallocation; the profit-share estimates, which the model does not target, corroborate the mechanism rather than serving as a benchmark.[16]

Table (3) Local comparative statics under 5pp demographic reallocations

Shock	Framework	Δ Price/wage (%)	Δ Quantity (%)	Δ Markup (%)
Y→M	Sector partial	+0.45	−4.77	−0.06
Y→M	GE	+0.48	−0.41	+0.16
M→O	Sector partial	−3.79	+10.15	−2.69
M→O	GE	−5.37	−0.50	−4.87

Notes: Shocks are five-percentage-point reallocations across adjacent cohorts. "Price/wage" is the demand-weighted mean transaction price relative to the wage. "Quantity" is aggregate production. "Markup" is the demand-weighted ratio of price to marginal cost (p/mc); its empirical counterpart is operating profit relative to revenue, which also reflects the sectoral cost structure. "GE" is the demand-only general equilibrium, holding labor supply fixed at its 1995 level.

Aging consumers in the United States. We now trace the aggregate implications of the U.S. demographic transition, focusing on the United States because it is closer to a closed economy, so a domestic demographic counterfactual is less affected by simultaneous foreign demand shifts. The U.S. demographic path, reported in Figure 3, exhibits the two-stage pattern central to our mechanism: the baby-boom cohort drove a $Y \rightarrow M$ transition until around 2010, raising the middle-aged share while the young share declined, and an $M \rightarrow O$ transition thereafter, as baby boomers entered retirement.

Figure 4 decomposes the total effect of aging into a demand-side component and an additional supply-side component. The benchmark demand-side exercise holds labor supply

way, since they also incorporate the response of productivity-enhancing investment.

[16] The demand-weighted markup captures the price-cost margin, whereas the estimated economic profit share also reflects operating expenses and estimated capital costs.

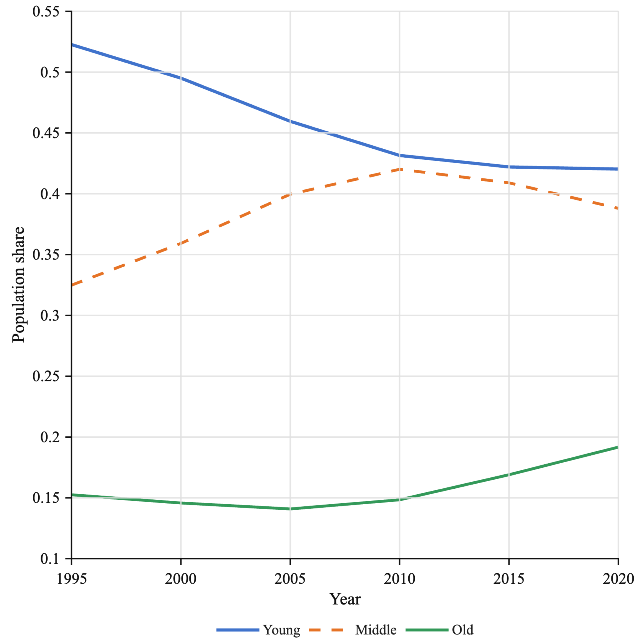

Figure (3) **Exogenous paths used in the quantitative exercise**

Notes: The figure reports cohort population shares from UN-WPP for 1995-2020.

fixed at its 1995 level, isolating the competition mechanism studied in this paper. The full exercise instead allows labor supply to vary with age-specific participation rates, thereby activating the standard supply-side channel.[17] In each panel, the solid red line reports the total effect, the dashed blue line the demand-side component, and the dotted green line the additional supply-side contribution.

Panel (a) reports the competition moment of the model's price distribution: the demand-weighted skewness of prices, which Nord (2022) shows moves monotonically with the intensity of price competition. As the baby-boom cohort moves into the low-elasticity, high-search-cost middle-aged group, the demand shift weakens competition and skewness rises by up to about 20 percent by 2010. Panel (b) shows that weaker competition in turn depresses firms' productivity-enhancing investment: the investment input falls by up to about 6 percent along the demand channel. As the same cohorts enter retirement and search intensity rises, competition recovers and the chain partly reverses: the demand-side lines turn back toward zero at the end of the sample. Finally, Panel (c) shows that the demand-side channel initially exerts a sizable and negative effect on aggregate output. This effect, however, partly reverses as baby boomers transition into retirement and search intensity rises.

[17] As in the benchmark exercise, we keep income constant across generations.

The demand channel operates through an effect on *consumption* and on *investment*. Regarding the former, weaker competition raises prices and lowers the quantity transacted, and aggregate production, hence, consumption, falls by about 0.9 percent below the fixed-1995-demographics counterfactual by the mid-2010s. Weaker competition also depresses firms' real investment expenditure, which is only about 4 percent of output but is far more elastic to the channel, falling by up to roughly 10 percent. Adding the two, real GDP measured as consumption plus investment ($C + I$ at constant 1995 prices), deepens the peak loss to about 1.2 percent, of which roughly 75% is the consumption margin and 25% the investment margin.[18]

Although the demand-side effect is smaller than the supply-side channel, which peaks at around 3 percent above the 1995 counterfactual around 2005, it is in the same order of magnitude. The standard view of aging as primarily a labor-supply shock therefore misses a quantitatively important offsetting force operating through product-market competition.[19]

5 Conclusion

Population aging changes not only the age structure of the labor market, but also the age composition of demand. Since consumers of different ages differ systematically in their willingness to substitute across varieties and in the intensity with which they compare prices, demographic change alters the competitive environment faced by firms. This paper shows that this demand-side competition channel is a distinct and quantitatively relevant mechanism through which aging affects aggregate outcomes.

The main force operates through the rise in middle-aged demand. As demand shifts toward middle-aged consumers, firms face less elastic demand while search intensity remains low. Competition weakens, prices rise, and incentives to invest in productivity-enhancing technologies decline. The empirical evidence supports this mechanism: sectors more exposed

[18]The two components are additive and not double-counted: in the model's resource accounting firm profits are net of the investment cost, so household income, and hence consumption, is already net of investment, and adding the real investment flow back recovers total value added, counting investment exactly once.

[19]These magnitudes are economically meaningful and are comparable to existing estimates of aging's aggregate effects. For instance, Maestas et al. (2023) estimate that a 10-percentage-point increase in the share of the population aged 60 and over lowers U.S. state-level GDP per capita by about 5.5 percent through employment and labor-productivity channels.

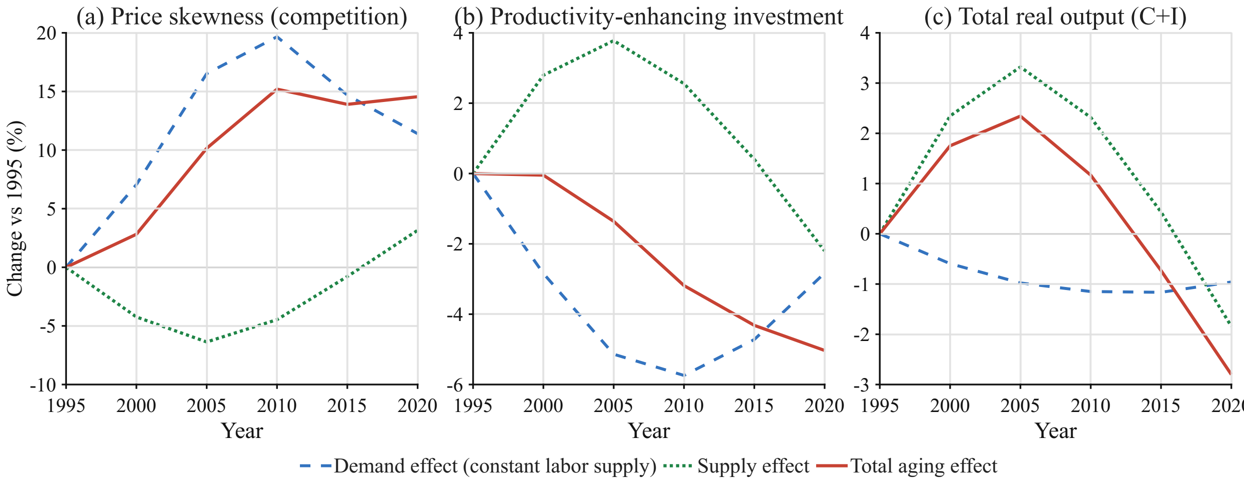

Figure (4) **Demand-side versus supply-side effects of aging**

Notes: Panel (a) reports the demand-weighted skewness of the price distribution, the price moment that moves monotonically with the intensity of competition (Nord, 2022). Panel (b) reports productivity-enhancing investment and Panel (c) total real output ($C + I$ at constant 1995 prices). In each panel, the dashed blue line is the demand-side effect (demography only, constant labor supply), the dotted green line the additional supply-side effect, and the solid red line the total aging effect; all series are percent deviations from 1995.

to middle-aged demand experience higher producer prices, higher profit shares, and lower real output.

In a U.S.-calibrated general equilibrium model, this aging demand competition channel lowers aggregate output by up to about 1.2 percent at its peak relative to a counterfactual that holds 1995 demand shares fixed. However, the effect is non-monotone. As the same cohorts move into retirement, search intensity rises, and competition strengthens, partly offsetting the earlier decline. In our U.S. calibration, this reversal is already underway by the end of the sample period. This competition-enhancing phase may be more pronounced in economies whose demographic transition is further advanced.

These results speak to broader debates on market power, declining business dynamism, and secular stagnation. The competition channel provides a demographic force that moves markups, profit shares, productivity-enhancing investment, and output in directions consistent with these secular trends, while emphasizing that its contribution depends on the economy's stage in the demographic transition.

The framework also has implications for retirement-age policy. Such reforms are usually evaluated through their supply-side effects, but delaying retirement may also delay the transition into the low opportunity cost of time stage of the life cycle. By reducing the mass of price-comparing consumers, higher retirement ages may weaken product-market competition and partially offset the supply-side benefits. Quantifying this policy trade-off is a natural direction for future work. A complete macroeconomic assessment of aging societies should therefore account not only for the labor-market and fiscal effects of demographic change, but also for its demand-side effects on competition.

A Model appendix

A.1 Proof of Proposition 2.1

Part (i). The reallocation increases $\lambda^{(l,L)}$ and decreases $\lambda^{(h,L)}$, holding $\lambda^{(h,H)}$ fixed. Consumers move from the high-search-cost (captive) pool to the low-search-cost (shopping) pool, affecting $\Theta = C/B$ through both components simultaneously and in the same direction: $B(p)$ falls because fewer consumers are captive to any given firm, reducing the revenue forgone by undercutting; $C(p)$ rises because more consumers compare prices and purchase at the lowest price. Since the numerator rises and the denominator falls, $\Theta(p)$ rises pointwise on $[b, \bar{r}]$. Because $F(p) = 1 - \Theta(p)^{-1/(N-1)}$, a pointwise increase in Θ raises $F(p)$ everywhere on the support, placing more mass on lower prices, i.e., a downward FOSD shift.

Part (ii). Let expected market-level production be

$$Q(\lambda) \;\equiv\; \lambda^{(h,H)}\mathbb{E}_F\big[D^{(h,H)}(p)\big] + \lambda^{(h,L)}\mathbb{E}_F\big[D^{(h,L)}(p)\big] + \lambda^{(l,L)}\mathbb{E}_{F_{\min}}\big[D^{(l,L)}(p)\big], \tag{A1}$$

where $F_{\min}(p) \equiv 1-(1-F(p))^N$ is the transaction-price CDF of low-search-cost consumers defined in Section 2. Since $D^{(i,I)}(p)$ depends only on the elasticity type I, middle-aged and old consumers face the same demand schedule at any given price, so the reallocation leaves the type composition of demand unchanged. Its effects on $Q(\lambda)$ operate through two channels, both non-negative. First, the downward FOSD shift in prices established in Part (i) raises expected demand for every cohort, since $D^{(i,I)}(p)$ is non-increasing in p. Second, since $(1-F(p))^N \le 1-F(p)$ for $F(p) \in (0,1)$ and $N \ge 2$, we have $F_{\min}(p) = 1-(1-F(p))^N \ge F(p)$, meaning old consumers already face stochastically lower prices than middle-aged consumers; the reallocation of weight from F to $F_{\min}$ therefore further raises $Q(\lambda)$. Both effects are non-negative, so $Q(\lambda)$ rises. □

A.2 Proof of Proposition 2.2

Let μ denote a marginal reallocation from $\lambda^{(h,H)}$ to $\lambda^{(h,L)}$, holding $\lambda^{(l,L)}$ fixed. All affected consumers remain in the high-search-cost pool, so $C(p)$ is unaffected. Differentiating with respect to μ gives

$$\text{(A2)} \qquad \frac{\partial B(p)}{\partial \mu} = \frac{1}{N}\big[\Delta R^{L}(p) - \Delta R^{H}(p)\big], \qquad \frac{\partial C(p)}{\partial \mu} = 0.$$

Since $D^{(i,I)}(p)$ depends only on I, we have $\Delta R^{(h,I)}(p) = \Delta R^{I}(p)$ for any i, so condition (13) is equivalent to $\Delta R^{L}(p) \geq \Delta R^{H}(p)$, which implies $\partial B/\partial\mu \geq 0$. With $C(p)$ unchanged and $B(p)$ non-decreasing, $\Theta(p) = C(p)/B(p)$ falls pointwise, so $F(p) = 1 - \Theta(p)^{-1/(N-1)}$ falls pointwise, an upward FOSD shift. $\square$

B Empirical appendix

B.1 Young and old regressions

B.2 Robustness checks

We perform a series of robustness checks focusing on the middle-aged category. We consider alternative age definitions by changing the thresholds: middle-aged consumers are defined as those aged 45-59, 40-64, and 40-59, relative to 45-64 in the baseline. Rows (2)-(4) of Table 5 show that the results are consistent across these alternative definitions.

We also consider revisions between the 1996 and 2006 demographic projections for year $t \in \{2010, 2015, 2020\}$. We define:

$$\text{(A3)} \qquad \Delta ForeignMiddleAgeConsumers_i^s \equiv \sum_{j \neq i} \xi_{i,j,1996}^{s} \left[\mathbb{E}_{2006}\left(age_{j,t}\right) - \mathbb{E}_{1996}\left(age_{j,t}\right)\right].$$

Rows (5)-(7) of Table 5 confirm that the results are qualitatively and quantitatively consistent with the baseline.

Table (4) Demand-Composition Aging and Sectoral Outcomes: Young and Old Consumers

	Δ log Price			Δ log Production			Δ log Profit		
	OLS	IV^A	IV^U	OLS	IV^A	IV^U	OLS	IV^A	IV^U
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Young consumers									
Δ Young (25–44)	1.034	−9.946	−19.402	0.029	10.339	15.832	1.171	−8.512	−353.098
	(0.670)	(8.959)	(30.197)	(0.804)	(7.483)	(12.497)	(3.046)	(16.443)	(1177.788)
Initial foreign exposure	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,353	1,353	1,353	1,353	1,353	1,353	917	917	917
R^2	0.884	0.859	0.799	0.578	0.524	0.450	0.269	0.260	-11.468
F statistic	-	14.613	13.942	-	14.613	13.942	-	15.999	0.820
Panel B: Old consumers									
Δ Old (65–79)	−4.437	−4.843	−9.189	0.838	2.685	10.186	−31.190	−51.785	−31.112
	(0.939)	(2.110)	(2.342)	(1.135)	(4.131)	(7.380)	(3.984)	(7.967)	(11.209)
Initial foreign exposure	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,353	1,353	1,353	1,353	1,353	1,353	917	917	917
R^2	0.885	0.885	0.883	0.578	0.577	0.556	0.318	0.297	0.318
F statistic	-	88.834	54.735	-	88.834	54.735	-	91.461	69.305

Notes: This table reproduces the Table 1 specification separately for young consumers, aged 25–44, and old consumers, aged 65–79, with all age shares defined relative to the population aged 25–79. Each panel reports OLS, IV^A, and IV^U estimates for prices, production, and profit shares over 1996–2006. IV^A uses actual changes in the corresponding foreign age share; IV^U uses unexpected changes, defined as the 2019-vintage estimate for 2006 minus the 1996-vintage projection for 2006. Both instruments weight foreign demographic changes by initial sectoral exposure to foreign demand. Standard errors are clustered by main exposure country in the IV columns and reported in parentheses. Observations are weighted by country-sector value added. Profit-share regressions use the available trimmed non-agricultural profit-share sample.

Table (5) Robustness checks for middle-aged consumers

		Δ log Price	Δ log Production	Δ log Profit
Panel A: Alternative age definitions				
(1)	Δ Middle-aged (45-64)	7.664	-5.488	50.058
	Unexpected demographics, $t = 2006$	(4.028)	(2.416)	(17.895)
(2)	Δ Middle-aged (45-59)	7.356	-4.189	54.811
	Unexpected demographics, $t = 2006$	(3.863)	(2.625)	(13.788)
(3)	Δ Middle-aged (40-64)	8.360	-4.849	48.203
	Unexpected demographics, $t = 2006$	(2.940)	(2.996)	(9.380)
(4)	Δ Middle-aged (40-59)	7.764	-3.082	49.676
	Unexpected demographics, $t = 2006$	(2.557)	(2.937)	(5.460)
Panel B: Alternative expectation horizons				
(5)	Δ Middle-aged (45-64)	9.279	-7.849	43.359
	Unexpected demographics, $t = 2010$	(4.095)	(2.252)	(19.434)
(6)	Δ Middle-aged (45-64)	9.615	-7.249	47.258
	Unexpected demographics, $t = 2015$	(4.056)	(2.096)	(19.613)
(7)	Δ Middle-aged (45-64)	7.511	-5.340	42.963
	Unexpected demographics, $t = 2020$	(3.096)	(1.496)	(13.481)

Notes: This table reports shift-share IV^U estimates for the middle-aged regressor under alternative specifications. Panel A varies the definition of the middle-aged age group. The unexpected demographic shift is defined as the 2019-vintage estimate for 2006 minus the 1996-vintage projection for 2006. Panel B varies the forecast horizon t and defines the demographic revision as the 2006-vintage projection for year t minus the 1996-vintage projection for the same year. All specifications include initial foreign exposure, country fixed effects, and sector fixed effects; observations are weighted by initial country-sector value added, and standard errors are clustered by main exposure country.

C Quantitative appendix

C.1 General equilibrium environment

The economy features a unit measure of sectors indexed by $s \in [0,1]$. In each sector, $N \geq 2$ ex-ante identical firms compete in prices and choose productivity-enhancing investment as in Section 2. Sectors are symmetric, so equilibrium strategies are identical across sectors.

Model outcomes and data counterparts. We report two sector-level outcomes that correspond closely to the empirical objects: (i) a demand-weighted average transaction price, the model analogue of the sectoral price deflator, and (ii) total quantities sold, which, in the absence of quality adjustments and intermediate inputs in the model, correspond to real value added in the data. We additionally report the demand-weighted markup. The empirical profitability measure is the operating profit share, which is related to but not identical to the markup because it also reflects the sectoral cost structure and productivity-enhancing investment.

Households, search, and transaction prices. There are three age groups $i \in \{Y, M, O\}$ with population shares λ^i. Within each sector, young and middle-aged consumers are "non-shoppers" who sample one price (high search costs), while old consumers are "shoppers" who sample all prices and purchase at the lowest observed price.[20] Let $F(\cdot)$ denote the equilibrium distribution of prices in a representative sector. Then the transaction-price CDF faced by young and middle-aged consumers coincides with $F(\cdot)$, while the CDF faced by old consumers is

$$F^O(p) \equiv F_{\min}(p) = 1 - (1 - F(p))^N . \tag{A4}$$

[20] This mapping corresponds to the reduced-form representation in Section 2.2: $Y \equiv (h, H)$, $M \equiv (h, L)$, $O \equiv (l, L)$, with $\lambda^{(l,H)} = 0$ in the quantitative implementation.

Preferences and sectoral demands. Each cohort derives utility from a CES aggregate of sectoral consumption:

$$\max_{\{c_s^i\}} \; C^i \equiv \left[\int_0^1 (c_s^i)^{\frac{\sigma_i - 1}{\sigma_i}}\, ds\right]^{\frac{\sigma_i}{\sigma_i - 1}}, \tag{A5}$$

subject to $I^i = \widetilde{P}^i C^i$, where σ_i is the age-specific elasticity of substitution and $\widetilde{P}^i$ is the cohort-specific normalized price index.[21] Each agent receives the same income, given by wages plus profits net of investment costs. Standard CES demand yields:

$$c_s^i = C^i (\widetilde{P}^i)^{\sigma_i} (\widetilde{p}_s^i)^{-\sigma_i}. \tag{A6}$$

Aggregation and factor-market clearing. Under sector symmetry, the cross-sector integral can be written as an expectation with respect to the cohort-specific transaction-price distribution in a representative sector. Market-clearing implies

$$Q = \sum_i \lambda^i C^i (\widetilde{P}^i)^{\sigma_i} \mathbb{E}\left[(\widetilde{p}^i)^{-\sigma_i}\right], \tag{A7}$$

where the expectation is taken over the cohort-specific transaction-price distribution (F for $i \in \{Y, M\}$ and F^O for $i = O$). Aggregate labor demand is

$$ALD = \sum_i \lambda^i C^i (\widetilde{P}^i)^{\sigma_i} \mathbb{E}\left[(\widetilde{p}^i)^{-\sigma_i} \left(\bar{a} - a(p)\right)\right]. \tag{A8}$$

In the demand-channel experiments, aggregate labor supply is fixed at $ALS = 1$ so the wage adjusts to clear the labor market. In the full-channels experiments, labor supply shifts with age-specific participation rates, activating the standard supply-side aging mechanism.

C.2 Calibration details

The objective function is $\mathcal{L}(\theta) = \sqrt{\frac{1}{3}\sum_{k=1}^{3}\left(\frac{m_k^{\text{model}}(\theta)}{m_k^{\text{data}}} - 1\right)^2}$.

[21] Following Ghironi and Melitz (2005), we normalize by the economy-wide average price: $\widetilde{p}_s^i \equiv p_s^i / P_{\text{AVR}}$, $\widetilde{P}^i \equiv P^i / P_{\text{AVR}}$, with $P^i \equiv \left[\int_0^1 (p_s^i)^{1-\sigma_i}\, ds\right]^{\frac{1}{1-\sigma_i}}$ and $P_{\text{AVR}} \equiv \sum_i \lambda^i P^i$.

We minimize $\mathcal{L}(\theta)$ over $\bar{a} \in [1.00, 3.00]$, $\nu \in [0.005, 0.050]$, and $N \in [2.00, 8.00]$ using bounded derivative-free search. We restrict ν to the active-search region $\nu \leq I_{\max} \equiv \max_z ECS^{(h,I)}(z)$, in which the reservation-price condition $ECS^{(h,I)}(r^{(h,I)}) = \nu$ (equation (2)) admits an interior root and consumer search is operative; a smooth barrier in $\mathcal{L}$ enforces this restriction, and at the calibrated values $\nu/I_{\max} \approx 0.62$.

To match the middle-aged-to-old price gap implied by Aguiar and Hurst (2007), the model counterpart is the demand-weighted transaction log-price ratio $m_1^{\text{model}} = \exp(\mathbb{E}_{\rho_M}[\log p] - \mathbb{E}_{\rho_O}[\log p]) - 1$, where $\rho_i(p) = \frac{p^{-\sigma_i} f_i(p)}{\int p^{-\sigma_i} f_i(p)\, dp}$ and f_i denotes the cohort-specific transaction-price density implied by the equilibrium price distribution.

C.3 Within- and between-market decomposition of the demand channel

The demand-side channel bundles two competitive margins: a *between-market* (elasticity) margin, through which the $Y \to M$ transition lowers the demand elasticity faced by firms, and a *within-market* (search) margin, through which the $M \to O$ transition raises the share of price-comparing shoppers. Figure 5 separates the two using a Shapley decomposition of the demand-only real-GDP effect, so the margins are additive by construction. The between-market margin accounts for roughly two-thirds of the peak output loss (-0.78 percentage points at its 2015 trough, against -0.38 percentage points for the within-market margin). The within-market margin, in turn, drives nearly all of the within-sample recovery after 2015, as baby boomers enter retirement and the shopper share rises.

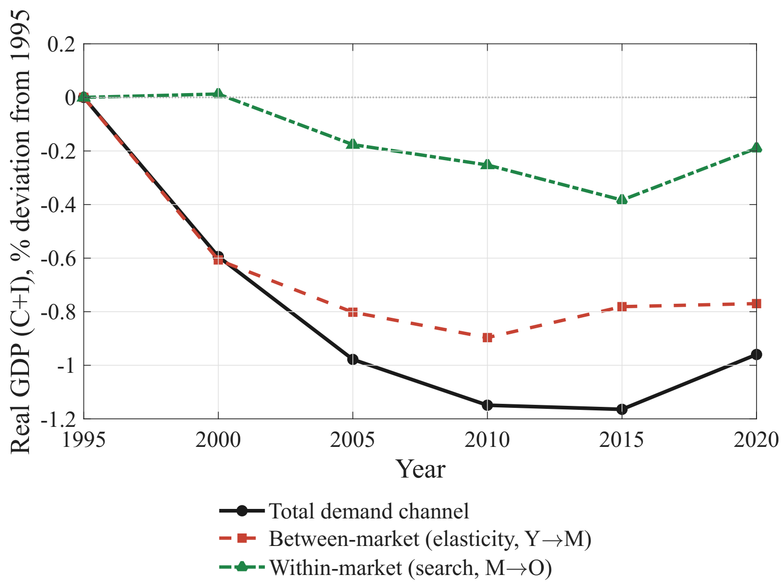

Figure (5) **Within- versus between-market margins of the demand channel**

Notes: Shapley decomposition of the demand-only effect on real GDP ($C + I$, percent deviation from 1995) into a between-market (elasticity, $Y \to M$) margin and a within-market (search, $M \to O$) margin; the two margins sum to the total demand channel by construction.

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