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Essays on International Economics: Theory and Evidence from Micro-level Data

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Essays on International Economics: Theory and Evidence from Micro-level Data

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Professor Andrés Rodríguez-Clare, Chair
Professor Ben Faber
Professor Thibault Fally

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Abstract

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This dissertation explores modern international economics, whereby the accessibility of micro-level data has propelled the boundaries of the discipline, both in terms of theoretical modeling as well as empirical substantiation.

In Chapter 1, we propose a model that features firm heterogeneity in both exposure and responses to input tariff shocks. We show that this setting gives rise to a new anti-competitive effect that extends the benchmark welfare gains from trade liberalization. We derive a sufficient statistic for the anti-competitive effect in a general environment — the correlation between firm market shares and their cost shares of imported inputs. The interplay between import-intensiveness and market power implies that larger firms both benefit more from input tariff cuts and pass through less of the cost reductions, leading to an increased dispersion of markups in the aggregate.

In Chapter 2, we provide empirical evidence using a unique collection of firm-level microdata from Colombia around its 2010 trade reform to empirically test this framework. The dataset records the entirety of firm-level inputs, both imported and domestically sourced, which enables us to disentangle and identify firm-specific exposure and responses to input tariff shocks. Our quantitative analysis demonstrates that input tariff liberalization brings about a substantial anti-competitive effect, whose magnitude can be on par with the pro-competitive effects in the episode we study.

In Chapter 3, we switch gears from firm heterogeneity to household heterogeneity to investigate the main factors driving household saving rates using cross-country household survey data collected by the Household Finance and Consumption Survey. This allows us to observe household-specific characteristics and examine the ambiguity in the existing literature on the signs of the main determinants of household saving rates. We find that households at lower saving quantiles are more vulnerable to macroeconomic shocks. The evidence from household microdata suggests the need for targeted rather than universal policy intervention.

To my loving parents:

"Unschuld ist das Kind und Vergessen, ein Neubeginnen, ein Spiel, ein aus sich rollendes Rad, eine erste Bewegung, ein heiliges Ja-sagen."

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Chapter 1

Theoretical Framework

1.1 Background

How large are the gains from trade through the competitive channel? Existing studies mostly focus on the pro-competitive effects of output tariff liberalization. The benchmark work of Arkolakis, Costinot, and Rodríguez-Clare (2012, hereinafter ACR) provides a sufficient statistic for quantifying gains from trade under constant markups. Other seminal studies, such as Edmond, Midrigan, and Xu (2015) and Arkolakis et al. (2019, hereinafter ACDR) enrich the benchmark framework by allowing for variable markups to account for additional sources of gains from trade that result from reduced markup distortions due to fiercer competition from foreign exporters. Despite the coincidence of most output and input trade liberalization episodes, relatively little attention has been paid to the input tariff channel.

In this chapter, we explore the competitive welfare effects of input tariff liberalization. In a standard oligopoly model setting (Atkeson and Burstein, 2008) where a firm optimally chooses its markup according to its domestic market share, we embed firm-specific input tariff shocks into the model to uncover a new channel of the anti-competitive effect of input tariff liberalization. We prove that the existence of the anti-competitive effect hinges on one commonly observed feature in firm data. Firms with larger market shares tend to have higher import shares and smaller firms tend to exhibit lower import intensities.[1] Because large firms have higher import shares they benefit more from cheaper imported inputs. Large firms nevertheless raise their markups and do not fully pass through the input cost cuts. Small firms, in contrast to the large ones, have much poorer access to input importing and are thus far less exposed to input tariff cuts despite their willingness to keep markups constant and perfectly pass through the cost reductions. The interplay of exposure and responses at the micro-level aggregates up to a greater markup dispersion and muted welfare

[1] In the context of this chapter, we use "import share" and "import intensity" interchangeably. Both terms are defined as the value share of imported inputs over total input purchases. Firm market shares are within-sector.

gains from trade. This anti-competitive effect of input tariff liberalization pulls against the well-studied pro-competitive gains from trade of output tariff liberalization.

By decomposing the overall welfare effects into the pro- and anti-competitive effects resulting from output and input tariff liberalization, respectively, we derive an analytical formula for the change in welfare level before and after trade liberalization. We show that the anti-competitive effect exists if and only if firm market shares and firm import shares are positively correlated. In this case, incorporating the input tariff channel into the benchmark framework predicts lower welfare gains from trade than in standard settings without accounting for heterogeneous firm markup responses to input tariff shocks.

To empirically test our theoretical framework, we use the firm microdata in Colombia from its Annual Manufacturing Survey (Encuesta Anual Manufacturera (EAM)) around its 2010 trade reform. The EAM requires firms to report their value shares of each imported input and exported output among all 8-digit CPC product codes.[2] The richness of the dataset allows us to observe firm-level heterogeneity in both exposure and responses to input tariff shocks.

In the year 2010, Colombia pushed through its Tariff Structural Reform (TSR) to promote imports of intermediate inputs.[3] Using the Colombian firm microdata before and after the trade reform, we observe two stylized facts. First, there is a positive correlation between firm market shares and import shares. Second, large firms, unlike small firms, increase their profit margins when benefiting from cheaper imported inputs upon input tariff liberalization. The synergy of the two — one on the heterogeneous exposure and the other on the responses — sheds light on the aforementioned mechanism of how the input tariff liberalization can lead to anti-competitive welfare effects on post–reform Colombia.

Our empirical results show: (a) that a given input tariff cut affects the sales of large firms more positively than small firms before converting the tariff cut to a firm-specific input cost share,[4] and (b) that this interaction effect flips sign and remains significant after we convert input tariff shocks into firm-level cost shocks to take into account differences in import-intensiveness of a given input bundle. With this measure of the firm-specific exposure to input tariff reductions, our main results are consistent with a large class of models that predict that larger firms exhibit lower pass-through of own cost shocks.

We then feed the firm microdata into the model to analyze quantitatively the determi-

[2]The first five digits can be concorded to the UN standard 5-digit CPC codes and then to the HS 6-digit tariff data. The last three digits are specifically encoded within Colombia. We still leverage all the 8-digit entries for variations in firm-product input shares.

[3]Another agenda of TSR is to encourage imports of capital goods. Meleshchuk and Timmer (2020) study the same trade liberalization episode in Colombia but focus on capital goods.

[4]This has been the common measure of input tariffs, i.e., the weighted average of import tariffs with weights being sectoral input-output coefficients, as firm-product-level input information is rarely observed. The measure implicitly assumes away firm heterogeneity in import-intensiveness, which is instead picked up by the coefficient. The results would misleadingly suggest that large firms are more responsive to cost reductions. In fact, large firms take market shares from small firms not because they pass through more input cost reductions and expand sales by more, but only because they are exclusively benefiting from the input tariff cuts.

nants of the anti- and pro-competitive effects and their relative magnitudes in the overall welfare gains from trade. Our analysis suggests that the magnitude of the anti-competitive effects can be on par with the pro-competitive effects in the Colombian trade liberalization episode.

Our work is most related to three strands of literature: a) quantification of welfare gains from trade through the competitive channels; b) empirical evidence on input tariff liberalization and firm performance; c) firm performance in response to broader cost shocks.

ACDR (2019) provides a new ACR formula when allowing for markup endogeneity and underlines two opposite competitive effects from output tariff liberalization: a) exporters' markup adjustment which can go in the opposite direction to the changes in domestic markups, and b) reallocation of market share to more productive firms due to selection. The overall competitive effects depend on the relative importance of the two. Edmond, Midrigan, and Xu (2015) study the pro-competitive gains from trade due to reduced markup distortion. Hsu, Lu, and Wu (2020) shows similar results using Chinese firm-level data. The pro-competitive effects of trade can lead to welfare losses if trade increases markup dispersion and hence amplify distortions (Epifani and Gancia, 2011). Dhyne, Kikkawa, and Magerman (2022) introduce network structure and simulate the aggregate effects of uniform trade liberalization. They find that the welfare effects are similar under fixed and endogenous markups and that the effects on markups of domestic firms are on average close to zero. Our work adds to the existing literature by highlighting the competitive effects through the input trade channel. As opposed to the pro-competitive effects of output trade liberalization, we show that the input trade channel can lead to anti-competitive effects.

The second strand of the literature documents the empirical evidence on the impact of input trade liberalization. Copious studies find that imports of intermediates or declines in input tariffs are associated with sizable firm performance improvement (Amiti and Konings, 2007; Kasahara and Rodrigue, 2008; Goldberg et al., 2010; Halpern, Koren, and Szeidl, 2015). The most relevant ones to ours are De Loecker et al. (2016) and Fan et al. (2018). The authors point out the importance of incorporating the input tariff channel and document that firms raise markups when facing input tariff cuts. In this chapter, we disentangle firm-level heterogeneity in both exposure and responses and go one step further to provide a framework for a better understanding of the aggregate welfare implications.

A broader literature looks into the firm markup responses to cost shocks. Berman, Martin, and Mayer (2012) study the exchange rate shocks and show that currency depreciation leads to enlarged market shares thus increased markups, more so for large firms. Amiti, Itskhoki, and Konings (2019) find evidence of heterogeneity in markup variability across small and large firms in response to exchange rate shocks, in terms of both own cost pass-through and strategic complementarities. Our work is closely linked to this strand of the literature yet with an emphasis on input cost shocks whose impact is differential across domestic firms through the input tariff channel.

1.2 Model Setting

In this section, we first describe the theoretical framework that allows for the embedding of firm-level heterogeneity in both market shares and import shares as observed in the data. Based on this framework we proceed to derive the overall welfare gains from trade and show the conditions for the existence of the anti-competitive effect.

Marginal Cost

We begin with the firm side and impose mild assumptions on the production structure. The marginal cost function of firm i is[5]

$$MC_i = \frac{1}{A_i}\mathbf{C}_i\left(P^m_{fi}, P^m_d\right), \tag{1.1}$$

where A_i is a Hicks-neutral firm productivity shifter, and $\mathbf{C}_i\left(P^m_{fi}, P^m_d\right)$ is a function of firm i's price indices for foreign inputs P^m_{fi} and domestic inputs P^m_d, which includes intermediates and labor.[6]

Based on this general marginal cost function, we use Shephard's Lemma to write the log change in firm marginal cost as[7]

$$\mathrm{d}mc_i = z_i \mathrm{d}p^m_{fi} + (1 - z_i)\,\mathrm{d}p^m_d - \mathrm{d}a_i, \tag{1.2}$$

where small letters denote log transformation, and z_i is the import intensity of firm i, measured as the expenditure share on imported inputs in total expenditure including that on domestic and foreign intermediate inputs and the wage bill. Lower-case letters are logs.

We can further write out the imported input cost index as $\mathrm{d}p^m_{fi} = \sum_{s'}\theta_{i,s'}\mathrm{d}p^m_{fs'}$ with $\theta_{i,s'}$ being firm i's expenditure share of imported input s' in its total cost of imported inputs. Importing intermediate input s' incurs iceberg trade costs $\tau_{s'}$. During a trade liberalization episode, $\mathrm{d}p^m_{fs'}$ can be largely driven by changes in trade costs $\mathrm{d}\tau_{s'}$. Now assume that the cost changes are mainly due to changes in tariffs. Hence the first component in the first-order expansion can be written explicitly as $\mathrm{d}p^m_{fi} = z_i\sum_{s'}\theta_{i,s'}\mathrm{dlog}(1+\tau_{s'})$, which is a function of the tariff shocks $\mathrm{d}\tau_{s'}$, and a firm's overall import intensity z_i, plus the composition of the firm's imported intermediate inputs $\theta_{i,s'}$. We map our model to the widely adopted Bartik-type construction of input tariff shocks in many existing empirical studies by defining input tariff shocks as the weighted average of output tariff shocks $\mathrm{d}\tau^{input}_i \equiv \sum_{s'}\theta_{i,s'}\mathrm{dlog}(1+\tau_{s'})$, and simplify the first term as $\mathrm{d}p^m_{fi} = z_i\mathrm{d}\tau^{input}_i$.

[5]This and the following expressions applies to all periods and the time t subscript is suppressed. We will show the t subscript when moving to the firm panel data analysis.

[6]Note that the markup function implies constant returns to scale.

[7]While the following derivations are of first-order approximation, we write down a general equilibrium model to study the overall welfare effects. Our simulation results show that the first-order effects indeed captures the main effects and the second-order effects are negligible under imperfect competition. We leave these results in Appendix B so that the main body remains coherent in that we do not impose a specific firm production function.

As we will focus on the effects of trade shocks on firm marginal cost, we further simplify the change in firm marginal cost by assuming that there is one domestic intermediate producer who prices at CES markups and uses only labor. The intermediate good producer does not directly sell to consumers. Lastly, we assume constant productivity, $\mathrm{d}a_i = 0$. Therefore, the first-order expansion of the change in the marginal cost of domestic firm i can now be written down as

$$\mathrm{d}mc_i = z_i \mathrm{d}\tau_i^{input} + (1 - z_i)\,\mathrm{dlog}w, \tag{1.3}$$

which depends on firm import share z_i and the firm-specific input tariff shock $\mathrm{d}\tau_i^{input}$.

Prices

We take the price change decomposition from the Amiti, Itskhoki, and Konings (2019) setup and write the first-order expansion of firm i's price responses to its own cost shocks and to the price setting of its competitors within a given industry (i.e. strategic complementarities)[8]

$$\mathrm{d}p_i = \frac{1}{1+\Gamma_i}\mathrm{d}mc_i + \frac{\Gamma_{-i}}{1+\Gamma_i}\sum_{j\neq i}^{N}\frac{s_j}{1-s_i}\mathrm{d}p_j + \frac{\Gamma_{-i}}{1+\Gamma_i}\frac{s_f}{1-s_i}\mathrm{d}p_f, \tag{1.4}$$

where s_i is firm i's market share, $s_f = 1 - \sum_i s_i$ is the share of foreign goods in the final goods market, and Γ_i and Γ_{-i} are the own and competitor markup elasticities, respectively.[9]

Rearrange the price terms to obtain

$$\mathrm{d}p_i = \frac{1-s_i}{1-s_i+\Gamma_i}\mathrm{d}mc_i + \frac{\Gamma_{-i}}{1-s_i+\Gamma_i}\mathrm{dlog}P_i, \tag{1.5}$$

where $\mathrm{dlog}P_i = s_i\mathrm{d}p_i + \frac{\Gamma_{-i}}{\Gamma_i}\left(\sum_{j\neq i}^{N} s_j\mathrm{d}p_j + s_f\mathrm{d}p_f\right)$ is a weighted average of price change in the industry where the weights depend on firm i's own-markup elasticity relative to its competitor markup elasticity.

Under the Cournot quantity competition with Cobb-Douglas between-industry demand, we have $\Gamma_i = \Gamma_{-i} = (\sigma-1)s_i$, a monotonically increasing function of firm i's market shrae s_i. The price change decomposition becomes

$$\mathrm{d}p_i = \frac{1-s_i}{1+(\sigma-2)s_i}\mathrm{d}mc_i + \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}\mathrm{d}p. \tag{1.6}$$

The percentage change in the industry price index $\mathrm{d}p$ can be written out as the average of price change in the sector weighted by firm market shares

[8] Note that this requires the demand system to be invertible, a rather mild assumption on demand that is compatible with common demand systems in the literature.

[9] This and the following derivations are all applied to firms in one industry, therefore the industry subscript s is dropped. We do allow for multiple sectors when moving toward empirics in the next section, and in the welfare analysis as shown in robustness results (see Appendix C). Specifically, there are 26 two-digit manufacturing sectors in the Colombian manufacturing firm data.

$$\mathrm{d}p = \sum_{i=1}^{N} s_i \mathrm{d}p_i + s_f \mathrm{d}p_f. \tag{1.7}$$

Note that p can be viewed as the full price index in the sector as it incorporates both domestic and foreign competitors selling in the domestic final market.
Assuming that home is small and foreign firms do not play the cournot game, we simply have

$$\mathrm{d}p_f = \mathrm{d}\tau. \tag{1.8}$$

where τ is the output tariff.[10]

Combining equations (1.3), (1.6), (1.7), and (1.8), we are able to derive a closed-form solution for the change in real wage as shown in the next subsection.

Welfare Analysis

We proceed to analyze the welfare effects of trade liberalization by combining the above price equations. We derive an analytical result of the change in welfare level before and after the trade liberalization, and decompose the welfare effects into the pro- and anti-competitive effects due to output and input trade liberalization, respectively.[11]

Proposition 1. *When firms compete in the final goods market à la Cournot, as in the goods market environment described above, the change in the price index is given by:*

$$\mathrm{d}p = \underbrace{s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input}}_{\text{Gains without competitive effects}} + \underbrace{s_f \mathrm{d}\tau \frac{\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}}_{\text{Pro-competitive effect}} + \underbrace{\frac{Cov\left(z_i, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right)}{1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}}_{\text{Anti-competitive effect}} \tag{1.9}$$

where $Cov(a_i, b_i; c_i)$ is the weighted covariance between a_i and b_i with weights c_i.

Proof. Appendix A. □

[10] Note that import intensity is irrelevant when it comes to exposure to output tariff shocks, so $\mathrm{d}\tau$ is not i-variant. In the empirical section, however, we do control for firm-specific output tariff shocks as we oberve the output composition at the firm-product level. The model is so far silent on such firm heterogeneity on the output side.

[11] We take labor as the numeraire in the single-sector model. We do not consider tariff revenue in the welfare formula, and the result should best be interpreted as the consumer welfare.

The welfare decomposition expression provides us with the foundation for analyzing the sufficient and necessary conditions for the existence of an anti-competitive effect, and for discussing its quantative significance compared to the well-documented pro-competitive effect. Below we provide an intuitive interpetation of the welfare decomposition formula.

Gains Without Competitive Effects

If all firms are small relative to the market ($s_i \to 0$), we converge to the full pass-through world as the second and the third term in the decomposition go towards zero. Both output and input tariff liberalization brings about welfare gains without considering variable markups.

Gains from output trade are governed by openness (s_f) and the size of output tariff cuts ($\mathrm{d}\tau$), while gains from input trade depend on the size of input tariff cuts ($\mathrm{d}\tau^{input}$) and the correlation of firm market shares and import shares. Without incorporating the competitive effects, input tariff liberalization brings about greater welfare gains when large firms have higher import exposure as these firms take up higher weights in the aggregate (Blaum, Lelarge, and Peters, 2018).

The Pro-Competitive Effects

During a trade liberalization episode, the second term is always negative given $\mathrm{d}\tau < 0$ and increases with: a) import competition governed by the foreign share $s_f = 1 - \sum_i s_i$, and b) rising concentration in the domestic sector, measured by $\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}$.

To understand this term in an intuitive manner, we consider a special case as $\sigma \to 2$. Under this case, the pro-competitive effect term converges to:

$$\frac{HHI}{1 - HHI} s_f \mathrm{d}\tau$$

where $HHI = \sum_{i=1}^{N} s_i^2$. The magnitude of the pro-competitive effect is increasing in the Herfindahl-Hirschman Index (HHI). The intuition is that pro-competitive effects are greater when we see higher concentration thus more misallocation to be corrected by the competition pressure from output tariff liberalization.

The Anti-Competitive Effect

The third term depends on the covariance of firm import intensity z_i and a positive function of firm market share $\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}$, weighted by the multiplication of a firm's market share and its exposure to input tariff shocks – if there is a positive correlation between the two, which corresponds to higher import intensity among larger firms, there will be a positive effect on the price index and hence a negative one on real wage. As this is more likely to be the empirically relevant case, one would expect this term to lead to an anti-competitive effect. As is the case with the pro-competitive effect, the magnitude of the potential anti-competitive effect is increasing in market concentration.

Consider again a special case with $\sigma = 2$, for which we can simplify the weighted covariance term into:

$$\frac{Cov\left(z_i, s_i; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right)}{1 - HHI}$$

It becomes clear in this special case that we have an anti-competitive effect **if and only if** $Cov\left(z_i, s_i; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right) > 0$, which means that the correlation of firm market share and import share is positive when weighted by $s_i\left(-\mathrm{d}\tau_i^{input}\right)$. Moreover, the strength of the anti-competitive effect increases with HHI in the domestic sector. Beyond the special case, we have the following corollary on the existence of an anti-competitive effect:

Corollary 1. *Under Cournot competition, a necessary and sufficient condition for the existence of an anti-competitive effect of trade is given by*[12]

$$Cov\left(z_i, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right) > 0. \tag{1.10}$$

The proof immediately follows from Proposition 1. Below is a case-by-case discussion on $Cov\left(z_i, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right) > 0$ being both **necessary** and **sufficient** for the the existence of the anti-competitive effect.

Case 1. $Cov\left(z_i, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right) = 0.$

We provide a formal proof in Appendix A that markup dispersion remains unchanged in the case with symmetric exposure to input tariff shocks across firms. Here, we discuss intuitively the theoretical reason for this result. Now that the marginal cost shocks are identical across firms, we argue that large firms do not want to lose their market shares to small firms and end up having to keep their markup levels unchanged. It is helpful here

[12] With $\sigma > 1$, $\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}$ is increasing in s_i. Given that, one may tend to think that $cov\left(s_i^I, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(\mathrm{dlog}w - \mathrm{d}\tau_i^{input}\right)\right) > 0$ and $cov\left(s_i^I, s_i; s_i\left(\mathrm{dlog}w - \mathrm{d}\tau_i^{input}\right)\right) > 0$ are equivalent. According to Lehmann (1966), however, we need a slightly stronger positive dependence between s_i and s_i^I to guarantee a positive correlation between any increasing function of s_i and s_i^I, which is $\left(s_i^I, s_i\right)$ being positive quadrant dependent (PQD). PQD is commonly used as a benchmark as to the strength of positive dependence. While positive correlation is the weakest concecpt of positive dependence, PQD is slightly stronger. To be more specific, (X, Y) is positive quadrant dependence if $\Pr\left(X \geq x, Y \geq y\right) \geq \Pr\left(X \geq x\right)\Pr\left(Y \geq y\right)$. Lehmann (1966) showed that PQD is equivalent to $cov\left(a\left(x\right), b\left(y\right)\right) \geq 0$ for any pair of increasing functions a and b defined on R. Both positive correlation and PQD belong to the family of positive dependence, which in our context means firm i having a large market share tends to coincide with it having a large import share. Therefore, a slightly stronger sufficient condition for the existence of an anti-competitive effect of trade is $\left(s_i^I, s_i\right)$ being PQD. In practice, we find that $cov\left(s_i^I, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(\mathrm{dlog}w - \mathrm{d}\tau_i^{input}\right)\right) > 0$ and $cov\left(s_i^I, s_i; s_i\left(\mathrm{d}\ln w - \mathrm{d}\tau_i^{input}\right)\right) > 0$ are almost always equivalent out of 100,000 simulations under a reasonable range of σ's and a large number of firms $n > 100$.

to bring up one intermediate step in deriving the price equations: $\mathrm{d}\mu_{i,t} = -\Gamma_{i,t}(\mathrm{d}p_{i,t} - \mathrm{d}p_t)$ where $\mu_{i,t}$ stands for firm i's log markup in period t.[13] Suppose large firm i increases its markup level, we then have $\mathrm{d}p_{i,t} - \mathrm{d}p_t > 0$ | large firm i's relative price goes up as the price index goes down by more considering that small firms fully pass through the now symmetric shocks. Then back to the above markup equation | large firm i will face a downward pressure on its markup until $\mathrm{d}p_{i,t} - \mathrm{d}p_t$ is no longer positive, that is, $p_{i,t}$ does not decrease by less or large firm i does not pass through less. Hence, large firms would not be able to raise markup levels, and markup dispersion would remain unchanged.

In short, large firms (a) pass through less of the cost reduction and (b) react more to the decrease in the price index. In the case with no correlation between firm market and import shares, the two effects exactly balance out so that input tariff liberalization would not lead to anti-competitive effects.[14]

Case 2. $Cov\left(z_i, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right) > 0.$

In this case, large firms benefit more from cheaper imported inputs compared to small firms. Following a similar argument in Case 1, large firm i can now raise its markup level without worrying about losing its market share to small firms who do not enjoy input cost cuts of the same amount. There will not be the same downward pressure on firm i's markup as long as its relative price is still going down. This is because large firms are now exclusively exposed to the input tariff cuts. This positive correlation between firm market and import shares leads to greater markup dispersion and dampens welfare gains from trade.

To summarize, large firms face less downward pressure on their markups relative to the upward incentive. The aforementioned effect (a) dominates effect (b). With a posive correlation between firm market shares and input shares, input tariff liberalization will lead to an anti-competitive effect.

Case 3. $Cov\left(z_i, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(-\mathrm{d}\tau_i^{input}\right)\right) < 0.$

In the opposite case with small firms having higher import shares (albeit inconsistent with most empirical findings), we flip the argument in case 2. The aforementioned effect (b) dominates effect (a) and large firms face even more downward pressure on their markups. This leads to a lower markup dispersion and an additional pro-competitive effect of input tariff liberalization.

[13] Note that this is a first-order approximation result, and holds under a wide class of models including CES+MP, CES+oligopoly (Atkeson-Burstein), and non-CES (markups decreasing in demand elasticity).

[14] The mechanism here differentiates from that in Berman, Martin, and Mayer (2012) in which depreciation leads to enlarged market shares thus increased markups of exporters, the more so the larger the firms. Large firms adjust markups in response to exchange rate shocks by more than small firms because large firms perceive a lower demand elasticity and charge higher markups. In our work, however, large firms face competition pressures from small firms when they are equally exposed to input tariff cuts. Therefore, it is an essential element in our work that there is firm heterogeneity not only in terms of the markup elasticities with respect to the shocks but also in terms of the exposure to the trade shocks themselves.

Chapter 2

Empirical Evidence on Firm Performance

2.1 Empirical Analysis

In this chapter, we document important stylized facts during a recent trade liberalization episode in Colombia and estimate the heterogeneous responses of large and small firms to input tariff cuts. We observe two layers of firm heterogeneity: one in terms of the exposure to the input tariff shocks, and the other in terms of their responses.

Data

We use a firm microdata in Colombia from 2008-2015 which allows us to oberve firm input and output information around its 2010 trade liberalization.[1] The EAM dataset is particularly well-suited to our study in that it contains information on physical quantities and unit values of all products a firm produces and all inputs it uses. For each input (output) entry, we observe the value share of imported inputs (exported outputs) across all 8-digit CPC product codes that concord to 6-digit HS codes. EAM also contains standard firm-specific variables including sales, value added, investment, employment, wage bills, and more.

Table 2.1 shows the summary statistics of the Colombia firm dataset with the main firm-level variables including sales, purchases of materials, and purchases of imported materials. Large firms, compared to small firms, have higher sales, purchase more intermediate products, and disproportionately use imported inputs more intensively. The last three rows display import intensities calculated as the ratio of imported materials across large and small firms. In both subsamples, most firms do not import. This is especially true for the small

[1]The EAM data dates back to the 1980s and updates on an annual basis. We did not want to cross the Global Financial Crisis in 2008 or extends to after 2015 when additional reforms kicked in that increased tariffs for locally produced raw materials and capital goods while lowering the rates for non-produced goods; this policy has been maintained since PIPE 2.0.

Table 2.1: Summary Statistics

Variable	Sample	Mean	SD	p5	p10	p50	p90	p95	N
Sales	All	12,038	33,996	213	313	1,822	30,475	68,239	73,815
	Small	3,220	14,507	204	296	1,531	13,606	73,325	67,571
	Large	77,326	82,037	9,692	13,446	60,785	157,943	207,138	6,244
Materials	All	10,747	116,358	20	72	697	14,414	39,640	73,798
	Small	4,826	37,443	18	66	582	6,335	14,051	67,556
	Large	74,841	374,740	1,686	4,032	26,401	145,094	236,883	6,242
Materials (Imported)	All	2,156	28,618	0	0	0	725	4,689	73,798
	Small	489	4,552	0	0	0	131	1,178	67,556
	Large	20,200	95,414	0	0	815	42,189	80,414	6,242
Import Intensity	All	0.068	0.197	0	0	0	0.253	0.591	71,383
	Small	0.052	0.174	0	0	0	0.118	0.466	65,272
	Large	0.243	0.309	0	0	0.066	0.772	0.892	6,111

Note: Summary statistics of main firm characteristics using the final sample of EAM. The data span the period 2008 to 2015. Nominal variables are expressed in million of Colombian pesos (1 million COP $\approx$ 500 USD in year 2008). A firm is large if it belongs to the top quartile sectoral market share the first time it enters the sample and small otherwise. Materials stand for values of intermediate inputs. Materials (imported) only include the imported inputs. Firm import intensity is defined as its value share of imported inputs over total inputs.

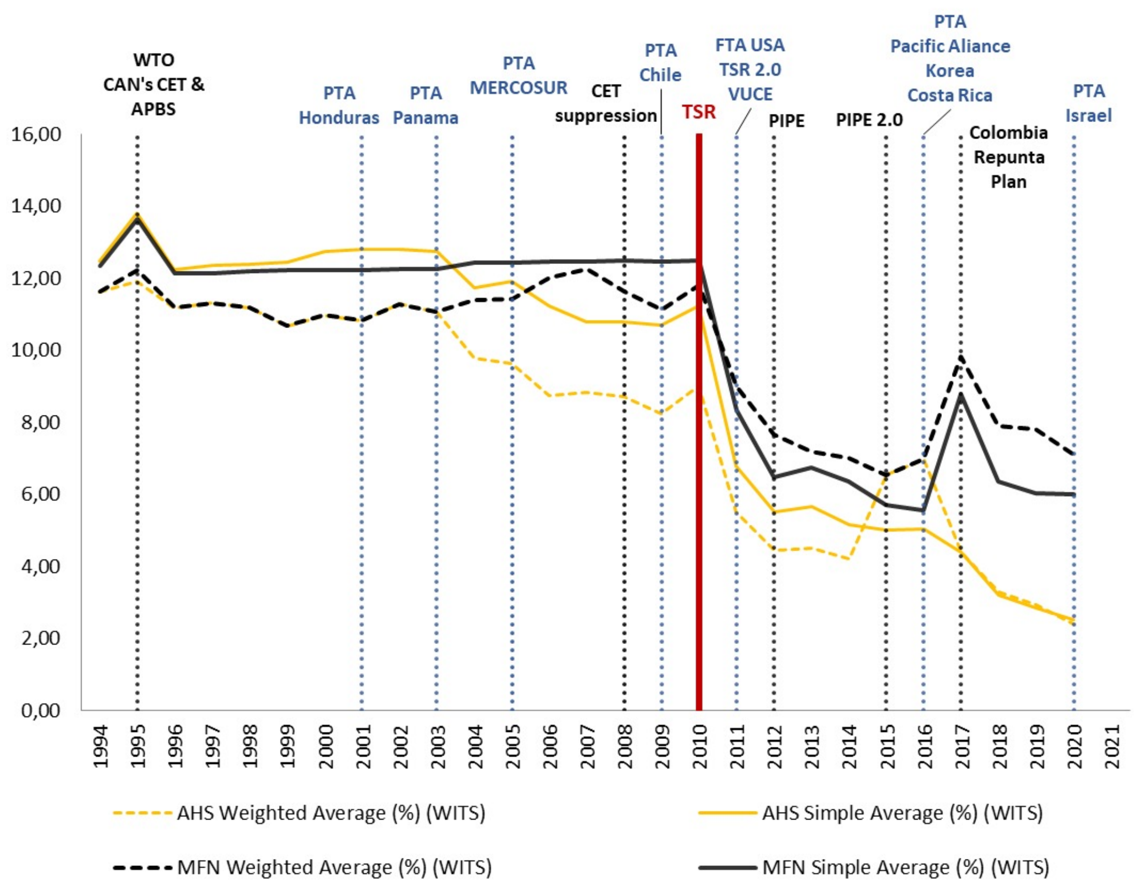
firm sample. On average, small firms source 5.2% of intermediate products from abroad. The number is much higher at 24.3% for large firms.

Policy Background

Since the 1980s, Colombia has established several commercial agreements with Costa Rica, Chile, Cuba, Mexico, Nicaragua, Panama, and the Bolivarian Republic of Venezuela in the framework of the Latin American Integration Association (LAIA) (ALADI, 2022). Additionally, for several decades, Colombia's tariff policy was determined by its membership in the Andean Community of Nations (CAN). Compliance with the CAN's Common External Tariff (CET) was no longer mandatory in 2008, allowing Colombia greater flexibility in trade policy from 2008 onward.

The year 2010 is considered a breakpoint during which Colombia implemented a Tariff Structural Reform (TSR). The TSR was designed with several objectives, including reducing dollar supply pressures on the exchange rate, supporting the competitiveness of Colombian

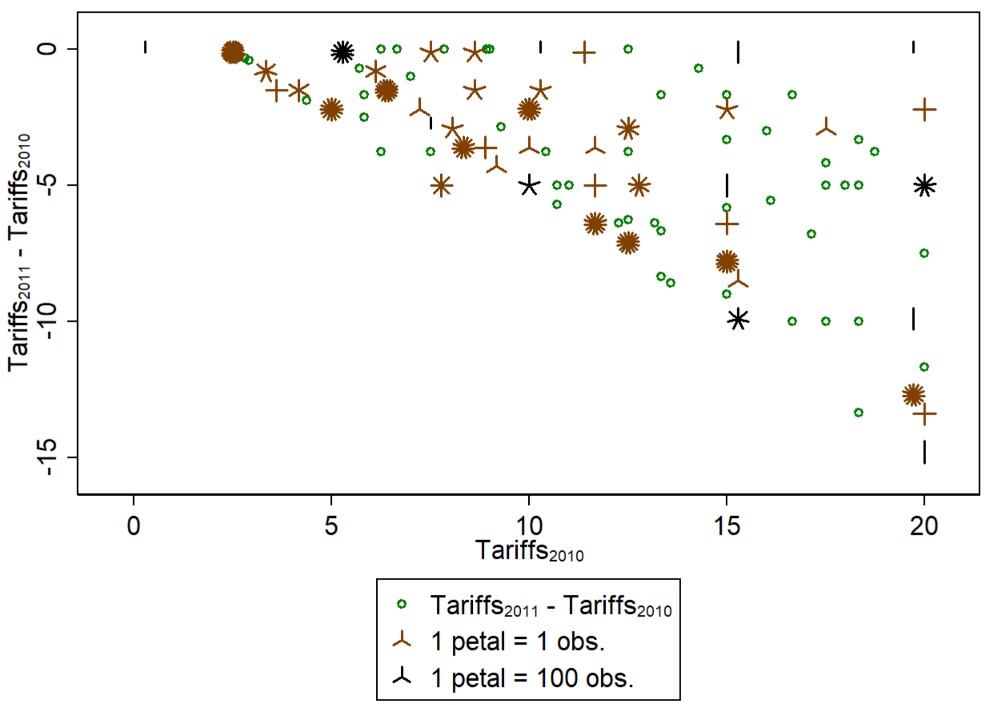
Figure 2.1: Tariff rates, Timeline, All Products, in Percentage Points



Note: CAN - The Community of Andean Nations; CET - The Common External Tariff; APBS - The Andean Community's Price Band System; PTA - Preferential Trade Agreement; MERCOSUR - Mercado Común del Sur (The Southern Common Market); TSR - Tariff Structural Reform; FTA - Free Trade Agreement; VUCE - Ventanilla Única de Comercio Exterior (Foreign Trade Single Window); PIPE - Plan de Impulso a la Productividad y el Empleo (Productivity and Employment Promotion Plan). Events colored in black impact multi-lateral tariff rates and events in blue affect only bi-lateral tariff rates.

industry in international markets by reducing the cost of tradable inputs, and simplifying the tariff structure. The TSR implemented a tariff reduction targeted at imported raw materials and capital goods used for domestic production. The strategy consisted of gradually boosting the competitive capacity of local entrepreneurs and thus creating more jobs by reducing their costs and transforming the national market into an international one. On average, the MFN tariff rate went down from around 12% in 2010 to 8% in 2011, and further down to 6% in 2015. Figure 2.1 plots the timeline of Colombia tariff rates against its major tariff-related events.

Figure 2.2: Colombia Trade Structural Reform, 2010-2011

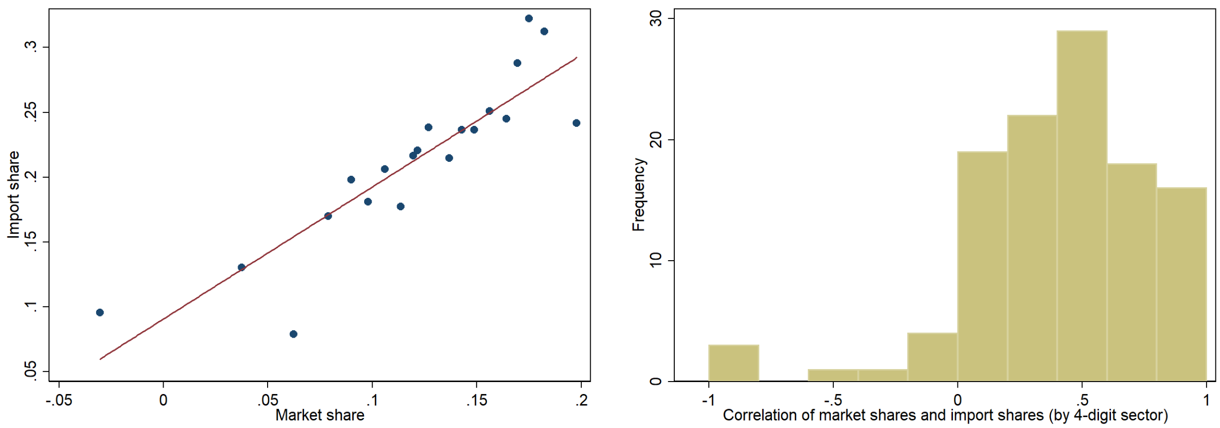


Note: tariff cuts calculated using the WTO TAO tariffs across ~5000 HS 6-digit products.

The 2010 trade reform in Colombia contains enough variations both over time and across sectors. Figure 2.2 plots the tariff cuts against the initial tariffs. Meleshchuk and Timmer (2020) argue that the trade reform can be treated as a "quasi-natural experiment" since the sectoral tariff cuts are highly correlated to the inital tariff rates. This suggests that some sectors underwent greater tariff cuts because they were previously more protected. Thus, the trade reform is aimed at reducing tariff dispersion rather than targeted at specific goods. We will deal with the potential endogeneity of tariff cuts when we proceed to the IV estimation.[2]

[2]Pilar Esguerra argues that the 2010 reduction in tariffs was related to the demands of some export-

Figure 2.3: Firm Import Shares and Market Shares



(a) Binscatter (b) Density Histogram

Note: correlation calculated using the 2010 firm data right before the trade reform took place. The scatter plot includes four-digit ISIC sector fixed effects and is weighted by firm market share.

Stylized Facts

Using data on Colombian firms during the recent episode of trade liberalization, we document two stylized facts we observe in the Colombian firm microdata, which serves as the motivation for our study.

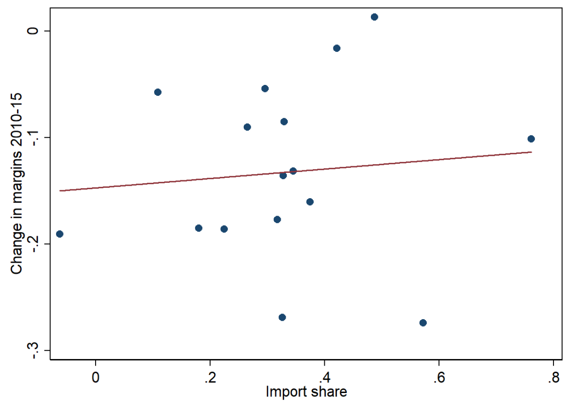
Fact 1. *Firm import shares and market shares are positively correlated.*

Figure 2.3a plots firm market shares against firm import shares and show the positive correlation of the two. Similar to what have been documented in many other countries, importers in Colombia are on average large firms, and large firms tend to be importers. In figure 2.3b, we further show the distribution of the correlation of firm market share and import share calculated for each 4-digit ISIC sector. The correlation distribution reinforces what we observe in the summary statistics, and indicates that the strength of the correlation also varies by sector.

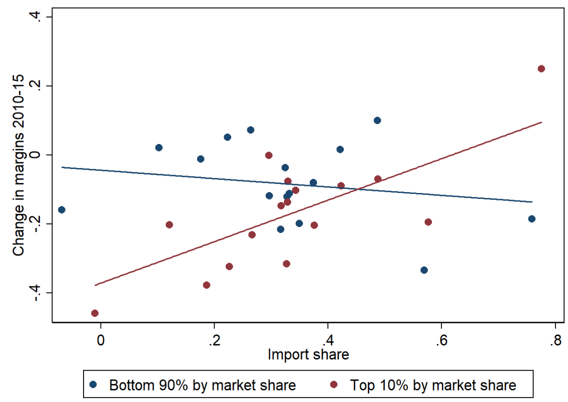
Fact 2. *Import-intensitve firms exhibits increasing margins since the trade reform; the effect is driven mainly by large firms.*

ing guilds to fight against the negative effect that the appreciation of the peso was having on them. It is also worth mentioning that the 2010 trade liberalization episode overlaps with the Juan Manuel Santos government (2010-2018), during which there were several changes in the Colombian trade policy. The Santos administration was characterized by using trade as a strategy of global insertion and foreign policy to create links with several countries worldwide (Vargas-Alzate, Sosa, and Rodriguez-Rios, 2012). Interestingly, the earlier major trade reform in the 1990s was when Santos got appointed the first minister of foreign trade in Colombia, who claimed to be "responsible for inserting the country to the world economy" (`https://www.rockefellerfoundation.org/profile/juan-manuel-santos/`).

Figure 2.4: Changes in Firm Profit Margins from 2010 to 2015



(a) All Firms, Binscatter



(b) Top 10% Firms versus bottom 90% by Market Share, Binscatter

Note: firm profit margins calculated as the firm revenue to cost ratio using the 2010 firm data right before the trade reform took place. Both plots include the subsample of importers and four-digit ISIC sector fixed effects and are weighted by firm market share.

Figure 2.4a and 2.4b show the changes in firm profit margins against firm import share.[3] While we observe an overall increase of firm margins in firm import shares, the pattern is solely driven by large firms. This pattern suggests that it is the synergy of high import share and high market share that leads to the changes in firm profit margins.

The Reduced-Form Regression

We run the following regression to capture the heterogeneous firm responses to both input and output tariff shocks, based on equations (1.6) and (1.8):[4]

$$\Delta y_{i,t} = \beta_1 \Delta\tau_{i,t}^{input} \times \text{Big}_i + \beta_2 \Delta\tau_{i,t}^{input} + \beta_3 \Delta\tau_{i,t}^{output} \times \text{Big}_i + \beta_4 \Delta\tau_{i,t}^{output} + \beta_{i(s),t} + \varepsilon_{i,t} \quad (2.1)$$

where the outcome variable $\Delta y_{i,t}$ is firm i's sales growth at year t, and $\Delta\tau_{i,t}^{input}$ and $\Delta\tau_{i,t}^{output}$ stand for the input and output tariff shocks faced by firm i at year t, and $\beta_{i(s),t}$ are the

[3]At this stage, we do not yet estimate firm-level markups to avoid assumptions on production function and parameter values. The firm profit margin measure serves well as our motivating facts.

[4]The baseline regression can be easily extended to account for multi-product firms. We prefer the firm-level to the firm-product-level regressions because firm inputs are reported as used by the firm as a whole but not by each product the firm produces. Firms can practically use the higher profits earned in one product line to subsidize and expand another one. The firm-produc-level regressions will not add to variations in the explanatory variables and can potentially contaminate the response estimation.

sector-year fixed effects, and Big_i is a time-invariant dummy variable indicating if firm i is large the first time it enters the sample.[5]

Firm i's exposure to input tariff shocks is constructed as a weighted average: $\Delta\tau_{i,t}^{input} = \sum_{g \in G^I(i)} \theta_{i,g,t}^I \Delta\log(1+\tau_{g,t})$, where $G^I(i)$ is the set of imported inputs of firm i, $\tau_{g,t}$ is the import tariff on product g, weighted by $\theta_{i,g,t}^I$, the value share of input g in total input cost of firm i. Similarly, firm i's exposure to output tariff shocks is constructed as a weighted average: $\Delta\tau_{i,t}^{output} = \sum_{g \in G^O(i)} \theta_{i,g,t}^O \Delta\log(1+\tau_{g,t})$, where $G^O(i)$ is the set of outputs of firm i, i.e., products firm i produces and sells, and $\tau_{g,t}$ is again the import tariff on product g, weighted by $\theta_{i,g,t}^O$, the value share of output g in total sales of firm i. The firm-specific input-output shares are observable at 8-digit CPC in EAM.

Table 2.2 shows the results of the baseline regression. Column 1-4 show the results using the "naive" value shares $\theta_{i,g,0}^I$, the pre-sample value share of input g in *total* input cost of firm i. Columns 5-8 switch to the "actual" value shares $\theta_{i,g,t}^I$, the comtemporaneous value share of *imported* input g in total input cost of firm i. The responses of large firms to input tariff shocks relative to small firms are basically flipped when using the naive input tariff measure (using the overall input-output shares) versus the actual input tariff measure (taking into account firm-level import intensities). This shows that large firms expand relative to small firms not because they lower price and sell by more but only because they benefit more from input tariff shocks. Using the "naive" measure that implicitly assumes all firms import, the coefficient on input tariffs is picking up how large firms take advantage of the cheaper imported inputs to steal market shares from small firms.[6] The EAM data enables us to use the "actual" measure to disentangle the actual changes in firm marginal costs from their responses as a result of the input tariff cuts. Controlling for firm-level heterogeneous exposure to such shocks reveals that large firms do not respond by as much as small firms do when they face the same own cost shocks.

We proceed with an instrument variable design to address the strategic targeting of tariff cuts following Faber (2014). We extract from the full list of 8-digit input product codes the most commonly used ones in terms of frequency and re-construct the input tariff measure for each firm. The instrument captures a significant portion of the "actual" tariff changes while being less likely to be influenced by unobserved firm-year-specific characteristics, e.g. firm lobbying. Table 2.3 shows the IV estimation results. Both the full-sample and sub-sample results are broadly consistent with a large class of model: small firms are more responsive to their own cost shocks (input tariffs) and large firms show stronger strategic complementarities (output tariffs).[7] One needs to be careful when interpreting the magnitude of the coefficients

[5]In the baseline estimation, we define big firms as those in the top decile of the sectoral market share distribution the first time firms enter the sample. We explore alternative definitions of large firms, and the results remain qualitatively unchanged.

[6]Note that the naive measure is commonly used in the literature to study the effect of input tariffs shocks, mainly due to the lack of firm-level input data. The fact that alternative measures of inputs tariffs can lead to completely opposite interpretations may explain the noisiness in the coefficient on input tariffs documented in the literature (for example, see De Loecker et al. (2016)).

[7]We use subgroups instead of the interaction term to allow for heterogeneous sector-time fixed effects as

Table 2.2: Coefficient Heterogeneity, by Large and Small Firms, OLS Estimation

Input Tariff Measure Using	"naive" input tariff measure				"actual" input tariff measure			
Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \ln(\text{Sales}_{i,t})$	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Sample:	All	All	Importers	Importers	All	All	Importers	Importers
$\Delta\tau_{i,t}^{input}$	0.125	0.264**	0.688***	0.581**	0.380*	0.264	−0.238	−0.371
	(0.106)	(0.106)	(0.242)	(0.269)	(0.229)	(0.244)	(0.259)	(0.281)
$\Delta\tau_{i,t}^{input}$ ×Large Firm Dummy	−0.318**	−0.591***	−0.510**	−0.485	−0.0785	−0.136	0.766**	0.796**
	(0.126)	(0.155)	(0.252)	(0.295)	(0.299)	(0.316)	(0.341)	(0.365)
$\Delta\tau_{i,t}^{output}$		−0.00759		0.0565		0.0203		0.0351
		(0.0486)		(0.0954)		(0.0414)		(0.124)
$\Delta\tau_{i,t}^{output}$ ×Large Firm Dummy		0.134*		0.0549		0.0919		0.126
		(0.00371)		(0.125)		(0.0702)		(0.132)
Obs.	43,708	37,363	8,956	8,094	57,345	47,608	9,706	8,781
Sector×Year FEs	yes	yes	yes	yes	yes	yes	yes	yes

Note: OLS estimation using the final sample of EAM firm panel from 2008 to 2015. Column 1-4 using the "naive" input tariff measure, i.e. weighted averages in input tariff shocks where weights are firm-specific value shares of inputs over total purchase of inputs; column 5-8 using the "actual" input tariff measure where weights are firm-specific value shares of imported inputs over total purchase of inputs. All regressions include sector×year fixed effects and firm fixed effects. Standard errors are clustered at the firm level. ***1%, **5%, and *10% significance levels.

on input tariff shocks. The coefficients are economically huge due to the small (but not weak) coefficient in the first stage, which is almost mechanic due to the construction of the IV.[8] For an average small firm, a 1% decrease in input cost will lead to an increase in sales by 9% times its import intensity.[9] When it comes to the large firms, their responses to input tariff changes are neither statistically nor economically significant compared to the small ones.[10]

For robustness, we use alternative definitions of large firms. Column 3-4 of table 3 corresponds to the results using firm employment and column 5-6 are based on firm sectoral market share. We tried alternative cutoffs for the set of most commonly used inputs (¿50%, 75%, 90%, etc.) and alternative definitions for large firms (top quantile, quintile, decile, etc.). The results remain qualitatively unchanged.

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these fixed effects absorb the changes in the industry price indices to which firms of different sizes respond differently. More importantly, we do not find justification for using an instrumented interaction term with a dummy variable regarding firm charateristics (whether the definition of large firms are based on firm sales or employment).

[8]Magnitude-wise, the instrumented variable $\approx$ the instrument$\times$import intensity.

[9]Note that the tariff cuts should be interpreted as percentage changes in input cost but not as changes in percentage points of tariff rates due to the construction of the tariff measure in log transformation. This facilitates the connection of the model to the reduced-form.

[10]Despite our focus on how firms respond to input tariff shocks, we add controls for output tariff shocks and find that large firms exhibit statistically and economically significant response to output tariff shocks, consistent with models that predict stronger strategic complementarities of large firms. The opposite is true for small firms.

Table 2.3: Coefficient Heterogeneity, by Large and Small Firms, IV Estimation

Large Firm Def.:			# Employees≥100		Top 10% Market Share	
Sample:	All	All	Small	Large	Small	Large
Dependent var.:	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\ln(\text{Sales}_{i,t})$	IV	IV	IV	IV	IV	IV
$\Delta\tau_{i,t}^{input}$	−5.553**	−7.148*	−8.983**	−3.411	−9.051**	−3.957
	(2.756)	(3.697)	(4.570)	(5.654)	(4.437)	(5.183)
$\Delta\tau_{i,t}^{output}$	0.301***	0.325***	0.111	0.389***	0.249**	0.578***
	(0.073)	(0.087)	(0.114)	(0.117)	(0.097)	(0.199)
Obs.	8,413	8,409	4,066	4,327	5,639	2,762
1^{st} Stage F-Stat	44.2	25.5	13.9	15.5	21.0	6.4
Sector & Year FEs	Yes	No	No	No	No	No
Sector×Year FEs	No	Yes	Yes	Yes	Yes	Yes

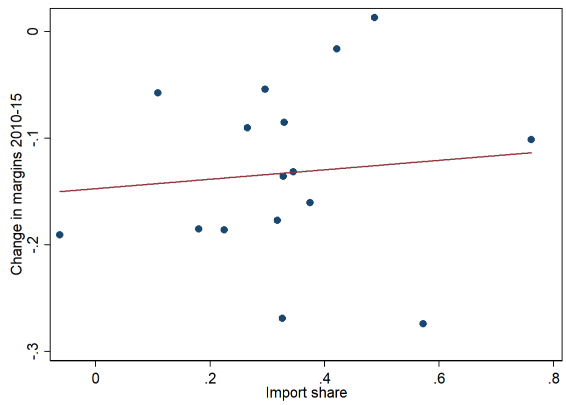
Note: IV estimation using the final sample of EAM firm panel from 2008 to 2015. Results are 2nd stage IV estimates after instrumenting for input tariff changes. The specicfication is exactly identified. The instrument is based on the composition of imported inputs, i.e. weighted averages of input tariff changes where weights are firm-specific value shares of imported inputs over total purchase of imported inputs, fixed at the initial period. In constructing the weights, we only keep the most commonly used input product codes that belong to the top quantile across all Colombian firms in terms of input frequencies. Column 1 includes sector and year fixed effects; column 2-6 include sector×year fixed effects. The definition of large firm is based on employment in columns 3-4 and on firm's sectoral market share the first time it enters the sample in columns 5-6. Standard errors are clustered at the firm level. ***1%, **5%, and *10% significance levels.

2.2 Quantitative Analysis

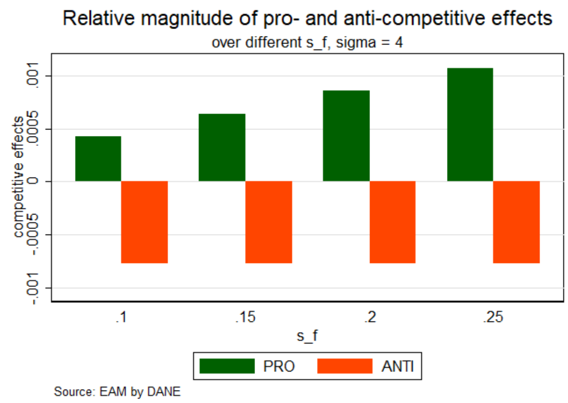
In this section, we quantify the aggregate implication on the overall welfare effects and the relative magnitude of pro- and anti-competitive effects by combining the welfare decomposition equation (1.9) with the microdata on the distribution of firm market shares and import shares.[11]

[11]Note that the relative magnitudes are governed by the pre-reform distribution of firm market shares and import shares plus the parameters (σ and s_f), but are independent of the relative sizes of the output and input tariff cuts. Therefore, the comparison result is not a pure coincidence due to the nature of the trade liberalization episode in Colombia. One can think of these numbers as the pro- and anti-competitive coefficients and multiply them by a set of possible tariff cuts to obtain counterfactual welfare effects.

Figure 2.5: Relative Magnitudes of Pro- and Anti-Competitive Effects, Single Sector



(a) $s_f = 0.2$ and over Alternative σ's



(b) $\sigma = 4$ and over Alternative s_f's

Note: calculated using the 2010 firm data right before the trade reform took place.

One-Sector Analysis

We loop over a set of reasonable values of the elasticity of substitution σ and of foreign goods shares in the domestic final goods market s_f and compare the resulting welfare consequence to test the sentitivity of our welfare estimation to alternative parameter values.

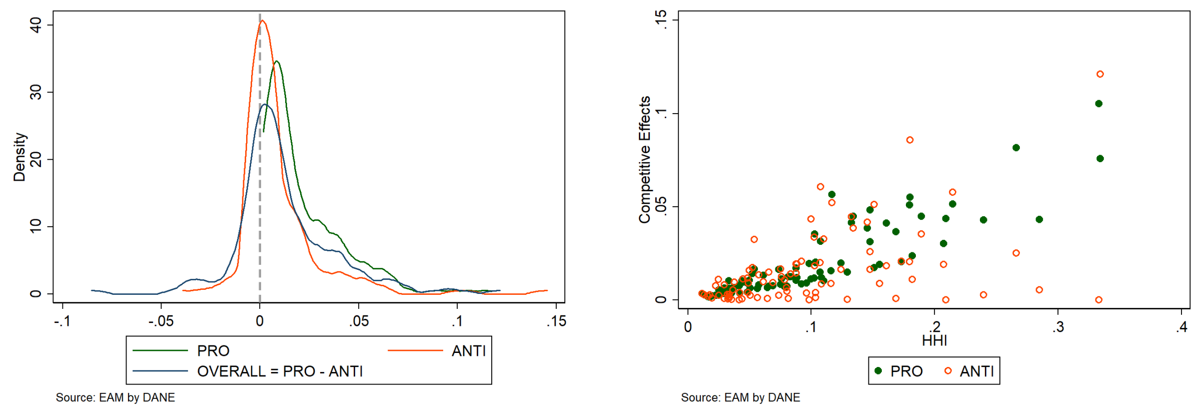
Figure 2.5a shows the decomposed welfare effects over a range of σ from 2 to 5 and under a fixed share of foreign goods in the final goods market $s_f = 0.2$. In the setting of the Colombian firms, the existence of the anti-competitive effect does not fully cancel out the pro-competitive effect, it wipes out around 80% of the latter. Since the sign of the anti-competitive effect is solely determined by the weighted covariance of firm market share and import intensity, the value of σ does not affect the existence of the anti-competitive effects. It is no surprise that the estimated welfare effects are qualitatively consistent over different σ's.

Figure 2.5b shows the results over different levels of foreign competition under a fixed $\sigma = 4$. As foreign competition becomes fiercer, the pro-competitive effect starts to outweigh the anti-competitive effects, and vice versa. When the country is not facing enough foreign competition, which can be the case with home bias, the anti-competitive effect can dominate pro-competitive effect. In such cases, omitting the anti-competitive effect can lead to substantial overestimation of the aggregate welfare gains from trade.

Multi-Sector Analysis

We now extend the welfare quantification exercise in 2.2 to allow for multiple sectors. In Figure 2.6a, we plot out the distribution of the pro- and anti-competitive effects and the

Figure 2.6: Relative Magnitudes of Pro- and Anti-Competitive Effects, Multiple Sectors



(a) Density Plot, 4-digit ISIC Sectors (b) Scatter Plot, 4-digit ISIC Sectors

Note: calculated using the 2010 firm data right before the trade reform took place. Parameter s_f calibrated using OECD Input-Output Tables (IOTs), and the multi-sector σ's using Broda and Weinstein (2006).

overall competitive effects for all 4-digit ISIC sectors.[12] While the median of the anti-competitive effect is smaller than the pro-competitive effect, its upper bound can be much higher due to high correlation of firm market shares and import shares in certain sectors. For 1/4 of the sectors, the anti-competitive effect dominates the pro-competitive effect.

Figure 2.6b shows a scatter plot of the pro-competitive effects against the anti-competitive effects for all 4-digit ISIC sectors.[13] The anti-competitive effect tends to be stronger in industries where the pro-competitive effect is stronger. As predicted by our model, market concentration has a common role to play in amplifying both pro- and anti-competitive effects.

2.3 Discussion and Policy Implications

Our results contribute to the literature on firms' heterogeneous responses to own cost shocks, and specifically to input tariff shocks. To our knowledge, our study is the first one to disentangle firm-level exposure and responses to input tariff shocks using a rich firm microdata that spans over a major trade reform in the country. Without observing firm-specific ex-

[12]For ease of display, we inverse the sign the the anti-competitive effect before comparing the magnitudes. It is worth meantioning that the anti-competitive effect term can yield an additional pro-competitive effect ("anticompetitive gains") in a small portion of sectors where firm market shares and import shares are negatively correlated. This is not observed in the single sector analysis when we aggregate over all firms across all sectors.

[13]Here, we drop sectors with "anticompetitive gains" in order to compare the absolute values of pro- and anti-competitive effects by sector.

posure, the regression coefficient on input tariff cuts misleadingly suggests that large firms would expand relative to small firms as the coefficient absorbs the differential import intensities across large and small firms. Large firms steal market shares from small firms during input trade liberalization not because they cut prices and sell more but because they are the ones who benefit more from input cost cuts. To acount for the firm-varying import intensities, we instead measure input tariff shocks precisely at the firm level and use an instrumental variable design to address common endogeneity issues with trade policies. The resulting estimates now support a wide class of trade and macro models in which large firms are less responsive to own cost shocks than small firms are.

Our findings on the micro-level firm heterogeneity in exposure and responses to input tariff shocks also have important welfare implications at the aggregate level. The fact that large firms benefit exclusively from the input tariff cuts yet do not fully pass through the shocks by raising their markups leads to increased markup dispersion and muted welfare gains. Neglecting the anti-competitive welfare effect can overestimate welfare gains from trade liberalization, during which we oftentimes see coincidence of output and input tariff cuts.

Our study suggests that trade liberalization does not necessarily lower the aggregate price level or increase the welfare level by as much as policymakers may expect, especially when the big firms are exposed exclusively to input tariff cuts but not necessarily output tariff cuts if they are too good at lobbying. In such a case, the anti-competitive effects of trade reform can outweigh its pro-competitive effects, leading to a higher aggregate price and lower welfare level than in a counterfactual scenario with less unequal import access among domestic firms. Our work provides an example that policymakers in emerging economies should not blindly copy-paste successful reforms from developed countries given the disparities in preconditions. Our framework can also be extended to understand supply chain resilience at the micro level. While large firms are better able to diversify input sources, small firms are more likely to encounter supply chain bottlenecks as they largely source domestically. This calls for targeted intervention to enhance input access and substitutability especially for small business.[14]

While we focus on the first-order terms on firm-specific exposure and response to input tariff shocks, further questions can be asked about the second-order effects. Can we add an additional covariance term on a firm's market share and the composition of its imported inputs? This can be especially relevant to political economics as it is to the interest of the large firms to lobby to have input tariffs lowered specifically for the products they themselves import intensively. Accounting for the endogeneity of tariff cuts should give even more significant anti-competitive effects of trade. Our focus of market power is restrained to the final goods market, and we have not opened the box of distortions in labor markets or

[14]DANE at Colombia also provides customs data that records firm-product-level import flows data at HS 10-digit. In addition, the dataset records the source country for each data entry. One could potentially merge the customs data with the EAM to study supply chain diversification at the firm level. We have not been able to merge the two due to their different firm coding systems.

intermediate product markets through the input tariff channel.[15] We leave related questions to future research.

[15] See, for example, Tortarolo and Zarate (2018) and Felix (2021).

Chapter 3

Empirical Evidence on Household Savings

There is persistent heterogeneity in household saving behavior across Euro Area (EA) countries. Specifically, the household saving rates for EA periphery countries are persistently lower than countries such as Germany, France, and Belgium. The cross-country divergence in household savings became particularly wider in the run-up to the 2007-08 global financial crisis (GFC), reflecting fast consumption growth in the EA periphery countries. Following a temporary increase during the GFC, the household saving rates in these periphery countries dropped significantly during the European sovereign debt crisis (SDC). The household savings in these countries have since stabilized or gradually recovered but remained among the lowest in the EA. While there was a broad-based surge in overall household savings during the Covid-19 pandemic, latest data suggest that household savings have come down again after the pandemic.

Persistently low household savings have important implications for economic growth and reflect fundamental economic imbalances. First, household saving is an important financing source of investment and thus economic growth. This is particularly relevant for EA periphery countries given the need for higher investment rates to raise convergence prospects for these economies. Second, low household saving rates may result in persistent external imbalances, as financing for domestic investment becomes increasingly reliant on foreign savings. Also, the resulted foreign liabilities make these countries more vulnerable to external shocks. Third, low household savings are often associated with weak household balance sheets. Households with negative or low saving rates may have to borrow more to smooth consumption in response to economic shocks or purchase durable goods including housing. Moreover, given that low-income households are typically saving less, low saving rates may indicate that inequality of income or wealth across households may be an issue. High household indebtedness also represents a source of vulnerability for the financial sector.

This chapter aims to investigate the causes of persistently low household savings in three Southern European countries: Cyprus, Greece, and Portugal (SE3) with the lowest household saving rates in the EA. By examining microdata from the Household Finance and

Consumption Survey (HFCS) and conducting policy simulations, the chapter aims to answer the following questions: i) What are the main factors driving household savings in SE3 countries? ii) Why do SE3 countries differ from more advanced EA countries in terms of household saving rates?, iii) How is the saving behavior in SE3 countries expected to change in the current context of high inflation and monetary policy tightening?, and iv) How can economic and structural policies increase household savings in a sustainable way?

3.1 Empirical Analysis

This section provides a conceptual framework for the empirical analysis undertaken in the subsequent sections before presenting data sources and empirical analysis. Building on the identified drivers of household savings, the first part discusses evidence from descriptive statistics, while the second part presents a multivariate regression analysis conducted to assess the simultaneous effect of individual factors.

Drivers of Household Savings

Based on a comprehensive literature review, we identify the main factors driving household saving decisions. A summary with expected signs and key references is presented in Appendix E.

The life cycle and permanent income theories have served as a benchmark framework to analyze household savings behavior. Departing from the absolute income hypothesis developed by Keynes (1936) that postulated savings would be a positive function of current income, the life-cycle and permanent income theories recognize the intertemporal nature of household consumption and savings. According to the basic standard life-cycle theory hinging on consumer heterogeneity formulated by Modigliani and Brumberg (1954), young people work, earn income, and save while they spend their savings (dissave) once they stop working, e.g. in retirement. Relying on the assumption of homogenous consumers, the basic permanent income theory proposed by Friedman (1957) postulates that only a permanent income component has a significant impact on consumption and savings, with a transitory component having a limited or no effect. While these theories suggest that household saving behavior depends not only on current income, but also on other factors affecting their long-term income potential, they typically do not explicitly reflect the role of bequest, uncertainty about the future, wealth, access to financial markets, and household heterogeneity across various characteristics.

Households save to secure consumption smoothing throughout their lifetime, including during retirement. While the standard life-cycle theory is a useful departure point to analyze household saving behavior, it abstracts from bequest motives (Kopczuk and Lupton, 2007) and precautionary savings arising from longevity risk (Ameriks and others, 2020). Once these features are embedded in the models, savings can be positively correlated to age. Both the life-cycle theory and the permanent income hypothesis imply that income is a critical determinant of household savings (Deaton, 1992). Current income is generally expected to be correlated positively with savings because the marginal propensity to save increases in disposable income, as evidenced by Dynan and others (2004) and Grigoli and others (2014). Taking into account permanent income or expectations regarding future income proxied by education suggests that higher education is translated into higher savings (Browning and Lusardi, 1996; Dynan and others, 2004; Attanasio and Weber, 2010).

The impact of interest rates on savings can be ambiguous. There are three distinct effects at play that determine the overall impact of interest rates on household savings (Elmendorf, 1996; Schmidt-Hebbel, 1997). The substitution effect involves postponement (substitution) of today's consumption to future, as a higher interest rate allows for higher future consumption that is gained by forgoing present consumption. By making today's consumption more costly relative to tomorrow's consumption, higher interest rate encourages people to consume less today and save more. The income effect arises as higher interest rate translates into fewer current dollars needed to fund a given amount of future consumption. As future consumption becomes less expensive, making people better off in a lifetime sense, people increase their current spending and save less. Finally, the wealth effect works through two channels. With an increase in the interest rate, the present value of future labor income, pension benefit, as well as future capital income and life-long accumulated assets declines. Both of these channels make people worse off in a lifetime sense and lead them to consume less today and save more.

Uncertainty about future leads to precautionary savings. Following the seminal work of Friedman (1957), and Hall (1978), subsequent literature has explicitly introduced uncertainty in models and analyzed its impact on household savings through the precautionary motive (Skinner 1988; Zeldes 1989, Deaton 1991, Carroll 1992). The models developed by Deaton (1991) and Carroll (1992, 1997) predict that households accumulate a buffer stock of wealth to insure against possible adverse shocks. The buffer-stock savers have a target wealth to permanent income ratio such that if actual wealth is below the target, the precautionary saving motive will dominate impatience, and the consumer will save, while if actual wealth is above the target, impatience will dominate prudence, and the consumer will dissave (Jappelli and others 2008). While higher uncertainty about the future reduces current consumption and increases savings (Loayza and others, 2000), introducing uncertainty into the model results in savings that are above the level predicted by the standard permanent income and life-cycle hypotheses (Carroll, 1992; Schmidt-Hebbel, 1997). Longevity risks associated with bequests and health costs can be an important element of precautionary savings (Ameriks and others, 2020).

Borrowing constraints may play a significant role in household saving decisions. Relaxing the assumption of perfect capital markets makes credit institutions relevant for household consumption and saving decisions. Households are usually exposed to housing through borrowing to finance a property purchase and house price fluctuations associated with the wealth effect (Muellbauer, 2007). There may be restrictions on mortgage availability because of high down payment for mortgage loans, so households need to accumulate larger amounts for down payments and thus save more (Japelli and Pagano, 1994; Deaton, 1999). House price declines reduce the availability of home-equity-based borrowing and lead to lower consumption and higher savings (Campbell and Cocco, 2007; Case and others, 2001).

Household heterogeneity has important implications for saving behavior too. Family characteristics can have important implications for household savings behavior (Love, 2010). For example, while households with fewer children devote a smaller share of income to support dependents and consequently save more, declining family sizes mean that the ratio of workers per retiree decreases and the current working age population may need to save more (Curtis and others, 2015). Gender can be a contributing factor too, with evidence provided by Lupton and Smith (2003) that female-headed households typically generate lower savings as a result of differences in investment behavior (Hira and Loibl, 2005; Jianakoplos and Bernasek, 1998) and less time spent on average in workforce that is affecting earning (Ryan and Siebens, 2012; Sierminska and others,2010).

Fiscal policy can have some bearing on household savings behavior as well. The Ricardian equivalence hypothesis suggests that an increase in permanent government consumption would be fully offset by lower private consumption (Seater, 1993). This is because households anticipate future tax increases, which are necessary to finance higher government debt reflecting higher current government consumption. Assuming consumption smoothing, a drop in expected future income will dampen current consumption and thus increase current household savings. Public insurance schemes may also influence household savings (Feldstein, 1985). Availability of government-provided retirement income programs can make households consider their retirement benefits as a substitute for their working-age savings and reduce their pre-retirement savings.

While the literature on household savings is abundant and growing further, there are limitations, which this chapter attempts to address. There are numerous studies examining the determinants of household savings for European countries, but these are either based on macroeconomic cross-country data (Rocher and Stierle, 2015) or done individually for countries using household-level data (Kolerus and others, 2012). To our knowledge, there are only a few studies analyzing household saving behavior using household-level data for EA countries, which include the work of Rodriguez-Palenzuela and others (2016) and Le Blanc and others (2016). However, these studies rely on cross-sectional data for EA countries covering 2009-2011 and do not use the household saving rate as a continuous variable. This study employs the measure of household savings in the form of continuous variable for three waves of household-level data—spanning periods beyond the GFC and SDC stress episodes—for 10 EA countries. To analyze the distributional impact of individual factors on household savings, this study employs the quantile regression approach. Furthermore, building on the results from the econometric analysis, we conduct policy simulations and propose measures to increase household savings in SE countries.

Data

The analysis is conducted on household-level data augmented by standard macroeconomic variables. The ECB's HFCS provides rich information on households' characteristics in a harmonized fashion across three waves.[1] The dataset contains 192 micro indicators for a total of 170,699 households in 10 EA countries with individual-country sample size ranging from 3,829 for Cyprus to 40,726 for France. To limit the extent of missing values or non-response items, the source dataset provides five imputed values generated by stochastic imputation conditional on observed variables. We follow Lamarche (2017) and Browning and others (2003) and impute consumption spending to each household in the dataset using a framework that was largely based on country-level estimation of the Engle curve equations from data of expenditures on food, utilities and rents as well as demographic variables such as age, household size and labor status. Similarly, we also estimated net income from gross income reported in HFCS using tax rate data from OECD. Appendix II provides technical details of imputations and matching. Macroeconomic data are sourced from IMF, OECD, and World Bank.

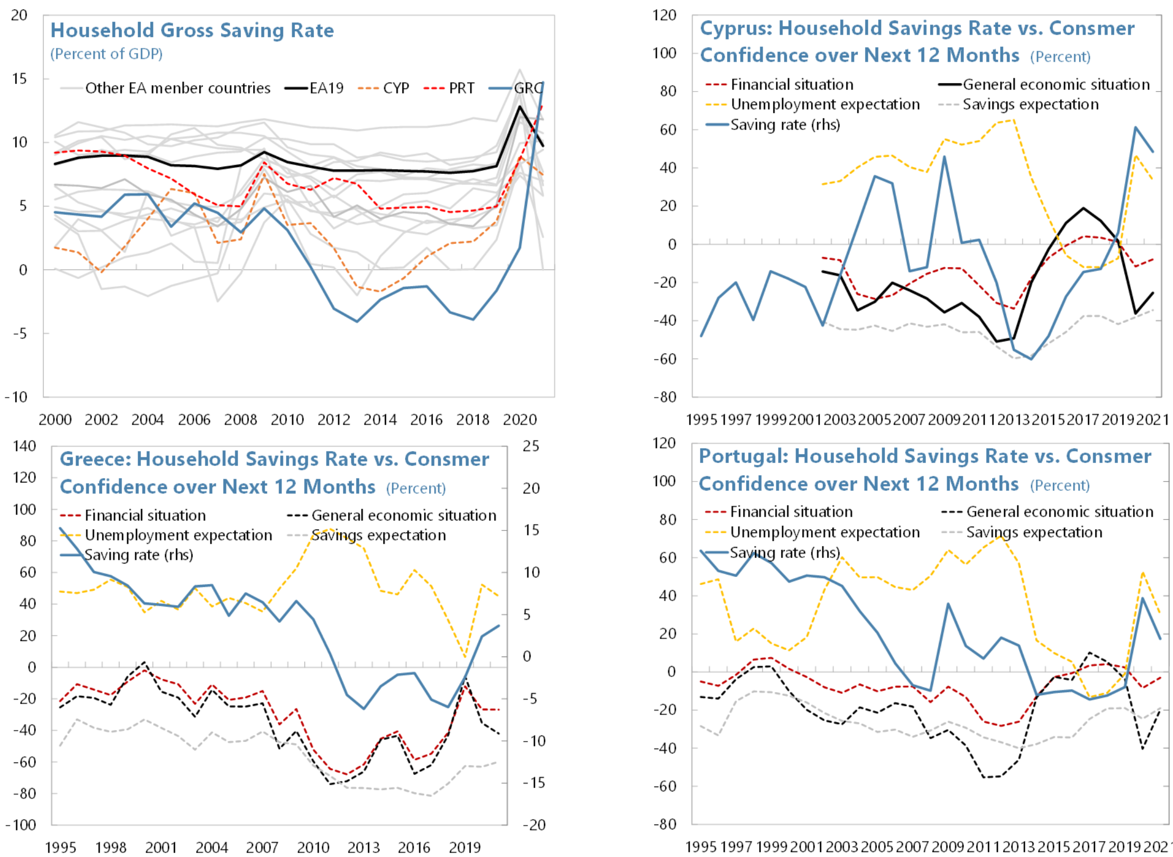
Descriptive analysis

There is evidence of an increase in savings for the whole region during stress episodes, with SE3 countries recording the lowest saving rates among EA countries (Figure 3.1). SE3 countries have the lowest savings rates among the EA countries, with a significant contribution from the household savings rate. While the household savings rate of EA countries was relatively stable until the GFC crisis, saving rates in SE3 countries recorded a noticeable decline in the run-up to the crisis. When the GFC hit, there was a significant increase in savings across the EA countries, with SE3 countries experiencing a particularly steep increase, reflecting most likely the precautionary motive associated with high uncertainty about the future (Mody and others, 2012). While the ensuing recession and subsequent SDC were relatively short-lived for most of the EA countries, SE3 countries experienced particularly deep and protracted recession, especially in case of Cyprus and Greece, leading to a sharp decline in household savings in these countries. In fact, household savings of Cyprus and Greece plummeted into the negative territory and recorded the lowest rate amongst the EA countries, remaining negative for almost a decade in case of Greece. With the COVID pandemic in 2020, household savings jumped in an unprecedent fashion for all the EA countries, bringing the saving ratio back into the positive territory for all the EA countries. The improvement in household saving rates reflected both the precautionary savings, the involuntary savings due to pandemic-related restrictions, as well as policies protecting employment and income (Dossche and Zlatanos, 2020).

The breakdown of disposable income into consumption and savings offers additional insights (Figure 3.2). Prior to the GFC, savings behavior was largely determined by disposable income dynamics. This co-movement was particularly significant for SE3 and was driven predominantly by high consumption dynamics. This pattern changed dramatically during the GFC when savings spiked despite a drop in disposable income reflecting a sharp decline in

[1] Most of the data collection took place between 2009-2011 during the first wave. The second wave was conducted between 2013-2014 for the second wave; and the third wave between 2014-2018.

Figure 3.1: Saving Rate and Uncertainty

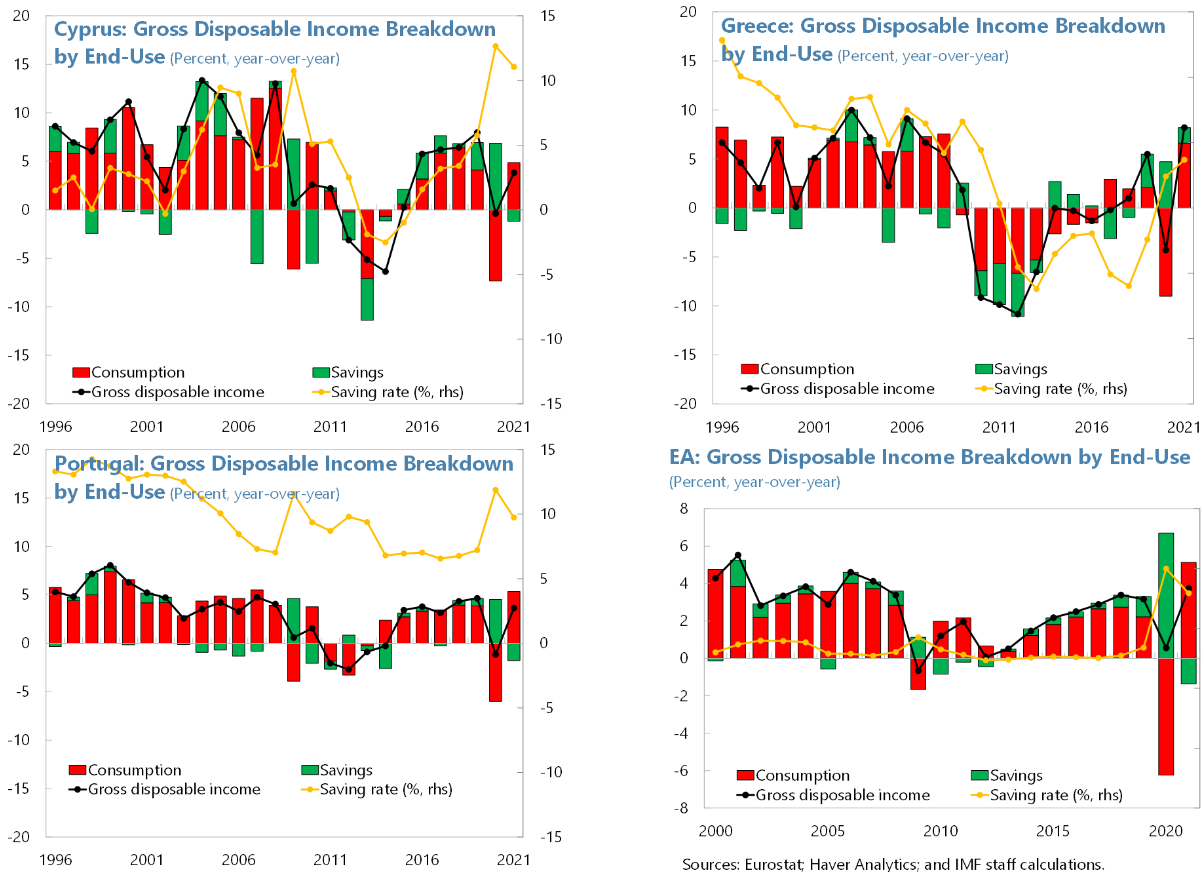


Source: European Central Bank, HFCS database; and IMF staff calculations.

private consumption, offset by a jump in precautionary savings. The recovery in disposable income for the EA average, which started earlier than for SE3 countries, was accompanied by some decrease in savings and a significant increase in consumption. While the drop in disposable income and consumption was particularly pronounced and protracted for Greece, it was also to some extent the case for Cyprus and Portugal. Given that the level of the saving rate was still lower compared to pre-GFC level, especially for SE3 countries (except Cyprus), this might suggest some consumption smoothing behavior of households (Rodriguez-Palenzuela and others, 2016). During the pandemic, the pattern was to some extent similar to the GFC, so the sharp increase in household saving rate was accompanied by the substantial drop in consumption partially offset by savings boosted by fiscal transfers. The massive decline in consumption and a spike in the savings rate originated from the drop in consumer services because of the imposition of social distancing measures (Dossche and others, 2021).

The household-level data confirm the dynamic pattern of savings as observed in the macroeconomic indicators and provide additional insights on their distribution (Figure 3.3).

Figure 3.2: Household Disposable Income



Saving rates in the EA countries declined over the three waves of the HFCS. Household saving rates in SE3 countries noticeably differ from the EA benchmark with the average saving rate being below the EA average, especially for Cyprus and Greece. In terms of savings dynamics, SE3 countries recorded a more pronounced decline in the saving rate across the waves than the EA average. In addition, the saving rate in the EA countries is characterized by a negatively skewed distribution. This reflects the fact that consumption is typically positive, but income can essentially sometimes be close to zero, leading to large negative saving ratios for some households, which is consistent with evidence for other advanced economies (Finlay and Price, 2015). SE3 countries differ in terms of their distributions from the EA benchmark, exhibiting a longer tail of negative saving ratios. Finally, there is also some evidence suggesting a contraction in savings for the right-hand side of the distribution across the waves, with top savers generally reducing their saving rate following the GFC, as shown by the data for waves 2 and 3.

The HFCS survey allows to analyze self-declared motives for savings by households (Fig-

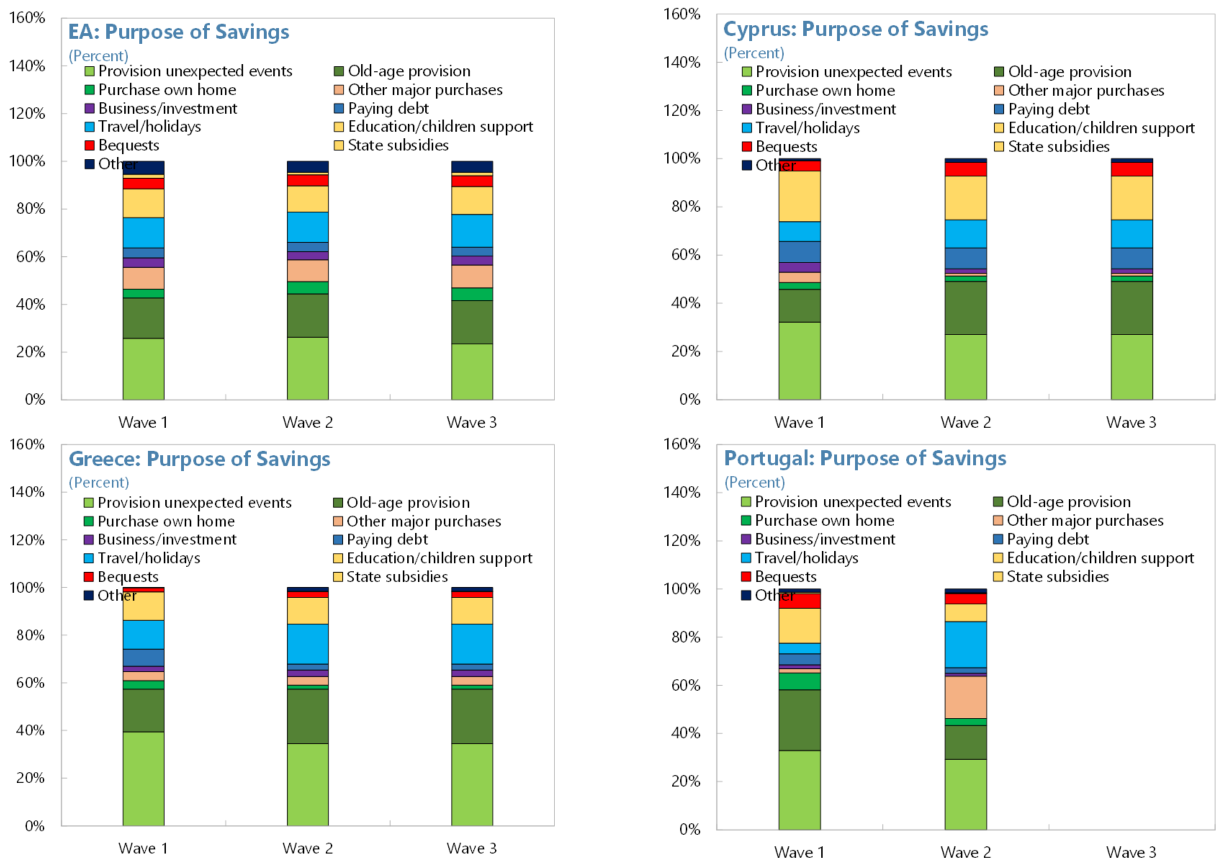
Figure 3.3: Household-Level Saving Distribution

Source: European Central Bank, HFCS database; and IMF staff calculations.

ure 3.4). The evidence from the HFCS survey suggests that an important saving motive for EA households is to have protection against unexpected events, which is in line with theory and empirical findings from studies for advanced economies. Households in Cyprus and Greece declare to save more for this motive compared to the EA average, with Greece recording the strongest precautionary motive among them. The other key declared motives, also in line with the previous studies, include old-age provision, education and support of children, and travel, which reflect savings for retirement, consumption smoothing, and support of dependents. Other motives for savings include home purchase, bequest, investment, and debt repayment, as well as other major purchases, but are typically less important. Comparing to the EA average, households in Cyprus seem to save more for debt repayment, while household in Greece save less for this purpose and the importance of this motive declined across waves.

Variables capturing retirement and consumption smoothing appear to be associated with savings (Figure 3.5 and 3.6). The evidence from household-level data demonstrates hump-shaped age saving profiles. While the saving rate for the elderly does not typically enter the

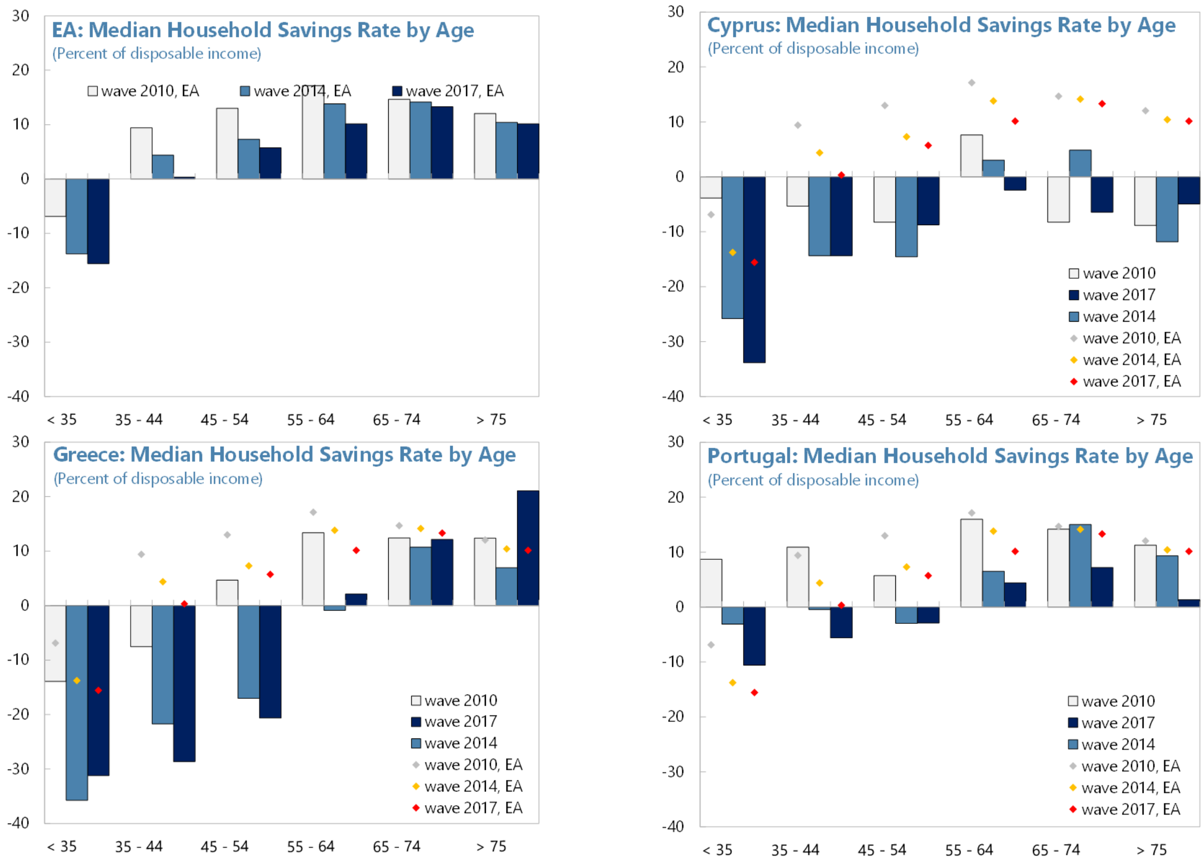
Figure 3.4: Purpose of Saving



Source: European Central Bank, HFCS database; and IMF staff calculations.

negative territory, as suggested by the basic life-cycle theory, this is in line with theoretical underpinnings of richer models and evidence from Bosworth and others (1991) and Poterba and others (1994). Of note, the general pattern is that the saving rate for the elderly declined across waves, although Greece was an exception in this respect for wave 3, reflecting perhaps the particularly uncertain period for this country following the SDC and the large income gap by age associated with relatively high social protection benefits and high youth unemployment. There is also evidence for a positive relationship between income and savings, which might in part reflect consumption smoothing behavior after transitory variations in income (Rodriguez-Palenzuela and others, 2016). More specifically, savings are negative for the first and second income quintiles and the highest for the top quintile, confirming the findings of Browning and Lusardi (1996). Education approximating permanent and future income is also positively correlated to savings, with particularly strong evidence for those with tertiary education, although declining across waves for both SE3 countries and EA average. For Greece, the income gap by education is shrinking likely due to rising unemployment for high education population and low demand for skilled labor.

Figure 3.5: Household Saving Rate by Age



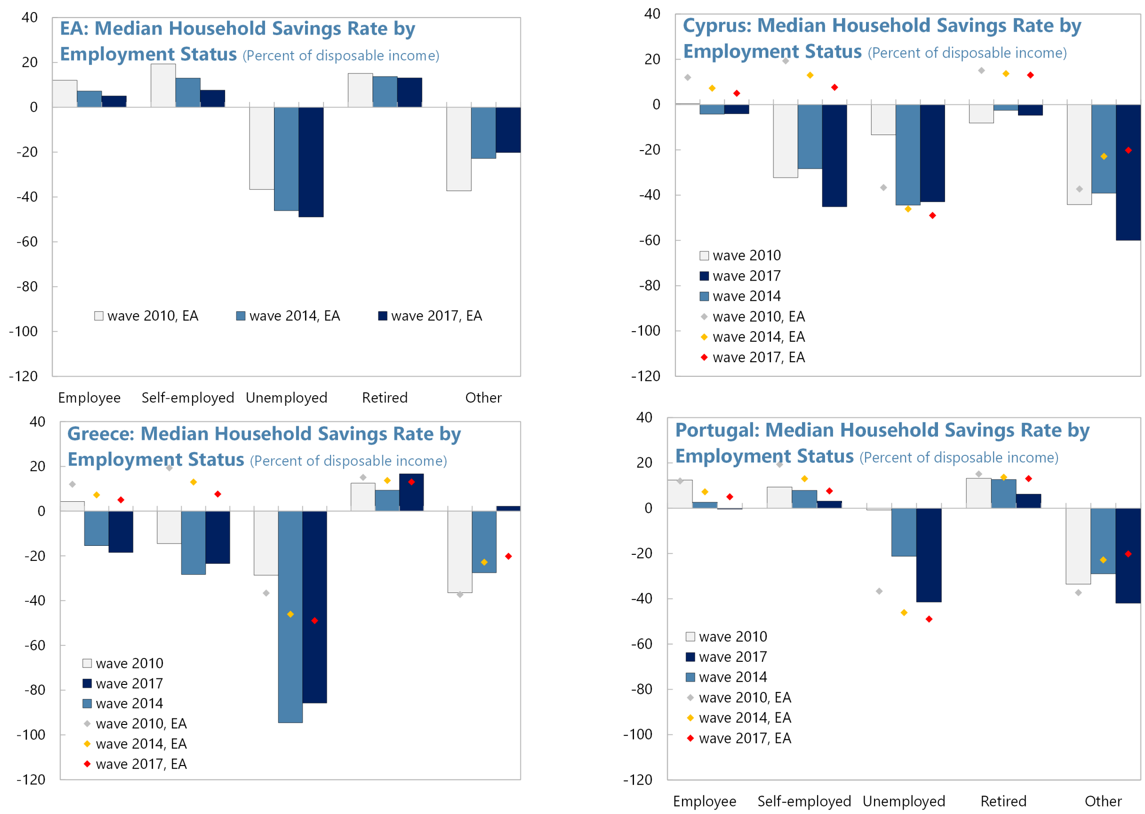
Source: European Central Bank, HFCS database; and IMF staff calculations.

Evidence for precautionary motive is marred by multiple effects, possibly acting in opposite directions (Figure 3.7 and 3.8). Building on the theoretical contributions of Carroll (1992, 2001), unemployment and wealth are suggested to be shaping household savings. Unemployment is considered to reflect uncertainty about the future, particularly in terms of labor income, therefore higher unemployment rate would suggest higher household savings. But higher unemployment has also a direct negative effect on savings originating from lower income of those unemployed, as suggested by Callen and Thiman (1997) and Juster and Wachtel (1972). The evidence from household-level data suggests that households whose heads are unemployed have predominantly a much lower savings rate compared to those in different labor statuses, which is also to a certain extent captured by the negative relationship between household savings and unemployment rate at the macroeconomic level. Furthermore, in presence of shocks, a reduction in wealth requires a higher saving rate as households accumulate savings to regain the optimal level of precautionary wealth, suggest-

Figure 3.6: Household Saving Rate by Income and Education

ing a negative correlation between household savings and wealth. There can however be an offsetting factor at play associated with the fact that wealth can be considered as a proxy for permanent income, which would imply a positive correlation with savings (Rodriguez-Palenzuela and others, 2016). The evidence from household-level data suggests that the positive effect dominates the negative effect, as evidenced in terms of stylized facts by Finley and Price (2015) for Australia.

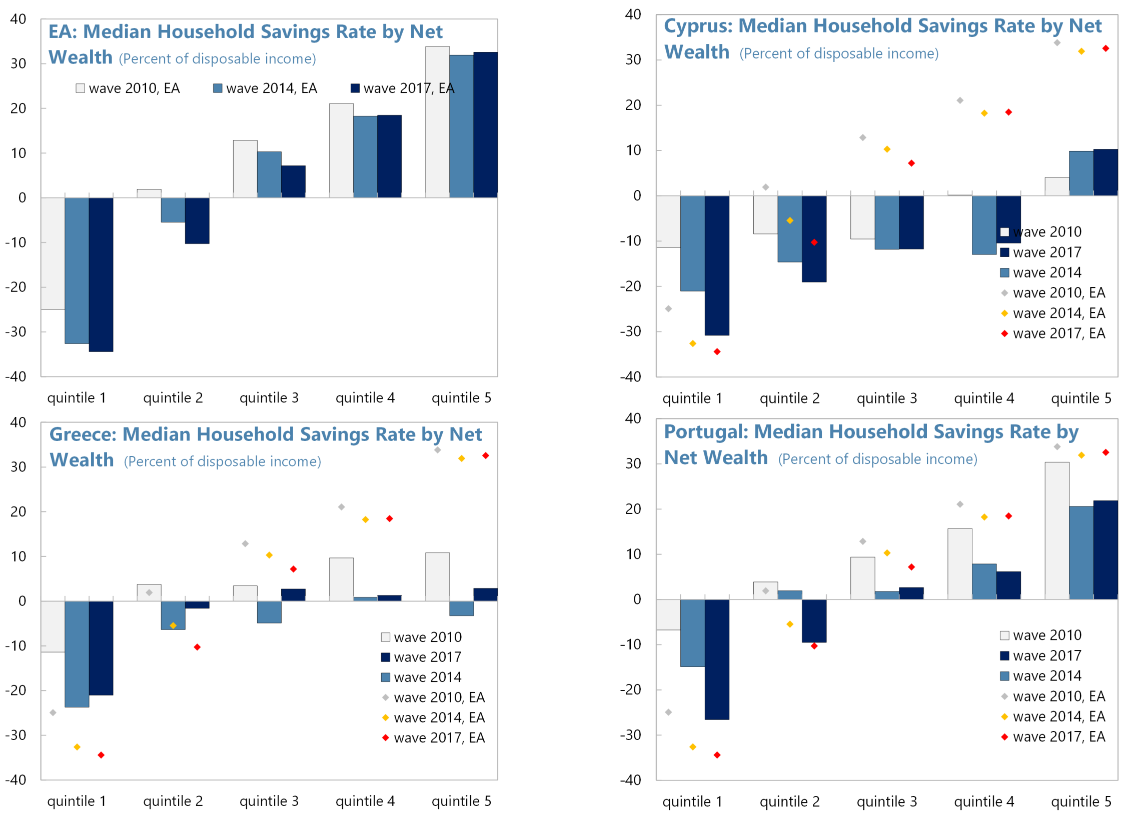
Figure 3.7: Household Saving Rate by Employment Status



Source: European Central Bank, HFCS database; and IMF staff calculations.

Borrowing constraints seem to shape savings (Figure 3.9). With a relaxation of borrowing constraints and ensuing increase in household debt prior to the GFC, there was subsequently a need for balance sheet repair, which led to tighter regulatory requirements and deleveraging (Cuerpo and others, 2013). Evidence suggests that households subject to tighter credit conditions have more limited access to credit and tend to accumulate more savings, especially for those countries deleveraging significantly (Bouis, 2021). As shown by household-level data, this was the case for SE3 countries where household debt declined significantly following the GFC and SDC, suggesting that households with lower debt in those countries tend to

Figure 3.8: Household Saving Rate by Net Wealth

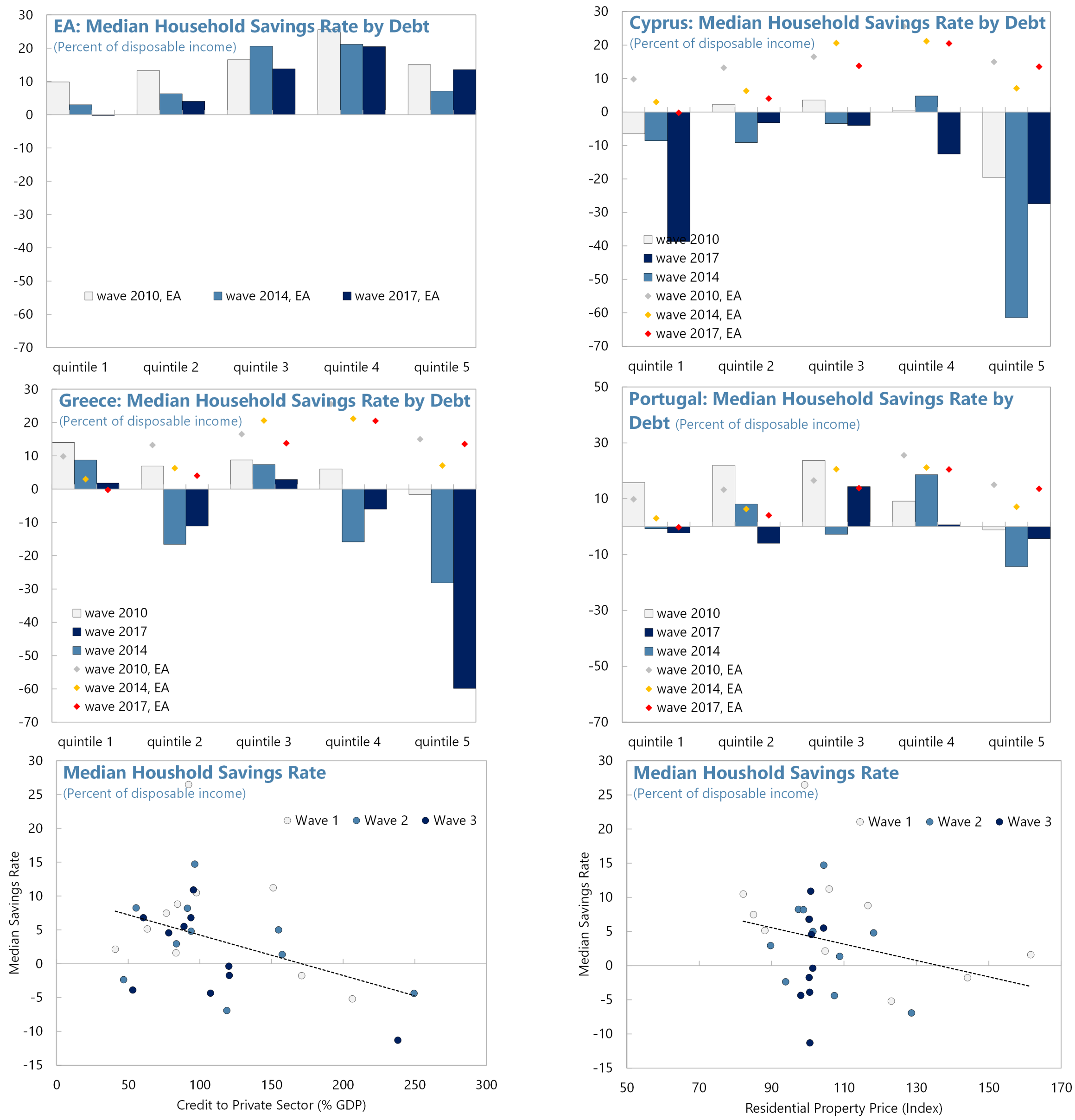


Source: European Central Bank, HFCS database; and IMF staff calculations.

have higher savings. This correlation appears to be less clear for the EA average, which may stem from a much more subdued deleveraging. There is also support for the role of borrowing constraints based on macroeconomic data. Specifically, tightening of credit conditions proxied by credit to income is accompanied by increasing savings, while house price declines working through the wealth effect are associated with higher savings (Mody and others, 2012).

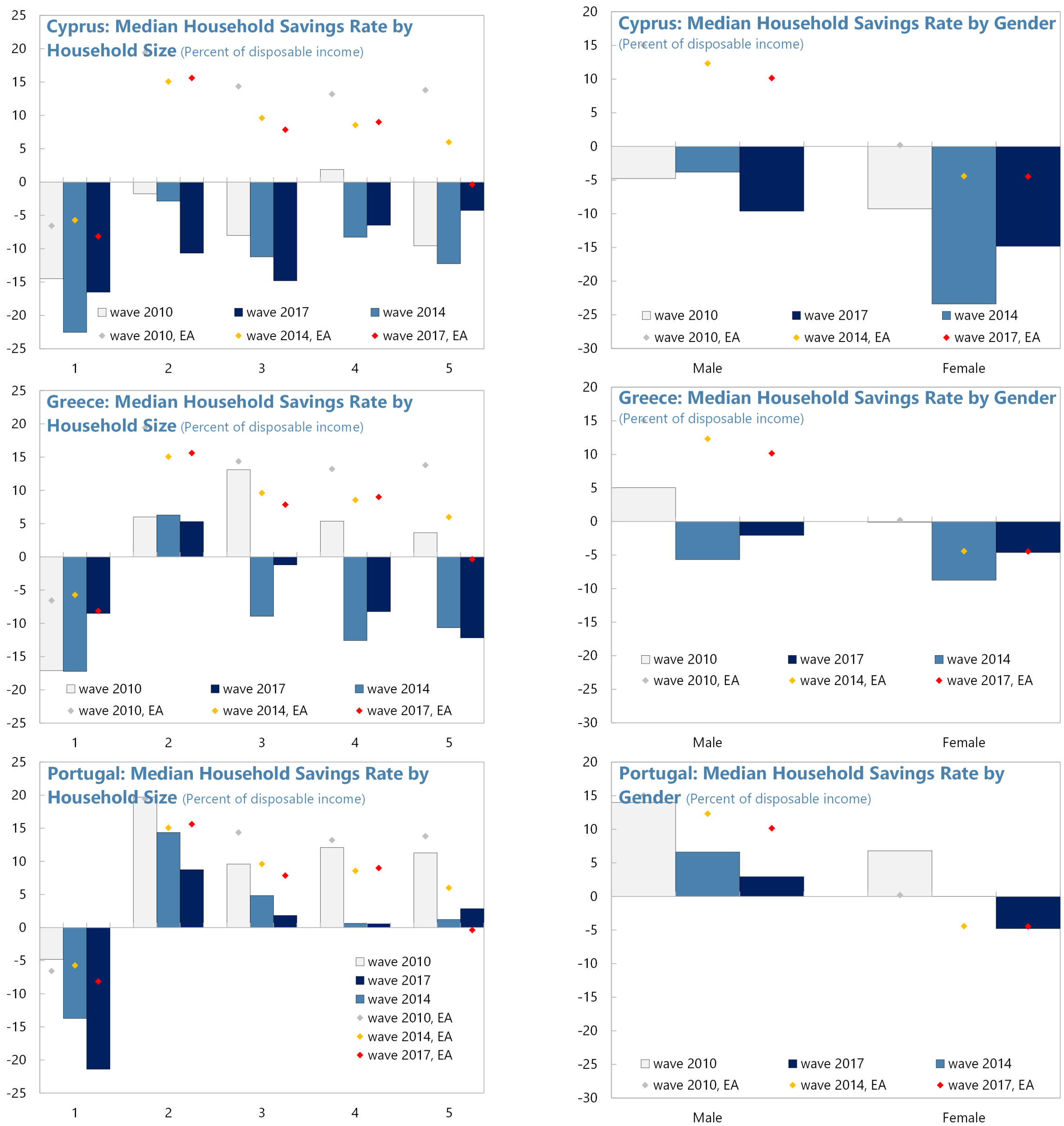
There is also support for correlation of other household characteristics to savings (Figure 3.10). There is evidence based on household-level data confirming that household characteristics identified in the literature correlate with savings, although there is some heterogeneity in the sample. Family size appears to be negatively associated with savings. The average EA and Portuguese households with dependents appear to generate positive savings, while the Cypriot and Greek households with dependents generally dissave, especially for wave 2 and 3. Female-headed households tend to have lower savings compared to male-headed households, although the difference is much smaller for Cyprus and Greece.

Figure 3.9: Household Saving Rate and Borrowing Constraints



Source: European Central Bank, HFCS database; and IMF staff calculations.

Figure 3.10: Household Saving Rate by Household Characteristics



Source: European Central Bank, HFCS database; and IMF staff calculations.

Econometric Analysis

Methodology

We conduct a multivariate regression analysis to consider variables simultaneously. Building on the literature identifying drivers of household savings and our findings from the descriptive statistics section, we estimate the following equation:

$$SR_{i,j} = \alpha_0 + \sum_{k=1}^{F} \alpha_{1,k} HSV_{k,ij} + \sum_{k=1}^{Z} \alpha_{2,k} MACFV_{k,j} + \sum_{k=1}^{N} \alpha_{3,k} OTHV_{k,ij} + \varepsilon_{i,t} \tag{3.1}$$

where SR denotes the saving rate in household i in country j, which is explained by household characteristics variables (HSV) that comprise income, age, size, gender, income uncertainty, wealth, debt, and housing; macroeconomic and financial variables ($MACFV$) that include inflation, interest rate, government budget balance, private debt, and government pension; and other variables ($OTHV$) that are considered in the robustness checks.

Regression results

The first set of specifications encompassing basic household-level variables sheds light on household saving drivers. Consistent with the evidence from descriptive statistics, median regressions suggest that savings are positively associated with income and age, and negatively correlated with household debt service. Quintile regressions reveal that the associations between income and debt are particularly strong for the lowest quintile of savers. In addition, median regressions also confirm the relevance of household size and gender for household savings, with the latter suggesting that households headed by males save more compared to households headed by females, as suggested by previous studies and descriptive statistics. The impact of household size across the distribution of savings is much more pronounced for lower quintiles compared to higher quintiles.

There is some support for the prevalence of precautionary motive. In line with evidence from descriptive statistics, median regressions indicate that uncertainty captured by unemployment does not on average appear to confirm the predictions of the buffer-stock model. This result is consistent with the findings obtained by Kolerus and others (2012) using household-level data for Germany, Finley and Price (2015) for Australia, and Rodriguez-Palenzuela and others (2016) for EA countries. But the results based on quantile regressions shed more light, suggesting that uncertainty is positively correlated to savings for more than [50] percent of the distribution of savings and implying that the precautionary motive seems to be at work for a sizeable portion of households. This may reflect the dominance of the positive effect stemming from the precautionary motive over the negative effect on savings originating from lower income, which broadly confirms the relevance of unexpected events as a motive for savings declared by households in the survey. Consistent with the buffer-stock model, there is also support for the adverse impact of wealth on consumption and savings, likely reflecting that a reduction in wealth requires a higher saving rate as households accumulate savings to regain the optimal level of precautionary wealth. There is much higher sensitivity to wealth for households with lower savings.

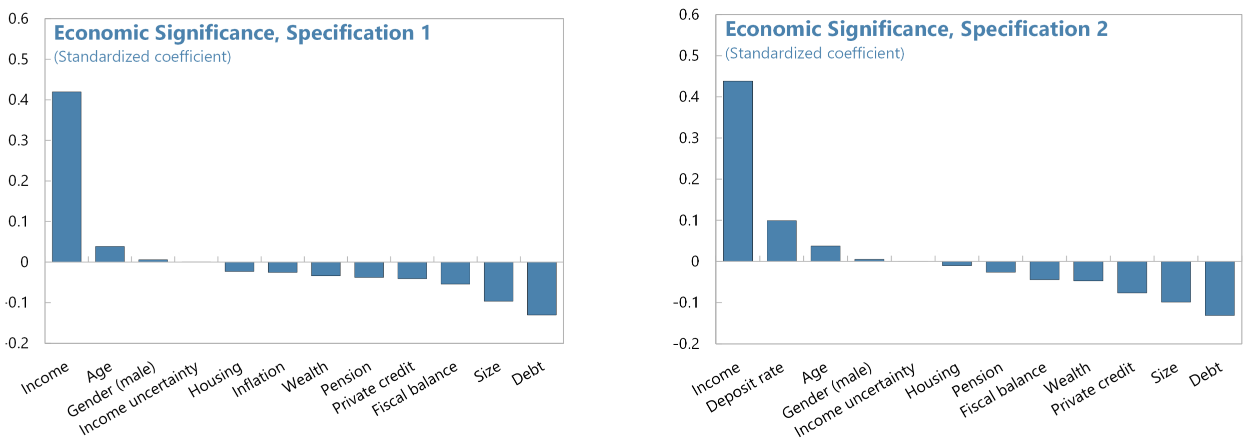
Borrowing constraints and financial variables are estimated to impact household saving as well. Controlling for the household characteristics, we use private credit to GDP as a proxy to capture credit conditions as in Mody and others (2012). Our results suggest there is a negative association between credit conditions and savings, especially for those households with higher savings. This indicates that an increase in households' credit implies that households can borrow resources to offset the negative income shock and may reduce precautionary savings. Real interest rate on deposits tends to increase with household savings, pointing to the likely dominance of the substitution and wealth effects over the income effect. The result is consistent with the evidence from Mody and others (2012), Grigoli and others (2014, 2018), and Checherita-Westphal and Stechert (2021), obtained from macroeconomic cross-country data. The impact of the interest rate is estimated to be much stronger for those households with higher savings and negative for households in the lowest quintile.

Fiscal policy and macroeconomic environment are found to have some impact too. Controlling for the household characteristics, there is support for the relevance of fiscal policy in shaping household savings. Higher government deficits are found to be associated with higher household savings, confirming the relevance of the Ricardian equivalence, consistent with evidence from Callen and Thiman (1997) and Checherita-Westphal and Stechert (2021). The impact of government budget balance is estimated to be much weaker for households with lower savings, becoming even positive for households with a very low level of savings. Higher spending on government-provided pension schemes tends to be negatively correlated with household savings, suggesting that households consider their retirement benefits as a substitute for their working-age savings and reduce their pre-retirement savings. While the impact of inflation can be subject to forces acting in opposite directions, as suggested by Juster and Wachtel (1972) and Grigoli and others (2014, 2018), there is evidence showing a negative association between inflation and savings. This likely reflects the dominance of the intertemporal consumption argument suggesting that inflation may encourage expenditures on durables at the expense of savings, which appears to be stronger that the macroeconomic instability aspect that suggests a positive impact. The finding is in line with the results from Checherita-Westphal and Stechert, (2021).

The analysis of economic significance of factors underpinning household savings sheds light on the relative importance of individual drivers. Employing standardized coefficients allows to compare the relative importance of explanatory variables on household savings, so that a change of one standard deviation in the explanatory variable results in a certain standard deviation change in the dependent variable. The results suggest that in addition to the important role of income, other drivers shape savings decisions in a meaningful way too. The combined effect of borrowing constraints and financial variables is estimated to be significant. Specifically, an increase in household debt service ratio and private credit by one standard deviation is estimated to decrease household saving ratio by around 0.1 standard deviation, respectively. Similarly, an increase in deposit rate by one standard deviation is associated with an increase in household saving ratio by around 0.1 standard deviation.

Furthermore, the results also suggest that family size and age play some role as well, with the former estimated to have a comparable impact as debt and deposit rate. The combined impact of fiscal variables is estimated to be smaller, while the other variables are estimated to play even a less important role.

Figure 3.11: Economic Significance



Source: European Central Bank, HFCS database; and IMF staff calculations.

While the drivers of savings for SE countries are broadly similar to the EA average, their respective magnitudes differ. The inclusion of interactive variables for SE countries shows that the drivers of savings for these countries are relatively similar, although the quantitative impact differs in particular for income, deposit rate, inflation, and government balance (coefficients are relatively smaller in SE3 relative to the EA). Building on these findings, regressions are run using data for SE countries, with results broadly in line with the ones based on the whole sample. The magnitude of the impact for these variables is also different for SE countries. Given the marginal propensity to consume declines with higher income, increasing income will increase saving rates. However, due to the lower income level of SE3 countries, households in SE need to allocate a higher share of income on consumption on necessities. With higher income, the share of consumption on necessities and therefore the share of overall consumption for households in SE declines more rapidly than other EA countries. The results also suggest that inflation has a smaller impact on savings in SE countries, which may reflect the fact that inflation in those countries was below the EA average. The impact of the interest rate is also estimated to be smaller in SE countries, likely reflecting a stronger income effect and the lower level of financial market development in SE countries. The impact of the government balance is estimated to be smaller too, reflecting generally higher fiscal multipliers (Kilponen and others, 2016) and informality in SE countries (Schneider, 2021).

We ran a set of robustness checks, which aim at examining the sensitivity of the estimations to different aspects (Annex III presents tables with results). Specifically:

Permanent income. Drawing on Finley and Price (2015), a proxy for permanent income is estimated using household characteristics such as education, unemployment, age, gender, and martial status. The results show an important role played by education, which is in line with the descriptive analysis and the findings of Attanasio and Weber (2010). The results based on the specification accounting for the permanent income proxy and education do not qualitatively differ from the baseline specifications.

Endogeneity. Given likely endogeneity issues between households and individual regressors, especially income, we apply an instrumental variable technique for the quantile regression developed by Chernozukov and Hansen (2005) and Kaplan and Sun (2017). The results do not qualitatively differ compared to the baseline regressions.

Uncertainty. In addition to the income uncertainty defined at a household-level, regressions are estimated taking into account a measure of uncertainty defined at a macroeconomic-level, which follows the approach taken by Kolerus and others (2012). The results do not qualitatively differ from the baseline median regressions, showing nevertheless a much stronger positive association between uncertainty and household savings.

Housing. Similarly, in addition to reflecting housing wealth at a household-level, the regressions are estimated using a measure representing developments in housing prices on a macroeconomic level. The results do not qualitatively differ from the baseline regressions.

Outliers. Sensitivity to outliers is formally investigated. Following Blanchard and Leigh (2013), we re-estimate the baseline specification using robust regression, which down-weighs observations with larger absolute residuals using iterative weighted least squares (Andersen, 2008). Employing this methodology results in a broadly similar outcome to the baseline regressions, although there seems to be a stronger effect associated with uncertainty for which the coefficient becomes positive and statistically significant, confirming some relevance of the precautionary motive.

Alternative estimator. Since the dependent variable can be considered a limited dependent variable due to its natural upper bound of unity, we apply Tobit regressions as Lugauer and others (2019) in their study of household savings based on household-level data. Employing this methodology results in a broadly similar outcome to the baseline regressions. But when savings are censored, there is strong support for the role of uncertainty for which the coefficient becomes positive and statistically significant, confirming the relevance of the precautionary motive.

HFCS waves. Estimating the baseline regression for individual waves does not reveal major differences among the results except for the results for Wave 1 with unemployment and housing switching signs compared to the baseline regressions. This is likely because wave 1 includes a very volatile period of GFC.

3.2 Quantitative Analysis

Policy simulations presented in this section help assess the impact of changing macroeconomic conditions and policies on household savings. The regression analysis presented in the previous section suggests that income, inflation, interest rate, and government budget balance are important drivers of household savings. Using these variables, we construct simple model-based simulations to examine the sensitivity of household savings to those macroeconomic shocks. In addition, these variables can to certain extent be considered as ones over which policymakers should be able to exercise some influence and thus implement policies.

The quantile regression-based simulations assume the baseline specifications (6 and 8 in Table 3.1) conducted on the full sample of EA countries, as well as separately on a subsample of SE economies (3 and 4 in Table 3.2), with the model parameters being re-estimated for each of the 99 quantiles. This approach allows us to assess how households' saving behavior in SE countries differs from the average of the EA across the household saving distribution. The exercise is based on the partial equilibrium framework and does not account for general equilibrium effects. Finally, as the exercise is based on cross-sectional regressions, the results can be considered as estimates of long-term relationships, capturing comparative static effects.

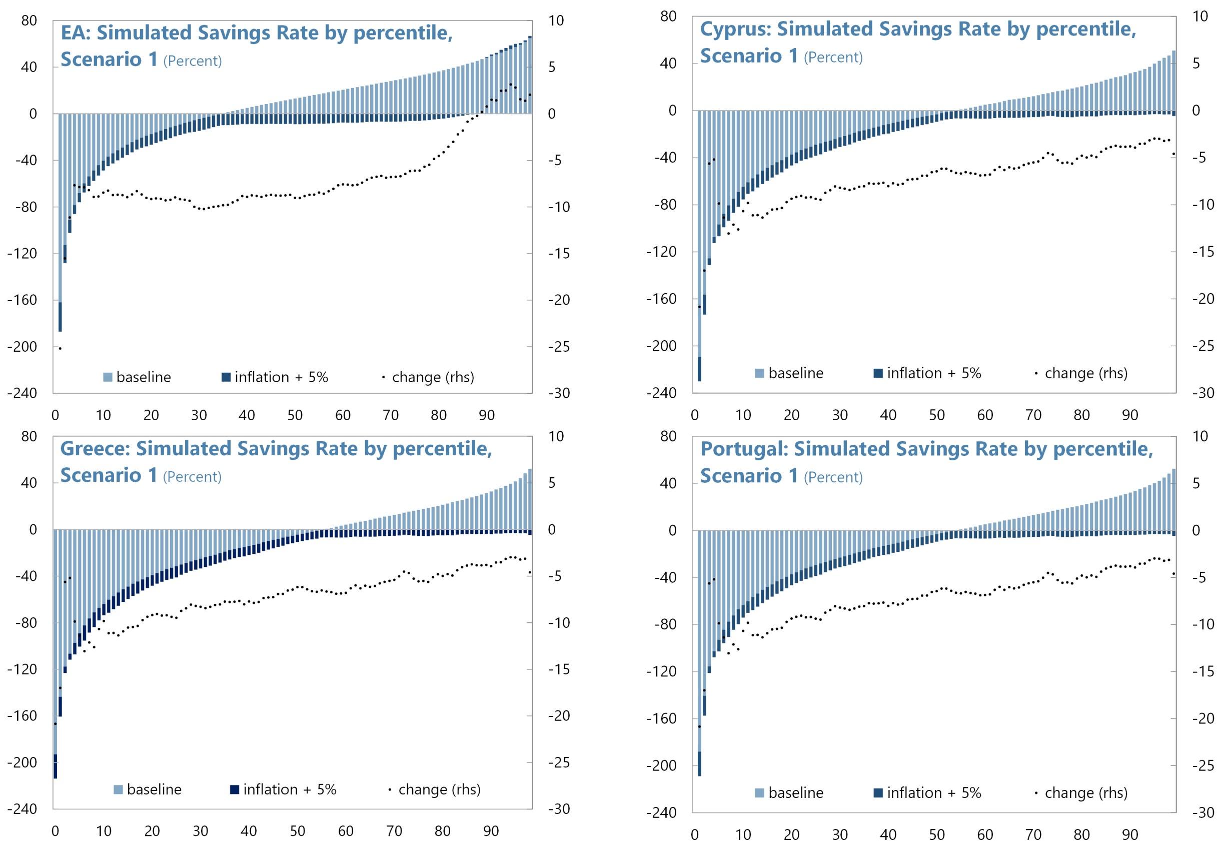
We consider five macroeconomic policy scenarios. The first scenario assumes a 5-ppt increase in the inflation rate. The second scenario simulates the impact of a 200-bps increase in the real interest rate. The third scenario explores the impact of better overall government balance by 2 percentage points of GDP. The fourth scenario simulates the impact of a stylized income support to households. Under this scenario, it is assumed that each household receives a lump-sum income transfer equivalent to 3 percent of an average income in the country. Finally, the fifth scenario assumes that the same total amount of transfers—as assumed under scenario four—is distributed only towards low-income households. The magnitudes of the shocks under each scenario are mainly illustrative, not meant to reflect specific country developments.

Inflation Shock

Higher inflation has a significantly adverse effect on the household saving rate. On average, a 5-ppt increase in inflation reduces aggregate household saving rate by 3.5 ppts for the EA, with the least-saving households being affected disproportionally more by the inflation shock. The impact of the higher inflation on household savings eases as households move up in the distribution and the impact eventually turns positive for households near the highest saving quintile. In particular, the household saving rate of the top decile household increases, on average, by about 2 pps in response to the inflation shock, suggesting that the highest-saving households may perceive high inflation as a signal of macroeconomic instability, raising their precautionary motive of saving.

Among SE countries, household saving rate in Greece seems to be impacted the least by the inflation shock (by about 1.8 pps) while Cyprus household saving rate is estimated to drop by 4.3 pps. In general, the responses of SE households are comparable to those of the EA households, e.g. mostly negative response across the distribution, but on average, the size of estimated adjustment tends to be smaller. Similarly, the least-saving households in SE are hit particularly hard and the higher-saving households are impacted much less. Nonetheless, the positive impact of higher inflation on saving rates of top saving households is not present in case of SE households.

Figure 3.12: Simulation Results, Inflation Shock

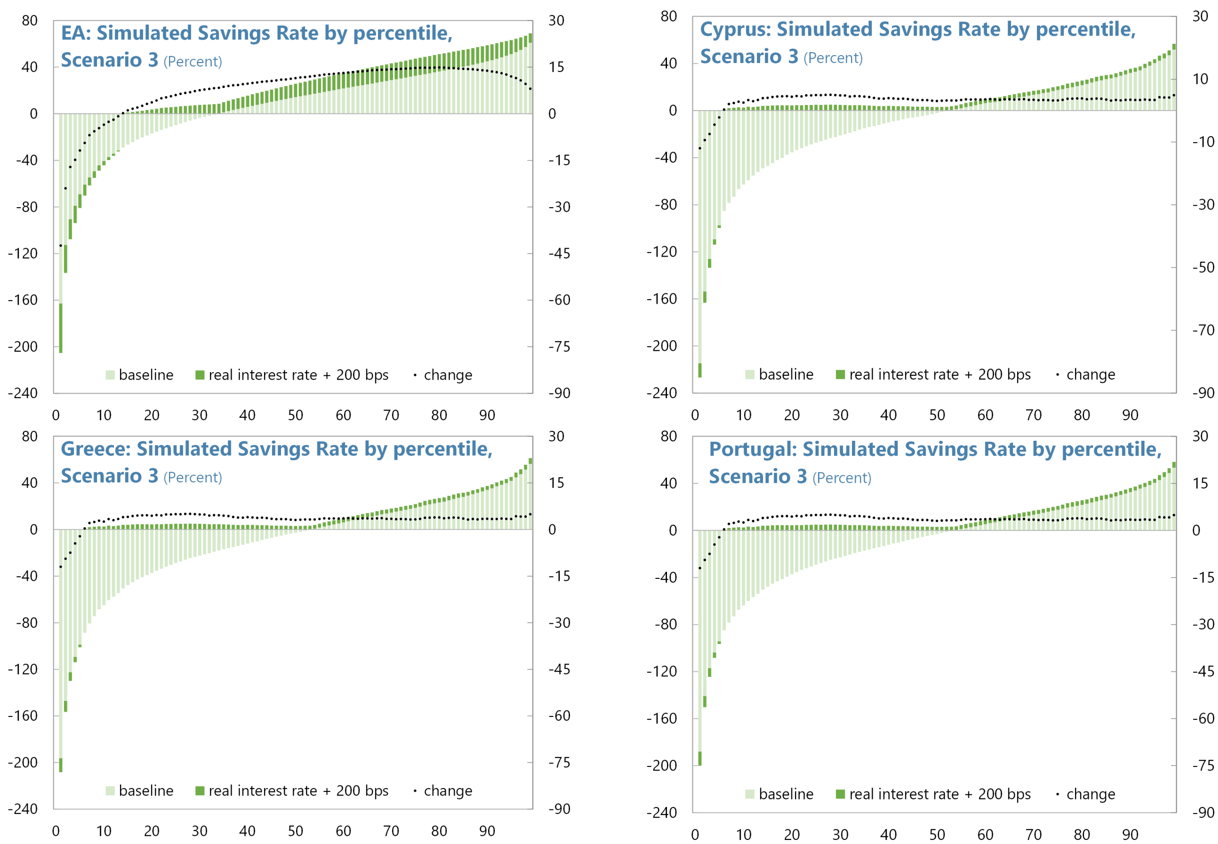


Source: European Central Bank, HFCS database; and IMF staff calculations.

Interest Rate Shock

An interest rate shock has a markedly positive effect on the household saving rate. The effect of higher interest rate by 200 bps is found to raise the household saving rate by 4.6 ppts for EA, and by around 1-2 ppts for Cyprus, Greece and Portugal. However, the increase is highly uneven across the distribution. As expected, the saving rate of the high-saving households tends to increase the most, while the households with lowest savings take sizeable loss in their savings, reflecting the more dominant income effect over the substitution and wealth effect. These results suggest, that without additional income support to low-saving households, monetary tightening risks leaving the lowest-saving households significantly worse off, despite the overall impact being positive. Similar to the inflation shock, the responses of SE households, when compared to the EA sample, tend to be smaller in size across the distribution. In addition, the distributional impact also exhibits less linearity, as the simulated increase in household saving rate peaks at around 5 ppts for households near the 30th percentile before gradually easing and stabilizing at around 3-4 ppts.

Figure 3.13: Simulation Results, Interest Rate Shock

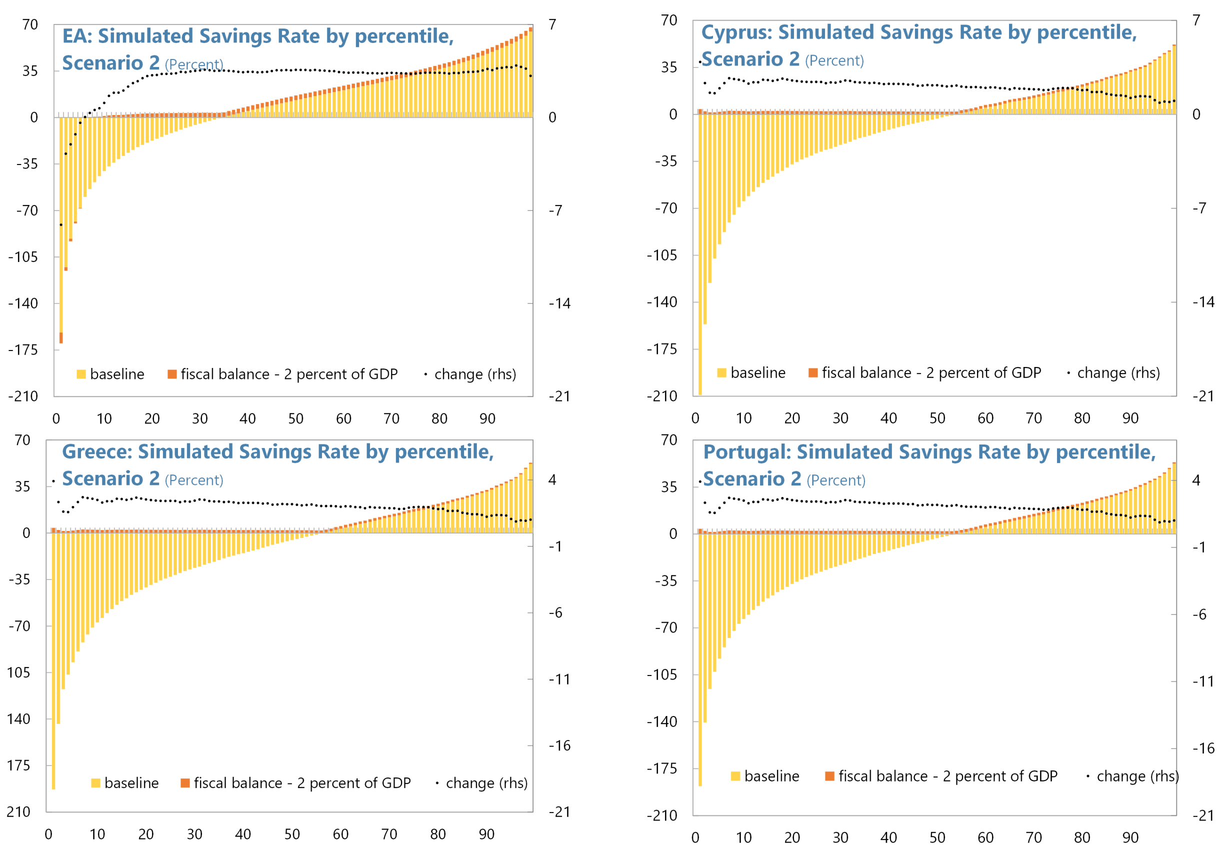


Source: European Central Bank, HFCS database; and IMF staff calculations.

Government Budget Balance Shock

Fiscal balance has a modestly negative effect on the household saving rate. A reduction in fiscal balance by 2 percent of GDP raises household savings by more than 1 ppts for EA, and almost 1 ppts for Cyprus, Greece, and Portugal. The resulting changes to the household saving rate are significantly smaller compared to the previous two shocks. Savings for the bottom 10 percent of households decreased by around 1 ppt on average. In contrast, such an adverse impact is not observed in case of the lowest-saving households in SE economies. Instead, the lower-saving households in SE countries generally see higher increase in their savings. For example, the average savings rate increases by around 2.5 ppts for households in the lowest-saving decile, but only by around 1 ppt for the household in the highest-saving decile. The results suggest that expansionary fiscal policies could be effective in supporting savings of the low-saving households in SE economies. However, given the existing large external imbalances and high public debt level, policymakers would have to ensure sufficient targeting of the policy mix.

Figure 3.14: Simulation Results, Fiscal Balance Shock

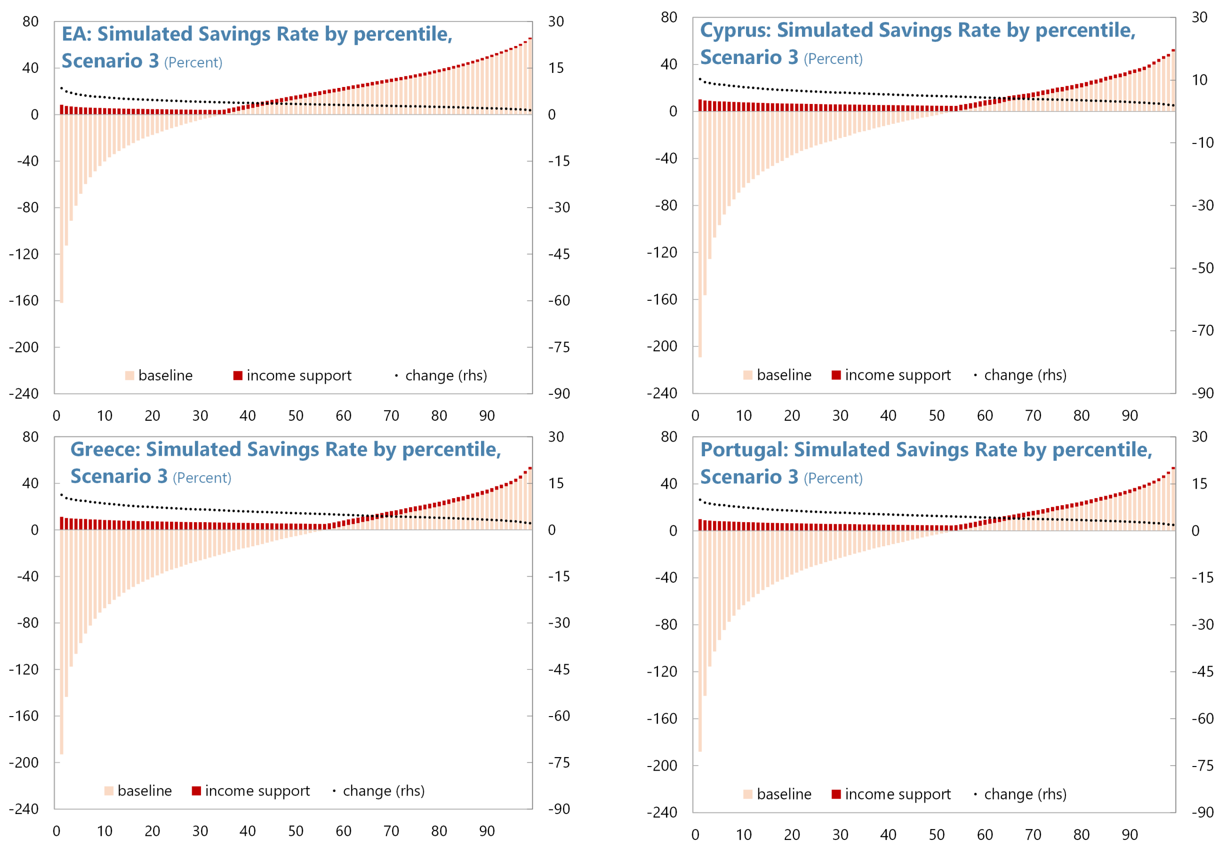


Source: European Central Bank, HFCS database; and IMF staff calculations.

Income Shock

Increasing households' disposable income has a noticeable effect on their saving rates, with the impact being stronger in case of low-saving households. For EA, we estimate that a lump sum transfer of 3 percent of the average income improves the median household saving rate by about 1 percentage point.[2] While the impact of a lump sum transfer seems negligible (0.2 percentage point increase) on high-saving households, it is estimated to be much stronger in case of low-saving households (4.2 percentage points increase). The estimates for the EA are broadly aligned with the results for Cyprus, Greece, and Portugal.

Figure 3.15: Simulation Results, income shock (broad-based)



Source: European Central Bank, HFCS database; and IMF staff calculations.

In a modified scenario,[3] we estimate the impact of a targeted income support on household saving rates. As the impact of an additional unit of income on savings tends to be more

[2]Under this scenario—e.g., broad-based income support—each household receives a lump sum income transfer equivalent to 3 percent of the average income in each country regardless of its income.

[3]Under the targeted income support scenario, the same amount of resources, as under the broad-based income support scenario, however, is distributed only among households with income below the 25th income

pronounced in case of low-saving households, the effect of the targeted income support on household savings is expected to be stronger relative to the broad-based income support in the previous scenario. For the AE—under the targeted support scenario—we estimate that the saving rate of a median household improves by 1.3 percentage points (0.3 percentage point above the broad-based income support case). While the effect of income targeting on the median-household saving rate in the EA does not seem large, it is estimated to be more pronounced in case of Portugal (1.3 percentage point, e.g., additional 0.4 percentage point above the broad-based scenario) and particularly in case of Cyprus and Greece (2 and 1.8 percentage points, respectively, e.g., additional 0.7and 0.6 percentage point above the broad-based scenario). The impact on low-income households is estimated to be even stronger, with household saving rates improving by 3, 4.4, and 4 percentage points in case of Portugal, Cyprus and Greece (an additional 0.4, 1.2, and 1 percentage point increase in household savings on top of the effect of the broad-based income support).

3.3 Discussion and Policy Implications

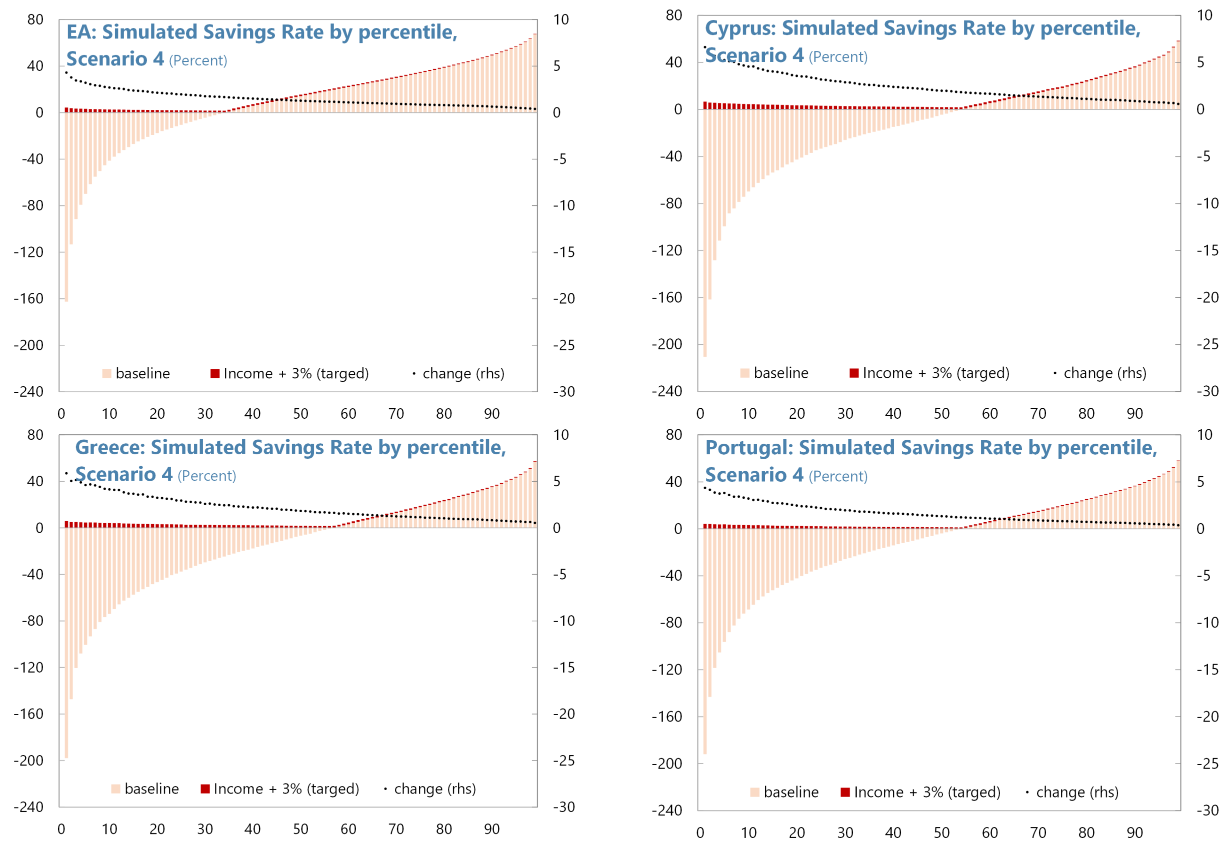
Both macro-level indicators and household survey data indicate that the saving rates in the EA countries display some decline after the GFC and prior to the pandemic, with SE3 countries recording the lowest saving rates among EA countries. The survey data suggests that while the saving rate in the EA countries is overall characterized by a negatively skewed distribution, SE3 countries exhibit an even longer tail of negative savingratios.

Descriptive analysis of the household-level survey data suggests that the household saving behavior varies depending on household characteristics and reveals that: i) there is a positive relationship between income and savings, and the saving gaps between SE3 and other EA countries tend to be wider for higher income households, ii) education is also positively correlated to savings, with highest saving rates for those with tertiary education, iii) employment status has positive influence on savings. It should also be noted that the saving gaps between SE3 and other EA countries are larger for employed households, and iv) the family size appears to be negatively associated with savings, and female-headed households tend to have lower savings. Our analysis also indicates that the deleveraging in the SE3 countries after the GFC was accompanied by higher household saving, reflecting the positive impact of borrowing constraints on savings, and this correlation appears to be stronger in SE3 countries than the EA average.

While the econometric analysis generally supports the results from the descriptive analysis and is consistent with previous studies, it provides additional insights on the distributional impact. Standard cross-sectional regressions suggest that income, age, and education are positively associated with savings, whereas household debt service and wealth are negatively correlated to savings. Real interest rate on deposits tends to increase with household savings. Higher government deficits are found to be associated with higher household savings while higher government-provided pension benefits tend to be negatively correlated to

percentile.

Figure 3.16: Simulation Results, income shock (targeted)



Source: European Central Bank, HFCS database; and IMF staff calculations.

household savings. Quintile regressions reveal that households at lower saving quantiles are more vulnerable to macroeconomic shocks. The associations are particularly strong for income and debt for lower savers, and uncertainty is positively correlated to savings for more than half of households. There is evidence for somewhat different magnitudes of the impact of income, deposit rate, inflation, and government balance on savings in SE3countries.

The simulated impactof the macroeconomic and policyshocks indicates that there are significant differences in sensitivity of household savings to these shocks depending on the type of the household. Specifically, higher inflation hit lower-saving households particularly harder, while high-saving households gain more in their saving rates under higher interest rates. A reduction in fiscal balance tends to increase the savings rates more for lower-saving households than higher-savings ones. Simulation results also suggest that the impact of these shocks is generally smaller for SE countries than the EA average. Income support has a noticeable effect on households' saving rates, with the impact being stronger in case of low-saving households. In addition, the effect of the targeted income support on household savings is stronger relative to the broad-based income support.

The results of the analysis and policy simulations have important policy implications for SE3 countries. First of all, a holistic approach should be adopted to address low household savings. This is because policies to promote higher savings may entail trade-offs in terms of macroeconomic stability. For example, while higher fiscal deficits are found to be associated with higher household savings, seeking higher government deficits to increase household savings would not be a right policy choice, particularly given the high public debt level and current account deficit of SE3 countries. Also, although economic uncertainty is an important factor driving household savings, a rise in uncertainty would hamper employment and economic growth. Therefore, a proper policy mix and coordination is needed to increase low household savings in SE3 countries in a sustainable way. More specifically:

The fiscal policy in SE3 countries should aim to achieve a more growth-friendly composition of government spending. Income plays a central role for household savings, and the income gaps to a large extent explain the differences in saving rates between SE3 countries and higher income EA countries. Enhancing economic growth and income levels is key and a fundamental way to encourage household savings. Given the limited fiscal space of SE3 countries, it is important for the governments to contain the current spending and make room for much-needed public investment to address growth bottlenecks and enhance growth potential. Improving public investment management can enhance the efficiency and productivity of public investment.

Sound financial sector policies and continued deleveraging can help increase household savings. Financial sector policies are particularly relevant for SE3 countries given the legacy issue of high household leverage from the debt crisis. Tighter lending standards could contain excess consumption financed by borrowing and encourage households to save more. Measures to facilitate deleveraging can help build healthier household balance sheets, which is particularly important for low-income households with high leverage to accumulate savings. A more resilient and efficient banking sector can provide more attractive saving products to tap householdsavings.

Structural reforms in the education sector and labor market are also important, given the clear positive correlation between education levels, employment status, and household saving rates. Measures in the education sector could include improving educational performance, enhancing access to higher education, and modernizing curricula. Improving the quality of vocational training can help address skill mismatch and facilitate job seeking. Labor market policies to enhance female labor participation and address gender inequality can narrow the saving gaps between male and female led households.

Last but not least, well-designed and targeted social transfers can stimulate household savings more effectively. Our analysis shows that the correlation between savings rates and independent variables are generally stronger for households with lower saving rates. Similarly, the policy simulations also suggest that households with lower saving rates are generally more sensitive to changes in policy variables. This indicates that targeting income transfers—by income level or employment status, or family composition—could further raise household savings while limit the cost of themeasures.

Table 3.1: Baseline Regressions

	(1)		(2)		(3)		(4)		(5)		(6)	
	OLS	QR	OLS	QR	OLS	QR	OLS	QR	OLS	QR	OLS	QR
Income	0.699***	0.425***	0.741***	0.445***	0.657***	0.405***	0.697***	0.425***	0.681***	0.422***	0.698***	0.423***
	(0.003)	(0.002)	(0.004)	(0.002)	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)
Age	0.001***	0.002***	0.000**	0.002***	0.002***	0.002***	0.002***	0.002***	0.003***	0.002**	0.003**	0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Debt	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01**	-0.01***	-0.01***	-0.01***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Size	-0.08***	-0.05***	-0.09***	-0.05***	-0.08***	-0.05***	-0.08***	-0.05***	-0.08***	-0.05***	-0.08***	-0.05***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
	-0.00	0.02***	-0.00	0.01***	-0.00	0.01***	-0.00	0.01	-0.00	0.01***	-0.00	0.00
Gender (male)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)
Income					-0.11***	0.00	-0.11***	0.02**	-0.12***	0.00	-0.11***	0.02**
Uncertainty					(0.014)	(0.010)	(0.014)	(0.009)	(0.014)	(0.009)	(0.014)	(0.009)
Wealth					-0.07***	-0.02***	-0.09***	-0.03***	-0.08***	-0.02***	-0.09***	-0.03***
					(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.002)	(0.004)	(0.002)
Housing					-0.07***	-0.03***	-0.06***	-0.01***	-0.07***	-0.02***	-0.06***	-0.01***
					(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)
Inflation									-0.03***	-0.02***	-0.01***	-0.01***
									(0.002)	(0.002)	(0.004)	(0.003)
Deposit rate												
Private credit									-0.00***	-0.00***	-0.00***	-0.00***
									(0.000)	(0.000)	(0.000)	(0.000)
									-0.03***	-0.02***	-0.01***	-0.01***
Fiscal balance									(0.001)	(0.001)	(0.003)	(0.002)
Pension									-0.03***	-0.01***	-0.03***	-0.04***
									(0.001)	(0.001)	(0.004)	(0.003)
Constant	2.311***	1.391***	2.415***	1.465***	4.103***	1.963***	4.147***	1.940***	4.591***	2.188***	4.507***	2.345***
	(0.019)	(0.012)	(0.023)	(0.014)	(0.047)	(0.033)	(0.050)	(0.034)	(0.053)	(0.035)	(0.069)	(0.045)
Fixed effect	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes
Observation	68246	68246	68246	68246	56103	56103	56103	56103	56103	56103	56103	56103
adj. R-sq	0.419		0.435		0.426		0.440		0.432		0.441	

***1%, **5%, and *10% significance levels.

Table 3.2: Baseline Regressions for Southern-European Countries

	(1)	(2)	(3)	(4)
Income	0.366***	0.368***	0.532***	0.531***
	(0.00550)	(0.00552)	(0.00781)	(0.00763)
Income uncertainty	-0.00741	-0.00881	0.0196	0.0143
	(0.0118)	(0.0126)	(0.0157)	(0.0164)
Wealth	-0.00792***	0.000297	-0.0610***	-0.0614***
	(0.00301)	(0.00320)	(0.00428)	(0.00418)
Debt	-0.0136***	-0.0134***	-0.0135***	-0.0135***
	(0.0000543)	(0.0000535)	(0.000116)	(0.000116)
Housing	-0.00342	-0.00459	-0.0115**	-0.0136**
	(0.00376)	(0.00383)	(0.00574)	(0.00561)
Age	0.00243***	0.00266***	0.00267***	0.00249***
	(0.000177)	(0.000181)	(0.000248)	(0.000254)
Size	-0.0393***	-0.0427***	-0.0766***	-0.0752***
	(0.00155)	(0.00172)	(0.00249)	(0.00249)
Gender (male)	0.0169***	0.0186***	-0.00201	-0.00294
	(0.00385)	(0.00397)	(0.00548)	(0.00555)
Deposit rate	0.0745***		0.0153***	
	(0.00167)		(0.00266)	
Inflation		-0.0605***		-0.0129***
		(0.00300)		(0.00226)
Private credit	0.00152***	0.00761***	0.0000588	0.000241**
	(0.000297)	(0.000519)	(0.000113)	(0.000111)
Government budget balance	-0.0341***	-0.0787***	-0.00977***	-0.0109***
	(0.00236)	(0.00366)	(0.000944)	(0.000990)
Government pension	-0.0263***	-0.0908***	-0.000249	-0.000570
	(0.00229)	(0.00466)	(0.00149)	(0.00151)
SE	1.139***	1.050***		
	(0.0873)	(0.0852)		
Income*SE	0.166***	0.163***		
	(0.00946)	(0.00910)		
Income uncertainty*SE	0.0270	0.0231		
	(0.0198)	(0.0215)		
Wealth*SE	-0.0531***	-0.0617***		
	(0.00523)	(0.00510)		
Debt*SE	0.0000755	-0.000123		
	(0.000109)	(0.000108)		
Housing*SE	-0.00811	-0.00896		
	(0.00692)	(0.00658)		
Age*SE	0.000241	-0.000170		
	(0.000303)	(0.000311)		
Size*SE	-0.0372***	-0.0325***		
	(0.00299)	(0.00305)		
Gender male*SE	-0.0189***	-0.0215***		
	(0.00685)	(0.00680)		
Deposit rate*SE	-0.0592***			
	(0.00321)			
Inflation*SE		0.0476***		
		(0.00378)		
Private credit*SE	-0.00146***	-0.00737***		
	(0.000320)	(0.000532)		
Government budget balance*SE	0.0243***	0.0678***		
	(0.00255)	(0.00379)		
Government pension*SE	0.0261***	0.0903***		
	(0.00274)	(0.00489)		
Constant	1.528***	1.654***	2.668***	2.704***
	(0.0484)	(0.0484)	(0.0715)	(0.0715)
Observation	56103	56103	20981	20981
R-sq	0.415	0.424	0.487	0.488

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Appendix A

Proofs

Proof of Proposition 1

Proof. Combining the price equations (1.6), (1.7), and (1.8) to get:

$$\begin{aligned}
\mathrm{d}\ln P &= \sum_{i=1}^{N} s_i \mathrm{d}p_i + s_f \mathrm{d}p_f \\
&= \sum_{i=1}^{N} s_i \mathrm{d}p_i + s_f \mathrm{d}\tau_s \\
&= \sum_{i=1}^{N} s_i \left[\frac{1-s_i}{1+(\sigma-2)s_i} \mathrm{d}c_i + \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i} \mathrm{d}\ln P \right] + s_f \mathrm{d}\tau_s \\
&= \sum_{i=1}^{N} s_i \left[\frac{1-s_i}{1+(\sigma-2)s_i} \left(s_i^I \mathrm{d}\tau_i^{input} + \left(1-s_i^I\right) \mathrm{d}\ln w \right) + \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i} \mathrm{d}\ln P \right] + s_f \mathrm{d}\tau_s \\
\implies \mathrm{d}\ln P &= \sum_{i=1}^{N} \frac{s_i(1-s_i)}{1+(\sigma-2)s_i} \left[\left(1-s_i^I\right) \mathrm{d}\ln w + s_i^I \mathrm{d}\tau_i^{input} \right] + \sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i} \mathrm{d}\ln P + s_f \mathrm{d}\tau_s
\end{aligned} \tag{A.1}$$

Rearranging terms, we obtain:

$$\sum_{i=1}^{N} \frac{s_i(1-s_i)}{1+(\sigma-2)s_i} \left[\left(1-s_i^I\right) \mathrm{d}\ln w + s_i^I \mathrm{d}\tau_i^{input}\right] - \left[1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right] \mathrm{d}\ln P + s_f \mathrm{d}\tau_s = 0$$

$$\implies \sum_{i=1}^{N} \frac{s_i(1-s_i)}{1+(\sigma-2)s_i} \left(-s_i^I \mathrm{d}\ln w + s_i^I \mathrm{d}\tau_i^{input}\right) + \sum_{i=1}^{N} \frac{s_i(1-s_i)}{1+(\sigma-2)s_i} \mathrm{d}\ln w$$

$$- \left[1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right] \mathrm{d}\ln P + s_f \mathrm{d}\tau_s = 0$$

$$\implies \sum_{i=1}^{N} \frac{s_i(1-s_i)}{1+(\sigma-2)s_i} \left(-s_i^I \mathrm{d}\ln w + s_i^I \mathrm{d}\tau_i^{input}\right) + \sum_{i=1}^{N} \frac{s_i(1-s_i)}{1+(\sigma-2)s_i} \mathrm{d}\ln w$$

$$- \left[1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right] \mathrm{d}\ln P + s_f \mathrm{d}\tau_s$$

$$+ \left[1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right] \mathrm{d}\ln w - \left[1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right] \mathrm{d}\ln w = 0$$

$$\implies \sum_{i=1}^{N} \frac{s_i(1-s_i)}{1+(\sigma-2)s_i} \left(-s_i^I \mathrm{d}\ln w + s_i^I \mathrm{d}\tau_i^{input}\right) + \left[1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right] (\mathrm{d}\ln w - \mathrm{d}\ln P)$$

$$+ s_f \mathrm{d}\tau_s + \left[-\mathrm{d}\ln w + \sum_{i=1}^{N} \frac{(\sigma-2)s_i^2}{1+(\sigma-2)s_i} \mathrm{d}\ln w + \sum_{i=1}^{N} \frac{s_i}{1+(\sigma-2)s_i} \mathrm{d}\ln w\right] = 0$$

$$\implies \sum_{i=1}^{N}\left[\frac{(1-s_i)}{1+(\sigma-2)s_i}-\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]\right]\left[s_i\left(s_i^I \mathrm{d}\ln w - s_i^I \mathrm{d}\tau_i^{input}\right)\right]$$

$$+\sum_{i=1}^{N}\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]\left[s_i\left(s_i^I \mathrm{d}\ln w - s_i^I \mathrm{d}\tau_i^{input}\right)\right]$$

$$+\left[\mathrm{d}\ln w-\sum_{i=1}^{N}\frac{(\sigma-2)s_i^2}{1+(\sigma-2)s_i}\mathrm{d}\ln w-\sum_{i=1}^{N}\frac{s_i}{1+(\sigma-2)s_i}\mathrm{d}\ln w\right]=$$

$$\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right](\mathrm{d}\ln w-\mathrm{d}\ln P)+s_f\mathrm{d}\tau_s$$

$$\implies \sum_{i=1}^{N}\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]\left[s_i\left(s_i^I \mathrm{d}\ln w - s_i^I \mathrm{d}\tau_i^{input}\right)\right]$$

$$-\left[-\mathrm{d}\ln w+\sum_{i=1}^{N}\frac{(\sigma-2)s_i^2}{1+(\sigma-2)s_i}\mathrm{d}\ln w+\sum_{i=1}^{N}\frac{s_i}{1+(\sigma-2)s_i}\mathrm{d}\ln w\right]=$$

$$\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right](\mathrm{d}\ln w-\mathrm{d}\ln P)+s_f\mathrm{d}\tau_s$$

$$-\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)+\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)$$

$$-\sum_{i=1}^{N}\left[\frac{(1-s_i)}{1+(\sigma-2)s_i}-\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]\right]\left[s_i\left(s_i^I \mathrm{d}\ln w - s_i^I \mathrm{d}\tau_i^{input}\right)\right]$$

$$\implies \left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]\sum_{i=1}^{N}\left[s_i\left(s_i^I \mathrm{d}\ln w - s_i^I \mathrm{d}\tau_i^{input}\right)\right]$$

$$+\left[\left(1-\sum_{i=1}^{N}s_i\right)\mathrm{d}\ln w\right]-s_f\mathrm{d}\tau_s$$

$$+\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)-\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)$$

$$-\sum_{i=1}^{N}\left[\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]-\frac{(1-s_i)}{1+(\sigma-2)s_i}\right]\left[s_i\left(s_i^I \mathrm{d}\ln w - s_i^I \mathrm{d}\tau_i^{input}\right)\right]=$$

$$\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right](\mathrm{d}\ln w-\mathrm{d}\ln P)$$

$$\implies \left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]\sum_{i=1}^{N}\left[s_i\left(s_i^I\mathrm{d}\ln w - s_i^I\mathrm{d}\tau_i^{input}\right)\right]$$

$$+s_f\mathrm{d}\ln w - s_f\mathrm{d}\tau_s$$

$$+\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)-\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)$$

$$-\sum_{i=1}^{N}\left[\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]-\frac{(1-s_i)}{1+(\sigma-2)s_i}\right]\left[s_i\left(s_i^I\mathrm{d}\ln w - s_i^I\mathrm{d}\tau_i^{input}\right)\right]$$

$$=\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]\left(\mathrm{d}\ln w-\mathrm{d}\ln P\right)$$

$$\implies \mathrm{d}\ln w-\mathrm{d}\ln P = s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)+\sum_{i=1}^{N}\left[s_i\left(s_i^I\mathrm{d}\ln w - s_i^I\mathrm{d}\tau_i^{input}\right)\right]$$

$$+s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)\frac{\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$-\sum_{i=1}^{N}\frac{\left[\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]-\frac{(1-s_i)}{1+(\sigma-2)s_i}\right]}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}s_i s_i^I\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)$$

$$\implies \mathrm{d}\ln w-\mathrm{d}\ln P = s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)+\sum_{i=1}^{N}\left[s_i\left(s_i^I\mathrm{d}\ln w - s_i^I\mathrm{d}\tau_i^{input}\right)\right]$$

$$+s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)\frac{\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$-\frac{\sum_{i=1}^{N}\left[\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)\left(s_i^I-\sum_{i'=1}^{N}s_{i'}^I s_{i'}\left(\mathrm{d}\ln w-\mathrm{d}\tau_{i'}^{input}\right)\right)\right]}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$\implies \mathrm{d}\ln w-\mathrm{d}\ln P = s_f\left[\mathrm{d}\ln(w)-\mathrm{d}\tau_s\right]+\sum_{i=1}^{N}\left[s_i\left(s_i^I\mathrm{d}\ln w - s_i^I\mathrm{d}\tau_i^{input}\right)\right]$$

$$+s_f\left(\mathrm{d}\ln w-\mathrm{d}\tau_s\right)\frac{\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}-\frac{Cov\left(s_i^I,\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i};s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)\right)}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

where the second last equality holds because

$$\frac{\sum_{i=1}^{N}\left[\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]-\frac{(1-s_i)}{1+(\sigma-2)s_i}\right]s_i s_i^I\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$=\frac{\sum_{i=1}^{N}\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}-\frac{(1+(\sigma-2)s_i-(\sigma-1)s_i)}{1+(\sigma-2)s_i}\right]s_i s_i^I\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$=\frac{\sum_{i=1}^{N}\left[\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)-s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]s_i^I}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$=\frac{\sum_{i=1}^{N}\left[\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I-s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$=\frac{\sum_{i=1}^{N}\left[\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I\right]-\sum_{i=1}^{N}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$=\frac{\sum_{i=1}^{N}\left[\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I\right]-\sum_{i=1}^{N}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$=\frac{\sum_{i=1}^{N}\left[\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I\right]-\sum_{i=1}^{N}\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\sum_{i=1}^{N}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)s_i^I}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$\Longrightarrow\frac{\sum_{i=1}^{N}\left[\left[1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}\right]-\frac{(1-s_i)}{1+(\sigma-2)s_i}\right]s_i s_i^I}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}$$

$$=\frac{\sum_{i=1}^{N}\left[\frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}s_i\left(\mathrm{d}\ln w-\mathrm{d}\tau_i^{input}\right)\left(s_i^I-\sum_{i'=1}^{N}s_{i'}\left(\mathrm{d}\ln w-\mathrm{d}\tau_{i'}^{input}\right)s_{i'}^I\right)\right]}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}} \tag{A.2}$$

This allows us to solve for the following decomposition:

$$\text{dln}(w) - \text{dln}(P) =$$

$$\underbrace{s_f\left(\mathrm{d}\ln w - \mathrm{d}\tau_s\right) + \sum_{i=1}^{N} s_i s_i^I (\mathrm{d}\ln(w) - \mathrm{d}\tau_i^{input})}_{\text{Gains without competitive effects}}$$

$$+ \underbrace{s_f\left(\mathrm{d}\ln w - \mathrm{d}\tau_s\right)\frac{\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}}_{\text{Pro-competitive effects on the final goods' market}}$$

$$- \underbrace{\frac{Cov\left(s_i^I, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(\mathrm{d}\ln w - \mathrm{d}\tau_i^{input}\right)\right)}{1-\sum_{i=1}^{N}\frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}}_{\text{Anti-competitive effects of the input cost changes}}$$

where $\mathrm{d}\tau_{i,t}^{input} \equiv \sum_{s'}\theta_{i,s',t}\text{dlog}(1+\tau_{s',t})$. □

Generalization of Proposition 1

Proposition 2. *For any arbitrary invertible demand system and competition structure and under the assumption that i) the industry expenditure function is a sufficient statistic for competitor prices and ii) that the perceived demand elasticity is a function of the price of the firm relative to the industry expenditure function, the firm's markup change is the solution to the following fixed point equation:*

$$\mathrm{d}\mu_{it} = \frac{\Gamma_{it}(1-s_{it})}{1-s_{it}+\Gamma_{it}}\left(-\mathrm{d}mc_{it}+\mathrm{d}mc_{-it}\right) + \frac{\Gamma_{it}}{1-s_{it}+\Gamma_{it}}\underbrace{\left(\sum_{j=1}^{N} s_{jt}\mathrm{d}\mu_{jt}\right)}_{\text{average markup change}}, \tag{A.3}$$

where $dmc_{-it} \equiv \sum_{j\neq i}^{N}\frac{s_{jt}}{1-s_{it}}\mathrm{d}mc_{jt}$ *is the index of competitor marginal cost changes.*

Proof. Taking the price change decomposition equation from the Amiti, Itskhoki, and Konings (2019) setup (assumptions from proposition 2, i) and rewriting the price changes in terms of markup changes using $\text{dlog}(\mu_j) = \text{dlog}(p_j) - \text{dlog}(mc_j)$, we obtain

$$\text{dlog}(\mu_i) = -\frac{\Gamma_i}{1+\Gamma_i}\text{dlog}(mc_i) + \frac{\Gamma_{-i}}{1+\Gamma_i}\sum_{j\neq i}^{N}\frac{s_j}{1-s_i}\left(\text{dlog}(\mu_j)+\text{dlog}(mc_j)\right).$$

Let's collect all of the markup terms on the left-side to get

$$(1+\Gamma_i)(1-s_i)\text{dlog}(\mu_i) - \Gamma_{-i}\sum_{j\neq i}^{N} s_j \text{dlog}(\mu_j) = -\Gamma_i(1-s_i)\text{dlog}(mc_i) + \\ + \Gamma_{-i}\sum_{j\neq i}^{N} s_j \text{dlog}(mc_j).$$

This could be interpreted as an equation for firm markup change decomposition

$$\text{dlog}(\mu_i) = \frac{\Gamma_{-i}}{1-s_i+\Gamma_i}\left(\frac{\Gamma_i}{\Gamma_{-i}} s_i \text{dlog}(\mu_i) + \sum_{j\neq i}^{N} s_j \text{dlog}(\mu_j)\right) \\ - \frac{\Gamma_i}{1-s_i+\Gamma_i}(1-s_i)\text{dlog}(mc_i) + \frac{\Gamma_{-i}}{1-s_i+\Gamma_i}\sum_{j\neq i}^{N} s_j \text{dlog}(mc_j).$$

If $\Gamma_i = \Gamma_{-i}$ (assumptions from proposition 2, ii in Amiti, Itskhoki, and Konings (2019)), then the whole expression simplifies to

$$\text{dlog}(\mu_i) = \frac{\Gamma_i}{1-s_i+\Gamma_i} \underbrace{\left(\sum_{j=1}^{N} s_j \text{dlog}(\mu_j)\right)}_{\text{average (weighted) markup change}} \\ + \frac{\Gamma_i}{1-s_i+\Gamma_i}\left[-(1-s_i)\text{dlog}(mc_i) + \sum_{j\neq i}^{N} s_j \text{dlog}(mc_j)\right].$$

□

Corollary 2. If the marginal cost changes by the same percentage for all firms, i.e., $\text{d}mc_i = \text{d}mc_j \ \forall i, j$, we have

$$\text{d}\mu_i = 0 \ \forall i.$$

Proof. The proof immediately follows from Proposition 2. □

Proposition 3. *For any arbitrary invertible demand system and competition structure and under the assumption that i) the industry expenditure function is a sufficient statistic for competitor prices and ii) that the perceived demand elasticity is a function of the price of the firm relative to the industry expenditure function, the change in the price index is given by:*

$$\mathrm{d}p = \underbrace{s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input}}_{\text{Gains without competitive effects}} + \underbrace{s_f \mathrm{d}\tau \frac{\bar{\kappa}}{1-\bar{\kappa}}}_{\text{Pro-competitive effect}} - \underbrace{\frac{\mathrm{cov}\left(\kappa_i, z_i \mathrm{d}\tau_i^{input}; s_i\right)}{1-\bar{\kappa}}}_{\text{Anti-competitive effect}},$$

where $\kappa_i \equiv \frac{\Gamma_i}{1-s_i+\Gamma_i}$, $\bar{\kappa} \equiv \sum_{i=1}^{N} s_i \kappa_i$, *and* $cov(a_i, b_i; c_i)$ *is the weighted covariance between* a_i *and* b_i *with weights* c_i.

Proof. We use the fix point equation (A.3) and add over all i's to obtain:

$$\begin{aligned}
\mathrm{d}\bar{\mu}_t &= \sum_{i=1}^{N} s_{it} \mathrm{d}\mu_{it} = \sum_{j=1}^{N} s_{it} \left[\frac{\Gamma_{it}(1-s_{it})}{1-s_{it}+\Gamma_{it}} \left(-\mathrm{d}mc_{it} + \mathbf{d}mc_{-it}\right) + \frac{\Gamma_{it}}{1-s_{it}+\Gamma_{it}} \mathrm{d}\bar{\mu}_t \right] \\
\mathrm{d}\bar{\mu}_t &= \sum_{j=1}^{N} s_{it} \left[-\kappa_{it}(1-s_{it}) \left(\mathrm{d}mc_{it} - \mathbf{d}mc_{-it}\right) + \kappa_{it} \mathrm{d}\bar{\mu}_t \right] \\
\left(1-\bar{\kappa_t}\right) \mathrm{d}\bar{\mu}_t &= -\sum_{j=1}^{N} s_{it} \left[\kappa_{it}(1-s_{it}) \left(\mathrm{d}mc_{it} - \mathbf{d}mc_{-it}\right) \right] \\
&= -\sum_{j=1}^{N} s_{it} \left[\kappa_{it}(1-s_{it}) \left(\mathrm{d}mc_{it} - \sum_{j \neq i}^{N} \frac{s_{jt}}{1-s_{it}} \mathrm{d}mc_{jt} \right) \right] \\
&= -\sum_{j=1}^{N} s_{it} \left[\kappa_{it}(1-s_{it}) \mathrm{d}mc_{it} - \kappa_{it} \sum_{j \neq i}^{N} s_{jt} \mathrm{d}mc_{jt} \right] \\
&= -\sum_{j=1}^{N} s_{it} \left[\kappa_{it} \mathrm{d}mc_{it} - \kappa_{it} \sum_{j}^{N} s_{jt} \mathrm{d}mc_{jt} \right] \\
\left(1-\bar{\kappa_t}\right) \mathrm{d}\bar{\mu}_t &= -\sum_{j=1}^{N} s_{it} \kappa_{it} \left[\mathrm{d}mc_{it} - \mathrm{d}\bar{mc}_t \right] \\
\left(1-\bar{\kappa_t}\right) \mathrm{d}\bar{\mu}_t &= -\mathbf{cov}\left(\kappa_{it}, \mathrm{d}mc_{it}; s_{it}\right)
\end{aligned}$$

Now combine with the average change in marginal cost $\mathrm{d}\bar{mc} = s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input}$, we obtain

$$\begin{aligned}
\mathrm{d}p = \mathrm{d}\bar{mc} + \mathrm{d}\bar{\mu} &= s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input} - \sum_{j=1}^{N} s_i \frac{\kappa_i}{1-\bar{\kappa}} \left[\mathrm{d}mc_i - \mathrm{d}\bar{mc}\right] \\
&= s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input} - \sum_{j=1}^{N} \frac{\kappa_i}{1-\bar{\kappa}} s_i \left[z_i \mathrm{d}\tau_i^{input} - \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input} \right] + s_f \mathrm{d}\tau_t \sum_{j=1}^{N} \frac{s_{it}\kappa_{it}}{1-\bar{\kappa}_t} \\
&= s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input} - \frac{\sum_{j=1}^{N} s_{it}\kappa_{it} \left[z_i \mathrm{d}\tau_i^{input} - \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input} \right]}{1-\bar{\kappa}} + s_f \mathrm{d}\tau_t \frac{\bar{\kappa}}{1-\bar{\kappa}} \\
\Rightarrow \mathrm{d}p &= \underbrace{s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input}}_{\text{Gains without competitive effects}} + \underbrace{s_f \mathrm{d}\tau \frac{\bar{\kappa}}{1-\bar{\kappa}}}_{\text{Pro-competitive effect}} - \underbrace{\frac{\operatorname{cov}\left(\kappa_i, z_i \mathrm{d}\tau_i^{input}; s_i\right)}{1-\bar{\kappa}}}_{\text{Anti-competitive effect}}
\end{aligned}$$

Note that this is a general version of Proposition 1, which is a special case when $\kappa_{it} = \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}$:

$$\begin{aligned}
\mathrm{d}p = & \underbrace{s_f \mathrm{d}\tau + \sum_{i=1}^{N} s_i z_i \mathrm{d}\tau_i^{input}}_{\text{Gains without competitive effects}} + \underbrace{s_f \mathrm{d}\tau \frac{\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}}_{\text{Pro-competitive effect}} \\
& + \underbrace{\frac{\operatorname{cov}\left(z_i, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i \left(-\mathrm{d}\tau_i^{input}\right)\right)}{1-\sum_{i=1}^{N} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}}_{\text{Anti-competitive effect}}
\end{aligned}$$

□

Appendix B

Simulations

Model for Simulation (Single Importer)

Consumers

Under the Atkeson-Burstein setting, we have Cournot oligopoly for the final sector with CES elasticity of substitution parameter σ. Consider a representative consumer household that supplies one unit of labor and earns national income (I). Consumer preferences are given by the following utility function:

$$U = \left[\sum_{i=1}^{n} \beta_i q_i^{\frac{\sigma-1}{\sigma}} + \beta_f q_f^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = \frac{I}{\left[\sum_{i=1}^{n} \beta_i^{\sigma} p_i^{1-\sigma} + \beta_f^{\sigma} p_f^{1-\sigma}\right]^{\frac{1}{1-\sigma}}} = \frac{I}{P}$$

There are n final goods producers in the economy. Demand parameter for firm i is equal to β_i, while β_f is the parameter guiding consumer demand for the foreign goods.

Additionally, there is demand for domestic firms' final products on the foreign market:

$$q_{if} = \beta_{if}^{\sigma} p_{if}^{-\sigma}$$

Firms

Domestic firms that produce final goods combine labor and intermediate inputs in their production. There is one domestic intermediate producer which prices at CES markups and uses only labor. Intermediate good producer does not sell to consumers. Intermediate inputs are tradable and produced competitively or with constant markups using labor. Each firm i produces using a Cobb-Douglas production function, with CES aggregate of intermediate goods either domestically sourced or imported. This leads to the following cost function:

$$c_i = \frac{w^{\alpha_i} \left(c_i^{m}\right)^{1-\alpha_i}}{\phi_i}$$

where

$$c_i^m = \left(\alpha_{di}^{\rho}\left(p_d^m\right)^{1-\rho} + \left(P_{fi}^m\right)^{1-\rho}\right)^{\frac{1}{1-\rho}}$$

with

$$P_{fi}^m = \left(\sum_s \alpha_{fsi}^{\rho}\left(p_{fs}^m\right)^{1-\rho}\right)^{\frac{1}{1-\rho}}$$

Importing intermediate inputs incurs trade costs τ_s. Foreign firms producing final goods have marginal costs equal to c_f, and foreign firms producing intermediate goods have marginal costs equal to c_{fs}^m. Assume that foreign firms do not take part in the cournot competition with domestic firms, thus fully passing through the cost shocks.

Equilibrium

Let's first write down cost and income as functions of the vector of all markups in the economy. [1] The markup vector consists of n markups of domestic firms on final goods market (μ_i), n markups of domestic firms on intermediate goods market (μ_{mi}), n markups of domestic firms on foreign market (μ_{if}), and $n+1$ foreign markups (μ_f, and μ_{fi}). Under Cournot competition in the final goods market, firm i's markup μ_i depends on its market share:

$$\mu_i = \frac{\epsilon_i}{\epsilon_i - 1}$$

where $\epsilon_i = \left[s_i + \frac{1}{\sigma}\left(1 - s_i\right)\right]^{-1}$.

Below are expressions for marginal cost of firm i, its total output and sales:

$$c_i = \frac{w^{\alpha_i}}{\phi_i}\left[\alpha_{di}^{\rho}\left(\mu_i^m w\right)^{1-\rho} + \sum_s \alpha_{fsi}^{\rho}(\tau_s \mu_{fs} c_{fs}^m)^{1-\rho}\right]^{\frac{1-\alpha_i}{1-\rho}}$$

$$q_i = \mu_i^{-\sigma}\beta_i^{\sigma}c_i^{-\sigma}\frac{I}{P^{1-\sigma}} + \mu_{if}^{-\sigma}\beta_{if}^{\sigma}c_i^{-\sigma}$$

$$\pi_i = \frac{\mu_i - 1}{\mu_i^{\sigma}}\beta_i^{\sigma}c_i^{1-\sigma}\frac{I}{P^{1-\sigma}} + \frac{\mu_{if} - 1}{\mu_{if}^{\sigma}}\beta_{if}^{\sigma}c_i^{1-\sigma}$$

$$s_i = \mu_i^{1-\sigma}\beta_i^{\sigma}c_i^{1-\sigma}\frac{I}{P^{1-\sigma}}$$

For the intermediate firm:

[1] We later allow for alternative markup equation to determine markups in the equilibrium: for example, 1) constant markups (Melitz 2003, ACR 2012, Tintelnot et al. 2020), 2) markups depending on elasticities and market shares (Atkeson and Burstein 2008, Kikkawa et al. 2019), 3) non-CES monopolistic competition (ACDR 2019), 4) markups depending on Lagrange multiplier for additive VES preferences (Krugman 1979, Dhingra and Morrow 2019), etc.

$$\pi_m = \sum_{i=1}^{n} \frac{1}{\eta} \left(\frac{1-\alpha_i}{1+\mu_{fi}^{1-\rho}\alpha_{fi}^{\rho}(\tau_i^{in} c_{mf}/w)^{1-\rho}} \right) \left[\beta_i^{\sigma} \mu_i^{-\sigma} c_i^{1-\sigma} \frac{I}{P^{1-\sigma}} + \beta_{if}^{\sigma} \mu_{if}^{-\sigma} c_i^{1-\sigma} \right],$$

where η is the CES elasticity of substitution parameter for the intermediate sector.

Closing the model: The two conditions that pin down the equilibrium of the model are: 1) expression for total domestic income incorporating the labor market clearing condition:

$$\sum_{i=1}^{n} \pi_i + \pi_m + w = I,$$

and 2) trade balance equation:

$$\sum_{i=1}^{n} \mu_{if}^{1-\sigma} \beta_{if}^{\sigma} c_i^{1-\sigma} = \sum_{i=1}^{n} \frac{\mu_{fi}^{1-\rho} \alpha_{fi}^{\rho} (\tau_i^{in} c_{mf})^{1-\rho}}{(p_{mi})^{1-\rho}} c_i q_i + \beta_f^{\sigma} (p_f)^{1-\sigma} \frac{I}{P^{1-\sigma}}.$$

Parameter Restrictions

There is 1 large firms in the economy, 9 small ones, and 1 intermediate good producer let $n = 1 + 9 + 1 = 11$.

For large firm demand parameter is equal to $\beta_1 = 5$ and $\beta_{1F} = 5$, and for small firms demand parameter is equal to $\beta_i = 1$ and $\beta_{iF} = 0$, $\beta_F = 5$ is the parameter guiding consumer demand for the foreign goods. Intermediate good producer does not sell to consumers. Foreign cost is $c_F = 1$, and $\tau = 1.25$, $\tau' = 1$.

Labor shares: $\alpha_1 = 1$, $\alpha_i = 2/3$ for $2 \le i \le 10$. Intermediate cost parameters: $\phi_i = 1$ for everybody, $\alpha_{1i} = 1$ for everybody, $\alpha_{F1} = 1$ and $\alpha_{Fi} = 0$ for $2 \le i \le 10$, $c_F^m = 1$.

Assume $\sigma = 5$, $\rho = 2$. For markups: assume $\mu_i = \mu_{iF} = \mu_F = \sigma/(\sigma - 1)$ for $2 \le i \le 10$, $\mu_1 = 1.5$, $\mu_{ji} = \rho/(\rho - 1)$.

System of Equations

Below is the simplified version with only 1 intermediate good producer which uses only labor:

$$c_i = \frac{w^{\alpha_i}}{\phi_i} \left[\mu_{ji}^{1-\rho} \alpha_{ji}^{\rho} w^{1-\rho} + \mu_{Fi}^{1-\rho} \tau^{1-\rho} \alpha_{Fi}^{\rho} (c_F^m)^{1-\rho} \right]^{\frac{1-\alpha_i}{1-\rho}}$$

$$P = \left[\sum_{i=1}^{n} \beta_i^{\sigma} p_i^{1-\sigma} + \beta_F^{\sigma} p_F^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

$$p_{mi} = \left(\alpha_i^{\rho} \left(\mu_{ji} w \right)^{1-\rho} + \alpha_{Fi}^{\rho} p_{Fi}^{1-\rho} \right)^{\frac{1}{1-\rho}}$$

$$q_i = \mu_i^{-\sigma} \beta_i^{\sigma} c_i^{-\sigma} \frac{I}{P^{1-\sigma}} + \mu_{iF}^{-\sigma} \beta_{iF}^{\sigma} c_i^{-\sigma}$$

$$q_i = \mu_i^{-\sigma}\beta_i^{\sigma}c_i^{-\sigma}\frac{I}{P^{1-\sigma}} + \mu_{iF}^{-\sigma}\beta_{iF}^{\sigma}c_i^{-\sigma} + \sum_{j\neq i}^{n}\frac{\mu_{ij}^{-\rho}\alpha_{ij}^{\rho}c_i^{-\rho}}{p_{mj}^{1-\rho}}c_jq_j$$

$$\pi_i = \frac{\mu_i - 1}{\mu_i^{\sigma}}\beta_i^{\sigma}c_i^{1-\sigma}\frac{I}{P^{1-\sigma}} + \frac{\mu_{iF}-1}{\mu_{iF}^{\sigma}}\beta_{iF}^{\sigma}c_i^{1-\sigma} + \sum_{j\neq i}^{n}\frac{\mu_{ij}-1}{\mu_{ij}^{\rho}}\frac{\alpha_{ij}^{\rho}c_i^{1-\rho}}{p_{mj}^{1-\rho}}c_jq_j$$

$$\begin{aligned}
I &= \sum_{i=1}^{n}\pi_i + \sum_{i=1}^{n}\alpha_ic_iq_i\\
&= \sum_{i=1}^{n}\left(\frac{\mu_i-1}{\mu_i^{\sigma}}\beta_i^{\sigma}c_i^{1-\sigma}\frac{I}{P^{1-\sigma}} + \frac{\mu_{iF}-1}{\mu_{iF}^{\sigma}}\beta_{iF}^{\sigma}c_i^{1-\sigma} + \sum_{j\neq i}^{n}\frac{\mu_{ij}-1}{\mu_{ij}^{\rho}}\frac{\alpha_{ij}^{\rho}c_i^{1-\rho}}{p_{mj}^{1-\rho}}c_jq_j\right)\\
&+ \sum_{i=1}^{n}\left(\alpha_i\mu_i^{-\sigma}\beta_i^{\sigma}c_i^{1-\sigma}\frac{I}{P^{1-\sigma}} + \alpha_i\mu_{iF}^{-\sigma}\beta_{iF}^{\sigma}c_i^{1-\sigma} + \sum_{j\neq i}^{n}\frac{\alpha_i\mu_{ij}^{-\rho}\alpha_{ij}^{\rho}c_i^{1-\rho}}{p_{mj}^{1-\rho}}c_jq_j\right)\\
&\implies I - \sum_{i=1}^{n}\left(\frac{\mu_i-1}{\mu_i^{\sigma}} + \alpha_i\mu_i^{-\sigma}\right)\beta_i^{\sigma}c_i^{1-\sigma}\frac{I}{P^{1-\sigma}}\\
&= \sum_{i=1}^{n}\left[\left(\frac{\mu_{iF}-1}{\mu_{iF}^{\sigma}} + \alpha_i\mu_{iF}^{-\sigma}\right)\beta_{iF}^{\sigma}c_i^{1-\sigma} + \sum_{j\neq i}^{n}\left(\frac{\mu_{ij}-1}{\mu_{ij}^{\rho}} + \alpha_i\mu_{ij}^{-\rho}\right)\frac{\alpha_{ij}^{\rho}c_i^{1-\rho}}{p_{mj}^{1-\rho}}c_jq_j\right]\\
&\implies I = \frac{\sum_{i=1}^{n}\left[\left(\frac{\mu_{iF}-1}{\mu_{iF}^{\sigma}} + \alpha_i\mu_{iF}^{-\sigma}\right)\beta_{iF}^{\sigma}c_i^{1-\sigma} + \sum_{j\neq i}^{n}\left(\frac{\mu_{ij}-1}{\mu_{ij}^{\rho}} + \alpha_i\mu_{ij}^{-\rho}\right)\frac{\alpha_{ij}^{\rho}c_i^{1-\rho}}{p_{mj}^{1-\rho}}c_jq_j\right]}{1 - \sum_{i=1}^{n}\left(\frac{\mu_i-1}{\mu_i^{\sigma}} + \alpha_i\mu_i^{-\sigma}\right)\beta_i^{\sigma}c_i^{1-\sigma}\frac{1}{P^{1-\sigma}}}
\end{aligned}$$

$$\sum_{i=1}^{n}\mu_{iF}^{1-\sigma}\beta_{iF}^{\sigma}c_i^{1-\sigma} = \sum_{i=1}^{n}\frac{\mu_{Fi}^{1-\rho}\alpha_{Fi}^{\rho}\tau^{1-\rho}(c_F^m)^{1-\rho}}{p_{mi}^{1-\rho}}c_iq_i + \mu_F^{1-\sigma}\beta_F^{\sigma}\tau^{1-\sigma}(c_F^m)^{1-\sigma}\frac{I}{P^{1-\sigma}}$$

Things we assume throughout — there is one large firm (indexed 1), n small ones (indexed 2 to $n+1$), and intermediate producer (indexed $n+2$), small firms do not export or import, β_i for small firms is 1, small and intermediate domestic firms price at CES markups.

We need first to write down expression for income as a function of wage and parameters:

$$I = \sum_{i=1}^{n+2}\pi_i + w$$

Let's denote labor share of firms producing final goods simply as α. Given that small firms do not use imported intermediate inputs (we can model this as either $\alpha_{Fi} = 0$ for $2 \leq i \leq n+1$ or by assuming small has additional costs of importing so for them $\tau_i = \tau \times d_i$ with $d_i \to \infty$), $c_{11} = w$ and other productivity parameters: $\phi_i = 1$ and normalizing $\alpha_{11i} = 1$ for $1 \leq i \leq n+1$, we have for $2 \leq i \leq n+1$:

$$c_i = \frac{w}{\phi_i}(\mu_{ji})^{1-\alpha} = w\left(\frac{\rho}{\rho-1}\right)^{1-\alpha}$$

The cost of the large firm assuming $\phi_1 = 1$ and $\alpha_{F1} = \alpha_F$ is given by:

$$c_1 = w\left[\left(\frac{\rho}{\rho-1}\right)^{1-\rho} + \tau^{1-\rho}\alpha_F^{\rho}\left(\frac{p_F^m}{w}\right)^{1-\rho}\right]^{\frac{1-\alpha}{1-\rho}} = c_i\left[1 + \tau^{1-\rho}\alpha_F^{\rho}\left(\frac{(\rho-1)p_F^m}{\rho w}\right)^{1-\rho}\right]^{\frac{1-\alpha}{1-\rho}}$$

$$c_1/c_i = \left[1 + \tau^{1-\rho}\alpha_F^{\rho}\left(\frac{(\rho-1)p_F^m}{\rho w}\right)^{1-\rho}\right]^{\frac{1-\alpha}{1-\rho}}$$

This gives expression for price index as function of wage and given parameters:

$$P = \left[w^{1-\sigma}\underbrace{\left(\frac{\rho}{\rho-1}\right)^{(1-\alpha)(1-\sigma)}}_{\psi}\left(\beta_1^{\sigma}\mu_1^{1-\sigma}\left(\frac{c_1}{c_i}\right)^{1-\sigma} + n\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\right) + \beta_F^{\sigma}(\tau p_F)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

Let's write down expression for profits. First, for small firms given $\beta_i = 1$:

$$\pi_i = \psi\frac{(\sigma-1)^{\sigma-1}}{\sigma^{\sigma}}\frac{I}{P^{1-\sigma}}w^{1-\sigma}$$

For the large firm:

$$\pi_1 = \psi\left(\frac{c_1}{c_i}\right)^{1-\sigma} w^{1-\sigma}\left(\frac{\mu_1-1}{\mu_1^{\sigma}}\beta_1^{\sigma}\frac{I}{P^{1-\sigma}} + \frac{(\sigma-1)^{\sigma-1}}{\sigma^{\sigma}}\beta_{1F}^{\sigma}\right)$$

For the intermediate firm we need to solve for the share that large firm spends on domestic intermediate goods:

$$s_{11} = \frac{1-\alpha}{1+\tau^{1-\rho}\alpha_F^{\rho}\left(\frac{(\rho-1)p_F^m}{\rho w}\right)^{1-\rho}} = \frac{1-\alpha}{1+(c_1/c_i)^{\frac{1-\rho}{1-\alpha}}-1} = (1-\alpha)(c_1/c_i)^{\frac{\rho-1}{1-\alpha}}$$

Share spent on imported inputs is:

$$s_I = (1-\alpha)\left(1-(c_1/c_i)^{\frac{\rho-1}{1-\alpha}}\right)$$

Then profits of the intermediate firm are given by:

$$\pi_{n+2} = \frac{(1-\alpha)}{\rho}\left[\psi\left(\frac{c_1}{c_i}\right)^{\frac{\rho-\alpha}{1-\alpha}-\sigma}\left(\frac{\beta_1^{\sigma}}{\mu_1^{\sigma}}\frac{I}{P^{1-\sigma}} + \frac{(\sigma-1)^{\sigma}}{\sigma^{\sigma}}\beta_{1F}^{\sigma}\right)w^{1-\sigma} + n\pi_2(\sigma-1)\right]$$

Expression for income is then a function of wage:

$$I = \pi_1 + n\pi_2 + \pi_{n+2} + w \Rightarrow$$

$$I = n\psi \frac{Iw^{1-\sigma}}{P^{1-\sigma}} \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} \left(1 + \frac{(1-\alpha)(\sigma-1)}{\rho}\right) +$$

$$+ \psi \frac{Iw^{1-\sigma}}{P^{1-\sigma}} \left(\frac{c_1}{c_i}\right)^{1-\sigma} \left(\frac{\beta_1}{\mu_1}\right)^\sigma \left[\frac{(1-\alpha)}{\rho} \left(\frac{c_1}{c_i}\right)^{\frac{\rho-1}{1-\alpha}} + \mu_1 - 1\right] +$$

$$+ \psi \left(\frac{c_1}{c_i}\right)^{1-\sigma} w^{1-\sigma} \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} \beta_{1F}^\sigma \left[\frac{(1-\alpha)(\sigma-1)}{\rho} \left(\frac{c_1}{c_i}\right)^{\frac{\rho-1}{1-\alpha}} + 1\right] + w \Rightarrow$$

$$I = \frac{w + \psi \left(\frac{c_1}{c_i}\right)^{1-\sigma} w^{1-\sigma} \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} \beta_{1F}^\sigma \left[\frac{(1-\alpha)(\sigma-1)}{\rho} \left(\frac{c_1}{c_i}\right)^{\frac{\rho-1}{1-\alpha}} + 1\right]}{1 - \psi \frac{w^{1-\sigma}}{P^{1-\sigma}} \left[n \frac{\rho + (1-\alpha)(\sigma-1)}{\rho} \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} + \left(\frac{c_1}{c_i}\right)^{1-\sigma} \left(\frac{\beta_1}{\mu_1}\right)^\sigma \left[\frac{(1-\alpha)}{\rho} \left(\frac{c_1}{c_i}\right)^{\frac{\rho-1}{1-\alpha}} + \mu_1 - 1\right]\right]}$$

Next, use trade balance equation.

Algorithm for Simulation (Single Importer)

1. Set number of small firms n.
2. Set parameter values ($\underbrace{\alpha, \sigma, \rho, \alpha_{n+2}, \alpha_F}_{\text{elasticities, cost shares}} \quad \underbrace{\gamma, \beta_1, \beta_{1F},}_{\text{demand for large firm}} \quad \underbrace{\tau, p_F^m, p_F, \beta_F}_{\text{importer parameters}}$)
3. Assume value for w.
4. Preliminary expressions:

$$\psi = \left(\frac{\rho}{\rho-1}\right)^{(1-\alpha)(1-\sigma)}$$

$$c_1/c_i = \left[1 + \tau^{1-\rho} \alpha_F^\rho \left(\frac{(\rho-1)p_F^m}{\rho w}\right)^{1-\rho}\right]^{\frac{1-\alpha}{1-\rho}}$$

$$s_I = (1-\alpha)\left(1 - (c_1/c_i)^{\frac{\rho-1}{1-\alpha}}\right)$$

5. Solving for μ_1.

Given guess for μ_1, we have:

$$P = \left[\psi w^{1-\sigma} \left(\beta_1^\sigma \mu_1^{1-\sigma} \left(\frac{c_1}{c_i}\right)^{1-\sigma} + n \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\right) + \tau^{1-\sigma} \beta_F^\sigma p_F^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

Error from markup equation:

$$\mu_1 - \gamma\mu_1^{1-\sigma}\frac{\psi(\beta_1)^\sigma (c_1/c_i)^{1-\sigma} w^{1-\sigma}}{P^{1-\sigma}} = \frac{\sigma}{\sigma-1}$$

6. Iterate μ_1 until error ≈ 0.
7. Expression for income:

$$I = \frac{w + \psi\left(\frac{c_1}{c_i}\right)^{1-\sigma} w^{1-\sigma}\frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma}\beta_{1F}^\sigma\left[\frac{(1-\alpha)(\sigma-1)}{\rho}\left(\frac{c_1}{c_i}\right)^{\frac{\rho-1}{1-\alpha}}+1\right]}{1-\psi\frac{w^{1-\sigma}}{P^{1-\sigma}}\left[n\frac{\rho+(1-\alpha)(\sigma-1)}{\rho}\frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma}+\left(\frac{c_1}{c_i}\right)^{1-\sigma}\left(\frac{\beta_1}{\mu_1}\right)^\sigma\left[\frac{1-\alpha}{\rho}\left(\frac{c_1}{c_i}\right)^{\frac{\rho-1}{1-\alpha}}+\mu_1-1\right]\right]}$$

8. Error from trade balance:

$$\underbrace{\psi\beta_{1F}^\sigma\left(\frac{c_1}{c_i}\right)^{1-\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}w^{1-\sigma}}_{\text{exports}} - \\ -\underbrace{\left(s_I\psi\left(\frac{c_1}{c_i}\right)^{1-\sigma}\left(\frac{\beta_1^\sigma}{\mu_1^\sigma}\frac{I}{P^{1-\sigma}}+\frac{(\sigma-1)^\sigma}{\sigma^\sigma}\beta_{1F}^\sigma\right)w^{1-\sigma}+\tau^{1-\sigma}\beta_F^\sigma(p_F)^{1-\sigma}\frac{I}{P^{1-\sigma}}\right)}_{\text{imports}}$$

9. Iterate w until error ≈ 0.

Model for Simulation (Many Importers)

Firms and workers: There are N domestic firms (indexed i) and a foreign exporter (indexed F), intermediate domestic producer (indexed ID) and intermediate exporter (indexed IF), intermediate domestic producer prices at CES markups and uses only labor. Domestic firms in the final sector engage in Cournot competition a-la Atkeson-Burstein (2008). Exporters are for now assumed to price competitively (equivalently to fixed markups). Total labor force is 1 and is supplied inelastically. We normalize everything relative to fixed foreign wage $w_F = 1$.

Parameters: Each domestic firm is characterised by a set of 4 different (potentially correlated) parameters: $(\beta_i, \beta_{Fi}, \alpha_{Fi}, \phi_i)$ — shifters of domestic demand, foreign demand, importing share and efficiency. Demand for foreign goods in the final sector is determined by parameter β_F. For domestic intermediate producer productivity parameter $\phi_{ID} = 1$ and foreign demand is given by parameter β_{FID} Importing trade costs for the final sector are (τ_F, τ_I). Labor share of firms producing final goods is α. E-o-s in the final sector is σ, e-o-s in the intermediate sector is ρ.

Solution: We want to solve for two general equilibrium equilibrium objects (I, P) — domestic nominal income and final sector price index — in terms of domestic wage. Then we can write down trade balance equation to pin down the domestic wage. First, write down expression for income as a function of wage and parameters:

$$I = \sum_{i=1}^{N} \pi_i + \pi_{ID} + w \tag{B.1}$$

To do that we need to solve for firms' costs to then derive their profits. To simplify the notation, let's normalize the production function in the following way:

$$q_i = \left(\frac{\rho^{1-\alpha}}{\alpha^{\alpha} \left((1-\alpha)(\rho-1)\right)^{1-\alpha}} \right) l_i^{\alpha} m_i^{1-\alpha} \tag{B.2}$$

$$m_i = \left(m_{Di}^{\frac{\rho-1}{\rho}} + \alpha_{Fi} \left(\frac{\rho-1}{\rho} \right)^{\frac{\rho-1}{\rho}} m_{Fi}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \tag{B.3}$$

This is equivalent from the perspective of firm to assuming that there is firm-specific importing iceberg cost $d_i = \frac{\rho}{\rho-1} \alpha_{Fi}^{-\frac{\rho}{\rho-1}}$.

Cost minimization gives us the marginal cost of the firm i as a function of w:

$$c_i(w) = \frac{w}{\phi_i} \left[1 + \tau_I^{1-\rho} \alpha_{Fi}^{\rho} w^{\rho-1} \right]^{\frac{1-\alpha}{1-\rho}} \tag{B.4}$$

Let's now derive parts of profit functions that depend on exogenous markups — export profits of intermediate producer and export profits of final producers.

Given the firm-specific foreign demand function for final goods, we derive export profit of the final producers:

$$q_{Fi} = \left(\frac{\sigma}{\sigma-1} \right)^{-\sigma} \beta_{Fi} p_{Fi}^{-\sigma} \Rightarrow \pi_{Fi} = \frac{1}{\sigma-1} \beta_{Fi} c_i^{1-\sigma} \tag{B.5}$$

Analogously given the foreign demand function for domestic intermediates, we derive export profit of the intermediate producer:

$$q_{FID} = \left(\frac{\rho}{\rho-1} \right)^{-\rho} \beta_{FID} p_{FID}^{-\rho} \Rightarrow \pi_{FID} = \frac{1}{\rho-1} \beta_{FID} w^{1-\rho} \tag{B.6}$$

Domestic profits depend on endogenous markups μ_{Hi} that firm charge on the domestic market for the final good. To derive them, consider the expression for price index:

$$P = \left[\sum_{i=1}^{N} \beta_i \mu_{Hi}^{1-\sigma} c_i^{1-\sigma} + \beta_F (\tau_F)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{B.7}$$

Each markup is given implicitly by the following equation, which has a unique solution on $[1, +\infty)$:

$$\mu_{Hi} - \left(\frac{\beta_i c_i^{1-\sigma}}{P^{1-\sigma}}\right)\mu_{Hi}^{2-\sigma} = \frac{\sigma}{\sigma-1} \tag{B.8}$$

Once we solve equation for each markup, price index is simply a function of domestic wage and model parameters.

Then we can write profits of the final good producers on the domestic market:

$$\pi_{Hi} = (\mu_{Hi}-1)\underbrace{\left(\frac{\beta_i \mu_{Hi}^{-\sigma} c_i^{1-\sigma}}{P^{1-\sigma}}\right) I}_{\text{Domestic cost of } i} \tag{B.9}$$

For the intermediate firm:

$$\pi_{HID} = \sum_{i=1}^{N} \frac{1}{\rho} \underbrace{\left(\frac{1-\alpha}{1+\tau_I^{1-\rho}\alpha_{Fi}^{\rho} w^{\rho-1}}\right)}_{\text{Domestic cost share of } i} \underbrace{\left[\left(\frac{\beta_i \mu_{Hi}^{-\sigma} c_i^{1-\sigma}}{P^{1-\sigma}}\right) I + \beta_{Fi} c_i^{1-\sigma}\right]}_{\text{Total cost of } i} \tag{B.10}$$

We can now come back to the equality:

$$I = \sum_{i=1}^{N} \pi_i + \pi_{ID} + w = \sum_{i=1}^{N} \pi_{Hi} + \sum_{i=1}^{N} \pi_{Fi} + \pi_{HID} + \pi_{FID} + w \tag{B.11}$$

This equality allows us to solve for the income as a function of wage and parameters of the model:

$$I = \frac{\left(\sum_{i=1}^{N}\left(\frac{1}{\sigma-1} + \frac{1}{\rho}\frac{1-\alpha}{1+\tau_I^{1-\rho}\alpha_{Fi}^{\rho}w^{\rho-1}}\right)\beta_{Fi}c_i^{1-\sigma}\right) + \frac{1}{\rho-1}\beta_{FID}w^{1-\rho} + w}{1 - \left(\sum_{i=1}^{N}\left(\mu_{Hi} - 1 + \frac{1}{\rho}\frac{1-\alpha}{1+\tau_I^{1-\rho}\alpha_{Fi}^{\rho}w^{\rho-1}}\right)\frac{\beta_i \mu_{Hi}^{-\sigma} c_i^{1-\sigma}}{P^{1-\sigma}}\right)} \tag{B.12}$$

Next, use trade balance equation:

$$\underbrace{\frac{\sigma}{\sigma-1}\sum_{i=1}^{N}\beta_{Fi}c_i^{1-\sigma} + \frac{\rho}{\rho-1}\beta_{FID}w^{1-\rho}}_{\text{Exports}} =$$

$$= \underbrace{\sum_{i=1}^{N}\left(\frac{(1-\alpha)\tau_I^{1-\rho}\alpha_{Fi}^{\rho}w^{\rho-1}}{1+\tau_I^{1-\rho}\alpha_{Fi}^{\rho}w^{\rho-1}}\right)\left[\left(\frac{\beta_i \mu_{Hi}^{-\sigma} c_i^{1-\sigma}}{P^{1-\sigma}}\right) I + \beta_{Fi} c_i^{1-\sigma}\right] + \left(\frac{\beta_F(\tau_F)^{1-\sigma}}{P^{1-\sigma}}\right) I}_{\text{Imports}} \tag{B.13}$$

Algorithm for Simulation (Many Importers)

1. Set number of the domestic final good producers N.

2. Set parameter values ($\underbrace{\sigma, \rho}_{\text{elasticities}} \quad \underbrace{\alpha, \beta_{FID}}_{\text{intermediate good}} \quad \underbrace{\tau_F, \tau_I, \beta_F}_{\text{foreign goods}}$)

3. Generate (correlated) vector of variables $(\beta_i, \beta_{Fi}, \alpha_{Fi}, \phi_i)$ for each of the domestic final good producers.

4. Assume value for w.

5. Derive marginal cost for each firm c_i using equation (1).

6. Assume value for the price index and then solve for each μ_i using equation (5). Iterate until equation (4) holds as equality.

7. Derive profits using equations (2)-(3) and (6)-(7). Combine them using equation (8) to derive income.

8. Derive error from trade balance using equation (9).

9. Iterate wage until error from trade balance is equal to 0.

Simulation Results (Many Importers)

Parameters of simulation: There are 25 domestic final good producers. The parameters for the simulation are given by the following: $\sigma = 5, \rho = 3, \alpha = 0.5, \beta_{FID} = 1000$, and $\beta_F = 0.1$. Trade liberalization is given by changing trade costs from $\tau_F = \tau_I = 1.25$ to $\tau_F = \tau_I = 1$. Firm-specific variables are generated in following way: $\beta_i = exp(x_{1i})$, $\beta_{Fi} = exp(x_{2i})$, $\alpha_{Fi} = 0.05 \times exp(x_{3i})$, $\phi_i = exp(x_{4i})$, where

$$X = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & c & c & c \\ c & 1 & c & c \\ c & c & 1 & c \\ c & c & c & 1 \end{pmatrix} \right)$$

Results: Let's present results for different levels of correlation parameter c and different types of trade liberalizations.

Table B.1 shows the changes in aggregate (cost-weighted) domestic markup:

$$M_d = \frac{\sum_{i=1}^{25} \beta_i \mu_{Hi}^{1-\sigma} c_i^{1-\sigma}}{\sum_{i=1}^{25} \beta_i \mu_{Hi}^{-\sigma} c_i^{1-\sigma}} \tag{B.14}$$

We could see that liberalizing final goods' tariffs generally has pro-competitive effects, while liberalizing intermediate goods' tariffs generally has anti-competitive effects. Both effects intensify as correlation parameter increases | for final tariff this is driven by fact that market concentration increases with higher c (firms with better productivity shocks also have strong advantage in access to foreign inputs and grow larger), while for input tariffs it combines direct effect of larger firms benefiting more from input tariff cuts with the effect of increased concentration.[2]

τ/c	$c = 0$	$c = 0.25$	$c = 0.5$	$c = 0.75$
$\tau_F = 1.25, \tau_I = 1.25$	1.2998	1.5949	1.6866	1.8766
$\tau_F = 1, \tau_I = 1.25$	1.2786	1.5162	1.5925	1.7763
$\tau_F = 1.25, \tau_I = 1$	1.3039	1.6806	1.7561	1.9407
$\tau_F = 1, \tau_I = 1$	1.2809	1.5897	1.6544	1.8327

Table B.1: Simulation Results - Aggregate Markup

The following Table B.2 presents results for real wages.

τ/c	$c = 0$	$c = 0.25$	$c = 0.5$	$c = 0.75$
$\tau_F = 1.25, \tau_I = 1.25$	5.3085	5.7149	6.8177	7.8127
$\tau_F = 1, \tau_I = 1.25$	6.1676	6.6008	7.6337	8.7215
$\tau_F = 1.25, \tau_I = 1$	5.3436	5.8501	7.1701	8.4218
$\tau_F = 1, \tau_I = 1$	6.1944	6.7563	7.9930	9.3619

Table B.2: Simulation Results - Real Wage

Finally, Table B.3 presents results for the total welfare (real income).

[2]Interestingly, while aggregate markup decreases in case \$c=0.5\$ under liberalization, sum of competitive effects of tariffs on the real wage is slightly negative --- this is likely driven by increased variance of markups that decreases real wages (similar to Epifani and Gancia 2011, Edmond et al. 2019).

τ/c	$c = 0$	$c = 0.25$	$c = 0.5$	$c = 0.75$
$\tau_F = 1.25, \tau_I = 1.25$	8.0370	9.3733	12.0160	14.7503
$\tau_F = 1, \tau_I = 1.25$	9.2757	10.3966	12.6324	15.2422
$\tau_F = 1.25, \tau_I = 1$	8.1006	9.8534	13.0669	16.3729
$\tau_F = 1, \tau_I = 1$	9.3200	10.8442	13.5684	16.7340

Table B.3: Simulation Results - Real Income

From the tables we can see that as c increases gains from intermediate input tariff cuts, as increasing c leads to higher total share of imported inputs | this is a separate effect from considering effects on competition. One could also see that higher c and τ_F, and lower τ_I leads to lower share of real wage in real income.

Decomposition exercise: To explain the connection between competitive effects (markup table) and effects on the real wages/incomes, we decompose changes in real wage from full liberalization (moving from $\tau_F = \tau_I = 1.25$ to $\tau_F = \tau_I = 1$) into three first-order terms and a remainder term for cases $c = 0$ and $c = 0.5$. Table B.4 shows the decomposition results.

Effect on Real Wage	$c = 0$	$c = 0.25$	$c = 0.5$	$c = 0.75$
Direct Cost Effect	0.1418	0.1484	0.1320	0.1443
Pro-Competitive Effect	0.0050	0.0284	0.0410	0.0567
Anti-Competitive Effect	-0.0004	-0.0154	-0.0212	-0.0268
Second-Order effects	0.0079	0.0059	-0.0018	0.0067
Total Effect	0.1543	0.1673	0.1590	0.1809

Table B.4: Simulation Results - Welfare Decomposition

We see that knowing c parameter affects our interpretation of pro/anti-competitive effects of trade. Competitive effects are generally more pronounced once c is higher as market is more concentrated. Note, however, that competitive effects of input tariffs almost completely disappear under $c = 0$, while becoming comparable in size (albeit smaller) to competitive effects of output tariffs under $c > 0$. We can also see that first-order decomposition provides a reasonably good approximation to the total effect on real wages (e.g. second-order effects are small).

Appendix C

Robustness

Alternative Market Structures

We proceed by redoing the above welfare analysis for alternative market structures. While the baseline model is derived assuming quantity competition (Cournot), we now consider the alternative price competition (Bertrand). Under the Bertrand price competition with Cobb-Douglas industry aggregator, $\Gamma_{i,t} = \Gamma_{-i,t} = \frac{(\sigma-1)s_{i,t}}{1+(\sigma-1)(1-s_{i,t})}$, which is still a monotonically increasing function of s_i.

$$\mathrm{d}p_i = \frac{1-s_i}{1-s_i+\frac{(\sigma-1)s_i}{1+(\sigma-1)(1-s_i)}}\mathrm{d}mc_i + \frac{\frac{(\sigma-1)s_i}{1+(\sigma-1)(1-s_i)}}{1-s_i+\frac{(\sigma-1)s_i}{1+(\sigma-1)(1-s_i)}}\mathrm{d}\ln P \tag{C.1}$$

We proceed with the quantitative analysis following the same method as described in section 1.2.

Aggregation across Sectors

We extend our welfare decomposition to a multi-sector environment. When assuming Cobb-Douglas industry aggregator we have:

$$
\begin{aligned}
\text{dln}(w) - \text{dln}(P) &= \sum_s \phi_s \left[\text{dln}(w_s) - \text{dln}(P_s)\right] \\
&= \underbrace{\sum_s \phi_s \left[s_{f,s} \left(\mathrm{d}\ln w_s - \mathrm{d}\tau_s\right) + \sum_{i=1}^{N(s)} s_i s_i^I (\mathrm{d}\ln(w_s) - \mathrm{d}\tau_i^{input}) \right]}_{\text{Gains without competitive effects}} \\
&+ \underbrace{\sum_s \phi_s \left[s_{f,s} \left(\mathrm{d}\ln w_s - \mathrm{d}\tau_s\right) \frac{\sum_{i=1}^{N(s)} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}}{1 - \sum_{i=1}^{N(s)} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}} \right]}_{\text{Pro-competitive effects}} \\
&- \underbrace{\sum_s \phi_s \left[\frac{Cov\left(s_i^I, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i \left(\mathrm{d}\ln w_s - \mathrm{d}\tau_i^{input}\right)\right)}{1 - \sum_{i=1}^{N(s)} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}} \right]}_{\text{Anti-competitive effects}} \qquad \text{(C.2)}
\end{aligned}
$$

In the model with multiple sectors, the overall anti-competitive effects is now determined by $-\sum_s \phi_s \left[\frac{Cov\left(s_i^I, \frac{(\sigma-1)s_i}{1+(\sigma-2)s_i}; s_i\left(\mathrm{d}\ln w - \mathrm{d}\tau_i^{input}\right)\right)}{1-\sum_{i=1}^{N(s)} \frac{(\sigma-1)s_i^2}{1+(\sigma-2)s_i}} \right]$, which is a weighted average of the weighted covariance between firm market share and import share across all industries, where the weights are the Cobb-Douglas coefficients.

Appendix D

Statistical Matching

Matching HFCS to HBS

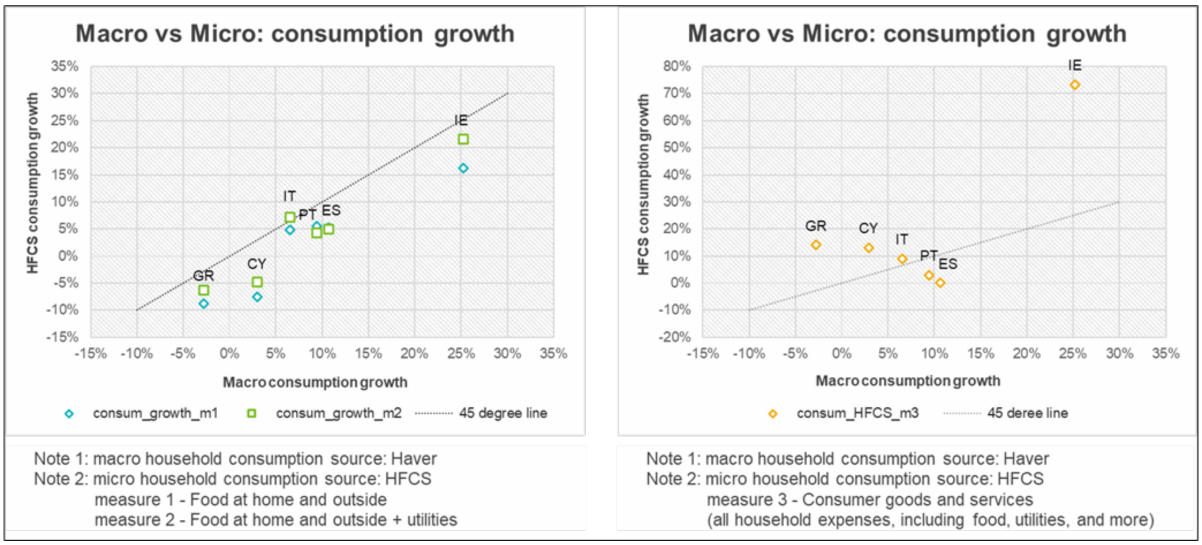
Household Budget Surveys (HBS) record household consumption expenditure on 12 subcategories of goods and services, the summation of which gives the total consumption expenditure. In HFCS, the survey is designed in such a way that households are asked about a subset of consumption categories on food, utilities, and rent4, together with a one-shot question on their total consumption expenditure. While one-shot questions usually receive relatively high response rates, they tend to give significant underestimation of total consumption expenditure compared to more questions asking about a series of subcategories. This is consistent with what we observe in HFCS: levels are off from the national accounts, and changes as well. Figure D.1 shows the growth in the total consumption expenditure on consumer goods and services in HFCS, plotted against the consumption growth from national accounts data. While food consumption comoves closely with the macro numbers, the total consumption obtained from single questions barely lines up.

Based on our observation of the available consumption variables in HFCS, we follow Lamarche (2017) to impute total consumption from the subset of consumption categories in HFCS. The imputation method can be traced back to Skinner (1987) and is adopted more recently by Browning et al. (2003), Blundell (2004, 2008), and Attanasio and Pistaferri (2014). The procedure is essentially statistical matching: the total consumption we observe in HBS are imputed to HFCS assuming a linear inverse Engel curve:

$$\text{HBS: } c_h = \beta_0 + \sum_j c_h^j \beta_j + \gamma' \mathbf{X} + \varepsilon_h$$
$$\text{HFCS: } \hat{c}_h = \hat{\beta}_0 + \sum_j c_h^j \hat{\beta}_j + \gamma' \mathbf{X}$$

where c_h is household total consumption expenditure (in logs), c_h^j is household consumption of food (at home or away from home), utilities, and rent, and $\mathbf{X}$ is a vector of household demographic variables. In practice, we incorporate interaction terms of food consumption

Figure D.1: HFCS Consumption Measures



Source: European Central Bank, HFCS database; and IMF staff calculations.

with household income quintiles to capture the fact that the Engel coefficient varies by household income level.

Figure D.2 is a side-by-side comparison of the distributions of consumption from HBS and HFCS for Greece5. We test out different set of covariates to keep the ones with the most explanatory power, with an aim to match as closely as possible the distribution of household total consumption to the HBSobservations.

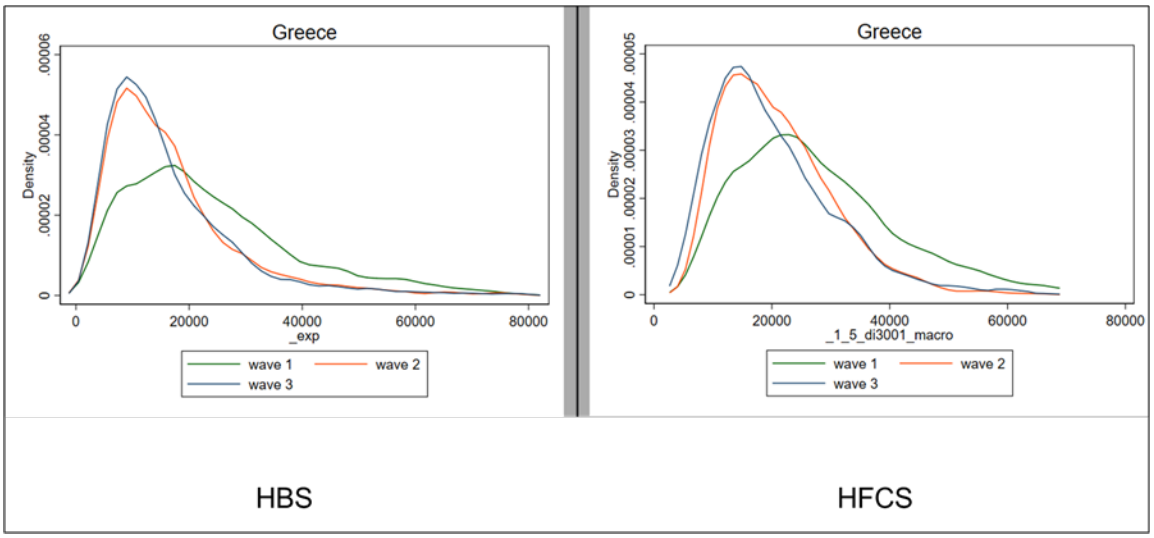
Matching HFCS to OECD income tax

We follow Slacalek et al. (2020) to compute after-tax income by applying the marginal tax rates according to the household taxable income then plus 2/3 of self-employment income. The income tax rates are obtained from the OECD Tax Database.

Matching HFCS to National Accounts

A well-documented caveat in survey data is the underreporting of income and consumption, and more so for income than for consumption. As a results, the survey sample tends to yield substantially lower savings than the national account numbers (Deaton, 2019). To correct for the underestimation issue, we follow Slacalek et al. (2020) to further match the aggregate income and consumption level to the national accounts. The resulting savings rates in our

Figure D.2: Matching HFCS to HBS



Source: European Central Bank, HFCS database; and IMF staff calculations.

sample data always match the savings rates obtained from the national accounts. Note that we do not alter the relative level of income or consumption households of the same country.

Appendix E

Additional Figures and Tables

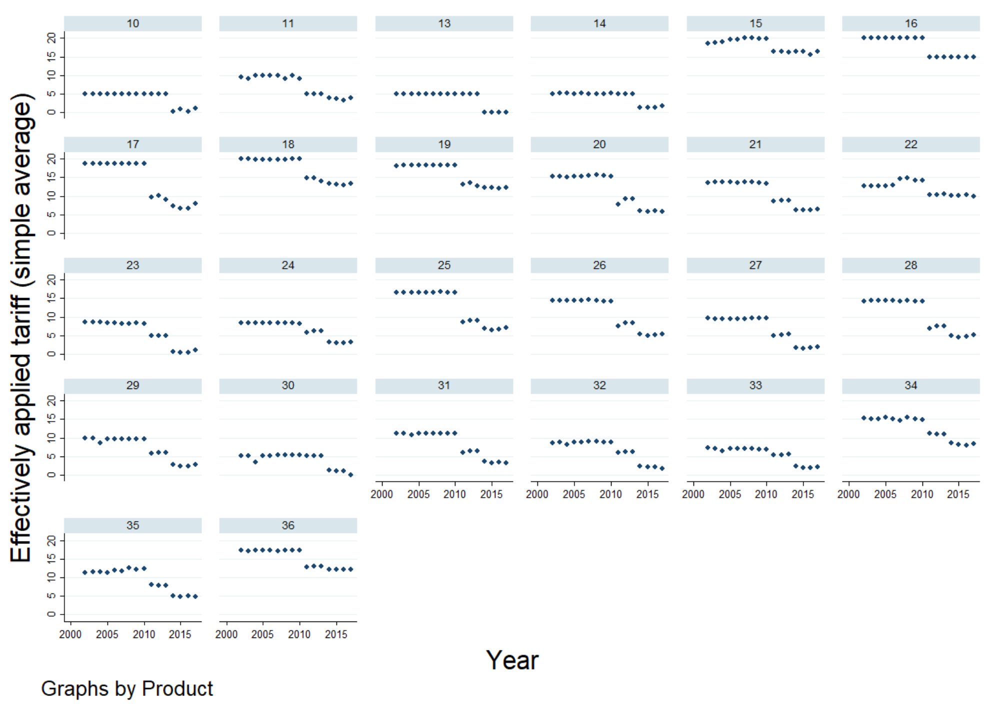


Figure E.1: Tariff Rates, Simple Mean, By Product, Percentage Points

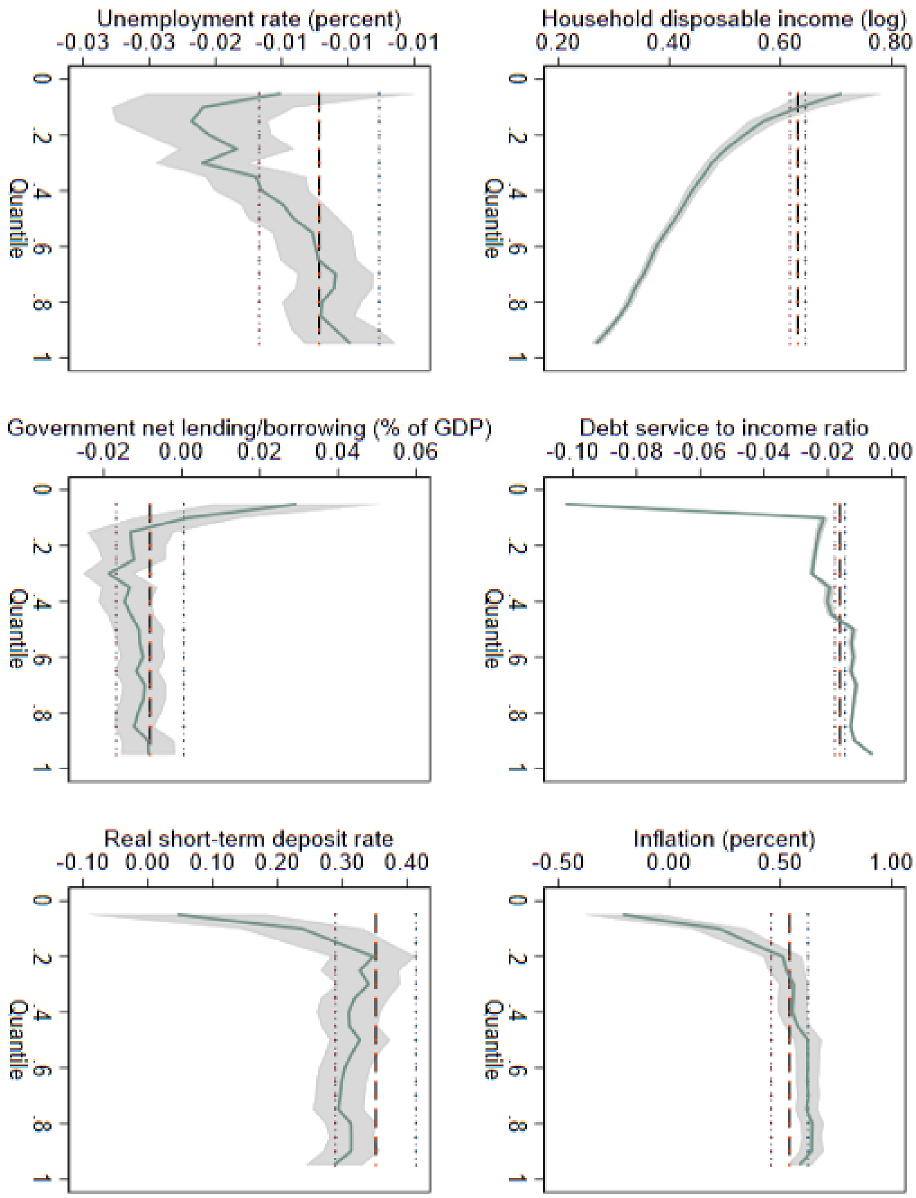


Figure E.2: Quantile Regression Coefficients Across Distribution of Savings

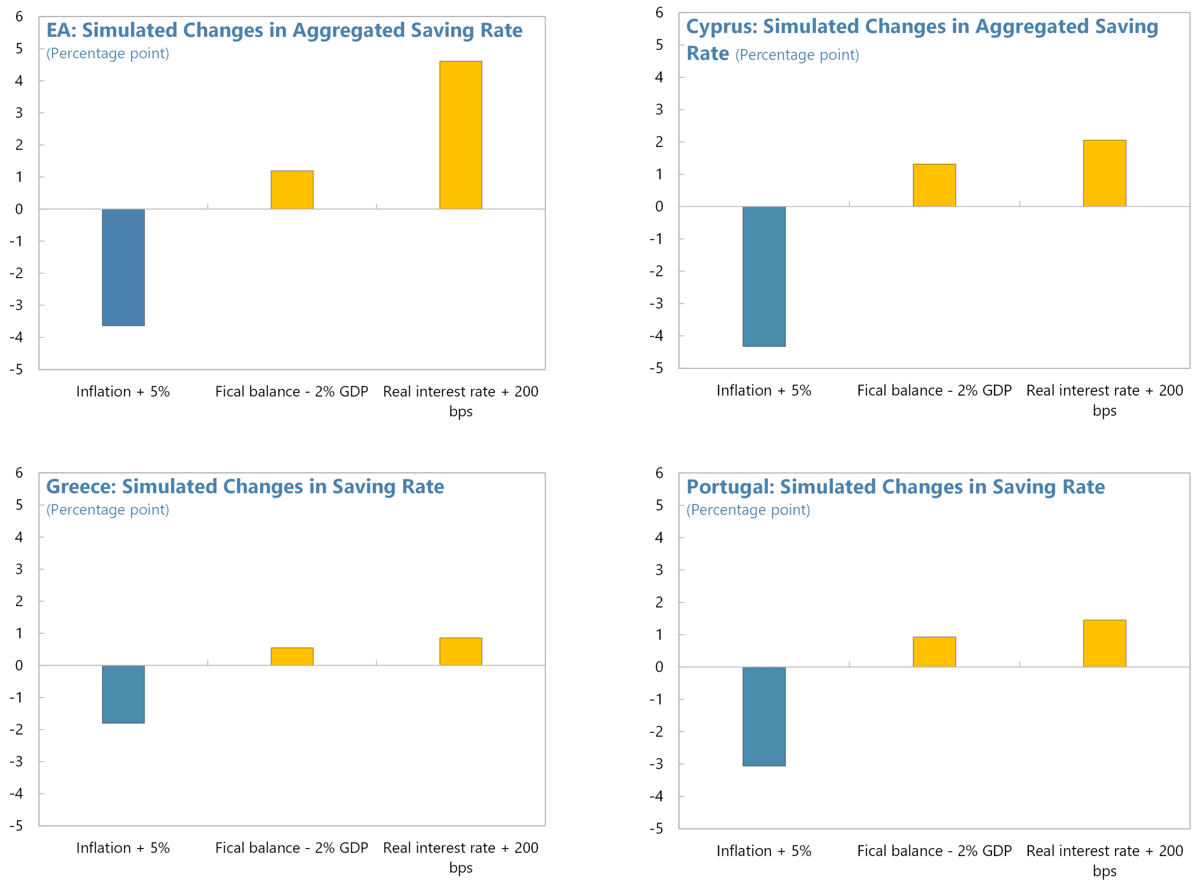


Figure E.3: Simulation Results, Country Aggregate

Table E.1: Concentration Facts

	Moments		Moments
Within-sector concentration			
Mean HHI	0.30	Mean inverse HHI	6.43
Median HHI	0.29	Median inverse HHI	3.25
p10 HHI	0.064	p10 inverse HHI	1.58
p25 HHI	0.12	p50 inverse HHI	2.89
p75 HHI	0.34	p75 inverse HHI	7.83
p90 HHI	0.63	p90 inverse HHI	15.08
Distribution of market shares			
Mean share	0.068	Mean top share	0.44
Median share	0.00056	Median top share	0.46
p75 share	0.020	Mean CR4	0.75
p90 share	0.17	Median CR4	0.84
p95 share	0.50	Mean CR8	0.86
SD share	0.19	Median CR8	0.95

Note: Summary statistics of main firm concentration facts using the final sample of EAM. The data uses the pre-shock firm distribution in year 2010. Producers' market shares are measured by their share of domestic sales revenue within a given 8-digit sector. HHI is the Herfindahl-Hirschman Index. The CR4 and CR8 are four-firm and eight-firm concentration ratios, defined as the market share of the 1st to the nth largest firm in an industry as a percentage of total industry market share.

Table E.2: Welfare Decomposition

ISIC	Descriptions	OUT_NOCOMP	PRO_COMP	IN_NOCOMP	ANTI_COMP
15	Food products and beverages	.01559	.0096231	.0995632	-.0018021
16	Tobacco products	.01559	.09	.5482612	0
17	Textiles	.0263048	.0332848	.284035	-.0226498
18	Wearing apparel; dressing and dyeing of fur	.0263048	.0034724	.0986912	-.0032811
19	Tanning and dressing of leather	.0263048	.0123615	.1359874	-.005752
20	Wood and of products of wood and cork, except furniture	.0231405	.0309218	.0840705	-.0157796
21	Paper and paper products	.0194271	.0071859	.2444555	.0007039
22	Publishing, printing and reproduction of recorded media	.0194271	.0036252	.2697303	-.0040856
23	Coke, refined petroleum products and nuclear fuel	.032766	.0754328	.3020252	-.0423389
24	Chemicals and chemical products	.0550142	.0183806	.3836652	-.0162502
25	Plastics products	.0387577	.0102586	.3142702	-.0010061
26	Oher non-metallic mineral products	.0162749	.0067375	.1434734	.0002907
27	Basic metals	.0553074	.0129045	.2152173	.0036009
28	Fabricated metal products, except machinery and equipment	.0418605	.0044067	.2971714	-.0096032
29	Machinery and equipment n.e.c.	.1460323	.009064	.226525	-.0046542
30	Office, accounting and computing machinery	.1961198	.075773	.6563208	-.1211559
31	Electrical machinery and apparatus n.e.c.	.0756014	.0229864	.2577966	.0000909
32	Radio, television and communication equipment and apparatus	.1961198	.0154723	.3693828	-.0087104
33	Medical, precision and optical instruments, watches and clocks	.1961198	.0110399	.132975	-.0043377
34	Motor vehicles, trailers and semi-trailers	.0839094	.0448139	.379887	-.0650204
35	Other transport equipment	.0980109	.0433579	.5898158	-.0385084
36	Furniture; manufacturing n.e.c.	.0559177	.0085307	.1369055	.0134106

Note: Summary statistics of main firm concentration facts using the final sample of EAM. The data uses the pre-shock firm distribution in year 2010. Welfare effects are measured at 4-digit ISIC level and then aggregated to 2-digit level weighted by sales. OUT_NOCOMP (IN_NOCOMP) denotes the welfare effects of output (input) tariff liberalization without considering the competitive effects, and PRO_COMP (ANTI_COMP) the pro- (anti-)competitive effects considering markup distortions.

Table E.3: Determinants of Household Savings

Variable	Expected sign	References
Income	+	Keynes (1936); Friedman (1957); Dynan and others (2004)
Age	+/-	Modigliani and Brumberg (1954); Kopczuk and Lupton (2007); Ameriks and others (2020)
Uncertainty	+/-	Deaton (1991); Carroll (1992, 1997); Loayza and others (2000); Jappelli and others (2008)
Wealth	-	Carroll (1992, 1997); Jappelli and others (2008)
Housing	-	Muellbauer (2007); Japelli and Pagano (1994); Deaton (1999); Campbell and Cocco (2007); Case and others (2001)
Debt	-	Carroll (1992, 1997); Mody and others (2012)
Size	-	Curtis and others (2015)
Education	+	Browning and Lusardi (1996); Dynan and others (2004); Attanasio and Weber (2010)
Household head gender: male	+	Lupton and Smith (2003); Hira and Loibl (2005); Jianakoplos and Bernasek (1998); Ryan and Siebens (2012); Sierminska and others (2010)
Interest rate	+/-	Elmendorf (1996); Schmidt-Hebbel (1997)
Inflation	+/-	Juster and Wachtel (1972); Grigoli and others (2014, 2018)
Private credit	-	Mody and others (2012)
Government budget balance	-	Barro (1974, 1989); Seater (1993)
Government pension	-	Feldstein (1985)

Table E.4: Variable Definition and Sources

Variable	Description	Source
Income	Logarithm of disposable income	HFCS
Age	Household head age	HFCS
Uncertainty	Unemployment rate	HFCS
Wealth	Logarithm of wealth to disposable income	HFCS
Housing	Share of housing wealth in disposable income	HFCS
Debt	Debt service to disposable income	HFCS
Size	Number of household members	HFCS
Education	Education attainment	HFCS
Household head gender	Gender of the reference person	HFCS
Interest rate	Real deposit rate	IMF
Inflation	Annual dynamics of Consumer Price Index	IMF
Private credit	Private sector credit to GDP	IMF
Government budget balance	General government budget balance to GDP	IMF
Government pension	General government pension expenditures to GDP	IMF

Table E.5: Permanent Income and Education

	(1) OLS	(2) OLS	(3) QR	(4) QR
permanent income	0.689***	0.686***	0.424***	0.425***
	(0.00574)	(0.00574)	(0.00463)	(0.00441)
income uncertainty	-0.585***	-0.584***	-0.280***	-0.279***
	(0.0141)	(0.0141)	(0.0110)	(0.0106)
wealth	-0.0528***	-0.0517***	-0.0126***	-0.0106***
	(0.00361)	(0.00361)	(0.00228)	(0.00219)
debt	-0.00956***	-0.00957***	-0.0141***	-0.0141***
	(0.000311)	(0.000311)	(0.0000832)	(0.0000843)
housing	-0.0812***	-0.0819***	-0.0241***	-0.0246***
	(0.00472)	(0.00472)	(0.00302)	(0.00288)
age	0.00692***	0.00689***	0.00547***	0.00539***
	(0.000238)	(0.000238)	(0.000148)	(0.000147)
size	-0.0427***	-0.0427***	-0.0253***	-0.0271***
	(0.00196)	(0.00196)	(0.00113)	(0.00115)
gender male	0.134***	0.133***	0.0923***	0.0933***
	(0.00526)	(0.00526)	(0.00310)	(0.00303)
eduacation	0.0972***	0.0961***	0.0665***	0.0655***
	(0.00205)	(0.00205)	(0.00131)	(0.00126)
deposit rate	0.0170***		0.0385***	
	(0.00247)		(0.00184)	
inflation		-0.00404		-0.00619***
		(0.00420)		(0.00240)
private credit	-0.00101***	-0.00103***	-0.00141***	-0.00101***
	(0.000241)	(0.000241)	(0.000164)	(0.000155)
government budget balance	-0.00307	-0.00309	-0.0120***	-0.00941***
	(0.00203)	(0.00258)	(0.00138)	(0.00171)
government pension	-0.0135***	-0.0163***	-0.0347***	-0.0313***
	(0.00253)	(0.00390)	(0.00179)	(0.00272)
constant	1.380***	1.412***	0.495***	0.434***
	(0.0650)	(0.0729)	(0.0429)	(0.0471)
N	55835	55835	55835	55835
R-sq	0.442	0.442	0.404	0.410

Table E.6: Income Uncertainty - Macro

	(1) ols	(2) qr	(3) ols	(4) qr
income	0.705***	0.426***	0.708***	0.428***
	(0.00580)	(0.00380)	(0.00581)	(0.00387)
income uncertainty - macro	0.0108***	0.0131***	0.00735***	0.00997***
	(0.00184)	(0.00120)	(0.00180)	(0.00120)
wealth	-0.0883***	-0.0282***	-0.0896***	-0.0305***
	(0.00374)	(0.00245)	(0.00374)	(0.00249)
debt	-0.00970***	-0.0145***	-0.00967***	-0.0145***
	(0.000312)	(0.000204)	(0.000312)	(0.000208)
housing	-0.0544***	-0.0112***	-0.0534***	-0.00961***
	(0.00486)	(0.00318)	(0.00486)	(0.00324)
age	0.00265***	0.00228***	0.00265***	0.00226***
	(0.000224)	(0.000147)	(0.000224)	(0.000149)
size	-0.0799***	-0.0510***	-0.0802***	-0.0497***
	(0.00199)	(0.00130)	(0.00199)	(0.00132)
gender male	-0.00311	0.00339	-0.00303	0.00219
	(0.00517)	(0.00338)	(0.00516)	(0.00344)
inflation	-0.0176***	-0.0193***		
	(0.00430)	(0.00282)		
deposit rate			0.0214***	0.0408***
			(0.00249)	(0.00166)
private credit	-0.00130***	-0.00120***	-0.00123***	-0.00154***
	(0.000242)	(0.000159)	(0.000242)	(0.000161)
government balance	-0.00455*	-0.00812***	-0.00132	-0.00667***
	(0.00262)	(0.00172)	(0.00220)	(0.00147)
government pension	-0.0567***	-0.0728***	-0.0361***	-0.0583***
	(0.00626)	(0.00410)	(0.00485)	(0.00323)
constant	4.762***	2.661***	4.574***	2.550***
	(0.0796)	(0.0522)	(0.0680)	(0.0453)
N	56103	56103	56103	56103
adj. R-sq	0.441		0.441	

Table E.7: Housing - Macro

	(1)	(2)	(3)	(4)
	ols	qr	ols	qr
income	0.753***	0.434***	0.755***	0.434***
	(0.00416)	(0.00275)	(0.00417)	(0.00267)
income uncertainty	-0.123***	-0.00748	-0.122***	-0.0118
	(0.0132)	(0.00872)	(0.0132)	(0.00845)
wealth	-0.0542***	-0.00386***	-0.0546***	-0.00387***
	(0.00186)	(0.00123)	(0.00186)	(0.00119)
debt	-0.00943***	-0.0128***	-0.00941***	-0.0128***
	(0.000333)	(0.000220)	(0.000333)	(0.000213)
housing - macro	-0.00339***	-0.00433***	-0.00239***	-0.00284***
	(0.000350)	(0.000231)	(0.000373)	(0.000239)
age	0.00212***	0.00208***	0.00213***	0.00215***
	(0.000214)	(0.000141)	(0.000214)	(0.000137)
size	-0.0824***	-0.0507***	-0.0825***	-0.0497***
	(0.00199)	(0.00132)	(0.00199)	(0.00128)
gender male	0.00153	0.00889***	0.00156	0.00875***
	(0.00522)	(0.00345)	(0.00522)	(0.00334)
inflation	-0.0128***	-0.0187***		
	(0.00429)	(0.00283)		
deposit rate			0.0177***	0.0339***
			(0.00265)	(0.00170)
private credit	-0.000327	-0.000222	-0.000469*	-0.000615***
	(0.000250)	(0.000165)	(0.000249)	(0.000160)
government balance	-0.00749***	-0.0110***	-0.00467**	-0.00812***
	(0.00265)	(0.00175)	(0.00213)	(0.00136)
government pension	-0.0418***	-0.0634***	-0.0273***	-0.0466***
	(0.00448)	(0.00296)	(0.00321)	(0.00206)
constant	3.793***	2.548***	3.560***	2.238***
	(0.0788)	(0.0520)	(0.0711)	(0.0455)
N	62766	62766	62766	62766
adj. R-sq	0.429		0.429	

Table E.8: Sensitivity to Outliers - Robust Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
income	0.371***	0.370***	0.372***	0.376***	0.371***	0.377***
	(0.00282)	(0.00197)	(0.00280)	(0.00275)	(0.00194)	(0.00273)
income uncertainty - micro	0.0297***	0.0119*		0.0295***	0.0120*	
	(0.00675)	(0.00624)		(0.00658)	(0.00614)	
income uncertainty - macro			0.0152***			0.0108***
			(0.000885)			(0.000849)
wealth	-0.0213***	0.00512***	-0.0215***	-0.0242***	0.00430***	-0.0241***
	(0.00181)	(0.000877)	(0.00180)	(0.00177)	(0.000865)	(0.00176)
debt	-0.0149***	-0.0131***	-0.0149***	-0.0149***	-0.0131***	-0.0148***
	(0.000167)	(0.000174)	(0.000166)	(0.000163)	(0.000171)	(0.000162)
housing - micro	-0.00195		-0.00106	0.000216		0.000768
	(0.00235)		(0.00234)	(0.00229)		(0.00229)
housing - macro		-0.00464***			-0.00278***	
		(0.000165)			(0.000174)	
age	0.00248***	0.00224***	0.00242***	0.00246***	0.00226***	0.00241***
	(0.000108)	(0.000101)	(0.000108)	(0.000106)	(0.0000996)	(0.000105)
size	-0.0435***	-0.0432***	-0.0436***	-0.0433***	-0.0430***	-0.0434***
	(0.000962)	(0.000942)	(0.000957)	(0.000937)	(0.000928)	(0.000934)
gender male	0.00304	0.00823***	0.00289	0.00313	0.00837***	0.00306
	(0.00250)	(0.00246)	(0.00249)	(0.00244)	(0.00243)	(0.00243)
inflation	-0.0134***	-0.0206***	-0.0229***			
	(0.00203)	(0.00202)	(0.00207)			
deposit rate				0.0437***	0.0379***	0.0428***
				(0.00117)	(0.00124)	(0.00117)
private credit	-0.00104***	-0.000316***	-0.00135***	-0.00118***	-0.000687***	-0.00141***
	(0.000116)	(0.000118)	(0.000117)	(0.000112)	(0.000116)	(0.000114)
government balance	-0.0124***	-0.0132***	-0.00929***	-0.0115***	-0.00984***	-0.00656***
	(0.00125)	(0.00125)	(0.00126)	(0.000962)	(0.000991)	(0.00104)
government pension	-0.0415***	-0.0698***	-0.0827***	-0.0354***	-0.0479***	-0.0595***
	(0.00189)	(0.00211)	(0.00302)	(0.00118)	(0.00150)	(0.00228)
constant	1.982***	2.303***	2.322***	1.946***	1.929***	2.128***
	(0.0332)	(0.0372)	(0.0384)	(0.0283)	(0.0331)	(0.0320)
N	56102	62765	56102	56102	62765	56102
adj. R-sq	0.574	0.555	0.578	0.592	0.566	0.594

Table E.9: Tobit Regressions

	(1) tobit	(2) tobit	(3) tobit	(4) tobit
income	0.698***	0.321***	0.702***	0.326***
	(0.00582)	(0.00273)	(0.00584)	(0.00271)
income uncertainty	-0.107***	0.0418***	-0.106***	0.0421***
	(0.0139)	(0.00663)	(0.0139)	(0.00656)
wealth	-0.0881***	-0.0127***	-0.0896***	-0.0151***
	(0.00374)	(0.00165)	(0.00374)	(0.00163)
debt	-0.00971***	-0.00735***	-0.00968***	-0.00597***
	(0.000312)	(0.00181)	(0.000311)	(0.00177)
housing	-0.0551***	-0.000588	-0.0538***	0.000977
	(0.00486)	(0.00215)	(0.00486)	(0.00212)
age	0.00266***	0.00211***	0.00265***	0.00208***
	(0.000224)	(0.0000975)	(0.000224)	(0.0000963)
size	-0.0793***	-0.0384***	-0.0796***	-0.0388***
	(0.00199)	(0.000875)	(0.00199)	(0.000865)
gender male	-0.00299	0.00368	-0.00297	0.00376*
	(0.00516)	(0.00225)	(0.00516)	(0.00222)
inflation	-0.0119***	-0.00783***		
	(0.00419)	(0.00185)		
deposit rate			0.0225***	0.0310***
			(0.00247)	(0.00104)
private credit	-0.000980***	-0.000774***	-0.000971***	-0.000716***
	(0.000239)	(0.000107)	(0.000238)	(0.000106)
government balance	-0.00719***	-0.00832***	-0.00467**	-0.00787***
	(0.00258)	(0.00117)	(0.00204)	(0.000911)
government pension	-0.0277***	-0.0320***	-0.0192***	-0.0254***
	(0.00390)	(0.00173)	(0.00251)	(0.00110)
constant	4.507***	1.602***	4.427***	1.557***
	(0.0686)	(0.0316)	(0.0599)	(0.0276)
N	56103	56103	56103	56103

Table E.10: Regression Results Across Waves

	(1) wave 1	(2) wave 2	(3) wave 3	(4) wave 1	(5) wave 2	(6) wave 3
income	0.453***	0.442***	0.432***	0.465***	0.425***	0.411***
	(0.0108)	(0.00573)	(0.00601)	(0.0103)	(0.00586)	(0.00561)
income uncertainty	-0.0120	0.0158	0.00868	-0.0332	0.00736	-0.00487
	(0.0245)	(0.0134)	(0.0157)	(0.0232)	(0.0138)	(0.0151)
wealth	-0.0467***	-0.0246***	-0.0223***	-0.0519***	-0.0275***	-0.0196***
	(0.00747)	(0.00361)	(0.00379)	(0.00709)	(0.00372)	(0.00365)
debt	-0.0127***	-0.0506***	-0.0145***	-0.0128***	-0.0515***	-0.0146***
	(0.000459)	(0.00131)	(0.000264)	(0.000436)	(0.00135)	(0.000255)
housing	0.00393	-0.0120**	-0.00457	0.0150*	-0.0155***	-0.0115**
	(0.00923)	(0.00480)	(0.00498)	(0.00877)	(0.00493)	(0.00477)
age	0.00110***	0.00270***	0.00219***	0.000573	0.00297***	0.00225***
	(0.000404)	(0.000226)	(0.000229)	(0.000382)	(0.000233)	(0.000220)
size	-0.0472***	-0.0537***	-0.0561***	-0.0466***	-0.0498***	-0.0533***
	(0.00364)	(0.00198)	(0.00205)	(0.00346)	(0.00203)	(0.00196)
gender male	0.00961	0.00721	0.00645	-0.00749	0.00861	0.00665
	(0.00961)	(0.00517)	(0.00527)	(0.00910)	(0.00533)	(0.00509)
deposit rate	0.0979***	0.0562***	0.0995***			
	(0.00462)	(0.00345)	(0.00659)			
inflation				-0.232***	-0.121***	-0.130***
				(0.00998)	(0.00559)	(0.0119)
private credit	-0.000619***	-0.00157***	-0.00236***	-0.00153***	-0.000725***	-0.00159***
	(0.000141)	(0.000107)	(0.000151)	(0.000140)	(0.0000937)	(0.000128)
government budget balance	-0.0161***	-0.0119***	-0.00325*	-0.0285***	-0.0125***	-0.00115
	(0.00290)	(0.00131)	(0.00167)	(0.00291)	(0.00129)	(0.00173)
government pension	0.0187***	-0.00589***	-0.00157	-0.00288	-0.0101***	-0.00253*
	(0.00225)	(0.00125)	(0.00146)	(0.00239)	(0.00132)	(0.00149)
constant	1.880***	2.190***	2.033***	2.711***	2.398***	2.012***
	(0.0915)	(0.0548)	(0.0554)	(0.0911)	(0.0589)	(0.0534)
N	14669	20039	21395	14669	20039	21395