Online appendix to "Kaldor and Piketty's Facts: the Rise of Monopoly Power in the United States"

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Abstract

In this online appendix we provide the full set of model equations and define the equilibrium conditions as well as the steady state equilibrium conditions. Further, we provide proofs for the propositions in the paper, and discuss markup estimation techniques in the existing literature. We also consider transition dynamics, and provide impulse responses under different assumptions about the underlying dynamics. Finally, we include some additional tables and figures - illustrating how our baseline results vary with different markup estitmates and sample periods.

1. Full equations of model

1.1. Final goods firms

There is a unit mass of monopolistically competitive final goods firms that differentiate an intermediate good and resell it to consumers. The final good composite is the CES aggregate of these differentiated final goods, which are indexed by i:

$$Y_t = \left[\int_0^1 y_t^f (i)^{\frac{\Lambda_t - 1}{\Lambda_t}} di \right]^{\frac{\Lambda_t}{\Lambda_t - 1}}.$$

Final goods firms set prices in each period, and face a demand curve that takes the following form: $y_t^f(i) = Y_t \left(\frac{p_t(i)}{P_t} \right)^{-\Lambda_t}$, where Λ_t is a time-varying measure of a firm's market power. An increase in Λ_t decreases a firm's market power and lowers equilibrium markups. The nominal price index is defined as

$$P_t = \left(\int_0^1 p_t(i)^{1-\Lambda_t} di \right)^{\frac{1}{1-\Lambda_t}}.$$

Each final goods producer uses y_t^m of intermediate goods to produce output, according to a linear technology function $y_t^f = y_t^m$. A final goods firm chooses real prices $\frac{p_t(i)}{P_t}$ and $y_t^f(i)$ to maximize real

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profits, subject to the production and demand constraints:

$$\begin{aligned} \max \quad & \frac{p_t\left(i\right)}{P_t} y_t^f\left(i\right) - \frac{p_t^{int}}{P_t} y_t^f\left(i\right) \\ \text{subject to} \quad & y_t^f\left(i\right) = Y_t \left(\frac{p_t\left(i\right)}{P_t}\right)^{-\Lambda_t}, \end{aligned}$$

where $\frac{p_t^{int}}{P_t}$ is the price of the intermediate good taken as given by the firm.

The optimality condition for the real price of the firm's good is a time-varying markup over the price of the intermediate good:

$$\frac{p_t\left(i\right)}{P_t} = \frac{\Lambda_t}{\Lambda_t - 1} \frac{p_t^{int}}{P_t} = \mu_t \frac{p_t^{int}}{P_t}, \tag{1}$$

where μ_t is the optimal markup of the firm.

Since the price of the intermediate good is the same, all final goods firms make the same pricing decisions, and thus $p_t\left(i\right) = P_t$, yielding $\frac{p_t^{int}}{P_t} = \frac{1}{\mu_t}$.

Final goods firms have market power which allows them to set prices above marginal costs. Market power is determined by the CES elasticity Λ_t, which determines markups. We posit that $\frac{\Lambda_t}{\Lambda_t - 1}$, i.e. markups μ_t, follow an AR(1) process, given by

$$ln(\mu_t) = (1 - \rho_\mu) ln(\bar{\mu}) + \rho_\mu ln(\mu_{t-1}) + \epsilon_t^\mu. \tag{2}$$

The long run level of markups (determined by the long-run level of Λ) in the economy is given by $\bar{\mu}$. Final goods firms make aggregate profits equal to

$$\Pi_t = \frac{\mu_t - 1}{\mu_t} Y_t. \tag{3}$$

Pure profits go to shareholders of final goods firms, who own the rights to the economic rents, as dividends. Aggregate dividends distributed to shareholders at time t are thus given by

$$d_t^f = \Pi_t. \tag{4}$$

Since all firms make identical profits, each firm receives an equal fraction of aggregate dividends.

1.2. Long Run Risk

Let A_t denote the level of productivity, and lowercase letter denote log-units. The growth rate or productivity is given by:

$$\Delta a_{t+1} = \zeta + x_t + \sigma_a \epsilon_{a,t+1} \tag{5}$$

$$x_t = \rho x_{t-1} + \sigma_x \epsilon_{x,t} \tag{6}$$

$$\begin{bmatrix} \epsilon_{a,t+1} \\ \epsilon_{x,t+1} \end{bmatrix} \sim iid\ N \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho_{xa} \\ \rho_{xa} & 1 \end{bmatrix} \right) \tag{7}$$

Here x_t is the "long run risk" of productivity growth, and $\epsilon_{a,t+1}$ is the short run risk.

1.3. Consumer's problem

The model mainly follows Caldara et al. (2012) and Croce (2014). An infinitely lived individual has Epstein-Zin utility given by

$$V_t = \left[(1-\beta) \left(c_t^{\nu} (A_{t-1}(1-L_t))^{1-\nu} \right)^{\frac{1-\gamma}{\theta}} + \beta D \left(E_t V_{t+1}^{1-\gamma} \right)^{\frac{1}{\theta}} \right]^{\frac{\theta}{1-\gamma}}, \tag{8}$$

where the time discount factor is β, the labor supply coefficient is ν, γ is the risk aversion parameter, and θ is defined as $\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}$.

In this last expression, ψ is the elasticity of intertemporal substitution. The term D_t is an additional wedge between utility in period $t+1$ and period t, beyond the time discount rate of β. Individuals maximize utility subject a series of budget constraints,

$$\begin{aligned} c_t + X_t^i S_{t+1}^i + X_t^f S_{t+1}^f = w_t L_t + d_t^i S_t^i + d_t^f S_t^f \\ +\Delta_{t+1} X_t^f + (1-\Delta_t) X_t^f S_t^f + X_t^i S_t^i. \end{aligned} \tag{9}$$

On the left hand side of the budget constraint, individuals use their income to purchase either consumption, shares of intermediate good firms ($X_t^i S_{t+1}^i$), or shares of final goods firms ($X_t^f S_{t+1}^f$). On the right hand side of the budget equation, agents receive income from a variety of sources:

1. Labor income $w_t L_t$
2. Dividends from intermediate goods firms $d_t^i S_t^i$
3. Dividends from final goods firms $d_t^f S_t^f$
4. IPO issued securities of final goods firms $\Delta_{t+1} X_t^f$

5. Remaining share value of final goods firms. Agents come into the period holding S_t^f shares of the security. Because of firm exit, a fraction Δ_t of shares lose their value, and thus the value remaining is $(1-\Delta_t)X_t^f S_t^f$.
6. Remaining share value of intermediate goods firms, $X_t^i S_t^i$

Due to the nature of the recursive utility, we can write the optimal solution as a recursive function

$$\begin{aligned} V_t(S_t^i, S_t^f) = max_{c_t, L_t, S_{t+1}^i, S_{t+1}^f} \Bigg[(1-\beta)\left(c_t^{\nu}(A_{t-1}(1-L_t))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}} + \\ \beta D \left(E_t V_{t+1}(S_{t+1}^i, S_{t+1}^f)^{1-\gamma}\right)^{\frac{1}{\theta}} \Bigg]^{\frac{\theta}{1-\gamma}} \\ s.t.\ c_t + X_t^i S_{t+1}^i + X_t^f S_{t+1}^f = w_t L_t + d_t^i S_t^i + d_t^f S_t^f \\ + \Delta_{t+1} X_t^f + (1-\Delta_t) X_t^f S_t^f + X_t^i S_t^i. \end{aligned} \tag{10}$$

From this equation, we can derive the first order conditions for optimization. Setting up the Lagrangean and differentiating with respect to c_t, we have

$$\frac{\partial \mathcal{L}}{\partial c_t} : (1-\beta) V_t^{1-\frac{1-\gamma}{\theta}} \left(c_t^{\nu}(A_{t-1}(1-L_t))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}} \nu \frac{1}{c_t} = \lambda_t. \tag{11}$$

Taking first order conditions with respect to L_t, we have

$$\frac{\partial \mathcal{L}}{\partial L_t} : (1-\beta) V_t^{1-\frac{1-\gamma}{\theta}} \left(c_t^{\nu}(A_{t-1}(1-L_t))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}} (1-\nu)\frac{1}{(1-L_t)} = w_t \lambda_t. \tag{12}$$

Combining the first order conditions with respect to labor and with respect to consumption, we have

$$\frac{(1-\nu)}{\nu}\frac{c_t}{(1-L_t)} = w_t, \tag{13}$$

and taking the first order condition with respect to S_{t+1}^f, we have

$$\frac{\partial \mathcal{L}}{\partial S_{t+1}^f} : X_t^f \lambda_t = \beta E_t[\lambda_{t+1}((1-\Delta_{t+1})X_{t+1}^f + d_{t+1}^f)]. \tag{14}$$

Now, taking the first order condition with respect to c_{t+1}, we have

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial c_{t+1}} : V_t^{1-\frac{1-\gamma}{\theta}} \beta D \left(E_t V_{t+1}^{1-\gamma}\right)^{\frac{1}{\theta}-1} \times \\ E_t\left[V_{t+1}^{-\gamma}(1-\beta) V_{t+1}^{1-\frac{1-\gamma}{\theta}} \left(c_{t+1}^{\nu}(A_t(1-L_{t+1}))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}} \nu \frac{1}{c_{t+1}} \right], \end{aligned} \tag{15}$$

where in the last step we make a substitution by forwarding $\frac{\partial}{\partial c_t}$ one period. Canceling redundant terms, we get

$$m_{t+1} = \frac{\partial V_t / \partial c_{t+1}}{\partial V_t / \partial c_t} = \beta D \left(\frac{c_{t+1}}{c_t}\right)^{\frac{\nu(1-\gamma)}{\theta}-1} \left(\frac{A_t(1-L_{t+1})}{A_{t-1}(1-L_t)}\right)^{\frac{(1-\nu)(1-\gamma)}{\theta}} \left(\frac{V_{t+1}^{1-\gamma}}{E_t V_{t+1}^{1-\gamma}}\right)^{1-\frac{1}{\theta}} \tag{16}$$

1.4. Intermediate Goods Firm's Problem

Representative intermediate goods firms use labor L_t and capital K_t to produce intermediate goods Y_t^m according to the production function

$$Y_t^m = \left(\alpha K_t^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_t L_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{17}$$

where σ is the production elasticity of substitution. $\sigma = 1$ corresponds to Cobb-Douglas. The firm finances part of its investment I_t through retained earnings RE_t and issues shares to cover the remaining part, $I_t = X_t^i(S_{t+1}^i - S_t^i) + RE_t$. It distributes the excess of its profits over retained earnings to its shareholders as a dividend, $d_t^i S_t^i = \frac{1}{\mu_t} Y_t^m - w_t L_t - RE_t$. Since $Y_t = Y_t^m$, we have $d_t^i S_t^i = \frac{1}{\mu_t} Y_t - w_t L_t - RE_t$. Investment increases the firm's future stock of capital according to

$$K_{t+1} = \Phi(I_t/K_t)K_t + (1-\delta)K_t, \tag{18}$$

where δ is the rate of depreciation and adjustment costs $\Phi(\cdot)$ are a positive concave function. The adjustment costs function is given by $\Phi(I_t/K_t) = \frac{a_1}{1-\xi}\left(\frac{I_t}{K_t}\right)^{1-\xi} + a_2$.

Following Jermann (1998), we will choose the adjustment costs parameters so that the steady state ratio of investment to capital is not affected. In a model with productivity growth, the investment to capital ratio is given by $\frac{I}{K} = (\delta + e^{\zeta} - 1)$. From equation (18), in the steady state with productivity growth we have that $K(\delta + e^{\zeta} - 1) = \Phi(I/K)K$, thus we must have in the steady state $\Phi(I/K) = (\delta + e^{\zeta} - 1)$. Note that this also ensures that if a firm replaces depreciation and accounts for growth, adjustment costs are zero.

In addition, we also need q to be 1 in the steady state, and thus $\Phi'(I/K) = 1$. These conditions imply the following two conditions:

$$\frac{a_1}{1-\xi}\left(\delta + e^{\zeta} - 1\right)^{1-\xi} + a_2 = (\delta + e^{\zeta} - 1) \tag{19}$$

$$a_1(\delta + e^{\zeta} - 1)^{-\xi} = 1. \tag{20}$$

Thus we have that $a_1 = (\delta + e^{\zeta} - 1)^{\xi}$, and $a_2 = (1 - \frac{1}{(1-\xi)})(\delta + e^{\zeta} - 1)$.

1.4.1. Computation of the intermediate good firm's value

Intermediate goods maximize the expected value of cash flow to the shareholders, discounted by the stochastic discount factor of individuals. Defining cash flow, $CF_t^i = \frac{1}{\mu_t} Y_t - w_t L_t - I_t$, the value of the intermediate good firm is given by

$$V_t^i = E_t\left[\sum_{s=t}^{\infty}\beta^{s-t}D^{s-t}\frac{\lambda_s}{\lambda_t}CF_s^i\right]. \tag{21}$$

Firms maximize (21) subject to (18). The first order conditions are given by:

$$\frac{\partial}{\partial I_t}:\frac{1}{\Phi'(I_t/K_t)} = q_t, \tag{22}$$

where q_t is the the Lagrange multiplier of the maximization problem. Continuing, we have

$$\begin{aligned}\frac{\partial}{\partial K_{t+1}}: -q_t + E_t\Bigg[\beta D\frac{\lambda_{t+1}}{\lambda_t}\Bigg[\frac{1}{\mu_{t+1}}f'(K_{t+1}) + \\ q_{t+1}\left(-\Phi'\left(\frac{I_{t+1}}{K_{t+1}}\right)\left(\frac{I_{t+1}}{K_{t+1}}\right)+\Phi\left(\frac{I_{t+1}}{K_{t+1}}\right)+(1-\delta)\right)\Bigg]\Bigg].\end{aligned}$$

Then, using the fact that $\Phi'(I_{t+1}/K_{t+1}) = \frac{1}{q_{t+1}}$ and $F'(K_{t+1}) = \left(\alpha(K_{t+1})^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_{t+1}L_{t+1})^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}\alpha K_{t+1}^{\frac{-1}{\sigma}}$, we have that

$$\begin{aligned}q_t = E_t\Bigg[\beta D\frac{\lambda_{t+1}}{\lambda_t}\Bigg[\frac{1}{\mu_{t+1}}\left(\alpha(K_{t+1})^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_{t+1}L_{t+1})^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}\alpha K_{t+1}^{\frac{-1}{\sigma}} \\ -\left(\frac{I_{t+1}}{K_{t+1}}\right) + q_{t+1}\left(\Phi\left(\frac{I_{t+1}}{K_{t+1}}\right)+(1-\delta)\right)\Bigg]\Bigg].\end{aligned}$$

Finally, we have

$$\frac{\partial}{\partial L_t}:\frac{1}{\mu_t}\left(\alpha(K_t)^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_tL_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}(1-\alpha)L_t^{\frac{-1}{\sigma}} = w_t. \tag{23}$$

1.5. Asset pricing implications

As usual, the return on the risk free rate is given by $R_t = \frac{1}{E_t[m_{t+1}]}$. The return for investing in intermediate goods firms is given by $R_{t+1}^i = \frac{d_{t+1}^iS_{t+1}^i + X_{t+1}^iS_{t+1}^i}{X_t^iS_{t+1}^i} = \frac{d_{t+1}^i + X_{t+1}^i}{X_t^i}$. Now, using the fact that $q_tK_{t+1} = X_tS_{t+1}^i$, we have

$$\begin{aligned}R_{t+1}^i &= \frac{\frac{1}{\mu_t}Y_{t+1}^m - w_{t+1}L_{t+1} - RE_{t+1} + X_{t+1}^iS_{t+1}^i}{q_tK_{t+1}} \\ &= \frac{\frac{1}{\mu_t}Y_{t+1} - w_{t+1}L_{t+1} - I_{t+1} + X_{t+1}^i(S_{t+2}^i - S_{t+1}^i) + X_{t+1}^iS_{t+1}^i}{q_tK_{t+1}} \\ &= \frac{\frac{1}{\mu_t}Y_{t+1} - w_{t+1}L_{t+1} - I_{t+1} + q_{t+1}K_{t+2}}{q_tK_{t+1}}.\end{aligned} \tag{24}$$

As usual, we have the asset pricing equation $1 = E_t[m_{t+1}R_{t+1}^i]$. The return for investing in final goods firms is given by $R_{t+1}^f = \frac{d_{t+1}^fS_{t+1}^f + (1-\Delta_{t+1})S_{t+1}^fX_{t+1}^f}{S_{t+1}^fX_t^f} = \frac{\frac{\mu_{t+1}-1}{\mu_{t+1}}Y_{t+1} + (1-\Delta_{t+1})X_{t+1}^f}{X_t^f}$

1.6. Equilibrium

An equilibrium is a set of quantities: $\{c_t, K_t, L_t, I_t, Y_t, Y_t^m, d_t^i, d_t^f\}_{t=0}^{\infty}$, a set of prices $\{w_t, X_t^i, X_t^f, q_t, m_t\}_{t=0}^{\infty}$, and a set of exogenous processes $\{\mu_t, A_t, x_t, \Delta_t\}_{t=0}^{\infty}$ that jointly satisfy:

1. Consumption maximizes (8) subject to (9)
2. The stochastic discount factor is given by (16)
3. Intermediate firms maximize (21) subject to (18)
4. Intermediate good production is given by (17), and final good production is given by $Y_t = Y_t^m$
5. Aggregate profits of final goods firms are given by (3), and aggregate dividends are given by (4)
6. The price of securities satisfies (14)
7. The wage is given by (23)
8. The stochastic processes for μ_t, A_t, and x_t are given by (2), (5), and (6)
9. The paths for Δ_t is exogenously specified

While this model is not stationary, we can make it so by applying a standard transformation: divide all quantities (except labor) by A_{t-1}, as well as wages and the price of securities X_t^i and X_t^f.

1.7. Full Equations of Model

Now, collecting the equations of the model, we have

$$V_t = \left[(1-\beta)\left(c_t^{\nu}(A_{t-1}(1-L_t))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}} + \beta D\left(E_t(V_{t+1})^{1-\gamma}\right)^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}} \tag{25}$$

$$m_{t+1} = \beta D\left(\frac{c_{t+1}}{c_t}\right)^{\frac{\nu(1-\gamma)}{\theta}-1}\left(\frac{A_t(1-L_{t+1})}{A_{t-1}(1-L_t)}\right)^{\frac{(1-\nu)(1-\gamma)}{\theta}}\left(\frac{V_{t+1}^{1-\gamma}}{E_t V_{t+1}^{1-\gamma}}\right)^{1-\frac{1}{\theta}} \tag{26}$$

$$\frac{(1-\nu)}{\nu}\frac{c_t}{(1-L_t)} = w_t \tag{27}$$

$$\frac{1}{\Phi'(I_t/K_t)} = q_t, \tag{28}$$

$$\begin{aligned} q_t = E_t\Bigg[m_{t+1}\Bigg[\frac{1}{\mu_{t+1}}\left(\alpha(K_{t+1})^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_{t+1}L_{t+1})^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}\alpha K_{t+1}^{\frac{-1}{\sigma}} \\ -\left(\frac{I_{t+1}}{K_{t+1}}\right) + q_{t+1}\left(\Phi\left(\frac{I_{t+1}}{K_{t+1}}\right) + (1-\delta)\right)\Bigg]\Bigg] \end{aligned} \tag{29}$$

$$\frac{1}{\mu_t}\left(\alpha(K_t)^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_tL_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}(1-\alpha)A_t^{\frac{\sigma-1}{\sigma}}L_t^{\frac{-1}{\sigma}} = w_t \tag{30}$$

$$Y_t^m = \left(\alpha K_t^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_tL_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{31}$$

$$Y_t = Y_t^m \tag{32}$$

$$Y_t = c_t + I_t \tag{33}$$

$$K_{t+1} = \Phi(I_t/K_t)K_t + (1-\delta)K_t, \tag{34}$$

$$\begin{aligned} \Delta a_{t+1} &= \zeta + x_t + \sigma_a \epsilon_{a,t+1} \\ x_t &= \rho x_{t-1} + \sigma_x \epsilon_{x,t} \end{aligned} \tag{35}$$

$$ln(\mu_t) = (1-\rho_\mu)ln(\bar{\mu}) + \rho_\mu ln(\mu_{t-1}) + \epsilon_t^\mu. \tag{36}$$

$$R_t = \frac{1}{E_t[m_{t+1}]} \tag{37}$$

$$R_{t+1}^i = \frac{\frac{1}{\mu_t}Y_{t+1} - w_{t+1}L_{t+1} - I_{t+1} + q_{t+1}K_{t+2}}{q_t K_{t+1}}. \tag{38}$$

$$d_t^f = \frac{\mu_t - 1}{\mu_t} Y_t \tag{39}$$

$$X_t^f = E_t[m_{t+1}((1-\Delta_{t+1})X_{t+1}^f + d_{t+1}^f)]. \tag{40}$$

$$R_{t+1}^f = \frac{\frac{\mu_{t+1}-1}{\mu_{t+1}}Y_{t+1} + (1-\Delta_{t+1})X_{t+1}^f}{X_t^f} \tag{41}$$

The variables are $V, Y, Y^m, c, L, m, w, q, K, I, a, x, \mu, R, R^i, R^f, d_t^f, X^f$. Thus there are 18 equations and 18 variables.

1.8. Making the model stationary

We now make a standard transformation by dividing the following variables by A_{t-1}: V, Y, Y^m, c, w, K, I, X^f, X^i, d^f, d^i. We then have the following set of equations:

$$V_t = \left[(1-\beta)\left(c_t^\nu((1-L_t))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}} + e^{\left(\frac{1-\gamma}{\theta}\right)\Delta a_t}\beta D\left(E_t(V_{t+1})^{1-\gamma}\right)^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}} \tag{42}$$

$$m_{t+1} = \beta D \left(\frac{c_{t+1}}{c_t}\right)^{\frac{\nu(1-\gamma)}{\theta}-1} \left(\frac{(1-L_{t+1})}{(1-L_t)}\right)^{\frac{(1-\nu)(1-\gamma)}{\theta}} \left(\frac{V_{t+1}^{1-\gamma}}{E_t V_{t+1}^{1-\gamma}}\right)^{1-\frac{1}{\theta}} e^{\left(\frac{(1-\gamma)}{\theta}-1\right)\Delta a_t} \tag{43}$$

$$\frac{(1-\nu)}{\nu}\frac{c_t}{(1-L_t)} = w_t \tag{44}$$

$$\frac{1}{\Phi'(I_t/K_t)} = q_t, \tag{45}$$

$$\begin{aligned} q_t = E_t \Bigg[m_{t+1} \Bigg[\frac{1}{\mu_{t+1}} \left(\alpha (K_{t+1})^{\frac{\sigma-1}{\sigma}} + (1-\alpha) e^{\frac{\sigma-1}{\sigma}\Delta a_{t+1}} (L_{t+1})^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}} \alpha K_{t+1}^{\frac{-1}{\sigma}} \\ - \left(\frac{I_{t+1}}{K_{t+1}}\right) + q_{t+1}\left(\Phi\left(\frac{I_{t+1}}{K_{t+1}}\right) + (1-\delta)\right)\Bigg]\Bigg] \end{aligned} \tag{46}$$

$$\frac{1}{\mu_t}\left(\alpha (K_t)^{\frac{\sigma-1}{\sigma}} + (1-\alpha) e^{\frac{\sigma-1}{\sigma}\Delta a_t} (L_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}} (1-\alpha) e^{\frac{\sigma-1}{\sigma}\Delta a_t} L_t^{\frac{-1}{\sigma}} = w_t \tag{47}$$

$$Y_t^m = \left(\alpha K_t^{\frac{\sigma-1}{\sigma}} + (1-\alpha) e^{\frac{\sigma-1}{\sigma}\Delta a_t} (L_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{48}$$

$$Y_t = Y_t^m \tag{49}$$

$$Y_t = c_t + I_t \tag{50}$$

$$K_{t+1} e^{\Delta a_t} = \Phi(I_t/K_t) K_t + (1-\delta) K_t, \tag{51}$$

$$\begin{aligned} \Delta a_{t+1} &= \zeta + x_t + \sigma_a \epsilon_{a,t+1} \\ x_t &= \rho x_{t-1} + \sigma_x \epsilon_{x,t} \end{aligned} \tag{52}$$

$$ln(\mu_t) = (1-\rho_\mu) ln(\bar{\mu}) + \rho_\mu ln(\mu_{t-1}) + \epsilon_t^\mu. \tag{53}$$

$$R_t = \frac{1}{E_t[m_{t+1}]} \tag{54}$$

$$R_{t+1}^i = \frac{\frac{1}{\mu_t} Y_{t+1} - w_{t+1} L_{t+1} - I_{t+1} + q_{t+1} K_{t+2} e^{\Delta a_{t+1}}}{q_t K_{t+1}}. \tag{55}$$

$$d_t^f = \frac{\mu_t - 1}{\mu_t} Y_t \tag{56}$$

$$X_t^f = E_t[m_{t+1}((1-\Delta_{t+1})X_{t+1}^f e^{\Delta a_t} + d_{t+1}^f e^{\Delta a_t})]. \tag{57}$$

$$R_{t+1}^f = \frac{d_{t+1}^f e^{\Delta a_t} + (1-\Delta_{t+1})X_{t+1}^f e^{\Delta a_t}}{X_t^f} \tag{58}$$

1.9. Steady State

In the steady state, all transformed variables are constant.

We begin by finding steady state investment. From equation (51), and using the assumed properties of the $\Phi(\cdot)$ function, in particular that in the steady state $\Phi(\cdot) = \delta + e^{\zeta} + 1$ we have that $\frac{I}{K} = \delta + e^{\zeta} - 1$. Next, using the fact that

$$\bar{m} = \beta D e^{\left(\frac{(1-\gamma)}{\theta} - 1\right)\zeta}, \tag{59}$$

from equation (46) we have that

$$1 = \bar{m}\left[\frac{1}{\bar{\mu}}\left(\alpha\left(\frac{\bar{K}}{\bar{L}}\right)^{\frac{\sigma-1}{\sigma}} + (1-\alpha)e^{\frac{\sigma-1}{\sigma}\zeta}\right)^{\frac{1}{\sigma-1}} \alpha\left(\frac{\bar{K}}{\bar{L}}\right)^{\frac{-1}{\sigma}} + 1 - \delta\right]. \tag{60}$$

Rearranging, we have

$$\left(\frac{\bar{K}}{\bar{L}}\right) = \left[\frac{(1-\alpha)e^{\frac{\sigma-1}{\sigma}\zeta}}{\left[\left(\frac{1}{\bar{m}} - 1 + \delta\right)\frac{\mu}{\alpha}\right]^{\sigma-1} - \alpha}\right]^{\frac{\sigma}{\sigma-1}}. \tag{61}$$

Continuing, from (48) and (50) we have that

$$\frac{\bar{c}}{\bar{L}} = \frac{\bar{Y}}{\bar{L}} - (e^{\zeta} + \delta - 1)\frac{\bar{K}}{\bar{L}}, \tag{62}$$

where

$$\frac{\bar{Y}}{\bar{L}} = \left(\alpha\left(\frac{\bar{K}}{\bar{L}}\right)^{\frac{\sigma-1}{\sigma}} + (1-\alpha)e^{\frac{\sigma-1}{\sigma}\zeta}\right)^{\frac{\sigma}{\sigma-1}}. \tag{63}$$

Now, combining the definition for the wage with the first order condition for labor, and rearranging, we have $\left(\frac{1}{\bar{\mu}}\right) M\bar{P}L = \frac{(1-\nu)}{\nu}\frac{\bar{c}}{(1-\bar{L})}$, where $M\bar{P}L = (1-\alpha)e^{\frac{\sigma-1}{\sigma}\zeta}\left(\alpha\left(\frac{\bar{K}}{\bar{L}}\right)^{\frac{\sigma-1}{\sigma}} + (1-\alpha)e^{\frac{\sigma-1}{\sigma}\zeta}\right)^{\frac{1}{\sigma-1}}$. Rearranging, we have

$$\frac{\bar{c}}{\bar{L}} = \frac{\nu}{1-\nu}\frac{(1-\bar{L})}{\bar{L}}\left(\frac{1}{\bar{\mu}}\right) M\bar{P}L. \tag{64}$$

Now combining (62) and (64), we have $\frac{\bar{Y}}{\bar{L}} - (e^{\zeta}+\delta-1)\frac{\bar{K}}{\bar{L}} = \frac{\nu}{1-\nu}\frac{(1-\bar{L})}{\bar{L}}\left(\frac{1}{\bar{\mu}}\right) M\bar{P}L$. Solving for $\bar{L}$, we have

$$\bar{L} = \frac{\frac{\nu}{1-\nu}\left(\frac{1}{\bar{\mu}}\right) M\bar{P}L}{\frac{\bar{Y}}{\bar{L}} - (e^{\zeta}+\delta-1)\frac{\bar{K}}{\bar{L}} + \frac{\nu}{1-\nu}\left(\frac{1}{\bar{\mu}}\right) M\bar{P}L}$$

Turning now to the value function, we have

$$\bar{V} = \left(\frac{(1-\beta)\left(\bar{c}^{\nu}((1-\bar{L}))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}}}{1-e^{\left(\frac{1-\gamma}{\theta}\right)\zeta}\beta}\right)^{\frac{\theta}{1-\gamma}}$$

2. Proofs

2.1. Comparative statics of markups

Proposition 1.1, part a. $\frac{\partial\frac{\bar{K}}{\bar{L}}}{\partial\bar{\mu}} < 0$. *If steady-state markups $\bar{\mu}$ increase, the steady state capital-to-labor ratio $\frac{\bar{K}}{\bar{L}}$ will decrease.*

Equation 61 gives the steady state level of the capital-to-labor ratio. Differentiating with respect to $\bar{\mu}$, we have

$$\begin{aligned}\frac{\partial\frac{\bar{K}}{\bar{L}}}{\partial\bar{\mu}} = \left[\frac{\left[\left(\frac{1}{\bar{m}}-1+\delta\right)\frac{\bar{\mu}}{\alpha}\right]^{\sigma-1}-\alpha}{(1-\alpha)e^{\frac{\sigma-1}{\sigma}\zeta}}\right]^{\frac{2\sigma-1}{1-\sigma}} \frac{\sigma}{1-\sigma}(\sigma-1) \\ \left[\left(\frac{1}{\bar{m}}-1+\delta\right)\frac{1}{\alpha}\right]^{\sigma-1}\bar{\mu}^{\sigma-2}\frac{1}{(1-\alpha)e^{\frac{\sigma-1}{\sigma}\zeta}}.\end{aligned} \tag{65}$$

This term is negative, since either $(\sigma-1)$ or $\frac{\sigma}{1-\sigma}$ is negative, but not both. Note that both bracketed terms are positive: the first, because the capital-to-labor ratio is positive; the second, because the steady state real interest rate cannot be negative.

Proposition 1.1, part b. $\frac{\partial\frac{\bar{K}}{\bar{Y}}}{\partial\bar{\mu}} < 0$. *If steady-state markups $\bar{\mu}$ increase, the capital-to-output ratio $\frac{\bar{K}}{\bar{Y}}$ will decrease.*

We have $\frac{\bar{K}}{\bar{Y}} = \frac{\bar{K}}{\bar{L}}\cdot\frac{\bar{L}}{\bar{Y}}$. We can write the elasticity of the capital-to-output ratio with respect to markups as

$$\epsilon_{\frac{\bar{K}}{\bar{Y}},\bar{\mu}} \equiv \frac{\partial\frac{\bar{K}}{\bar{Y}}}{\partial\bar{\mu}}\cdot\frac{\bar{\mu}}{\frac{\bar{K}}{\bar{Y}}} = \frac{\partial\frac{\bar{K}}{\bar{L}}}{\partial\bar{\mu}}\cdot\frac{\bar{\mu}}{\frac{\bar{K}}{\bar{L}}} + \frac{\partial\frac{\bar{L}}{\bar{Y}}}{\partial\bar{\mu}}\cdot\frac{\bar{\mu}}{\frac{\bar{L}}{\bar{Y}}}$$

From equation 63, we see that $\frac{\partial \frac{\bar{L}}{\bar{Y}}}{\partial \bar{\mu}} = \frac{\partial \frac{\bar{L}}{\bar{Y}}}{\partial \frac{\bar{K}}{\bar{L}}} \frac{\partial \frac{\bar{K}}{\bar{L}}}{\partial \bar{\mu}}$. We thus have

$$\epsilon_{\frac{\bar{K}}{\bar{Y}},\bar{\mu}} = \frac{\partial \frac{\bar{K}}{\bar{L}}}{\partial \bar{\mu}} \cdot \frac{\bar{\mu}}{\frac{\bar{K}}{\bar{L}}} \left[1 + \frac{\partial \frac{\bar{L}}{\bar{Y}}}{\partial \frac{\bar{K}}{\bar{L}}} \frac{\frac{\bar{K}}{\bar{L}}}{\frac{\bar{L}}{\bar{Y}}} \right]. \tag{66}$$

From equation 63, we have that

$$\frac{\partial \frac{\bar{L}}{\bar{Y}}}{\partial \frac{\bar{K}}{\bar{L}}} \frac{\frac{\bar{K}}{\bar{L}}}{\frac{\bar{L}}{\bar{Y}}} = \frac{-\alpha \left(\frac{\bar{K}}{\bar{L}}\right)^{\frac{\sigma-1}{\sigma}}}{\left(\alpha \left(\frac{\bar{K}}{\bar{L}}\right)^{\frac{\sigma-1}{\sigma}} + (1-\alpha) e^{\frac{\sigma-1}{\sigma}\zeta}\right)}, \tag{67}$$

which is negative and less than 1 in absolute value, thus the term in square brackets in equation 66 is positive. Since we have already shown $\frac{\partial \frac{\bar{K}}{\bar{L}}}{\partial \bar{\mu}} < 0$, $\epsilon_{\frac{\bar{K}}{\bar{Y}},\bar{\mu}} < 0$.

Proposition 1.6. $\frac{\partial \frac{\bar{I}}{\bar{Y}}}{\partial \bar{\mu}} < 0$. *If steady-state markups $\bar{\mu}$ increase, the steady state investment-to-output ratio $\frac{\bar{I}}{\bar{Y}}$ will decrease.*

This follows from the investment equation in the paper and proposition 1.1. Since investment-to-output is proportional to the capital-to-output ratio, if this ratio declines, the investment ratio will as well.

Proposition 1.4 and 1.5. $\frac{\partial PS}{\partial \bar{\mu}} > 0$. $\frac{\partial LS}{\partial \bar{\mu}} < 0$, *if* $\sigma \leq 1$. $\frac{\partial KS}{\partial \bar{\mu}} < 0$, *if* $\sigma \geq 1$. *An increase in steady state markups will increase the steady state profit share. If $\sigma \leq 1$, an increase in steady state markups will decrease the steady state labor share. if $\sigma \geq 1$, an increase in markups will decrease the capital share.*

Since the profit share is given by $PS = \frac{\bar{\mu}-1}{\bar{\mu}}$, an increase in markups will increase the profit share. Thus the combined labor and capital share will decrease. From the first order conditions of the firm, the ratio of the rental rate of capital to the wage is given by $\frac{r^k}{w} = \frac{\alpha}{1-\alpha}\left[\frac{\bar{K}}{\bar{L}}\right]^{\frac{-1}{\sigma}}$.

Multiplying both sides by $\frac{\bar{K}}{\bar{L}}$, the left hand side is the ratio of the capital share to the labor share, and thus we have

$$\frac{KS}{LS} = \frac{\alpha}{1-\alpha}\left[\frac{\bar{K}}{\bar{L}}\right]^{\frac{\sigma-1}{\sigma}}. \tag{68}$$

Thus if $\sigma < 1$, a decrease in $\frac{\bar{K}}{\bar{L}}$ will lead to a decrease in the labor share relative to the capital share. When markups increase, there is a decrease in the combined labor and capital share. In addition, since there is a decrease in $\frac{\bar{K}}{\bar{L}}$, labor takes a smaller portion of this decreased overall share. Thus the labor share unambiguously declines. Similarly, when $\sigma > 1$, the capital share unambiguously declines with an increase in markups. If $\sigma = 1$, production is Cobb-Douglas, and the relative factor shares of capital and labor are unchanged by the capital-to-output ratio. In this case, both the capital and labor share unambiguously decline with an increase in markups.

Proposition 1.2. $\frac{\partial Q}{\partial \bar{\mu}} > 0$. *If markups increase, Tobin's Q will increase.*

We can write steady state Q as $Q = 1 + \frac{X^f}{K} = 1 + \frac{X^f}{Y}\frac{Y}{K}$. From the steady state security value euqation in the paper, if markups increase there will be an increase in $\frac{X^f}{Y}$, and since there will also be an increase in $\frac{Y}{K}$, there will be an increase in Tobin's Q.

Proposition 1.3. $\frac{\partial AR}{\partial \bar{\mu}} > 0$. *If markups increase, the average return will increase.*

This follows from the average return equation in the paper. When markups increase, the profit share increases and the capital-to-output ratio will decrease, thus the average return will increase.

2.2. Comparative statics of D

Proposition 2.3. $\frac{\partial AR}{\partial D} < 0$. *An increase in D will lead to a decrease in the average return.*

From equation 59, an increase in D will increase $\bar{m}$, which will lower the steady state interest rate $\bar{r}$, since $\bar{r} = \frac{1}{\bar{m}}$. From equation 61, a decrease in r will also increase the capital-to-output ratio. Then from the average return equation in the paper, this will lower the average return.

Proposition 2.2. $\frac{\partial \frac{K}{Y}}{\partial D} > 0$, $\frac{\partial \frac{K}{L}}{\partial D} > 0$. *An increase in D will lead to an increase in the capital-to-output ratio and the capital-to-labor ratio.*

An increase in D will decrease r. From equation 61 and the further derivations, a decrease in r will increase the capital-to-labor ratio and the capital-to-output ratio.

Proposition 2.6. $\frac{\partial \frac{I}{Y}}{\partial D} > 0$. *An increase in D will lead to an increase in the investment-to-output ratio.*

This follows from the investment equation in the paper. Since investment-to-output is proportional to the capital-to-output ratio, if this ratio increases, the investment ratio will as well.

Proposition 2.4. $\frac{\partial LS}{\partial D} > 0$ *if* $\sigma < 1$. *An increase in D will lead to an increase in the labor share if* $\sigma < 1$. *If* $\sigma > 1$, $\frac{\partial LS}{\partial D} < 0$.

Proposition 2.5. $\frac{\partial KS}{\partial D} < 0$ *if* $\sigma < 1$. *An increase in D will lead to a decrease in the capital share if* $\sigma < 1$. *If* $\sigma > 1$, $\frac{\partial KS}{\partial D} > 0$.

This follows directly from equation 68. If $\sigma < 1$, an increase in $\frac{\bar{K}}{L}$ will lead to a increase in the labor share relative to the capital share. When D increases, there is an increase in the capital-to-labor ratio, and the labor share relative to the capital share increases. Since there is no change in the combined labor and capital share, the labor share unambiguously increases, and the capital share declines. Similarly, when $\sigma > 1$, the capital share unambiguously increases with an increase in D, and the labor share decreases. If $\sigma = 1$, production is Cobb-Douglas, and the relative factor shares of capital and labor are unchanged by the capital-to-output ratio. In this case, both the capital and labor share do not respond to a change in D.

Proposition 2.1. $\frac{\partial \frac{W}{Y}}{\partial D} > 0$. *An increase in D will lead to an increase in wealth-to-output.*

From the steady state security value equation in the paper, a decrease in interest rates will lead to an increase in the ratio of the security value to output. This result, combined with an increase in the capital-to-output ratio, leads to an increase in the wealth-to-output ratio.

3. Markup estimation techniques

Markup estimates from the literature fall into three categories. We discuss each in turn.

The first method is taken from the New Keynesian literature, which has historically estimated markups in order to test their cyclicality. With the assumption that the production function is CES, it can be shown (see Nekarda and Ramey (2013)) that markups are equal to

$$M^{CES} = \frac{\alpha}{s}\left(\frac{Y}{ZhN}\right)^{\frac{1}{\sigma}-1}, \tag{69}$$

Where α is the coefficient on labor in the production function, Z is the level of labor productivity, hN the labor input, and σ the production CES parameter.

The idea behind the New Keynsian estimate of markups is that given constant production parameters α and σ and a constant ratio of output to labor inputs, any decrease in the labor share must be because markups are higher. While this may be useful for estimating cyclicality of markups, there are a few reasons to believe why they are less useful for estimating long run changes in markups. First, over the long run it may be possible that aggregate production parameters can change, if, for example, there have been a shift from manufacturing to services. Second, the estimates are highly reliant on a specific production function and estimates of the production parameters, as well as on labor productivity and labor inputs that may be imprecisely estimated.

The second category uses techniques from IO and firm level data to estimate markups. The key insight of this, as described in De Loecker and Warzynski (2012), is that the output elasticity of a variable factor of production is only equal to its expenditure share under perfect competition, thus in order to estimate markups at the firm or industry level all that is needed is an estimate of production elasticities. This method is related to that of Hall (1988), who also uses a production-side approach to measure marginal cost. De Loecker and Eeckhout (2017) use this method to estimate a new time series of markups and find a massive increase in markups, from 18% in 1980 to 67% in the present. This paper has been criticized by Traina (2018) and Gutiérrez and Philippon (2017), who note that the estimates are sensitive to the definition of variable input. If total expenses are used in the estimation instead of the cost of goods sold, there are more moderate increases in markups, on the order of 3-5 percentage points.

The third category estimates markups using aggregate macroeconomic data in the spirit of Barkai (2016), exploiting the fact that under constant returns to scale production, markups are proportional to the profit share of the economy. In particular, under CRS markups equal the inverse of the share of production not accounted for by pure profits:

$$PS = \frac{\mu - 1}{\mu} \implies \mu = \frac{1}{1-PS}. \tag{70}$$

4. Transition dynamics

In this section we discuss the dynamics of our model economy. Although the main purpose of this paper is to explain long term trends in the macroeconomic data, a separate (and important) question is to try and explain the transition dynamics of the economy over the past forty years. As the data in the paper shows, although many of the data series show a fairly smooth transition from 1970 to the present, there are exceptions, such as the spike in Tobin's Q in the late 1990s. The biggest challenge in modeling these changes is in determining the stochastic process under which they were generated. Are these increases in markups a one-time occurrence? Or is there a stochastic process under which the permanent component of markups can change? A separate, but related, challenge in modeling dynamics is to determine the *timing* when agents are aware that there has been a shift in the economy. If agents realized starting in 1980 that profits would increase in the future, then stock prices (and Q) should jump in 1980. If instead there was a slow process or learning, we would see a graduate increase in Tobin's Q.

We consider four types of transition dynamics, leaving more detailed models of the transition to future work. First, we will compute impulse response functions of our economy to a shock to markups, in order to examine the dynamics of the model and the speed of convergence. Second, we solve the model around its 2015 steady state, and then simulate the model, taking as initial conditions the steady state value of all variables in 1970. Third, we feed in a smooth series of markup shocks, so that the level of markups moves from its empirical level in 1970 to its level in 2015. Finally, we will feed in a series of markup shocks so that the time series for markups matches the time series of markups in the data.

We examine the impulse response function of the model to a one-time shock to markups, ϵ_t^{μ}. Figure 1 shows the model's response to a one standard deviation increase in markups, which is an increase of .5%. The model responds as we would expect: there is an increase in the profit share of .44 p.p., and a corresponding combined decrease in the combined labor and capital share of .44 p.p.. There is an increase in the wealth-to-output ratio of .014 (.52%), an increase of .006 (.5%) in Tobin's Q, and an increase in the average return of .2 p.p.. Finally, there is a decrease in the investment-to-output ratio of .2 p.p. (1.4%). The transition to the new steady state is relatively fast: after a temporary increase in markups, the effects have largely dissipated after 20 months.

In the second exercise, we solve the policy and transition functions of the model around its 2015 steady state. We then simulate the model, taking as the initial condition the steady state value of all variables in 1970, in particular, the 1970 level of markups and capital-to-labor ratio. Figure 2 shows the results of this exercise. The transition between steady states is slower: it takes around 7 years for most variables to reach the 2015 steady state, starting at 1970 steady state values. There are significant differences between some of the magnitudes in the transition IRFs and the magnitudes when comparing stochastic stationary states. The IRFs show an increase in the wealth-to-output ratio of .24 during the transition, compared to an increase of .5 in the comparative statics exercise, and an increase Tobin's Q

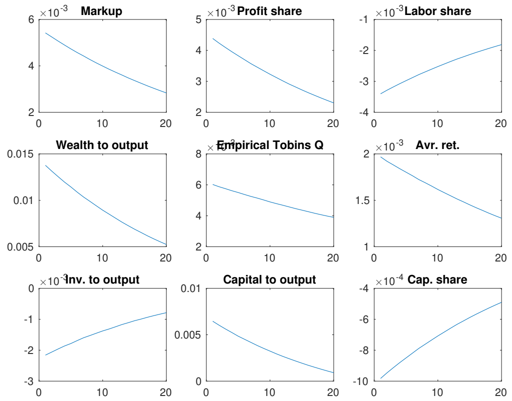

Figure 1: Impulse response to increase in markups of 1 s.d. ($\approx .5\%$)

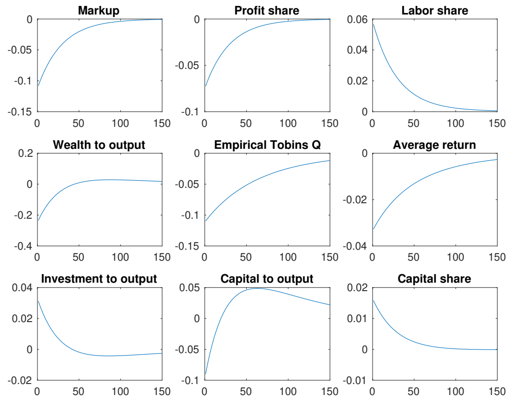

Figure 2: Transition from 1970 markups to 2015 markups, one time shock

of .09, compared to an increase of .34 in the comparative statics exercise. It is not surprising that the magnitudes are smaller in the transition exercise, for changes in markups are not permanent, and are assumed to return to their steady state. The changes in the factor shares in the transition are similar in magnitude to the changes in the comparative statics exercise.

In the third exercise, we solve the policy and transition functions of the model around its 1970 steady state. We then feed in a smooth series of shocks, chosen so that markups increase from their steady state level in 1970 to their level in 2015. Figure 3 shows these results. The results of this transition exercise show linear dynamics, with a few exceptions: the transition path for wealth-to-output and investment are non-linear. The magnitudes of the changes, once again, show significant differences to that of the comparative statics exercise. In the fourth exercise, we feed into the model a series of shocks such that markups follow the exact empirical pattern of the data, from 1970 to 2015. Figure 4 shows these results. Although there is an increase in markups over the period, the increase is not smooth: during the early 1980s there is a significant decrease in markups. This is due to an increase in the capital share in the data. Overall, the magnitudes of the changes seen in figure 4 are similar to those in figure 3.

Figure 3: Transition from 1970 to 2015 steady state, smooth series of shocks

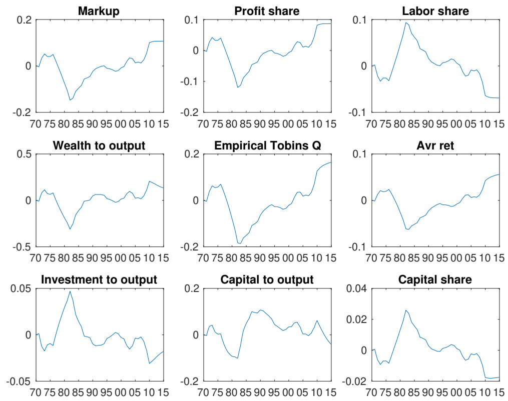

Figure 4: IRF for full path of markups, 1970-2015

5. Additional tables

Table 1: Quantitative results: changes in markups only

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.32	1.10
Capital-to-output ratio (**P1**)	-0.15	0.31
Tobin's Q (**P2**)	0.27	0.26
Real interest rate (**P3**)	$-0.01\,pp$	$-2.00\,pp$
Average return (**P3**)	4.04	-0.14
Profit share (**P4**)	$7.45\,pp$	$7.66\,pp$
Labor share (**P4**)	$-6.04\,pp$	$-5.51\,pp$
Capital share (**P4**)	$-1.41\,pp$	$-2.15\,pp$
Investment-to-output (**P5**)	$-0.12\,pp$	$-4.09\,pp$
Equity Premium	$2.09\,pp$	$0-2\,pp$

Table 2: Quantitative results: changes in D only

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.38	1.10
Capital-to-output ratio (**P1**)	0.35	0.31
Tobin's Q (**P2**)	-0.03	0.26
Real interest rate (**P3**)	-1.79 *pp*	-2.00 *pp*
Average return (**P3**)	-2.97	-0.14
Profit share (**P4**)	-0.00 *pp*	7.66 *pp*
Labor share (**P4**)	0.38 *pp*	-5.51 *pp*
Capital share (**P4**)	-0.38 *pp*	-2.15 *pp*
Investment-to-output (**P5**)	0.34 *pp*	-4.09 *pp*
Equity Premium	0.20 *pp*	$0 - 2$ *pp*

Table 3: Quantitative results: changes in productivity growth only

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.03	1.10
Capital-to-output ratio (**P1**)	0.04	0.31
Tobin's Q (**P2**)	-0.01	0.26
Real interest rate (**P3**)	-0.21 *pp*	-2.00 *pp*
Average return (**P3**)	-0.30	-0.14
Profit share (**P4**)	-0.00 *pp*	7.66 *pp*
Labor share (**P4**)	0.04 *pp*	-5.51 *pp*
Capital share (**P4**)	-0.04 *pp*	-2.15 *pp*
Investment-to-output (**P5**)	-0.70 *pp*	-4.09 *pp*
Equity Premium	-0.09 *pp*	$0 - 2$ *pp*

Table 4: Quantitative results: changes in D and productivity growth

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.43	1.10
Capital-to-output ratio (**P1**)	0.40	0.31
Tobin's Q (**P2**)	−0.04	0.26
Real interest rate (**P3**)	−2.00 *pp*	−2.00 *pp*
Average return (**P3**)	−3.27	−0.14
Profit share (**P4**)	−0.00 *pp*	7.66 *pp*
Labor share (**P4**)	0.43 *pp*	−5.51 *pp*
Capital share (**P4**)	−0.43 *pp*	−2.15 *pp*
Investment-to-output (**P5**)	−0.48 *pp*	−4.09 *pp*
Equity Premium	0.08 *pp*	0 − 2 *pp*

Table 5: Alternative markup estimates. Ramey quantitative results: changes in markups, productivity growth rates, interest rates

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.49	1.10
Capital-to-output ratio (**P1**)	0.11	0.31
Tobin's Q (**P2**)	0.16	0.26
Real interest rate (**P3**)	−1.99 *pp*	−2.00 *pp*
Average return (**P3**)	2.38	−0.14
Profit share (**P4**)	9.77 *pp*	7.66 *pp*
Labor share (**P4**)	−7.10 *pp*	−5.51 *pp*
Capital share (**P4**)	−2.67 *pp*	−2.15 *pp*
Investment-to-output (**P5**)	−0.68 *pp*	−4.09 *pp*
Equity Premium	3.57 *pp*	0 − 2 *pp*

Table 6: Alternative markup estimates. De Loecker quantitative results: changes in markups, productivity growth rates, interest rates

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	1.10	1.10
Capital-to-output ratio (**P1**)	-0.14	0.31
Tobin's Q (**P2**)	0.68	0.26
Real interest rate (**P3**)	$-2.00\,pp$	$-2.00\,pp$
Average return (**P3**)	5.43	-0.14
Profit share (**P4**)	$24.87\,pp$	$7.66\,pp$
Labor share (**P4**)	$-20.76\,pp$	$-5.51\,pp$
Capital share (**P4**)	$-4.11\,pp$	$-2.15\,pp$
Investment-to-output (**P5**)	$-0.73\,pp$	$-4.09\,pp$
Equity Premium	$4.38\,pp$	$0-2\,pp$

Table 7: Alternative markup estimates. Gutierrez quantitative results: changes in markups, productivity growth rates, interest rates

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.60	1.10
Capital-to-output ratio (**P1**)	0.35	0.31
Tobin's Q (**P2**)	0.06	0.26
Real interest rate (**P3**)	$-2.00\,pp$	$-2.00\,pp$
Average return (**P3**)	-2.23	-0.14
Profit share (**P4**)	$4.31\,pp$	$7.66\,pp$
Labor share (**P4**)	$-3.16\,pp$	$-5.51\,pp$
Capital share (**P4**)	$-1.15\,pp$	$-2.15\,pp$
Investment-to-output (**P5**)	$-0.48\,pp$	$-4.09\,pp$
Equity Premium	$1.12\,pp$	$0-2\,pp$

Table 8: Alternative markup estimates. Hall quantitative results: changes in markups, productivity growth rates, interest rates

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.87	1.10
Capital-to-output ratio (**P1**)	0.16	0.31
Tobin's Q (**P2**)	0.31	0.26
Real interest rate (**P3**)	-2.00 *pp*	-2.00 *pp*
Average return (**P3**)	1.26	-0.14
Profit share (**P4**)	10.55 *pp*	7.66 *pp*
Labor share (**P4**)	-8.16 *pp*	-5.51 *pp*
Capital share (**P4**)	-2.38 *pp*	-2.15 *pp*
Investment-to-output (**P5**)	-0.60 *pp*	-4.09 *pp*
Equity Premium	3.09 *pp*	$0-2$ *pp*

Table 9: Decomposing the change in the equity premium

Moments	*1970 EP (p.p.)*	*2018 EP (p.p.)*
Final goods firms	14.32	14.16
Capital	-0.67	-0.78
Weighted Avg	2.85	4.78
Total 1970 weight	2.85	2.73

Table 10: Alternative sample period. 1960-2018: changes in markups, productivity growth rates, interest rates

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	-0.00	-0.34
Capital-to-output ratio (**P1**)	0.29	0.30
Tobin's Q (**P2**)	-0.20	-0.51
Real interest rate (**P3**)	-1.30 *pp*	-1.30 *pp*
Average return (**P3**)	-4.79	-1.57
Profit share (**P4**)	-5.10 *pp*	-5.61 *pp*
Labor share (**P4**)	4.37 *pp*	-0.53 *pp*
Capital share (**P4**)	0.73 *pp*	6.14 *pp*
Investment-to-output (**P5**)	-0.34 *pp*	-0.11 *pp*
Equity Premium	-1.68 *pp*	$0-2$ *pp*

6. Additional figures

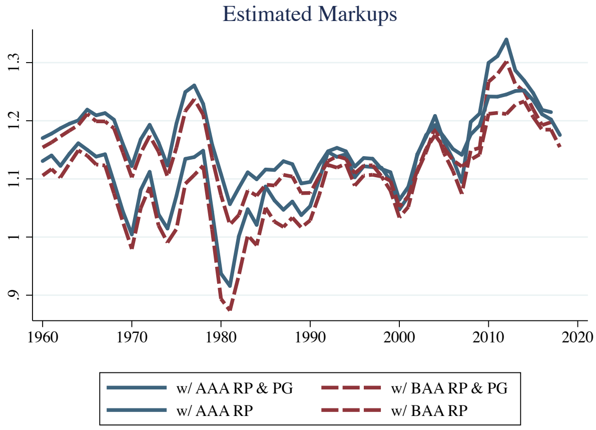

Figure 5: Markups, 1960-2018

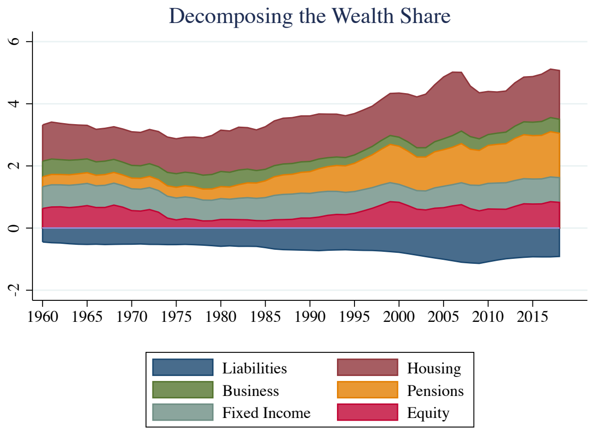

Figure 6: Wealth and Capital as a share of Gross Value Added.

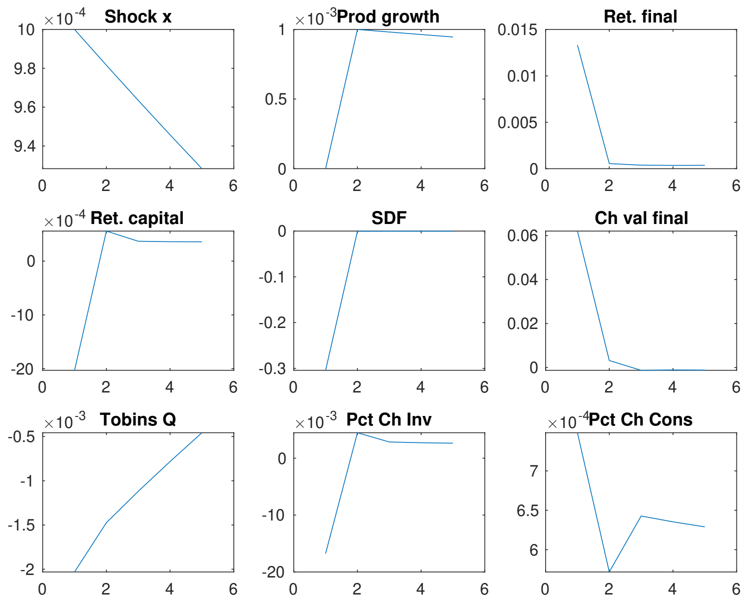

Figure 7: Impulse responses from a shock to long run productivity.

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