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A note on labor share, price markup and monetary policy

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ABSTRACT

This paper extends Kaplan and Zoch's (2020) insight that the total labor share is neither solely nor inversely determined by the price markup in a medium scale dynamic stochastic general equilibrium (DSGE) model with nondurables and durables. Our calibration results show that when monetary policy shocks and markup shocks are set to be positively (negatively) correlated, monetary contraction increases (decreases) total labor share and price markup. The total labor share is countercyclical (procyclical) conditional on a monetary policy shock.

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1. Introduction

Empirical studies have documented a declining labor share across countries[1] and posed concern for the increasingly unequal income distribution between firms and employees. The cyclical property of labor share and price markup affects the efficacy of macroeconomic policies on the reduction of income inequality and market distortion. In a canonical New Keynesian model with a competitive labor market, labor share negatively co-moves with the markup of price over marginal cost. When facing a drop in aggregate demand resulting from monetary contraction, price rigidity prompts firms to increase the price markup by lowering the labor cost. Hence, the basic New Keynesian model predicts the price markup to be countercyclical and labor share to be procyclical when responding to monetary policy shocks.

However, empirical studies have shown mixed results on the cyclicality of labor share and price markup conditional on a monetary policy shock. Labor share is determined to be countercyclical in Cantore et al. (2019) and Nekarda and Ramey (2020). Price markups are estimated to be countercyclical in Smets and Wouters (2007) and procyclical in Nekarda and Ramey (2020). The empirical findings do not seem compatible with the theoretical predictions.

One possible solution to this dispute is to disconnect the ad hoc inverse relationship between labor share and price markup. Kaplan and Zoch (2020) assume that the retailer branch requires additional employment for sales promotion activities while the wholesaler branch hires employees for traditional production. They break down the unambiguously inverse relationship between the labor share and the price markup and demonstrate that the overall labor share is determined not only by the price markup, but the degrees of decreasing returns in the retailer and wholesaler productions.

In this paper, we extend Kaplan and Zoch's (2020) insight to build a medium scale DSGE model with nondurables and durables. The total labor share in our model generalizes the sectoral labor shares and price markups of nondurables and durables. Our calibration results indicate that when a monetary policy shock and a markup shock are set to be positively (negatively) correlated, monetary contraction increases (decreases) the total labor share and price markup. The total labor share is countercyclical (procyclical) to output conditional on a monetary policy shock.

2. Model

2.1. Wholesale branch

There is a continuum of firms producing homogeneous intermediate goods in the wholesale branch. A representative wholesaler operating in a competitive market has a production function represented by Eq. (1).

$$Y_t^l = A_{W,t}^l \left(N_{W,t}^l\right)^{\alpha_W^l}, \quad l = C, D, \tag{1}$$

where Y_t^l is the output for a wholesaler in nondurable sector C and durable sector D. $A_{W,t}^l$ is the sectoral technology, $N_{W,t}^l$ is the

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[1] Some seminal works include Karabarbounis and Neiman (2014), Autor et al. (2017), Piketty et al. (2018) and Barkai (2019).

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labor and α_W^l is the degree of decreasing returns in wholesaler production. The optimal wholesaler price for two sectors $P_{W,t}^l$ is given in Eq. (2) and $W_{W,t}^l$ denotes nominal wage.

$$P_{W,t}^l = \frac{W_{W,t}^l}{A_{W,t}^l \alpha_W^l \left(N_{W,t}^l\right)^{\alpha_W^l - 1}}, l = C, D. \tag{2}$$

2.2. Retail branch

A unit measure continuum of retailers operates in a monopolistically competitive market. Retailers sell goods produced by the wholesale branch to consumers. The aggregate production for the retailer branch is given in Eq. (3).

$$M_t^l = \left(\int_0^1 \left(M_{j,t}^l\right)^{\frac{\theta_t^l - 1}{\theta_t^l}} dj \right)^{\frac{\theta_t^l}{\theta_t^l - 1}} \tag{3}$$

M_t^l is output and θ_t^l is the price elasticity of demand among differentiated retailers. A retailer j maximizes Eq. (4) subject to Eq. (5).

$$\Pi_t^l = \int_0^1 \left(\frac{P_{j,t}^l}{P_t^l} - P_{W,t}^l \right) \left(\frac{P_{j,t}^l}{P_t^l} \right)^{-\theta_t^l} M_t^l dj - \frac{W_{R,t}^l}{P_t^l} N_{R,j,t}^l \tag{4}$$

$$M_{j,t}^l = A_{R,t}^l \left(N_{R,j,t}^l\right)^{\alpha_R^l}, l = C, D. \tag{5}$$

$P_{j,t}^l$ is the retail price, $W_{R,t}^l$ is nominal wage and $N_{R,j,t}^l$ denotes labor. $A_{R,t}^l$ is the sectoral technology and is assumed to be the same across retailers. α_R^l is the degree of decreasing returns in the retailer production. Eq. (6) defines the relationship between retail price, price markup μ_t^l and wholesale price. Nominal wages in the two sectors are given in Eqs. (7)–(8). Q_t is the relative price of durable goods to nondurable goods, defined as P_t^D / P_t^C.

$$\frac{P_{j,t}^l}{P_t^l} = \frac{\theta_t^l}{\theta_t^l - 1} P_{W,t}^l = \mu_t^l P_{W,t}^l, \quad l = C, D. \tag{6}$$

$$W_{R,t}^C = P_{j,t}^C \left(1 - \frac{1}{\mu_t^C}\right) \alpha_R^C \frac{Y_{j,t}^C}{N_{R,j,t}^C} \tag{7}$$

$$W_{R,t}^D = P_{j,t}^D \frac{1}{Q_t} \left(1 - \frac{1}{\mu_t^D}\right) \alpha_R^D \frac{Y_{j,t}^D}{N_{R,j,t}^D} \tag{8}$$

In a symmetric equilibrium, all retailers charge the same price. Define the aggregate production function as $Y_t = \left(Y_t^C\right)^{\alpha} \left(Y_t^D\right)^{1-\alpha}$ for the wholesaler and $M_t = \left(M_t^C\right)^{\alpha} \left(M_t^D\right)^{1-\alpha}$ for the retailer. α is the steady-state share of nondurable goods production. The overall labor share is derived as Eq. (9). The first bracketed expression multiplied by α is the labor share for the nondurable sector and the second bracketed expression multiplied by $1 - \alpha$ is the labor share for the durable sector. The cyclicality between the respective labor share and its price markup is determined by the relative magnitude of the degree of decreasing returns in wholesale and retail branches. A generalization to multiple sectors allows us to discuss the asymmetric impact of shocks on sectoral labor shares and the possible spillover effect between sectors.

$$s_t = \alpha \left[\alpha_W^C \frac{1}{\mu_t^C} + \alpha_R^C \left(1 - \frac{1}{\mu_t^C}\right) \right] + (1 - \alpha) \left[\alpha_W^D \frac{1}{\mu_t^D} + \alpha_R^D \left(1 - \frac{1}{\mu_t^D}\right) \right] \tag{9}$$

2.3. Households

The objective of the representative household is to maximize the expected present discounted utility (10) subject to the budget constraint (11) in real terms.

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\ln C_t + \eta_t \ln D_t - \frac{\Phi_W^l \left(N_{W,t}^l\right)^{1+\varsigma}}{1+\varsigma} - \frac{\Phi_R^l \left(N_{R,t}^l\right)^{1+\varsigma}}{1+\varsigma} \right] \right\}, \quad l = C, D. \tag{10}$$

$$C_t + Q_t \left(D_t - (1-\delta) D_{t-1}\right) + b_t = \frac{W_{W,t}^l}{P_t^C} N_{W,t}^l + \frac{W_{R,t}^l}{P_t^C} N_{R,t}^l + (1 + r_{t-1}) \frac{b_{t-1}}{\pi_t^C} + \frac{\Pi_t^l}{P_t^C} + T_t \tag{11}$$

where β is the discount factor, C_t represents nondurable goods, η_t is a preference shock and D_t represents durable goods. $N_{W,t}^l$ and $N_{R,t}^l$ denote the employment for the wholesaler and retailer in each sector. Φ_W^l and Φ_R^l are the weights of work disutility for the wholesaler and retailer. ς is the inverse of the Frisch elasticity of labor supply. δ is the depreciation rate of durable goods. $b_t \equiv B_t / P_t^C$ represents the purchase of government bonds in real terms, which are assumed to be risk-free with a rate of return r_t. The inflation rate of nondurable goods is $\pi_t^C \equiv P_t^C / P_{t-1}^C$. Households also receive nominal profits Π_t^l from the retailer. T_t is the lump-sum transfer from the government.

2.4. Fiscal and monetary authorities

The central bank is assumed to conduct monetary policies via a Taylor-type rule characterized by Eq. (12). ρ_R is the weight imposed on a lagged interest rate, κ_π is the coefficient of aggregate inflation and κ_Y is the coefficient of the output gap. $\overline{\pi}$ and $\overline{Y}$ represent the steady-state aggregate inflation and output, respectively. Aggregate inflation is a combination of nondurable inflation and durable inflation. u_t represents a policy shock. Suppose the government has no additional purchases. The government's budget constraint in real terms is expressed as Eq. (13).

$$r_t = (r_{t-1})^{\rho_R} \left[\left(\frac{\pi_t}{\overline{\pi}} \right)^{\kappa_\pi} \left(\frac{Y_t}{\overline{Y}} \right)^{\kappa_Y} \right]^{(1-\rho_R)} u_t \tag{12}$$

$$b_t - \frac{b_{t-1}}{\pi_{C,t}} r_{t-1} = T_t \tag{13}$$

2.5. Equilibrium

Eqs. (14) and (15) clear the goods market. Eq. (16) implies that labor is immobile across the nondurable and durable sectors. Eq. (17) shows that the nominal bond is in zero net supply.

$$Y_t^l = M_t^l, \quad l = C, D. \tag{14}$$

$$Y_t = C_t + Q_t \left[D_t - (1-\delta) D_{t-1}\right] \tag{15}$$

$$N_{W,t}^C + N_{R,t}^C = N_{W,t}^D + N_{R,t}^D \tag{16}$$

$$B_t = 0 \tag{17}$$

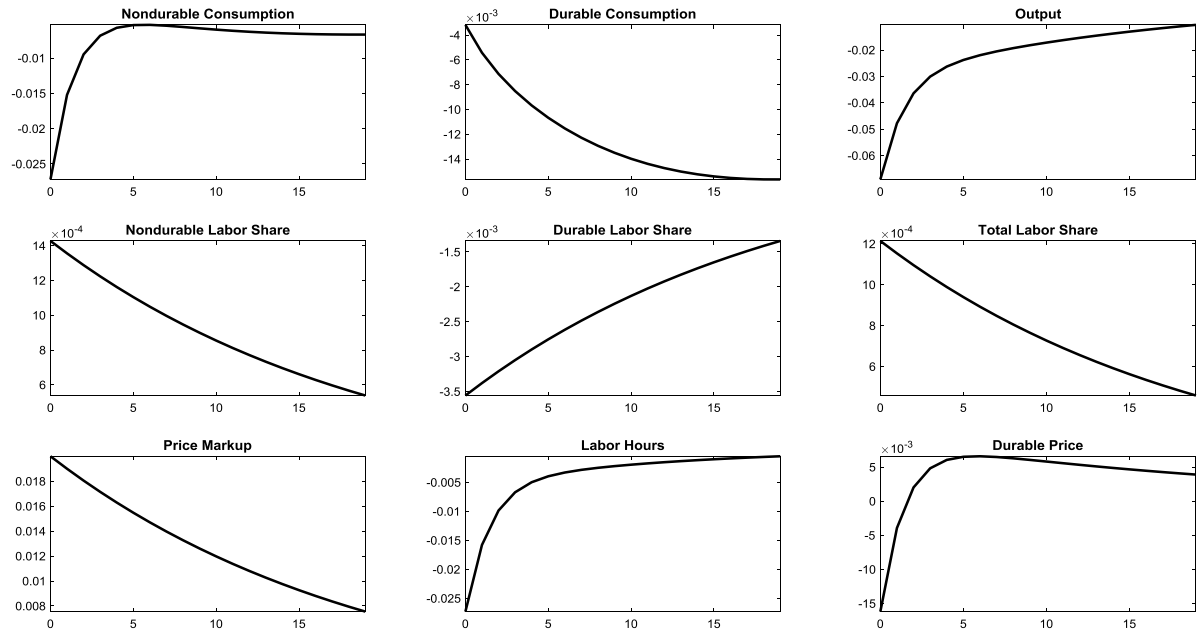

Fig. 1. Responses to contractionary policy shocks (Positive Cross Persistence).

2.6. Exogenous shocks

The model is calibrated in responses to preference shocks η_t, productivity shocks $A^C_{W,t}$, $A^D_{W,t}$, $A^C_{R,t}$ and $A^D_{R,t}$ in two branches of the nondurable and durable sectors, policy shocks u_t, and markup shocks μ^C_t and μ^D_t in the nondurable and durable sectors. The shocks are assumed to be exogenous and follow an exogenous AR(1) process. The persistency of each shock is assumed to be less than 1.

3. Calibration results

The model is solved with a first-order approximation of the equilibrium conditions around the non-stochastic steady state with zero inflation. Table 1 presents the baseline parameters. Some parameters are set in accordance with the standard DSGE literature (Monacelli, 2009; Ireland, 2014). In line with the U.S. national account data, the steady-state share of nondurable goods in total production is set to be 0.90.[2] We refer to Kaplan and Zoch's (2020) estimated results and set the degree of decreasing returns for nondurable wholesaler, nondurable retailer, durable wholesaler, and durable retailer to be 0.716, 0.780, 0.284, and 0.22, respectively.[3] Moreover, the steady-state price markup in both sectors is set to be 1.20. The calibrated steady-state values are summarized in Table 2.

We impose a positive interest rate shock with a standard deviation of 0.25 and a positive price markup shock in each sector with a standard deviation of 0.10. Fig. 1 displays the model dynamics in response to monetary contraction when monetary policy shocks and price markup shocks in the two sectors are assumed to have a 0.20 coefficient of cross persistence. Nondurable consumption, durable consumption, total output and durable price drop on impact. Monetary contraction increases total labor share and the labor share of the nondurable sector.

Table 1
Baseline parameters.

Parameter	Value	Description
β	0.99	Discount factor
δ	0.025	Depreciation rate of durables (quarterly)
ς	1	Inverse of the Frisch elasticity of labor supply
α	0.90	Steady-state share of nondurable goods in total production
α^C_W	0.716	Degree of decreasing returns for wholesaler in nondurable sector
α^C_R	0.78	Degree of decreasing returns for retailer in nondurable sector
α^D_W	0.284	Degree of decreasing returns for wholesaler in durable sector
α^D_R	0.22	Degree of decreasing returns for retailer in durable sector
ρ_R	0.80	Weight imposed on the lagged policy rate
κ_π	1.50	Coefficient of inflation in the Taylor rule
κ_Y	0.50	Coefficient of the output gap in the Taylor rule
ρ	0.95	Persistency of preference shocks, productivity shocks and markup shocks
ρ_u	0.50	Persistency of monetary policy shocks

The labor share of the durable sector decreases. With only labor in production, labor hours decline as output falls. The results demonstrate that in a model with augmented employment in the retailer branch, price markup and total labor share are no longer inversely related. They are countercyclical to output conditional on a monetary policy shock. Fig. 2 presents the results when monetary policy shocks and price markup shocks in the two sectors have a -0.20 coefficient of cross persistence. The total labor share still moves positively with the price markup. However, they become procyclical to output in response to monetary contraction.

4. Conclusions

This paper generalizes the one-sector labor share in Kaplan and Zoch (2020) to a two-sector labor share and analyzes the cyclical movement of labor share and price markup in a DSGE model. Price rigidity and wage rigidity are usually the sources of price markup fluctuations in response to monetary policy shocks.

[2] Technically, the nondurable goods in our calibration include nondurables and services in household consumption.

[3] Using table 3 in Kaplan and Zoch (2020), we categorize high-tech, repair, construction and machinery production in a durable sector and categorize services, administration, management, professional specialties and sales production in a nondurable sector.

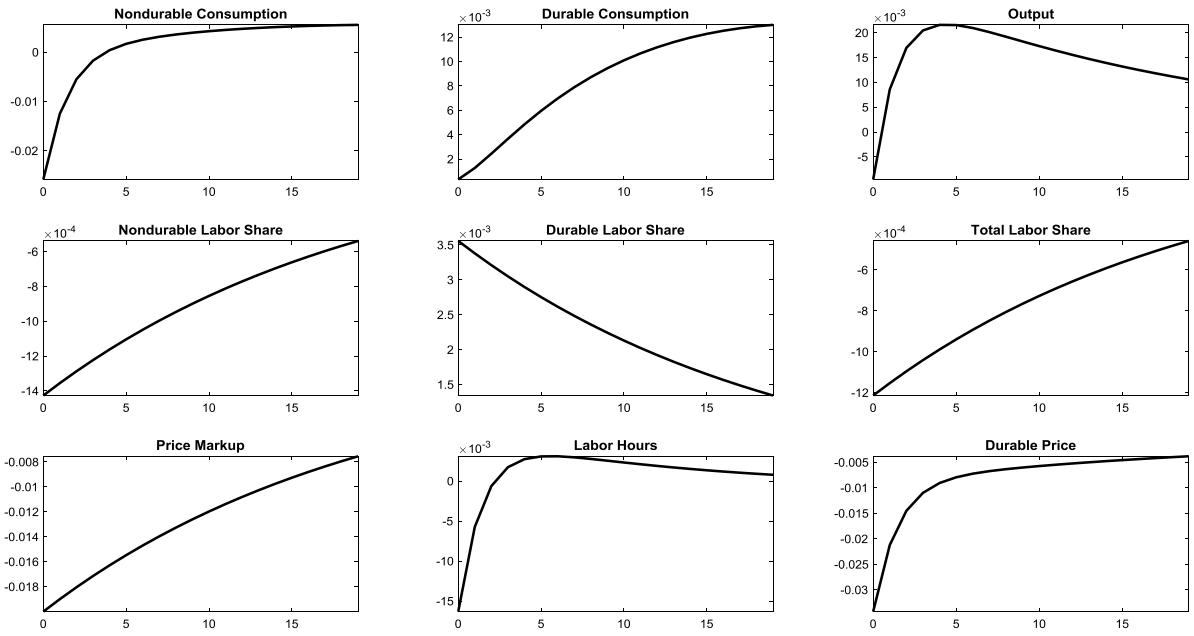

Fig. 2. Responses to contractionary policy shocks (Negative Cross Persistence).

Table 2
Calibrated steady-state values.

Variable	Value	Description
$\overline{C}$	0.9168	Nondurable consumption
$\overline{D}$	26.3829	Durable consumption
$\overline{\mu}^C$	1.20	Price markup in nondurable sector
$\overline{\mu}^D$	1.20	Price markup in durable sector
$\overline{N}^C_W = \overline{N}^C_R$	0.33	Labor hours for wholesaler and retailer in nondurable sector
$\overline{N}^D_W = \overline{N}^D_R$	0.33	Labor hours for wholesaler and retailer in durable sector
$\overline{\Pi}^C$	0.1458	Profits in nondurable sector
$\overline{\Pi}^D$	0.3753	Profits in durable sector
$\bar{s}$	0.6834	Total labor share
$\bar{s}^C$	0.6542	Labor share of the nondurable sector
$\bar{s}^D$	0.0291	Labor share of the durable sector
$\overline{W}^C_W = \overline{W}^D_W$	1	Nominal wage of the wholesale branch
$\overline{Y}$	1.5764	Total production
$\overline{Y}^C$	0.8733	Nondurable production
$\overline{Y}^D$	1.5135	Durable production

In the absence of price rigidity and wage rigidity, we impose exogenously positive price markup shocks and positive (negative) cross-persistence between a monetary policy shock and a markup shock to generate model dynamics. Our research can be extended to a richer model with price and wage rigidity or a model that incorporates collateral-constrained households who pledge durable goods for loans for building more sectoral interaction.

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