

The New Keynesian Transmission Channel*

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Abstract

The success of the New Keynesian framework stems from its ability to match the aggregate responses to innovations in monetary policy and total factor productivity (TFP). Specifically, the model can account for negative responses of output to innovations in the policy rate and a negative response of employment to innovations in TFP. We reexamine the transmission channel of the textbook model and show that these successful results rely on the assumption that firm profits are redistributed to working households. We contrast the textbook model to a worker-capitalist model where profits are consumed by non-working capitalists. This modification renders employment and output unresponsive to monetary policy and employment unresponsive to TFP. The reason is that the income and substitution effects of changes in the wage level cancel when the worker receive income from wages alone. Given the empirically observed distribution of equity ownership and the VAR evidence on the business cycle behavior of profits, we argue that our results cast doubt on the transmission channel in the textbook model.

JEL-code: E12

1 Introduction

The textbook New Keynesian model, as presented in *e.g.* Galí (2009), has been widely used for business cycle analysis, ranging from the old literature on monetary policy rules, Rotemberg and Woodford (1999), to newer findings on policy options at the zero lower bound, Farhi and Werning (2012). Apart from its micro-founded notion of "aggregate demand", the success of the model stems largely from its ability to match the aggregate responses to innovations in monetary policy and total factor productivity (TFP). VAR evidence shows that output reacts negatively to positive innovations in the policy rate and that employment

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reacts negatively to positive innovations in TFP.¹ These findings are consistent with the predictions of the New Keynesian model, but not with that of the real business cycle (RBC) theory.

What explains these results? We reexamine the model by concentrating on the labor market equilibrium. We find that the transmission mechanism relies entirely on the distribution and cyclical behavior of firm profits. We make this argument by means of a thought-experiment that contrasts the textbook model to a simple alternative model, in which non-working capitalists consumes profits and workers only receive labor income. We feed in a monetary and a TFP shock to both models, and compare the equilibrium responses.

Consider first the response to a positive monetary policy shock: In the textbook model, higher interest rates lead to a contraction in current demand as households back-load their consumption in line with the 'Dynamic IS (DIS) curve'. To bring down supply real wages fall. The decrease in wages depress labor supply and aggregate output because, with an additional source of income in the form of redistributed profits, the substitution effect of wage changes on labor supply dominates the income effect. Moreover, and equally important in our standard parameterization, profits rise in response to the shock as markups are strongly countercyclical, increasing the labor supply response through a negative income effect. In contrast, our worker-capitalist model features none of these effects. Because worker only receive wage income, the substitution and income effect cancel out, leaving labor supply and output constant. Consumption increases in line with the DIS curve, by an amount exactly equal to the increase in wages. This increase in consumption is offset on the demand side through an commensurate fall in profits, equal to capitalist consumption.

Next, consider the response to a positive TFP shock. In the textbook model, the shock temporarily increases output, wage income and profits by raising productivity. As a consequence of temporarily increased income, demand increases and through the DIS curve the real interest rate falls. Due to sticky prices, markups rise and so the increase in profits becomes substantially larger than the increase in wages. Because the labor-reducing income effect of higher profits dominates the labor-increasing effect of higher wages, equilibrium employment falls. In contrast, this effect cannot happen in the worker-capitalist model. The increase in profits only raises capitalist consumption, and the income and substitution effect from wage changes on labor supply cancel out. Thus, employment stays constant.

That the textbook model features a countercyclical (procyclical) response in firm markups and profits to monetary policy (TFP) shocks is well-known in the literature, see *e.g.* Christiano and Evans (1997); Nekarda and Ramey (2013). To the best of our knowledge, however, it is not well-known that the distribution and cyclical behavior of firm profits is key to the transmission mechanism. We think that these results cast some doubt on the plausibility of the transmission mechanism of the textbook model. Given the observed distribution of financial assets, profits cannot significantly affect the elasticity of labor supply to wages for

¹Concerning monetary policy shocks, see *e.g.* Christiano et al. (1999) and Christiano and Eichenbaum (2005). Concerning TFP shocks, VAR evidence supporting the negative response of employment to TFP is found in Galí (1999), Galí and Rabanal (2004) and Francis and Ramey (2005). These findings have been criticized by Christiano et al. (2003) and Chari et al. (2008)

the majority of the workforce. Moreover, VAR evidence shows that profits are pro-cyclical with respect to monetary policy shocks. Our result points to that the usual 'aggregate demand' interpretation of the model should not be taken for granted, since it ignores the factors governing labor supply.

Our analysis is related to recent papers on the role of income distribution in the New Keynesian framework. Close in spirit to our work is Walsh (2014) who constructs a model where capitalists receive profits and return to capital, while workers only receive wage income. Capitalists have access to a capital market, while workers do not. This will introduce a direct aggregate channel for wages and employment, and boost the output effect to a monetary policy shock. Bilbiie (2008) incorporates limited asset market participation, and show how the standard aggregate demand logic in the New Keynesian framework hinges on participation rates being above a certain threshold. Indeed, if participation is low enough the sign on the impact of monetary policy can be reversed.

We proceed as follows. Section 2 lays out the standard new-Keynesian model and our worker-capitalist model. Section 3 analyses and contrasts the responses to monetary policy and TFP shocks of the two models. We discuss evidence and suggest ways for future research in Section 4.

2 Two models

Throughout the paper, we will compare two models: the model presented in Galí (2009) and a model which distinguishes households that can supply labor (workers) from households that hold claims to firm profits (capitalists).² The former will be referred to as the "standard model" and the latter to as the "worker-capitalist model". We will describe and derive the log-linearized equilibrium of the standard model, and then show how the worker-capitalist model differs.³

2.1 The standard model

The standard model consists of a measure 1 of identical households, one final good producer, a continuum of intermediate goods producers and one government.

²Strictly speaking, we deviate slightly from Galí (2009). Galí (2009) assumes that households' demand a variety of goods produced by a final goods sector under monopolistic competition. More convenient for our purposes, we assume that the households demand only one good produced by a competitive final goods sector. The final good producers in turn demand a variety of inputs produced by an intermediate goods sector, the latter being under monopolistic competition. The models are isomorphic.

³For the step-by-step derivation of the standard model we refer to Galí (2009). For the step-by-step derivation of the worker-capitalist model we refer to the appendix.

2.2 Households

Households derive utility from consuming the final good and disutility for working. They collect wage and profit income and can trade a in a riskless nominal bond. A household's problem reads

$$\max_{C_t, B_{t+1}, N_t} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right) \quad (1)$$

$$\text{s.t.} \quad P_t C_t + Q_t B_t \leq B_{t-1} + W_t N_t + P_t D_t \quad (2)$$

where D_t is real per capita profits. The solution is characterized by an Euler equation and an intratemporal optimality condition:

$$Q_t = \beta E_t \left\{ \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{P_t}{P_{t+1}} \right\} \quad (3)$$

$$\frac{W_t}{P_t} C_t^{-\sigma} = N_t^{\varphi} \quad (4)$$

2.3 Final good production

A representative final goods producer operates under perfect competition and combines intermediate goods Y_{it} with the technology:

$$Y_t = \left(\int_{i=0}^1 Y_{it}^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}} \quad (5)$$

The firm takes prices $P_t, \{P_{it}\}_{i=0}^1$ as given and solves a standard profit-maximization problem

$$\max_{Y_{it}} P_t Y_t - \int_{i=0}^1 P_{it} Y_{it} di \quad (6)$$

subject to (5). The solution is characterized by a demand curve for intermediate goods:

$$Y_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\epsilon} Y_t \quad (7)$$

2.4 Intermediate goods producers

Intermediate goods producers have monopoly power and set prices according to the scheme proposed by Calvo (1983). Specifically, they use a concave production technology with labor as the sole input:

$$Y_{it} = A_t N_{it}^{1-\alpha} \quad (8)$$

In each period, a firm can change its price with probability $1 - \theta$. In its decision problem, it maximizes the present discounted value of profits using the market discount factor Q_t taking the wage W_t , the aggregate price level P_t and the demand function (7) as given. The optimal resetting price P_t^* is found as the solution

to the problem

$$\max_{P_t^*} \sum_{k=0}^{\infty} \theta^k E_t Q_{t,t+k} \{P_t^* Y_{t+k|t} - \Psi_{t+k}(Y_{t+k|t})\} \quad (9)$$

$$\text{s.t.} \quad (10)$$

$$\Psi_{t+k}(Y_{t+k|t}) = \frac{W_{t+k}}{P_{t+k}} \left(\frac{N_{t+k|t}}{A_{t+k}} \right)^{\frac{1}{1-\alpha}}$$

$$Y_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\epsilon} Y_t$$

The solution is characterized by

$$\sum_{k=0}^{\infty} \theta^k E_t \{Q_{t,t+k} Y_{t+k|t} (P_t^* - \mathcal{M} \psi_{t+k|t})\} = 0 \quad (11)$$

where $\psi_{t+k|t} = \frac{\partial \Psi_{t+k}(Y_{t+k|t})}{\partial Y_{t+k|t}}$ and $\mathcal{M} = \frac{\epsilon}{\epsilon-1}$ is the markup over marginal cost that would have prevailed under flexible price setting ($\theta = 0$).

Given the resetting price P_t^* and the price level in the previous period P_{t-1} , it can be shown that the Calvo pricing scheme imply an aggregate law of motion of the form:

$$\left(\frac{P_t}{P_{t-1}} \right)^{1-\epsilon} = \theta + (1-\theta) \left(\frac{P_t^*}{P_{t-1}} \right)^{1-\epsilon} \quad (12)$$

2.5 Central bank

The central bank sets monetary policy according to standard Taylor rule with persistent shocks.

$$\frac{1}{Q_t} = \frac{1}{\beta} \Pi_t^{\phi_\pi} \left(\frac{Y_t}{Y_t^{flex}} \right)^{\phi_y} e^{\nu_t} \quad (13)$$

where Y_t^{flex} is the (efficient) output that would have prevailed at time t under flexible price setting.

2.6 Resource constraints

The economy is closed by the following set of resource constraints

$$C_t \leq Y_t \quad (14)$$

$$B_{t+1} \leq 0 \quad (15)$$

$$N_t \leq \int_{i=0}^1 N_{it} di \quad (16)$$

2.7 The log-linearized equilibrium

Of any variable X_t , $\bar{X}$ denotes the steady state value, x_t denotes the log and $\tilde{x}_t$ the log deviation from the flexible prices equilibrium.

Log-linearizing the intermediate goods firms' first order condition (11), using the aggregate law of motion for prices (12) and substituting in the household intratemporal condition (4) and market clearing conditions (16), (14), we get the "forward-looking Phillips curve":

$$\pi_t = \beta E_t \pi_{t+1} + \kappa \tilde{y}_t \quad (17)$$

where $i_t = -\log Q_t$ and $\kappa = \frac{\alpha + \varphi + \sigma(1-\alpha)}{1-\alpha+\alpha\epsilon} \frac{(1-\theta)(1-\beta\theta)}{\theta}$.

Log-linearizing the Euler equation (3) and substituting goods market clearing (14) we get the "Dynamic IS" (DIS) curve:

$$\tilde{y}_t = -v(i_t - E_t \pi_{t+1} - r_t^n) + E_t \tilde{y}_{t+1} \quad (18)$$

where $v = \frac{1}{\sigma}$ and r_t^n denotes the natural real interest rate, that is the real interest rate that would have prevailed in the equilibrium with flexible prices. We solve for r_t^n by finding the output path when $\theta = 0$, using that prices are set as a constant markup $\mathcal{M}$ over marginal cost in (11):

$$r_t^n = \rho + \xi E_t \Delta a_{t+1} \quad (19)$$

where $\rho = -\log \beta$ and $\xi = \frac{\sigma(1+\varphi)}{\alpha + \varphi + \sigma(1-\alpha)}$. Summarizing, the equilibrium is described by (17), (18), (19), and the log of the Taylor rule:

$$i_t = \rho + \phi_\pi \pi_t + \phi_y \tilde{y}_t + \nu_t \quad (20)$$

2.8 The worker-capitalist model

The worker-capitalist model differs from the standard textbook model only in one aspect. Instead of a measure 1 of identical households the worker-capitalist model has a measure 1 of workers, who receive only labor income, and a measure 1 of capitalists, who receive only profit income.

Workers solve the problem:

$$\max_{C_{wt}, B_{wt+1}, N_t} E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{wt}^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right) \quad (21)$$

$$\text{s.t.} \quad P_t C_{wt} + Q_t B_{wt} \leq B_{wt-1} + W_t N_t \quad (22)$$

Accordingly, their solution is characterized by an Euler equation and an intratemporal condition analogous to (3) and (4).

The capitalists in the model are assumed to be hand-to-mouth as thus simply receive and consume firm profits each period ($C_{ct} = D_t$). The purpose of this assumption is to do away with all labor supply effects stemming from profits. It is thus a way to high-light, by way of contrast, the role that profits play in the textbook model. We assume that capitalists control the intermediate goods firms and, when allowed to reset

prices, maximise the profit stream with discount factor β . Since $Q_t = \beta$ in the steady state of the standard model, the linearized first order condition of the firms' maximization problems around the steady state will be identical in the two models.

Everything else is identical to the standard model. Deriving the equilibrium is analogous. The equations that describe the log-linearized equilibrium are

$$\pi_t = \beta E_t \pi_{t+1} + \kappa_{wc} \tilde{y}_t \quad (23)$$

$$\tilde{y}_t = -v_{wc} (i_t - E_t \pi_{t+1} - r_t^n) + E_t \tilde{y}_{t+1} \quad (24)$$

$$r_t^n = \rho + \xi_{wc} E_t \Delta a_{t+1} \quad (25)$$

$$i_t = \beta + \phi_\pi \pi_t + \phi_y \tilde{y}_t + \nu_t \quad (26)$$

where $\kappa_{wc} = \frac{1+\varphi-(1-\sigma)(1-\alpha)}{(1-\sigma)(1-\alpha+\alpha\epsilon)} \frac{(1-\theta)(1-\beta\theta)}{\theta}$, $v_{wc} = \frac{(1-\sigma)(1-\alpha)}{\sigma(1+\varphi)}$ and $\xi_{wc} = \frac{\sigma(1+\varphi)}{1+\varphi-(1-\sigma)(1-\alpha)}$.

2.9 Parameterization

All parameters are the same in the two models. We choose the same calibration as that in Chapter 3 in Galí (2009), in which a time period should be interpreted as a quarter of a year. Thus, we set an elasticity of intertemporal substitution $1/\sigma = 1$ (balanced growth path preferences), Frisch elasticity $\varphi = 1$, $\alpha = 1/3$, $\epsilon = 6$, $\theta = 2/3$, $\beta = 0.99$. For the Taylor rule, we set $\phi_\pi = 1.5$, $\phi_y = 0.125$.

For this parameterization, it is easily confirmed that both models have two eigenvalues outside the unit circle, implying a unique stable equilibrium for any shock.

3 Results

We start describing a sufficient statistic for analyzing the response of labor supply to any equilibrium variation in wages and profits. We then show and contrast the response of the two models to innovations in monetary policy and TFP.

3.1 Labor supply and non-labor income: A primer

Since labor is the only factor of production in the models, understanding labor supply will be the key to understanding the equilibrium response to any shock.

Naturally, we turn to the labor F.O.C. In line with most previous studies, we focus on the case of balanced growth preferences by considering the case of $\sigma = 1$ under the CRRA utility function. Under this condition, the intratemporal condition (4) of the standard model is:

$$\frac{W_t}{P_t} = C_t N_t^\varphi \quad (27)$$

In any equilibrium the bond market must clear, and so

$$C_t = \frac{W_t}{P_t} N_t + Z_t \quad (28)$$

where Z_t is real non-labor income, which in the standard model consists solely of profits. To see how Z_t affects labor supply, we rewrite Z_t as a time-dependent fraction of real wages $Z_t = z_t \frac{W_t}{P_t}$. Putting this with (28) into (27) we get

$$\frac{W_t}{P_t} N_t^{-\phi} = \frac{W_t}{P_t} N_t + z_t \frac{W_t}{P_t} \quad (29)$$

$$\Leftrightarrow F(N_t) = z_t \quad (30)$$

where $F(N_t) = N_t^{-\phi} - N_t$ is a positive and decreasing function of $N_t \in [0, 1]$. This shows that labor supply at any time t is governed by z_t , the fraction of non-labor income to real wages. The reason is that under balanced growth preferences, the income and substitution effect of changes in the real wage level cancel each other out. And if non-labor income moves in tandem with the wage, it is as if the wage movement is only scaled by some factor. In contrast, for a given change in the wage level, a constant level of positive non-labor income decreases the relative income effect of that change. So labor supply becomes an increasing function of the wage level, *ceteris paribus*. For a given wage level, any change in non-labor income has a usual income effect, so that labor supply becomes decreasing in non-labor income. These results will be useful for understanding the response to monetary and TFP shocks.

3.2 Innovations in monetary policy

We start by considering innovations to monetary policy. The success of the New Keynesian framework in policy analysis partly stems from its ability to match the VAR evidence on how output respond to innovations in the policy rate. We will compare the impulse-responses of the two models to explore how the distribution of profits affect theses results.

We assume that innovations in the policy rate follows the process

$$\nu_t = \rho_\nu \nu_{t-1} + \epsilon_{\nu t} \quad (31)$$

with $\rho_\nu = 0.9$. We feed a positive 25 basis point shock to the models. The responses are plotted in Figure 1.

A positive shock to the policy rate in the standard model yields a substantial negative response in the output gap and inflation, as seen on the left hand side of Figure 1. How can we explain these results? Due to the policy innovation, the nominal interest jumps. Ignoring the equilibrium formation now, assume that this also induce the real interest rate to jump. From the Euler equation we then know that the consumption gap ("aggregate demand") must initially fall and follow an upward-sloping path. Since $C_t = Y_t$ in this model, the output gap follows the same path. The fall in the output gap and wages leads to lower marginal cost

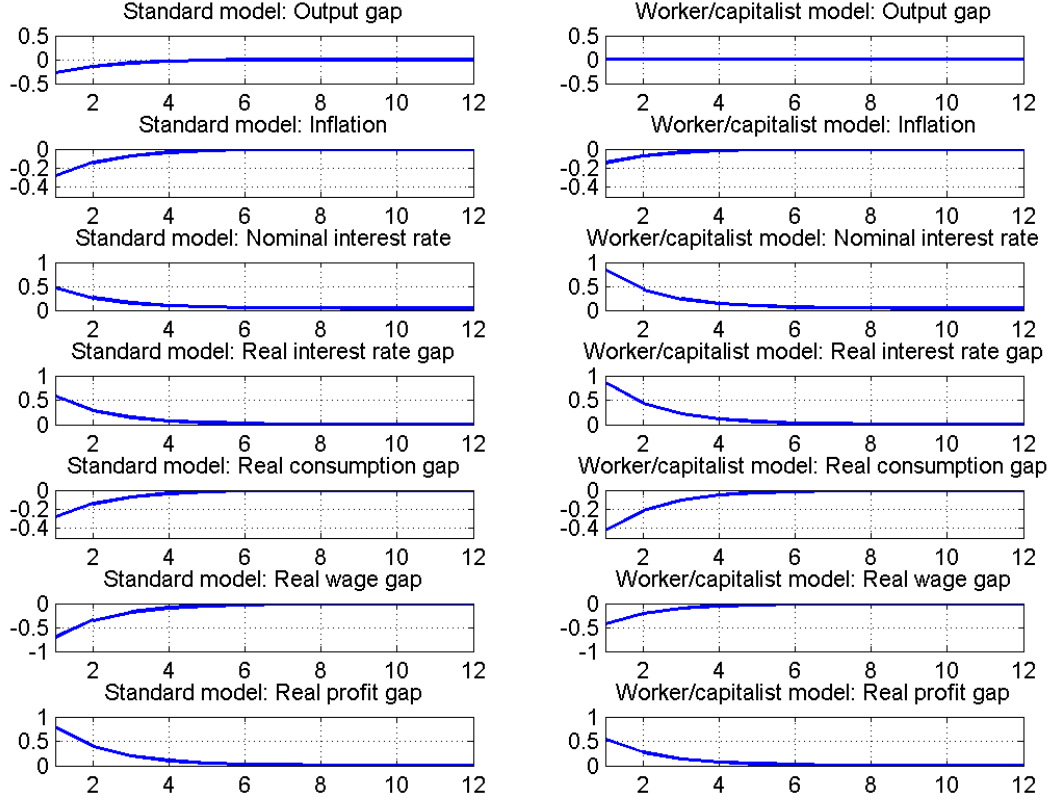


Figure 1: Equilibrium responses to 25 basis shock in the policy rate. The left panel shows the standard model, the right panel the worker/capitalist model. Inflation and interest rates are expressed in yearly terms, while the other variables are expressed in quarterly terms.

of production, in turn thus raising markups and profits. And because of lower marginal costs, the prices of price-resetting firms will fall. This creates deflation and so the assumption about the fall in the real interest rate is consistent with the equilibrium.

This is not the full story, however. We left out the supply side of the model in the explanation. To understand this part of the equilibrium, it is helpful to first study the response of the worker-capitalist model, as seen on the right hand side of Figure 1. The jump in the real interest rate causes workers' consumption to fall, and so the consumption gap of workers in this model behave similar to the consumption gap in the standard model. The output gap, however, is constant. This is because households that supply labor only get wage income, and thus the income and substitution effect of wages on labor supply cancel under any variation in wages, as seen in equation (30). The fall in real wages is necessary to generate the

fall in workers' consumption. Marginal costs thus also fall in this model, leading to an increase in markups and profits as well as a fall in the price level, but less so compared to the standard model since the output gap is not affected.

So how did the fall in output and stronger deflation response come about in the standard model? In this model, profits are distributed back to working households, decreasing the relative income effect from wages on labor supply, as seen in equation (30). So a falling wage level depresses labor supply and output. Moreover, the increase in profits acts as a positive income effect, further depressing labor supply. In total, these two effects sum to the fall in output via the production function.

From the labor first order condition, we can deduce the relative contribution of these two effects. We let ω_t denote the log of the real wage $\frac{W_t}{P_t}$ at time t . The log-linearized first order condition is

$$\tilde{\omega}_t = \sigma \tilde{c}_{tt} + \varphi \tilde{n}_t \quad (32)$$

$$= \sigma \tilde{y}_t + \varphi \tilde{n}_t \quad (33)$$

$$= \sigma(1-s)(\tilde{\omega}_t + \tilde{n}_t) + \sigma s \tilde{d}_t + \varphi \tilde{n}_t \quad (34)$$

$$\Leftrightarrow \tilde{n}_t = \frac{1-\sigma(1-s)}{\varphi+\sigma(1-s)} \tilde{\omega}_t - \frac{\sigma s}{\varphi+\sigma(1-s)} \tilde{d}_t \quad (35)$$

where we have used the market-clearing conditions $\tilde{d}_t = \tilde{y}_t = (1-s)(\tilde{\omega}_t + \tilde{n}_t) + s \tilde{d}_t$ and where s is the steady state profit share of output. With $\sigma = 1$, and plugging in the numbers from the simulation, we get that

$$\frac{\frac{1-\sigma(1-s)}{\varphi+\sigma(1-s)} \tilde{\omega}_t}{\frac{1-\sigma(1-s)}{\varphi+\sigma(1-s)} \tilde{\omega}_t - \frac{\sigma s}{\varphi+\sigma(1-s)} \tilde{d}_t} = \frac{\tilde{\omega}_t}{\tilde{\omega}_t - \tilde{d}_t} = 0.47 \quad (36)$$

$$\frac{-\frac{\sigma s}{\varphi+\sigma(1-s)} \tilde{d}_t}{\frac{1-\sigma(1-s)}{\varphi+\sigma(1-s)} \tilde{\omega}_t - \frac{\sigma s}{\varphi+\sigma(1-s)} \tilde{d}_t} = \frac{-\tilde{d}_t}{\tilde{\omega}_t - \tilde{d}_t} = 0.53 \quad (37)$$

which shows that the wage effect accounts for 47 % of the total variation in labor supply whereas the countercyclical variation in profits accounts for 53 %.

Summarizing, the existence of profits in the households budget constraint is pivotal to generate the contractive response of output to a positive shock in the policy rate. First, the presence of positive profits in the household budget reduces the relative income effect of wages, thus creating a positive effect of higher wages on the labor supply. Second, labor supply is further depressed via the direct income effect from the countercyclical response in profits.

3.3 Innovations in TFP

Next, we consider innovations in TFP. A second strength of the New-Keynesian model lies in its ability to match negative response in employment to positive TFP shocks (Galí, 1999; Galí and Rabanal, 2004). We will compare the impulse-responses of the two models to explore how the distribution of profits affect these results.

We assume that the log of TFP a_t follows the process

$$a_t = \rho_a a_{t-1} + \epsilon_{at} \quad (38)$$

with $\rho_a = 0.9$. We feed a positive 1 % shock to the models. The responses are plotted in Figure 2. Here, we do not plot deviations from the flex price equilibrium, as in Subsection 3.2, but the log deviations from steady state.

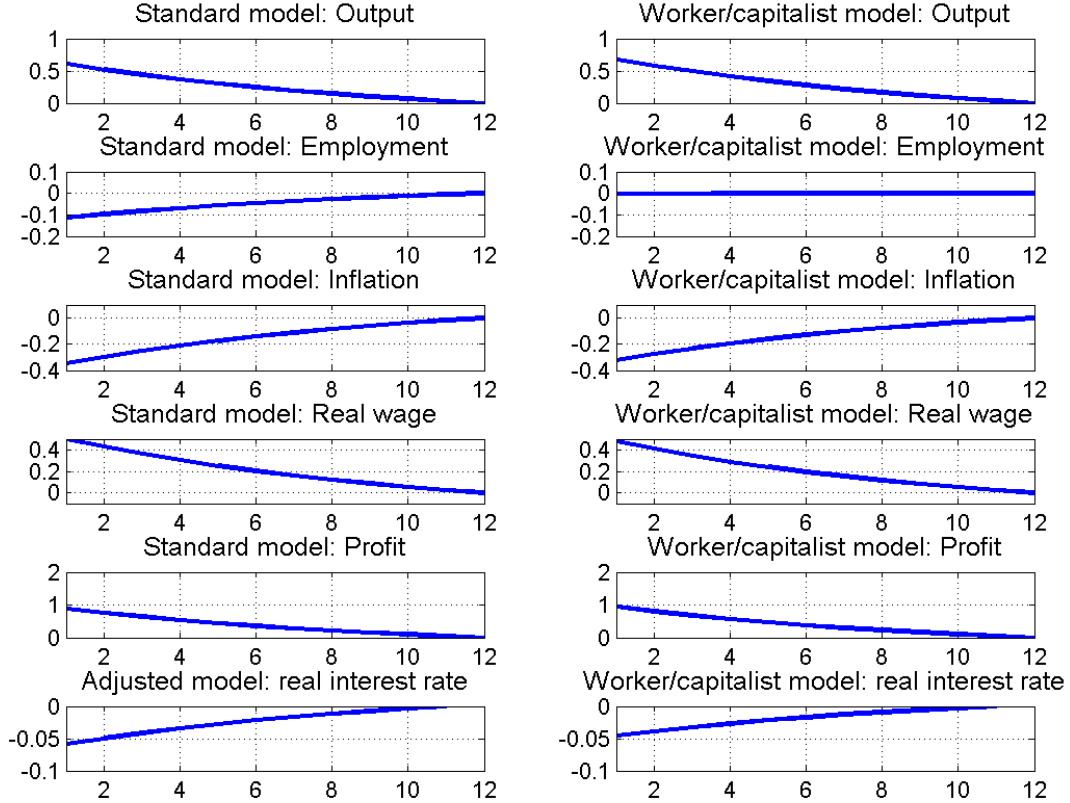


Figure 2: Equilibrium responses to 1 % shock to TFP. The left panel shows the standard model, the right panel the worker/capitalist model. Inflation and interest rates are expressed in yearly terms, while the other variables are expressed in quarterly terms.

In the standard model, plotted on the left hand side of Figure 2, the positive innovation to TFP renders a positive response in output, wages and profits and a negative response in employment, inflation and the real interest rate. In the worker-capitalist model, plotted on the right hand side of Figure 2, all variables behave similarly except employment, which is not affected.

What explains the results? This time we begin analyzing the worker-capitalist model. The positive innovation in TFP directly raise output and profits. Marginal cost of firms falls as the rise in productivity increases the marginal product of labor. Lower marginal costs incentivize firms that can reset their prices to cut them. Deflation follows and will via the central bank's policy function bring about a drop in the nominal interest rate. In accordance, the real interest falls to follow an upward-sloping path. Consumption must then, via the Euler equation, initially rise to follow a downward-sloping path. Since the share of non-labor income is unaltered labor supply will be unchanged. Thus, consumption can only increase if real wages rise. Note also that the increase in real wages is substantially smaller than the increase in profits. This is a consequence of Calvo-pricing, which leave some firms with higher than optimal prices. Markups thus rise, raising profits by more than the mere volume effect from expanded production.

Now we turn to the standard model. The only qualitative difference in the response is in the behavior of employment. In this model, profits are included in the workers' income. As such, the relative income effect of wages to labor supply is depressed, so that the increase in wages *ceteris paribus* will increase employment. On the other hand, the increase in firm profits acts as a positive income effect and depresses labor supply. Since the response of wages and the income effect from profits pull labor supply in opposite directions, the model needs the profit income effect to dominate in order to generate the resulting contraction in employment. This happens because of the rise in markups, which raises profits beyond the volume effect of increased output. It is in contrast to the response to a monetary policy shock seen in the previous section, where the response in wages and profits both contributed to depressing labor supply.

4 Discussion

To summarize, the distribution and cyclical behavior of firm profits are of first-order importance for the responses to monetary and technological innovations in the New Keynesian textbook model. More specifically, profits play two roles in the textbook model. (1) A positive income stream from firm profits in the household budget reduces the relative income effect of wage changes, creating a positive effect from wages on labor supply and (2) fluctuations in profits in reaction to shocks directly affect the response of labour supply. A positive shock to the nominal interest rate contracts output both because wages fall and because profits increase. A positive innovation in TFP contracts employment because the labour-reducing income effect from pro-cyclical profits dominates the labour-increasing effect of rising wages. Taken together our results suggest that the usual 'aggregate demand' interpretation of the model should not be taken for granted, since it ignores the factors governing labor supply.

We illustrated the importance of redistributed profits by means of a thought-experiment that contrasted the impulse-responses of the textbook model to that of a highly stylised alternative setting with hand-to-mouth capitalists that own firms and consume profits every period. Of course, we do not see this alternative

model as a superior description of real economies. Rather, we use it as a heuristic instrument to highlight, by way of contrast, the transmission mechanism in the textbook model. We do, however, think that there are reasons to believe that the textbook model overstates the roles of redistributed profits. Specifically, that profits are a substantial part of household income or that profits are counter-cyclical with respect to a monetary policy shock appears to be at odds with US data. Saez and Zucman (2014) show that 91.5 % of non-pension equity wealth and 55.37 % of pension wealth is owned by by 10 % of the wealthiest households. Moreover, VAR evidence shows that profits vary pro-cyclically with respect to monetary policy shocks (Christiano et al., 1999; Christiano and Eichenbaum, 2005).⁴

Let us also stress that our findings are specific to the textbook model. Thus, any change to the environment other than our very stylized thought-experiment may also affect the transmission of shocks, and the role of profits that we highlight. Particularly, as the analysis in Section 3.1 shows, any change that affects the comovement and relative magnitudes of wage income and consumption can be expected to change the response of labor supply to the shocks we consider. Thus, other non-wage sources of income, *e.g.* from asset investments or non-labor taxes and transfers, create an average difference of consumption and labor income that, if positive, could be expected to increase the labor supply response to wage changes, or, if negative, to dampen it. Similarly, additional consumption-smoothing opportunities, for example in the form of financial trade between workers and capitalists or agents outside the domestic economy, may act to dampen the income effect of wage changes on labor supply. Finally, any frictions in the labor supply response to income and wage changes may affect the nature of the New-Keynesian transmission mechanism more fundamentally. There are several examples of such frictional models in the literature, see *e.g.* Erceg et al. (2000); Walsh (2005); Blanchard and Galí (2010); Ravn and Sterk (2012). To analyze the role of these extensions for the New Keynesian transmission mechanism, we would ideally consider a general version of the New Keynesian model that captures the empirical joint distribution of incomes from various sources and asset holdings across households, and features a realistic description of frictions in labor markets. To explore the transmission channels in such a more general and realistic departure from the textbook model seems an interesting avenue for future research.

⁴We are not aware of any study who investigates the cyclicity of profits with respect to TFP shocks. Nekarda and Ramey (2013), however, find that markups over marginal costs are pro-cyclical conditional on TFP shocks.

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