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M. Alper Çenesiz
Luís Guimarães

Centro de Economia e Finanças da UP
www.fep.up.pt

Sticky Price Models, Durable Goods, & Real Wage Rigidities*

M. Alper Çenesiz & Luís Guimarães

cef.up, Faculdade de Economia, Universidade do Porto,

R. Roberto Frias, 4200-464, Porto, Portugal†

Abstract

The standard two-sector New Keynesian model with durable goods is at odds with conventional wisdom and VAR evidence: Following a monetary shock, it generates (i) either negative or no comovement across sectoral outputs, and (ii) aggregate neutrality of money when durable-goods' prices are flexible. We reconcile theory with evidence by incorporating real wage rigidities into the standard model: As long as durable-goods' prices are more flexible than nondurable-goods' prices, we obtain positive sectoral comovement and, thus, aggregate non-neutrality of money.

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†E-mail addresses: acenesiz@fep.up.pt (M. A. Çenesiz), lguimaraes.phd@fep.up.pt (L. Guimarães).

1. Introduction

Using the standard two sector New Keynesian model, Barsky, House, and Kimball (BHK) (2007) eloquently demonstrate that the degree of price flexibility in the durable goods sector dictates the response of aggregate output to a monetary shock. When nondurable-goods' prices are sticky but durable-goods' prices are flexible, the outputs of the two sectors move in opposite directions, leaving aggregate output unchanged. Aggregate output, however, reacts significantly when nondurable- and durable-goods' prices are sticky. But then nondurables output virtually does not react. In other terms, the standard New Keynesian model generates either negative sectoral comovement and aggregate neutrality or no sectoral comovement.

Yet, VAR evidence overwhelmingly suggests positive comovement in the aftermath of a monetary shock (see, for example, BHK 2003, Erceg and Levin 2006, Monacelli 2009). Two stylized facts are that (i) aggregate output and sectoral outputs move together, and (ii) the response of the durable output is stronger in comparison to the responses of nondurables and aggregate output. Moreover, the distinctive feature of a business cycle is that the output of many sectors of the economy move together. Therefore, the New Keynesian model, the workhorse in analysis of monetary business cycles, needs to be reconciled with these facts. We do so simply by introducing real wage rigidities into an otherwise standard two sector New Keynesian model.

One supporting argument for the existence of real wage rigidities flows from the Dunlop-Tarshis observation –that hours worked and real wages are uncorrelated (Dunlop 1938 and Tarshis 1939). Regarding the dynamic effects of monetary shocks on the real wage, VAR evidence suggests that the reaction of the real wage is rather muted (see, for example, Altig, Christiano, Eichenbaum, and Lindé 2011, Amato and Laubach 2003, Christiano, Eichenbaum, and Evans 2005). As a modeling feature, the crucial role of real wage rigidities in propagating shocks has long been recognized as well. In his review of the business cycle theory, Lucas (1981) argues that models relying on systematic real wage movements are *doomed to failure*. Ball and Romer (1990) show that real wage rigidities amplify the effects of nominal rigidities. Hall (2005) shows that real wage rigidities generate volatile unemployment and vacancies in the context of search and matching models. Blanchard and Gali (2007) show that real wage rigidities generate a trade-off between output and inflation stabilization. More recently, Shimer (2012) shows that real wage rigidities can account for jobless recoveries.

To model real wage rigidities, we follow Blanchard and Gali (2007): We modify the labor supply equation of the standard New Keynesian model by assuming that real wages are a weighted sum of lagged real wages and the marginal rate of substitution between consumption and leisure. Without any other change to the standard model, this simple modification removes the above mentioned puzzling theoretical results. We show that when durable-goods' prices are perfectly flexible, following a monetary shock, real wage rigidities (i) magnify the response of aggregate output; (ii) generate positive sectoral comovement; and (iii) generate a rather reasonable response of real wages, which in the standard model is 70 times higher than the response of aggregate output. Using our modification we also show that the outputs of both sectors move together as long as durable-goods' prices are (slightly) more flexible than nondurable-goods' prices. This last condition is in line with the empirical evidence documented in the literature on micro-price data (for a survey, see Klenow and Malin 2010).

The economic intuition behind our results is also simple: Real wage rigidities decrease the elasticity of marginal costs, suppressing the reaction of prices in both sectors. This, in turn, renders positive comovement and aggregate non-neutrality possible.

Our reconciliation of the two sector New Keynesian model is not the first one. Bouakez, Cardia, and Ruge-Murcia (2011) and Sudo (2012) argue that input–output interactions help solve the comovement problem. In the models employed in both papers, because the production of nondurable goods requires durable goods as inputs, and vice versa, and because nondurable-goods' prices are sticky, the pass-through of the monetary impulse into durable-goods' prices is limited. Accordingly, durables output can move in the same direction of the change in aggregate demand. Carlstrom and Fuerst (2010) document that adding three features –sticky nominal wages, adjustment costs in housing construction, and habit formation in consumption– into an otherwise standard model brings it closer to reality. Sticky nominal wages is enough to generate sectoral comovement in the first quarter. But to generate sectoral comovement for more than one quarter, adjustment costs in housing construction are required. Monacelli (2009) and Sterk (2010) discuss the role of credit market frictions in accounting for positive sectoral comovement.

To make our paper self-contained and our model easy to compare to the one analyzed in BHK (2007), in Section 2. we briefly present their benchmark model, which, hereafter, we call the standard model. In Section 3., we incorporate real wage rigidities simply by modifying the labor supply equation of the standard model. Also in the same section we analytically assess the role of real wage rigidities in the neutrality and comovement problems. In Section 4., we calibrate the two models, and present the results of our numerical simulations. In Section 5., we offer some concluding remarks.

2. The Model

2.1. The Household

The household supplies labor, n_t, and capital, k, to the firms in durable and nondurable sectors. The stock of capital is fixed. Because production factors are perfectly mobile, the prices of these factors do not differ across sectors. The household chooses the consumption of nondurable goods, c_t, the stock of durable goods, d_t, labor supply, and purchases of durable goods, x_t, to maximize her utility

$$\mathbb{E}_t \left[\sum_{i=0}^{\infty} \beta \left(\psi_c \ln c_{t+i} + \psi_d \ln d_{t+i} - \frac{\phi}{2} n_{t+i}^2 \right) \right],$$

subject to the budget constraint

$$\frac{p_{c,t} c_t}{p_t} + \frac{p_{x,t} x_t}{p_t} + \frac{m_t}{p_t} \leq w_t n_t + \Pi_t + t_t + \frac{m_{t-1}}{p_t} + r_t k,$$

and the law of motion for the stock of durable goods

$$d_t = x_t + (1-\delta)d_{t-1}, \tag{1}$$

where w_t, Π_t, t_t, and r_t are the real wage, the real dividend income from owning intermediate firms, real lump-sum transfers, and the real rental price of capital, respectively; m_t is nominal money balances; p_t is the GDP deflator; and $p_{c,t}$ ($p_{x,t}$) is the price index of the composite nondurable (durable) good. Regarding the parameters, $\delta > 0$ is the rate of depreciation of the stock of durable goods, $0 < \beta < 1$ is the discount factor, $\psi_c > 0$ and $\psi_d > 0$ are the weights of nondurable and durable goods in the subutility, and $\phi > 0$ measures the disutility from labor.[1]

Let λ_t and μ_t be the Lagrange multipliers associated with the constraints above. The first order conditions to the household's problem are then

$$\psi_c c_t^{-1} = \frac{\lambda_t p_{c,t}}{p_t}, \tag{2}$$

$$\mu_t = \psi_d d_t^{-1} + \beta(1-\delta)\mathbb{E}_t[\mu_{t+1}], \tag{3}$$

$$\phi n_t = \lambda_t w_t, \tag{4}$$

$$\frac{\lambda_t p_{x,t}}{p_t} = \mu_t. \tag{5}$$

2.2. Firms

Within both sectors, there are perfectly competitive final good producers and monopolistically competitive intermediate good producers. Because the structure of production is symmetric across sectors, below we use a generic letter, $j = c, x$, to denote any of the sectors.

The production technology for the final good j_t is given by

$$j_t = \left[\int_0^1 j_t(i)^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}i\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{6}$$

where $j_t(i)$ is a differentiated intermediate good. The elasticity of substitution among intermediate goods, $\epsilon > 1$, is assumed to be the same in both sectors. Denoting the price of good i in sector j by $p_{j,t}(i)$, profit maximization of final good producers implies the demand function

$$j_t(i) = \left(\frac{p_{j,t}(i)}{p_{j,t}}\right)^{-\epsilon} j_t. \tag{7}$$

Together with eq. 7, zero profits of final goods producers imply the sectoral price index

$$p_{j,t} = \left[\int_0^1 p_{j,t}(i)^{1-\epsilon} \mathrm{d}i\right]^{\frac{1}{1-\epsilon}}. \tag{8}$$

[1] The felicity $\psi_c \ln c_t + \psi_d \ln d_t - \frac{\phi}{2} n_t^2$ implies that the intertemporal elasticity of substitution, the intratemporal elasticity of substitution between durable and nondurable consumption, and the Frisch labor supply elasticity equal one.

The production technology for an intermediate good is given by

$$j_t(i) = k_{j,t}(i)^{\alpha} n_{j,t}(i)^{1-\alpha}, \tag{9}$$

where $k_{j,t}(i)$ and $n_{j,t}(i)$ are the capital and labor services hired by firm i operating in sector j. Prices are set a la Calvo (1983). Specifically, each period, only a $1-\theta_j$ fraction of intermediate good producers can reset their prices. Then profit maximization implies the demands for labor and capital services

$$w_t = (1-\alpha)\frac{j_t(i)}{n_{j,t}(i)} mc_t, \tag{10}$$

$$r_t = \alpha \frac{j_t(i)}{k_{j,t}(i)} mc_t, \tag{11}$$

and the optimal price of good i

$$p^*_{j,t}(i) = \frac{\epsilon}{\epsilon-1} \frac{\sum_{s=0}^{\infty} (\theta_j \beta)^s \mathbb{E}_t[\lambda_{t+s} p^{\epsilon}_{j,t+s} j_{t+s} mc_{t+s}]}{\sum_{s=0}^{\infty} (\theta_j \beta)^s \mathbb{E}_t[\lambda_{t+s} p^{\epsilon}_{j,t+s} j_{t+s} p^{-1}_{t+s}]}, \tag{12}$$

where mc_t is the real marginal cost. Note that the real marginal cost is the same in both sectors. This stems from the Cobb-Douglas production function and the perfect mobility of production factors.

Because of symmetry across intermediate firms within each sector, intermediate firms who can reset their prices set the same price. And because only a $1-\theta_j$ fraction of prices can be reset every period, and, thus, the remaining fraction remains unchanged, the sectoral price index, eq. 8, is now read

$$p^{1-\epsilon}_{j,t} = \theta_j p^{1-\epsilon}_{j,t-1} + (1-\theta_j) p^{*1-\epsilon}_{j,t}. \tag{13}$$

2.3. Aggregation, Real GDP, and Money

At any point in time, production factors can be divided between the durable and non-durable sectors according to

$$n_t = n_{c,t} + n_{x,t}, \tag{14}$$

$$k = k_{c,t} + k_{x,t}, \tag{15}$$

where $n_{c,t}$ and $k_{c,t}$ ($n_{x,t}$ and $k_{x,t}$) are labor and capital hired in the nondurable (durable) sector. Market clearing implies $n_{j,t} = \int_0^1 n_{j,t}(i)\mathrm{d}i$ and $k_{j,t} = \int_0^1 k_{j,t}(i)\mathrm{d}i$ for $j = c, x$.

Real GDP, y_t, is defined by using the steady state values of the sectoral price indices in nominal GDP

$$y_t \equiv \bar{p}_c c_t + \bar{p}_x x_t. \tag{16}$$

Hence the GDP deflator is obtained by

$$p_t = \frac{p_{c,t}c_t + p_{x,t}x_t}{y_t}. \tag{17}$$

The demand for money is motivated simply by assuming that it is proportional to nominal GDP

$$m_t = p_t y_t. \tag{18}$$

Any difference in money supply from one period to the next is distributed to the household through lump-sum transfers $p_t t_t = m_t - m_{t-1}$. And the (log) growth rate of money supply is simply a mean zero i.i.d. random variable:

$$\ln \frac{m_t}{m_{t-1}} = \varepsilon_t. \tag{19}$$

3. Real Wage Rigidities

In our model with real wage rigidities, the real wage differs from the marginal rate of substitution between consumption and leisure – i.e., eq. 4 does not hold. To model real wage rigidities, we follow Blanchard and Gali's (2007) ad hoc but parsimonious formulation. Namely, we assume that the (log) real wage for which the household members are willing to work is a weighted sum of the lagged (log) real wage and the marginal rate of substitution between consumption and leisure

$$\ln w_t = \gamma \ln w_{t-1} + (1-\gamma) \ln mrs_t, \tag{20}$$

where $0 \leq \gamma \leq 1$ measures the degree of real wage rigidities in the economy, and mrs_t is the marginal rate of substitution between consumption and leisure, $mrs_t \equiv \frac{\phi n_t}{\lambda_t} = \frac{p_{x,t}\phi n_t}{p_t \mu_t}$. That is, to obtain our model, we replace eq. 4 in the standard model with eq. 20.

Next we analytically assess the role of real wage rigidities in the comovement problem arising under flexibly priced durable goods. Following the neat analysis of BHK (2007) we display a crucial property of the shadow value of durable goods: μ_t is nearly invariant. To this end, we rewrite eq. 3 as

$$\mu_t = \psi_d \mathbb{E}_t \left[\sum_{i=0}^{\infty} (\beta(1-\delta))^i d_{t+i}^{-1} \right].$$

Two remarks are in order about the shadow value of durable goods. First, the last equation states that the shadow value of durable goods is the expected sum of the discounted value of marginal utilities of durable goods. With low values of δ, temporary changes in the marginal utility of durable goods have insignificant effects on their shadow value. Second, because the stock-flow ratio of durable goods is high ($d/x = 1/\delta$ in the steady state), the effect of purchases of durable goods on the stock is also insignificant. These two properties justify treating the shadow value of durable goods as constant in our analytical exposition (i.e., $\mu_t \approx \mu$).

To continue with our analysis of the role of real wage rigidities, we first rewrite eq. 20

as $\left(\frac{w_t^{1/\gamma}}{w_{t-1}}\right)^{\frac{\gamma}{1-\gamma}} = mrs_t = \frac{p_{x,t}\phi n_t}{p_t \mu_t}$. To substitute $p_{x,t}/p_t$ out from the last expression, recall that durable-goods' prices are flexible, and that the capital-labor ratio is common to all firms, implying $\frac{p_{x,t}}{p_t} = \frac{\epsilon}{\epsilon-1}mc_t = \frac{\epsilon}{\epsilon-1}\frac{w_t}{(1-\alpha)}\left(\frac{n_t}{k}\right)^{\alpha}$. This together with $\mu_t \approx \mu$ enable us to rewrite eq. 20 as

$$\left(\frac{w_t}{w_{t-1}}\right)^{\frac{\gamma}{1-\gamma}} \approx \frac{\epsilon\phi k^{-\alpha}}{(\epsilon-1)(1-\alpha)\mu} n_t^{1+\alpha}. \tag{21}$$

It is now easy to see that in the standard model, i.e., $\gamma = 0$, the only solution to eq. 21 is invariant aggregate employment. Also, because $n_t = n_{c,t} + n_{x,t}$, positive comovement between sectoral employment levels is impossible. But if $\gamma > 0$, aggregate employment moves in the direction of the change in the real wage, and sectoral employment levels may move together. The economic intuition is straightforward. Once the real wage is rigid, marginal costs, common to all sectors, become less sensitive to changes in aggregate demand. This, in turn, limits the extent to which prices in both sectors react to changes in aggregate demand, rendering it possible for the output in both sectors to move together.

To confirm these results and to provide further details, next we report the results of our numerical simulations, using the log-linear approximation to the model around the nonstochastic steady state.

4. Numerical Simulations

4.1. Calibration

We start by calibrating the parameters. Our choice of parameter values is the same made by BHK (2007), except that we calibrate our model to quarterly data. Table 1 summarizes our choice of parameters targeting the following steady state values. Namely we set an annual discount rate of 2% implying $\beta = 0.9951$. We set an annual depreciation rate of 5% implying $\delta = 0.0123$. We set the shares of sectoral outputs in GDP such that in the steady state the output of the nondurable sector is thrice that of the durable sector implying $\psi_c/\psi_d = 2.1467$. We set a capital share of 35% implying $\alpha = 0.35$.

As a benchmark, we set an half-life of two quarters for nominal stickiness in the nondurable sector implying $\theta_c = 0.6534$. The comovement and aggregate neutrality problems are immense when durable-goods' prices are flexible. For this reason we set $\theta_x = 0$. Yet, in Section 4.2.3. we also consider a wide range of values for θ_c and θ_x. The parameters ϕ and ϵ do not play any role in the log-linear model.

In all our experiments, we study the response of key macroeconomic aggregates to a permanent increase in money supply: The growth rate of money supply, ε_t, assumes 0.01 at $t = 1$ and zero thereafter. Thus the monetary shock expands the money supply once-and-for-all by 1%.

We are not aware of a direct empirical evidence for the parameter governing the degree of real wage rigidities. In the literature, the values assumed range from 0.5 to 1. Blanchard and Gali (2007) set $\gamma = 0.9$ in their baseline calibration and also experiment both with $\gamma = 0.8$ and $\gamma = 0.5$. Duval and Vogel (2007) experiment with $\gamma = 0.79$ and $\gamma = 0.93$. Shimer (2012) assumes that the real wage rate is constant in business cycle frequencies, implying $\gamma = 1$. To set a benchmark value for γ, we target the standard deviation of US GDP in a version of our model that also allows for total factor productivity shocks. To produce a standard deviation of GDP of 1.72%, we choose $\gamma = 0.9546$.[2] Because this parameter is key to our discussion, we start by assuming not a single value but a range: $\gamma \in [0, 1]$.

4.2. Results

4.2.1. The Role of γ

First we study how the degree of real wage rigidities, γ, affects the responses of four selected variables –GDP, the real wage, durables output, nondurables output– to a permanent 1% increase in money supply.[3] To this end, we compute the first quarter and the first year (quarterly averaged) responses of these four variables for $\gamma \in [0, 1]$ with a grid of 0.01. Figure 1 illustrates the two measures as a function of γ (first quarter as solid line; first year as dashed line).

Eyeballing the graphs related to GDP and the two sectors' outputs, we observe that as γ increases, both problems, aggregate neutrality and negative sectoral comovement, cease to exist. Simultaneously, the first quarter and the first year responses of the relative real wage approach empirically plausible values.

The response of GDP is always positive and increasing in γ. More specifically, the first year response starts increasing at a faster rate around $\gamma = 0.8$; for $\gamma \in [0.8, 1]$ aggregate non-neutrality is significant. The interval $\gamma \in [0.8, 1]$ also suffices to generate positive comovement between the sectoral outputs at first quarter responses. Regarding first year responses, the threshold value of γ generating positive comovement between sectoral outputs is 0.93. In the standard model, i.e., when $\gamma = 0$, the first quarter response of the real wage is 70 times higher than that of aggregate output. By contrast, the response of the relative real wage decreases in γ as implied by the law of motion of the real wage, eq. 20. With our baseline calibration, $\gamma = 0.9546$, the first quarter response of the real wage is 10% of that of aggregate output.

4.2.2. Impulse Response Functions

To gain further intuition, in Figure 2 we contrast the standard model ($\gamma = 0$; solid line) with the model with real wage rigidities ($\gamma = 0.9546$; dashed line) in terms of impulse

[2]Specifically, we assume that the production technology for an intermediate good is given by $j_t(i) = a_t k_{j,t}(i)^{\alpha} n_{j,t}(i)^{1-\alpha}$, where a_t is total factor productivity and follows $\log(a_t) = 0.95 \log(a_{t-1}) + \nu_{a,t}$. The growth rate of money supply, ε_t, follows $\log(\varepsilon_t) = 0.49 \log(\varepsilon_{t-1}) + \nu_{m,t}$. The innovations $\nu_{m,t}$ and $\nu_{a,t}$ are mean zero i.i.d. random variables with standard deviations of 0.89% and 0.7%. The correlation between the innovations is set to zero. The HP smoothing parameter is set to 1600. Accordingly, 85% of the deviation in output are due to shocks to total factor productivity.

[3]For the sake of brevity, we select only four variables. We select GDP to address aggregate neutrality; we select the sectoral outputs to address the comovement problem; and we select the relative real wage to address real wage rigidities.

response functions. Again, the innovation is a permanent 1% increase in money supply, and durable-goods' prices are flexible.

In both models, the impulse response functions for the durable sector illustrate that the reaction of the output is the mirror image of that of the price index. The contrast is primarily on impact effects. In the model with real wage rigidities, the durable-price index, on impact, undershoots its long-run value by 0.2%. In the standard model, however, it overshoots by 1.5%. Because of these temporary changes in prices, in the standard model durables output decreases on impact by 5%, while with real wage rigidities it increases by 0.85%. Thus the most striking aspect of incorporating real wage rigidities into the standard model is the reversal of the durable-output response: The household switches expenditure from nondurable to durable goods. This switch in expenditure also attenuates the impact response of nondurables output and price index.

Obviously, the key variable to understand the under- and overshooting of the durable-price indices, and, thus, the reversal of the durable-output response, is the reaction of the real wage. In the model with real wage rigidities, the response of the real wage is muted, being in line with the empirical evidence documented in VAR studies (see, for example, Altig et al. 2011, Amato and Laubach 2003, and Christiano et al. 2005). With real wage rigidities, thanks to this muted response of the real wage, the durable-price index can under-shoot its long-run value, allowing the durable-output to react positively on impact to monetary expansions.

In the standard model, because the sectoral outputs move in opposite directions, GDP, which is the weighted average of the sectoral outputs, is essentially unchanged. In the model with real wage rigidities, the responses of the sectoral outputs increase simultaneously, and, thus, the response of GDP increases as well. In short, with real wage rigidities, we obtain non-neutral money and positive comovement between sectoral outputs.

Ordering the magnitudes of peak-responses of the sectoral variables and GDP reveals that in the model with real wage rigidities: (i) Durables output reacts sharply to monetary shocks; (ii) GDP and nondurables output react similarly and less dramatically than durables output; (iii) The durable-price index reacts more strongly than the nondurable-price index. These three results are also in line with the stylized facts documented in BHK (2003), Erceg and Levin (2006), and Monacelli (2009).

4.2.3. The Roles of θ_c and θ_x

As in the majority of the related literature, in our evaluation so far we have only considered the case of flexibly priced durable goods.[4] In their survey of the micro-price studies analyzing data that underlie U.S. consumer and producer price indices, Klenow and Malin (2010) document that while price flexibility increases with durability, durable-goods' prices, on average, are not perfectly flexible.

To detect how the imperfect flexibility of durable-goods' prices affects the nature of

[4]See Bouakez et al. (2011), Carlstrom and Fuerst (2010), and Sudo (2012). Bouakez et al. experiment also with an half life of one month for nominal stickiness in the durable sector.

comovement in both models we evaluate, we first compute the first-year effects of a permanent increase in money supply on nondurables and durables outputs for all possible combinations of ten equally distanced values of θ_c and θ_x in the range $[0.1, 0.9]$. To produce a basic summary statistic of sectoral comovement, we, then, compute the ratio of the first year multiplier of nondurables output to that of durables output; positive and negative values implying positive and negative comovement, respectively. Focusing only on the cases in which durable-goods' prices are more flexible than the nondurable-goods' prices, $\theta_x \leq \theta_c$, Table 2 presents how our summary statistic changes with the sectoral price flexibility in the standard model (Panel A) and in the model with real wage rigidities (Panel B).[5] In Table 2, we use bold-faced type to highlight the cases in which the statistic falls into the empirically plausible range of $[10\%, 50\%]$ (BHK 2003, Erceg and Levin 2006, and Monacelli 2009).

Regarding the standard model, from Panel A of Table 2 we observe that in 30 of all 36 cases considered we obtain negative comovement. In two cases we obtain positive comovement but the effect on the nondurable-output exceeds that on the durable-output. Only in four cases our statistic lies within the empirically plausible range. Regarding the model with real wage rigidities, from Panel B of Table 2 we observe that in all cases we obtain positive comovement, and the response of the nondurables-output is less than that of the durable-output. In 21 cases, the statistic lies within the empirically plausible range.

Thus, Table 2 confirms our previous argument that in the model with real wage rigidities the comovement problem disappears as long as durable-goods' prices are more flexible than nondurable-goods' prices.

5. Concluding Remarks

In this paper, we argue that real wage rigidities are a missing element in the standard two sector New Keynesian model. In the standard model, for aggregate output to increase following a monetary shock, durable-goods' prices must be sticky. If durable-goods' prices are flexible, and nondurable-goods' prices are sticky, then the standard model predicts negative sectoral comovement besides aggregate neutrality. If both durable- and nondurable-goods' prices are sticky, then the standard model predicts no sectoral comovement. By incorporating real wage rigidities into the standard model, we obtain positive sectoral comovement and, thus, aggregate non-neutrality as long as durable-goods' prices are more flexible than nondurable-goods' prices.

Real wage rigidities have been advocated as a missing element also in other contexts (Blanchard and Gali 2007, Hall 2005, and Shimer 2012, just to name a few recent examples). Our research thus justifies our agreement with Shimer (2012) that wage rigidities should be put back into the center of research on macroeconomics. This paper is a contribution to that program.

[5] In the cases of equal flexibility, $\theta_x = \theta_c$, for the two models considered, the statistic ranges between 0.009 and 0.035 implying the lack of sectoral comovement. In the cases of extra flexibility in the nondurable-goods' prices, $\theta_x > \theta_c$, again for the two models considered, the statistic ranges between -0.020 and -0.199 implying negative comovement.

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Table 1: Benchmark Parameters

Discount factor:	$\beta = 1.02^{-1/4}$
Rate of depreciation:	$\delta = 1.05^{1/4} - 1$
Relative weight in subutility:	$\psi_c/\psi_d = 3\delta/(1-\beta(1-\delta))$
Capital share:	$\alpha = 0.35$
Degree of price stickiness	
in the nondurable sector:	$\theta_c = 0.6534$
in the durable sector:	$\theta_x = 0$
Degree of real wage rigidities:	$\gamma = 0.9546$

Table 2: Sectoral Comovement & Price Stickiness

Panel A: Standard Model ($\gamma = 0$)

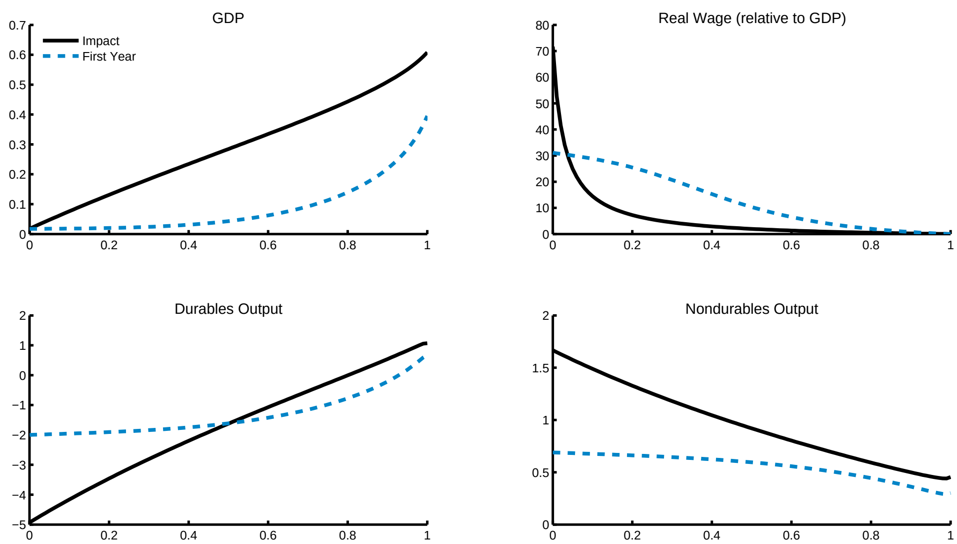
	$\theta_c = 0.2$	$\theta_c = 0.3$	$\theta_c = 0.4$	$\theta_c = 0.5$	$\theta_c = 0.6$	$\theta_c = 0.7$	$\theta_c = 0.8$	$\theta_c = 0.9$
$\theta_x = 0.1$	−0.746	−0.458	−0.405	−0.383	−0.372	−0.365	−0.361	−0.363
$\theta_x = 0.2$		−6.730	−0.613	−0.468	−0.419	−0.396	−0.383	−0.380
$\theta_x = 0.3$			1.319	−0.833	−0.534	−0.454	−0.419	−0.405
$\theta_x = 0.4$				0.679	−1.183	−0.609	−0.492	−0.449
$\theta_x = 0.5$					**0.479**	−1.920	−0.701	−0.542
$\theta_x = 0.6$						**0.374**	−5.112	−0.850
$\theta_x = 0.7$							**0.305**	4.956
$\theta_x = 0.8$								**0.245**

Panel B: The Model with Real Wage Rigidities ($\gamma = 0.9546$)

	$\theta_c = 0.2$	$\theta_c = 0.3$	$\theta_c = 0.4$	$\theta_c = 0.5$	$\theta_c = 0.6$	$\theta_c = 0.7$	$\theta_c = 0.8$	$\theta_c = 0.9$
$\theta_x = 0.1$	**0.252**	**0.496**	0.699	0.833	0.896	0.896	0.838	0.689
$\theta_x = 0.2$		**0.145**	**0.291**	**0.431**	0.548	0.626	0.650	0.581
$\theta_x = 0.3$			**0.110**	**0.220**	**0.331**	**0.427**	**0.490**	**0.477**
$\theta_x = 0.4$				0.093	**0.185**	**0.278**	**0.355**	**0.379**
$\theta_x = 0.5$					0.083	**0.164**	**0.242**	**0.287**
$\theta_x = 0.6$						0.078	**0.149**	**0.204**
$\theta_x = 0.7$							0.074	**0.132**
$\theta_x = 0.8$								0.071

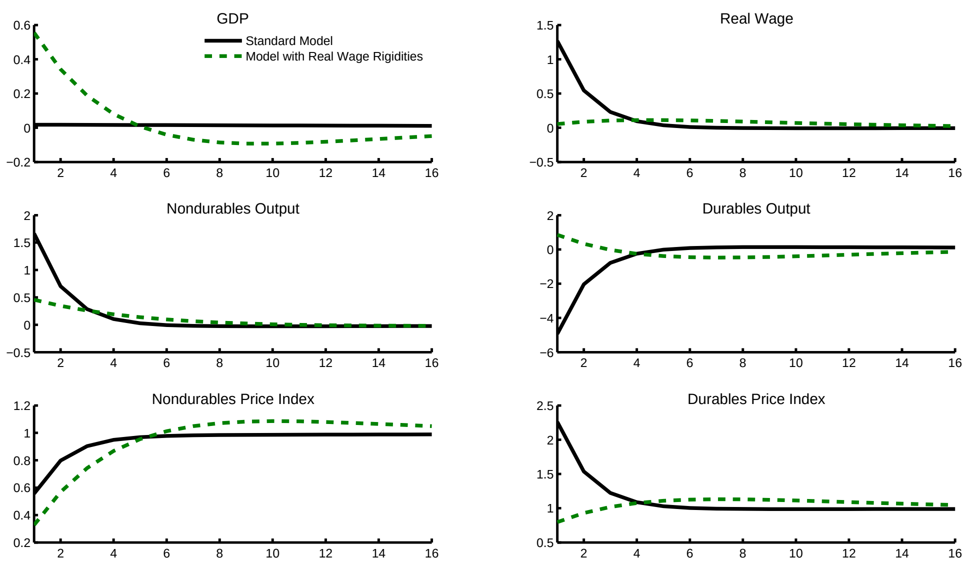
Note: The table gives the ratio of first year multiplier of nondurables output to that of durables output. A negative value implies negative sectoral comovement. Bold-faced type is used to highlight the cases in which the ratio falls into the empirically plausible range: $[10\%, 50\%]$.

Figure 1: The Role of Real Wage Rigidities



Note: The horizontal axis measures the degree of real wage rigidities, $\gamma \in [0, 1]$. The vertical axis measures the impact (solid line) and first year quarterly average (dashed line) responses to a permanent monetary expansion. The rest of the parameters assume their benchmark values.

Figure 2: Impulse Response Functions



Note: The horizontal axis measures time in quarters. The vertical axis measures the logarithmic deviation from the steady state. The impulse is a permanent monetary expansion. Solid lines represent the responses in the standard model, $\gamma = 0$, while the dashed lines represent the responses in the model with real wage rigidities, $\gamma = 0.9546$. The rest of the parameters assume their benchmark values.