Relative wage concern: the missing piece in the contract multiplier?

G. Ascarì and J.A. García

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Abstract

We build a dynamic general equilibrium model with staggered wages that incorporates relative wage concern on the part of workers. We then investigate the effects of money shocks on both inflation and output. In contrast to previous models of staggered wages/prices, both output and inflation persistence is a robust finding of the model. Persistence results hold for all the sensible parametrisations. Given the empirical evidence in favour of a relative wage concern, we conclude that this may be the missing piece in the money shocks persistence puzzle.

Keywords: Staggered wages, output persistence, business cycles
JEL Codes: E24, E32

* Corresponding author: Guido Ascari, Jean Monnet Fellow, Department of Economics, European University Institute, Via dei Roccettini 9, Badia Fiesolana, San Domenico di Fiesole (FI), 50016 ITALY. E-mail: ascari@datacomm.iue.it.

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Modern business cycle research is almost entirely carried out within the context of quantitative dynamic general equilibrium (DGE) macromodels. In such a framework, the role of monetary shocks in generating the output fluctuations observed in actual data is still controversial. Existing monetary DGE macromodels have incorporated various forms of nominal rigidities. The overlapping contracts models of Calvo (1983) and Taylor (1979, 1980a) have played a prominent role in that approach. The reason is that such contracting schemes bring in not only the nominal rigidity necessary for the impact effect of the monetary innovation, but they also provide a nominal propagation mechanism in a framework otherwise lacking endogenous propagation mechanisms. In Taylor’s (1980a, p.2) words: “In effect, each contract is written relative to other contracts, and it causes shocks to be passed on from one contract to another – a sort of “contract multiplier.”

Recent quantitative DGE macromodels, notably Chari, Kehoe and McGrattan (1996) (CKM henceforth) and Ascar (1997), have cast serious doubts on the explanatory power of staggered price/wage setting in accounting for output persistence. They show that persistence does not exceed the length of the contracts. In other words, there is no contract multiplier. Indeed persistence requires endogenous stickiness in the sense that price-setting agents do not want to change their prices/wages by a large amount when they reset them. On the contrary, CKM and Ascar (1997) have shown that, for sensible values of the intertemporal elasticity of substitution of consumption and/or the intertemporal elasticity of substitution of labour, the response of wages to the output gap is too high to generate output persistence.

This paper reconsiders the existence of a contract multiplier. We focus on wage staggering for two reasons. First, we believe that persistent nominal rigidities are more likely to arise in the labour market rather than in the goods market. Second, in contrast to the simpler approach of the above previous studies, we argue that the wage setting process is better represented as the result of the combination of small nominal and real rigidities.

In our model the real rigidity in the labour market arises from taking into explicit account relative real wage concern in the bargaining process. We review below the empirical evidence pointing at relative wages as a fundamental factor in the wage setting process. Taylor’s model was thought to incorporate a “Keynesian” component of relative wage concern on the part of the workers. However, his model is analytically equivalent to one in which workers are (“neoclassically”) concerned only about the
level of their own real wages (see Buiter and Jewitt (1981), Blanchard (1990), Ascari (1997)). Relative wage concern considerations have been therefore neglected so far. This omission seems to be a serious weakness of the contracting specification assumed in Taylor’s model, as Buiter and Jewitt (1981) suggest. Also in a recent contribution closely related to ours, Fuhrer and Moore (1995) (FM henceforth) have pointed to the lack of inflation persistence generated by Taylor’s staggered wage contracting scheme as a major empirical failure.

We keep our analytical framework as close as possible to those of the previous studies that have highlighted the weaknesses of the Taylor contracting specification, namely CKM, FM and Ascari (1997). By incorporating relative wage concern in this framework, we try to capture the spirit of the original work of Taylor since it was aimed at considering relative wage considerations. Our analysis then should be seen as a first step towards assessing how crucial is the omission of relative wage concern for the analytical and quantitative results of CKM and Ascari (1997).

Contrary to previous studies, the quantitative results of the paper provides strong support for the existence of a powerful contract multiplier. Two features of the model strengthen the importance of our result. First, the wage contracting specification is the only mechanism through which the effects of nominal shocks are propagated in our model. We refrain from introducing capital accumulation, adjustment costs, input-output structure, endogenous mark-ups, or any other possible factor which enhances the nominal propagation mechanism derived here. Second, as in previous analyses of staggered wage setting, our results also highlight the potential role of high intertemporal elasticities of substitution of consumption and labour supply in favouring persistence, but by no means rely on them to generate a substantial degree of persistence. This latter point is evident from our calibration exercise. Despite these features of the model, we find that output persistence is a likely outcome.

Some intuition for the sharp contrast between our results and those of CKM can be obtained by comparing the log-linearisation of the two wage setting equations. The key difference is the elasticity of wages with respect to business cycle conditions. Relative wage concern on the part of workers lowers that elasticity. A sensible calibration of the parameters governing relative wage considerations generates a powerful contract multiplier and thus substantial persistence in both inflation and output.

The remainder of the paper is organized as follows. In section 2 we present some empirical evidence and our formalisation of relative wage concern on the part of wage-setters. Our model is presented in section 3. We study the analytical implications of relative wage concern in section 4, and compare our findings to previous studies.
of staggered wage/price models. We then proceed to analyse the quantitative implications. Section 5 describes the calibration of the model and reports our simulation results. Finally, Section 6 concludes.

2 THE CASE FOR RELATIVE WAGE CONCERN

The existence of relative comparisons has a long tradition in economics, starting from Adam Smith (1976). However, the most influential account of relative wage concern and its implications came undoubtedly from John Maynard Keynes (1936, p. 14):

"Though the struggle over money-wages between individuals and groups is often believed to determine the general level of real wages, it is, in fact, concerned with a different object. Since there is imperfect mobility of labour, and wages do not tend to an exact equality of net advantage in different occupations, any individual or group of individuals, who consent to a reduction of money-wages relatively to others, will suffer a relative reduction in real wages, which is sufficient justification for them to resist it. [...] In other words, the struggle about money-wages primarily affects the distribution of the aggregate real wage between different labour groups, and not its average amount per unit of employment, [...] . The effect of combination on the part of a group of workers is to protect their relative real wage."

In the recent literature, relative wage considerations have been introduced with reference to fair wage determination and its impact on effort and unemployment (e.g., Frank (1984), Summers (1988), Akerlof and Yellen (1990)). In contrast, in this paper we focus on the implications of relative wage concern on the wage setting process and the contract multiplier.

2.1 Some empirical evidence

Labour economists pointed out long ago the interdependence between trade union’s wage claims as a stylized fact in the bargaining process. Theoretical foundations of

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1 The emphasis is as in the original.
union “rivalry” and inter-union “jealousy” have been studied in Oswald (1979) and Gylfason and Lindbeck (1984). Risager (1992) empirically investigates the wage rivalry hypothesis in Danish data for skilled and unskilled workers. He found strong evidence in favour of interdependence between wage claims. In particular, his analysis of wage setting behaviour:

(i) identifies a very strong “following” behaviour in wage setting by
(ii) finds the level of unemployment/business cycle conditions statistically non-significant.

Furthermore, in recent years a new source of empirical evidence has received considerable attention by economists: surveys on self-reported levels of satisfaction of workers, which already form the fundamental material of study for a large empirical literature in social psychology. Such data has been used as proxy for utility data. Capelli and Sherer (1988) use data from a major U.S. airline; Clark and Oswald (1996a) from the British Household Panel Survey. Both studies report measures of the importance of relative wages for individual workers. Their results:

(i) identify relative wages as the fundamental factor (and statistically strongly significant) on regressions of job satisfaction for individual workers;
(ii) the level of the own real wage/income plays a minor role in explaining job satisfaction, if any at all. Moreover, its coefficient is found statistically non-significant.

These findings from individual survey data provide strong support for utility functions that allow for relativities in wage setting. Besides, they justify the presence of the union rivalry mentioned above from the personal preferences of their potential members.

Moreover, other studies have asked employers which are the determinants of wage negotiations with workers. Campbell and Kamlani (1997) (Table II) report results from other studies based on survey data from firms which suggest that relative wage concern is very significant, especially in heavily unionized firms (Agell and Lundborg (1995)).

2.2 Relative real wage concern and staggered wage setting

The structure of wage setting in our model is defined by two features: (i) staggered wage setting; (ii) relative real wage concern.

\[ \text{Footnote: As pointed out by Clark and Oswald (1996a), footnote 4: “It might be argued, in the extreme, that these are random numbers merely made up by survey respondents. Psychologists, who are at least as aware of this possibility as economists, have long since abandoned such a view.”} \]
(i) **Staggered wage setting**

This setting is standard in the related literature. The economy consists of a continuum of industries, indexed by $i \in [0, 1]$, and a continuum of industry-specific unions, indexed by $j \in [0, 1]$. The economy is divided into $N$ sectors. Each sector is composed of $1/N$ industries and their corresponding unions. Wage contracts, denoted by $X$, are negotiated in nominal terms, and are fixed for $N$ periods. That is, for a union setting the nominal wage in period $t$, $X_{jt+k} = X_{jt}$ for $k = 0, \ldots, N-1$. Furthermore, unions indexed $j \in [0, 1/N]$ set their wages in periods $0, N, 2N$, unions indexed $j \in [1/N, 2/N]$ do so in periods $1, N+1, 2N+1$, etc. Note that staggered wage setting breaks the complete symmetry among households in different sectors. However, unions belonging to the same sector will set the same wage. Thus, in any period $t$ there are $N$ different contracts in effect.

(ii) **Relative real wage concern**

Taylor’s model was originally thought to incorporate a “Keynesian” component of relative wage concern on the part of the workers. However, his model is analytically equivalent to a model in which workers are “neoclassically” concerned only about the level of their real wages. Instead, the evidence in Section 2.1 suggests that relative wage considerations play a fundamental role in the wage setting process. Then, the two questions of interest here are how to introduce relative wage concern in the model and how to analytically specify it.

With respect to the first question, given the result in the previous subsection, we model relative wage concern by including an additional argument in the utility function of the representative household. Despite the available empirical evidence on unions’ behaviour, sociological and psychological considerations, our introduction of relativities in the utility function may be seen as an *ad hoc* unjustifiable short-cut. This approach runs in fact against the deeply-rooted resistance to modify the structure of preferences

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3 A continuum of industries means that no imperfectly competitive agent is ‘large’ relative to the economy as a whole. The ‘household-union’ should be thought of as an aggregate of all the households which work in the industry, who collude in the setting of the wage.

4 Let us call the new wage set in period $t$ in industries $i \in [0, 1/N]$, $X_t$. Then, unions indexed $j \in [1/N, 2/N]$ will set their new nominal wage in period $t+1$, unions indexed $j \in [2/N, 3/N]$ will set their new nominal wage in period $t+2$, and so on. Therefore $X_t, X_{t+1}, X_{t+2N}, \ldots$ are the wages fixed by the sector which comprises industries $i \in [0, 1/N]$, $X_{t+1}, X_{t+2N}, \ldots$ the wages fixed by the sector that comprises industries $i \in [1/N, 2/N]$ and so on.

5 This point, already noted by Buiter and Jewitt (1981) and Blanchard (1990), is explicitly demonstrated by Ascari (1997) to hold in a DGE model of wage staggering.
of agents.\footnote{As Akerlof (1997, p. 1005) puts it: “Traditional economics has been based on methodological individualism. Until quite recently, with some rare exceptions, it has not been appreciated that this method can be, or perhaps I should say, \textit{should be}, extended in describing social decisions to include dependence of individuals’ utility on the utility or the actions of others.”} Nevertheless, similar kind of preferences have been proposed as an explanation for some puzzles in asset pricing (see Abel (1990), Gali (1994), Campbell and Cochrane (1995)), consumption (see Carrol and Weil (1994)), and growth (see Carrol \textit{et al.} (1997)).\footnote{Depending on the particular specification they are referred to as “interdependent preferences”, “external habit formation”, “keeping up (or catching up) with the Joneses” or “relative income hypothesis”.} More generally, in recent years a growing literature has emerged encompassing economic and social elements, and in particular status concern (see Frank (1984, 1985) and the references therein, Baxter (1988), Kandel and Lazear (1992), Clark and Oswald (1996a,b) and Akerlof (1997)). Moreover, by introducing relative wage considerations explicitly we aim at: (i) identifying the analytical implications of relative wage concern in wage setting; (ii) establishing whether sensible values of the key parameters governing relative wage concern can explain output and inflation persistence. In this way, we can then assess how critical is the omission of relative wage concern for the analytical and quantitative results of CKM and Ascari (1997).\footnote{Further microfoundations of relative wage concern are certainly desirable and are already in our agenda for future research.}

We now turn to the analytical definition of relative wage concern. We denote the relative wage argument in the utility function of the representative household \( j \), \( RW_j \). Following FM\footnote{In what follows we keep the notation as close as possible to that of FM. Our definition of the case presented in the main text corresponds to their \textit{Theoretically Preferable Case}. Appendix B introduces two alternative specifications. We also present a brief comparison of our model with FM’s one in Section 4.3.}, we define the contract price in period \( s \), \( CP_s \), as the value of the contract signed by the union \( j \) in period \( s \). To clarify the definitions note that in this subsection, we use the index \( t \) to indicate the period in which the real wage comparison takes place, while \( s \) refers to the period in which the contract is signed. Recall that for a union setting the nominal wage in period \( s \), \( X_s \), for \( k = 0, \ldots, N - 1 \). As the nominal wage \( X_s \) is fixed for \( N \) periods, such is its contract price, i.e., \( CP_s \), (hence, we index it by \( s \)). Workers compare the value of the contract they sign in period \( s \), \( CP_s \), to the index of contract prices “\( V \)”. Crucial to the modelling of the relative wage concern is the choice of the reference wage index for comparison purposes. We define \( V_t \) as the average of the contract prices of the workers in the \textit{other} sectors in effect in period \( t \), that is, the average of the contracts negotiated by the \textit{other} unions. We believe this
"outward comparison" specification to be the most relevant in the real world. Thus, $RW_j^t$ is defined as the ratio between the value of the contract in force for union $j$ in period $t$ to the index of contract prices signed by the other sectors and still valid in period $t$.

At any period $t$ there are $N$ different nominal contracts in effect, hence $N$ different $CP_s$ and $N$ different $RW_j^t$, one for each representative sectoral union. Consider the problem faced by a union setting the nominal wage in period $t$.

Assume that the contract lasts for four periods ($N/4=2$). The decision of the union then takes into account that by setting $X_s$, it also fixes $CP_s$ for the next four periods. The optimal $X_s$ is thus set by comparing the price contract the union is currently negotiating (i.e., $CP_s$) to the indexes of real contract prices $V$ for the four periods in which the contract will be in force, that is $t$ to $t+3$. The $RW$ the workers will face in period $t$ and in the following three periods as a result of the wage they negotiate in $t$ are then

$$RW_j^t = \left(\frac{CP_s}{V_t}\right) = \frac{CP_s}{(1/3)(CP_{s-3} + CP_{s-2} + CP_{s-1})};$$

$$RW_j^{t+1} = \left(\frac{CP_s}{V_{t+1}}\right) = \frac{CP_s}{(1/3)(CP_{s-2} + CP_{s-1} + CP_{s+1})};$$

$$RW_j^{t+2} = \left(\frac{CP_s}{V_{t+2}}\right) = \frac{CP_s}{(1/3)(CP_{s-1} + CP_{s+1} + CP_{s+2})};$$

$$RW_j^{t+3} = \left(\frac{CP_s}{V_{t+3}}\right) = \frac{CP_s}{(1/3)(CP_{s+1} + CP_{s+2} + CP_{s+3})}.$$

Note that, because of the "outward comparison" specification, the $V_t$ terms are not symmetrically updated in the four periods of duration of the contract. 

Last we just need to define the contract price, $CP$. We suppose that the workers are concerned with their average real wage over the life of the contract. Consequently $CP$ is defined as the money wage deflated by a weighted average of the price levels in the four periods in which the contract will be in force. That is: $CP_t = X_t/\overline{P}_t$, where $\overline{P}_t = \frac{\beta + \beta^2 + \beta^3 + \beta^4}{1 + \beta + \beta^2 + \beta^4}$. Agents therefore calculate the average $\overline{P}_t$ discounting the future price levels by the preference discount factor $\beta$. Then they compare the value of

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10 The term "outward comparison" follows a recent work by Carrol et al. (1997). Its purpose is to highlight the absence of own variables in the definition of the reference stock for comparison purposes. Specifically, in our setting the “own contract price” does not enter the definition of the index of contract prices to which it is compared in the bargaining process.

11 Future variables are replaced by their expected values. We drop the expectation operator for notation convenience. Note also that the $RW$ terms are different for each household-union in different sectors, depending on the period in which they set their wage. Recall in fact that in each period there are $N$ different contracts in force and hence $N$ different $RW$. 

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their contract, i.e., $CP_t$, with an average of the ones that overlap with it, that is,

$$CP_t = \frac{X_t}{P_t}; \quad RW_t = \frac{X_t}{P_t} \left( \frac{X_{t-1}}{P_{t-1}} + \frac{X_{t-2}}{P_{t-2}} + \frac{X_{t-3}}{P_{t-3}} \right)^\frac{1}{3}.$$

In Appendix B we present two alternative formulations for $RW_t$.

3 THE MODEL

There are three types of agents in the economy: firms, households and the government. The economy consists of a continuum of industries and every industry produces a single perishable product and comprises a continuum of firms. The goods market in every industry is hence competitive. All households have the same preferences. Each household $j$ consumes a composite good, defined by a CES index over consumption goods of each industry, i.e.

$$C_{jt} = \left[ \int_0^1 C_{jt}^\theta \, di \right]^{\frac{1}{\theta}}.$$

The elasticity of substitution among goods, $\theta$, is assumed strictly greater than one. This specification gives rise to the standard demand function for good $i$ by household $j$

$$C_{jit} = \left( \frac{P_{it}}{P_t} \right)^{-\theta} \frac{E_{jt}}{P_t}, \quad (1)$$

where $E_{jt}$ is household’s total nominal expenditure on goods, and $P_t$ is the aggregate price index defined as $P_t = \left[ \int_0^1 P_{it}^{1-\theta} \, di \right]^{\frac{1}{1-\theta}}$.

3.1 Firms

All firms have the same technology, given by $Y_{it} = \alpha L_{it}^\sigma$, where labour is the only factor of production. Firms within each industry are price takers both in the goods and the labour market. Profits are maximised period by period given the nominal wage, $X_{it}$, which is set by the industrial union. The labour demand and output of firm $i$ are respectively given by

$$L_{it} = \left( \frac{1}{\alpha \sigma P_t} \right) \frac{X_{it}}{P_t}; \quad Y_{it} = \alpha \left( \frac{1}{\alpha \sigma P_t} \right) \frac{X_{it}}{P_t}. \quad (2)$$
Imposing the equilibrium condition in the industry goods market, that is,

\[ C_{it} = \int_{0}^{1} C_{j} dj = Y_{it} \quad \forall i \in [0, 1], \]  

(3)
yields the following relation between the labour demand and the nominal wage

\[ L_{it} = K_{t}X_{it}^{-\varepsilon} \quad \text{where} \quad \varepsilon = \frac{\theta}{\sigma + (1 - \sigma)\theta} \quad \text{and} \quad K_{t} = \sigma^{\varepsilon} \left[ \frac{E_{t}}{P_{t}^{1-\sigma}} \right]^{\frac{\theta}{\sigma}}. \]  

(4)
The labor demand function faced by the monopolistic household-union in each industry exhibits a constant money-wage elasticity equal to \( \varepsilon \), which depends on technology and preference parameters. \( K_{t} \) is parametric to the union, which takes aggregate variables as given \( (E_{t} = \int_{0}^{1} E_{j} dj = \text{aggregate nominal expenditure}) \).

### 3.2 Households

The two fundamental features of the households’ behaviour are their monopoly power in nominal wage setting and their concern with relative wages.

The industry-specific household-unions enjoy monopoly power because labour is not allowed to move across industries. In period \( t \), the household maximises a utility function of the form (the index \( j \) is dropped to lighten notation)

\[ U = \sum_{k=0}^{\infty} \beta^{k} E_{t}[u(C_{t+k}, m_{t+k}, L_{t+k}, RW_{t+k})]. \]  

(5)
The arguments in the utility function \( C_{t+k}, m_{t+k} \) and \( L_{t+k} \) are, respectively, the consumption of the composite good, the real money balances \( (m_{t+k} = M_{t+k}/P_{t+k}) \) at the end of the period and the labour supply of the households.\(^{12}\) The specification of the relative wage argument \( RW_{t+k} \) is the novelty of the model and has been discussed in Section 2.2. The utility function satisfies the conditions: \( u_{w}(\cdot) > 0, u_{ww}(\cdot) < 0 \).

The household’s budget constraint evolves according to

\[ P_{t}C_{t} + M_{t} + \sum_{s_{t+1}} Q(s_{t+1} | s')B(s'+1) \leq M_{t-1} + B_{t} + W_{t}L_{t} + \Pi_{t} + T_{t} \]  

(6)

\(^{12}\) The utility function satisfies the standard conditions \( u_{c}(\cdot) > 0, u_{m}(\cdot) > 0, u_{L}(\cdot) < 0, u_{cc}(\cdot) < 0, u_{mm}(\cdot) < 0, u_{LL}(\cdot) < 0 \), where \( u_{r}(t) \) denotes the first partial derivative of the instantaneous utility function and \( u_{rr}(\cdot) \) the second one, with respect to the argument \( r \).
where $Q(s^{t+1} | s^t)$ is the stochastic discount factor equal to the money value of a contingent claim in state $s^t$ to one dollar in state $s^{t+1}$. $M_t$ denotes money holdings at the end of period $t$, $B_t$ the quantity of bonds in period $t$, $T_t$ the nominal lump-sum transfer received by the household from the government, $\Pi_t$ the profits distributed by firms, and $L_t W_t$ the labour income.

Households maximise their expected lifetime utility subject to the sequence of budget constraints (6), the sequence of labour demand curves (4), and the additional constraint that the nominal wage will be fixed for $N$ periods. They choose the level of consumption, the quantities of money and bonds to be transferred to the next period and the level of the nominal wage that must be fixed for $N$ periods. However, they fix the wage before the realisation of period $t$ shock, while the other decisions are taken after the shock has been realised. The first-order conditions for this problem can be expressed as follows

$$\frac{u_m(t)}{u_C(t)} = \frac{R_t - 1}{R_t} \quad (7)$$

$$u_C(t) = \beta R_t E_t \left( \frac{u_C(t + 1) P_t}{P_{t+1}} \right) \quad (8)$$

$$\sum_{s^{t+1}} Q(s^{t+1} | s^t) = \frac{\beta E_t (\lambda_{t+1})}{\lambda_t} = \beta E_t \left( \frac{u_C(t + 1) P_t}{u_C(t) P_{t+1}} \right) = \frac{1}{R_t} \quad (9)$$

$$X_t = \left( \frac{\varepsilon}{\varepsilon - 1} \right) \left\{ \frac{E_{t-1} \left[ \sum_{r=0}^{N-1} \beta^r \left( \frac{u_L(t+r) K_{t+r}}{P_{t+r}} \right) \right]}{E_{t-1} \left[ \sum_{r=0}^{N-1} \beta^r \left( \frac{K_{t+r}}{P_{t+r}} \right) \right]} + \frac{E_{t-1} \left[ \frac{1}{\varepsilon} uRW(t + r) \frac{\partial RW[t + r]}{\partial x_t} \right]}{E_{t-1} \left[ \sum_{r=0}^{N-1} \beta^r \left( \frac{u_L(t+r) K_{t+r}}{P_{t+r}} \right) \right]} \right\} \quad (10)$$

where $\lambda_t$ is the multiplier attached to the budget constraint in period $t$. The first three equations are standard: (7) represents the optimal choice between consumption and money, (8) is the Euler equation for consumption and (9) gives the gross nominal interest rate $R_t$.\(^{13}\)

\(^{13}\) Following CKM, let $s^t$ denote the state of the world in period $t$. Denote with $Pr(s^{t+1} | s^t)$ the probability that in the next period the state of the world will be $s^{t+1}$, conditional to the state $s^t$ in period $t$. To lighten notation and avoid indexing each variable with respect to the state of the world, we use the expectation operator and the dating of the variables. Then, $\Theta_t = \Theta(s^t)$ and $E_t(\Theta_k) = \sum_{s^k} Pr(s^k | s^t) \Theta(s^k)$, where $\Theta$ is whatever variable or function of variables, $s^k$ is the state in period $k > t$ and the sum is calculated over all the possible future states $s^k$.

\(^{14}\) Note that $\sum_{s^{t+1}} Q(s^{t+1} | s^t)$ is the current value of a nominal bond that gives one unit of money for sure in the next period. On the other hand, $Q(s^{t+1} | s^t) = \beta Pr(s^{t+1} | s^t) \left( \frac{u_L(s^{t+1}) P_t}{u_C(t) P(s^{t+1})} \right)$ is the current price of a claim of one unit of money contingent on the realisation of state $s^{t+1}$ in the next period.
Equation (10) gives the optimal nominal wage set by the monopolistic household-union for the following $N$ periods, on the basis of period $t-1$ information set. The optimal wage is given by a fixed mark-up, i.e., $\varepsilon/(\varepsilon - 1)$, over the quantity in the curly brackets. This latter expression is composed of two terms. The first term represents the ratio between expected weighted averages of the marginal disutility of labour and the marginal utility of consumption over $N$ periods. In other words, the first component is a weighted average of the optimal flexible wages of the $N$ periods. The second term is an expected weighted average of the relative wage concern components over the $N$ periods. In both terms the weights are defined by $\beta, K_{t+i}, P_{t+i}$ and $\varepsilon$.\(^{15}\)

3.3 Government

The role of the government is limited to provide lump-sum transfers through which money is introduced in the economy. These transfers satisfy

$$T_t = M_t - M_{t-1}$$

(11)

and the growth of the nominal money supply is described by

$$M_t = \mu_t M_{t-1}$$

(12)

where $\mu_t$ follows a stochastic process (to be specified below).

The resource constraint for this economy is obtained by aggregating (6) over all households and imposing equilibrium conditions on the bonds and money markets

$$\int_0^1 P_t C_{jt}dj \leq \int_0^1 (W_{jt}L_{jt} + \Pi_{jt})dj$$

(13)

while the equilibrium condition on goods markets (3) implies

$$\int_0^1 P_t C_{dt}di = \int_0^1 P_t Y_0di = P_t Y_t$$

(14)

where $Y_t = \frac{\int_0^1 P_t Y_0 di}{P_t} = C_t$ is real aggregate output, defined as in national income accounting.\(^{15}\)

\(^{15}\)Given (10), note that it is *ex-post* optimal for the unions to satisfy an unexpected increase in labour demand. Unions are obviously *ex-post* willing to satisfy extra demand for labour until the real wage is equal to the competitive one. In what follows we suppose that never to be the case. The fact that employment is always on the labour demand curve is hence consistent with optimisation in this case, in contrast to the old style Gray-Fischer-Taylor models in which the wage was set in accordance with a target level that cleared the labour market in expectation.
An equilibrium for this economy is described by a vector of allocations \{C_{jt}, M_{jt}, B_{jt}, X_{t-k}, L_{jt}, Y_{jt}, P_{jt}, P_t, Y_t, R_t, Q(s_t^t | s_t^t)\} for \(k = 0, \ldots, N - 1\) such that: (i) taking other sectors’ variables and aggregate variables as given, consumer allocations solve the consumer’s problem \(\forall j\), that is, (7), (8), (9) and (10) hold \(\forall j\); (ii) taking the nominal wage as given, firms’ output and labour demand maximise profits according to (2) and (4); (iii) the transfers and the money supply process satisfy (11) and (12); (iv) the resource constraint (13) and the goods market equilibria ((3) and (14)) are satisfied.

To solve for the model dynamics, we first calculate the steady state of the model and then apply the Blanchard-Khan’s (1980) methodology to the log-linearised model around the steady state.

4 ANALYTICAL IMPLICATIONS OF RELATIVE WAGE CONCERN

4.1 The “\(\gamma\)-puzzle”

The literature building on Taylor (1979, 1980a) has investigated whether the “contract multiplier” induced by staggered wage-setting can propagate monetary shocks so as to mimic the output persistence properties exhibited by US data. Those models can be summarised by a wage setting equation, a price level equation and a static aggregate demand equation, that is

\[
    x_t = \frac{1}{2}(P_t + E_{t-1}P_{t+1}) + \frac{\gamma}{2}(E_{t-1}Y_t + E_{t-1}Y_{t+1}) 
\]

\[
    p_t = \frac{1}{2}(x_t + x_{t-1}) 
\]

\[
    y_t = m_t - p_t 
\]

where lower case letters denote log-deviations from steady state. The fundamental property of the wage setting equation is the dependence of wages on business cycle conditions. Since output levels feed back directly into equation (15), it immediately follows that output fluctuations will have a small impact on prices if and only if the elasticity of wages with respect to output, Taylor’s \(\gamma\), is low. In fact, empirical literature suggests a value of \(\gamma\) around 0.1, which is consistent with the existence of a contract multiplier.16

\[16\] For the US, Taylor (1980b) estimates \(\gamma\) to be between 0.05 and 0.1, while Sachs (1980) estimates it to be between 0.01 and 0.07. In his numerical investigation of persistence properties
Recent research incorporating staggered wages/prices into a DGE framework, notably CKM and Ascari (1997), has opened the “black box” of the ad hoc parameters in the wage setting equation. Log-linearising the optimal wage setting rule around a deterministic steady-state with constant money supply ($\pi = 1$) and constant returns to scale to labour ($\sigma = 1$), the parameter $\gamma$ is found to be determined by the elasticities of the marginal utilities of consumption with respect to consumption, i.e., $\eta_c$, and of labour with respect to labour, i.e., $\eta_L$, both evaluated at steady state. For example, a log-linearisation of our model with an additively separable utility function in all its arguments and without relative wage concern yields

$$\gamma = \left\{ \frac{\eta_c - \eta_c}{\theta \eta_c + 1} \right\}. \quad (18)$$

Given the existing evidence from microdata on the intertemporal elasticities of substitution of consumption ($-1/\eta_c$) and of labour supply ($1/\eta_L$), a sensible calibration of (18) gives a value of $\gamma$ far too high to generate persistence. As a conclusion, the calibration of $\gamma$ based on well-established evidence from microdata is at odds with all the empirical estimates from macrodata. This is what we called the “$\gamma$-puzzle”.

### 4.2 Effects of relative wage concern

Can our model solve the “$\gamma$-puzzle”? We argue that this is the case. The intuition is as follows. A negative $\eta_{RW}$ determines a “following” behaviour in wage setting. Suppose a negative shock to the rate of growth of money. Agents want to keep their real wage in line with the existing ones. Under staggering, it generates a slower adjustment of Taylor’s (1980a) model, West (1988) uses two possible values for $\gamma$: 0.01 and 0.1. More recently, Phaneuf (1990) takes estimated values for $\gamma$ for Canada, Germany, Italy, UK and US. He finds $\gamma$ to lie between 0 and 0.32 and hence Ambler and Phaneuf (1992) calibrate $\gamma = 0.15$. Jeanne (1997) suggests that $\gamma$ should lie between 0.05 and 0.2. Furthermore, Blanchflower and Oswald (1994) using microdata from household statistics provide estimates of the effects of unemployment on wages in more than 10 countries, which are consistently around “-0.1”.

The present model without the relative wage concern term coincides exactly with Ascari’s (1997) model. See Ascari (1997) for an exhaustive analysis of the persistence properties of such a model.

A low intertemporal elasticity of substitution of labour supply means that a substantial increase in wages is required for workers to supply more labour. This makes the marginal cost to rise fast after a money shock, pushing up the nominal variables and thus dampening persistence.

See Clark and Oswald (1996b). $\eta_{RW}$ represents the elasticity of the marginal utility of the relative wage term in the utility function with respect to the relative wage term.
in nominal variables, that is, a degree of *endogenous stickiness*, which leads to persistence of the real effects of money shocks. In short, relative real wage concern lowers the sensitivity of nominal variables to the business cycle conditions.

The intuition can be formalised as follows. Let the utility function be separable in all its argument and the $RW_t$ term be linear in $X_t$. Then, log-linearising the resulting wage setting rule around the steady-state with $\bar{\pi} = 1$, the elasticity of wages with respect to output is

$$
\gamma_{RW} = \left\{ \frac{\tilde{\sigma} \eta_L - \eta_C}{\eta_L + \bar{\pi}} \right\} - \left\{ \frac{\tilde{\sigma} + \eta_C}{\eta_L + \bar{\pi}} \right\} \left\{ \frac{U_{RW}(\cdot)}{-\epsilon U_L(\cdot) K_t X_t^{\bar{\pi}}} \right\} \left\{ 1 - \frac{\eta_{RW} + \epsilon}{\eta_L + \bar{\pi}} \left\{ \frac{U_{RW}(\cdot)}{-\epsilon U_L(\cdot) K_t X_t^{\bar{\pi}}} \right\} \right\}. \tag{19}
$$

It is then evident that $\gamma_{RW}$ is decreasing in the absolute value of $\eta_{RW}$.

The first term in curly brackets in the numerator corresponds to the $\gamma$ arising from staggered wages, i.e., (18). In our model, it is complemented by additional terms incorporating the marginal utility of the relative wage term, $U_{RW}(\cdot)$, and its own elasticity $\eta_{RW}$. The inconsistency of the microfounded wage setting equations and the empirical estimates can then be solved. For this, the presence of $\epsilon - \eta_{RW}$ increasing the denominator of the expression is critical, as it lowers the sensitivity of wages to the business cycle conditions, allows for endogenous stickiness and hence makes output persistence a likely outcome. The quantitative implications of this finding are the focus of the remaining sections of the paper.\(^{20}\)

### 4.3 A comparison with the FM specification

This section completes the description of the analytics of the model by deriving the full log-linearisation of the money-wage setting rule. Our log-linearised model is somehow close to the FM contract equation. A brief comparison between the two specifications clarifies further the driving forces behind the model. Moreover, the log-linearised wage setting equation that we obtain here will play a fundamental role for the calibration of the relative wage parameters in Section 5.

\(^{20}\) It is also worth noting that the effect of the intertemporal elasticity of substitution in labour supply, i.e. $\eta_L$, is ambiguous.
We parameterise the instantaneous utility function as

\[
    u(C, \frac{M}{P}, L, RW) = \frac{1}{\nu} \ln \left[ b C^\nu + (1 - b) \left( \frac{M}{P} \right)^\nu \right] - dL^\varepsilon + \frac{\phi}{1 - \tau} (RW)^{1 - \tau}. \tag{20}
\]

Note that \( \eta_{rw} \) is simply equal to \(-\tau\) in our formulation.

A log-linearisation of (10) around the steady state with \( \mp = 1 \) and \( \beta = 1 \) then yields

\[
    \Omega x_t = \frac{1}{4} \sum_{i=0}^{3} E_t p_{t+i} + \frac{1}{4} \Lambda \sum_{i=0}^{3} E_t (v_{t+i} - cp_t) + \frac{1}{4} \Gamma \sum_{i=0}^{3} E_t y_{t+i} \tag{21}
\]

where lower case letters denote log-deviations from steady state values and

\[
    \Omega \equiv \frac{\sigma(\varepsilon - 1)[1 + \varepsilon(1 - \varepsilon)] - \phi \varepsilon}{\sigma(\varepsilon - 1)}; \quad \Lambda \equiv \frac{\phi (\tau - 1)}{\sigma(\varepsilon - 1)}; \quad \Gamma \equiv \frac{\sigma(\varepsilon - 1)[\theta + \varepsilon(1 - \varepsilon)] - \phi \varepsilon}{\theta \sigma(\varepsilon - 1)}.
\]

\( \Omega \) represents the weight on the own real wage, \( \Lambda \) weights the relative wage concern and \( \Gamma \) captures the sensitivity of the nominal wage with respect to the business cycle conditions, exactly as in Taylor’s model.\(^{21}\) The fundamental novelty of the paper is the presence of the relative wage concern weighted by \( \Lambda \) in the wage setting rule. Traditional staggered wage models, like Taylor (1980a), CKM and Ascari (1997), instead impose \( \Lambda = 0 \).

Our log-linearised wage setting rule could be thought as a microfounded version of that of FM. They present and estimate an \textit{ad hoc} \textit{... contracting model, in which agents are concerned with relative real wages, that is data consistent”} (FM, abstract). In FM, agents set nominal wages such that \( CP \) equals the average real contract price index expected to prevail over the life of the contract, adjusted for excess demand conditions, that is

\[
    cp_t = \sum_{i=0}^{3} f_i E_t (v_{t+i} + y_{t+i}). \tag{22}
\]

Since, given the definition of the contract price in our model, \( cp_t = x_t - \frac{1}{4} \sum_{i=0}^{3} E_t p_{t+i} \), we can rewrite equation (21) as

\[
    cp_t = \frac{1}{4} \Lambda + \Omega \sum_{i=0}^{3} E_t v_{t+i} + \frac{1}{4} \Gamma \sum_{i=0}^{3} E_t y_{t+i}, \tag{23}
\]

which looks very much alike FM’s formulation (23).

\(^{21}\) Given the restrictions on parameters, \( \Omega, \Lambda \) and \( \Gamma \) are non-negative.
However, note that there are two important differences between our microfounded wage setting equation and the one of FM. First, FM define the \( v_{t+i} \) terms as the average of the existing real contract prices including its own real contract price. As explained in Section 2.2, we believe that our outward comparison better replicates actual relative wage concern. Second, the coefficient on the sum of \( v_{t+i} \) is not necessarily equal to unity in our model, being equal to \( \Lambda/(\Lambda + \Omega) \). For equation (24) to match FM’s formulation we need to impose \( \Omega = 0 \) which implies: (i) setting the own real wage concern equal to zero; (ii) imposing a one-to-one following behaviour in wage setting, since a 10% change in \( v_{t+i} \) leads then to a 10% change in \( CP_t \).

5 QUANTITATIVE IMPLICATIONS OF RELATIVE WAGE CONCERN

5.1 Model calibration

We set one period equal to one quarter and assume that contracts last for one year \((N = 4)\). The rate of growth of money is assumed to follow the stochastic process

\[
\ln \mu_t = \rho \ln \mu_{t-1} + (1 - \rho) \ln \pi + \xi_t \tag{24}
\]

where \( \xi \) is a normally distributed i.i.d. mean zero shock with standard deviation \( \sigma \). Following CKM, we calibrate \( \mu = 1.06^{1/4} \) and \( \rho = 0.57^{23} \)

Since households can exchange contingent claims, they perfectly insure themselves against fluctuations in income by pooling resources. They will therefore attain the same marginal utility of consumption in every period. Given (20), they will enjoy the same level of consumption and real money balances in each period. Moreover, given (20), (7) implies the following money demand equation

\[
\ln \left( \frac{M_t}{P_t} \right) = - \frac{1}{1 - \nu} \ln \left( \frac{b}{1 - b} \right) + \ln \gamma_t - \frac{1}{1 - \nu} \ln \left( \frac{R_t - 1}{R_t} \right) \tag{25}
\]

22 A third minor difference highlights the additional insights obtained from microfoundations. FM impose the weights \( f_i \) to be decreasing linearly and estimate the slope parameter. Instead, without imposing \( \beta = 1 \), in our model the equivalent to the \( f_i \) terms are decreasing and have a very intuitive interpretation: they depend naturally on the discount factor \( \beta \), i.e., \( f_i = \beta^i / \sum_{i=0}^{\infty} \beta^i \).

23 Since we are just interested in the persistence properties of the model, we actually focus only on impulse response functions to money shocks. Hence, the standard deviation of the rate of growth of money process does not play any role. In addition, in what follows, we calibrate the model as closely as possible to CKM to allow for a comparison with their results.
which is identical to equation (43) in CKM. Following CKM, we use Mankiw and Summers’ (1986) money demand regressions, and set $\nu = -17.52$ and $b = 0.73$.

The parameter $e$ determines the intertemporal elasticity of labour supply ($1/\eta_L = 1/(e - 1)$). Macurdy (1981) suggests $e = 4.3$, while Pencavel’s (1986) estimations place $e$ between 3.2 and infinity. We calibrate $e = 6$ (which implies a small intertemporal elasticity of substitution of labour supply of 0.2).

For the discount factor we choose the standard value from business cycle literature, i.e. $\beta = 0.96^{\dagger}$. We interpret our production function as a short-run production function where the level of capital is fixed. Hence, the labour share of output, i.e. $\sigma$, is set equal to 0.67. Following Hairault and Portier (1993), we calibrate $\theta = 6.24$. Finally we calibrate $d$ such that the number of average aggregate hours of work in steady state is equal to $1/3$ and $\alpha$, which is just a scaling factor, such that aggregate output is equal to one.

5.2 Calibration of the relative wage concern parameters

Crucial for the analysis are the values of the parameters of the relative wage concern argument in the utility function, i.e. $\phi$ and $\tau$. To our knowledge, there are no microestimates in the labour literature for these parameters. We thus proceed as follows.

Traditional staggered wage models (as Taylor (1980a), CKM or Ascari (1997)) impose $\Lambda = 0$. The empirical evidence reviewed in Section 2.1 instead suggests that wage setting behaviour is better characterized by strong following behaviour and almost pure relative wage considerations, with the level of own real wage playing a minor role, if any at all. We therefore impose $\Omega = 0$ and employ the estimates in FM to calibrate $\phi$ and $\tau$. Specifically, from equation (24), we use the constraint $\Omega = 0$ to pin down $\phi$; then use FM’s estimate of $\gamma = 0.00109$ to determine $\tau$. We obtain a value for $\phi$ of 0.76. However the value of $\tau$ implied by the estimate of FM is sky-high, equal to 844!! With

24 There is no parameter corresponding to our $\theta$ in CKM. Since they use a CES function as technology for producing final goods from intermediate goods, it follows that their CES parameter is a technology parameter which gives the elasticity of substitution in input demand.

25 This value of $\gamma$ estimated by FM is extremely low and only marginally significant: the t-ratio for their Theoretically Preferable Specification (the equivalent to our benchmark case) is 1.54.

26 The steady state of the model imposes an upper bound on the value of $\phi$ equal to $\bar{\phi} = 0.84$, to avoid negativity of nominal wages.
$\tau = 844$ the model generates a ridiculous degree of persistence, as Figure 1 shows. The level of output remains above its steady state value for more than 60 periods. FM estimates of $\gamma$ are however substantially lower than the results form the empirical literature discussed in Section 4.1, which suggests a value around 0.1. We have shown in Section 4.2 that such value is not incompatible with sound microfundations once relative wage concern is taken into account. We therefore consider as a benchmark case a value of $\gamma$ equal to 0.1. Thus, the implied value of $\tau$ is 10.2. Table 1 below summarizes the calibration of the model parameters.

<table>
<thead>
<tr>
<th>Preferences</th>
<th>$\beta = 0.96^\tau$; $\nu = -17.52$; $b = 0.73$; $\theta = 6$; $e = 6$; $d =$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>$\sigma = 0.67$</td>
</tr>
<tr>
<td>Money Growth Process</td>
<td>$\bar{\mu} = 1.06^\tau$; $\rho = 0.57$</td>
</tr>
<tr>
<td>Relative Wage Concern</td>
<td>$\phi = 0.76$; $\tau = 10.2$</td>
</tr>
</tbody>
</table>

Appendix A presents some sensitivity analysis with respect to the calibration of the relative wage concern parameters.

5.3 Simulation results

Figure 2 shows the impulse response functions for output and inflation, following a 1% money shock. Output jumps on impact 1.02% above its steady state value. Its adjustment path then mimics the hump-shaped response of output found by Blanchard and Quah (1989), Cochrane (1994) and Cogley and Nason (1995) and persistence both in output and inflation is substantial. Specifically, the effects on output last for 3 years.\(^{27}\) Our analysis hence suggests that staggered wage setting together with a relative real wage concern can be a powerful mechanism through which monetary shocks are propagated. Previous studies may have therefore failed to obtain output persistence after money shocks in a microfounded model with staggering because of their oversimplified modelling of the wage setting decisions. These quantitative results show that both output and inflation persistence are a likely outcome in our framework.

This paper aims to highlight the effects of the omission of relative wage considerations in wage setting on the findings of the recent literature that questions the existence of a contract multiplier. It is then very much important to stress the robustness of our results. The two crucial elements of our approach are the specification of the rela-

\(^{27}\) To measure the degree of persistence we take the quarter in which the log-deviation of output from steady state falls and remains thereafter below 0.05% in absolute value.
tive wage argument, $RW$, and the calibration of the parameters governing the relative wage concern. We present some sensitivity analysis in the appendices. Specifically, Appendix A considers alternative values for the key parameters $\phi$ and $\tau$. The effects of allowing for constant returns to scale in labour, arising for example from labour hoarding, are also considered. Appendix B addresses the robustness of our results to the specification of the relative wage argument $RW$ by presenting two alternative cases of the relative real wages the wage-setters are concerned with. In the first case, in each period workers compare the real wage they get, with the real wage workers in the other sectors are paid in that period. In the second case, the basis of the comparison is instead the real wage workers attain in the period they negotiate the contract. The persistence results in output and inflation are very robust to the alternatives considered in both appendices. Thus, given our results and the empirical evidence in favour of the existence of a relative wage concern, we conclude that this may be the missing piece in the money shocks persistence puzzle.

6 CONCLUSIONS

We have reconsidered the presence of a contract multiplier as a potential nominal propagation mechanism in staggered wage economies. Recent research has questioned the existence of such a multiplier because their microfounded staggered wage models have failed to generate persistence of the effects of money shocks on output and inflation persistence. We built a DGE model with staggered wage setting and relative real wage concern on the part of the workers and found that this combination of nominal and real rigidities generates a substantial amount of endogenous stickiness, even with a very inelastic intertemporal elasticity of labour supply. As a result, output and inflation persistence are a likely outcome in our framework.

The relative wage concern on the part of workers is the key feature of the model. The notion of relative wage concern is not new for economists and goes back a long way, at least to J.M. Keynes, and has substantial support from empirical work. Introducing a relative wage concern in the analysis places our work within the growing economic literature that drops the assumption of methodological individualism to explain some puzzles that standard economic framework has trouble with. The explicit account of relative wage concern allows us to provide clear analytical insights of its effects and rely on a key parameter to assess the importance of its omission for the quantitative results of Chari et al. (1996). Our analysis can be seen as a first step towards a
deeper understanding of the effect of relative wage concern on the monetary propagation mechanism. Further microfoundations of relative wage concern are desirable given the robustness of our results.
A ALTERNATIVE CALIBRATION OF THE RELATIVE WAGE CONCERN PARAMETERS

We provide here some sensitivity analysis of the two key parameters $\phi$ and $\tau$. Our aim is to show that the results do not critically depend on the specific calibration of these parameters, but are mainly due to the introduction of relative wage considerations in wage setting. This appendix also contributes to highlight the mechanisms at work in the model to generate persistence.

A.1 Sensitivity of persistence with respect to $\tau$

Figures 3, 4 and 5 show the impulse response functions for values of $\tau$ of 31.63, 19.38 and 5.59, corresponding to values of $\gamma$ of 0.03, 0.05 and 0.2 respectively. Unsurprisingly, the degree of output persistence consistently decreases with $\tau$. With $\tau = 31.36$, the effects of money shocks on output die away after 21 quarters, if $\tau = 19.38$ after 4 years and if $\tau = 5.59$ after 9 quarters.

In CKM’s model: “the persistence properties of output are highly nonlinear in $\gamma$, so that increasing $\gamma$ to a small amount above 0.05 reduces persistence sharply. [...] even with values of $\gamma$ as low as 0.25 output movements are not very persistent.” (CKM (1996), p. 15). Values of $\gamma$ higher than 0.25 also decrease persistence in our model. Nevertheless, the perspective changes: even with values of $\gamma$ as high as 0.25, our staggered wage model is still able to generate output persistence. As discussed in Section 4.1, empirical estimates put 0.25 among the highest possible values for $\gamma$. CKM argue that only values of $\gamma$ greater than one are compatible with sound microfoundations in staggered wage models. On the contrary, our model suggests that traditional staggered wage models omit fundamental features of the wage setting. Once relative wage concern considerations are embedded into the analysis, we show in Section 4.2 that they may solve the data inconsistency of microfounded staggered wage models with respect to the calibration of $\gamma$. We further investigate the relationship between $\gamma$ and the key parameter $\tau$. Figure 6 shows the trade-off between the values of $\gamma$ and $\tau$. This relationship is highly non-linear and it implies that fairly small departures from our conservative parameter choices can increase persistence sharply.

Inflation persistence is, on the other hand, very little sensitive to changes in $\tau$. The effects of money shocks on inflation die away in all cases after 10/12 quarters, as it is
in the base case.

A.2 Sensitivity of persistence with respect to \( \phi \)

In the previous section, we set \( \Omega = 0 \) in our wage setting rule and calibrated \( \phi \) to be 0.76. Empirical evidence reviewed in Section 2.1 points to this case as the most relevant one. However, our money-wage setting equation (21) incorporates two elements: (i) the absolute real wage concern (weighted by \( \Omega \)); (ii) the relative wage concern (weighted by \( \Lambda \)). In this section we analyse the implications of both relative wage and level of own real wage considerations for wage setting decisions.

Recall that equation (21) can be written as (24). We consider two alternative cases. In the first case \( \Lambda = 3\Omega \). The parameter on the indexes of real wages in the other sectors \( (\sum_{i=0}^{3}E_{iV_{t+1}}) \) in equation (24) above is equal 3/4. Thus, there is no more one-to-one following behaviour: a 10% increase in the sum of the future indexes of real contract prices leads to a 7.5% in the current contract price, \( CP \). The implied value for \( \phi \) in this case is 0.62.\(^{28}\) Output and inflation persistence decrease to 9 quarters (see Figure 7). In the second case we set \( \Lambda = \Omega \). There is then equal weighting of absolute and relative real wage considerations in wage setting. It follows that a 10% increase in the sum of the future indexes of real contract prices leads only to a 5% in the contract price, \( CP \). The implied value for \( \phi \) in this case is extremely low and equal to 0.2.\(^{29}\) Persistence in both inflation (2 years) and output (7 quarters) decreases further (see Figure 8).

Both output and inflation persistence therefore decrease with \( \phi \). The intuition is simple. If \( \Omega = 0 \) wage setting is mainly influenced by relative wage considerations and persistence is then a likely outcome. On the other hand, as \( \Omega \) increases, we go back to Taylor’s model, which we already know cannot generate neither output nor inflation persistence.

\(^{28}\) \( d \) is the weight of the labour supply term and \( \phi \) that of the relative wage concern in the utility function. \( d \) is calibrated to produce an average level of hours worked in the economy equal to 1/3, as standard in this literature. For the benchmark case \( \phi = 0.76, d = 3.4 \). Note however that as \( \phi \) decreases, then \( d \) has to increase to maintain the average aggregate labour hours at 1/3. Specifically, \( d \) in this case becomes 10.77. This tends to make more costly any marginal increase in the supply of labour.

\(^{29}\) The implied value of \( d \) is 32.7!!
A.3 Sensitivity of persistence with respect to $\sigma$

A final remark concerns the sensitivity of output and inflation response to $\sigma$. Our stylised production function should be taken as a short-run production function where capital is fixed. We thus calibrate $\sigma = 0.67$. This implies $(1 - \sigma)/\sigma \simeq 0.5$. Hence, a 10% increase in output automatically leads on impact to a 5% increase in prices.\(^{30}\)

However, factor hoarding and inventory stocks may limit the impact of increased output on prices, leading to nearly constant returns to scale in the short-run, that is, $\sigma \simeq 1$. For illustrative purposes, Figure 9 shows the impulse responses of output and inflation for $\sigma = 1$.\(^{31}\) Inflation becomes much more sluggish: it peaks after 5 quarters and then gradually returns to its steady state level. As a result, the shape of the impulse response function for output also changes: after 6 quarters from the shock, the economy would enter a recession which peaks after 8 quarters. This shows how this model, once allowed to incorporate some factor hoarding, can generate strong inflation persistence.

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\(^{30}\) The log-linearised formula for the price level is $p_t = (\frac{1-\sigma}{\sigma}) y_t + \sum_{i=0}^{3} q^i x_{t-i}$ where $q^i = \frac{\phi^i / (\epsilon - 1)}{\sum_{i=0}^{3} \phi^i / (\epsilon - 1)}$.

\(^{31}\) In this case, some values of the parameters change: $\tau = 10.67$ (to keep $\gamma = 0.1$), $\phi = 4.2$ (to keep $\Omega = 0$) and $d = 10.72$ (to keep steady-state working hours equal to 1/3). Note that also the upper value on $\phi$ changes, i.e., $\phi$ is now equal to 4.82; the value of $\phi$ above is thus still consistent.
We consider here two additional definitions of the value of a contract and hence of $RW$. We also drop the distinction between the indexes $s$ and $t$ introduced in the main text for explanatory purposes. For we highlight the differences on the $RW_j^t$ faced by the union $j$ arising in these two cases, we also drop the superscript $j$.

**B.1 Case A: current value relative real wage concern**

In this case agents compare the real wage they earn in period $t$ with the average of the real wages earned by the other workers in period $t$. Then all the nominal wages are deflated by the same price index $P_t$. It follows that the price level cancels out in the definition of $RW_t$ and we are left only with nominal wages. Hence, in every period the wage-setters behave as comparing their “money wage” with the average “money wages” in the other sectors,

$$CP_t = X_t; \quad RW_t = \frac{X_t}{(1/3)(X_{t-3} + X_{t-2} + X_{t-1})}.$$ 

**B.2 Case B: simplified relative real wage concern**

In this case workers care about the relative real wage unions manage to attain at the negotiation table. $CP$ is therefore defined as the money wage deflated only by the aggregate price level in the period the wage was negotiated, that is

---

32 Suppose a union negotiates in period $t$ and succeeds to get a real wage $X_t/P_t$ in period $t$. Then, in the next period, i.e. $t + 1$, another union will negotiate a new wage. This union does not want to leave the negotiation table with a real wage for that period lower than the one negotiated last period by the previous union. In other words, the real wage the unions obtain in the negotiation is seen by the members as a sign of their bargaining power. This approach to the wage bargaining process implies a degree of myopic behaviour from the union since the wage contract lasts four periods. Even if theoretically unsatisfactory, this behavioural hypothesis: (i) could be interpreted as a simplified case of the one considered in the main text (ii) indeed it corresponds to the simplified case considered by FM; (iii) it is probably not far from actual unions’ behaviour.
To sum up, in Case A workers compare their real wage period by period, in Case B they compare the real wage they manage to attain at the time they negotiated. In the case presented in the main text, our benchmark case, they instead compare their real wage over the whole life of the contract.

Figures 10 and 11 present the impulse responses to a 1% money shock for these two additional cases. Case A (the Current Value Real Wage Concern) exhibits the lowest degree of output persistence equal to 11 quarters. Persistence increases to 18 quarters in Case B (the Simplified Relative Real Wage Concern)\textsuperscript{33}, above that of our benchmark case. There is an intuitive reason for those differences. Case A implies the lowest order of dynamics in the model, since the price level is absent from $CP$. The degree of agents backward-lookingness is the same as their forward-lookingness, but both these degrees are limited with respect to the two other cases. That is, substituting the definitions of $CP$ and the equation for the price level in equation (21), the highest lagged nominal wage term is $x_{t-3}$, while the highest lead nominal wage term is $x_{t+3}$. The dynamics instead goes from $x_{t-6}$ to $x_{t+3}$ in Case B in this appendix and from $x_{t-6}$ to $x_{t+6}$ in the theoretically preferable case presented in the main text.\textsuperscript{34} In fact, in the Simplified Case, the price level enters the specification of $CP$ and hence, since $V_t$ includes $CP_{t-3}, X_{t-6}$ enters equation (21). However, since future prices do not enter the specification of $CP_t$, $V_{t+3}$ brings in only $p_{t+3}$ and hence $x_{t+3}$. In the theoretically preferable case, instead, agents are less myopic and $CP$ includes future prices through $\pi$. Then, it follows that $v_{t+3}$ depends on $\pi_{t+3}$ and hence $x_{t+6}$. To sum up, in Case A agents basically care about their relative nominal wages over the length of the contract and hence the order of the dynamics is limited with respect to the other two cases, since the price level does not enter $CP$. In Case B agents are only concerned about the real wage attained in the negotiation period and hence they myopically look backward more than they look forward. Finally, in our benchmark case in the main text, agents compare relative real wages over the whole length of the contract and hence look backward the same degree they look forward. This implies a higher degree of inertia in Case B with respect to our benchmark one and hence an higher degree of persistence,

\textsuperscript{33} After ten quarters, output actually falls below the steady state value.

\textsuperscript{34} The same holds if we express (21) in terms of inflation, because we get: $\Psi(\pi_{t-3}, \ldots, \pi_{t+3}, \bar{y}_t) = 0$ in case A; $\Psi(\pi_{t-6}, \ldots, \pi_{t+3}, \bar{y}_t) = 0$ in case B and $\Psi(\pi_{t-6}, \ldots, \pi_{t+6}, \bar{y}_t) = 0$ in our benchmark case in the main text.
as shown in the figures.\textsuperscript{35}

Given these results, we conclude that both output and inflation persistence are robust to alternative specifications of the relative wage concern term.

\textsuperscript{35} Higher dynamics do not necessarily imply higher persistence. It mainly depends on the relative weights on backward vs forward looking variables. Hence, it seems that the relative weight of backward and forward looking variables is not the same in the three models. This suggests that the different specifications do not simply spread the same relative weights over higher order dynamics.
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Figure 1  Benchmark case, 1% money shock: output and inflation.
\[ \tau = 843.9689, \phi = 0.7588 \]

Figure 2  Benchmark case, 1% money shock: output and inflation.
\[ \tau = 10.1884, \phi = 0.7588 \]
Figure 3  Benchmark case, 1% money shock: output and inflation.
\[ \tau = 31.6279, \phi = 0.7588 \]

Figure 4  Benchmark case, 1% money shock: output and inflation.
\[ \tau = 19.3767, \phi = 0.7588 \]
Figure 5  Benchmark case, 1% money shock: output and inflation.
\( \tau = 5.5942, \phi = 0.7588 \)

Figure 6  Benchmark case, \( \gamma \) and \( \tau \) trade-off
Figure 7  Benchmark case, 1% money shock: output and inflation.
\[ \tau = 10.1884, \phi = 0.6192 \]

Figure 8  Benchmark case, 1% money shock: output and inflation.
\[ \tau = 10.1884, \phi = 0.2032 \]
Figure 9  Benchmark case, 1% money shock: output and inflation.
\( \sigma = 1, \tau = 10.7, \phi = 4.2, d = 10.7 \)

Figure 10  Current value relative wage concern, 1% money shock: output and inflation.
\( \tau = 10.1884, \phi = 0.7588 \)
Figure 11  Benchmark case, Simplified relative real wage concern, 1% money shock: output and inflation.

$\tau = 10.1884$, $\phi = 0.7588$
COMMENTS ON ‘RELATIVE WAGE CONCERN: THE MISSING PIECE IN THE CONTRACT MULTIPLIER?’ BY G. ASCARI AND J.A. GARCIA

Philippe Moutot∗

Ascari and Garcia argue that some micro foundations can be developed to make relative wage concerns explain some of the puzzles raised by the real business cycle literature concerning inflation persistence. In order to assess this claim, I will successively summarise the general approach of the paper and describe the technique used to develop this micro foundation. Then I will discuss whether the proposed micro foundation is helpful and produces new insights. My conclusion will be that, although such micro foundations are highly desirable, this attempt by Ascari and Garcia to lay them is far from convincing.

1 THE GENERAL APPROACH OF THE PAPER

The paper is based on the remark that although the Phelps-Taylor approach concerning wage contracting specifications is not borne by data, the concept of relative wage concern is relevant to explain the persistence of price and inflation shocks.

Let the price index \( p_t \) be the average of the contract wage \( x_t \) negotiated in periods \( t \) and \( t-1 \).

\[
p_t = \frac{1}{2} (x_t + x_{t-1})
\]  

Suppose also that, as assumed by Taylor (1980), that current contract wage is an average of the lagged and expected future nominal wage contracts adjusted for excess demand.

\[
x_t = \frac{1}{2} (x_{t-1} + E_t (x_{t+1})) + \gamma y_t
\]  

Then two problems arise. First, the Taylor model, while allowing persistence of shocks to the price level [see (3)], does not allow shocks to inflation to persist beyond shocks to the output gap. Second, econometric estimates of \( \gamma \) are typically lower than would be expected from calibration.

\[
p_t = \frac{1}{2} (p_{t-1} + E_t p_{t+1}) + \frac{1}{2} \gamma (y_t + y_{t+1})
\]
Consequently, it becomes logical to explore whether alternative ways of modelling wage concerns can better explain the data. As shown by Ascari and Garcia, the concept of relative wage concerns should not be summarily discarded given that a series of micro studies do show that both workers and trade unions give a lot of importance to such concerns. Keynes himself had argued that this element was essential to a good understanding of the labour market. More recently, Akerlof (1997) also argued that social concerns did influence the decisions of individuals and should enter their utility function. As a first solution, Fuhrer and Moore (1995) replaced nominal contracts by real contracts to obtain (4) and to generate a degree of inflation persistence that could match data in a satisfactory manner.

\[ x_t \cdot p_t = [(x_t \cdot p_{t-1}) + E_t(x_{t+1} \cdot p_{t+1})] + \gamma y_t \] (4)

As a second solution, Ascari and Garcia introduce the real wage concerns in the utility function of their agents.

2  HOW ASCARI AND GARCIA LAY (OR THINK THEY LAY) A MICRO FOUNDATION FOR RELATIVE WAGE CONCERNS

Their technique is relatively straightforward, probably too straightforward. Firstly, they suppose that N consumers exist in their economy and that each of these consumers is a union in a specific industrial sector. Why each of these consumers is constrained to offer his/her labour only to a given sector is not clear. These N consumer/unions negotiate N-period contracts and they do it successively. In the paper N is then set equal to 4. This choice is probably done for calculation convenience but proves to be adapted to the US data, according to the authors. However, this question is not explicitly tackled in the paper. Intuitively, the larger N is, the higher the persistence effects are. It also depends on the time scale. Here, it seems to be quarterly. The case \( N = 4 \), therefore, corresponds to a situation of annual wage negotiations. Thus, the consumers/unions compare their real wages by calculating (5).

\[ RW_j = \frac{X_j}{P_j} - \frac{1}{3} \left( \frac{X_{j-1}}{P_{j-1}} + \frac{X_{j-2}}{P_{j-2}} + \frac{X_{j-3}}{P_{j-3}} \right) \] (5)

* Deputy Director General Economics, European Central Bank. Views expressed are those of the author and not necessarily those of the ECB.
Secondly, Ascari and Garcia include real wage concerns into the utility function of their economic agents who maximise it under a standard cash constraint.

\[
Max \quad U = \sum_{t=0}^{\infty} \beta^t E_t u \left( C_t, \frac{M_t}{P_t}, L_t, RW_t \right)
\]  

(6)

Thirdly, they solve (6) for \(x_t\) and find that one part of \(x_t\) is characteristic of a flexible economy while another is dependant on the preference of agents concerning their relative real wage.

\[
x_t = \frac{\epsilon}{\epsilon - 1} \{ A ( - ) + B ( - ) \}
\]  

(7)

\[\text{based on flexible wages} \quad \text{based on RW}\]

Fourthly, they linearise the utility function [see (8)] and show that (7) can then be written as (9), i.e. an equation that is similar to (4) and therefore encompasses the type of model advocated byFuhrer and Moore (1995).

\[
u(C, \frac{M}{P}, L, RW) = \frac{1}{\phi} \ln \left[ bC^\upsilon + (1 - b) \left( \frac{M}{P} \right)^\upsilon \right] - dL^\upsilon + \frac{\phi}{1 - \tau} \cdot RW^{1 - \tau}
\]  

(8)

\[
x_t - \bar{p}_t = \frac{1}{4} A + \Omega \sum_{i=0}^{3} E_t(x_t - \bar{p}_{t+i}) + \frac{1}{4} A + \Omega \sum_{i=0}^{3} E_t \gamma_{t+i}
\]  

(9)

Fifthly, they calibrate the model in two steps: they first choose the standard parameters of the utility function, i.e. \(\beta, b,\) and \(\nu\) by recourse to the literature in the usual way. Then, based on estimates of \(\gamma\) compatible with the volatility of actual inflation, they propose a series of guesses for \(\tau\) and \(\phi\) able to make these estimates of \(\gamma\) consistent with the second coefficient of (9).

Finally, they check that with for adequate \(\tau\) and \(\phi\), they are able to reproduce the persistence of observed shocks.
IS THIS TYPE OF MICRO FOUNDATION REALLY HELPFUL? DOES IT PROVIDE NEW INSIGHTS?

Hence, Ascari and Garcia show that relative wage concerns may indeed explain some inflation persistence.

However, is the micro foundation they offer really helpful? Does it provide new insights to researchers or applied economists, i.e. insights beyond those opened by previous literature? In my view, the answer to these questions will remain uncertain or negative as long as the main ingredient to their paper is the inclusion of a ratio representing relative wage concerns into the utility function of the union/consumer.

Of course, including new variables into the utility function is not always a bad thing. Even G. Becker (1991) does not reject it in special cases. However, one should distinguish between the case of individual agents who may, from time to time, incorporate social factors into their utility function and the case of large institutions playing repeated games like trade unions. In the former case, the inclusion of social factors into the utility function may be the only practicable modelling strategy. In the latter case, it is either unlikely that such institutions would consistently be solely motivated by respective positions or some more sophisticated modelling of behaviours is needed to explain it fully. On the one hand, if these institutions are viewed as rational enough to have a maximising behaviour, they can also measure the impact of the externalities created by their relative wage concern. They can therefore decide to ignore the latter if it is not advantageous to them. On the other hand, if some relative wage concern nevertheless exists, one should justify it in a more detailed way than through a simple predisposition to ‘jealousy’ between trade unions. This is especially the case when another model, like the Fuhrer and Moore model, which is based on the simple idea that real wages for the present period depend on past and future real wages, goes a long way toward adequately mimicking data.

This relative wage concern may for instance well be explained by the functioning of the trade unions themselves and the nature of their internal organisation. The late Mancur Olson (1965) made strong contributions in that direction, showing however that the behaviours of collective organisations could not be well understood without recourse to the individual and selfish interests of their members. With this view, including a relative wage concern into the utility function would make sense only if this inclusion could be backed by a detailed analysis of the functioning of trade unions.
However, even so, it would still be preferable to model this ‘jealousy’ as a constraint to the maximisation problem of the consumer. After all, the acceptability of including a real money variable inside the utility functions of economic agents is largely based on the fact that, under well identified conditions, this inclusion is equivalent to modelling money through a cash in advance constraint. Moreover, if ‘jealousy’ was modelled as a constraint external to the utility function, the scope of the model for being calibrated on the basis of microeconomic evidence would rise. The coefficients which would replace \( \tau \) and \( \varphi \) in such a constraint could find some institutional meaning. Hence, instead of being simply fitted to data as done by Ascari and Garcia, they could be calibrated on the basis of evidence coming from past trade negotiations. In that case, modelling relative wage concerns in a micro founded manner would provide more insights into practical questions of interest to applied economists.

For instance, what are the consequences of EMU for the persistence of price and inflation shocks in the Euro area? One could hope that the model of Ascari and Garcia could help us answer this question. In fact, using it, one cannot answer such question. On the one hand, it might be viewed as implying a higher number of union/consumers, which may increase persistence. On the other hand, only four trade unions seem enough to fit US data. So, would the higher number of union/consumers in the euro area translate into a higher number of representative sectors in the model of the euro area? In short, it does not allow us to guess on the basis of data available or needed by the model if ‘jealousy’ across trade unions will increase or decrease as a result of the monetary union.

To give an answer to this kind of practical questions of interest to applied economists is, in my view, what an adequate micro foundation of relative wage concerns should aim at. One can hope that the authors will further develop the model in that direction.
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