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Abstract:

We analyse the implications of habit formation relating to wages in a multi-period efficiency-wage model. If employees have such preferences, their *existence* provides firms with incentives to raise wages and reduce employment over time. Greater *intensity* does not necessarily have the same consequences, because wage adjustments counteract the initial level impact. The firm's response additionally depends on the wage-dependency of dismissal costs since such costs make an increasing wage profile more attractive and mitigate the effects of greater intensity of habit formation. We further show that short-lived productivity shocks have long-lasting wage and employment consequences. Moreover, habit concerns by firm owners reduce wages.

Keywords: Efficiency wages, Habit formation, Wage profile, Wage rigidity

JEL: D 90, J 31, J 41

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1. Introduction

1.1 Motivation

The widespread interest of economists in habit formation has focused on a variety of aspects, but largely ignored repercussions on labour market behaviour.[1] Notable exceptions are contributions on labour supply, which usually adopt an individual perspective, often assume a given wage and consider habit concerns with regard to leisure or working hours (Bover 1991, Vendrik 1998, 2003, Woittiez and Kapteyn 1998, Kubin and Prinz 2002, Faria and León-Ledesma 2004). The relative neglect of labour demand is surprising because there is ample evidence that habit formation does not only occur with respect to leisure or working hours but, more importantly from our perspective, concerning wages (Clark 1999, Grund and Sliwka 2007, Clark et al. 2010, Diriwaechter and Shvartsman 2018).

In this paper, we assume that wages enhance productivity. Employing an efficiency-wage framework to capture such linkage, we can incorporate a distinct trait of a firm's behaviour into our analytical framework: Wages are set in a profit-maximising manner. Based on this feature, we enquire how habit formation relating to wages affects the trade-off resulting in an efficiency-wage setting between labour costs, on the one hand, and productivity on the other hand. In particular, we analyse whether the existence of habit formation by employees induces firms to provide an increasing or decreasing wage profile over time. The intertemporal variation in wages, in turn, implies that productivity and labour demand vary over time because a firm responds to habit preferences. Moreover, changes in economic conditions in one period have longer-lasting labour market consequences. Given such variations, employment adjustment costs become relevant, as well. It turns out that employment protection, i.e. dismissal costs, decisively influence the effects of habit concerns because they establish another intertemporal linkage of payoffs.

Habit formation implies that an individual evaluates today's payoff in comparison to an internal reference point established in the past. If habit formation relates to wages, the wage income from previous periods constitutes the so-called habit stock (a terminology employed, for example, by Carroll et al. 2000, Loewenstein et al. 2003, Faria and León-Ledesma 2004, Havranek et al. 2017) or habit level (Guo and Krause 2011, Koehne and Kuhn 2015). This habit stock reduces

[1] Constantinides (1990) and Abel (1990), for example, argue that habit formation can help to explain the equity premium puzzle. Campbell and Cochrane (1999) focus, more broadly, on various asset-pricing phenomena. Carroll et al. (2000) investigate the impact of growth on savings. Fuhrer (2000) looks at the responses to monetary policy. Guo and Krause (2011), Tuomala and Tenhunen (2013), and Koehne and Kuhn (2015) analyse optimal taxation. Struck (2014) investigates aggregate labour supply effects and Faria and McAdam (2018) consider the optimal consumption path in an economy with a renewable environmental good. This selection of contributions is somewhat arbitrary and certainly omits many other relevant ones.

the utility derived from the given wage. Habit concerns are often associated with adaptation effects, as individuals become used to the wage they were paid. Since such adaptation relates to an individual's past payoff, habit formation is usually distinguished from social preferences, which incorporate external reference points, such as colleagues' remuneration, average wages in an industry or the economy, or the distribution of income. One decisive difference between preferences incorporating internal reference points and external ones is that a firm's wage-setting behaviour can directly influence the former, whereas this is not necessarily the case for the latter. This particularly true if wages paid outside the firm constitute the reference standard.

1.2 Overview of Results

In our theoretical analysis, we first compare a situation, in which there is no habit formation, with a setting, in which employees exhibit such preferences concerning wages. Habit formation could induce the firm to raise wages in early periods and to lower them subsequently because the habit stock builds up and, hence, has a more pronounced impact in later periods. Thus, it is easier to attain the desired effort level early on. This line of argument suggests that also effort and productivity decline over time. Alternatively, firms may increase wages to mitigate the adverse productivity impact of the habit stock established in early employment periods. The net impact of a higher wage and the habit stock on effort and productivity is ambiguous. We show that the *existence* of such preferences induces the firm to raise wages over time. Hence, the second line of arguments describes firm behaviour.

When concentrating on the *intensity* of habit formation, a change in marginal incentives complements the level impact of their *existence*. In particular, stronger habit concerns and greater intensity of such preferences raise the number of dismissals in later periods, because employees are, ceteris paribus, less productive. This mitigates the gains from lowering wages early on. Hence, the net impact of greater intensity of habit formation on the wage profile is generally uncertain. This ambiguity no longer arises if there is a pronounced wage-dependency of dismissal costs. Such costs make a wage increase in early periods unattractive because this raises expected dismissal costs.

We further show that productivity shocks in a specific period have wage and employment consequences over longer time horizons. They arise because a shock in one period alters the habit stock and the firm's gain from altering the wage also in later periods.

Finally, if wages and productivity vary over time because of employees' habit concerns, there also is an intertemporal linkage of profits, output, and revenues. In consequence, habit concerns

by firms or managers modify their behaviour. If, for example, the level of profits today determines the habit stock, which affects the evaluation of profits earned in subsequent periods, firms adjust wage payments, to optimise the profit profile over time. Hence, habit concerns by firm owners or managers have an impact, as well. We show that the firm benefits from lower wages in early periods in the absence of dismissal costs because this reduces contemporaneous profits and, thus, negatively affects the firm's habit stock. If wages in early periods decline, habit formation by employees allows for a wage reduction in later periods, too.

1.3 Implications

Knowledge about the impact of habit formation on wage determination is highly relevant because such preferences can affect the functioning of labour markets and resulting policy responses. If the habit stock rises with labour market experience, internal reference points affect older employees most. In the light of an ageing workforce in many countries, a larger labour force participation of older individuals can contribute to the greater importance of habit formation. Given increasing wages over time due to habit formation, therefore, wages and labour costs rise with the average age of the labour force, as well. If higher wages, in turn, translate into higher prices and inflation, habit formation in combination with ageing societies can result in greater inflation. Hence, the consequences of internal reference points could mitigate or reverse the moderating wage and price effects of greater labour force participation by older individuals (Mojon and Ragot 2019).

In addition, habit formation creates wage flexibility in settings, which are characterised by wage rigidity in the absence of such preferences. The reason is that economic shocks affect a firm's benefits and costs of higher wages differently than the gains and losses of more employment. The difference, inter alia, arises since employees undertake intertemporal comparisons of wages, but not of employment levels. Therefore, our analysis explores a novel mechanism in an efficiency-wage setting, which generates wage fluctuations in the presence of output market shocks. This mechanism is compatible with the emerging evidence, based on firm-level data, that wages are substantially more flexible downwards than estimates based on household surveys suggest (Elsby and Solon 2019).

As a further example of their relevance, note that habit concerns change behavioural incentives over time, also if prices and constraints remain constant. This implies that economic policies, for example, relating to the optimal level of social insurance or unemployment benefits, depend on the strength of habit effects and, therefore, may vary with the habit stock of individuals.

Moreover, at the level of the firm, a habit stock, which increases with age and tenure, can provide incentives to substitute younger for older employees. If the development of the habit stock also depended on the probability of future employment – an aspect not considered in this paper – firms could react by substituting fixed-term contracts for permanent ones. By doing so, they could postpone or reduce the building-up of its employees' habit stock.

Finally, one may speculate about the implications of habit formation in an era characterised by the prevalence of social media. There is substantial evidence that the flourishing use of these communication modes makes social comparisons more frequent and important (cf. Clark and Senik 2010, Lohmann 2015, Sabatini and Sarracino 2018, and Krause et al. 2020). Enhanced opportunities to compare oneself with others can make it more likely that individuals undertake comparisons with their economic situation in the past. If this type of evaluation takes the form of habit concerns, our analysis predicts that the surge in social media usage is likely to increase wage pressure. This would especially be true for more social media-affine employees.

1.4 Relation to Literature

Contributions inspired by Keynes' (1936, p. 14) assertion that "workers … resist reductions of money-wages" may be analytically similar to our approach in an efficiency-wage context because past money-wages can represent an internal reference point. Elsby (2009), for example, assumes that productivity declines with the last period wage if the current wage falls below this level. Hence, (nominal) past wages constitute the habit stock in case of wage cuts. In the absence of negative shocks, however, habit concerns are absent – in contrast to our framework.

Besides, numerous contributions are using efficiency-wage models, in which effort depends on the own wage, relative to an external reference point. This may the wage of a reference group either within the firm or (also) consisting of workers outside the company (see, for example, Akerlof and Yellen (1990) and Johansen and Strøm (2001)). Moreover, Danthine and Kurmann (2006, 2007) show that excessive wage flexibility arises in efficiency-wage models with external reference points, such as the unemployment rate or the competitive wage. If, however, the reference wage depends on firm-specific variables, such as per capita output, wages become more rigid (see also Collard and de la Croix 2000). Danthine and Kurmann (2004) specify an effort function, which depends positively on current and negatively on past wages, inter alia. When determining the firm's wage policy, they simplify by "replacing the individual's past wage in the effort function with the aggregate past wage" (Danthine and Kurmann 2004, p. 115). In

consequence, the optimal wage is characterised by the standard Solow-condition.[2] Moreover, because an individual firm cannot influence the average wage, wage choices in the presence of habit considerations do not affect future effort directly. This is a crucial difference to our setting.

Drago (1995) considers "tolerance effects" of income addiction, which are analytically comparable to habit formation. He assumes that the firm minimises the cost of inducing an exogenous effort level, such that – in contrast to the present analysis – employment repercussions cannot occur. Drago (1995) shows that firms can have an incentive to provide an increasing wage profile over time.

In a more elaborate set-up, de la Croix et al. (2000) presume an effort function which increases in the growth rate of the own wage, relative to the respective rate of the reference wage. While the positive impact of the own wage on effort can be interpreted as habit formation, de la Croix et al. (2000) indicate that the relative growth rate effectively captures how unemployment impacts on wages, thus establishing the importance of external, and not of firm-specific variables.

In Grund and Sliwka's (2007) model, individuals choose effort, which increases current wages. They assume preferences, which depend positively on the current wage and the difference to the last period wage, while effort reduces utility. In such a setting, a high past wage provides incentives to obtain a high current wage. This implies that effort rises with the past wage and that wages grow continuously over time. In contrast to the present setting, Grund and Sliwka (2007) do not consider the firm's optimization problem.

Finally, Dickson and Fongoni (2019) set up a two-period model, in which preferences exhibit reference-dependent reciprocity and individuals are loss averse. The resulting effort function increases in the positive difference between the wage and reference income, given by the last period wage. Dickson and Fongoni (2019) distinguish between a myopic firm, which does not take the repercussion of its wage setting behaviour on future reference income into account, and a forward-looking firm. They, inter alia, show that the latter type of firm tends to pay lower wages than the myopic one. Dickson and Fongoni (2019) focus on loss aversion and, contrary to our approach, the firm employs at most one worker.

In summary, while there are various efficiency-wage approaches, which incorporate habit formation, none of them has looked at the questions we deal with below. In the further course of the paper, we describe the model in Section 2. We consider the effects resulting from the *existence* of habit formation in Section 3. In Section 4, we look at greater *intensity*, also allowing

[2] See Çenesiz and Piedrzioch (2009) for a similar approach.

for wage-dependent dismissal costs. In Section 5, we analyse the implications of habit formation for the wage rigidity prediction obtained in standard efficiency-wage models. In Section 6, we add the idea of habit formation by firms. Finally, Section 7 concludes. An appendix contains second-order conditions, stability requirements and most proofs.

2. Model

2.1 Preferences and Payoffs

The essence of an intertemporal linkage in effort depends neither on the number of periods, for which such relationship exists, nor on output market interactions. Therefore, we consider a two-period, partial equilibrium efficiency-wage model, in which a single, price-taking firm determines wages and employment in each period.[3] In the second period, wages paid in period one constitute the habit stock, which affects employee effort. In period one, the habit stock is fixed and, without loss of generality, normalised to zero. We characterise period one payoffs and variables by *capital* letters, while we use *lower case* characters for their period two counterparts. The firm hires labour at no cost in period one and pays all identical employees the same wage. At the beginning of period two productivity declines and firms reduce their workforce. The resulting costs describe the strength of employment protection. The assumption of a certain adverse shock facilitates the analysis since we do not have to distinguish between situations, in which dismissals occur and employment protection plays a role and states, in which dismissal costs are zero. We comment on the implications of this simplification at the end of Section 3.

The effort of workers depends on wages. In particular, effort in period one, denoted by E, increases with the contemporary wage, W, implying that $E'(W) > 0$ holds. Effort, e, in period two rises with the difference, $w - \beta W$, between the wage, w, paid in that period and a fraction β, $0 \leq \beta < 1$, of the wage, W, in period one. Therefore, the wage W constitutes the habit stock in period two. The parameter β is given exogenously and measures the strength of habit formation. A value of $\beta = 0$ ($\beta = 0$) indicates the absence (existence) of such concerns. We denote the difference, $w - \beta W$, as *perceived income*. Such difference specification for perceived income is commonly used and analytically convenient, without determining results.[4]

[3] Similar two-period frameworks – without labour market focus – have, inter alia, been looked at by Cremer et al. (2010), Guo and Krause (2011), and Tuomala and Tenhunen (2013).

[4] Campbell and Cochrane (1999), Cremer et al. (2010), Guo and Krause (2011), Alvarez-Cuadrado et al. (2016), and Aronsson and Schöb (2017), among others, consider linear specifications of habit effects in utility functions. Alternatively, Abel (1990), Carroll et al. (2000), Fuhrer (2000), Seckin (2001), and Goméz (2012) use Cobb-Douglas formulations. Wendner (2003) discusses the differences between and the similarities of these approaches. If we define

The negative dependence of effort in period two on the previous wage can be motivated by evidence that individuals prefer increasing wages over time (Loewenstein and Sicherman 1991, Duffy and Smith 2013) and that effort is higher if the wage profile is increasing (Ockenfels et al. 2015, Sliwka and Werner 2017). Moreover, job satisfaction decreases with the wage paid in the past (Clark 1999, Grund and Sliwka 2007, Smith 2017, Diriwaechter and Schwartzman 2018).

In our context, the effort function $e = e(w - \beta W)$ captures the notion of habit or adaptation effects. Alternatively, we could assume that effort is a function of expected future incomes, such that anticipation comes into play. In this case, the probability of retaining the job in period two, the strength of employment protection, or the alternative income would affect effort in period one (cf. Pisauro 1991). In other contexts, anticipation effects have substantially different analytical consequences than preferences exhibiting habit concerns and, thereby, adaptation (Faria and McAdam 2018). Moreover, there is experimental evidence indicating that unanticipated wage increases raise effort, whereas this is not the case if wage growth is known in advance (Sliwka and Werner 2017). Given the possibly conflicting effort effects of adaptation and anticipation, we focus on a reference income established in the past, i.e., habit formation.[5]

The effort functions, e and E, are strictly concave. This restriction can be tantamount to the assumption that individuals are strictly risk-averse, while linearity would imply risk-neutrality (cf. Pisauro 1991). If the arguments of e and E coincide, that is, if $W = w - \beta W$ holds, also effort levels are the same. Moreover, we normalise the absolute levels of effort, such that the effort functions attain a negative value for e(0), respectively E(0).[6]

The firm uses labour as sole input and sells its product on a competitive market at a price normalised to unity. The production functions F in period one and f in period two are increasing and strictly concave in effective labour input ($F', f' > 0 > F'', f''$), which equals the product of the number of employees and effort per employee. Moreover, $F'(0), f'(0) \rightarrow \infty$ holds. Denoting employment in period one by M, output is $F(E(W) \times M)$. Output in period two equals $f(e(w - \beta W) \times [M - n])$, with n being the number of people who are dismissed at the beginning of that period. A downward adjustment in employment in period two occurs because $F = \mu f$ and $\mu > 1$ hold, for a given level of effective labour input.

period two effort as a function of the wage ratio, such that $e = e(w/(W\beta))$, the basic findings derived below in Sections 3 and 4 continue to hold. However, they sometimes require different or additional assumptions.

[5] Eliaz and Spiegler (2013) consider a search-and-matching framework, in which effort depends on a reference point, to provide a rationale for downward wage rigidity. The model can also be interpreted as efficiency-wage set-up. The reference point is mostly given by the expected future wage, implying the existence of anticipation effects.

[6] $E(0), e(0) \geq 0$ and effort functions which are first convex and then concave are also sufficient for an optimum.

According to the OECD (2004, 2013), severance payments are often defined in terms of past wages. Moreover, the costs of procedural inconveniences and notice periods are often wage-related. We integrate such institutional features by assuming that a dismissal results in costs s(W), $s(W) \geq 0$, where $s', s'' \geq 0$. If these costs are positive, the decline in revenues from period one to two, as captured by the parameter $\mu > 1$, is assumed to be sufficiently strong for dismissals to occur, implying that the number of dismissals is positive, $n > 0$.

On the basis of the above assumptions, period two profits can be expressed as:

$$\pi(w, n) = f(e(w - \beta W) \times [M - n]) - w \times [M - n] - s(W) \times n, \quad (1)$$

while period one profits equal $\Pi(W, M) = F(E(W) \times M) - WM$. In equation (1) and subsequently, we indicate functional relationships by parentheses, whereas sums and differences are collected in square brackets.

The timing is as follows: First, the firm chooses wages, W, and employment, M, in period one. When doing so, it takes into account repercussions on period two outcomes. For simplicity, we do not discount future payoffs. Hence, the firm's objective in period one, P, is given by:

$$\begin{aligned} P(W, M) &= \Pi(W, M) + \pi(w(W, M), n(W, M), W, M) \\ &= F(E(W) \times M) - WM + f(e(w - \beta W) \times [M - n]) - w \times [M - n] - s(W) \times n \quad (2) \end{aligned}$$

At the beginning of period two, M and W are given and the firm selects the optimal values of period two wages and of dismissals, w and n. We solve the model by backward induction.

2.2 Optimal Behaviour

Denoting optimal values by a star, the firm's first-order conditions with respect to wages, w, and dismissals, n, in period two are (for the second-order conditions, see Appendix A.1):

$$\frac{\partial \pi}{\partial w} = [M^* - n^*][f'(w^*, W, M, n^*, \beta) \times e'(w^*, W, \beta) - 1] = 0 \quad (3)$$

$$\frac{\partial \pi}{\partial n} = 0 \Longrightarrow B(w^*, W, M, n^*, \beta) \coloneqq f'(w^*, W, M, n^*, \beta) \times e(w^*, W, \beta) - w^* + s(W) = 0 \quad (4)$$

When maximizing its payoff P in period one with respect to wages, W, and employment, M, the firm takes into account that period two optimisation variables, n and w, are chosen optimally:

$$\begin{aligned} \frac{\partial P}{\partial M} &= \frac{\partial \Pi}{\partial M} + \frac{\partial \pi}{\partial M} + \underbrace{\frac{\partial \pi}{\partial w}}_{=0} \frac{\partial w^*}{\partial M} + \underbrace{\frac{\partial \pi}{\partial n}}_{=0} \frac{\partial n^*}{\partial M} \\ &= F'(W^*, M^*, \mu) \times E(W^*) - W^* + f'(w^*, W^*, M^*, n^*, \beta) e(w^*, W^*, \beta) - w = 0 \quad (5) \end{aligned}$$

$$\frac{\partial P}{\partial W} = \frac{\partial \Pi}{\partial W} + \frac{\partial \pi}{\partial W} + \underbrace{\frac{\partial \pi}{\partial w}}_{=0}\frac{\partial w^*}{\partial W} + \underbrace{\frac{\partial \pi}{\partial n}}_{=0}\frac{\partial n^*}{\partial W}$$

$$= [F'(W^*, M^*, \mu) \times E'(W^*) - 1] \times M^*$$

$$-\beta \times f'(w^*, W^*, M^*, n^*, \beta) \times e'(w^*, W^*, \beta) \times [M^* - n^*] - s'(W^*) \times n^* = 0 \quad (6)$$

Combining the first-order conditions, yields the following equations, which we use together with (4) for the comparative static analysis below:

$$A(w^*, W^*, \beta) \coloneqq \frac{e(w^*, W^*, \beta)}{e'(w^*, W^*, \beta)} - w^* + s(W^*) = 0 \quad (7)$$

$$C(W^*, M^*, \mu) \coloneqq F'(W^*, M^*, \mu) \times E(W^*) - W^* - s(W^*) = 0 \quad (8)$$

$$D(W^*, M^*, n^*, \beta, \mu) \coloneqq [F'(W^*, M^*, \mu) \times E'(W^*) - 1 - \beta] \times M^* + [\beta - s'(W^*)] \times n^* = 0 \quad (9)$$

For later use it is helpful to note that the expression $\beta M^* - [\beta - s']n^*$ (cf. equation (9)) is positive, because $n^* < M^*$ and $\beta - s' \leq \beta$ hold. From equation (6) we then have $F'E' > 1$ for $\beta > 0$. Equation (7) describes a modified Solow-condition (Solow 1979), according to which the wage elasticity of effort is unity in the absence of dismissal costs, and less than one in their presence.[7] Without habit formation and dismissal costs also period one wages would be defined by the Solow-condition, $E'W^* - E = 0$, as the combination of equations (8) and (9) clarifies. Moreover, wages would be constant over time, $w^* = W^*$.

If dismissal costs are positive, whereas there are no habit concerns ($s > 0 = \beta$), wages in period two are lower than in period one because dismissal costs raise employment in period two. Hence, the firm requires less effort and reduces wages in that period. In period one, dismissal costs entice the firm to reduce employment in order to save on these costs in period two. To compensate for the loss in output, the firm increases wages and, thereby, effort.

The equilibrium is given by equations (4) and (7) to (9), setting $W = W^*$ and $M = M^*$. Omitting arguments and the multiplicative sign ($\times$) for simplicity, using $f'e' = 1$ from (3), and the fact that $F'E' - 1 - s' = [\beta - s'][M^* - n^*]/M^*$ according to (9) in (10d) below, the derivatives of the four equilibrium conditions with respect to the endogenous variables, w, W, M, n, and the exogenous parameter β are given by $A_M = A_n = C_w = C_n = C_\beta = D_w = 0$, $D_n = \beta - s'$, and by:

$$A_W = A_\beta \frac{\beta}{W^*} + s' = -[\beta - s'] - \beta \underbrace{A_w}_{(+)} = -D_n + \beta \frac{ee''}{(e')^2} \quad (10a)$$

[7] This impact of adjustment costs, such as dismissal or hiring costs, or employment taxes, is well established. See, inter alia, Schmidt-Sørensen (1990), Pisauro (1991), Goerke (2000), and Faria (2004).

$$B_W = B_\beta \frac{\beta}{W^*} + s' = -[\beta - s'] - \beta \underbrace{B_w}_{(-)} = -D_n - \beta f''e[M^* - n^*]e' \tag{10b}$$

$$B_M = f''e^2 = -B_n < 0 \tag{10c}$$

$$C_W = [F''EM^* + F']E' - 1 - s' = F''EM^*E' + [\beta - s']\frac{M^* - n^*}{M^*} = D_n + D_M \tag{10d}$$

$$C_M = F''E^2 < 0 \tag{10e}$$

$$D_M = F''EM^*E' - [\beta - s']\frac{n^*}{M^*} \tag{10f}$$

$$D_W = F''[M^*E']^2 + F'M^*E'' - s''n^* < 0 \tag{10g}$$

$$D_\beta = -[M^* - n^*] < 0 \tag{10h}$$

The determinant, Det, of the system of four equations (4), (7), (8), and (9) is unambiguously positive for $D_n = 0$, i.e., a setting in which $\beta = s'$ (see Appendix A.2). If $\beta - s' \neq 0$, stability depends on the concavity of the effort function, E(W), and the dismissal cost function, s(W), relative to the strength of habit effects, corrected by marginal dismissal costs, $\beta - s'$. Accordingly, we assume Det > 0 for our further analysis.

3. Existence of Habit Formation with Constant Dismissal Costs

In this section, we focus on a setting in which dismissal costs do not depend on wages (s' = 0). This allows us to straightforwardly compare outcomes in the presence of habit formation ($\beta > 0$) with those resulting in the absence of such preferences ($\beta = 0$). Ceteris paribus, period two effort is lower ($e(w - \beta W) < e(w)$). Thus, the firm has an incentive to raise wages, w, in period two. This wage increase overcompensates the negative habit impact, such that perceived income, $W - \beta w$, and period two effort, $e(w - \beta W)$, rise. Higher wages and greater effort reduce contemporaneous employment if the production function is not too concave. Moreover, habit formation lowers the gain from raising the wage in period one because of the detrimental productivity effects in period two. Thus, period one wages, W, fall to below the level paid in the absence of habit formation (see also Dickson and Fongoni (2019), who derive a similar prediction). Accordingly, effort increases in period one and falls in period two due to the existence of habit formation. Since wages are constant in the absence of dismissal costs (s = 0) and fall in their presence (s > 0), wages surely rise from period one to period two if dismissal costs are sufficiently low. If wages rise over time, so does effort. In addition, period one employment increases if lower wages have beneficial employment effects ($C_W < 0$).

Employment would be constant in the absence of habit formation if revenues were time-invariant, that is, if $\mu = 1$ were to hold. Given an increase in the second-period wage and a decline in the first-period wage, relative to a setting without habit concerns, employment declines over time on account of such preferences. If revenues are lower for a given input level in period two than in period one ($\mu > 1$) and dismissal costs do not prevent any dismissals, as assumed above, the reduction in employment over time is stronger in the presence of habit concerns than in their absence.

We can summarise these findings in:

Proposition 1

Assume, dismissal costs do not depend on wages ($s' = 0$). Comparing outcomes in the presence of habit formation by employees (such that $\beta > 0$) with outcomes in their absence (i.e., for $\beta = 0$), we find that:

a) Wages and effort are lower in period one and higher in period two ($W^*(0) > W^*(\beta)$; $w^*(0) < w^*(\beta)$; $E(W^*(0)) > E(W^*(\beta))$; $e(w^*(0)) < e(w^*(\beta) - \beta W^*(\beta))$).
   If there are no dismissal costs ($s = 0$), therefore, wages and effort rise over time.

b) Period one employment is higher if $C_W < 0$ holds ($M^*(0) < M^*(\beta)$), while period two employment is lower for $f''e(M - n) + f' \geq 0$ ($M^*(0) - n^*(0) > M^*(\beta) - n^*(\beta)$), such that employment declines over time.

Proof: See Appendix A.3.

The changes in wages and effort due to habit concerns in a given period, as summarised in Proposition 1, arise irrespective of the level of dismissal costs. This is the case because, by assumption, dismissal costs do not to vary with wages. Hence, wage adjustments because of habit concerns do not change the magnitude of dismissals costs. Thus, there is no interaction between habit formation and dismissal costs. This will no longer be true if dismissal costs depend on wages. In this case, there are additional incentives to reduce wages in order to lower such cost. This, in turn, mitigates or reverses the impact of period one wages on the amount paid in period two. Once the effects of habit concerns on period two wages cannot be determined, also employment variations become ambiguous.

To streamline the exposition, we have assumed that employment declines over time already without habit concerns ($\mu > 1$). Suppose instead that productivity (or the price) in period two can also be higher than in period one ($\mu < 1$). In period one, only the probability distribution of productivity is known, which is unaffected by the habit concerns. The firm learns about the true

productivity in period two, i.e. μ, at the beginning of that period. Hence, it can condition period two wages and employment on μ. If productivity rises sufficiently over time, the firm hires additional employees and dismissal costs do not affect the wage. In period one, decisions are based on the expected outcome in period two.

In such a setting, equations (4) and (7) describe the firm's choices in period two. Dismissals costs are positive if employment declines and zero if it rises. A modified equation (8) determines employment in period one, since dismissal costs are incurred with a positive probability of less than one. Finally, wages in period one rise with the expected number of dismissals (as in equation (9)) and decline in the number of new hires if their habit stock is determined by wages paid in period one. Moreover, dismissals mitigate the impact of the rise in the habit stock of those employees who remain in the firm, whereas new hires have the opposite effect.

These considerations – the underlying calculations are available upon request – clarify that the basic findings concerning the existence of habit effects also arise in a world in which period two employment may rise. This is the case because the firm's decisions in period two are qualitatively unaffected. In particular, wages in the presence of habit concerns are higher than in their absence. Moreover, the incentives to reduce wages in period one are strengthened if employment can also rise in period two because the expected number of employees who leave the firm is lower. Hence, the detrimental effort effects of habit formation apply to a higher expected number of employees.

In sum, if employment can also rise in period two because productivity and/ or the price increase sufficiently, the existence of habit formation reduces period one wages and effort and raises their period two counterpart, for a given productivity change. Whether wages rise over time in the absence of dismissal costs, as stated in Proposition 1 for a setting in which productivity surely declines, obviously depends on the distribution of productivity shocks.

4. Intensity of Habit Formation with Wage-dependent Dismissal Costs

The predictions summarised in Proposition 1 compare outcomes in the presence and the absence of habit formation and, hence, concern the *existence* of habit concerns. The proposition does not necessarily inform us about the consequences of change in the *intensity* of such preferences. This is the case because more pronounced habit formation makes a dismissal in period two, ceteris paribus, more profitable. In particular, habit effects raise period two wages. This enhances labour cost savings resulting from dismissals. If there are more dismissals, reducing period one wages provides a lower gain to the firm because the increase in the habit stock affects fewer employees.

Hence, the adjustment in period one wages becomes ambiguous, which occurs in response to a marginal change in the intensity of habit concerns. In that case, also the variation in period two wages is indeterminate.

To make the above line of reasoning precise, note that the intensity of habit formation affects period two wages as follows (see Appendix A.3 for the subsequent derivations):

$$\frac{dw^*}{d\beta} = \frac{1}{Det}\underbrace{A_\beta}_{-}\underbrace{B_n}_{+}\underbrace{F'M^*E''}_{-} + \frac{D_n}{Det}X, \tag{11}$$

where the sign of X (defined in equation (A.3.10) in the Appendix) is indeterminate. For $C_W < 0$ period one wages, W*, and employment, M*, change in the opposite direction.

$$\frac{dW^*}{d\beta} = -\frac{C_M}{C_W}\frac{dM^*}{d\beta} = \frac{1}{Det}\underbrace{C_M}_{-}\left[\underbrace{A_w B_n[M^* - n^*]}_{+} - D_n\underbrace{W^*[A_w - B_w]}_{+}\right] \tag{12}$$

Employment in period two, M* – n*, varies with habit intensity, as well.

$$\frac{d[M^* - n^*]}{d\beta}$$

$$= \underbrace{\frac{A_w - B_w}{Det}}_{+}\left[D_n\frac{M^* - n^*}{M^*}\{F''EM^*[E'W^* - E] + C_W W^*\} - W^*\underbrace{C_M\,[F'M^*E'' - s''n^*]}_{+}\right] \tag{13}$$

Evaluating the derivatives (11) to (13) at $\beta = 0$, and assuming the absence of wage-dependent dismissal costs ($s' = 0$), such that $\beta - s' = D_n = 0$ holds, clarifies that period one wages, W*, and employment, M* – n*, in period two decline, while period two wages, w*, and period one employment, M*, rise. The predictions for the emergence of habit effects, hence, mirror those for the level comparison (Proposition 1), because adjustments in wages do not play a role. For $D_n \neq 0$, additional effects arise. They may be indeterminate, as for the period two wage, w*. In the case of period one wages, W*, and employment, M*, they work in the opposite (the same) direction as the immediate consequences, if $D_n > 0$ ($D_n < 0$) holds. The change in period two employment, M* – n*, is ambiguous. It is feasible, though, to derive conditions under which the immediate effect stated in Proposition 1 is reinforced. We can summarise our findings in:

Proposition 2

a) Assume that dismissal costs are constant ($s' = 0$).

The emergence of habit formation by employees reduces period one wages and raises period two wages. The reverse is true concerning period two employment and also employment in period one, for $C_W < 0$.

b) Assume that dismissal costs weakly rise with the wage, but that this link is dominated by the intensity of habit formation ($s' \geq 0$; $D_n = \beta - s' > 0$).

A marginal increase in the intensity of habit formation by employees has indeterminate effects for wages and period two employment and changes period one employment in the opposite direction than contemporaneous wages (for $C_W < 0$).

c) Assume that dismissal costs rise with the wage and that this link dominates the intensity of habit formation ($s' > 0$; $D_n = \beta - s' < 0$).

A marginal increase in the intensity of habit formation by employees has ambiguous consequences for period two wages and employment, lowers period one wages and raises employment in that period (for $C_W < 0$).

Proof: See above and Appendix A.3.

To provide intuition for Proposition 2a), note that the higher β is, the more a decrease in the first-period wage, W*, ceteris paribus, raises effort in period two. Thus, period one wages are lowered. In addition, the increase in the strength of habit formation raises marginal effort, owing to the strict concavity of the effort function. Therefore, the firm increases period two wages, w*. In consequence, a higher number of people, n*, is dismissed, for a given level of employment, M*, in period one. Lower wages in period one reduce effort, E, in this period, such that marginal productivity, F'(E(W*)M) x E(W*), changes. Moreover, marginal employment costs fall because of the wage reduction. If $C_W < 0$, there is an incentive to raise period one employment, M*. The net impact of the employment change in period one and additional dismissals, n*, in period two is negative, such that employment in that period declines.

The above line of reasoning will be adequate if level effects due to the increase in β can be disregarded, as it is done when evaluating variations in endogenous variables at $\beta = 0$. However, the fall in employment in period two alters the effect of period one wages on period two profits, as captured by the term $(\beta - s')n^*$ in condition (9). Consequently, we next consider a setting in which more intense habit formation is evaluated at $\beta > 0$, while the level impact of habit formation always dominates the consequences of a possible wage dependency of dismissal costs ($D_n = \beta - s' > 0$; Proposition 2b)). Incorporating this effect makes wage reductions in period one, ceteris paribus, less beneficial because they do not affect dismissed employees. This impact becomes stronger, the more intense habit concerns are, because the detrimental productivity consequences of habit formation are more pronounced and, thus, more beneficial to avoid. Hence, the incentives to reduce period one wages are mitigated and may be reversed. In

consequence, the adjustment in period two wages becomes uncertain for two reasons: First, the habit stock βW^* may rise or fall. Second, if the change in the first-period wage is indeterminate, this is also true for the variation in marginal dismissal costs, $s'(W^*)$. If wage variations are ambiguous, also changes in employment cannot be ascertained.

Finally, for $\beta - s' < 0$ (Proposition 2c)), any dismissal raises the costs of a wage increase. Thus, higher period one wages reduce the payoff in period one because they raise the habit stock and reduce the number of dismissals. Consequently, the habit stock effect occurs for more employees, and wages in period one surely fall. Thus, contemporaneous employment goes up. Furthermore, greater dismissal costs, ceteris paribus, raise employment in period two. The ensuing decline in productivity in period two due to habit formation lowers employment. Accordingly, the net impact on period two employment becomes uncertain.

Irrespective of the intensity of habit concerns, relative to the strength of the wage-dependency of dismissal costs, such preferences reduce the sum of profits. This is the case because wages and employment in both periods are chosen in a profit-maximising manner. Accordingly, a marginal change in the intensity of habit formation has no impact on the sum of profits, $P = \Pi + \pi$, via wages or employment, but only via its direct negative impact on effort in period two. This prediction provides substance to the conjecture made in the Introduction that firms may have incentives to offer employment contracts, which reduce the effects of habit concerns.

Such contracts could reduce current remuneration and raise future income by tying wages to tenure or paying for pension entitlements. Moreover, performance-related components of pay may be linked to outcomes, which can be achieved not in the nearby, but only the more distant future. Firms could also try to hire younger staff and provide only temporary contracts. Once the habit stock has grown sufficiently, the firm will dismiss workers or no longer rehire them. To ascertain, which of these or further strategies are optimal for the firm, the effort function would have to be specified in more detail and the time horizon would have to be expanded. Moreover, the analysis would have to be more specific about the components of the employee's remuneration, which affect the habit stock and which do not. In the present setting, they are subsumed under the heading of wages for simplicity.

The findings summarised in Proposition 2 have, further, interesting implications. First, they indicate a (partial) qualitative equivalence between habit formation and dismissal costs. The opposite effects of β and s' arise because there are repercussions from a change in period two employment, $M^* - n^*$, on wages, W^*, in period one. These repercussions occur as period one wages affect, first, productivity in period two and, second, dismissal costs. The net impact of period one wages on period two wages is zero if the productivity effect and the dismissal cost

impact neutralise each other ($\beta = s'$). In this case, varying the number of dismissals, n*, or altering employment, M* – n*, in period two, does not change the incentives to set period one wages. In consequence, solely the level impact determines the variation in period one wages.[8] In Section 3, we have established that this impact of habit formation is unambiguously negative.

Second, our findings indicate the importance of labour market institutions for the effects of habit concerns, in this case the design of employment protection legislation. We have characterised conditions, which ensure that the two features reinforce or mitigate each other. It may be worthwhile to analyse whether similar interaction effects also arise for other institutions, such as minimum wages, unemployment benefits, collective bargaining or active labour market policies.

A third interesting implication of Propositions 1 and 2 arises for empirical work. The theoretical analysis predicts increasing wage profiles over time if the workforce exhibits habit formation and dismissal costs are zero (Proposition 1), while constant wages maximise profits if there are no such concerns. If dismissals are costly but independent of wages, habit formation mitigates the decline in wages over time or reverses this time profile. However, our investigation cannot substantiate a conjecture according to which greater intensity of habit formation raises the slope of the wage profile. Thus, empirical work on the wage consequences of habit formation cannot be based on indicators of the strength of such preferences, nor be used to infer their intensity.

5. Wage Rigidity and Habit Persistence

Efficiency-wage models, in which the wage is determined by the Solow-condition, are characterised by wage rigidity, as neither firm-specific nor more encompassing productivity and price shocks affect the optimal wage (Solow 1979, Carruth and Oswald 1989, p. 13, Nickell 1999). Instead, employment bears the whole burden of adjustment. If the efficiency wage is also determined by wages paid to other workers, by profits or the general labour market situation, wages will not be rigid. Collard and de la Croix (2000) and Danthine and (Kurmann 2004, 2007) even argue that such models generate excessive wage flexibility.

In this section, we analyse how habit formation by employees affects the wage rigidity prediction. In order to do so, we assume an increase in the parameter μ. This raises the marginal productivity in period one, at given wage and employment levels ($C_\mu = f'(W^*, M^*)E > 0$;

[8] Fuhrer (2000), for example, has noted the partial congruence of habit formation and wage-dependent dismissal costs in a different context. He analyses the effects of shocks in a monetary policy model and states (p. 369): "If the source of gradual responses (to shocks) is unlikely to be found in costs of adjustments …, a natural alternative is … to explore the implications of a utility function that … allows for consumers who form slowly changing habits."

$D_\mu = f'(W^*, M^*)E'M^* > 0$), and has no direct impact on the optimality conditions for period two ($A_\mu = B_\mu = 0$). We can establish the following result as a benchmark:

Proposition 3
If habit concerns by employees and wage-dependent dismissal costs have the same strength or if they are absent ($\beta = s' \geq 0$), a positive productivity or price shock in period one raises contemporaneous employment and has no impact on wages, effort, and period two employment.

Proof: Set $D_n = \beta - s' = 0$ in equations (A.4.1) to (A.4.5) in Appendix A.4.

Allowing for habit formation and wage-dependent dismissal costs alters these predictions.

Proposition 4
Suppose, employee preferences exhibit habit persistence, while dismissal costs are wage-dependent, such that $D_n = \beta - s' \neq 0$. A positive productivity or price shock in period one
a) raises (reduces) wages in both periods and effort in period one if $\beta > s'$ ($s' > \beta \geq 0$) holds,
b) has ambiguous effects on employment in period one and dismissals in period two,
c) lowers employment in period two,
d) raises effort in period two.

Proof: See equations (A.4.1) to (A.4.5) in Appendix A.4.

To provide intuition for Propositions 3 and 4, we focus on the productivity interpretation of μ. A positive shock, ceteris paribus, raises employment in period one since marginal productivity goes up. Moreover, the firm raises wages, which, ceteris paribus, reduces employment. Consequently, the overall impact on employment is indeterminate. Moreover, higher wages in period one reduce effort and productivity in period two due to the habit effect. This period two productivity impact is less detrimental to profits the more employees are dismissed. The net effect of dismissals in period two on incentives to set period one wages depends on the relationship between the strength of habit formation, β, and marginal dismissal costs, s'. If the two effects balance out, dismissals do not alter period one wage setting (cf. equation (9)). The wage rigidity result reappears. If habit formation dominates ($D_n = \beta - s' > 0$), higher wages in period one induce the firm to augment wages in period two, to mitigate the habit effect. If period one wages decline, the change in period two wages is also reversed. Irrespective of the direction of the wage change perceived income goes up, such that effort in period two increases (for $D_n \neq 0$). Despite

this increase in effort, employment in period two declines (for $D_n \neq 0$), because the net impact of changes in period one and two wages on the gain from increasing period two employment is negative (see Appendix A.4, equation (A.4.5)).

Our findings indicate that a positive productivity shock in one period has the expected, positive wage consequences in that period, as long as $\beta > s'$ holds, but not necessarily a contemporaneous employment-enhancing impact as well. Surprisingly, in the period after the shock, wages also rise and employment falls. Hence, the model predicts persistence in wage responses and adverse, delayed employment responses to a one-period shock.

While we have derived the finding of a persistent wage response for a positive price or productivity shock in period one, it arises as well – with the reverse sign – for a negative shock. Such symmetry exists because the effort function does not differentiate between an increase and a reduction of the wage. In contrast to our findings, downward wage rigidity can emerge as dominating outcome if individuals exhibit loss aversion, and habit formation is particularly – or only relevant – in case of wage reductions (see, for example, Elsby (2009) or Dickson and Fongoni (2019)).

We can further contrast our predictions with those from other efficiency wages models with internal reference standards. Danthine and Kurmann (2004, 2006, 2007) effectively presume that the relevance of the past wage varies with the employment level, such that a positive shock affects effort and, thus, the optimal wage, via the adjustment in employment. Collard and de la Croix (2000) consider an effort function, which depends on internal and external reference wages. Since the later vary with employment, once again, wage adjustments in response to shocks arise. Although these models focus on internal reference standards, that is, past own wages, they implicitly rely on repercussions from market outcomes. Hence, we establish a novel channel by which the prediction of rigid wages in an efficiency-wage setting can be invalidated.

6. Habit Formation in the Firm's Objective

While there is ample evidence of habit persistence in the behaviour of individuals (see the survey by Havranek et al. (2017)), the issue has hardly attracted attention when looking at firms. Dividend smoothing could be interpreted in terms of habit persistence but is more commonly viewed as providing signals to investors or as a response to agency problems (Leary and Michaely 2011). As an exception, Lambrecht and Myers (2012) show that managers with habit concern have an incentive to smooth payouts to balance rents over time. However, they do not look at the effects of intertemporal linkages in profits on wage and employment outcomes.

Analytically, the neglect of habit effects in a firm's objective may be due to the feature that a weighted sum of profits is maximised if profits in each period are maximal. This assertion holds as long as profits in one period do not directly affect previous or subsequent payoffs.[9]

In our framework, though, there is no intertemporal separability of profits because wage and employment choices in period one affect profits in both periods. To illustrate the consequences, suppose that the firm also exhibits habit formation and that its payoff in period two is given by $\rho = \pi - \gamma\Pi$, where period one profits, Π, constitutes the habit stock in period two and $\gamma \geq 0$ indicates the intensity of habit considerations.[10] The firm may pursue such an objective, for example, since the owner has habit preferences. Alternatively, a manager's pay may be linked to profits, while his/ her utility function incorporates habit concerns.

Optimal choices in period two are independent of the existence of habit concerns by the firm (cf. equations (3) and (4)). Maximisation of the first-period objective, $\Pi + \rho = \Pi(1 - \gamma) + \pi$, with respect to W and M, using equation (4), yields:

$$\tilde{C}(W^*, M^*, \gamma) \coloneqq [1 - \gamma][F'(W^*, M^*) \times E(W^*) - W^*] - s(W^*) = 0 \quad (14)$$

$$\tilde{D}(W^*, M^*, n^*, \beta, \gamma) \coloneqq [1 - \gamma][F'(W^*, M^*) \times E'(W^*) - 1]M^* - \beta M^* + [\beta - s'(W^*)]n^* = 0 \quad (15)$$

We assume that the second-order conditions are fulfilled and the determinant of the system, $\widetilde{Det}$, of the four equations (4), (7), (14) and (15) is positive. The derivatives of the first-order conditions with respect to the indicator of the strength of habit formation, γ, are $A_\gamma = B_\gamma = 0$ and:

$$\tilde{C}_\gamma = -[F'E - W^*] \quad (16)$$

$$\tilde{D}_\gamma = -[F'E' - 1]M^* = -[\beta M^* - [\beta - s']n^*] < 0 \quad (17)$$

If there are neither dismissal costs nor habit concerns by employees, the derivatives in (16) and (17) are zero and habit concerns in the firm's objective have no impact. If employees' preferences exhibit habit formation ($\beta > 0$), while there are no dismissal costs ($s(W) = 0$), the derivative $\tilde{C}_\gamma$ is also zero and we can establish:

[9] Dynamic models of trade union membership, for example, also provide a partial exception to the claim that intertemporal linkages in profits are not relevant for the analysis of wage and employment determination. In the settings considered by Jones (1987), Kidd and Oswald (1987), and Chang and Lai (1997), wages and employment determine contemporaneous profits and future union membership. If membership, in turn, alters future wages and employment, today's profits also affect tomorrow's level. Besides, multi-period efficiency-wage models incorporating fairness concerns, in which the fairness standard depends on last period's division of payoffs, can also exhibit intertemporal profit linkages (cf. Benjamin 2015).

[10] Firm habit formation is modelled as a change in the period two payoff, for a given level of contemporaneous profits, while such preferences of employees are captured by a reduction in period two effort, for a given wage payment in that period. These formulations are qualitatively equivalent because the effort functions $E(W)$ and $e(w - \beta W)$ can also be derived from a utility maximization exercise of employees.

Proposition 5

If employees and firms exhibit habit persistence concerning income in the previous period, while there are no dismissal costs (s(W) = 0), greater intensity of firm habit formation reduces wages in both periods, increases period two employment and also employment in period one for $C_W < 0$.

Proof: See Appendix A.5.

The firm's gain from raising the period one wage, W, consists of the rise in contemporaneous effort and productivity. In the absence of dismissal costs, the firm's loss from increasing W results from the direct contemporaneous labour costs impact and the fall in period two effort. If the costs of increasing wages become relatively more important due to habit formation by the firm, first-period wages fall. This mitigates the incentives to increase wages in the second period. A fall in period two wages, while marginal productivity is unaffected for a given wage, result in an increase in employment. This outcome also occurs in period one if the direct employment effect of wages is negative ($C_W < 0$).

If there are dismissal costs (s > 0), wage and employment variations become ambiguous (see Appendix A.5) because a firm's habit concerns negatively affect the net gain from more employment ($\tilde{C}_Y < 0$). Hence, the firm has an incentive to reduce employment in period one, for a given wage. This makes a wage increase less costly. Thus, the change in period one wages also becomes uncertain. In consequence, the variations in perceived income and the period two wage cannot be determined and the contemporaneous employment response is also indeterminate.

It is noteworthy that for habit formation by firms to have an impact, habit formation by employees or, alternatively, wage-dependent dismissal costs have to exist. The opposite, however, is not true. The reason for this asymmetry is that the firm's habit preferences are defined in terms of a variable, which the firm maximises, i.e. profits. Hence, habit concerns on their own create no intertemporal payoff link. The employees' habit formation relates to an element of their payoff, namely wages, which is exogenous from an individual's perspective. Thus, employee habit formation not only rescales payoffs but also requires an adjustment in behaviour. Such adjustment creates an intertemporal profit linkage and, therefore, is a prerequisite for habit formation by firms to affect outcomes. A similar line of reasoning applies to wage-dependent dismissal costs. They create an intertemporal link in the firm's payoff for a parameter, which the firm cannot choose optimally. In addition, it is worth emphasising that habit formation by firms may alter quantitatively the consequences of employee habit considerations, but not qualitatively. This is because habit preferences by firms effectively scale

up or down (relative) payoffs. Hence, the direction of the change in (marginal) profits due to employee habit formation is independent of how strongly the firm values the change in period one profits, relative to the variation in period two profits.

A final remark relates to the feature that habit formation by firm owners lowers the value of first-period profits relative to profits obtained latter. Therefore, discounting the future is having the opposite effect because it reduces period two payoffs relative to profits in period one. In consequence, discounting by employers affects wages and employment in a world in which employees exhibit habit persistence for the same reason as habit concerns by firm owners: Reducing period one wages has a smaller impact on the discounted level of profits because of the repercussions on period two wages, relative to a setting without the firm discounting future payoffs.

7. Summary

In this paper, we consider a multi-period efficiency-wage setting in which employees exhibit habit concerns about wages. Such preferences imply that current wage income, ceteris paribus, reduces future effort. We show that the existence of habit concerns induces the firm to raise wages from one period to the next, as long as dismissal costs are sufficiently low. This results in an effort and productivity profile, which also rises over time, while employment surely falls if higher wages reduce the number of employees. Greater intensity of habit concerns has ambiguous wage, productivity and employment effects because a marginal rise in their importance makes dismissals in period two more attractive. This, in turn, provides incentives to raise period one wages. Our first important insight is that greater intensity of habit concerns is more likely to have the same effects as the existence of such preferences, i.e., to result in an increasing wage profile, the greater the wage dependency of dismissal costs is. This is because the wage dependency counteracts the incentives to raise period one wages, as this increases the costs of a dismissal. We further demonstrate that the standard prediction that output market shocks do not affect wages no longer results in the presence of habit concerns, even if effort is independent of external reference standards. Our second major insight is that if employees feature preferences exhibiting habit formation, analogous concerns by firms or their managers can result in wage reductions and higher levels of employment.

These findings have been derived for a setting in which employees adapt to past wages and, therefore, adjust effort to the wages they were paid in the previous period. However, habit formation may also arise with respect to leisure, working hours and consumption. In all these

instances, at least one further adjustment channel would have to be taken into account. It may, for example, be the case that working hours can be adjusted and the amount of leisure in previous periods or working time in the past constitute the habit stock. This creates a further intertemporal linkage. Depending on who can determine working hours – employees or the firm – and how working hours, effort, and the number of employees are aggregated in the production function, the effects of habit formation concerning wages may be strengthened or weakened. If, for example, habit formation relates to working hours, the disutility from work will, ceteris paribus, fall over time, resulting in greater labour supply. This effect on its own would contribute to a declining wage profile. The reverse can be expected if leisure determines the habit stock. It may also be possible for employees to transfer income over time, by saving or borrowing, such that the linkage between wages and consumption is loosened. Once again, the effects of habit formation on wage setting derived above may become more pronounced or be mitigated. The analysis of such additional or alternative adaptation effects on a firm's wage setting strategy is beyond the scope of the present paper. In particular, the interaction of multiple determinants of the habit stock constitutes a promising topic for future research.

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9. Appendix

A.1 Second-order conditions

The second-order conditions for a maximum of period two profits, π, are given by:

$$\frac{\partial^2 \pi}{\partial w^2} = [M^* - n^*]^2 f'' e'^2 + [M^* - n^*] f' e'' < 0 \tag{A.1.1}$$

$$\frac{\partial^2 \pi}{\partial n^2} = f'' e^2 < 0 \tag{A.1.2}$$

$$\frac{\partial^2 \pi}{\partial w \, \partial n} = -[M^* - n^*] f'' e e' > 0 \tag{A.1.3}$$

$$\frac{\partial^2 \pi}{\partial w^2} \frac{\partial^2 \pi}{\partial n^2} - \left[\frac{\partial^2 \pi}{\partial w \, \partial n}\right]^2 = [M^* - n^*] f' e'' f'' e^2 > 0 \tag{A.1.4}$$

The second-order conditions for a maximum of the firm's period one payoff, $P = \Pi + \pi$, are:

$$\frac{\partial^2 P}{\partial M^2} = F'' E^2 + \frac{\partial^2 \pi}{\partial n^2} < 0 \tag{A.1.5}$$

$$\frac{\partial^2 P}{\partial W^2} = F''[E' M^*]^2 + F' E'' M^* + \beta^2 \frac{\partial^2 \pi}{\partial w^2} - s'' n^* < 0 \tag{A.1.6}$$

$$\frac{\partial^2 P}{\partial W \, \partial M} = F'' E E' M^* + F' E' - 1 - \beta[1 + f'' e' e[M^* - n^*]] \tag{A.1.7}$$

$$\frac{\partial^2 P}{\partial M^2} \frac{\partial^2 P}{\partial W^2} - \left[\frac{\partial^2 P}{\partial W \, \partial M}\right]^2 > 0 \tag{A.1.8}$$

We assume that the inequality in (A.1.8) is fulfilled, which is easily established for $\beta = s' = 0$.

A.2 Stability

The system of equations (4), (7), (8), and (9) can be written in matrix form as:

$$\begin{bmatrix} A_w & A_W & 0 & 0 \\ B_w & B_W & B_n & B_M \\ 0 & C_W & 0 & C_M \\ 0 & D_W & D_n & D_M \end{bmatrix} \begin{bmatrix} dw \\ dW \\ dn \\ dM \end{bmatrix} = \begin{bmatrix} -A_\beta & 0 \\ -B_\beta & 0 \\ 0 & -C_\mu \\ -D_\beta & -D_\mu \end{bmatrix} \begin{bmatrix} d\beta \\ d\mu \end{bmatrix} \tag{A.2.1}$$

The determinant of the matrix on the left-hand side of (A.2.1) equals:

$$\begin{aligned} Det = {} & D_n C_M \underbrace{[A_W B_w - A_w B_W]}_{= D_n [A_w - B_w]} - A_w B_n C_W D_n - A_w B_n [C_W D_M - D_W C_M] \\ = {} & \underbrace{A_w B_n}_{+} \underbrace{[F' M^* E'' - s'' n^*] C_M}_{+} + D_n{}^2 \underbrace{C_M}_{-} \underbrace{[A_w - B_w]}_{+} \\ & - D_n \underbrace{A_w B_n}_{+} \frac{M^* - n^*}{M^*} \left[\underbrace{F'' E M^* E'}_{-} + C_W\right] \end{aligned} \tag{A.2.2}$$

The determinant is unambiguously positive for $D_n = 0$.

For $\beta = s' = 0$, we have $D_n = 0$ and $C_W D_M - D_W C_M < 0$, because $C_M < 0$ (cf. equation (10e)), where $C_W D_M - D_W C_M$ is given by:

$$C_W D_M - D_W C_M = -D_n[2n^* - M^*]F''EE' - \left(\frac{D_n}{M^*}\right)^2 n^*[M^* - n^*] - [F'M^*E'' - s''n^*]C_M \quad (A.2.3)$$

A.3 Employee Habit Formation

For the comparison of a setting without habit formation ($\beta = 0$) and one in which individuals exhibit such preferences ($\beta > 0$), we allow for positive dismissal costs, $s \geq 0$, which do not depend on wages ($s' = 0$), as assumed in Proposition 1.

In order to compare wage and effort levels in period two, assume that $w^*(0) = w(\beta) - \beta W^*(\beta) < w(\beta)$, implying that effort levels in period two in the absence of habit concerns and in their presence are the same. The condition characterising the optimal wage in period two in the presence of habit effects, evaluated at the wage $w(\beta)$ and assuming $\beta W = \beta W^*(\beta)$, is given by:

$$A(w(\beta)) = \frac{e(w(\beta) - \beta W^*(\beta))}{e'(w(\beta) - \beta W^*(\beta))} - w(\beta) + s = \frac{e(w^*(0))}{e'(w^*(0))} - w(\beta) + s$$

$$= A(w^*(0)) + w^*(0) - w(\beta) = w^*(0) - w(\beta) < 0 \quad (A.3.1)$$

The second equality sign in (A.3.1) is due to the assumption that $w^*(0) = w(\beta) - \beta W^*(\beta)$, while the third follows from the definition of $w^*(0)$ in equation (7) for $\beta = 0$. Since A rises with the second-period wage, the wage $w^*(\beta)$ guaranteeing $A(w^*(\beta)) = 0$ has to exceed $w(\beta) = w^*(0) + \beta W^*(\beta)$. Therefore, $w^*(0) < w^*(\beta) - \beta W^*(\beta) < w^*(\beta)$ and $e(w^*(0)) < e(w^*(\beta) - \beta W^*(\beta))$ have to hold, in order to guarantee an optimal second-period wage in the presence of habit formation. The above proves the assertions relating to period two wages and effort in Proposition 1a).

Combining equations (8) and (9), we obtain a term we denote by $Z(W, \beta)$.

$$Z(W, \beta) := \frac{E(W)}{E'(W)}[M^* + \beta(M^* - n^*)] - [W + s] \quad (A.3.2)$$

$Z(W^*, \beta) = 0$ characterises the optimal choice of the first-period wage, W^*. As $\beta[M^* - n] > 0$, $Z(W, \beta > 0) > Z(W, \beta = 0)$ holds for any given wage, W. Moreover, $Z(W, \beta)$ rises with W, for a given value of $M^* + \beta[M^* - n]$.

$$\frac{\partial Z(W, \beta)}{\partial W} = \left[1 - \frac{EE''}{E'^2}\right][M^* + \beta(M^* - n^*)] - 1 > 0 \quad (A.3.3)$$

Thus, the firm sets a lower wage in period one in the presence of habit formation than in the absence of such preferences, $W^*(\beta) < W^*(0)$. This results in $E(W^*(\beta)) < E(W^*(0))$. The above completes the proof of the statements relating to period one wages and effort in Proposition 1a).

From equations (7) to (9) we know that wages are constant in the absence of habit formation and dismissal costs ($W^*(0) = w^*(0)$). Combining this insight with the inequalities derived above yields:

$$W^*(\beta) < W^*(0) = w^*(0) < w^*(\beta) - \beta W^*(\beta) < w^*(\beta) \quad (A.3.4)$$

Since $W^*(\beta) < w^*(\beta) - \beta W^*(\beta)$ entails $e(W^*(\beta)) < e(w^*(\beta) - \beta W^*(\beta))$, also effort rises over time for $s = 0$. If dismissal costs are positive ($s > 0$), wages decline over time in the absence of habit formation ($W^*(0) > w^*(0)$). Therefore, an increasing wage profile results if the dismissal cost impact is not too pronounced. Hence, we have proven Proposition 1b).

Employment in period one depends on habit formation insofar only, as period one wages are affected. Furthermore, period one employment declines with wages if $C_W < 0$ holds.

$$\frac{dM^*}{dW^*} = -\frac{C_W}{F''E^2} \tag{A. 3.5}$$

Since $W^*(\beta) < W^*(0)$, we obtain $M^*(\beta) > M^*(0)$, for $C_W < 0$, proving the first statement in Proposition 1b).

Moreover, we know that period two employment, $M^* - n^*$, as defined by $B = 0$, ceteris paribus declines in the contemporaneous wage and also in βW if $f''e(M^* - n^*) + f' < 0$. This will be the case for a Cobb-Douglas production function, since $f''e' = 1$.

$$\frac{\partial[M^* - n^*]}{\partial w} = -\frac{\frac{\partial B}{\partial w}}{\frac{\partial B}{\partial[M^* - n^*]}} = -\frac{f''[M^* - n^*]ee' + f'e' - 1}{f''e^2} = -e'\frac{M^* - n^*}{e} < 0 \tag{A. 3.6}$$

$$\frac{\partial[M^* - n^*]}{\partial(\beta W)} = -\frac{\frac{\partial B}{\partial(\beta W)}}{\frac{\partial B}{\partial[M^* - n^*]}} = -\frac{f''[M^* - n^*]e + f'}{f''e^2} \times \underbrace{\frac{\partial e(w - \beta W)}{\partial(\beta W)}}_{=-e' < 0} \tag{A. 3.7}$$

Since $w^*(\beta) > w^*(0)$ and $\beta W > 0$ in the presence of habit formation, higher period one wages and the effort change result in a decline in employment in period two (for $f''e(M - n) + f' \geq 0$). Given the assumption that employment declines over time in the absence of habit effects, higher period one employment and a fall in period two employment due to habit effects imply that employment falls. Hence, we have established the remainder of Proposition 1b).

Having compared outcomes in the presence and the absence of habit formation, we now consider a marginal rise in its intensity, that is, in the parameter β. For this purpose, we allow for the possibility of positive, wage-dependent dismissal costs, such that $s' \geq 0$.

From (A.2.1) and (A.2.2), the change in period two wages is determined by:

$$\mathrm{Det}\frac{dw^*}{d\beta} = A_\beta B_w D_n C_M + A_\beta B_n[C_W D_M - D_W C_M] + A_\beta B_n C_W D_n - A_W B_\beta D_n C_M + A_W B_n D_\beta C_M$$

$$= D_n C_M W^*[A_w - B_w] + A_\beta B_n[C_w{}^2 - D_W C_M + \frac{D_n}{W} D_\beta C_M] \tag{A. 3.8}$$

Substituting in accordance with equations (10), collecting terms and simplifying, we obtain:

$$\frac{dw^*}{d\beta} = \frac{1}{\mathrm{Det}}\underbrace{A_\beta}_{-}\underbrace{B_n}_{+}\underbrace{F'M^*E''}_{-} + \frac{D_n}{\mathrm{Det}}X, \tag{A. 3.9}$$

where the sign of X cannot be determined and X is given by:

$$X := \underbrace{C_M}_{-} W^*[\underbrace{A_w - B_w}_{+}] + \underbrace{A_\beta}_{-}\underbrace{B_n}_{+}\frac{M^* - n^*}{M^*}[C_W + \underbrace{F''EM^*}_{-}[\underbrace{E' - \frac{E}{W^*}}_{+ \text{ for } s'=0}]] \tag{A. 3.10}$$

For $\beta = s' = 0$, $D_n = 0$ results and the derivative in (A.3.9) is positive. If $D_n \neq 0$, the wage change is ambiguous (see Proposition 2).

The alteration in the period one wage, W*, is:

$$\frac{dW^*}{d\beta} = \frac{C_M}{Det}\left[D_n[A_w B_\beta - A_\beta B_w] + A_w B_n[M^* - n^*]\right]$$

$$= \frac{1}{Det}\underbrace{C_M}_{-}\left[\underbrace{A_w B_n[M^* - n^*]}_{+} + D_n \underbrace{W^*[B_w - A_w]}_{-}\right] \qquad (A.3.11)$$

This derivative is negative for $D_n = \beta - s' \leq 0$ and indeterminate otherwise (see Proposition 2).

Employment, M*, in period one changes in the opposite direction as the wage, W*, if $C_W < 0$.

$$\frac{dM^*}{d\beta} = \frac{A_w B_n C_W D_\beta + C_W D_n[A_\beta B_w - A_w B_\beta]}{Det}$$

$$= -\frac{C_W}{Det}\left[[M^* - n^*]\underbrace{A_w B_n}_{+} - D_n W^*\underbrace{[A_w - B_w]}_{+}\right] = -\frac{C_W}{C_M}\frac{dW^*}{d\beta} \qquad (A.3.12)$$

The change in the number of individuals, n*, who are dismissed in period two, is:

$$\frac{dn^*}{d\beta} = \frac{D_\beta C_M[A_w B_W - A_W B_w] + [A_w B_\beta - A_\beta B_w][C_W D_M - D_W C_M] - A_w B_M C_W D_\beta}{Det}$$

$$= \frac{-D_n \overbrace{D_\beta C_M[A_w - B_w]}^{+} - W^* \overbrace{[A_w - B_w]}^{+}[C_W D_M - D_W C_M] - C_W \overbrace{A_w B_M D_\beta}^{+}}{Det} \qquad (A.3.13)$$

Since $C_W D_M - D_W C_M < 0$ for $D_n = 0$ (cf. (A.2.3)), n* increases with β if $C_W < 0$. If D_n is non-zero, the change in the number of dismissals in period two is ambiguous.

Using (A.3.12) and (A.3.13), employment in period two, $M^* - n^*$, can be computed, as:

$$\frac{d[M^* - n^*]}{d\beta}$$

$$= \frac{dM^*}{d\beta} - \frac{D_\beta C_M[A_w B_W - A_W B_w] + [A_w B_\beta - A_\beta B_w][C_W D_M - D_W C_M] - A_w B_M C_W D_\beta}{Det}$$

$$= \frac{[A_\beta B_w - A_w B_\beta][C_W{}^2 - D_W C_M] - D_\beta C_M[A_w B_W - A_W B_w]}{Det}$$

$$= \frac{W^*[A_w - B_w][C_W{}^2 - D_W C_M] + D_\beta C_M D_n[A_w - B_w]}{Det}$$

$$= \underbrace{\frac{A_w - B_w}{Det}}_{+}\left[W^*\left\{D_n\frac{M^* - n^*}{M^*}[F''EM^*E' + C_W] - \underbrace{C_M\,[F'M^*E'' - s''n^*]}_{+}\right\} + D_n\underbrace{D_\beta C_M}_{+}\right]$$

$$= \underbrace{\frac{A_w - B_w}{Det}}_{+}\left[D_n\frac{M^* - n^*}{M^*}Q - W^*\underbrace{C_M\,[F'M^*E'' - s''n^*]}_{+}\right] \qquad (A.3.14)$$

From C = 0 and D = 0 for s = s' = 0, we have $D_n = \beta > 0$ and $W^*E'/E - 1 = \beta[M^* - n^*]/M^* > 0$. Hence, period two employment falls for s = 0 if $C_W \leq 0$. For $D_n = \beta - s' > 0$ and s(W) > 0, period two employment falls, if $Q := F''EM^*[E'W^* - E] + C_W W^*$ in (A.3.14) is non-positive.

A.4 Wage Rigidity

The wage effect of a rise in the parameter μ is determined by:

$$\frac{dw^*}{d\mu} = \frac{A_W B_n [C_M D_\mu - C_\mu D_M - C_\mu D_n]}{Det}$$

$$= -\frac{f'(W^*, M^*) A_W B_n E D_n (M^* - n^*)}{Det\, M^*} = -\frac{dW^*}{d\mu}\frac{A_W}{A_w} \qquad (A.4.1)$$

Since $A_W < 0 < A_w, B_n$, wages rise (fall) if $D_n >$ (<) 0. They remain constant for $D_n = 0$. As effort in period one rises with the wage, (A.4.1) establishes the statements relating to wages in Propositions 3 and 4a).

Using (10a) and (A.4.1), the variation in perceived income is:

$$\frac{d[w^* - \beta W^*]}{d\mu} = \frac{dw^*}{d\mu} - \beta\frac{dW^*}{d\mu} = -\frac{dW^*}{d\mu}\left[\frac{A_W}{A_w} + \beta\right] = -\frac{dW^*}{d\mu}\left[\frac{-[\beta - s'] - \beta A_w}{A_w} + \beta\right]$$

$$= {D_n}^2 \frac{f'(W^*, M^*) B_n E (M^* - n^*)}{Det\, M^*} > 0 \text{ for } D_n \neq 0 \qquad (A.4.2)$$

Therefore, period two effort rises with a positive shock in period one, unless β = s' holds. This proves the respective assertions in Propositions 3 and 4d).

Employment in period one rises if $D_n = \beta - s' = 0$. Otherwise, the employment change is indeterminate (cf. Propositions 3 and 4b)).

$$\frac{dM^*}{d\mu} = \frac{[A_w B_W - A_W B_w] D_n C_\mu + A_w B_n [C_W D_\mu - D_W C_\mu]}{Det}$$

$$= f'(W^*, M^*)\left[D_n \frac{A_w B_n [M^* - n^*]E' - [A_w - B_w] D_n E}{Det} - \frac{A_w B_n E[F'M^*E'' - s''n^*]}{Det}\right] \qquad (A.4.3)$$

The impact of a rise in μ on dismissals is ambiguous unless $D_n = 0$ (cf. Proposition 4b)).

$$\frac{dn^*}{d\mu} = \frac{A_w B_W [C_M D_\mu - C_\mu D_M] + A_w B_n [C_W D_\mu - D_W C_\mu] - A_W B_w [C_M D_\mu - C_\mu D_M]}{Det}$$

$$= D_n \frac{A_w B_n [M^* - n^*]E' - [A_w - B_w] D_n E \frac{n^*}{M^*}}{Det\, f'^{-1}(W^*, M^*)} - \frac{A_w B_n E[F'M^*E'' - s''n^*]}{Det\, f'^{-1}(W^*, M^*)} \qquad (A.4.4)$$

The combination of (A.4.3) and (A.4.4) yields:

$$\frac{d[M^* - n^*]}{d\mu} = -{D_n}^2 f'(W^*, M^*) E \frac{M^* - n^*}{M^*}\frac{A_w - B_w}{Det} = -\frac{dB/d\mu}{\frac{dB}{d[M^* - n^*]}} = \frac{dB/d\mu}{B_n} \qquad (A.4.5)$$

Therefore, period two employment declines as long as $D_n \neq 0$. The change is zero otherwise. This establishes the relevant statements in Propositions 3 and Proposition 4c).

A.5 Habit Formation by Firms

The effect of habit formation by firms on period two wages is found to be:

$$\frac{dw^*}{d\gamma} = A_W B_n \frac{\tilde{D}_\gamma C_M - \tilde{C}_\gamma [D_M + D_n]}{\widetilde{Det}} = A_W B_n \frac{\tilde{D}_\gamma C_M - \tilde{C}_\gamma C_W}{\widetilde{Det}}$$

$$= -A_W B_n \frac{F'' E M^* [W^* E' - E] + \tilde{C}_\gamma D_n (M^* - n^*)}{\widetilde{Det}\ M^*} = -\frac{A_W}{\underbrace{A_w}_{-}} \frac{dW^*}{d\gamma}, \qquad (A.5.1)$$

where the determinant $\widetilde{Det}$ is defined by

$$\widetilde{Det} = D_n C_M [A_W B_w - A_w B_W] - A_w B_n \tilde{C}_W D_n - A_w B_n [\tilde{C}_W \tilde{D}_M - \tilde{D}_W \tilde{C}_M]. \qquad (A.5.2)$$

In (A.5.2), the derivatives of $\tilde{C}$ and $\tilde{D}$ are given by $\tilde{C}_M = (1-\gamma)C_M$, $\tilde{C}_W = [1-\gamma]C_W + \gamma s'$, $\tilde{D}_M = [1-\gamma]D_M + \beta$, and $\tilde{D}_W = [1-\gamma][F'' M^* E'^2 + F' E'']M^* - s'' n^*$. If there are no dismissal costs, $D_n = \beta > 0$, $\tilde{C}_\gamma = 0$ and $W^* E' - E > 0$ hold. In this case, wages fall. If $D_n = \beta - s' > 0$ and $s(W) > 0$, $\tilde{C}_\gamma < 0$ results, while $E'W^* - E$ and the overall wage effect cannot be signed.

The impact of a rise in γ on employment in period one, M^*, is:

$$\frac{dM^*}{d\gamma} = \frac{A_w B_n [\tilde{D}_\gamma C_W - \tilde{C}_\gamma D_W] + A_w B_W \tilde{C}_\gamma D_n - A_W B_w D_n \tilde{C}_\gamma}{\widetilde{Det}}$$

$$= \frac{A_w B_n [\tilde{D}_\gamma C_W - \tilde{C}_\gamma D_W] - \tilde{C}_\gamma D_n{}^2 [A_w - B_w]}{\widetilde{Det}} \qquad (A.5.3)$$

If there are no dismissal costs ($\tilde{C}_\gamma = 0$), period one employment, M^*, rises iff $C_W < 0$. The change in the number of dismissals is given by:

$$\frac{dn^*}{d\gamma} = \frac{[A_w B_W - A_W B_w][\tilde{D}_\gamma C_M - \tilde{C}_\gamma D_M] + A_w B_n [\tilde{D}_\gamma C_W - \tilde{C}_\gamma D_W]}{\widetilde{Det}} \qquad (A.5.4)$$

Consequently, the variation in period two employment is:

$$\frac{d[M^* - n^*]}{d\gamma} = \frac{\tilde{C}_\gamma D_n [A_w B_W - A_W B_w]}{\widetilde{Det}} - \frac{[A_w B_W - A_W B_w][\tilde{D}_\gamma C_M - \tilde{C}_\gamma D_M]}{\widetilde{Det}}$$

$$= -D_n \frac{A_w - B_w}{\widetilde{Det}} \left[F'' E M^* [W^* E' - E] + \tilde{C}_\gamma D_n \frac{M^* - n^*}{M^*} \right] \qquad (A.5.5)$$

If $s' = s(W) = 0 < \beta$, $E'W^* - E > 0$ holds and employment, $M^* - n^*$, in period two rises. If $s(W) > 0$, $E'W^* - E$ cannot be signed and the employment change is ambiguous.

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