Discussion Paper
n. 139 - Giugno 2012

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Informal incentive labour contracts and product market competition

Abstract

This paper studies the dynamic interaction between product market competition and incentives against shirking. It is shown that efficiency wages can both increase and decrease when competition becomes fiercer. Instead, discretionary bonuses do not vary with competition but there exists an upper threshold for the number of competing firms, over which such schemes are no longer sustainable as equilibrium. Finally, industry profits under bonuses are generally higher than under efficiency wages, but the reverse actually applies when information about firms' misbehaviour flows at a low rate and the number of firms exceeds the critical threshold.

Classificazione JEL: J33, J41, L13
Keywords: efficiency wages, discretionary bonuses, competition, industry profits

Contents

I. Introduction

As well known, the difficulty of measuring individual performance in an objective way limits the use of legally enforceable incentive contracts and implies that firms often rely on informal agreements to motivate employees.[1] In order to provide parties with incentives to fulfil informal agreements, labour contracts must be designed so that the value of continuing the relationship in the future is sufficiently large that neither party wishes to renege on the contract. In this regard, efficiency wages (Shapiro and Stiglitz 1984) and contracts with discretionary bonuses (MacLeod and Malcomson 1989, 1998) have been largely studied and compared by the literature.[2]

This paper aims at extending previous literature on informal incentive labour contracts by introducing the role of imperfect (Cournot) competition in the product market into the analysis. While previous works concentrate on the labour market and implicitly assume that product markets, where firms operate, are perfectly competitive, we will analyze the dynamic interaction between product market competition and incentives against shirking.

The questions addressed here include the following: does product market competition affect wage profiles and how does this relate to the incentive scheme adopted by firms? Which relationship we should expect to find between product market competition and industry profits, according to alternative incentive contracts? Since, as known, efficiency wages imply firms must pay a rent to motivate their workers while discretionary bonuses do not, should we expect that profits are always higher with the latter? Or, does the degree of product market competition play a role, possibly, by affecting the relative profitability of alternative schemes? Moreover, while the standard shirking model of efficiency wages predicts a

[1] Such informal agreements or contracts are also referred to as "self-enforcing implicit contracts" (e.g., Bull 1987) or "relational contracts" (e.g., Levin 2003).

[2] As pointed out by MacLeod and Malcomson (1989, p. 448), also efficiency wage contracts have their own informal or implicit element, namely "that the employee will perform satisfactorily if employed and that the employer will continue the contract if performance is satisfactory, or terminate it if not".

clear-cut positive relationship between wages and employment, and it is quite natural to consider that employment increases with the number of competing firms, empirical evidence on the connection between wages and product market competition is mixed.[3] Hence, could introducing product market competion into a shirking model modify its standard prediction about the wage-employment nexus? All such issues are obviously relevant to the concerns of labour economics and industrial organization.

We also introduce an important departure with respect to standard hypothesis about workers' reputation. Particularly, we will assume that workers who have been previously fired as the result of shirking *may* have a lower probability of finding a new job with respect to other workers and, more importantly, we relate such a possibility to the number of firms competing in the product market. As we will discuss, this can be motivated hypothesizing that detecting shirkers in the unemployment pool (i.e., establishing workers' reputation) becomes more difficult as the number of firms in the market increases.[4]

Our main results can be summarized as follows. Firstly, the equilibrium efficiency wage may be decreasing in the probability of unemployed workers finding a job. This result, which is in contrast with Shapiro and Stiglitz (1984), is due to the fact that (when workers' reputation play a role) an increase in the probability of finding a job also increases the "opportunity-cost" of shirking and can permit firms to elicit effort from workers even with a lower wage. Moreover, depending on the degree of competition in the product market and on the role of changing competition in affecting workers' reputation, efficiency wages can both increase and decrease when competition becomes fiercer (i.e., employment increases).

When firms adopt discretionary bonuses, instead, workers' wages are generally uncorrelated with competition in the product market.

[3] See, e.g., Blanchflower (1986), Dickens and Katz (1987), Nickell et al. (1994), as well as the literature cited therein.

[4] The role of workers' reputation in affecting workers' *unverifiable* performance is discussed in Malcomson (1999), but it is not related to the degree of product market competition, as will be effected in this paper.

However, there is a critical threshold for the number of competing firms above which discretionary bonuses are no longer sustainable as equilibrium. Particularly, such a threshold relates to product market as well as labour market parameters.

The above results also open up the possibility of comparative analysis of the relation between the two incentive schemes considered and (industry) profits. Although efficiency wages imply firms pay a rent to motivate their workers while discretionary bonuses do not, there remains a possibility that, for some degree of product market competition, profits are higher with efficiency wages. Indeed, this could happen if the upper bound for the degree of competition with efficiency wages (i.e., the number of firms above which profits with efficiency wages become negative) is higher than that with discretionary bonuses (i.e., the number of firms above which discretionary bonuses are no longer sustainable as equilibrium). We show that this actually applies when there is a relatively low rate at which information about firms' misbehaviour in paying bonuses flows in the labour market.

Our work relates (and largely draws) on the informal contracts literature. Most notably, MacLeod and Malcomson (1998) model the choice between efficiency wages and performance pay as a function of *labour market* conditions. They show that, when there are unemployed workers, at an efficient equilibrium the rent required to make the agreement self-enforcing must go to the worker in the form of a high (efficiency) wage, while if there are unfilled vacancies, efficient market equilibrium has performance pay. In contrast to MacLeod and Malcomson (1998), our aim is to compare efficiency wages and performance pay in relation to product (instead of labour) market conditions.

This paper also deals with the literature that, starting from Machlup (1967), studies as product market competition interacts with incentive contracts in motivating managers and other workers (e.g., Schmidt 1997; Raith 2003; and, for a recent survey, Legros and Newman 2011). This literature, however, differs from our work mainly because it considers principal-agent problems, in which *for-*

mal incentive contracts (linking pay to performance) are feasible, and analyzes changes in the optimal "shape" of incentive contracts following changes in product market competition.[5] By contrast, we consider the interaction between incentive labour contracts and imperfect product market competition in a context in which formal incentive contracts are not feasible.

The relationship between the number of firms competing in the (oligopolistic) product market, wages and (industry) profits with endogenous production costs is also studied by Dowrick (1989), who shows that the effect of an increase in competition on wages is ambiguous but, generally, wages decrease as the number of competing firms increases. However, in Dowrick (1989) the effects of competition on wages operate by affecting rents over which unions bargain, while, in our framework, they relate to changes produced in the optimal incentive wage contract.

The rest of the paper is organized as follows: in Section II. the basic framework is described. The competition game in the product market and the design of alternative (incentive) labour contracts are studied in Section III.. Section IV. compares their outcomes in relation to the effects on industry profits. Concluding comments are in Section V., while further details and technical proofs are relegated to the Appendix.

II. Model

II.A. Economic environment

Time is discrete, $t = 1, 2, ...$[6] There is a number $n \geq 1$ of identical firms competing *à la* Cournot repeatedly over time in a homoge-

[5] See Cuñat and Guadalupe (2005) for an empirical study on the relationship between product market competition and compensation packages. They also recognize that the evidence regarding the relationship between product market competition and incentive pay is still very limited and this is particularly true for the case of informal incentive contracts. In this paper, we will provide some novel theoretical predictions on the relationship between informal labour contracts and product market competition, which could be suitable to be tested empirically (see, in particular, the discussion in the concluding section).

[6] Since in this environment the technology, the preferences and any other variable are stationary, we do not need to denote variables by a time index.

neous good market, with inverse demand function given by:

$$p = a - cQ \tag{1}$$

where Q is the overall market output. There is also a pool of ℓ identical workers, with $\ell > n$. Each employment relationship consists of a repeated game played between a firm and a pool worker who form an employment relationship in a certain period and interact until their relationship is severed. According to the substantial turnover of jobs in labour markets (e.g., Davis and Haltiwanger 1999), in each period employment relationships become unprofitable at the rate s for exogenous reasons and in such a case firm and employee separate. Firms and workers have infinite life, they are risk-neutral and discount the future with the same rate r. For simplicity, we concentrate on a situation in which each firm employs one single worker (e.g., a manager) and all marginal costs, other than the worker's wage, are constant and normalized at zero.

With regard to labour contracts and workers' effort, we follow MacLeod and Malcomson (1989, 1998) by assuming that: i) firms *perfectly observe* their workers' decision about effort, but the only legally verifiable pieces of information that can be included in a labour contract are money payments and whether or not a person is employed by a firm; and ii) in relation to the worker employed by firm i, the decision about effort consists in each period either to work ($e_i = 1$) or to shirk ($e_i = 0$), obtaining an utility given by:

$$u_i = w_i - ve_i \tag{2}$$

where w_i is the wage paid by firm i and $v > 0$ is the disutility of work, while we normalize to zero the utility of the worker when unemployed.[7]

[7] We consider the presence of product market-specific skills or other sources of mobility costs for workers across sectors. This implies the presence of "segmented" labour markets in relation to different product markets (e.g., Reich et al. 1973). However, this is not essential for our results. Alternatively, workers' reservation utility (normalized at zero) can be interpreted as utility from self-employment or from employment in other industries where formal incentive contracts are feasible.

Obviously, the worker's decision is essential for production and, in particular, we assume that:

$$q_i = \begin{cases} 0 & \text{if } \; e_i = 0 \\ \arg\max \pi_i & \text{if } \; e_i = 1 \end{cases} \tag{3}$$

where π_i is the firm i's per-period profit. That is, while worker's decision to work ensures producing the level of output that maximizes the firm's profit (which will be derived below in detail), there is no firm's production (hence, profits) when the worker shirks.

II.B. Workers reputation

We admit the possibility that workers' reputation *can* be established in some extent and, most importantly, we relate such a possibility to the number of firms competing in the product market. In particular, we hypothesize that, once a match has occurred, a firm does not hire a worker when finds out that the latter is a shirker, that is, he/she has been previously fired for shirking. However, we consider that workers' previous history is "soft" information (i.e., information that is not contained in hard evidence) that flows in the market more and more opaquely as the number of competing firms increases.

In order to motivate such an assumption, consider, from one hand, the extreme case of a monopoly. Since a worker who has been fired for shirking could find another job (in this market) only with the same firm, the possibility for the latter to know about the worker's previous misbehaviour is complete.

On the other hand, if there are many firms in the market, that is, the product market is extremely competitive, it can be more complex for firms to detect shirkers for various reasons. Firstly, this is in line with the literature stressing the importance of information about workers' previous performance as transmitted, essentially by means of word-of-mouth communication, through social networks or informal channels (e.g., Rees 1966; Granovetter 1974; Montgomery 1991). Indeed, at the moment of recruiting new workers, social networks among firms can represent potential channels to acquire this type of information, leading to more efficient hiring outcomes. At the same time, when firms tend to rely on their social contacts, they largely loss the opportunity to get information from agents outside their own network.[8] Also because social links formation is costly, the larger the overall number of firms, the higher the probability that a firm is not linked to (hence, does not communicate with) others in the market. Thus, in such a case, it is more likely for a shirker to find another job in firms which do not belong to his/her previous employer's social network.

Moreover, the larger the number of firms in the product market, the higher the job turnover, that is, the number of workers that, in each period, lose their jobs for exogenous (not related to shirking) reasons. This could make more difficult for firms to distinguish shirkers among all workers that have lost their jobs.[9]

Finally, as emphasized by Malcomson (1999, p. 2340), the Shapiro-Stiglitz's "anonymous" labour market assumption is plausible when acquiring information about workers' previous employment experience is costly for firms. For instance, firms could need to invest time and efforts to acquire information about applicants' previous histories and, most likely, the larger the pool of potential previous employers, the higher such time and efforts.[10]

[8] See Burt (1992). Schram et al. (2010) provide a recent experimental study on how firms choose between formal and informal recruitment channels.

[9] Also in this case an extreme example could be illuminating. Consider a situation in which job turnover for exogenous reasons is absent, thus workers lose their jobs only when fired for shirking. Obviously, in this case, firms always perfectly know that a worker losing the job is a shirker. A similar argument, namely labour turnover may obscure the history of the game in repeated employment relationships, has been recently put forward also by Mukherjee (2010).

[10] An anonymous referee correctly argues that, even if effort (and output) is not verifiable, it could be possible to infer a worker's effort by learning about his/her firm's output. In fact, this argument can provide a further rationale to our hypothesis about the relation between workers' reputation and product market competition. While with few firms it could be simple to learn about a firm's output (e.g., by inferring from the overall output in the market), this possibility becomes negligible when the number of firms is very large.

II.C. Timing and unemployment values and flows

The timing of events for each period is as follows: i) matching occurs between unmatched firm and worker and, unless the firm finds out that the worker has been previously fired for shirking, an employment relationship is formed; ii) the firm designs a proper labour incentive contract that can be either efficiency wage-type or bonus-type; iii) the firm makes production decision (the product market game) and the worker decides to work or to shirk; iv) the firm pays the (contractual) efficiency wage or, if instead the incentive contract provides for a discretionary bonus, decides whether or not to pay the bonus, hence payoffs realize; v) finally, separation may occur either for exogenous reasons or because the firm fires the (shirking) worker.

Starting from a generic period of time and using U^S and U^{NS} to indicate the expected discounted lifetime utility of an unemployed (unmatched) worker who has and has not been previously fired for shirking, respectively, we have (from here onwards, in order to streamline the notation, we omit the index i whenever it is unnecessary):

$$U^k = \frac{JmE^k}{1+r} + \frac{(1-Jm)U^k}{1+r} \Leftrightarrow U^k = \frac{JmE^k}{r+Jm} \tag{4}$$

where $k \in \{S, NS\}$, E^k indicates the expected discounted lifetime utility of an employed worker of type k, m is the per-period probability for an unemployed worker to match with a firm and, finally, J is an index function, such that $J = 1$ if $k = NS$ and $J = \theta$ if $k = S$.[11] In particular, in line with the discussion of Section II.B. about the relationship between workers' reputation and the number of firms in the product market, the following assumption is established in relation to θ.

[11] Since the model is stationary, if a worker is a shirker for one period, he/she is a shirker forever. This is because, in a stationary model, nonstationary allocations cannot improve on stationary ones (e.g., MacLeod and Malcomson 1989). This implies that the job-finding probability of a shirker does not depend on how many times has been previously fired.

Assumption 1 *The function $\theta = \theta(n) \in [0, 1)$, with $\theta(1) = 0$ and $\theta(n) \to 1$ for $n \to \infty$. Furthermore, for any n, $\theta(n)$ is increasing.*

According to Assumption 1, when the product market is perfectly competitive ($n \to \infty$), $\theta \to 1$ and the Shapiro-Stiglitz "anonymous" market hypothesis applies. Instead, when the product market is a monopoly, a worker once fired for shirking is never employed again in this market. Finally, "workers' reputation" can be established to some extent (depending on n) for intermediate n's values, hence workers previously fired for shirking could get new jobs with lower (but positive) probability than other workers.[12]

In a stationary equilibrium, all employed workers do not shirk and lose their jobs only for exogenous reasons. Furthermore, movements into and out of unemployment must balance. Accordingly, the matching probability for an unemployed worker is given by:

$$m = \frac{sn}{\ell - (1-s)n}. \tag{5}$$

Instead, since ℓ is sufficiently large to satisfy whatever labour demand and no search frictions are assumed in this economic environment, in a stationary equilibrium, where all implicit contracts are honoured, each firm promptly finds a new worker when an employment relationship is severed for exogenous reasons. Also note that, in this context, it is natural to assume that firms have all market power *vis-à-vis* their workers. In what follows, following the backward induction logic, we first analyze competition in the product market, conceding that labour contracts have been previously designed adequately. Then, we study as firms must properly design labour contracts.

[12]A sketch model of Assumption 1, based on qualitative arguments of Section II.B., can be provided as follows. Consider that time, costs or efforts firms must bear in order to acquire information about an applicant's previous history is $\kappa(n)$, with $\kappa'(n) > 0$, $\kappa(1) = 0$ and $\kappa(\infty) \to \infty$. Furthermore, each firm in the market has its own preferences or possibilities (e.g., budget) for bearing such costs, which can be summarized by a threshold λ (i.e., the maximum amount the firm can bear) drawn at random from a distribution defined on real positive numbers. Hence, once matched with a firm (which occurs with probability m), a shirker is hired only if the cost for the firm to find out his/her type is higher than the firm's λ, implying $\theta(n) = prob(\kappa(n) > \lambda)$. This is consistent with Assumption 1.

III. Oligopolistic competition and informal incentive labour contracts

III.A. The product market game

According to the economic environment described above, per-period profit for the representative firm i can be written as:

$$\pi_i = pq_i - w_i = [a - c(q_i + Q_{-i})]q_i - w_i \tag{6}$$

where Q_{-i} is the sum of the quantities supplied by the other firms. Under the Cournot-Nash assumption, differentiation of (6) with respect to q_i yields the first-order condition for profit maximization by firm i, from which we can derive the firm i's reaction function in the output space: $q_i = (a - cQ_{-i})/2c$. Solving all firms' reaction functions simultaneously allows us to derive the stage-two symmetric equilibrium firm i's output (with $q_i = q, \forall i$), as:

$$q = \frac{a}{(n+1)c}. \tag{7}$$

By substituting (7) into (6), we get an expression for the firm i's profit that, in symmetric equilibrium ($\pi_i = \pi, \forall i$), is given by:

$$\pi = \frac{a^2}{(n+1)^2 c} - w \tag{8}$$

where w ($= w_i, \forall i$) is the outcome of the game determining the optimal incentive labour contract.[13]

III.B. The incentive labour contract and wage profiles

III.B.i. Efficiency wages

The best known model in shirking versions of efficiency wages is provided by Shapiro and Stiglitz (1984). By incorporating into such model our hypothesis about workers' probability of getting a

[13] Owing to the w's nature of (quasi-)fixed cost, profits become negative for large n's values. In what follows, however, we will generally assume that the product market parameter a is large enough to ensure that results are meaningful.

job, standard analysis (see Appendix A.1) leads to the following equilibrium efficiency wage:

$$w_{EW} = v\left[\frac{(m+r)(1+\theta m+r)}{m+r-s(\theta m+r)}\right]. \tag{9}$$

Lemma 1 *With s and $r>0$ and for a sufficiently low n, the efficiency wage decreases when the matching probability m increases.*

Proof. See Appendix A.2. ■

The rationale behind Lemma 1 is quite straightforward. In our framework, two different effects affect the equilibrium wage when m increases. From one hand, by making losing a job less severe for *all* workers, it forces firms to pay higher wages to motivate them. This is the standard "Shapiro-Stiglitz effect", which is clearly stronger when the role of workers' reputation is weaker (n is higher) and there is not too much difference for workers between losing a job due to shirking or for exogenous reasons.

From the other hand, however, an increase in m also increases the "oppor- tunity-cost" of shirking. This is because it increases the differential probability of getting another job between non-shirkers and shirkers. This "reputation effect" operates against the Shapiro-Stiglitz effect, permitting firms to elicit high effort from workers, even with a lower wage. Furthermore, the lower n, the stronger the role played by the reputation effect. Thus, when m increases and n is sufficiently low, the reputation effect outweighs the Shapiro-Stiglitz effect, reducing the equilibrium wage.[14]

Moreover, since an increase in the number of firms increases the (steady-state) matching probability m (see (5)) and, according to Lemma 1, there could be a negative relationship between m and

[14] As formally shown in Appendix A.2, this result can never apply whenever s (and r) $= 0$. This is because, in such a case, a higher matching probability m only benefits shirkers, hence unambiguously leads to a higher efficiency wage (we owe such clarification to an anonymous referee). Also note that while here we concentrate on product market competition (highlighting a novel role that it can play in affecting wages), an analogous result would be obtain for reasons other than competition that cause a sufficiently large difference between job-finding rates of shirkers with respect to non-shirkers.

the equilibrium efficiency wage, it is interesting to investigate if also a negative relationship can exist between the latter and n. Notice that, in our framework, an increase of n also implies a decrease of unemployment, thus such a negative relationship would imply a reversal of the standard result that, in equilibrium, efficiency wage and unemployment are always negatively correlated.

Result 1 *When competition is low and the effect of changing competition on workers' reputation is sufficiently small, there exists a critical n below which the efficiency wage is decreasing when competition becomes fiercer (i.e., n increases) and above which the opposite applies. However, the industry total wage bill (i.e., the sum of the firms' wages) always increases with n.*

Proof. See Appendix A.3. ■

While a complete formal proof of Result 1 is provided in the final Appendix, in order to understand the rationale behind it, let define with α the term in brackets of (9)'s r.h.s., which represents the key term of the equilibrium efficiency wage. By differentiating α with respect to n:

$$\frac{\partial\alpha}{\partial n} = \underbrace{\theta'(n)\frac{\partial\alpha}{\partial\theta}}_{\text{changing } \theta \text{ effect } (+)} + \underbrace{\frac{\partial m}{\partial n}\frac{\partial\alpha}{\partial m}}_{\text{changing } m \text{ effect } (+/-)} . \tag{10}$$

An increase in competition increases employment, thus leading to an increase in the matching probability m. In turn, as discussed above in Lemma 1, the resulting effect on the equilibrium wage can be disentangled, distinguishing between the "Shapiro-Stiglitz effect" and the "reputation effect", which operate against one another. We have previously showed that only if n is sufficiently low, the latter outweighs the former, hence $\partial\alpha/\partial m$ (and the "changing m effect" in (10) as a whole) is negative.

However, besides increasing m, an increase in n also produces another important effect, namely it increases θ. That is, it reduces the role of workers' reputation. In turn, by lowering the cost of shirking, this drives firms to pay a higher rent to motivate their workers.[15] Thus, we can conclude that, for increasing n, the equilibrium wage actually decreases when: i) the "changing m effect" is negative (which requires that n is sufficiently low); *and* ii) the "changing θ effect" is so small that the "changing m effect" prevails.

Finally, note that Result 1 states also that even if $\partial\alpha/\partial n < 0$, only wages paid by infra-marginal firms decrease, while the industry total wage bill increases. This is because the total wage reduction for infra-marginal firms is always lower than the wage paid by marginal firm.

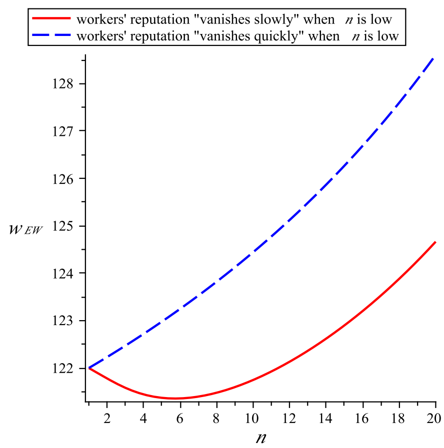

Figure 1: w_{EW} profile for varying n

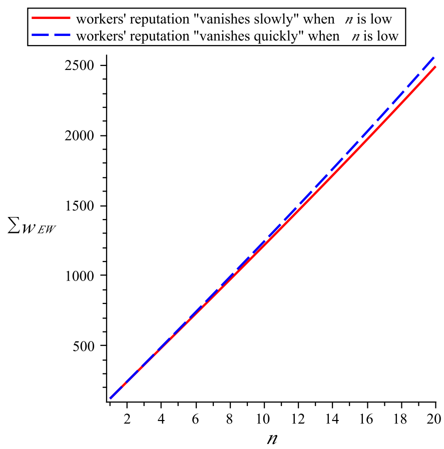

Figure 2: $\sum w_{EW}$ profile for varying n

As an illustrative example, consider a specific functional form for θ: $\theta = \frac{(n-1)^\gamma}{n^\gamma+\beta}$ (which is consistent with Assumption 1). For this case, in Figures 1 and 2, respectively, each single firm's equilibrium wage (w_{EW}) profile for varying n and the corresponding behaviour

[15] Overall, the effect of an increase of n on the equilibrium wage via increasing θ is captured by the first term of (10), which is always positive. It is worth noting that (10) can also provide some intuitions on the possibility to test Assumption 1 (i.e., $\theta'(n) > 0$) with data. In particular, since the (equilibrium) wage rent is increasing in θ, we should expect to find a positive relationship between wage rents and the number of competing firms in different industries if Assumption 1 actually applies. Obviously, this empirical strategy needs to control for several other variables, which is a non-trivial issue. This is because many factors, which are correlated with the degree of industrial concentration, can generate wage rents for workers (e.g., the presence and the structure of unionization).

of industry total wage bill ($\sum w_{EW}$) are plotted under two different configurations of β and γ parameters: $\gamma = 1$ and $\beta = 0$ (blue dashed lines), which imply that, for low n, $\theta'(n)$ is large, and $\gamma = 10$ and $\beta = 1000$ (red solid lines), which instead correspond to the case in which, for sufficiently low n, $\theta'(n)$ is very low.[16] Consistently with our theoretical analysis, for $\gamma = 10$ and $\beta = 1000$ (unlike that with $\gamma = 1$ and $\beta = 0$) the firm's wage initially decreases when n increases. However, also in this case, the industry wage bill is always increasing with n.

III.B.ii. Discretionary bonuses

Let consider now an incentive scheme that provides for a bonus payment conditional on the worker's choice about effort (e.g., Bull 1987; MacLeod and Malcomson 1989).[17] In the final Appendix (Section A.1, where further details about firms' and workers' strategies are provided), through standard analysis, we show that the equilibrium bonus chosen by firms is $w_B = v$. Notice that, unlike the efficiency wages case, with discretionary bonuses: i) the wage does not depend on the number of firms competing in the product market; and ii) firms can potentially motivate workers without providing them with a rent (e.g., Malcomson 1999). Furthermore, θ, hence differences in unemployment values between shirkers and non-shirkers, do not play any role in providing incentives. This is because, in the equilibrium with bonus, employed workers receive exactly the same utility as unemployed ones.

However, firms must be able to credibly commit themselves to paying the bonus and this requires that information about a firm's misbehaviour flows, at least in some extent, in the (labour) mar-

[16] Other parameters, common in both cases, used to get Figures 1 and 2 are: $v = 100; s = r = 0.1; \ell = 50$.

[17] Generally, together with the bonus that represents the implicit part of the contract, the latter also provides for a fixed salary, whose payment can be enforced by a court. Since in our framework firms have all the bargaining power *vis-à-vis* workers, the former fix the salary such that, given the equilibrium bonus, workers exactly receive their opportunity cost. Hence, the salary equals the workers' reservation utility, which has been normalized at zero, permitting us to concentrate, without loss of generality, only on the bonus.

ket. Labour unions, for instance, may contribute in this direction by monitoring the employment relationships between a firm and its workers and providing the workforce with valuable information regarding the firm's adherence to implicit contracts (Hogan 2001). Furthermore, also firms themselves could have an interest in credibly fostering the transmission of such information to the market since, by committing themselves more strongly, they can offer a broader range of incentives (Kreps and Wilson 1982; Tirole 1996; Tadelis 1999).

In line with Malcomson's (1999) argument that it is implausible that each time a firm loses employees because of cheating on promised bonuses it is never able to recruit a new worker, we will consider a situation in which information on firms' misbehaviour does not always flow in the labour market, but it does so only with a positive per-period probability z. Nevertheless, each time this occurs, cheating behaviour by a firm is interpreted by the labour workforce as a whole as evidence that firm does not fulfil informal agreements with its workers, meaning that no worker will be motivated to work for that firm in the future (Doering and Piore (1971) and Bewley (1999) provide empirical evidence supporting this hypothesis).[18]

Under such assumption about firms' reputation, the following condition, as derived in Appendix A.1, must be satisfied for making implicit agreements on bonuses self-enforceable:

$$\pi \geq \frac{rv}{z}. \tag{11}$$

Taking into account (8), the equilibrium value for the firm's profit

[18]It could be argued that, since we have related θ (which captures how workers' reputation flows in the market) to the number of competing firms, this could also be done for z. The latter argument, however, seems more problematic. In particular, difficulties for external agents to verify whether a monopolist has promised to pay a bonus or if the latter was actually paid appear to be exactly the same than in relation to a single firm in a more competitive setting. In case, since we postulate that θ (negatively) depends on n (which relates to the labour market demand side), symmetry would imply that z should depend on ℓ (that relates to the labour market supply side) instead of n. However, since we consider a situation with unemployed workers ($\ell > n$), ℓ does not play any important role in the analysis that follows, thus there is no loss of generality in considering z as exogenously given instead of as a function of ℓ.

in the product market game, and solving for n, we obtain a condition for the number of firms competing in the product market, which must be satisfied in a self-enforcing equilibrium:

$$n \leq \tilde{n} \equiv \frac{a}{\sqrt{cv\left(\frac{r+z}{z}\right)}} - 1. \tag{12}$$

Result 2 *There exists an upper threshold for the number of firms competing in the product market, over which discretionary bonuses are not sustainable as a self-enforcing equilibrium.*

Since firms' profits are decreasing in n, (12) establishes an upper constraint for competition in the product market, for which discretionary bonuses are sustainable as a self-enforcing equilibrium. Such an upper constraint is related to both product market and labour market parameters. In detail, the higher a and the lower c (i.e., the higher the scale or size of the product market), the higher the upper constraint $\tilde{n}$. Moreover, the lower the disutility of effort v and the higher the frequency with which information on firms' misbehaviour flows in the labour market z, the higher $\tilde{n}$.[19] Finally, for the usual reasons, it also negatively depends on the discount rate r.

IV. Informal incentive schemes, competition and industry profits

Using previous results, in this section, we will explore how competition in the product market affects industry profits according to the incentive scheme firms use to motivate their workers.

By substituting (9), the equilibrium efficiency wage, in the firm's profit equation (8), we get:

$$\pi_{EW} = \frac{a^2}{(n+1)^2 c} - v\alpha. \tag{13}$$

[19] In particular, note that if $z \rightarrow 0$ (i.e., a firm's reputational mechanism does not work at all), the firm would never gain by sticking to the agreement even if the relationships were repeated over time. Hence there is no (positive) number of firms for which implicit self-enforcing contracts can be established.

Instead, with self-enforcing discretionary bonuses firm's profit is given by:

$$\pi_B = \begin{cases} \frac{a^2}{(n+1)^2 c} - v & \text{if } \ n \leq \tilde{n} \\ 0 & \text{if } \ n > \tilde{n}. \end{cases} \tag{14}$$

Furthermore, from (13) and (14), we can easily derive corresponding industry profits with the two alternative incentive schemes as, respectively:

$$\sum \pi_{EW} = n\pi_{EW} = \frac{na^2}{(n+1)^2 c} - nv\alpha \tag{15}$$

$$\sum \pi_B = n\pi_B = \begin{cases} \frac{na^2}{(n+1)^2 c} - nv & \text{if } \ n \leq \tilde{n} \\ 0 & \text{if } \ n > \tilde{n}. \end{cases} \tag{16}$$

Obviously, since both with efficiency wages and discretionary bonuses industry's total wage bill increases (and total revenues decrease) with n, industry profits always decrease when competition increases. Formally, by differentiating (15) and (16), respectively, with respect to n (and recalling from the proof of Result 1 that $\alpha + n\frac{\partial \alpha}{\partial n} > 0$; see Appendix A.3), it is easy to show that:

$$\frac{\partial \left(\sum \pi_{EW}\right)}{\partial n} = \frac{(1-n)a^2}{(n+1)^3 c} - v(\alpha + n\frac{\partial \alpha}{\partial n}) < 0 \tag{17}$$

$$\frac{\partial \left(\sum \pi_B\right)}{\partial n}\Big|_{n \leq \tilde{n}} = \frac{(1-n)a^2}{(n+1)^3 c} - v < 0 \tag{18}$$

and

$$\left| \frac{\partial \left(\sum \pi_{EW}\right)}{\partial n} \right| > \left| \frac{\partial \left(\sum \pi_B\right)}{\partial n}\Big|_{n \leq \tilde{n}} \right| \tag{19}$$

that is, as n increases, industry profits decrease more rapidly with efficiency wages than with discretionary bonuses. However, discretionary bonuses are not sustainable as soon as the number of competing firms exceeds $\tilde{n}$. Thus, there remains a possibility that, for some degree of product market competition, profits are higher with efficiency wages.

Figure 3 clarifies this issue in more detail: it describes industry profits behaviour, in relation to the number of firms competing in the market, with alternative incentive schemes (blue dashed lines for efficiency wages and red solid lines for discretionary bonuses). Indeed, since profits are always decreasing in n with efficiency wages, it can be argued that an upper threshold for n does exist also under such an incentive scheme; it corresponds to the value of n for which profits become zero.[20]

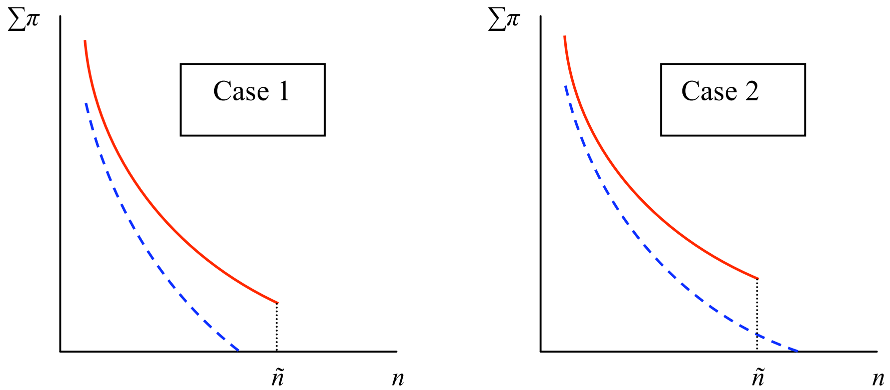

Figure 3: Incentive schemes, competition and industry profits

In Case 1 of Figure 3, industry profits with efficiency wages are already negative when n approaches $\tilde{n}$, that is, the upper bound for n with efficiency wages is lower than $\tilde{n}$. Hence, in such a case, there is no possibility for profits to be higher with efficiiency wages than with discretionary bonuses. By contrast, in Case 2, the upper bound for n with efficiency wages is higher than that with discretionary bonuses. Hence there exists a range, over and above $\tilde{n}$, for which firms can make positive profits by only paying efficiency wages.

Result 3 *If the rate z, with which firms' reputation flows in the labour market, is sufficiently low, the upper bound with efficiency*

[20]Due to the algebraic complexity of the equilibrium efficiency wage, this critical threshold is not easy to be defined. However, in what follows, we will provide a clear-cut procedure that permits to sharply relate such a threshold to the other one with bonuses.

wages is higher than that with discretionary bonuses. Hence, there exists a range of the number of competing firms, over and above $\tilde{n}$, for which firms can make positive profits by only paying efficiency wages.

Proof. See Appendix A.4. ■

In particular, in Appendix A.4 we show that for the critical threshold with efficiency wages to be larger than $\tilde{n}$ (which implies that there exists a range of n for which profits are higher with efficiency wages), the following condition must be satisfied:

$$z < \frac{r}{\tilde{\alpha} - 1} \tag{20}$$

where " ˜ " means that α is evaluated in $n = \tilde{n}$. This makes sense. Industry profits can be higher with efficiency wages only if they are positive when $n = \tilde{n}$. Taking into account that $\sum \pi_{EW}$ is (rapidly) decreasing in n, this can apply only if $\tilde{n}$ is sufficiently low, which occurs also if z is (relatively) low. Moreover, when firms pay efficiency wages, industry profits decrease with α (the term related to the wage rent). Hence, z should be relatively low with respect to a given threshold, negatively related to α computed for $n = \tilde{n}$. Also notice that the condition defined in (20) is always satisfied when $z \to 0$. This is because discretionary bonuses, in such a case, cannot be made self-enforcing. Instead, it is never satisfied for $z \to 1$, because $\tilde{n}$ becomes too high for the critical threshold with efficiency wages to be larger.[21]

V. Concluding comments

In this paper, the dynamic interaction between product market competition and incentives against shirking was analyzed in a framework where workers' effort is perfectly observable by firms, but is not

[21] In this regard, also note that the role of other parameters (particularly, of r) is not clear-cut, since their changes can generate both direct and indirect effects (e.g., increasing α and decreasing $\tilde{n}$ at the same time) that can act against one another.

verifiable by a third party (e.g., a court). Moreover, it was assumed that the probability of unemployed getting a job may depend on their employment histories and, more importantly, that such a possibility relates to the degree of market competition. In this context, the effects of two well-known incentive schemes, namely, efficiency wages and discretionary bonuses, were studied and compared.

In contrast with standard results, efficiency wages paid by each firm can decrease when competition (hence, employment) increases. Instead, when firms adopt discretionary bonuses, wages are uncorrelated with competition in the product market, but there exists an upper threshold for the number of competing firms, above which such contracts are not sustainable as a self-enforcing equilibrium. This is because each single firm's profit is too low to make its promise to pay the bonus credible. Moreover, although efficiency wages imply firms pay a rent to motivate their workers while discretionary bonuses do not, if the rate with which information about firms' cheating behaviour flows in the labour market is relatively low, there exists a range of the number of firms, over and above the critical threshold with bonuses, for which firms can make positive profits by only paying efficiency wages.

It is worth remarking some further implications deriving from the latter result. In particular, notice that when the upper bound with efficiency wages is lower than that with discretionary bonuses (i.e., Case 1 in Figure 3 of Section IV. applies), the latter represents the largest number of firms for which industry profits can be positive. As we remarked, this threshold is related to product market (as well as labour market) parameters. In particular, the larger the size of the market, the larger the critical number of firms for which profits can be positive. Although this statement is hardly breaking new ground, it is important to stress that with respect to the standard rationale, according to which the number of firms operating (efficiently) in a market is directly related to its size simply due to the presence of "demand constraints", we derived this result in quite a new fashion (which, in some sense, reinforces the standard rationale): when markets are thin, larger numbers of competing firms make implicit incentive contracts with discretionary bonus unsustainable as self-enforcing equilibria.

Instead, when the reverse (i.e., Case 2 represented in Figure 3 of Section IV.) applies, the threshold with bonuses represents a critical degree of product market competition, above which firms find it worth modifying the incentive scheme adopted to motivate their workers. More exactly, when the number of incumbent firms is equal to the threshold, a new firm can earn a positive profit by entering into the market, but only if it uses efficiency wages to elicit its worker's effort. Furthermore, the entry of the new firm also forces those already present in the market to change their incentive scheme, since discretionary bonuses become no longer sustainable as a self-enforcing equilibrium. Hence, in such a case, the profits of incumbent firms decrease for two different reasons: first, as usual, because increasing competition reduces their revenues; secondly, because it also increases their wages, due to the fact that it forces them to switch from a less costly to a more costly incentive wage contract (i.e., from bonus to efficiency wage).

Finally, notice that above considerations also open up to social welfare issues in relation to market entry by new firms which, however, fall outside the scope of this paper and are left for future research. Furthermore, even if empirically enucleating the effect of competition on wages via incentive schemes adopted by firms is a complex task, our results could also provide some important indications for new testable hypotheses on incentive contracts. For instance, they seem to suggest that, *ceteris paribus*, we would observe discretionary bonuses in industries with relatively low numbers of firms, while efficiency wages should emerge, in a time series view, when (in the same industries) competition becomes fiercer or, in a cross section view, in other industries characterized (at the same time) by a higher degree of competition.

Appendix

A.1 Derivation of equilibrium wages

Efficiency wages

Denoting with w_{EW} the (efficiency) wage paid by the firm and recalling that workers' decision about effort is perfectly observable by firms, hence a shirker is always fired at the end of the period, the expected discounted lifetime utilities for a shirker and for a non-shirker are given by, respectively:[22]

$$E_{EW}^{S} = \frac{w_{EW}}{1+r} + \frac{U^{S}}{1+r} \Leftrightarrow E_{EW}^{S} = \frac{w_{EW} + U^{S}}{1+r} \tag{A1}$$

$$E_{EW}^{NS} = \frac{w_{EW} - v}{1+r} + \frac{(1-s)E_{EW}^{NS}}{1+r} + \frac{sU^{NS}}{1+r} \Leftrightarrow E_{EW}^{NS} = \frac{w_{EW} - v + sU^{NS}}{r+s}. \tag{A2}$$

The worker will certainly shirk unless $E_{EW}^{NS} \geq E_{EW}^{S}$. Substituting for U^{S} and U^{NS} from (4) in (A1) and (A2), respectively, rearranging and solving for w_{EW}, we get the following "no-shirking condition" for the worker:

$$w_{EW} \geq v \left[\frac{(m+r)(1+\theta m+r)}{m+r-s(\theta m+r)} \right] \tag{A3}$$

which, in equilibrium, holds with equality because profit-maximizing firms pay the lowest wages consistent with it.

Discretionary bonuses

Since effort is perfectly observable, when firms adopt discretionary bonuses to motivate workers, a shirker never receives the bonus payment and is always fired at the end of the period.[23] Hence,

[22] In order to simplify algebra a little bit, we assume that payoffs of period t realize at the end of the period (see also the timing of events of Section II.C.). This, however, does not have any qualitative effect on the points that we make.

[23] The description of the game as well as of parties' strategies and equilibrium concept could be made more formally. However, we believe this would make analysis heavier without any important advantage both because it is standard in the literature (e.g., MacLeod and Malcomson 1989) and is unnecessary to our main purpose.

denoting with w_B the discretionary bonus, the expected discounted lifetime utilities of a shirker and a non-shirker are, respectively:

$$E_B^S = \frac{U^S}{1+r} \tag{A4}$$

$$E_B^{NS} = \frac{w_B - v}{1+r} + \frac{(1-s)E_{EW}^{NS}}{1+r} + \frac{sU^{NS}}{1+r} \Leftrightarrow E_B^{NS} = \frac{w_B - v + sU^{NS}}{r+s}. \tag{A5}$$

Clearly, workers will shirk unless $E_B^{NS} \geq E_B^S$. Solving for the bonus, we get the following incentive-compatibility condition for the worker:

$$w_B \geq v. \tag{A6}$$

Firms choose the lowest bonus compatible with (A6), which, in equilibrium, holds with equality.

Firms, however, must be able to credibly commit themselves to paying the bonus. Consider that workers play a trigger strategy. Thus, a (non-shirker) worker not receiving a promised bonus will decide to exert no effort for the firm in the future. However, since the firm's profit is negative when workers shirk, it is always better for a firm to end the employment relationship and looking for another applicant than let it continue with no effort by the worker in the future. But, according to the hypothesis about firms' reputation described in the main text, the possibility for a "cheating" firm to get another worker occurs at the rate $1 - z$.

Hence, the expected discounted profits for a "cheating" firm and for a "non-cheating" firm (that honestly pays the bonus) are, respectively:

$$\Pi^C = \frac{\pi + w_B}{1+r} + \frac{(1-z)\Pi^C}{1+r} \Leftrightarrow \Pi^C = \frac{\pi + w_B}{r+z} \tag{A7}$$

$$\Pi^{NC} = \frac{\pi}{1+r} + \frac{\Pi^{NC}}{1+r} \Leftrightarrow \Pi^{NC} = \frac{\pi}{r}. \tag{A8}$$

The firm cheats on the bonus payment unless $\Pi^{NC} \geq \Pi^C$. Solving for π, we obtain the following "no-cheating" condition for the firm:

$$\pi \geq \frac{rw_B}{z}. \tag{A9}$$

Finally, in order to define the aggregate condition that makes implicit agreements with bonus self-enforceable, we add (A6) to (A9) and, taking into account that the firm makes the lowest payments, we get:

$$\pi \geq \frac{rv}{z} \tag{A10}$$

which corresponds to (11) in the main text.

A.2 Proof of Lemma 1

Proof. By differentiating the efficiency wage $w_{EW} = v\alpha$ with respect to m yields:

$$\frac{\partial w_{EW}}{\partial m} = v\frac{\partial \alpha}{\partial m} \gtreqless 0 \Leftrightarrow \frac{\partial \alpha}{\partial m} \gtreqless 0 \tag{A11}$$

where

$$\frac{\partial \alpha}{\partial m} = \underbrace{\frac{\theta(m+r)\left[m+r-s(\theta m+r)\right]}{\left[m+r-s(\theta m+r)\right]^2}}_{\text{Shapiro-Stiglitz effect } (+)} \underbrace{-\frac{(1-\theta)rs(1+\theta m+r)}{\left[m+r-s(\theta m+r)\right]^2}}_{\text{reputation effect } (-)}. \tag{A12}$$

In particular, if $n \to \infty$, $\partial\alpha/\partial m > 0$. Instead, if $n = 1$, we have that $\partial\alpha/\partial m < 0$. Moreover, noting from (A12) that $\partial\alpha/\partial m$ is increasing in θ and taking into account, from Assumption 1, that θ is increasing in n, there will be a number of firms $\underline{n}^m \in (1, \infty)$ such that:

$$\frac{\partial w_{EW}}{\partial m} \lesseqgtr 0 \Leftrightarrow n \lesseqgtr \underline{n}^m. \tag{A13}$$

■

A.3 Proof of Result 1

Proof. By differentiating the efficiency wage $w_{EW} = v\alpha$ with respect to n yields:

$$\frac{\partial w_{EW}}{\partial n} = v\frac{\partial \alpha}{\partial n} \gtreqless 0 \Leftrightarrow \frac{\partial \alpha}{\partial n} \gtreqless 0 \tag{A14}$$

where:

$$\partial\alpha/\partial n =$$

$$\underbrace{\frac{\theta'(n)m(m+r)(m+r+s)}{[m+r-s(\theta m+r)]^2}}_{\underbrace{\theta'(n)\frac{\partial\alpha}{\partial\theta}}_{\text{changing }\theta\text{ effect}}} + \underbrace{\frac{\partial m}{\partial n}\Bigg[\underbrace{\frac{\theta(m+r)\,[m+r-s(\theta m+r)]}{[m+r-s(\theta m+r)]^2}}_{\text{standard Shapiro-Stiglitz effect}} - \underbrace{\frac{(1-\theta)rs(1+\theta m -}{[m+r-s(\theta m+}}_{\text{reputation effect}}}_{\underbrace{\frac{\partial m}{\partial n}\frac{\partial\alpha}{\partial m}}_{\text{changing }m\text{ effect}}} \tag{A15}$$

First of all, notice that, since $\theta'(n) > 0$, $\partial\alpha/\partial\theta > 0$ and $\partial m/\partial n > 0$, (A15) can be negative only if $\partial\alpha/\partial m < 0$. As shown in Section A.2, this can apply only if n is sufficiently low ($n < \underline{n}^m$). However, this is a necessary but not sufficient condition. Indeed, to be $\partial\alpha/\partial n < 0$, the following condition (with $\partial\alpha/\partial m < 0$) also needs to be satisfied:

$$\theta'(n)\frac{\partial\alpha}{\partial\theta} < \left|\frac{\partial m}{\partial n}\frac{\partial\alpha}{\partial m}\right|. \tag{A16}$$

To proof that, with efficiency wages, the industry total wage bill, $\sum w_{EW}$, always increases with n, recall that $\partial\left(\sum w_{EW}\right)/\partial n = v\left[\alpha + n(\partial\alpha/\partial n)\right]$, where $v\alpha$ is the wage paid by the marginal firm, while $nv(\partial\alpha/\partial n)$ is the total variation of wages paid by infra-marginal firms.

From (9) and (A15), we know that:

$$\alpha + n\frac{\partial\alpha}{\partial n} = \frac{(r+m)(1+\theta m+r)}{m+r-s(\theta m+r)} - \frac{n(1-\theta)\frac{\partial m}{\partial n}rs(1+\theta m+r)}{[m+r-s(\theta m+r)]^2} + n\Psi \tag{A17}$$

where $\Psi \equiv \frac{\theta'(n)m(m+r)(m+r+s)}{[m+r-s(\theta m+r)]^2} + \frac{\theta\frac{\partial m}{\partial n}(m+r)}{m+r-s(\theta m+r)} > 0$.

Using (5) and defining $\Omega \equiv \ell - (1-s)n > 0$, the r.h.s. of (A17) can be rewritten as:

$$\frac{1+\theta m+r}{[m+r-s(\theta m+r)]^2}\times \left[\left(\frac{r\Omega+sn}{\Omega}\right)\left(\frac{r\Omega(1-s)+sn(1-\theta s)}{\Omega}\right) - \frac{n(1-\theta)rs^2\ell}{\Omega^2}\right] + n\Psi \tag{A18}$$

which, with some tedious algebra (details available on request), becomes:

$$\frac{1+\theta m+r}{[m+r-s(\theta m+r)]^2}\times \left\{\frac{r\Omega\left[(r\Omega+sn)(1-s)+sn[r(1-s)(\ell-n)]\right]+s^2n^2\left[1+\theta r(1-s)-\theta s\right]}{\Omega^2}\right\} + n\Psi \tag{A19}$$

hence, $\partial\left(\sum w_{EW}\right)/\partial n = v\left[\alpha + n(\partial\alpha/\partial n)\right] > 0$, for any n. ■

A.3 Proof of Result 3

Proof. As discussed in the main text, industry profits can be higher with efficiency wages than with discretionary bonuses if (and only if), under efficiency wages, they are positive for $n = \tilde{n}$. By substituting for (12) in (15), and defining with $\tilde{\alpha}$ the corresponding wage rent term, we get:

$$\sum \pi_{EW}\big|_{n=\tilde{n}} = \tilde{n}\left\{\frac{a^2}{\left[\frac{a}{\sqrt{cv\left(\frac{r+z}{z}\right)}}\right]^2 c} - v\tilde{\alpha})\right\}. \tag{A20}$$

Using some algebra, (A20) becomes:

$$\sum \pi_{EW}|_{n=\tilde{n}} = \tilde{n}v\left(\frac{r+z}{z} - \tilde{\alpha}\right). \tag{A21}$$

which is strictly positive for:

$$z < \frac{r}{\tilde{\alpha}-1}. \tag{A22}$$

■

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