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ABSTRACT: In the dynamic model presented in the paper manufacturing and service firms coexist. They use labor inputs provided by households which buy both the manufactured good and the service. The latter may differ in its quality depending on the effort level of the firms' employees. Service firms must invest in reputation for quality. As the long-term equilibrium emerging in a competitive framework is characterized by unemployment, the imposition of a binding wage floor lowers employment in the service sector without affecting the employment level of the manufacturing sector: the wage differentials between the two sectors shrink and the quality level of the service improves, but unemployment increases. As the competitive solution leads the economy to a full-employment steady state, a binding but relatively low minimum wage may bring about a more equalitarian income distribution and upgrade the quality content of jobs in the service sector, without creating unemployment.

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INTRODUCTION

When the recent labor market performances of the US and continental Europe are compared, the difference in the employment rate, i.e., the proportion of the working-age population in employment, is even more striking than the differential in the unemployment rate.[1] What is more, the employment gap between the US and the EU depends in its entirety on service sector employment, since the proportion of the working-age population employed in manufacturing is the same in the two areas.[2] In the early 1970s, when differences in labor and product markets regulations and rigidities between the two sides of the Atlantic were just as marked as they are now, and when the structural process which is expanding the employment share of services at the expense of the manufacturing share was still in its initial stages in continental Europe,[3] labor markets performed slightly better in Europe than they did in the US. Therefore, one may plausibly conclude that institutions became relevant in differentiating labor

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[1] In 1997, the unemployment rate was 4.9 in the USA, 11.7 in Germany, 12.5 in France and 12.1 in Italy. In the same year, the employment rate was 73.5 in the USA, 63.5 in Germany, 58.8 in France and 50.5 in Italy.

[2] The share of the working-age population employed in manufacturing is 17.7 in the USA and 17.8 in the EU, while the share employed in services is 54.5 in the USA and 39.7 in the EU (see European Commission, 1999).

[3] On this process, see IMF (1997); Rowthorn and Ramaswamy (1999).

market outcomes when services replaced manufacturing as the major source of new jobs (see, Appelbaum and Schettak, 1994). On this view, the regulations and rigidities which restrict competition in the product and labor markets have hampered job creation in the services sector of continental Europe.

This paper focuses on the effects of wage compression on the sectoral distribution of employment and on aggregate employment. The model presented may shed light on how wage floors affect the relative size of the manufacturing and service sectors, the quality and price of services, and the overall employment rate. It is evident, in fact, that institutions like progressive taxation, centralized wage-setting, collective bargaining and minimum wage legislation tend to compress wage differentials (see Freeman, 1998; Blau and Kahn 1999), typically by bringing up the bottom of wage distribution. Furthermore, there is little doubt that these institutions are much more important in continental Europe than they are in the USA. In contrast with a controversial issue like the impact of minimum wage laws on aggregate employment,[4] it is widely accepted that wage setting institutions help explain the differences in factor allocation, output mix and relative

[4] Especially in the light of the debate begun by Card and Krueger (1995).

employment rates between continental Europe and the US. These differences the fact that the low-skilled have a higher employment/population ratio relative to the higher skilled in the US than they do in Europe,[5] or to the evidence showing that in European countries with low dispersion of earnings (relatively to the US) wage compression has shifted the industry distribution of employment away from industries with a low mean wage (see Davis and Henrekson, 2000). It is known that low wage workers are generally under-represented in manufacturing, and that sectors like trade, restaurants, hotels and personal services are typically those in which workers on or near the minimum wage are over-represented (see Dolado et al., 1996). Together with the fact that minimum wages (set by unions or by laws) are much more binding in Europe than in the US (see Dolado et al., 1996), this may also explain why the price level of the services sector is higher in Europe than in the US, although the latter have higher per-capita income (see Haffner et al., 1999), and why the production of certain services (meals, childcare and care for the elderly…) is more internalized within the family in many European countries than it is in the

[5] See Blau and Kahn (1996). Comparing Germany and the US, Freeman and Schettak (2000) find that even adjusting for the fact that German less skilled workers tend to be more skilled than American ones, the German distribution of wages is more compressed than the

US. Indeed, the relative abundance of low skilled workers in certain labor-intensive industries in the US yields a relatively large supply of low-quality services at cheap prices. Hence, it is not surprising that in these sectors productivity in the US is relatively low: a familiar trade-off between labor compensation and quality emerges.[6]

In this context, it is more appropriate to think of labor contracts as (explicitly or implicitly) multidimensional, so that a legally binding lower bound for one aspect of the contract (a minimum wage) is accommodated by adjustments to other aspects of the contract (see Leamer, 1999): wage compression can induce employers to upgrade productivity and the quality of jobs (see Davis, 1995). Unlike in manufacturing, where the equipment and technology in use often dictate a standardized level of attention, effort and skills for operating them, services based on a person-to-person relationship may vary widely in quality depending on the level of attention, care, effort and preparation of those who provide them. The nature of these

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American distribution, and disproportionately fewer low skill Germans than low skill Americans are employed.

[6] Gordon (1995) cites anecdotal evidence from Europe – the absence of grocery baggers in stores or bus-boys in restaurants – to support the hypothesis that labor market institutions like binding minimum wages explain why there are more low-wage workers in the US, and hence service sector productivity in the US is relatively low. About 20 per cent of the US working population is employed in low-skill jobs compared with 13 per cent in the EU (see European Commission, 1999).

jobs is better captured by thinking of this market as offering "a set of wage-effort contracts with higher daily wages offsetting the disutility of higher effort" (Leamer, p.1128).

A proper modelling of the functioning of product markets in services sector where quality is important and can vary depending on the workers' effort requires account to be taken of the informational asymmetry typically characterizing the relationship between the customer demanding the service and the firm providing it. This is captured here by assuming that firms operating in the services sector invest in enhancing their reputation for quality, which like all other types of investment is sensitive to changes in the discount rate.

The paper is organized as follows. Section 1 presents the model. Section 2 is devoted to deriving the optimizing behavior of agents. Section 3 characterizes the equilibrium paths of the economy. Section 4 compares the steady states of this economy that emerge when wages are determined in a purely competitive way against the steady states emerging in the presence of a binding minimum wage. Section 5 contains a brief summary of the main results of the paper and discusses a possible extension.

1 THE MODEL

Let us consider an economy in discrete time with a constant population of identical individuals--whose large number is normalized to be one--which consume both a manufactured good x_t and a service which may differ with respect to its quality q_t. The manufactured good is homogeneous and is produced by a large number of perfectly competitive firms. Similarly, there is a large number of firms which provide the service, whose quality depends on the effort and care of their employees.

The manufacturing firms

The large number of firms producing the homogeneous consumer good x_t is normalized to be one. They produce according to the technology

$$x_t = S_t^{\xi}, 0 < \xi < 1, \tag{1}$$

where S_t are the workers employed in period t by the representative firm producing the consumer good. Since production is standardized, it requires a fixed level of effort e_t=ê by any single worker. In each t the representative firm chooses its labor input in order to maximize its profit:

$$\pi_t^m = S_t^{\xi} - S_t w_t, \tag{2}$$

where w_t is the real wage paid to the firm's employees. Note that x_t is not storable and is taken to be the numéraire of this economy.

The service-producing firms

Also the large number of firms producing the consumer service is normalized to be one. The units of the service that a firm provides in period t, N_t, depend on the number of workers employed by the firm in that period, L_t:

$$N_t = L_t^{\zeta}, 0 < \zeta < 1. \tag{3}$$

The quality of the service provided by the firm in period t, q_t, depends on the effort level e_t of its employees in that period:

$$q_t = e_t. \tag{4}$$

Being the workers' effort perfectly observable, the representative firm makes pay contingent on the observed effort level:

$$v_t = v(e_t), \tag{5}$$

where v_t is the wage paid by the firm to its employees in period t if their observed effort level in that period is e_t.

In each t an individual buys the service that s/he wishes to consume from one single producer, which amounts to saying that in each period the consumer selects a unique (perceived) quality level for the service that s/he wishes to buy. Consumers cannot observe q_t ex ante (before they have purchased the service), and they know that the quality of the service may vary across firms and time. On the other hand, they are informed ex post about the quality of the service provided by each firm. In particular, the perceived quality of the service supplied in period t by a firm, q^e_t, is based on its reputation, which depends on its past performances in terms of quality:

$$q^e_t = \chi q^e_{t-1} + (1-\chi)q_{t-1},\ 0 < \chi < 1,\ q^e_0 \text{ given,} \tag{6}$$

where we assume for simplicity that χ =.5. Moreover, note that (6) entails both $q^e_t = q^e_{t-1}$ if $q^e_{t-i} = q_{t-1}$ and $\lim_{t\to\infty} q^e_t = q^\bullet$ if $q_t = q^\bullet$ $\forall t > 0$. In other words, a firm's reputation and the consumers' estimates of the quality of its service do not change if the quality level observed in the current period confirms what the consumers expected; and this reputation tends asymptotically to be equal to the observed level of quality if the latter remains constant forever, whatever the initial firm's reputation may be.

The price that a firm can charge for each unit of service depends on its reputation for quality:

$$p_t = p(q^e_t), \tag{7}$$

where the "hedonic" function $p(q^e_t)$ is given to any single firm.

Thus, the period profit function of a service-producing firm is:

$$\pi^s_t = p(q^e_t)L^\varsigma_t - v_t L_t. \tag{8}$$

In each period, a firm chooses its wage and labor policy in order to maximize its value, i.e. its discounted sequence of profits:

$$\max_{v_t, L_t} \sum_{j=0}^{\infty} \theta^j \pi^s_{t+j},\ 0 < \theta < 1, \tag{9}$$

subject to (3)-(8).

<u>Individuals as consumers and workers</u>

If y_t is the total income of an individual in period t, we have:

$$y_t \geq x_t + p(q^e_t)N_t, \tag{10}$$

where the hedonic function $p(q^e_t)$ is given to any single consumer.

The period utility that an individual obtains by consuming the service is separable between the units N_t and the quality q_t of the service that s/he buys:

$$g(N_t, q_t) = N^{\alpha}_t + q^{\beta}_t, 0 < \alpha < 1, 0 < \beta < 1. \tag{11}$$

Separability is assumed in (11) in order to simplify the analysis, in the light of the fact that both opposite cases can be plausible: the case in which the increment in utility obtainable by consuming an additional unit of the service is larger when the quality of the service is relatively low (quantity tends to substitute for quality), and the case in which consuming more units has a larger impact on utility when the quality of the service is high (quantity and quality tend to be complement).

The household's total income is given by

$$y_t = h_t + d_t, \tag{12}$$

where h_t is the household's labor income and d_t is the household's share of the firms' total profits in period t. The household's labor income is given by:

$$h_t = \begin{cases} 0 & \text{if the individual is not employed} \\ w_t & \text{if the individual works in a manufacturing firm} \\ v_t = v(e_t) & \text{if the individual works with effort } e_t \text{ in a service-producing firm.} \end{cases} \quad (13)$$

For simplicity and without loss of generality, we assume that all households receive an equal share of the firms' profits:

$$d_t = \pi_t^m + \pi_t^s. \quad (14)$$

An individual has a period utility function that is quasi-linear:

$$u_t = x_t - f(e_t) + g(N_t, q_t) \quad (15)$$

where $f(e_t)$, which captures the disutility of being employed in a firm instead of staying at home, gives the minimum wage for which an individual is willing to work at an effort level e_t:

$$f(e_t) = \begin{cases} 0 \text{ if the individual is not employed } (e_t = 0) & (16) \\ \eta \hat{e}^{\gamma} \text{ if the individual works in a manufacturing firm } (e_t = \hat{e}), \eta > 0, \gamma \geq 1 \\ \eta e_t^{\gamma} \text{ if the individual works with effort } e_t \text{ in a service-producing firm.} \end{cases}$$

The problem that the an individual has to solve in each t is the following:

$$\max_{q_t, N_t, e_t} u_t, \quad (17)$$

subject to the information asymmetry implying that a firm's reputation for quality q_t^e signals the "true" level of quality embodied in the service offered by that firm, and subject to the period budget constraint (10).

The utility function implies implicitely that the service satisfies a basic need. Even if some household is unemployed in t, s/he receives a share of the firms' profits (thanks to his/her property rights or to a redistributive policy), which allows him/her to devote any additional income to increasing his/her consumption of x_t: for all households and in all periods, the demand for the service is independent of the level of income and the consumption of x_t is strictly positive.

It follows straightforwardly from (10)-(17) that the necessary conditions for inducing an individual to work in a manufacturing firm or in a service-producing firm with an effort level e_t are, respectively,

$$w_t - \eta \hat{e}^{\gamma} \geq 0, \quad (18a)$$

and

$$v(e_t) - \eta e_t^{\gamma} \geq 0, \quad (18b)$$

where the optimal effort level of the worker depends on the incentive wage scheme of the firm.

Legislation or union activity establishes a wage level below which no firm is allowed to pay its employees. Thus,

$$m \leq w_t, \forall t, 0 < m < \eta \hat{e}^{\gamma}, \quad (19a)$$

and

$m \leq v_t, \forall t,$ (19b)

where m is the minimum wage that is legally enforced. Considering (18a) and (19a), one sees that m is never binding in the manufacturing sector, since it is assumed to be lower than the level below which no worker is willing to work in a manifacturing firm. The sole purpose of this assumption is to focus the analysis on the cases that are probably more relevant from an empirical viewpoint, since it is primarily as regards as some low-quality jobs of the service sector that market forces tend to push pay below the legally binding minimum wage.

Market equilibrium conditions

Assuming perfect labor mobility between the manufacturing and the service segments of the labor market, equilibrium in the labor market requires

$$w_t - \eta \hat{e}^{\gamma} = v(e_t) - \eta e_t^{\gamma}. \quad (20)$$

If $w_t - \eta \hat{e}^{\gamma} = v_t - \eta e_t^{\gamma} > 0$, each household strictly prefers working rather than remaining at home, and the equilibrium is necessarily characterized by full employment. Indeed, if there are unemployed workers, they exert downward pressure on the wages in both labor markets, and they raise the effort that the workers are willing to make in the service sector for any given pay level, up to the point at which $w_t - \eta \hat{e}^{\gamma} = v_t - \eta e_t^{\gamma} = 0$. Therefore, the presence of unemployment implies that at equilibrium $w_t - \eta \hat{e}^{\gamma} = v(e_t) - \eta e_t^{\gamma} = 0$: an unemployment equilibrium ($S_t + L_t < 1$) is a situation in which the optimizing firms do not create enough jobs to employ the entire workforce even if the employed workers do not receive any rent. Note that, in the presence of full employment, a marginal improvement of working conditions in the manufacturing sector (lower $\hat{e}$) tends to exert upward pressure on the monetary compensation necessary to induce the workers of the service sector to work at any given level of effort.

At equilibrium, supply and demand of the manufactured good must be equal:

$$x_t^s = x_t^d. \tag{21}$$

The equilibrium price of the service $p_t = p(q_t^e)$ must be such that at that price both the units of the service supplied are equal to the units demanded and the reputation for quality of the service-producing firms is equal to the quality level demanded by the representative consumer:

$$N_t^s = N_t^d, \tag{22}$$

and

$$q_t^e = q_t^d. \tag{23}$$

2 THE OPTIMIZING BEHAVIOR OF THE AGENTS

<u>Households</u>

Maximizing (17), we obtain the conditions that the consumers' demand for the service must satisfy for optimality:

$$p(q_t^e) = \alpha N_t^{\alpha-1} \quad (24a)$$

and

$$p'(q_t^e) N_t = \beta q_t^{\beta-1}, \quad (24b)$$

and the condition that the effort level of a household must satisfy if s/he works in a service-producing firm:

$$v'(e_t) = \gamma\eta e_t^{\gamma-1}. \quad (24c)$$

It is evident that the rule applied by an optimizing household to decide whether to work and--possibly--in what type of firm to work produces the conditions (18) and (20).

Equation (24a) states that for optimality the price charged for one additional unit of the service characterized by the (perceived) quality level desired by the consumer must be equal to the marginal increase in utility obtainable with this additional consumption. Equation (24b) establishes that--along an optimal path--the increment in expenditure that a consumer is willing to undertake for a marginal improvement in the (perceived) quality of the units of the service that s/he intends to buy must be equal to the additional utility brough about by this improvement. Finally, equation (24c) states that the optimal level of effort of a worker employed in a service-producing firm must be such that a marginal increment in the effort level causes an increase in disutility equal to the increase in pay that the worker is able to receive thanks to this additional effort.

Manufacturing firms

For optimality, the manufacturing firms equalize the value of the marginal productivity of labor to the market wage:

$$\xi S_t^{\xi\text{-}1} = w_t . \qquad (25a)$$

From this condition one can easily obtain the optimal demand for labor of the manufacturing firms:

$$S_t = S(w_t) = \left(\frac{\xi}{w_t}\right)^{1/(1-\xi)} . \qquad (25b)$$

Service-producing firms

Maximizing the Hamiltonian

$$H=\sum_{t=0}^{\infty}\theta^t \left\{ p(q_t^e)L_t^{\zeta} - v(e_t)L_t - \lambda_t \left[q_{t+1}^e - \frac{(e_t + q_t^e)}{2} \right] + \rho_t [v(e_t) - m] \right\}$$ with

respect to L_t, e_t and q_{t+1}^e, and eliminating the multiplier λ_t, we obtain the following conditions that an optimal path must satisfy:

$$\zeta p(q_t^e)L_t^{\zeta\text{-}1} = v(e_t), \qquad (26a)$$

$$(L_t - \rho_t)v'(e_t) = \frac{\theta L_{t+1}^{\zeta} p'(q_{t+1}^e) + \theta(L_{t+1} - \rho_{t+1})v'(e_{t+1})}{2}, \qquad (26b)$$

where $v(e_t) > m$ entails $\rho_t = 0$.

An optimal path must also satisfy equation (6) and the transversality condition

$$\lim_{t\to\infty}\theta^t 2L_t v'(e_t)q_t^e = 0. \qquad (26c)$$

Finally, the optimal wage scheme (the optimal labor contract) of the service-producing firm must satisfy (20), taking into account that optimal workers' behavior entails (18b) and (24c).

Condition (26a) equalizes the value of the marginal productivity of labor at the optimal effort level to the wage that must be paid to generate that level of effort. Condition (26b) captures the intertemporal trade-off that the firm has to face, while (26c) states that along an optimal path the current value of the firm must converge to a finite quantity.

According to (26b) and (26c), along an optimal path which is not affected by the existence of the statutory minimum wage $(v(\mathrm{e}_t) > \mathrm{m}$ entailing $\rho_t = 0$), the additional labor cost incurred in the current period by the firm in order marginally to improve the quality of all the units produced must be equal to the discounted increment in future revenues due to the higher prices that it will be able to charge on all the units of its service thanks to its improved reputation. In other words, its reputation for quality can be considered to be the only asset owned by a firm, and along an optimal path the current value of this asset must be equal to the discounted sequence of additional revenues that the firm can get by a marginal improvement of its reputation.

In contrast, along an optimal path which is affected by the existence of the statutory minimum wage, $v(\mathrm{e}_t) = \mathrm{m}$ and ρ_t can be different from zero to capture the forced deviation of the wage policy from the strategy that would be optimal in the absence of a tight constraint.

3 THE EQUILIBRIUM PATHS

Manufacturing sector

The presence of unemployment in period t implies that the wage at which the manufacturing firms would employ all the workers who do not work in a service-producing firm is strictly below the minimum wage at which a worker is willing to work in a manifacturing firm: even at $w_t = \eta \hat{e}^{\gamma}$ some worker remains unemployed. Thus, in the presence of unemployment, the employment level of the manufacturing sector must be such that

$$S_t = S = \left(\frac{\xi}{w}\right)^{1/(1-\xi)} < 1 - L_t, \qquad (27)$$

where we have used the optimal labor demand (25b), and where

$$w_t = w = \eta \hat{e}^{\gamma}. \qquad (28)$$

The presence of full employment in period t implies that the wage at which the manufacturing firms are induced to employ all the workers who do not work in a service-producing firm is larger than or equal to the minimum wage at which a worker is willing to work in a manifacturing firm. Thus,

$$S_t = \left(\frac{\xi}{w_t}\right)^{1/(1-\xi)} = 1 - L_t, \qquad (29)$$

from which we obtain that

$$w_t = w(L_t) = \xi(1 - L_t)^{1-\xi} \geq \eta \hat{e}^{\gamma}. \qquad (30)$$

Note that the wage that clears the labor market of the manufacturing sector in a full-employment equilibrium increases with the employment level of the service sector. Indeed, the labor supply of the manufacturing sector shrinks as more people are employed in the service sector, thus exerting an upward pressure on w_t.

<u>The dynamics as the existence of m does not affect the equilibrium path (competitive solution)</u>

As the minimum wage is never binding, equations (4), (6), (20), (24), (26), (28) and (30) can be used to obtain the system of difference equations in L_t and q_t^e governing the equilibrium path of the economy:

$$\Phi(L_t, L_{t+1}, q_{t+1}^e) = \gamma\eta L_t(f(L_t))^{\gamma-1} - \frac{\theta\beta(q_{t+1}^e)^{\beta-1}}{2} - \frac{\theta\gamma\eta L_{t+1}(f(L_{t+1}))^{\gamma-1}}{2} = 0, \quad (31a)$$

$$\Psi(L_t, q_{t+1}^e, q_t^e) = q_{t+1}^e - \frac{\left(q_t^e + f(L_t)\right)}{2} = 0, \quad (31b)$$

where

$$f(L_t) = e_t = \begin{cases} \left(\dfrac{v(L_t) - w(L_t)}{\eta} + \hat{e}^{\gamma}\right)^{1/\gamma} & \text{if there is full employment} \\ \left(\dfrac{v(L_t)}{\eta}\right)^{1/\gamma} & \text{if there is unemployment} \end{cases} \quad (31c)$$

and

$$v(L_t) = v_t = \alpha\zeta L_t^{\alpha\zeta-1}. \quad (31d)$$

Apparent in (31) is the negative relationship linking the employment level of the service sector and the effort level of the workers (and thus, the quality level of the service) along an equilibrium path. Moreover, no link exists between the manufacturing sector and the service sector in the presence of unemployment. In contrast, in the presence of full employment, both the effort level and the wage rate prevailing in the service sector depend on the conditions of the labor market in the manufacturing sector, which in their turn are affected by L_t: since $v_t - \xi(1 - L_t)^{\xi - 1} + \eta\hat{e}^{\gamma} = \eta e_t^{\gamma}$, the optimal wage scheme must offer higher pay for any effort level as employment in the service sector increases. A similar effect is produced by a reduction of the (standardized) disutility of working in a manifacturing firm (lower $\hat{e}$): in the presence of full employment, an improvement in the working conditions in the manufacturing sector tends to increase the monetary compensation that is necessary to induce the workers of the service sector to provide a given level of effort.

The dynamics as the existence of m affects the equilibrium path

If m is binding, one has:

$$L_t = L = L(m) = \left(\frac{\alpha\zeta}{m}\right)^{1/(1-\alpha\zeta)} \tag{32a}$$

and

$$q_{t+1}^{e} = \frac{q_t^{e} + r(m)}{2}, \tag{32b}$$

where

$$r(\mathrm{m}) = \mathrm{e_t} = \mathrm{e} = \begin{cases} \left(\dfrac{\mathrm{m} - \mathrm{w(L(m))}}{\eta} + \hat{\mathrm{e}}^{\gamma}\right)^{1/\gamma} & \text{if there is full employment} \\ \left(\dfrac{\mathrm{m}}{\eta}\right)^{1/\gamma} & \text{if there is unemployment} \end{cases} \qquad (32c)$$

and

$$\mathrm{v_t}=\mathrm{v}=\mathrm{m}. \qquad (32d)$$

It is not surprising that in (32a) an increase in m lowers the employment level of the service sector. However, if m<m'', where $\mathrm{m''} = m''(\alpha,\gamma,\eta,\xi,\zeta,\hat{\mathrm{e}})$ is the maximum value of m that is consistent with a full-employment equilibrium,[7] a marginal increment in m leads to a fall in $\mathrm{w_t}$ and to an increase in the employment level of the manufacturing sector, which leaves aggregate employment unchanged at its full-employment equilibrium. If this is not the case (m>m''), a higher m shrinks the employed workforce, since the manufacturing sector cannot absorb the workers left unemployed by the service sector.

Moreover, it is worth noting in (32c) that a larger m leads to a higher effort level and improves the quality of the service produced by the firms. Indeed, in an equilibrium with unemployment, the pressure exerted by the

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[7] In other words, m'' is that value of m satisfying

$$\mathrm{S} + \mathrm{L} = \left(\frac{\xi}{\eta\hat{\mathrm{e}}^{\gamma}}\right)^{1/(1-\xi)} + \left(\frac{\alpha\zeta}{\mathrm{m}}\right)^{1/(1-\alpha\zeta)} = 1.$$

unemployed workers induces the households to accept a wage scheme linking m to that effort level which makes an individual indifferent as to working or staying at home. Therefore, corresponding to a larger m is a higher e. In a full-employment equilibrium, the positive effect of a larger m on the effort level is magnified by the fact that the equilibrium w tends to decline, thus making it less convenient to work in a manifacturing firm and inducing the workers to accept worst working conditions in the service sector for a marginally larger m.

4 STEADY-STATE ANALYSIS

The steady states as the existence of m does not affect the equilibrium path

By setting $L = L_{t+1} = L_t$ and $q^e = q^e_{t+1} = q^e_t$, one can solve (31) for the steady states of this economy as the statutory minimum wage does not influence the equilibrium path (competitive solution).

In a steady state characterized by unemployment we have:

$$\overline{q}^e = \overline{q} = \overline{e} = \overline{e}(\theta, \eta, \beta, \gamma, \zeta), \ \overline{e}_\theta < 0, \ \overline{e}_\eta < 0 \quad (33a)$$ [8]

(the bar "$^{-}$" denotes the value of a variable evaluated at a steady state in which there is unemployment and m is not binding),

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[8] $\overline{e}(\theta, \eta, .) = \left[\frac{\alpha\zeta}{\eta^{\alpha\zeta}} \left(\frac{\gamma(2-\theta)}{\theta\beta} \right)^{1-\alpha\zeta} \right]^{\frac{1}{\alpha\gamma\zeta + (1-\alpha\zeta)\beta}}$.

$$\overline{\mathrm{L}} = \left(\frac{\alpha\zeta}{\eta\bar{\mathrm{e}}^{\gamma}}\right)^{1/(1-\alpha\zeta)}, \quad (33b)$$

$$\bar{\mathrm{v}} = \eta\bar{\mathrm{e}}^{\gamma} \quad (33c)$$

and (27)-(28). This steady state characterized by unemployment exists if and only if $\bar{\mathrm{v}} > \mathrm{m}$ and $\hat{\mathrm{e}} > \hat{\mathrm{e}}_{\min}$, where $\hat{\mathrm{e}}_{\min} = \bar{e}(\alpha,\beta,\theta,\gamma,\eta,\xi,\zeta)$ is that value of $\hat{\mathrm{e}}$ satisfying $\mathrm{S} + \overline{\mathrm{L}} = \left(\frac{\xi}{\eta\hat{\mathrm{e}}^{\gamma}}\right)^{1/(1-\xi)} + \left(\frac{\alpha\zeta}{\eta\bar{\mathrm{e}}^{\gamma}}\right)^{1/(1-\alpha\zeta)} = 1$ (if $\hat{\mathrm{e}} = \hat{\mathrm{e}}_{\min}$, there is full employment). In other words, in an economy in which the statutory minimum wage has no effect on the equilibrium path, the existence of structural unemployment (i.e., the existence of a steady state with unemployment) is due to the fact that it not profitable for the service-producing firms to absorb all the workers left unemployed by the manufacturing firms. Indeed, the wage required by the households to work in a manufacturing firm is too high (relatively to the values of the other structural parameters of the economy) to be consistent with full employment.

It is easy to check that $\bar{e}_{\theta} > 0$: one can see in (33) that, as the agents discount the future less heavily because of a lower interest rate ($\theta \uparrow$), the steady-state level of the effort (and the steady-state level of the quality of the service) decreases, thus increasing the steady-state level of employment. A lower discount rate raises the threshold which the wage paid in the manufacturing sector cannot exceed without creating structural unemployment. In fact, as the future increments in firms' profits resulting from an additional investment in quality are discounted less heavily, firms tend to invest up to a point at which the marginal cost of their investment is higher. This is achieved by enlarging the workforce to which a current marginal increase in pay can apply. This effect dominates the reduction in the marginal cost of a quality improvement due to the lower level of quality at which the firms operate. As a result, a larger θ brings about a larger steady-state level of employment and activity in the service sector (number of units produced), associated with a lower quality and effort level and with a lower price of the service. As the same effort level is associated with more disutility $(\eta \uparrow)$, $\bar{e}_\eta < 0$: we have in (33) that both the steady-state level of employment and the effort level in the service sector decline. Considering (27)-(28), it is apparent that a larger η has a depressive impact on total steady-state employment also because it raises the minimum wage below which no worker is willing to work in a manifacturing firm (note that a similar effect on S is caused by an increase in ê).

One can check that the system obtained by linearizing (31) around its steady state (33) exhibits saddle-path stability:[9] the linearized system characterizes a unique path converging to the steady state with unemployment.[10]

If the statutory minimum wage is not binding and $\hat{e}<\hat{e}_{min}$, a steady state characterized by unemployment cannot exist because the wage required by the households to work in a manifacturing firm is low enough (relatively to the values of the other structural parameters of the economy) to eliminate unemployment. In this case, there exists a full-employment steady state, which must satisfy the following system:

$$q^e = q = e(L) = e\,, \tag{34a}$$

$$n(L) = \hat{e}\,, \tag{34b}$$

---

9 The characteristic equation of the linearized system is the following: $\lambda^2 - \left\{\frac{2}{\theta} + \frac{1}{2} - \frac{(2-\theta)(1-\beta)(1-\alpha\zeta)}{2\theta\left[1+\alpha\zeta(\gamma-1)\right]}\right\}\lambda + \frac{1}{\theta} = 0$, where λ_1 and λ_2, which are the characteristic roots, are such that $\lambda_1 > 1$ and $0 < \lambda_2 < 1$. For instance, let $\zeta = .8$, $\alpha = \beta = .5,\ \gamma = \eta = 1,$ and $\theta = .9$: one has $\bar{e} = .581, \bar{L} = .5366,\ \lambda_1 = 1.9768$ and $\lambda_2 = .562.$

10 If $\hat{e} > \hat{e}_{min}$, which is a necessary condition for the existence of a steady state with unemployment, also a full-employment steady state exists: the existence of the steady state with unemployment characterized by (33) entails the existence of a full-employment steady state which is locally unstable (see the appendix). Since the economy tends to move away from this full-employment steady state existing when $\hat{e} > \hat{e}_{min}$, we can ignore it.

$v(L) = v = \alpha\zeta L^{\alpha\zeta-1} > m$ (34c)

and

$S=1-L,$ (34d)

where

$$e(L) = e = \left[\frac{\beta\theta}{(2-\theta)\gamma\eta L}\right]^{1/(\gamma-\beta)},\ n(L) = \left[\frac{\eta(e(L))^{\gamma} - v(L) + w(L)}{\eta}\right]^{1/\gamma}, \text{ and}$$

$$w(L) = w = \xi(1-L)^{\xi-1}.$$

If $\hat{e}<\hat{e}_{min}$, one can show that under general conditions the system obtained by linearizing (31) around $(\tilde{q}, \tilde{q}^e, \tilde{e}, \tilde{L}, \tilde{v})$ ("$\sim$" denotes the value of a variable evaluated at the full-employment steady state characterized by (34)) is saddle-path stable (see the appendix).

<u>The steady states as the existence of m affects the equilibrium path</u>

If the statutory minimum wage m is binding ($m>\bar{v}$), an economy structurally similar to the economy whose steady state exhibits unemployment, i.e., an economy having values of α, β, γ, η, θ, ξ, ζ and $\hat{e}$ consistent (in the absence of institutional constraints) with the existence of (33), converges to a steady state characterized by

$$q^{e*} = q^* = e^* = \left(\frac{m}{\eta}\right)^{1/\gamma}, \tag{35}$$

(27)-(28), (32a) and (32d) ("*" denotes the value of a variable evaluated at a steady state in which there is unemployment and m is binding). Inspection of equation (32b), immediately shows that (32) is dynamically stable.

Similarly, if the statutory minimum wage m is such that $\tilde{v} < m \leq m''$, an economy structurally similar to the economy with a (full-employment) steady state satisfying (34) converges monotonically to the full-employment steady state characterized by

$$q^{e\circ} = q^\circ = e^\circ = \left(\frac{m - w(L(m))}{\eta} + \hat{e}^{\gamma}\right)^{1/\gamma}, \tag{36a}$$

$$S^\circ = 1 - L(m), \tag{36b}$$

(32a) and (32d) ("°" denotes the value of a variable evaluated at a full employment steady state in which m is binding).

If the statutory minimum wage is strictly larger than m”, an economy structurally similar to the economy characterized by the full-employment steady state (34) converges monotonically to the steady state with unemployment given by (35).

Comparison between the steady-state levels of employment, pay and quality

Let us take an economy whose steady state is given by (33): the structural characteristics of this economy (its parameters' values) are such that its long-term equilibrium exhibits unemployement even if the statutory minimum wage is relatively low and is not binding. Suppose now that--other things remaining equal--m is increased up to a point where $m > \bar{v}$, the intention being to reduce wage dispersion. The end result will be an increase in aggregate unemployment due to a fall in the employment level of the service sector that does not affect the number of workers employed in the manufacturing sector: $L^* < \bar{L}$ and $S^* = \bar{S}$. However, the wage differential between the two sectors shrinks and the quality level of the service improves: $\bar{w} - \bar{v} > w^* - v^*$[11] and $\bar{e} = \bar{q} < e^* = q^*$, where $\bar{w} = w^*$ and $v^* = m$. In other words, in the service sector we end up with fewer and better paid jobs of higher quality.

Let us now take an economy in the full-employment steady state characterized by (34) (m is not binding). If m is increased up to a point where

[11] Typically, we can have an increase of the average wage of the employed workers.

$\tilde{v}$<m<m”, full employment is preserved, but with a different employment composition, since $L° < \tilde{L}$ and $S° > \tilde{S}$. The increased share of the manufacturing sector on total employment is accompanied by a reduction in the wage differential between the two sectors ($\tilde{w} > w°$ and $\tilde{v} < v°$, where v°=m) and by an improvement in the quality content of the jobs in the service sector ($\tilde{e} = \tilde{q} < e° = q°$). However, if m is increased up to a point where m>m”, the manufacturing sector cannot entirely compensate the job losses occurring in the service sector and unemployment is created: $L^* < \tilde{L}$ and $S^* < \tilde{S}$, where L*+S*<1. Again, an upgrading of the service quality occurs $(\tilde{e} = \tilde{q} < e^* = q^*)$.

5 CONCLUSIONS

We have compared the long-term equilibria emerging in a purely competitive framework to the steady states emerging when a minimum wage is binding in the service sector.

As the competitive solution is associated with the presence of structural unemployment, the imposition of of a binding minimum wage raises aggregate unemployment by lowering the employment level of the service sector without affecting the employment level of the manufacturing sector. In this case, the wage differential between the two sectors shrinks and the quality level of the service improves.

As the competitive solution leads the economy to a full-employment steady state, both a minimum wage that is binding but relatively low can be imposed and full employment can be preserved. In this case, the share of the manufacturing sector on total employment increases while the service sector shrinks. Moreover, the wage differential between the two sectors is reduced and the quality of the service improves. In other words, a more egalitarian income distribution and an upgrading of the quality content of the jobs in the service sector are obtained at no cost in terms of increased unemployment. However, if the minimum wage becomes too high, unemployment tends to emerge since the manufacturing sector does not absorb all the workers who cannot find jobs in the service sector.

An interesting extension of the model presented here is to allow for capital accumulation and differences in productivity growth between the two sectors, with the service sector lagging behind in terms of productivity advances.

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APPENDIX

1 <u>Proof that the existence of a steady state with unemployment entails the existence of a full-employment steady state that is locally unstable</u>

In order to verify that the existence of a steady state with unemployment implies necessarily the existence of a full-employmnent steady state as the economy is governed by (31), consider that: i) the steady-state value of the workforce employed in the service sector given by (33b), $\overline{\mathrm{L}}$, is that value of L satisfying $\eta(\mathrm{e(L)})^{\gamma} = \mathrm{v(L)}$; ii) $\eta(\mathrm{e(L)})^{\gamma}$ - v(L) >0 for L< $\overline{\mathrm{L}}$ and $\eta(\mathrm{e(L)})^{\gamma}$ - v(L) <0 for L> $\overline{\mathrm{L}}$; iii) a steady state with unemployment exists if and only if $\hat{\mathrm{e}} > \hat{\mathrm{e}}_{\min}$, where $\hat{\mathrm{e}}_{\min}$ is that value of $\hat{\mathrm{e}}$ such that $n(\overline{\mathrm{L}}) = \hat{\mathrm{e}}$, and iv) the function n(L) is continuous in L for $\mathrm{L} \geq \overline{\mathrm{L}}$ and is such that $\lim\limits_{\mathrm{L}\to 1} n(\mathrm{L}) \to \infty$.

Together with the participation condition (18b), i) and ii) imply that in a full-employment steady state the employment level of the service sector, $\tilde{\mathrm{L}}$, must be such that $\tilde{\mathrm{L}} \geq \overline{\mathrm{L}}$, while iii) and iv) imply that for any finite value of $\hat{\mathrm{e}} > \hat{\mathrm{e}}_{\min}$ there exists a value L<1 satisfying (34). Therefore, we can conclude considering iii) that, if there is a steady state with unemployment, then there exists also $\tilde{\mathrm{L}}$ satisfying (34) such that $\tilde{\mathrm{L}} > \overline{\mathrm{L}}$.

The characteristic equation of the system obtained by linearizing (31) around the (full-employment) steady state satisfying (34) is the following:

$$\lambda^2 - \left\{ \frac{2}{\theta} + \frac{1}{2} + \frac{(1-\beta)\beta\tilde{\mathrm{e}}^{\beta\text{-}2} \left.\dfrac{df(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\tilde{\mathrm{L}}}}{2\gamma\eta\left[\tilde{\mathrm{e}}^{\gamma\text{-}1} + (\gamma-1)\tilde{\mathrm{L}}\tilde{\mathrm{e}}^{\gamma\text{-}2} \left.\dfrac{df(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\tilde{\mathrm{L}}}\right]} \right\}\lambda + \frac{1}{\theta} = 0, \qquad \text{(A1)}$$

where λ_1 and λ_2 are the characteristic roots. Moreover, since

$$\frac{d^2 n(\mathrm{L})}{d\mathrm{L}^2} > 0 \text{ for } \mathrm{L} \geq \overline{\mathrm{L}}, \tag{A2}$$

we have necessarily that

$$\left.\frac{dn(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\tilde{\mathrm{L}}} > 0 \text{ if } \hat{\mathrm{e}} > \hat{\mathrm{e}}_{\min}. \tag{A3}$$

One can check that (A3) entails $-\left.\frac{df(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\tilde{\mathrm{L}}} > \frac{\tilde{\mathrm{e}}}{(\gamma - \beta)\tilde{\mathrm{L}}}$, which in its turn implies that both characteristic roots solving (A1) are greater than unity in absolute value. For instance, let $\alpha = \beta = .5$, $\xi = .25$, ê=.62002, $\theta = .9$ and $\gamma = \eta = 1$, $\zeta = .8$: one has $\tilde{\mathrm{e}} = .266, \tilde{\mathrm{L}} = .7926$, λ_1=b+ic and λ_2=b-ic, where b=.03674, c=1.0534 and i= $\sqrt{-1}$. The system is unstable since $\sqrt{\mathrm{b}^2 + \mathrm{c}^2} = \sqrt{\theta^{-1}} > 1$.

2 <u>Conditions insuring that the system obtained by linearizing (31) around a full-employment steady state is saddle-path stable</u>

If $\hat{\mathrm{e}} < \hat{\mathrm{e}}_{\min}$, the necessary condition for the existence of a full-employment steady state is that

$$\left.\frac{dn(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\overline{\mathrm{L}}} < 0. \tag{A4}$$

Together with (A3) and given the fact that $\lim_{\mathrm{L}\to 1} n(\mathrm{L}) \to \infty$, (A4) implies the existence of a value of L, call it L’, such that L’<1 and $\left.\frac{dn(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\mathrm{L}'} = 0$ (the function *n*(L) has a minimum at L=L’). In its turn, this implies that there exists a value of $\hat{\mathrm{e}}$, call it $\hat{\mathrm{e}}'$, such that $\hat{\mathrm{e}}' < \hat{\mathrm{e}}$ and $n(\mathrm{L}') = \hat{\mathrm{e}}'$. Given the continuity of *n*(L), for any $\hat{\mathrm{e}}$ such that $\hat{\mathrm{e}}' < \hat{\mathrm{e}} < \hat{\mathrm{e}}_{\min}$ there exists $\tilde{\mathrm{L}}$ satisfying (34b) and $\overline{\mathrm{L}} < \tilde{\mathrm{L}} < \mathrm{L}'$: the system obtained by linearizing (31) around this steady state is saddle-path stable. Indeed, we have

$$\left.\frac{dn(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\tilde{\mathrm{L}}} < 0, \; \overline{\mathrm{L}} < \tilde{\mathrm{L}} < \mathrm{L}'. \tag{A5}$$

One can check that (A5) entails $-\left.\frac{df(\mathrm{L})}{d\mathrm{L}}\right|_{\mathrm{L}=\tilde{\mathrm{L}}} < \frac{\tilde{\mathrm{e}}}{(\gamma - \beta)\tilde{\mathrm{L}}}$, which in its turn implies that the characteristic roots solving (A1) are such that $\lambda_1 > 1$ and $0 < \lambda_2 < 1$. For instance, let $\alpha = \beta = \xi = .5$, $\hat{\mathrm{e}} = .72328$, $\theta = .9$ and $\gamma = \eta = 1$, $\zeta = .8$: one has $\tilde{\mathrm{e}} = .543$, $\tilde{\mathrm{L}} = .55516$, $\lambda_1 = 1.5498$ and $\lambda_2 = .7169$.

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