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Economic Growth, Structural Change, and Search Unemployment

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Economic Growth, Structural Change, and Search Unemployment

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Abstract

Economic growth is driven by structural change. Structural change does not come without a cost, the most evident social cost being high and persistent unemployment. This paper develops an economy with an endogenously expanding service sector, where the constant flow of workers in and out of employment relation leads to structural unemployment. The main finding is that the level of unemployment is different between the initial period and the long-run equilibrium growth path, and that along the transition path, the level of unemployment will overshoot its equilibrium level, which can explain the long-run pattern of unemployment in most industrialized countries.

Keywords: IT, New Economy, Sectoral Shifts, Endogenous Growth, Structural Unemployment, Search Unemployment.

JEL-Classification: J63, J64, O11, O41.

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1 Motivation

Economic growth is driven by structural change. The introduction of new modes of production, which allow for a more efficient allocation of resources, or the innovation of a new product line itself, which augments the value of the produce, form the essence of the growth process, but necessitate the decline of existing product or production techniques alongside.

Structural change, however, does not come without a cost. The most evident social cost of structural change is high and persistent unemployment. Firms producing a product in a declining market will lay off workers. Workers specializing in a particular mode of production will loose their job as new modes of production make their qualifications redundant. Until these workers requalify and are matched to a new job in an expanding product segment or in a new technology, these workers will suffer through periods of unemployment.

The first aspect has been extensively studied in the literature on endogenous growth. In his seminal paper, Paul Romer (1990) shows that when technology changes to take account of new inputs into production, an economy may grow without bound. Although not explicitly formulated, the model implies that the labor force employed in the production of a specific factor input will permanently decline. The first to emphasize this aspect where Phillippe Aghion and Peter Howitt (1992), who claimed that growth is a permanent process of creative destruction.

The latter authors have also noted that this process of creative destruction can produce persistent unemployment in an imperfect labor market (Aghion and Howitt, 1994). They argue that the introduction of new products will render part of the workforce unemployed. If it takes time until the unemployed are matched to a job in the emerging sectors, persistent unemployment arises. Whilst their paper contributes in understanding structural unemployment, it exhibits scope for extensions. First, the unemployment rate is procyclical and entirely driven by the growth rate. Second, along the balanced growth path, unemployment rates will not change. The model, in particular, does not allow for long waves in the pattern of the unemployment rate.

The evolution of unemployment rates in the OECD has not been that straightforward, however. In OECD countries selected for the table 1, the initially low rates of unemployment have increased until they have reached a peek between 1982 (USA) and 1997(Switzerland), as shown in the second column.

Table 1: The unemployment experience in selected OECD countries

	Maximum rate of unemployment*	Upward bliss point*	Downward bliss point*	Ratio of downward to upward bliss point**
Australia	10,9	7,1	10,9	1,54
	(1993)	(1982)	(1993)	(0)
Belgium	13,2	7,9	11,3	1,43
	(1983)	(1980)	(1987)	(4)
Denmark	12,1	2,3	12,0	5,22
	(1993)	(1974)	(1994)	(1)
Finland	16,6	6,6	14,6	2,21
	(1994)	(1991)	(1996)	(2)
Ireland	17,1	7,0	14,8	2,11
	(1986)	(1980)	(1994)	(8)
Netherlands	11,0	2,1	3,8	1,81
	(1983)	(1981)	(1984)	(1)
New Zealand	10,3	7,8	8,1	1,04
	(1991)	(1990)	(1994)	(3)
Norway	6,0	3,2	4,1	1,28
	(1993)	(1988)	(1997)	(4)
Sweden	8,2	5,3	8,0	1,51
	(1993)	(1992)	(1997)	(4)
Switzerland	5,2	2,5	5,2	2,08
	(1997)	(1992)	(1997)	(0)
UK	11,8	6,1	10,2	1,67
	(1986)	(1980)	(1987)	(1)
USA	9,7	5,6	9,6	1,71
	(1982)	(1974)	(1983)	(1)

Source: OECD Economic Outlook, 1960 - 2000 (forecast), and own calculations. The table only presents those countries that have already experienced the second bliss point.

* Numbers in parenthesis are years of occurrence.

** Numbers in parenthesis is the time elapsed since the maximum rate of unemployment.

Then, it seems that unemployment rates have been fairly stable in the initial period of the sample, from 1960 onward. Unemployment rates have stabilized well below their maximum level recently, at least for those countries that had the peek early, notably the US and the Netherlands. Table 1 tries to capture this element by identifying two bliss points, that is the maximum increase of the unemployment rate and the maximum decrease of the unemployment rate, presented in columns three and four respectively. Note that we have selected all OECD countries where a second bliss point could be identified. Finally, it appears that equilibrium unemployment rates are higher now than they were in the initial period of the sample. This implies that the time path is asymmetric, which we try to capture by presenting the ratio of the downward bliss point over the upward bliss point in column five. Should it exceed unity, which it does in all cases, chances are that the ultimate level of unemployment exceeds the initial level.

These stylized facts lead to the conclusion that the economy has undergone substantial changes, and has shifted from a regime of low unemployment to a regime with high unemployment. Along the transition path, unemployment has increased beyond the equilibrium level. We try to capture these elements by assuming an economy with a manufacturing sector, that exhibits exogenous technological progress, and service sector with endogenous innovation of new services, where the later expands at the cost of the prior.

2 The Demand Side

Households are assumed to provide one unit of labor inelastically, and face an intertemporal trade-off between consumption and savings on the one hand, and an intratemporal tradeoff between the consumption of a single manufacturing product and an ever expanding variety of services on the other hand. Households are assumed to maximize intertemporal utility. The intertemporal tradeoff is modeled according to the conventional logarithmic utility function,

$$U_s = \int_s^{\infty} e^{-\rho(t-s)} \ln c_t dt \tag{1}$$

where ρ is the individual rate of time preference, and c_t is aggregate consumption over time t. Households maximize utility subject to an intertemporal budget constraint,

$$\dot{a}_t = r_t a_t + w_t E_t (1 - u_t) - c_t , \tag{2}$$

which states that a household saves that part of interest income $r_t a_t$, and labor income w_t for those who expect not to be unemployed u_t, that is not spent on consumption c_t. Unemployed workers receive no benefits, which, however, has no consequences on the macroeconomic outcome, as well be shown lateron. Hamiltonian optimization of the utility function subject to the budget constraint with respect to consumption, asset accumulation, and a shadow price of income yields the well-known Keynes-Ramsey-rule,

$$\hat{c}_t = r_t - \rho , \tag{3}$$

where the hat (^) denotes the growth rate of consumption. This intertemporal Euler condition states that households will delay consumption into the future when the interest rate exceeds their individual rate of time preference. Integrating the budget constraint (2), we find that lifetime consumption depends on initial wealth and expected level of human capital, defined as the discounted stream of future labor income,

$$\int_s^\infty c_t e^{-\int_s^t r_\tau d\tau} dt = a_t + E_t h_t = a_t + E_t \int_s^\infty w_t (1 - u_t) e^{-\int_s^t r_\tau d\tau} dt . \tag{4}$$

The only uncertainty in the proceeding expression is whether at a given point in time, someone is unemployed or not. As every single household can have a different record of employment and unemployment situations, a multitude of different consumption paths may arise. However, the change in human capital in every point in time will only be bivariate, and will be of great interest lateron. Taking time derivatives of expected human capital yields,

$$E_t \dot{h}_t = r_t E_t h_t - w_t E_t (1 - u_t) . \tag{5}$$

Consumption is devoted to services and manufacturing products according to the following Cobb-Douglas felicity (or subutility) function,

$$c_t = x_t^{\frac{n_t - 1}{n_t}} y_t^{\frac{1}{n_t}}, \tag{6}$$

where y_t is the amount of manufacturing products, x_t is the amount of services, and n_t is the increasing number of services in the society. The motivation for this specific functional form is twofold. The economic interpretation is that as the number of available services increase, agents devote an increasing share of expenditures on services. The sociological argument follows from the fact that n_t reflects knowledge in the society (see Zagler, 1999a). It states that agents will shift their consumption towards services as they become more educated (Hage, 1998, p. 7f). Given that households will spend an amount c_t on services and manufacturing products, the intratemporal budget constraint yields,

$$p_t x_t + q_t y_t \leq c_t, \tag{7}$$

where q_t is the price of manufacturing products, and p_t is the price index for services[1]. Upon Lagrange optimization of the subutility function subject to the budget constraints with respect to manufacturing and service consumption, one finds that the relative price must equal the marginal rate of substitution,

$$(n_t - 1)\frac{y_t}{x_t} = \frac{p_t}{q_t}. \tag{8}$$

Finally, we assume that services are heterogeneous and supplied at an increasing number of varieties. Households demand differentiated services according to the following constant elasticities of substitution subfelicity function,

$$x_t = [\int_0^{n_t} x_{i,t}^{\frac{\varepsilon - 1}{\varepsilon}} di]^{\frac{\varepsilon}{\varepsilon - 1}}, \tag{9}$$

where $x_{i,t}$ is a specific service variety. Households will only spend $p_t x_t$ on services, hence the budget constraint for optimization reads,

[1] to be defined below.

$$\int_0^{n_t} p_{i,t} x_{i,t} di \leq p_t x_t, \qquad (10)$$

where $p_{i,t}$ is the price of a specific service *i*. The final stage in the household problem yields after optimization a demand function for a specific service,

$$x_{i,t} = \left(\frac{p_{i,t}}{p_t} \right)^{-\varepsilon} x_t, \qquad (11)$$

and we find that ε is the demand elasticity for any particular service. Moreover, we obtain a definition for the price index of services,

$$p_t = [\int_0^{n_t} p_{i,t}^{1-\varepsilon} di]^{\frac{1}{1-\varepsilon}} \qquad (12)$$

To complete discussion of the household sector, note that the intratemporal maximization implies that the spending share on manufacturing products $q_t y_t / c_t$ will equal $1/n_t$, whilst the spending share on services $p_t x_t / c_t$ will equal $(n_t - 1)/n_t$.

3 Manufacturing

For the sake of simplicity, assume that competitive manufacturers face a constant returns to scale production function[2] with labor as the only input,

$$y_t = A_t l_t, \qquad (13)$$

where A_t measures productivity in manufacturing. It is assumed that productivity augments continuously by a factor α. Zagler (1999b) has shown that manufacturers will permanently reduce their labor force. Assuming that they incur a cost of firing workers equal to δw_t, profit maximization yields,

$$q_t A_t = w_t (1 + \delta\alpha - \delta\hat{y}_t), \qquad (14)$$

[2] As the number of manufacturers is undetermined, we normalize it to unity, assuming perfect competition nonetheless.

implying that each worker must earn its marginal product and his potential future firing costs.

4 The Service Sector

As argued, service are provided in various varieties. Moreover, it is assumed that the provision of services earns economic rents. The market setting is assumed to be monopolistically competitive. A firm in the service sector therefore operates along the demand function introduced above, and sets prices in order to maximize profits. However, service suppliers consider their individual influence on aggregate variables, such as the total amount of services x_t and the price index p_t thereof, as negligible. We simply assume that inputs in the service sector equal output, or $x_{i,t} = e_{i,t}$, where $e_{i,t}$ is service sector employment. It has been shown elsewhere (Zagler, 1999b), that service firms hire workers initially, and then continuously reduce their workforce. Without loss of generality, we may assume that an emerging service sector firm not only receives the blueprint for a novel type of service, but also the already recruited workforce, from the innovation sector. Hence, we defer the matching problem to the innovation sector, to be discussed below. Service sector firms do incur firing costs, however, which we assume to be identical the manufacturing sector. Therefore, δ corresponds to the firing rate of the firm or the firing probability facing the individual. Hence profit maximization yields the mark-up of prices over costs,

$$p_{i,t} = \tfrac{\varepsilon}{\varepsilon-1} w_t (1-\delta \hat{x}_{i,t}), \tag{15}$$

where it should be noted that the quantity of a particular service is declining, hence the mark-up is greater than in the absence of firing costs. The mark-up equation implies that prices, and according to the demand function also quantities, in the service sector are independent of the specific variety, given identical growth rates. Market shares of a particular service will decline as new services are provided,

$$x_{i,t} = n_t^{\frac{\varepsilon}{1-\varepsilon}} x_t . \tag{16}$$

The price index (12) therefore equals,

$$p_t = \tfrac{\varepsilon}{\varepsilon-1} w_t n_t^{\frac{1}{1-\varepsilon}} (1 - \delta\hat{x}_t + \tfrac{\varepsilon}{\varepsilon-1}\delta\hat{n}_t), \qquad (17)$$

making use of the time derivative of equation (16). Ceteris paribus, as the number of varieties increases, the price index declines, implying that even for a given spending share on services, they may increase in quantity. Due to the mark-up equation (15), all service sector firms will charge the same price, and sell the same quantity due to equation (16). The model therefore is completely symmetric. Hence we may set the labor force of a particular service sector firm *i* equal to average employment in the service sector, $e_{i,t} = e_t/n_t$ for all *i*. Substitution of manufacturing technology (13), service sector quantities (16) aggregate service sector prices (17), and manufacturing supply (14) into the optimality condition (8) yields,

$$e_t / l_t = \Gamma(n_t - 1)(\varepsilon - 1)/\varepsilon, \qquad (18)$$

with

$$\Gamma = (1 + \delta a - \delta\hat{y}_t)/(1 - \delta\hat{x}_t + \tfrac{\varepsilon}{\varepsilon-1}\delta\hat{n}_t),$$

hence aggregate service sector employment is proportional to manufacturing employment for a given number of varieties, but increases relatively, as variety increases. Taking logarithms and derivatives of the service to manufacturing employment ratio (18) for a constant fraction Γ, we find the numerator and the denominator in Γ are equal, implying indeed $\Gamma = 1$ to be constant. Service sector firms therefore lucrate rents equal to,

$$d_{i,t} = \tfrac{1}{\varepsilon-1} w_t e_{i,t} (1 - \delta\hat{x}_{i,t}), \qquad (19)$$

which implies that aggregate profits, d_t, equal,

$$d_t = \int_0^{n_t} d_{i,t}\,di = \tfrac{1}{\varepsilon-1}\int_0^{n_t} w_t e_{i,t}(1 - \delta\hat{x}_{i,t})\,di = \tfrac{1}{\varepsilon-1} w_t e_t (1 - \delta\hat{x}_t + \tfrac{\varepsilon}{\varepsilon-1}\delta\hat{n}_t). \qquad (20)$$

5 The Innovation Sector

The innovation sector is populated by perfectly competitive R & D firms, which sell innovations to emerging service sector firms in order maximize profits. The existing stock of knowledge, captured by the index n_t here, is assumed to exhibit a positive, and for the sake of simplicity linear, impact on the creation of new varieties (Romer, 1990). Moreover, labor enters linearly in this relation as well, where s_t are scientists in the innovative sector. The arrival rate of new innovations therefore equals,

$$\dot{n}_t = \phi s_t n_t , \tag{21}$$

where ϕ is a measure of productivity in the innovation sector. Given that it is uncertain whether a single innovation will be successful, ϕ measures the probability of success in innovation, when the number of attempts to innovate is large.

As successful workers in innovating firms leave the sector to join a newly created service sector firm at rate $\hat{n}_t e_t$, exogenous to the firm, innovation sector firms need to permanently hire new workers. For this purpose, they advertise vacancies v_t at a cost of κw_t, which yields a new worker with probability $m(\theta_t)$, where θ_t is the ratio of unemployed workers u_t to vacancies v_t. $m(\theta_t)$ is a conventional matching function as described by Pissarides (1990), stating that the probability that the matching process returns a worker for a particular firm increases when unemployment goes up, and declines when the aggregate number vacancies rises, given $m'(\theta_t) < 0$. The dynamics of the innovation sector labor force therefore reads,

$$\dot{s}_t = m(\theta_t) v_t - \hat{n}_t e_t . \tag{22}$$

Competitive firms in the innovation sector maximize profits. The highest price a potential service provider can pay to an innovator will equal the value of a particular service firm, b_t/n_t, normalized by the number of observations for reasons which will become apparent.

The only costs for an innovator are wages w_t, paid to scientists, s_t, and costs for vacancies, $\kappa w_t v_t$. Assuming that Hamiltonian multiplier λ_t is the shadow price of an additionally filled vacancy, the first order conditions are,

$$\lambda_t m(\theta_t) = \kappa w_t . \tag{23}$$

and the equation of motion,

$$b_t\phi - w_t = r_t\lambda_t - \dot{\lambda}_t . \tag{24}$$

Taking time derivatives of equation (23) and eliminating λ_t from the equation of motion, we find that the marginal cost for the provision of a new variety will equal its market price b_t,

$$b_t = \frac{w_t}{\phi}[1 + \frac{\kappa}{m(\theta_t)}(r_t + \frac{\theta_t m(\theta_t)}{m'(\theta_t)}\hat{\theta}_t - \hat{w}_t], \tag{25}$$

where $\theta_t m(\theta_t)/m'(\theta_t)$ is the elasticity of the matching function with respect to the unemployment to vacancy ratio.

6 Search Unemployment

When a firm is able to find a worker to fill its vacancy, there is a rent created, equal to the shadow value of an additionally filled vacancy, λ_t. If the firm and the worker bargain over the division of this rent, we need to derive the potential gain of the worker from accepting the offer. Noting from the integration of the budget constraint (6), that for a given initial wealth the worker's consumption path, and hence her utility is only affected from changes in human wealth, the potential gain for the worker depends only on the difference in her human wealth. Denoting the human wealth of a person currently unemployed ($u_t = 1$) with h_t^u, and the human capital of a person currently employed ($u_t = 0$) with h_t^e, the Nash bargaining problem reads,

$$Max\,(h_t^e - h_t^u)^\beta \lambda_t^{1-\beta} , \tag{26}$$

where β is the relative bargaining power of the individual worker. Given the simple structure of the model, the worker receives a share β of total rents, or after rearrangement,

$$(1-\beta)(h_t^e - h_t^u) = \beta\lambda_t . \tag{27}$$

As we have noted above, an employed worker keeps her job at rate $(1 - \delta)$, gets fired at rate δ, hence her change in human capital equals,

$$\dot{h}_t^e = \delta h_t^u + (1-\delta)h_t^e - h_t^e = \delta(h_t^u - h_t^e). \qquad (28)$$

Substituting h_t^e for $E_t h_t$ in equation (5), setting $u_t = 0$, solving for h_t^e, and substituting the result into the bargaining outcome (27), yields

$$(1-\beta)(w_t - r_t h_t^u) = \beta(r_t + \delta)\lambda_t. \qquad (29)$$

By a similar reasoning, an unemployed worker will find a job with probability $\theta_t m(\theta_t)$, implying that the change in human capital of the currently unemployed workers equals,

$$\dot{h}_t^u u = \theta_t m(\theta_t) h_t^e + (1-\theta_t m(\theta_t)) h_t^u - h_t^u = \theta_t m(\theta_t)(h_t^e - h_t^u), \qquad (30)$$

which will equal to $r_t h_t^u$, according to equation (5). This equation now allows us to eliminate human capital from the bargaining outcome altogether, leading to a bargaining outcome of

$$(1-\beta)w_t - \beta\theta_t \kappa w_t = \beta(r_t + \delta)\lambda_t. \qquad (31)$$

Eliminating the shadow value an additionally filled vacancy from the innovation sector first order condition, the interest rate from the intertemporal Euler condition (3), and rearranging terms yields,

$$\hat{c}_t = \frac{1-\beta}{\beta\kappa} m(\theta_t) - \theta_t m(\theta_t) - (\rho + \delta). \qquad (32)$$

As θ_t is defined as the number of unemployed to the number of vacancies, this expression defines a first relation between the growth rate of the economy and the unemployment rate. As the number of matches on the labor market, $m(\theta_t)$ will be zero when there is no unemployment, this expression yields a negative rate of growth, equaling $-(\delta - \rho)$. We will be able to solve for the number of vacancies in the general equilibrium as a function of unemployment and θ_t only. Moreover, as has been shown by Pissarides (1990, p. 23), the unemployment function will exhibit the same properties as the matching function, hence we may reformulate equation (32),

$$\hat{c}_t = \frac{1-\beta}{\beta\kappa} \eta(u_t) - u_t \eta(u_t) - (\rho + \delta). \qquad (33)$$

Equation (33) is the matching tradeoff between unemployment and economic growth.

7 Endogenous Growth

No-arbitrage on the stock market implies that changes in the value of a bond plus the profits the company earns must equal the return on a risk-free asset, or for the aggregate service sector,

$$\hat{b}_t - \hat{n}_t + \frac{d_t}{b_t} = r_t = \hat{c}_t + \rho . \tag{34}$$

Noting that the integrated budget constraint (4) implies that consumption growth must equal the change in private wealth a_t, and by the capital market clearing condition, the change in aggregate stock market evaluation, eliminating dividends d_t from equation (20) and stock market capitalization from equation (25), the growth rate of the economy equals,

$$\hat{n}_t = \frac{\phi}{\varepsilon - 1} \Omega e_t - \rho , \tag{35}$$

with

$$\Omega = \frac{1 - \kappa \hat{x}_t + \frac{\varepsilon\kappa}{\varepsilon - 1} \hat{n}_t}{1 + (\delta + \eta(\theta_t)\hat{\theta}_t)\kappa / m(\theta_t)} .$$

Assuming that households, if not unemployed, supply one unit of labor inelastically, and the number of households is normalized to unity, and manufacturers, service firms, and innovators demand labor according to its relative marginal product, the labor market clearing condition reads,

$$l_t + s_t + e_t = 1 - u_t . \tag{36}$$

Eliminating manufacturing labor from the service to manufacturing employment ratio, and innovation sector employment from the innovation sector employment, we may solve for service sector employment as a function of the deep parameters of the model and the rate of innovation only. Substituting this back into equation (35), we may solve for the innovation rate, noting upon passing, that will Ω be roughly equal to unity if innovation productivity does not deviate much from the productivity of a service firm. The innovation rate of the economy therefore equals,

$$\hat{n}_t = \frac{n_t - 1}{\varepsilon n_t}\phi(1-u_t) - \frac{(\varepsilon-1)n_t + 1}{\varepsilon n_t}\rho\,, \tag{37}$$

which is equivalent to the result known from Zagler (1999b). In order for the innovation locus (37) to be comparable to the matching locus (33), we first substitute manufacturing production (13) and aggregate service sector production (16) into the definition of the consumption bundle, and than take time derivatives, noting along passing that all employment growth rates will cancel out due to the service to manufacturing employment ratio (18), hence

$$\hat{c}_t = \frac{1}{\varepsilon - 1}\frac{n_t - 1}{n_t}\hat{n}_t + \frac{\alpha}{n_t}\,, \tag{38}$$

which yields the innovation locus in the unemployment to economic growth space, namely

$$\hat{c}_t = \left(\frac{n_t - 1}{n_t}\right)^2 \frac{\phi(1-u_t)}{\varepsilon(\varepsilon-1)} - \frac{n_t - 1}{n_t}\frac{(\varepsilon-1)n_t + 1}{\varepsilon n_t(\varepsilon - 1)}\rho + \alpha\,. \tag{39}$$

This innovation locus is downward sloping and linear in the unemployment rate. As the number of innovations increases as time goes bye, the slope innovation locus gets steeper, whilst the intercept increases if and only of $2\phi(n_t - 1) > (\varepsilon - 1)n_t\alpha$, until the consumption growth rate converges to

$$\lim_{n_t \to \infty} \hat{c}_t = \frac{\phi(1-u_t)}{\varepsilon(\varepsilon-1)} - \frac{\rho}{\varepsilon}\,. \tag{40}$$

as n_t goes to infinity. Apart from the evident results that higher productivity in innovation and more patience foster economic growth, we find that an increase in the elasticity of substitution reduces the growth rate for two reasons. First, high substitutability it reduces the magnitude of an innovation, which is equivalent to a decline in research productivity, as indicated by the first ε in the previous equation. Second, it reduces the mark-up, as the potential stream of profit from an innovation decline, which is indicated by the $(\varepsilon - 1)$ term in the above expression. Finally, we find that in contrast

Aghion and Howitt (1994), unemployment exhibits a direct and negative impact on the rate of economic growth, as a reduction in the employed workforce will reduce labor in all sectors, and here in particular in the innovation sector.

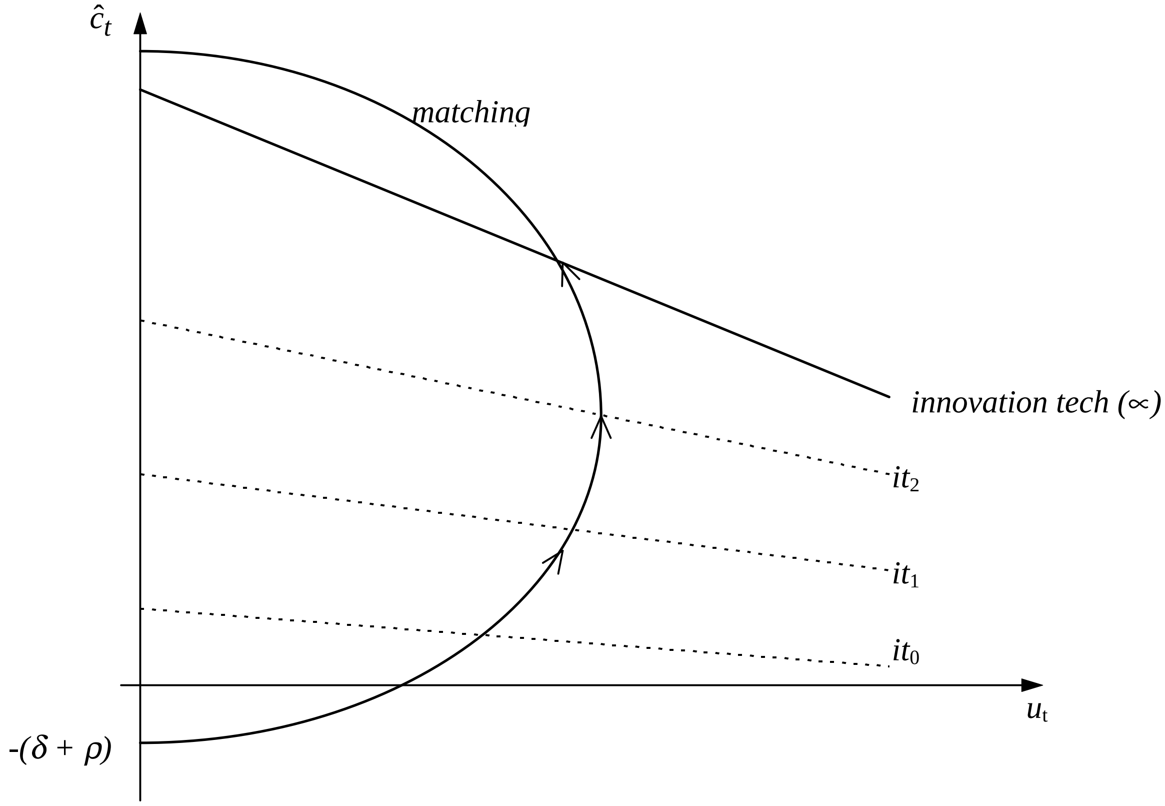
8 Unemployment Dynamics

The matching locus, equation (33), and the innovation technology locus (*it)*, equation (39), completely define a dynamic system in the unemployment to economic growth space. Whilst the innovation locus shift through time as the number of innovations goes to infinity, the matching locus is time invariant, hence describing the saddlepath of the system.
In the following graph, we describe the solution graphically for the case of an upward shifting *it*-locus. Whilst the innovation technology locus is linear as noted above, the matching locus is not. In particular, most conventional matching function used in the literature, in particular the isoelastic function, will cross the consumption growth axis at $-(\delta - \rho)$, as noted above, then gradually increase until it reaches a maximum level of unemployment, with unemployment rates declining thereafter as consumption growth continues to increase. Taking implicit derivatives of the matching locus (33), we find that the maximum level of unemployment will equal,

$$u_t^* = (1 - \beta)\eta/\beta\kappa(1 - \eta). \qquad (41)$$

As the innovation technology locus shifts upwards and gets steeper, the economy surpasses two distinct phases. Initially, a manufacturing regime prevails with low rates of unemployment and low rates of economic growth. As the service sector expands in the economy, unemployment raises for two distinct reasons. First, there is sectoral unemployment, mainly experienced by recently fired manufacturing workers looking for job opportunities in the emerging service sector. Second, structural unemployment, that is employees fired in declining service firms and attempting to find a job elsewhere in the new service economy, increases as the service sector as a whole expands in size.

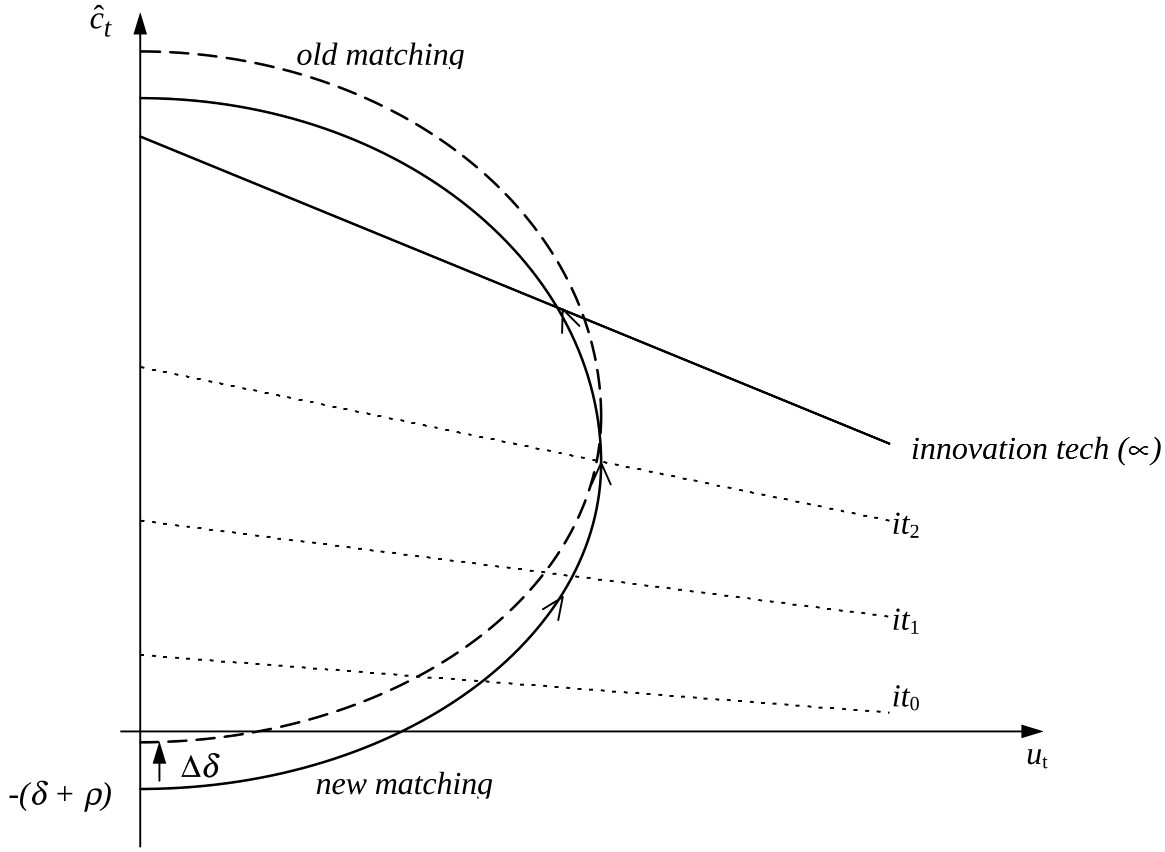
Graph 1: The unemployment to economic growth space



When most of the sectoral unemployment has been digested as the new service economy emerges, unemployment rates will decline again, but will never go to zero, as the new economy is defined by a continuous flow of people into unemployment and out of unemployment, which is the novel feature of the emerging flexible labor market. Note that this result is capable of explaining the stylized facts as described in the introduction, in particular the increase of unemployment rates, reaching a peak and then declining again, as shown in table one. The previous graph enables us to derive the comparative static results in the model economy, shown below.

First, an increase in the firing rate of the economy δ, will shift the matching-locus downward. This will lead to an increase of the rate of growth, and at the same time reduce the unemployment rate. The intuition behind this surprising result is the following. The firing rate works much like a depreciation rate. Indeed, δ, is the depreciation rate for jobs, which in this setting is similar to a minimum capital requirement. When job destruction increases, the shadow value of an existing job will increase, existing firms in the service sector will observe their profits rise as well. Given the monopolistic market structure, service firms can extract higher current profits than the higher discounted costs for layoffs, which fits recent empirical evidence by Walther (1999). As this makes entry in service markets more attractive, fostering innovation, and therefore leading to higher growth rates. Given the positive technological tradeoff between growth and employment, equation (39), unemployment rates will decline.

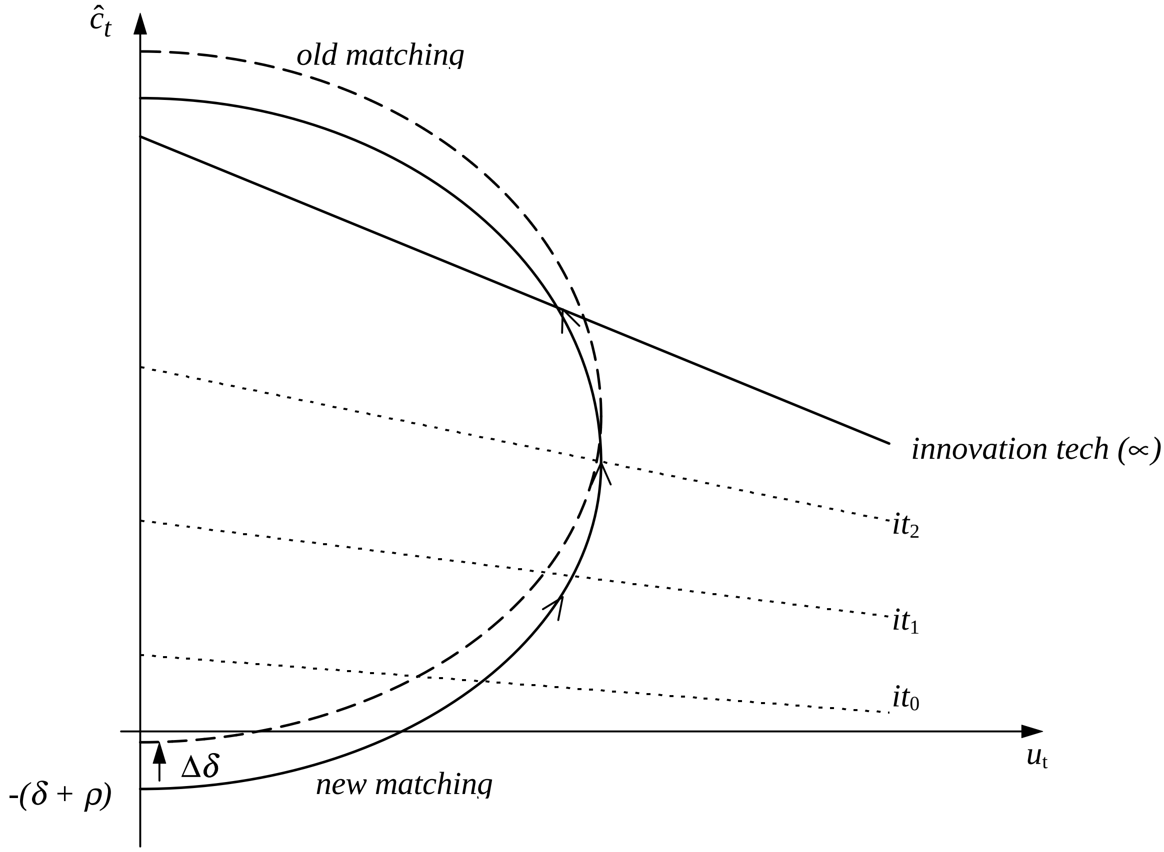
Graph 2: The comparative dynamics of an increase in the firing rate δ



For long spans of time, the unemployment rate will increase due to an increase in the firing rate, as can be observed from the graph below. This is due to the fact that an increase in the firing facilitates transition to the service economy, where unemployment rates will larger that in the pure manufacturing economy.

Second, an increase in the individual rate of time preference, ρ, will also lead to a downward shift in the matching-locus. At the same time, however, the *it*-locus, will also shift downwards by a factor of $1/\varepsilon$, which exceeds the shift of the matching-locus. We therefore observe a reduction in both the growth rate and the unemployment rate in the economy. The growth effect is evident. As agents become less patient, they refrain from deferring consumption into the future, thus save less, leading to higher interest rates and therefore a decline in innovative investments. The unemployment effect is due to the fact that low rates of innovations expand the average product cycle, hence the number of layoffs declines, and labor market fricitions will become less severe, lowering the unemployment rate.

Graph 3: The comparative dynamics of an increase in the hiring rate κ



Third, an increase hiring costs κ will exhibit the same lower intercept, a lower maximal rate of unemployment, as indicated by the first-order condition (41), but a higher upper intercept with the consumption growth axis, as a increase in hiring costs stretches the matching-locus upwards, as shown in the graph below. An increase in hiring costs will therefore unambiguously increase unemployment and reduce economic growth as n_t

converges to infinity. However, during transition, e.g. if the economy is at its maximum unemployment level, an increase in hiring costs may reduce unemployment and increase growth, due to the fact the hiring costs work as barrier to structural change, thus leading to less job destruction in existing sectors.

An increase in the individual bargaining power, β, has a similar effect than an increase in hiring costs, stretching the matching-locus upwards. Indeed, higher bargaining power can be directly interpreted as an increase in hiring costs. If every personnel manager faces on average a tougher new employee, he will have to pay higher wages in every period that follows. Instead, we may discount this stream of costs to the present date, in which case they are a perfect equivalent to an increase in hiring costs.

9 Conclusions

This paper has developed an economy with an endogenously expanding service sector, where the constant flow of workers in and out of employment relation leads to structural unemployment. The main finding is that the level of unemployment is different between the initial period, where everybody is employed in the service sector, and the final period, where a constant share of workers leave existing service firms to search for work in emerging service sector firms. During transition from the initial to the final state, the level of unemployment will overshoot its equilibrium level, the intuition being that in addition to the fluctuation within the service sector, workers from the manufacturing sector have to be allocated to the emerging service firms and the innovation sector.

Apart from the conventional results that an increase in innovation productivity, a higher product substitutability, and a lower rate of time preference will foster economic growth, leading to lower unemployment rates alongside, several unconventional results arise. These results concern hiring and firing costs, and are a central element in the debate on the high and persistent unemployment rates in Europe. Whilst the model suggests that hiring costs (alongside with a high bargaining power on the side of the individual worker) are a key determinant of unemployment. However, the model predicts that an increase in firing cots might even reduce the unemployment rate, as they induce an increase in marginal revenues for innovation (due to an increase in service sector profits), which will exceed the marginal costs, measured as the discounted firing costs of future layoffs. The new economy, which will consist of a range of highly innovative service firms, will therefore not only alter the growth process, as described in Zagler (1999b), but also the labor relations. First, the new economy will exhibit higher rates of unemployment, as the number of fluctuations in the economy increases. Given a more educated and flexible workforce in the new economy, we may assume that additional pressure on the labor market will come from the shift in relative bargaining power towards the workers.

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