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DEREGULATION SHOCK IN PRODUCT MARKET AND UNEMPLOYMENT *

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Abstract

In a dynamic general equilibrium model with endogenous markups and labor market frictions, we investigate the effects of increased product market competition. Unlike most macroeconomic models of search, we endogenize the labor supply along the extensive margin. We find numerically that a model with endogenous labor force participation decision produces a decline in the unemployment rate which is almost three times larger than that in a model with fixed labor force. For a calibration capturing alternatively European and the U.S. labor markets, a deregulation episode, which lowers the markup by 3 percentage points, results in a fall in the unemployment rate by 0.17 and 0.07 percentage point, respectively, while the labor share is almost unaffected in the long-run. The sensitivity analysis reveals that product market deregulation is more effective in countries where labor market regulation is high, product markets are initially highly regulated, unemployment benefits are smaller and labor force is more responsive.

Keywords: Imperfect competition; Endogenous markup; Search theory; Unemployment; Deregulation.
JEL Classification: E24; J63; L16.

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1 Introduction

The role of product market reforms in achieving the objective of lower unemployment rate has recently received a lot of attention amongst policy makers and academics. While the empirical literature finds that poor competition in product markets could be a cause of the poor performance of European labor markets, the connection between product market regulation and unemployment has received very little attention from the dynamic general equilibrium literature, except Ebell and Haefke [2009].[1] In particular, the relationship between product market competition and equilibrium unemployment has been studied by considering a static framework thus abstracting from dynamic effects (see Blanchard and Giavazzi [2003], Spector [2004]). As Ebell and Haefke [2009], we use a dynamic general equilibrium model to quantify the unemployment effect of regulation in goods market. In contrast to Ebell and Haefke, we endogenize labor supply along the extensive margin (i.e., the labor force participation decision), analyze both the dynamic and steady-state effects analytically, and use a different approach to calibrate the deregulation shock.

To illustrate the potential importance of regulation in product markets for labor market variables, we plot in Figure 1 the rate of activity, the employment rate and the unemployment rate against an indicator capturing the cost of entry.[2] The cost of entry index reflects the ease of starting up a business (including the number of steps, the time it takes on average, and the cost as a percentage of GNP per capita). Figures 1(a), 1(b), 1(c) suggest that more regulated countries have smaller rates of activity, lower employment rates and higher unemployment rates.[3] In our model, increased labor force participation amplifies the rise in the employment rate and the decline in the unemployment rate following a deregulation shock due to a multiplicative employment effect resulting from endogenous markups. In a nutshell, improving competitive conditions lowers the unemployment rate by stimulating labor demand and by encouraging individuals to join the labor force.

< Please insert Figure 1 about here >

Beneficial effects in labor market outcomes of product market deregulation are supported

[1] Bilbiie, Ghironi and Melitz [2010] analyze the effect of a deregulation shock within a dynamic general equilibrium model with entry and exit of firms but they abstract from labor market frictions.

[2] The construction and sources of data are detailed in Appendix A.1.

[3] The negative relationship between the extent of regulation in product markets and labor force participation is confirmed by Feldmann [2009]. His regression results indicate that anticompetitive business regulations, specifically price controls, administrative obstacles to start a new business and time-consuming bureaucratic procedures, appear to lower labor force participation (and employment rates).

by a growing body of empirical evidence. At a micro level, Bertrand and Kramarz [2002] find that French regions which restricted entry (into retailing) experienced slower rates of job growth. At a macro level, estimates by Bassanini and Duval [2006] show that stringent anti-competitive product market regulation raises aggregate unemployment, though the impact is much smaller than a reduction in unemployment benefits or in the tax wedge. Griffith et al. [2007] provide evidence that the product market deregulation experienced in the 1990s by some OECD countries was associated with a decline in the unemployment rate, particularly in countries with a higher workers' bargaining power.[4] More recently, using panel data for 20 OECD countries over the period 1980-2002, Fiori et al. [2012] confirm the findings by Griffith et al. [2007] for employment (rather than unemployment). Their estimates reveal that improving competitive conditions in product markets produce a larger increase in employment when labor market regulation (capturing the extent of worker bargaining power) is high.

To explore the dynamic link between product market regulation and unemployment, we develop a novel framework combining imperfect competition in product markets and unemployment in the labor market. We see our setup as an extension of the framework by Heijdra and Ligthart [2009] who solve analytically a dynamic open economy model with search unemployment and endogenous labor force participation.[5] In the tradition of Diamond-Mortensen-Pissarides, unemployment arises because it takes time for firms to hire workers and for unemployed workers to find a job. Because firms face a cost by maintaining job vacancies, they receive a surplus equal to the markup-adjusted marginal product of labor less the product wage. Symmetrically, so as to compensate for the cost of searching for a job, unemployed workers receive a surplus equal to the product wage less the reservation wage. Nash bargaining between firms and workers yields a product wage defined as the weighted sum of the marginal product of labor and a reservation wage. As Heijdra and Ligthart, we depart from the usual practice by assuming endogenous labor force participation which implies that the reservation wage varies over time.[6] In contrast to Heijdra and Ligthart who assume perfect competition in product markets, we consider monopolistic competition. Building on

[4] According to Griffith et al.'s (1997) findings, a fall of 3 percentage points of the price-cost margin, which correspond the magnitude of the shock we consider in the paper, will generate a decrease in the unemployment rate ranging between 0.6 and 1.1 percentage points as the bargaining coverage (capturing the worker bargaining power) increases from 53% to 97%. Note that the index used by Griffith et al. [2007] to capture the regulation in product markets covers the extent of both trade liberalization and restrictions on competition.

[5] Our framework also builds upon Merz [1995], Andolfatto [1996], Shi and Wen [1999] who construct dynamic general equilibrium models with labor markets characterized by search frictions. We depart from these papers by solving the model analytically and introducing endogenous markups.

[6] While we consider endogenous labor force participation decision by assuming that representative household members experience disutility from working and searching efforts, Haefke and Reiter [2006] consider a pool of workers with different productivity so that only the most productive agents devote time to market activities (rather than to home activities). We are grateful to a referee to bring to our knowledge this alternative way to introduce endogenous labor market participation.

Jaimovich and Floetotto [2008], we assume that only a limited number of intermediate good producers operate within each sector, so that the price-elasticity of demand and thereby the markup faced by each firm depends on the number of competitors.[7] The markup variation is central to the propagation mechanism of a deregulation shock. As in Jaimovich and Floetotto [2008], the number of firms in a sector is determined by the zero-profit condition which is enforced by firms' decisions to either enter or exit an industry.

We contribute to the product market regulation literature in three respects. First, our setup can be solved analytically and delivers simple formulas which illuminate the role of labor market institutions in driving the effects of a deregulation episode. Second, we are able to fully characterize the dynamics and to depict the transitional adjustment of key variables by using simple phase diagrams. Finally, we also provide a novel quantitative exploration, in particular by estimating the size of the short and long-term effects of a deregulation episode. We detail below our three contributions.

While using a fully dynamic general equilibrium model, our setup yields simple formulas which provide predictions related to the role of labor market variables in determining the size of the effects of a deregulation shock in product markets.[8] In particular, we find that a deregulation shock lowers unemployment more as labor supply at the extensive margin is larger, unemployment benefits are smaller, the workers' bargaining power is higher, and the product markets are initially not very competitive. Importantly, the combined effect of endogenous labor force participation, a feature that has been so far ignored by the literature, and endogenous markups triggers a multiplicative employment effect. The reason is that as more agents participate in the labor market, employment increases further. As a consequence, the markup falls by a larger amount which raises labor demand and thereby labor market tightness. Hence, the reservation wage rises more which increases further the labor force participation and thereby employment. Quantitatively, we find that about two thirds of the decline in the unemployment rate can be attributed to endogenous labor participation decision.

One attractive feature of our framework is that the model is tractable enough to derive analytically the condition for saddle-point stability and to fully characterize transitional dynamics. Additionally, we show that long-term effects on labor market variables crucially

[7] See e.g., Wu and Zhang [2000] and Zhang [2007] who develop dynamic general equilibrium models with monopolistic competition and free entry, in which price elasticity of demand at firm level (evaluated at symmetric equilibria) is proportional to the number of firms in the industry. In contrast to us, they abstract from imperfect labor markets.

[8] Koeniger and Prat [2007] also analyze the interaction of employment protection legislation and entry costs by considering a model with entry and exit of firms and search unemployment. Unlike our paper, they consider heterogenous firms with different productivity to assess firm and job turnover rates instead of focusing on short-run and long-run effects on employment growth and unemployment rate.

depend on the local stability properties of the dynamical system. If the long-run equilibrium is saddle-path, improving competitive conditions yields beneficial effects on labor market outcomes.[9] Moreover, in contrast to Heijdra and Lightart [2009], the introduction of endogenous markups restores transitional dynamics for labor market variables. Further, we are able to derive analytically the dynamics and illustrate the transitional adjustment by using phase diagrams. In particular, employment and labor market tightness co-vary, while employment and the unemployment rate vary in opposite direction. Interestingly, the unemployment rate unambiguously increases on impact as more agents search for a job and employment is initially predetermined.

While the model can be solved analytically, we propose some numerical simulations to illustrate key theoretical results and discuss policy implications. In the same spirit as Ebell and Haefke [2009], we investigate to which extent product market competition decreases unemployment and increases wages. In this regard, we offer two calibrations of the model, one aimed at capturing the United States, the other aimed at capturing Europe with its more "rigid" labor market. Since data show considerable heterogeneity across European Union members, we conduct a sensitivity analysis with respect to pivotal parameters capturing the regulation of goods and labor markets. In contrast to Ebel and Haefke [2009] who calibrate their model to quantify the extent to which the poor performance of European labor markets relative to the U.S. can be attributed to lower competition, we compare the size of the decline of the unemployment rate in Europe and the U.S. after a deregulation shock of the same magnitude. To do so, we use panel data for 16 OECD countries over the period 1985-2003. Our estimates show that when the OECD regulatory index falls by one unit, the subsequent decline in the markup falls in the range between 2.8 and 3.3 percentage points. Considering a fall in fixed costs which lowers the markup by 3 percentage points, we find that such a deregulation episode lowers the unemployment rate by about 0.17 percentage point and raises the Nash bargaining wage by about 2.1% for the Europe baseline calibration. These effects increase substantially in countries with higher worker bargaining power, initial poorly competitive product markets, larger elasticity of labor supply at the extensive margin, and smaller unemployment benefits. When the labor market parameters are chosen so as to match the U.S. economy, it is found that beneficial effects on labor market outcomes are mitigated.

As in Blanchard and Giavazzi [2003], we investigate the distribution effect between labor income and profits triggered by a deregulation episode. Whereas the short-run rise in the labor share falls in the range between 0.1 and 1.9 percentage points of GDP, the long-term effects are

[9] More precisely, we find that the saddle-stability condition requires product markets not to be too much regulated initially.

insignificant for all scenarios. Finally, exploring the welfare effects of a deregulation episode which lowers the markup by three percentage points, we find that improving competitive conditions produce a welfare gain ranging from a low of 2.2% if labor force is fixed to a high of 3.5% if product markets are initially highly regulated.[10]

The remainder of the paper is organized as follows. In section 2, we develop an open economy model with endogenous markups stemming from a limited number of competitors within each industry and unemployment arising from matching frictions. Section 3 analyzes equilibrium dynamics and steady-state. Section 4 provides an analytical exploration of the transmission of a deregulation shock. In Section 5, we report results from numerical simulations and discuss the role of labor and product market parameters. Section 6 summarizes our main results and concludes.

2 The Framework

We look at a small open economy which faces a given world interest rate, $r^{\star}$ and is populated by a constant number of identical households and firms that have perfect foresight and live forever. Households decide on labor market participation and consumption while firms decide on hours worked. The economy contains a large number of sectors. Within each sector, there are a limited number of monopolistically competitive intermediate firms who produce differentiated goods. Hence, within a given sector, the price-elasticity of demand faced by each firm depends on the number of competitors, which results in an endogenous markup. We assume instantaneous entry so that the number of competitors is determined endogenously by the zero-profit condition. Each firm produces a unique variety by renting labor services from a competitive human resource arm. The labor market, in the tradition of Diamond-Mortensen-Pissarides, consists of a matching process between the human resource arm who posts job vacancies and unemployed workers who search for a job. Finally, differentiated goods are aggregated into a sectoral good and a perfectly competitive firm aggregates sectoral goods to produce a final good. The final good can be exported or consumed domestically, or can cover both fixed cost and cost of recruiting.[11]

[10] Welfare effects are equivalent variation measures, calculated as the percentage change in the permanent flow of consumption necessary to equate the initial level of welfare to what it would be following the shock.

[11] More details on the model as well as the derivations of the results which are stated below are provided in a Technical Appendix which is available at `http://wwwfr.uni.lu/recherche/fdef/crea/publications2/discussion_papers`.

2.1 Households

The economy that we consider consists of a representative household with a measure one continuum of identical infinitely lived members. At any instant, members in the household derive utility from consumption goods C and experience disutility from working and searching efforts. More precisely, the representative household comprises members who engage in only one of the following activities: working, searching a job, or enjoying leisure. Assuming that the representative individual is endowed with one unit of time, leisure is defined as $l \equiv 1 - L - U$, where L denotes units of labor time and U corresponds to time spent on searching for a job. Hence, the labor force is not constant which enables us to focus on both the transition between employment and unemployment on the one hand, and the transition between leisure and labor force on the other. Unemployed agents are randomly matched with job vacancies according to a matching function described later. Since the timing of a match is random, agents face idiosyncratic risks. To simplify the analysis, we assume that members in the household perfectly insure each other against variations in labor income. The representative household chooses the time path of consumption and labor force to maximize the following objective function:[12]

$$\Upsilon(t) = \int_0^\infty \left[\ln X(t)\right] e^{-\rho t} \mathrm{d}t, \quad X \equiv C - \frac{L_P^{1+1/\sigma_L}}{1+1/\sigma_L}, \tag{1}$$

with ρ the consumer's subjective time discount rate. For later use, we denote by u the unemployment rate defined as $u = \frac{U}{U+L} = \frac{U}{L_P}$ with $L_P = L + U$ the labor force.

At each instant of time, mU unemployed agents find a job and sL employed individuals lose their job. Employment evolves gradually according to:

$$\dot{L}(t) = mU(t) - sL(t), \tag{2}$$

where m denotes the rate at which unemployed agents find jobs and s is the constant rate of job separation; $1/m$ can be interpreted as the average unemployment duration; m is a function of labor market tightness θ which is defined as the ratio of the number of job vacancies over unemployed agents in the economy.

[12] Following Greenwood et al. [1988], the sub-utility functional form is specified so as to eliminate the wealth effect in the household's labor force participation decision. We have alternatively explored the effects of a deregulation shock in product markets when preferences are separable in consumption and labor (see the Technical Appendix):

$$\Upsilon(t) = \int_0^\infty \phi(t) e^{-\rho t} \mathrm{d}t, \quad X \equiv \ln C - \frac{L_P^{1+1/\sigma_L}}{1+1/\sigma_L}.$$

In this case, the decline in the marginal utility of wealth produced by deregulation in product markets provides an incentive to exit the labor force which results in a fall in employment. Since empirical evidence overwhelmingly suggest that deregulation in product markets produces an increase in employment, we consider Greenwood et al.'s [1988] preferences. One additional advantage of such preferences given by (2) is that the model can be solved analytically.

Households supply $L(t)$ units of labor services for which they receive the product wage $w(t)$. They accumulate internationally traded bonds, $B(t)$, that yield net interest rate earnings $r^{\star}B(t)$. We denote by $A(t)$ the stock of financial wealth held by households which comprises the shadow value of employment defined later. Denoting by T the lump-sum taxes, the flow budget constraint is equal to households' real disposable income less consumption expenditure C:

$$\dot{A}(t) = r^{\star}A(t) + w(t)L(t) + B^{U}U(t) - T(t) - C(t), \tag{3}$$

where B^{U} represents unemployment benefits received by job seekers.

The representative household selects consumption, time dedicated for searching a job, and financial wealth:[13]

$$\frac{1}{X} = \lambda, \tag{4a}$$

$$L_{P}^{1/\sigma_{L}} = m(\theta)\,\xi + B^{U}, \tag{4b}$$

$$\dot{\lambda} = \lambda\left(\rho - r^{\star}\right), \tag{4c}$$

$$\dot{\xi} = \left(s + r^{\star}\right)\xi - \left(w - L_{P}^{1/\sigma_{L}}\right), \tag{4d}$$

where λ and ξ denote the shadow prices of wealth and finding a job, respectively. Eq. (4b) shows that labor market participation is a positive function of the reservation wage w^{R}, which is defined as the sum of the expected value of a job $m\xi$ and the unemployment benefit B^{U}. Solving eq. (4d) forward and invoking the transversality condition yields:

$$\xi(t) = \int_{t}^{\infty}\left[w(\tau) - w^{R}(\tau)\right]e^{(s+r^{\star})(t-\tau)}\mathrm{d}\tau. \tag{5}$$

Eq. (5) states that ξ is equal to the present discounted value of the surplus from an additional job consisting of the excess of labor income over the household's outside option. Note that as described above, we consider a representative household who splits available time between leisure and market activities (i.e., time devoted to job search and work). While labor supply is elastic at the extensive margin, search effort and worked hours are supplied inelastically.[14]

Equation (4a) can be solved for consumption:

$$C = C\left(\bar{\lambda}, L, U\right). \tag{6}$$

[13] First-order conditions consist of (4a) and (4c) together with $L_{P}^{1/\sigma_{L}}/X = m\xi' + B^{U}\lambda$ and $\dot{\xi}' = (s+\rho)\,\xi' - \left[\lambda w - L_{P}^{1/\sigma_{L}}/X\right]$. Denoting by $\xi \equiv \xi'/\lambda$, using (4a) and (4c), we get (4b) and (4d). Since ξ' is the utility value of an additional job and λ is the marginal utility of wealth, ξ is the pecuniary value of an additional job.

[14] More precisely, depending on the search parameters captured by s and m, labor force is split between working time and job search. Along the transitional dynamics, using the fact that $U = L_{P} - L$, agents supply working time L according to the following accumulation equation $\dot{L} = mU - sL = mL_{P} - (m+s)L$, where L_{P} is labor force and L corresponds to hours worked supplied by the representative household.

with $C_L = C_U = L_P^{1/\sigma_L} > 0$, $C_{\bar{\lambda}} = -X/\lambda < 0$. Finally, we require the time preference rate ρ to be equal to the world interest rate $r^\star$ in order to generate an interior solution. This standard assumption in an open economy setting implies that the marginal utility of wealth, λ, must remain constant over time, i. e. $\lambda = \bar{\lambda}$.

2.2 Firms

Final output, Y, is produced in a competitive retail sector using a constant-returns-to-scale production function which aggregates a measure one continuum of sectoral goods:

$$Y = \left[\int_0^1 (\mathcal{Q}_j)^{\frac{\omega-1}{\omega}} \mathrm{d}j\right]^{\frac{\omega}{\omega-1}}, \tag{7}$$

where $\omega > 0$ represents the elasticity of substitution between any two different sectoral goods and $\mathcal{Q}_j$ stands for intermediate consumption of sector j variety. The final good producers behave competitively, and the households use the final good for consumption.

Denoting by P the price of the final output and $\mathcal{P}_j$ the price of the jth sectoral good, the profit of the final good producer is given by:

$$\pi^F = P\left[\int_0^1 (\mathcal{Q}_j)^{\frac{\omega-1}{\omega}} \mathrm{d}j\right]^{\frac{\omega}{\omega-1}} - \int_0^1 \mathcal{P}_j \mathcal{Q}_j \mathrm{d}j. \tag{8}$$

Solving the maximization problem, we obtain the demand for each intermediate input:

$$\mathcal{Q}_j = \left(\frac{\mathcal{P}_j}{P}\right)^{-\omega} Y, \tag{9}$$

where the price of the final output is given by:

$$P = \left(\int_0^1 \mathcal{P}_j^{1-\omega} \mathrm{d}j\right)^{\frac{1}{1-\omega}}. \tag{10}$$

In each of the j sectors, there are $N > 1$ firms producing differentiated goods that are aggregated into a sectoral good by a CES aggregating function. The output of sectoral good j is given by:[15]

$$\mathcal{Q}_j = N^{-\frac{1}{\epsilon-1}} \left[\int_0^N (\mathcal{X}_{i,j})^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}i\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{11}$$

where $\mathcal{X}_{i,j}$ stands for output of firm i in sector j and ϵ is the elasticity of substitution between any two varieties.

Denoting by $\mathcal{P}_{i,j}$ the price of good i in sector j, the profit function for the jth sector good producer denoted by π_j^S is:

$$\pi_j^S = \mathcal{P}_j N^{-\frac{1}{\epsilon-1}} \left(\int_0^N (\mathcal{X}_{i,j})^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}i\right)^{\frac{\epsilon}{\epsilon-1}} - \int_0^N \mathcal{P}_{i,j}\mathcal{X}_{i,j}\mathrm{d}i. \tag{12}$$

[15] By having the term $N^{-\frac{1}{\epsilon-1}}$ in (11), the analysis abstracts from the variety effect and concentrates solely on the effects of markup variation.

The demand faced by each producer $\mathcal{X}_{i,j}$ is:

$$\mathcal{X}_{i,j} = \left(\frac{\mathcal{P}_{i,j}}{\mathcal{P}_j}\right)^{-\epsilon} \frac{\mathcal{Q}_j}{N}, \tag{13}$$

and the price index of sector j is given by:

$$\mathcal{P}_j = N^{-\frac{1}{1-\epsilon}} \left(\int_0^N \mathcal{P}_{i,j}^{1-\epsilon} \mathrm{d}i\right)^{\frac{1}{1-\epsilon}}. \tag{14}$$

Combining (9) and (13), the demand for variety $\mathcal{X}_{i,j}$ can be expressed in terms of the relative price of the final good:

$$\mathcal{X}_{i,j} = \left(\frac{\mathcal{P}_{i,j}}{\mathcal{P}_j}\right)^{-\epsilon} \left(\frac{\mathcal{P}_j}{P}\right)^{-\omega} \frac{Y}{N}. \tag{15}$$

Intermediate output $\mathcal{X}_{i,j}$ is produced using labor $\mathcal{L}_{i,j}$:

$$\mathcal{X}_{i,j} = \mathcal{L}_{i,j}. \tag{16}$$

As it is common in the literature, we assume that the production function is linear in labor.[16]

In our model, we have a monopolistically competitive set-up where non-zero profits signal entry or exit. We also have search activities where there could be surpluses (over the cost of posting vacancies). We do not want these surpluses (emanating from posting vacancies) to cause entry or exit from the industry. So we propose a human resource arm of the firm that negotiates with labor and then gets a payment for this that is consistent with zero profits for this agency in the long run.[17] It is important to note that we are not proposing this human resource agency as a separate firm capable of exploiting its monopoly power in selling the labor it has located to the parent firm.[18]

As discussed above, to avoid an interaction between hiring costs and market power, we break up the hiring decision by assuming that each intermediate producer uses labor services at a cost W paid to the employment agency sector. As intermediate good producers face a labor cost W per employee, the profit function of the intermediate good producer i in sector j denoted by $\pi_{i,j}^P$ is:

$$\pi_{i,j}^P = \mathcal{P}_{i,j}\mathcal{L}_{i,j} - \mathsf{W}\mathcal{L}_{i,j} - P\varphi, \tag{17}$$

[16] We have analyzed the implications of decreasing returns to scale in labor for steady-state changes and find that all results remain unchanged qualitatively.

[17] There are many agencies with free entry. Free entry means that in the steady state the surplus of these agencies would just cover the cost of posting a vacancy.

[18] Each intermediate good producer acts as a seller in a monopolistically competitive market while interacts competitively with an employment agency (who do not possess monopoly power). A similar description is used in Christiano et al. [2010] who assume that the employment agency is competitive in the supply of labor services. An alternative way (suggested by a referee) is that there is a continuum of these human resource firms (or employment agencies) that behave competitively in selling labor to the producing firms i.e., there is no bargaining in the second stage, after the worker meets the employment agency.

where φ corresponds to fixed costs measured in terms of the final good. Denoting by e the price-elasticity of demand and by μ the mark-up with $\mu \equiv \frac{e}{e-1}$, the first-order condition reads:

$$\mathcal{P}_{i,j}\frac{1}{\mu} = \mathsf{W}. \tag{18}$$

We consider a symmetric equilibrium where all firms in the intermediate good sector produce the output level $\mathcal{X}_{i,j} = \mathcal{X}$ with the same quantity of labor $\mathcal{L}_{i,j} = \mathcal{L}$, set the same price $\mathcal{P}_{i,j} = \mathcal{P}$, and have the same gross profits $\pi^P_{i,j} = \pi^P$. Considering the final good as the numeraire and normalizing its price to one, we have $\mathcal{P} = P = 1$. In equilibrium, eq. (18) rewrites as:

$$\frac{1}{\mu} = \mathsf{W}. \tag{19}$$

Eq. (19) determines firms' choice of working time. More precisely, the markup-adjusted marginal product of labor $1/\mu$ indicates the cost W that firms are willing to pay for an additional worker. The smaller the markup, the larger the marginal profitability of hiring and the higher labor demand. As described below, $1/\mu$ signals to employment agencies the price the firm will pay for an additional worker. Human resource arms know perfectly they can rent labor services to firms at rate W and then choose time paths of vacancies and working time to maximize their present value of discounted flow of profits subject to the employment accumulation constraint.

We now show that under some assumptions, the markup is endogenous and depends on the number of competitors. According to the Dixit and Stiglitz [1977] assumption, the number of competitors is large enough within each sector to yield a fixed price-elasticity of demand. Yet, as emphasized by Yang and Heijdra [1993], this assumption is an approximation when the final good is aggregated by a finite number of intermediate goods. We depart from the usual practice, following Galí [1995], in assuming that the number of firms is large enough so that we can ignore the strategic effects but not so large that the effect of entry is minuscule on the firm's demand curve. Consequently, the price elasticity of demand faced by a single firm is no longer constant and equal to the elasticity of substitution between any two varieties, but rather a function of the number of firms N. Taking into account that output of one variety does not affect the general price index P, but influences the sectoral price level, in a symmetric equilibrium, the resulting price elasticity of demand is:

$$e\left(N\right) = \epsilon - \frac{(\epsilon - \omega)}{N}, \quad N \in (1, \infty). \tag{20}$$

Assuming that $\epsilon > \omega$ (see Jaimovich and Floetotto [2008]), the price elasticity of demand faced by one single firm is an increasing function of the number of firms N within a sector.

Henceforth, the markup $\mu = \frac{e}{e-1}$ decreases as the number of competitors increases, i.e. $\mu_N < 0$.

2.3 Hiring

In the light of our discussion above, we assume that a human resource arm posts vacancies and hires labor, receiving the mark-up adjusted marginal product of labor W and paying the wage w decided by the generalized Nash bargaining solution. The human resource arm maintains job vacancies $\mathcal{V}$ to hire workers at a cost per vacancy κ which is assumed to be constant and measured in terms of the final good (with $P = 1$). Assuming that the cost of hiring is symmetric across human resource arms, its profit denoted by π^H is:

$$\pi^H = \mathsf{W}\mathcal{L} - w\mathcal{L} - \kappa P \mathcal{V}. \tag{21}$$

Denoting by f the rate at which a vacancy is matched with unemployed agents, the law of motion for labor is given by:

$$\dot{\mathcal{L}} = f(\theta)\,\mathcal{V} - s\mathcal{L}, \tag{22}$$

where $f\mathcal{V}$ represents the flow of job vacancies which are fulfilled; note that f decreases with labor tightness θ.

Denoting by γ the shadow price of employment to the human resource arm, and keeping in mind that f is taken as given, the maximization problem yields the following first-order conditions:

$$\gamma = \frac{\kappa}{f(\theta)}, \tag{23a}$$

$$\dot{\gamma} = \gamma\left(r^\star + s\right) - \left(\mathsf{W} - w\right). \tag{23b}$$

Eq. (23a) requires the marginal cost of vacancy, κ, to be equal to the marginal benefit of vacancy, $f(.)\,\gamma$. Solving equation (23b) forward and invoking the transversality condition yields:

$$\gamma(t) = \int_t^\infty \left\{ \frac{1}{\mu\left[N(\tau)\right]} - w(\tau) \right\} e^{(s+r^\star)(t-\tau)} \mathrm{d}\tau. \tag{24}$$

Eq. (24) states that γ is equal to the present discounted value of the cash flow earned on an additional worker, consisting of the excess of the labor cost paid by the intermediate good producer to the human resource arm over the Nash bargaining wage. Aggregating across symmetric human resource arms, overall labor and vacancies are $L = N\mathcal{L}$ and $V = N\mathcal{V}$.

2.4 Matching and Wage Determination

We now set the matching function and the wage determination scheme. As it is common in the literature, the matching function is assumed to take a Cobb-Douglas form:

$$M(V,U) = M_0 V^{\alpha_V} U^{1-\alpha_V}, \quad \alpha_V \in (0,1), \tag{25}$$

where M describes the number of job matches and α_V represents the elasticity of vacancies in job matches. We express the number of labor contracts per unemployment units:[19]

$$m = m(\theta) = M_0 \theta^{\alpha_V}, \quad f = f(\theta) = \frac{m(\theta)}{\theta} = M_0 \theta^{\alpha_V - 1}, \tag{26}$$

with

$$\frac{f'\theta}{f} = -(1-\alpha_V), \quad \frac{m'\theta}{m} = \alpha_V. \tag{27}$$

When a vacancy and a job-seeking worker meet, a rent is created which is equal to $\xi + \gamma$, where ξ is the value of an additional job and γ is the value of an additional worker. The division of the rent between the worker and human resource arm is determined by generalized Nash bargaining over the wage rate:

$$\max_w (\xi)^{\alpha_W} (\gamma)^{1-\alpha_W}, \quad \alpha_W \in (0,1), \tag{28}$$

where α_W and $1-\alpha_W$ correspond to the bargaining power of the worker and the employment agency, respectively.

Solving for (28), the product wage w is defined as a weighted sum of the markup-adjusted labor marginal product and the reservation wage:

$$w = \alpha_W \frac{1}{\mu} + (1-\alpha_W) L_P^{1/\sigma_L}. \tag{29}$$

A fall in the markup, which exerts an upward pressure on labor demand (see eq. (19)), or a rise in the labor market tightness, by raising the reservation wage (see eq. (4b)), pushes up the product wage.[20]

[19] Note that the flows of workers in and out of employment are equal to each other in any symmetric equilibrium, i.e., $mU = fV$. Hence equations $\dot{L} = fV - sL$ and $\dot{L} = mU - sL$ indicate that the demand for labor indeed equates the supply.

[20] Note that the Nash bargaining wage depends positively on unemployment benefits B^U. To see it more formally, using the fact that $\xi = \frac{\alpha_W}{1-\alpha_W}\gamma$, $\gamma = \kappa/f$, $m/f = \theta$, we have $(L_P)^{1/\sigma_L} = \frac{\alpha_W}{1-\alpha_W}\kappa\theta + B^U$. Plugging this term into the Nash bargaining wage (29), we have:

$$w = \alpha_W \frac{1}{\mu} + (1-\alpha_W)\left[\frac{\alpha_W}{1-\alpha_W}\kappa\theta + B^U\right] = \alpha_W\left(\frac{1}{\mu} + \kappa\theta\right) + (1-\alpha_W) B^U.$$

2.5 Free Entry and the Number of Firms

In investigating the effects of deregulation in product markets, we impose the simplifying assumption of static entry decisions. This assumption is made to ensure almost closed form solutions and the derivation of easily interpretable expressions.[21]

Since at each instant, new intermediate good producers may enter and produce a new variety, each intermediate-good producer makes zero-profit. The zero-profit condition determines the number of firms:

$$N = \frac{L}{\varphi}\left[1 - \frac{1}{\mu(N)}\right], \tag{30}$$

where L is aggregate stock of employment which is equal to aggregate output, i.e. $Y = L$. The zero profit condition can be solved for the number of intermediate producers:

$$N = N(L, \varphi), \tag{31}$$

where $N_L > 0$, $N_\varphi < 0$. A rise in employment lowers the average cost which provides an incentive for firms to enter the market. By contrast, an increase in fixed costs reduces the number of firms by reducing profit opportunities.

Finally, summing profits in the intermediary producer sector and human resource sector, we have:

$$\Pi = N\pi^P + N\pi^H = L - wL - \kappa V - N\varphi, \tag{32}$$

where $L - N\varphi = L/\mu(N)$. As it shall become clear later, this relationship will be useful when analyzing the behavior of the labor share.

2.6 Government

The final agent in the economy is the government. Unemployed benefits $B^U U$ are covered by lump-sum taxes T according to the following balanced budget constraint:[22]

$$B^U U = T, \tag{33}$$

[21] We assume instantaneous entry to keep analytical tractability. Introducing a cost of entry does not modify our main results (see the Technical Appendix). Additionally, because transitional dynamics cannot be analyzed analytically, we assume instantaneous entry which allows us to study the transitional adjustment by using phase diagrams.

[22] Deregulation can be achieved by simplifying legal procedures, reducing red tape or adopting related types of deregulation, such reforms should not impose the need for collecting taxes. However, rather than considering a deregulation in product markets reflected by an exogenous decline in fixed costs, we could consider alternatively that the government subsidizes entries. Governments often encourage firm entry by means of start-up grants, guaranteed loans, preferential tax treatments, or other forms of subsidies, as new entrants face upfront expenses for research and development, market search etc. Assuming that the government wishes to keep its budget balanced, lump-sum taxes must increase to finance subsidies which in turn produces a negative wealth effect. While labor market variables are unaffected, we find that consumption falls and overall welfare declines (see the Technical Appendix for further details).

where we abstract from government spending for simplicity.[23]

3 Solving the Model

In this section, we characterize the equilibrium dynamics and then discuss the steady-state.

3.1 Saddle-Path Stability

In this subsection, we analyze saddle-path stability; hence, we first derive the system of differential equations.

Linearized System

Differentiating first (4b) w. r. t. time and substituting (4d) yields the dynamic equation for job seekers:

$$\frac{1}{\sigma_L}\left(L_P\right)^{\frac{1}{\sigma_L}-1}\dot{U} = \left(L_P^{1/\sigma_L} - B_U\right)\left[(s+r^\star) + \alpha_V \frac{\dot{\theta}}{\theta}\right] - m\left(\theta\right)\left(w - L_P^{1/\sigma_L}\right) - \frac{1}{\sigma_L}\left(L_P\right)^{\frac{1}{\sigma_L}-1}\dot{L}, \tag{34}$$

where we used the fact that $m\left(\theta\right)\xi = \left(L_P^{1/\sigma_L} - B_U\right)$.

Differentiating eq. (23a) w. r. t. time, substituting into eq. (23b), and eliminating γ by using (23a), yields the dynamic equation for labor market tightness θ:

$$\dot{\theta}(t) = \frac{\theta(t)}{(1-\alpha_V)}\left\{(s+r^\star) - \frac{f\left(\theta\right)\left(1-\alpha_W\right)}{\kappa}\Psi\right\}, \tag{35}$$

where Ψ is the rent created when a job vacancy and a job-seeking worker meet, and is defined as

$$\Psi \equiv \Psi\left(L(t), U(t), \varphi\right) = \frac{1}{\mu\left(N(t)\right)} - \left(L(t) + U(t)\right)^{1/\sigma_L}. \tag{36}$$

Linearizing in the neighborhood of the steady-state, and denoting steady-state values with a tilde, the dynamic system which comprises three equations, i.e. the accumulation equation for employment (2), the dynamic equation for labor market tightness (35) and the dynamic equation for job seekers (34), writes in matrix form:

$$\left(\dot{L}, \dot{\theta}, \dot{U}\right)^T = J\left(L(t) - \tilde{L}, \theta(t) - \tilde{\theta}, U(t) - \tilde{U}\right)^T, \tag{37}$$

where the Jacobian matrix J is given by:

$$J \equiv \begin{pmatrix} -s & m'\tilde{U} & m\left(\tilde{\theta}\right) \\ -\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\tilde{\Psi}_L & (s+r^\star) & -\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\tilde{\Psi}_U \\ (2s+r^\star) + \frac{\alpha_W \tilde{m}\tilde{\Psi}_L}{1-\alpha_V}\frac{\tilde{L}_P\sigma_L}{\left(\tilde{L}_P\right)^{1/\sigma_L}} & -m'\tilde{U} & (s+r^\star) - \tilde{m} + \frac{\alpha_W \tilde{m}}{1-\alpha_V} \end{pmatrix}. \tag{38}$$

[23] Government spending G is considered in the numerical analysis for calibration purpose. Hence, eq. (33) rewrites as $B^U U + G = T$.

For analytical simplicity, we assume that the Hosios condition holds, i. e. $\alpha_V = 1 - \alpha_W$. Under these assumptions, the Trace and Determinant of the Jacobian matrix are[24]

$$\text{Tr J} = (s + r^\star) + r^\star, \tag{39a}$$

$$\text{Det J} = -(s + \tilde{m})(s + r^\star)^2 \left\{ \frac{(s + \tilde{m} + r^\star)}{(s + r^\star)} + \frac{\eta_{\mu,N}\eta_{N,L}}{\mu} \frac{(\alpha_V \tilde{u} + \sigma_L \tilde{\chi})}{(1 - \alpha_V)\tilde{\Psi}} \right\} \lessgtr 0, \tag{39b}$$

where $\tilde{\chi} = \frac{\frac{\alpha_W \tilde{m}\tilde{\Psi}}{s+r^\star}}{\left(\tilde{L}_P\right)^{1/\sigma_L}}$ represents the share of the surplus associated with a labor contract in the marginal benefit of search, $\eta_{\mu,N} < 0$ is the elasticity of the markup to entry and $\eta_{N,L} > 0$ the elasticity of entry to employment.

Condition for Saddle-Path Stability

We now derive the saddle-path stability condition and show that the price-elasticity of demand plays a pivotal role in producing potential dynamic instability. Denoting by ν the eigenvalue, the characteristic equation for the matrix J (38) of the linearized system is given by:

$$(s + r^\star - \nu_i) \left\{ \nu_i^2 - r^\star \nu_i + \frac{DetJ}{s + r^\star} \right\} = 0. \tag{40}$$

Saddle-path stability requires $\frac{DetJ}{s+r^\star} < 0$. Hence, the following inequality must hold:

$$\frac{(1 - \alpha_V)\tilde{\Psi} + \frac{\alpha_W \tilde{m}\tilde{\Psi}}{s+r^\star}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}} > (\alpha_V \tilde{u} + \sigma_L \tilde{\chi}). \tag{41}$$

The trivial special case of exogenous markup implies that $\eta_{\mu,N} = 0$ and thereby the inequality (41) above unambiguously holds. If the markup is endogenous, the sign of eq. (41) is not clear-cut and relies in particular upon the intensity of competition. To see it formally, let rewrite $-\eta_{\mu,N}\eta_{N,L}/\tilde{\mu}$ as follows:[25]

$$-\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}} = \frac{1}{e} - \frac{1}{\epsilon} = \left.\frac{1}{\tilde{\mu}}\right|_{\text{N large}} - \left.\frac{1}{\tilde{\mu}}\right|_{\text{N limited}}. \tag{42}$$

As shown by the RHS of eq. (42), the elasticity of the markup to employment is larger when the intensity of competition is initially low, i.e. $\tilde{\mu}|_{\text{N limited}}$ is high.[26] As a consequence, the saddle-path stability condition is less likely to be fulfilled as the denominator on the LHS of eq. (41) is large. Provided that the intensity of competition is initially high enough, i.e. the number of competitors N is not too small and thereby μ is not too high, the elasticity of the markup to firm entry is not too large. In this case, inequality (41) is fulfilled and the long-run equilibrium is saddle-path. Beside the intensity of competition in product markets,

[24]Imposing the Hosios condition does not affect our main results (see the Technical Appendix for further details). We set $\alpha_V = 1 - \alpha_W$ only for clarity purpose.

[25]It can be shown that the term $-\eta_{\mu,N}\eta_{N,L}/\tilde{\mu}$ is equal to $1/\tilde{e} - 1/\epsilon$. By adding and subtracting 1, and remembering that $\tilde{\mu} = \frac{\tilde{e}}{\tilde{e}-1}$ if the number of competitors is limited or $\tilde{\mu} = \frac{\epsilon}{\epsilon-1}$ if the number of competitors is large, as in the Dixit-Stiglitz specification, we get (42).

[26]More precisely, as N decreases, the gap between $1/e$ and $1/\epsilon$ increases so that $-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}$ becomes large.

additional parameters influence the saddle-path stability condition. As shown by the RHS term of inequality (41), the smaller the initial steady-state unemployment rate, $\tilde{u}$, the less responsive labor supply (i.e. the lower σ_L), the smaller the worker bargaining power or the larger unemployment benefits (i.e. the lower $\tilde{\chi}$), the more likely the condition for saddle-path stability holds.

As long as inequality (41) holds, the linearized dynamic system possesses one negative eigenvalue denoted by ν_1 and two positive eigenvalues denoted by ν_2 and ν_3. Since the number of predetermined variables (L) equals the number of negative eigenvalues and the number of jump variables (θ and U) equals the number of positive eigenvalues, the dynamic system exhibits a saddle-point behavior. Eigenvalues satisfy:

$$\nu_1 < 0 < r^\star < \nu_2, \tag{43}$$

with $\nu_2 = r^\star - \nu_1 > 0$, and $\nu_3 = s + r^\star > 0$.

If inequality (41) does not hold, the determinant of the Jacobian matrix becomes positive, implying that the two characteristic roots ν_1 and ν_2 have positive real parts. Hence, the dynamic system is locally unstable, and the solutions consistent with an equilibrium converging to the long-run equilibrium are the steady state, i.e. $L(t) = \tilde{L}$, $\theta(t) = \tilde{\theta}$ and $U(t) = \tilde{U}$. In the following, we assume that the saddle-path stability condition described by inequality (41) is fulfilled.

Stable Solutions

The stable paths for employment, labor market tightness, and job seekers are given by:

$$L(t) - \tilde{L} = A_1 e^{\nu_1 t}, \quad \theta(t) - \tilde{\theta} = \omega_2^1 A_1 e^{\nu_1 t}, \quad U(t) - \tilde{U} = \omega_3^1 A_1 e^{\nu_1 t}, \tag{44}$$

where we normalized ω_1^1 to unity and elements ω_2^1 and ω_3^1 of the eigenvector (associated with the stable eigenvalue ν_1) are:

$$\omega_2^1 = \frac{(2s + r^\star) + (s + r^\star - \nu_i)\left(\frac{s+\nu_i}{\tilde{m}}\right) + \frac{\tilde{m}\tilde{\Psi}_L}{\tilde{\Psi}_U}}{\frac{m'\tilde{U}}{\tilde{m}}\left(s + \tilde{m} + r^\star - \nu_i\right)}, \tag{45a}$$

$$\omega_3^1 = \left(\frac{s + \nu_1}{\tilde{m}}\right) - \frac{m'\tilde{U}}{\tilde{m}}\omega_2^1. \tag{45b}$$

The signs of (45) will be determined later.

3.2 Intertemporal Solvency Condition

Using the definition of the stock of financial wealth $A(t) \equiv B(t) + \gamma(t)L(t)$, differentiating with respect to time, substituting the accumulation equation of financial wealth and of labor, i.e. eqs. (3) and (2), together with the dynamic equation for the shadow value of an additional worker (23b), using the government budget constraint (see eq. (33)), the accumulation equation for foreign assets is:

$$\dot{B}(t) = r^{\star} B(t) + \frac{L(t)}{\mu\left(N(t)\right)} - C(t) - \kappa V(t). \tag{46}$$

where $\frac{L(t)}{\mu(N(t))}$ corresponds to output net of fixed costs.

The solution for $B(t)$ consistent with the intertemporal budget constraint for the open economy is:[27]

$$B(t) - \tilde{B} = \Phi\left(L(t) - \tilde{L}\right), \tag{47}$$

where $\Phi \equiv \frac{\Lambda}{\mu_1 - r^{\star}}$ with $\Lambda = \left(\frac{1-\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\right) - \kappa \tilde{U} \omega_2^1 + \left(v_{L^P} - \kappa \tilde{\theta}\right)\omega_3^1$. We are not able to sign Φ; yet, for all parametrization, numerical results yield $\Phi < 0$. The reason is that an increase in employment raises the marginal benefit from hiring (and thereby the shadow price γ), which in turn induces agents to switch investment from foreign assets to labor (i.e. shares on employment agency). As a result, the current account is negatively related to changes in employment. The linear approximation of the open economy's intertemporal budget constraint is:

$$\tilde{B} - B_0 = \Phi\left(\tilde{L} - L_0\right). \tag{48}$$

According to (48), the long-run accumulation of employment triggers a long-run fall in foreign bonds holding.

3.3 Steady-State

We now describe the steady-state of the economy which comprises six equations. First, the zero-profit condition describes the long-run relationship between the number of firms and both steady-state labor and fixed costs:

$$\frac{\varphi}{\tilde{L}} = \frac{1}{\epsilon\left(\tilde{N} - 1\right) + \omega}. \tag{49}$$

Since the RHS term of eq. (49) decreases as $\tilde{N}$ rises, a fall in fixed costs or a rise in employment raises the steady-state number of firms.

Second, setting $\dot{\theta} = 0$ into eq. (35), we obtain the vacancy creation equation:

$$\frac{\kappa}{f\left(\tilde{\theta}\right)} = \frac{(1-\alpha_W)}{s + r^{\star}} \left[\frac{1}{\mu\left(\tilde{N}\right)} - \left(\tilde{L} + \tilde{U}\right)^{1/\sigma_L}\right] \tag{50}$$

[27] Substituting first the short-run static solutions for the number of firms and consumption into (46), linearizing around the steady-state, substituting the solutions for $L(t)$, $U(t)$ and $\theta(t)$, and invoking the transversality condition, yields eq. (47).

The LHS term of eq. (50) represents the marginal cost of recruiting. The RHS term represents the marginal benefit of an additional worker which is equal to the share, received by the employment agency, of the rent created by the encounter between a vacancy and a job-seeking worker. Keeping the labor force $\tilde{L}_P = \tilde{L} + \tilde{U}$ fixed, a rise in the number of firms raises the marginal benefit of an additional worker which thereby triggers a long-run increase in labor tightness as the employment agency is induced to post more job vacancies.

Third, using the fact that $\tilde{\xi} = \frac{\alpha_W}{1-\alpha_W}\tilde{\gamma}$, $\tilde{\gamma} = \frac{\kappa}{\tilde{f}}$, and $\frac{\tilde{m}}{\tilde{f}} = \tilde{\theta}$ to rewrite the reservation wage, the decision of search equation reads as:

$$\left(\tilde{L} + \tilde{U}\right)^{1/\sigma_L} = \left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right]. \tag{51}$$

The LHS term of eq. (51) represents the disutility from entering the labor force. The RHS term corresponds to the reservation wage. Since higher labor market tightness increases the probability of hiring and thereby raises the reservation wage, labor force unambiguously increases.

Fourth, setting $\dot{L} = 0$ into eq. (2) implies that the flow of unemployed workers who find a job is equalized with the flow of employed workers who lose their job. Using the definition of the labor force, we obtain the standard negative relationship between the unemployment rate and labor market tightness:

$$\tilde{u} = \frac{s}{s + \tilde{m}}. \tag{52}$$

Hence, by raising the probability of finding a job $\tilde{m}$, increased labor market tightness lowers the unemployment rate in the long-run.

Fifth, substituting first the short-run static solution for consumption and setting $\dot{B} = 0$ into eq. (46), we obtain the zero current account equation:

$$r^\star \tilde{B} + \frac{\tilde{L}}{\mu\left(\tilde{N}\right)} - C\left(\bar{\lambda}, \tilde{L}, \tilde{U}\right) - \kappa\tilde{U}\tilde{\theta} = 0, \tag{53}$$

where the term $\frac{\tilde{L}}{\tilde{\mu}} - \tilde{C} - \kappa\tilde{U}\tilde{\theta}$ represents exports.

Finally, the intertemporal solvency condition (48) can be solved for the equilibrium value of the marginal utility of wealth:[28]

$$\bar{\lambda} = \lambda\left(\varphi\right). \tag{54}$$

Beside the labor force, steady-state consumption is affected by the change in the equilibrium value of the marginal utility of wealth.

[28]It is worthwhile noticing that the system comprising eqs. (49)-(52) can be solved for the steady-state number of firms, labor market tightness, employment and job seekers. All these variables can be expressed in terms of fixed costs, i.e. $\tilde{L} = L\left(\varphi\right)$, $\tilde{\theta} = \theta\left(\varphi\right)$, $\tilde{U} = U\left(\varphi\right)$, $\tilde{N} = N\left(\varphi\right)$. Substituting these equations into (53), we can solve for the stock of foreign assets as a function of the shadow value of wealth and fixed costs: $\tilde{B} = B\left(\bar{\lambda}, \varphi\right)$. Finally, plugging $\tilde{B} = B\left(\bar{\lambda}, \varphi\right)$ and $\tilde{L} = L\left(\varphi\right)$ into eq. (48) yields (54).

3.4 Graphical Apparatus

In order to facilitate the discussion of the model, the steady-state is summarized graphically. Focusing mainly on labor market variables, system (49)-(52) can be reduced to two equations. More precisely, eq. (49) solves for a unique number of firms $\tilde{N} = N\left(\tilde{L}, \varphi\right)$ while eq. (52), which can be restated as $s\tilde{L} = \tilde{m}\tilde{U}$, enables us to express unemployed workers as a function of employment and labor tightness, i.e. $\tilde{U} = \frac{s\tilde{L}}{\tilde{m}}$. Substituting these functions into eq. (50) and eq. (51) yields:

$$\tilde{L} = \frac{\tilde{m}}{\tilde{m}+s}\left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right]^{1/\sigma_L}, \tag{55a}$$

$$\frac{\kappa}{f\left(\tilde{\theta}\right)} = \frac{(1-\alpha_W)}{s+r^\star}\left\{\frac{1}{\mu\left[N\left(\tilde{L},\varphi\right)\right]} - \left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right]\right\}. \tag{55b}$$

This system jointly determines steady-state employment and labor market tightness and is summarized graphically by Figure 2(a) that depicts the logarithm form of the system in the (θ, L)-space.

The first eq. (55a) represents the decision of search schedule (henceforth DS) which is upward-sloping in the (θ, L)-space. The reason is that a rise in the labor market tightness raises the probability of finding a job and thereby the reservation wage. Hence, a worker gets a larger share of the surplus associated with a labor contract via higher wage, and thereby is induced to supply more labor.

The second eq. (55b) represents the vacancy creation schedule (henceforth VC) which is upward-sloping in the (θ, L)-space. The reason is that a rise in the labor market tightness raises the average cost of hiring together with the reservation wage which reduces the surplus from hiring. Hence, to compensate for higher cost and reduced surplus, employment must increase which triggers firm entry and thereby lowers the markup. As long as the condition for saddle-path stability holds, i.e. inequality (41) is satisfied, it can be proven formally that the VC-schedule is steeper than the DS-schedule.[29]

The intersection, denoted by point E, gives the unique solution for steady state labor market tightness $\tilde{\theta}$ and employment $\tilde{L}$. The slope of the stable branch described by eq. (45a) in the (θ, L)-space is ambiguous. If inequality (41) holds, the slope of the stable branch labelled SS is positive and steeper than the locus $\dot{\theta} = 0$, as illustrated in Figure 2(a).[30] Hence, as the

[29] Formally, we have:

$$0 < \left.\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\right|^{DS}_{\dot{L}=0} = \left[\alpha_V\tilde{u} + \sigma_L\tilde{\chi}\right] < \left.\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\right|^{VC}_{\dot{\theta}=0} = \frac{\left[(1-\alpha_V)\tilde{\Psi} + \left(\tilde{L}_P\right)^{1/\sigma_L}\tilde{\chi}\right]}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}}.$$

[30] Denoting by a hat the rate of change relative to initial steady-state, the slope of the stable branch in the

economy moves along the SS path to reach the steady-state E, labor market and employment co-vary. Let assume that initially, the economy starts with a stock of employment L_0 smaller than $\tilde{L}$. As employment increases, the markup falls which raises the overall surplus from hiring. As a consequence, the human resource arm posts job vacancies which raises labor market tightness.

The labor market can alternatively be summarized graphically in the (u, L)-space as shown in Figure 2(b). Using eq. (52), we find a negative relationship between the steady-state unemployment rate and labor market tightness. Hence, both the locus $\dot{L} = 0$ and $\dot{\theta} = 0$ display a negative slope in the (u, L)-space. As long as inequality (41) holds, the VC-schedule is steeper than the DS-schedule in the (u, L)-space. Additionally, as illustrated in Figure 2(b), the stable branch labelled XX is downward-sloping but flatter than the DS-schedule. Along the stable transitional path, employment and the unemployment rate vary in opposite direction. The reason is that a rise in hours worked raises the employment rate L/L_P which in turn lowers the unemployment rate u.

< Please insert Figure 2 about here >

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4 Deregulation Shock: An Analytical Exploration

In this section, we explore the macroeconomic effects of a deregulation shock, i. e. a fall in fixed costs, with a focus on labor market variables.[31]

Denoting by a hat the rate of change relative to initial steady-state, the long-run effects

(θ, L)-space can be written as:

$$\left.\frac{\hat{L}(t)}{\hat{\theta}(t)}\right|_{SS} = \frac{1}{\omega_2^1}\frac{\tilde{\theta}}{\tilde{L}} = \frac{\frac{\left(s+\tilde{m}+r^\star-\mu_1\right)}{(s+r^\star)}\left(1-\alpha_V\right)\tilde{\Psi}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}}.$$

Since $\frac{\left(s+\tilde{m}+r^\star-\mu_1\right)}{(s+r^\star)} > \frac{\left(s+\tilde{m}+r^\star\right)}{(s+r^\star)}$, the SS-schedule is steeper than the VC-schedule in the (θ, L)-space.

[31] Because fixed costs lower firm entry by reducing profit opportunities, such recurring costs act like a cost of entry. As stressed previously, whereas the introduction of a cost of entry would leave unchanged our main results, the dynamics could no longer be analyzed analytically, making use of phase diagrams. Analytical and numerical results for the firm entry-exit model can be found in the Technical Appendix.

of a deregulation shock in product markets are:[32]

$$\hat{\tilde{L}} = \frac{\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]}{\left[(1-\alpha_V)\tilde{\Psi} + \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}\right] + \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]}\hat{\varphi} > 0, \tag{56a}$$

$$\hat{\tilde{\theta}} = \frac{\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}}{\left[(1-\alpha_V)\tilde{\Psi} + \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}\right] + \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]}\hat{\varphi} > 0, \tag{56b}$$

where we consider a fall in fixed costs $\hat{\varphi} < 0$, and $\tilde{\Psi} > 0$, $\tilde{\chi} > 0$, $\eta_{\mu,N} < 0$, $\eta_{N,L} > 0$. Because $\tilde{u} = \frac{s}{s+m(\tilde{\theta})}$, the higher probability of finding a job lowers unambiguously the steady-state unemployment rate.

In a polar case where the markup is fixed, then $\eta_{\mu,N} = 0$ and both steady-state employment and labor market tightness remain unaffected by the drop in φ. When the markup is negatively correlated with the number of competitors, as long as the saddle-path stability condition holds, a fall in fixed costs raises employment. Graphically, as illustrated in Figure 3(a), a drop in fixed costs shifts to the right the VC-schedule which raises both $\tilde{\theta}$ and $\tilde{L}$. When considering the (u, L)-space illustrated in Figure 3(b), improving competitive condition in product markets lowers the unemployment rate as the VC-schedule shifts to the left.

The elasticity of labor supply plays a key role in driving long-run effects. Unlike previous literature investigating the effects of deregulation in product markets, we consider endogenous labor force participation decision. To highlight the role of labor supply at the extensive margin, it is useful to compare graphically the effects of improving competitive conditions when labor force is endogenous (i.e., if $\sigma_L > 0$) with those when labor force is fixed (i.e., if $\sigma_L = 0$). These two cases are depicted in Figure 4(a). While the patterns of the stable path and the VC-schedule remain unchanged, setting $\sigma_L = 0$ implies a flatter DS-schedule shown in the blue line. For a given fall in fixed costs, the shift of the VC-schedule results in larger increases in both steady-state employment and labor market tightness when $\sigma_L > 0$ (rather than $\sigma_L = 0$) as endogenous labor market participation amplifies the multiplicative employment effect that arises in model with search unemployment and endogenous markups. The reason is as follows. For a given increase in the reservation wage triggered by the rise in $\tilde{\theta}$, when labor force participation decision is endogenous, households are willing to join the labor force. Hence, employment increases further which in turn lowers more the markup and thereby induces firms to post more job vacancies. As a result, the labor market tightness increases by a larger amount which in turn raises further the reservation wage and thereby employment. As shown in Figure 4(b), endogenous labor participation decision results in a larger decline

[32] While the signs of eqs. (56a)-(56b) are not clear-cut, assuming that saddle-path stability condition holds implies that the denominator is positive so that the decline in fixed costs captured by $\hat{\varphi} < 0$ unambiguously raises $\tilde{L}$ and $\tilde{\theta}$.

in the unemployment rate as the DS-schedule is steeper than the locus $\dot{L}_P = 0$.[33] The reason is that the larger increase in labor market tightness raises further the probability of finding a job and thereby lowers more the unemployment rate when $\sigma_L > 0$.

Two additional labor market parameters play a pivotal role: the worker bargaining power α_W and unemployment benefits B^U. A higher α_W and/or a smaller B^U rotates to the left the DS-schedule by raising the share of the surplus associated with a labor contract in the marginal benefit of search $\tilde{\chi}$. Hence agents are more willing to join the labor force which in turn raises further employment.

Initial labor market conditions and product market competition also influence the size of the long-run effects of a deregulation shock. Inspection of eq. (56a) shows that countries having initially higher unemployment rate $\tilde{u}$ and poorly competitive product markets as captured by a larger markup $\tilde{\mu}$ will experience a larger increase in employment. Graphically, raising $\tilde{u}$ rotates to the left the DS-schedule. The reason is that a higher unemployment rate must be associated with a smaller $\tilde{\theta}$ which implies a stronger reaction of employment to a given change in the reservation wage. Poor competitive conditions in the product markets lead to a smaller number of competitors and thereby a larger elasticity of the markup to firm entry (see eq. (42)). Hence, labor market tightness increases more following a deregulation shock, and employment as well. Graphically, raising $\tilde{\mu}$ rotates to the right the VC-schedule which becomes less steep.

We turn now to the transitional dynamics which are illustrated in Figures 3(a) and 3(b). By reducing average costs, a fall in fixed costs φ fosters firm entry and thereby raises the number of firms. As intermediate good producers perceive a more elastic demand (reflected by a decline in the markup), they are induced to produce more by renting additional labor services. Higher labor demand raises the marginal cost of labor services W. Because the surplus from hiring increases, the employment agency posts additional job vacancies which in turn raises the labor market tightness on impact. The economy moves instantaneously from E_0 to point E', as displayed in Figure 3(a). The consecutive increase in the reservation wage provides an incentive to enter the labor force. Hence, the number of job seekers increases. Since labor is a state variable and thereby is initially predetermined, the unemployment rate increases abruptly from $\tilde{u}_0$ to $u(0)$ as the economy moves from F_0 to F' (see Figure 3(b)). Over time, employment builds up which reduces further average costs and triggers additional firm entry. As labor demand increases, the surplus from hiring rises further. Hence, the

[33]When labor force is fixed, the intersection of the VC-schedule and the locus $\dot{L}_P = 0$ gives the unique solution for steady-state labor and unemployment rate. Hence, after a deregulation shock, the economy moves along the path $X^{\sigma_L=0}X^{\sigma_L=0}$ to reach the steady-state H_1 if $\sigma_L = 0$.

employment agency posts additional job vacancies. Consequently, employment and labor market co-move along the transitional path SS. At the same time, the number of job seekers declines after its initial rise because increased employment raises the marginal cost of search, i.e. the disutility from entering the labor force. Yet, the rise in employment more than offsets the decline of job seekers so that the labor force increases gradually. The subsequent growth in the employment rate drives down u, as illustrated in Figure 3(b). When the economy reaches the final steady-state, employment and labor tightness are higher while the unemployment rate is smaller.

One major feature of the propagation mechanism of a deregulation shock is that the combined effect of the elastic labor supply and endogenous markups produces a multiplicative effect on labor market variables. As the markup depends on aggregate employment, the increase in labor force participation, triggered by the rise in the labor market tightness (which raises the reservation wage), reduces the markup which in turn raises further the labor market tightness and so on. The larger the elasticity of labor supply, the greater the successive waves of declining magnitude.

Unlike, when the labor force is fixed, the multiplicative employment effect becomes much smaller and transitional dynamics are somewhat modified. As shown in Figure 4(a), firms post less job vacancies which results in a smaller increase in labor market tightness on impact, i.e., the economy jumps initially on stable path $S^{\sigma_L=0}S^{\sigma_L=0}$ (at point G') instead of SS (at point E'). Intuitively, setting $\sigma_L = 0$ implies a smaller probability of filling job vacancies (as labor force remains unchanged) which in turn raises the cost of hiring and thereby induces employment agencies to post less vacancies on impact. Interestingly, as illustrated in Figure 4(b), if $\sigma_L = 0$, the stable path coincides with the locus $\dot{L}_P = 0$ and lies below the stable path XX in the (u, L)-space. On impact, the unemployment rate remains unchanged which contrasts markedly with the initial rise in u when $\sigma_L > 0$. The reason is that setting $\sigma_L = 0$ implies that the unemployment rate is the mirror image of employment (because $u(t) = 1 - L(t)$) and thereby adjusts sluggishly. As employment builds up, the unemployment rate declines monotonically along the path $X^{\sigma_L=0}X^{\sigma_L=0}$.

< Please insert Figure 3 about here >

< Please insert Figure 4 about here >

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5 Deregulation Shock: A Quantitative Exploration

While the model can be solved analytically, we propose some numerical simulations to illustrate key theoretical results.

5.1 Baseline Parametrization

We start by discussing our calibration of the model's parameters. We choose the model period to be one month, which corresponds to the frequency of the employment data we use. The world interest rate $r^{\star}$, equal to the subjective time discount rate ρ, is set to 0.4% (which corresponds to an annual interest rate of 5%). Below, we analyze two different calibrations of the model, one aimed at capturing the European labor markets "rigidities", the other aimed at capturing the U.S. labor markets. For these two calibrations, we present the implications of a deregulation shock.

Our reference period for the calibration corresponds to the pre-deregulation episode, i.e. 1995-1998. While some European countries started earlier like the U.S. or the U.K., i.e. at the end of the seventies or the beginning of the eighties, most of the European countries did not improve competitive conditions in the product market before the signature of the Maastricht Treaty. Further, the period over which the deregulation in product markets fastens coincides with the entry in the euro area. More precisely, the value added weighted sum of fifteen EU members' product market regulations indices show that the largest decrease in the indicator was in 1999.[34] Hence, we choose 1995-1998 as the pre-deregulation period to calibrate our model. Data are summarized in Table 4.

We start with the values of the labor market parameters which are chosen so as to match a typical European economy. Some of the values of the labor market parameters can be taken directly from data, but others need to be endogenously calibrated to fit a set of labor market features. As summarized in Table 4, unemployment rate and the job finding rate average 10% and 6.9% respectively for Europe (15). Hence, the matching efficiency parameter M_0 has been set to 0.105 and the job destruction rate s to 0.8% to target an unemployment rate u of 10% and a monthly job finding rate m of 6.9%, in line with the data shown in Table 4.[35] In the numerical analysis, we assume that unemployment benefits are a fixed proportion of the wage rate, i.e. $B^U = \tau^U w$, with τ^U the replacement rate. The unemployment benefit replacement rate has been set to 51.2%, in line with our estimates shown in Table 4.

[34] We use the aggregate indicator of regulation in energy, transport and communications. Source: Conway, De Rosa, Nicoletti, and Steiner [2006]. Data and calculations are available from the authors upon request.

[35] The data for the job finding rate are taken from Hobijn and Sahin [2009] as the authors provide estimates for the fifteen European countries. Note that EU-15 average (for the job finding rate, replacement rate, unemployment rate) shown in Table 4 are working age population weighted sum of fifteen EU members.

To capture the U.S. labor market, we set the matching efficiency parameter M_0 to 0.7 and the job destruction rate s to 3.03% to target an unemployment rate u of 5.1% and a monthly job finding rate m of 56.3%, in line with the data shown in Table 4.[36] Furthermore, the unemployment benefit replacement rate has been set to 28.3%. We keep other parameters unchanged.[37]

Using U.S. data, Barnichon [2011] reports an elasticity of the matching function with respect to unemployed workers of about 0.6, an estimate which lies in the middle of the plausible range reported by Petrongolo and Pissarides [2001]. Hence, we set the elasticity $1-\alpha_V$ of the matching function with respect to unemployed workers to 0.6. As it is common in the literature, we impose the Hosios [1990] condition, and set the worker bargaining power α_W to 0.6 in the baseline scenario but conduct a sensitivity analysis with respect to this parameter, keeping fixed $1-\alpha_V$.[38]

The next step is to choose a value for κ which reflects the recruiting cost. To target a labor market tightness θ of 0.55, a reference value for most of the matching literature for the US economy, we set the share of recruiting costs in GDP to 1.7% by choosing $\kappa = 0.55$ when calibrating for the US. Then we keep this value of κ for Europe.[39] In this case, we obtain $\theta = 0.33$ for the baseline European economy scenario.

Next, we turn to the parameters for which we conduct some sensitivity analysis: the Frisch elasticity of labor supply at the extensive margin σ_L, and the degree of competition in product markets as captured by the markup μ. Empirical studies based on micro data generally report much larger values for the Frisch elasticity of labor supply on the extensive margin than on the intensive margin. More precisely, while the former falls in the range of 0.6 to 0.8, the latter falls in the range of 0.1 to 0.5. We choose σ_L to be 0.5 in our baseline setting which

[36] To our knowledge, only Hobijn and Sahin [2009] provide estimates for the job finding rates for both the fifteen European countries and the US. While the value for the job finding rate is a bit higher than the standard one estimated by Shimer [2005] who reports a value of 0.45, we choose to take job finding rates provided by Hobijn and Sahin [2009] as the authors have applied the same econometric methodology to the OECD economies of their sample which make the job finding rate comparable across countries.

[37] The data we use for the unemployment replacement rate for both European countries and the US are taken from the OECD database which calculates average of the net unemployment benefit (including social assistance and housing benefits) replacement rates for two earnings levels, three family situations and 60 months of unemployment. It is worthwhile noticing that the unemployment benefit rates are very similar across counties when considering short-term unemployment (less than one year) but display considerable heterogeneity for long-term unemployment. We believe that the last measure is more able to capture the extent of generosity of the unemployment benefit scheme.

[38] The empirical literature usually finds small values for the worker bargaining power. Using a panel of French manufacturing firms, Crépon, Desplat, and Mairesse [1999] estimate that workers capture 25% of the rent while Cahuc, Gianella, Goux and Mairesse [1998] find the workers have an average bargaining power of about 0.2. More recently, estimates by Cahuc, Postel-Vinay and Robin [2006] show that the worker bargaining power falls in the range between 0-40%, depending on the particular industry considered and workers' skills. Hence, we conduct a sensitivity analysis with respect to the worker bargaining power, setting alternatively α_W to 0.2 and 0.9.

[39] A value of 0.55 for the labor market tightness accords well with the direct estimate of 0.539 obtained by Hall (2005a) from the Job Openings and Labor Turnover Survey (JOLTS).

is close to recent microeconometric estimates, see e.g., the discussion by Haefke and Reiter [2011].[40] In light of the data summarized in Table 4, the markup in EU-15 countries over the period 1995-1998 averages 1.4. We set the elasticity of substitution among sectoral goods ω to 1 and the elasticity of substitution among intermediate goods ϵ to 3.8 to target a markup of 1.4.[41]

Numerical results are reported in Table 2. Since data show considerable heterogeneity across European Union members, we conduct a sensitivity analysis with respect to pivotal parameters capturing the regulation of goods and labor markets. We consider seven alternative scenarios: benchmark parametrization (i. e. , $\sigma_L = 0.5$, $\alpha_W = 0.6$, $\epsilon = 3.8$), a smaller worker bargaining power (i. e. , $\alpha_W = 0.2$), a larger worker bargaining power (i. e. , $\alpha_W = 0.9$), poorly competitive product markets (i. e. , $\epsilon = 2.2$), a fixed labor force (i. e. , $\sigma_L = 0$), a weakly responsive labor force (i. e. , $\sigma_L = 0.1$), a highly responsive labor force (i. e. , $\sigma_L = 1$).[42] The eighth column displays the results for the calibration aimed at capturing the United States.

5.2 Calibrating the Deregulation Shock

We are interested in evaluating the size of unemployment effects triggered by a decline in product market regulation, captured by a fall in fixed costs in our theoretical framework. To calibrate the size of the deregulation shock, we adopt the following strategy. We estimate by how much the markup falls following a decrease in the product market regulation. To do so, we choose a particular deregulation phase in the EU-15 countries, corresponding to the period ranging from 1999 to 2005. During this period, EU-15 countries have experienced their fastest deregulation episode, measured by the OECD non-manufacturing regulatory index. More precisely, the weighted sum of fifteen EU members' PMR indices has decreased by 1 unit, i.e. from 2.8 to 1.8, which corresponds to the fastest decline in this index during the last thirty years. Hence, when we simulate the model, we consider a fall in fixed costs which lowers the markup by the same amount equivalent to the above mentioned drop in the PMR index. In adopting this strategy, we believe that we can get some sense of the magnitude of the effects that the fall in fixed costs we consider in numerical experiments might generate.

Following a vast empirical literature (see e.g., Tybout [2003], Griffith et al. [2007], Boulhol

[40] Using the Panel Study of Income Dynamics, Fiorito and Zanella [2008] find that aggregate time-series results deliver a Frisch elasticity of about 0.8, the contribution of employment (extensive margin) accounting for about 4/5 of the aggregate elasticity. Using Japanese data, Kuroda and Yamamoto [2007] report a Frisch elasticity on the extensive margin which falls in the range of 0.6 to 0.8 for both sexes.

[41] Due to the lack of empirical evidence regarding the elasticity of substitution among sectoral goods ω, we set this parameter to 1 and choose a value for ϵ to target a markup of 1.4. In our baseline setting, the choice of parameter values implies a share of fixed cost in GDP of 28%. This value is close to the ratio chosen by Jaimovich and Floetotto [2008]. Furthermore, consumption expenditure and government spending, as a share of initial GDP are 57% and 20%, respectively.

[42] Setting ϵ to 2.2 yields a markup of 1.9.

[2010]), we use price-cost margins as a proxy of market power. We compute the price-cost margin denoted by μ as value added over the sum of labor cost plus capital cost, all variables measured in current prices:[43]

$$\mu_{ijt} = \frac{\text{Value added}_{ijt}}{\text{Labor Costs}_{ijt} + \text{Capital Costs}_{ijt}}, \tag{57}$$

where i indexes countries, j the sector and t years.

Our strategy is to evaluate how much the markup has decreased in Europe as a result of the deregulation movement in the product markets. To do so, we regress the markup on indicators of product market regulation. To capture the intensity of regulation over time, we use the time-series regulatory indicators in product market provided by OECD. These regulatory indicators measure on a scale from 0 to 6 restrictions on competition, in particular barriers of entry and public ownership, which are available for two 1-digit ISIC-rev.3 industries, namely Electricity, gas, and water supply and Transport, storage and communications. Our sample includes 16 OECD countries and covers the period 1985-2003.[44] For these countries, the price-cost margins average 1.1 and 1.3 in Transport, communication and Electricity, gas, and water supply, respectively. We run regressions from 1985 until 2003, except specifications (3) and (4) where data for bargaining coverage end in 2000.

Labor market institutions also influence the price-cost margin by affecting the worker bargaining power and the reservation wage.[45] Following Griffith et al. [2007], we explore the following relationship empirically:

$$\mu_{ijt} = f_i + g_j + t_t + PMR_{ijt}\beta_1' + LMR_{it}\beta_2' + X_{ijt}\beta_3' + \epsilon_{ijt}, \tag{58}$$

where PMR represents a set of time, country, and sector varying indicators of product market regulations, LMR contains a set of time and country varying indicators of labor market regulations and institutions, and X represents a set of controls, including a measure of the deviation of sectoral output from trend and the change in the sectoral inflation rate. Indicators of labor market regulations and institutions include: tax wedge, replacement rate of unemployment benefits, employment protection legislation, union coverage, coordination.

[43] An important advantage of price-cost margin as a measure of market power is that it can vary both across industries and over time. An alternative approach would be to estimate the markups by applying the methodology developed by Roeger [1995]. One problem with this approach is that the time dimension would be sacrificed. The drawback of estimating markups by using price-cost margins is that this measure of market power is biased downwards in the presence of increasing returns to scale, see Roeger [1995].

[44] These countries are: AUS, AUT, BEL, CAN, DEU, DNK, FIN, FRA, GBR, ITA, NLD, NOR, NZL, SPA, SWE, USA.

[45] Boulhol [2010] analyzes the determinants of price-cost margins at sector manufacturing level for OECD countries between 1970 and 2003. Constructing a static theoretical framework with monopolistic competition and imperfect labor markets, Boulhol establishes that the higher the worker bargaining power and the stronger the intensity of competition, the lower the price-cost margin. Additionally, an increase in the tax wedge or in the replacement rate raises the reservation wage which should result in a smaller markup.

Country fixed effects are captured by country dummies, f_i, sectoral fixed effects by sector dummies, g_j, and common macroeconomic shocks by year dummies, t_t.

The estimation method which has been used is based on standard panel data techniques, using Driscoll and Kraay [1998] standard errors for the estimated coefficients.[46] Results are reported in Table 1. We restrict our comments of the results related to variables in our model. In column (1), we regress the price-cost margin on the indicator of product market regulation without controls for labor market regulations. Our panel data estimations suggest that a 1 unit decrease in PMR lowers the markup by 0.028 percentage points. In column (2), we add controls for the labor markets which amplify the fall in the markup up to 0.033 percentage points. Employment protection legislation has the expected sign and is significant. In column (3), we add bargaining coverage and the coordination index as labor market controls. Their coefficients have the expected sign but only the bargaining coverage has a significant impact (at 1%) on μ. In column (4), we split the regulatory index in two indicators, namely public ownership and cost of entry. Interestingly, only public ownership raises significantly the markup.[47]

Following these empirical results, the price-cost margin response to a product market regulation falls in the range of 2.8 to 3.3 percentage points over the period 1985-2003. In the sequel, when simulating the model, we will adopt a fall in fixed costs which reduces the markup by 3 percentage points.

< Please insert Table 1 about here >

5.3 Long-Run and Dynamic Effects of Deregulation in Product Markets

We now discuss the quantitative effects of a deregulation shock. The rise in the intensity of competition following the decline in fixed costs lowers the markup from 1.4 to about 1.37 in the baseline scenario.

[46] According to Driscoll and Kraay [1998], these standard errors are robust to very general forms of cross-sectional as well as temporal dependence, which may very likely plague our macro level variables.

[47] In all cases, the replacement rate is significant but has an unexpected sign. A possible explanation to this fact could be that higher unemployment benefits lower the labor market tightness which in turn reduces the reservation wage and thereby raises the markup. As long as all controls for labor market institutions are included, the coefficient associated to tax wedge has the predicted sign but is never significant. In all specifications, a change in the inflation rate has a negative effect on the price-cost margin and is statistically significant in specifications (3) and (4), i.e. when all labor market controls are included in the regression. According to the predictions of the model developed by Boulhol [2010], the negative impact of the change in the inflation rate on price-cost margins could be explained by price-stickiness. Finally, according to estimates by Nekarda and Ramey [2010], we expect procyclical markups. Yet, perhaps due to the specificity of the sectors, our regressions fail to detect a systematic and statistically significant positive impact on price-cost margins.

Long-Run Effects

In panel A of Table 2 we report numerical results for long-run effects of a deregulation shock. The subsequent increase in employment falls in the range between 0.06% of initial steady-state labor force if $\sigma_L = 0$ and 2.71% if $\sigma_L = 1$. As stressed previously, the interaction between endogenous labor force participation and endogenous markups produces a multiplicative effect on employment. The more responsive the labor supply at the extensive margin, the larger the successive increases in θ of declining magnitude, the greater the long-run rise in labor. In line with the evidence documented by Fiori et al. [2012], we find numerically that increasing competition raises employment by a larger amount when labor market regulation is high. Raising the worker bargaining power α_W from 0.2 to 0.9 raises employment growth from 1.04% to 1.30%.[48]

Furthermore, the combined effect of the decline in the markup reflecting a rise in the labor cost paid by intermediate-good producers (due to additional labor demand) and the increase in the reservation wage raises significantly the Nash bargaining wage w. As shown in the seventh line, the wage growth increases from 1.67% to 2.84% as σ_L is raised from 0 to 1. The fifth line of Panel A indicates that the number of job seekers U declines in most of the scenarios, except when the elasticity of labor supply at the extensive margin is high. The reason for the latter result is that assuming endogenous labor force participation decision implies that the model produces both inflow in unemployment and outflow from unemployment. When the labor force is highly responsive to a change in the reservation wage, the inflow in unemployment more than offsets the outflow from unemployment so that the number of job seekers increases.

The decline in the unemployment rate is moderated, ranging from a low of 0.06 percentage point when labor force is fixed to a high of 0.36 percentage point when the worker bargaining power is large and σ_L is set to 0.5. The moderated drop in $\tilde{u}$ is in line with the result reached by Ebell and Haefke [2009]. Yet, in our model, the major part of the fall in u can be attributed to the increased labor force. More precisely, for a typical European economy, while the number of job seekers falls by 0.06% of initial steady-state labor force when $\sigma_L = 0$, the unemployment rate falls by 0.17 percentage point when σ_L is set to 0.5. Hence, about two thirds of the decline in the unemployment rate can be attributed to endogenous labor force participation decision.

[48] It is worthwhile noticing that our numerical estimates can be compared with estimates by Fiori et al. [2012] who use the PMR OECD index to capture the extent of regulation in product markets. More precisely, we consider a fall in the markup by 3 percentage points which corresponds to a drop in the OECD PMR index by 1 unit. Fiori et al. [2012] report that decreasing the OECD index from 5.25 to 3.08 produces a long-run employment growth by 0.45% when labor market regulation is low and by 2.82% when labor market regulation is high. To compare their estimates with ours, we have to divide 0.45 and 2.82 by $5.25 - 3.08 = 2.17$. While our model overestimates employment growth when LMR is low (i.e., 1.04% rather than 0.18%), it predicts pretty well employment growth when LMR is high (i.e., 1.3% both numerically and empirically).

Numerical results show that the workers' bargaining power play a pivotal role in driving down $\tilde{u}$. Raising α_W from 0.2 to 0.9 amplifies the decline in the unemployment rate from 0.09 to 0.36 percentage points of the labor force. The reason is that as workers obtain a larger share of the surplus, they are more willing to supply labor. By reducing further the markup, this effect compensates the fact that the employment agency receives a smaller share of the surplus from hiring. Moreover, we find that the unemployment rate is also sensitive to the elasticity of labor supply at the extensive margin. More precisely, raising σ_L produces two opposite effects on $\tilde{u}$: on the one hand, raising σ_L amplifies the inflow in unemployment (as more agents are willing to join the labor force as shown in the fifth line of Table 2), and on the other hand, a more responsive labor supply amplifies employment growth. Numerical results show that the latter effect predominates.

The numbers shown in the first and the eighth column of Table 2 compare the change of labor market variables for a calibration capturing Europe and the U.S., respectively. By and large, beneficial effects in labor market outcomes are larger in Europe than in the United States. In particular, a deregulation shock results in a smaller decline in the U.S. unemployment rate than that in Europe, i.e. 0.07 rather than 0.17 percentage point. On the one hand, a lower unemployment benefit replacement rate provides a greater incentive to supply more labor following an increase in the reservation wage, i.e. $\tilde{\chi}$ is larger in the U.S. than in Europe in our baseline calibration. This effect amplifies the decline in the unemployment rate after a deregulation shock. On the other hand, the larger job destruction rate s in the U.S. moderates the long-run increase in employment. According to numerical results, the latter effect predominates so that employment increases more in a typical European country than in the the U.S. which results in a greater decline in the unemployment rate in the former economy.

< Please insert Table 2 about here >

< Please insert Figure 5 about here >

Dynamic Effects

In panel B of Table 2 we report numerical results for impact effects. The computed transitional paths of key variables under the baseline scenario (solid line) are displayed in Figure 5 and are compared to alternative (five) scenarios. The solid line shows results for a "standard" European economy, the dashed line for a smaller worker bargaining power (i.e.,

$\alpha_W = 0.2$), the dashed-dotted line for an economy with initially low intensity of competition in product markets (i.e., $\epsilon = 2.2$ which implies $\tilde{\mu} = 1.9$), the dotted line for fixed labor force (i.e., $\sigma_L = 0$), and the thin solid line for the U.S. economy. The responses of labor market variables are expressed in percent of initial steady-state labor force, with the exception of the Nash bargaining wage and the firm size which are expressed in percentage deviation from its initial steady state, and the labor share expressed in percent of initial GDP. Horizontal axes measure months.

The cut in overhead costs creates profit opportunities which induces new firms to enter the market. Because the number of firms is a jump variable, the markup falls abruptly. The consecutive increase in labor demand provides an incentive to post job vacancies, and more so in economies with a small worker bargaining power or a highly responsive labor force participation. As summarized in Table 2, job vacancies rises by 2.46% and 1.11% of initial labor force if $\alpha_W = 0.2$ or $\sigma_L = 1$, respectively, while V/L_P increases by 0.53% in the baseline scenario. In the former case (i.e. $\alpha_W = 0.2$), the employment agency receives a larger share of the surplus which provides a stronger incentive to post more job vacancies. In the latter case (i.e. $\sigma_L = 1$), because labor force participation is more elastic, employment increases more which lowers further the markup and thereby raises labor demand by a larger amount.

As shown in the fourth line of panel B in Table 2, the number of unemployed increases in all scenarios on impact, except when labor force is fixed, because the higher reservation wage provides an incentive to participate in the labor market. The fifth line of panel B of Table 2 reveals that the unemployment rate increases sharply; the rise of u ranges from 0.15 to 2.40 percentage points as σ_L is raised from 0.1 to 1. The reason is that increasing σ_L from 0.1 to 1 induces more agents to join the labor force which in turn amplifies the rise in u on impact. Furthermore, the wage rate rises substantially on impact, and more so in economies with higher workers' bargaining power, initially poorly competitive product markets, or strongly responsive labor supply. If product markets are initially strongly regulated, μ falls further as the elasticity of the markup to entry is larger. Hence, labor demand increases more which raises further the Nash bargaining wage.

Over time, employment builds up which creates profit opportunities, as depicted in Figure 5(a). Hence, the number of firms increases which results in a decline in the markup. As a consequence, the employment agency posts job vacancies so that the labor market tightness increases monotonically over time, as displayed in Figure 5(b). The consecutive rise in the reservation wage induces agents to supply more labor. The inflow in unemployment pursues, though it slows down over time (see Figure 5(d)). As illustrated in Figure 5(e), after its initial upward jump, the unemployment rate declines over time as employment keeps on increasing along the transitional path. Importantly, the unemployment rate exceeds its original value over about 24 months (i.e. two years). Figure 5(f) shows that the combined effect of an increasing reservation wage and a declining markup, the latter resulting in greater labor demand, pushes up the Nash bargaining wage. Production expands which raises firm size along the transitional path, as shown in Figure 5(h).[49]

When comparing the alternative scenarios shown in Figure 5, the overall picture that can be drawn is that, in the U.S., the employment rate converges rapidly towards the steady-state as the job destruction rate and the job finding rate, which jointly determine the speed of adjustment, are higher. This finding is in line with estimates by Fiori et al. [2012] which reveal that labor market regulation increases the persistence of the employment rate. Additionally, as illustrated in the dotted line, when $\sigma_L = 0$, labor market variables display low variability as the multiplicative employment effect is small (which results in moderated employment growth) and the unemployment rate adjusts sluggishly. Finally, as shown in the dashed-dotted line, the beneficial effects in labor market outcomes are substantial in a country with highly regulated product markets since the markup is more sensitive to entry and thereby decreases more.

5.4 Deregulation in Product Markets and the Labor Share

Blanchard and Giavazzi [2003] find that a deregulation shock has a positive impact on the share of labor income in output. We confirm this result numerically in the short-run in a model with instantaneous entry, while the long-run response of the labor share remains fairly muted.

To write out the shares of profit and labor income in GDP, we have to remember that overall profit plus labor income is equal to output less total fixed costs and the cost of recruiting (see eq. (32)):

$$N\pi^P + N\pi^H + wL = Y - N\varphi - \kappa V \equiv Q.$$

Denoting by $\Pi \equiv N\pi^P + N\pi^H$ overall profits, the share of labor income is given by:

$$\frac{wL}{Q} = 1 - \frac{\Pi}{Q}. \tag{59}$$

The labor share may fall or rise depending on whether the increase in labor income wL is larger or smaller than that of Q. Numerical results provided in the eighth line of panel A in

[49] It is worth noting that a deregulation shock lowers significantly the firm size on impact as employment remains unchanged while entry of new firms lowers output per firm.

Table 2 show that the steady-state labor share remains fairly stable, though it declines very slightly in most of the scenarios.

By contrast, in the short-run, the labor share wL/Q rises substantially, and more so in countries where the workers' bargaining power is smaller, product markets are initially highly regulated, labor supply at the extensive margin is higher. As α_W is reduced, net output Q increases much less as the cost of hiring absorbs more resources because V rises further. If competition in product markets is initially low, a deregulation shock shifts the labor demand by a larger amount which results in higher wages. Raising the elasticity of labor supply pushes up further the reservation wage as θ increases more.

The figures shown in the first and the eighth column of Table 2 compare the change of the labor share for a calibration capturing European and the U.S. labor markets, respectively. Whereas in the former case, as stressed above, the unemployment rate declines more and the product wage rises further, the labor share increases less than in the United States.[50]

Finally, Figure 5(g) depicts the transitional path for the labor share. The labor share declines along the adjustment towards the final steady-state as the rise in labor compensation (driven by increases in w and L) is more than offset by net output Q growth.

5.5 Welfare Effects of a Deregulation in Product Markets

We now investigate the effects of a deregulation shock in product markets on intertemporal welfare Υ which is defined as:

$$\Upsilon = \int_0^\infty \phi(t) \exp\left(-\rho t\right) \mathrm{d}t, \tag{60}$$

where $\phi \equiv \ln X$ with $X \equiv C - \frac{L_P^{1+1/\sigma_L}}{1+1/\sigma_L}$. The measure of overall welfare makes it possible to assess the felicity flows over the agent's infinite planning horizon, say both in the long-run and over the transitional path.

Using the first-order condition (4a), we have $\frac{1}{X} = \bar{\lambda}$. Since the marginal utility of wealth is constant, X must remain constant over time, i.e., $X(t) = \tilde{X} = 1/\bar{\lambda}$. Hence, transitional dynamics for instantaneous welfare degenerate:

$$\phi(t) = \tilde{\phi} = \ln\left(X(t)\right) = \ln\left(\tilde{X}\right) = -\ln\left(\bar{\lambda}\right). \tag{61}$$

According to (61), instantaneous welfare increases if a deregulation shock produces a positive wealth effect, as reflected by a drop in the marginal utility of wealth $\bar{\lambda}$.

[50] The reason is that in the latter case, the employment agency posts more job vacancies and the markup falls less which result in a smaller increase in net output Q.

Calculating the discounted value of instantaneous welfare over the entire planning horizon, we get: $\Upsilon = \frac{\tilde{\phi}}{\rho}$. Differentiating yields the change of overall welfare:

$$\mathrm{d}\Upsilon = -\frac{\hat{\bar{\lambda}}}{r^{\star}}. \tag{62}$$

The last line of panel A in Table 2 summarizes the effects of a decline in fixed costs on overall welfare Υ. The effects on welfare reported are equivalent variation measures, calculated as the percentage change in the permanent flow of consumption necessary to equate the initial level of welfare to what it would be after the deregulation shock. Hence, the measure of welfare is calculated as follows:

$$\zeta - 1 = \frac{\tilde{X} - \tilde{X}_0}{\tilde{C}_0} = -\frac{\tilde{X}_0}{\tilde{C}_0}\hat{\bar{\lambda}}, \tag{63}$$

Eq. (63) determines the change in consumption level that will enable the agent's base level of intertemporal welfare to equal that following the deregulation episode. As shown in Table 2, in all scenarios, a deregulation shock produces substantial welfare gains, ranging from a low of 2.20% when labor force is fixed to a high of 3.51% when a highly regulated economy implements enhancing competitive policies. A deregulation shock yields welfare gains by raising households' disposable income and thereby triggering a positive wealth effect.[51]

6 Conclusion

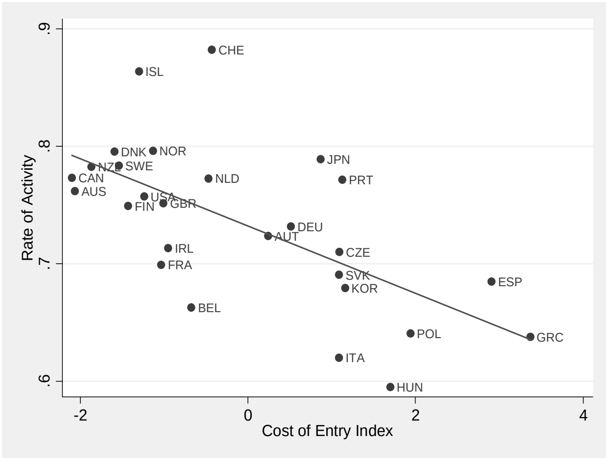
High rates of unemployment remain a key policy concern across many European countries. While labor market institutions have received a lot of attention as the main determinant of unemployment, recent empirical evidence suggest that the degree of regulation in the product markets is an important cause of unemployment. In this paper, we illuminate the dynamic link between product market regulation and unemployment by introducing search unemployment and endogenous markups. In contrast to the previous literature, we (i) consider endogenous labor force participation decision, (ii) fully characterize the transitional paths, (iii) determine the role of labor market parameters in driving the magnitude of the effects of a deregulation shock, and (iv) calibrate the deregulation shock by estimating the relationship between the markup and the product market regulation index provided by the OECD.

An important finding is that endogenous labor force participation decision and endogenous markups produces a multiplicative employment effect which amplifies employment growth and the decline in the unemployment rate. The more responsive the labor force to the reservation wage, the larger the multiplicative employment effect. We find analytically that both labor and

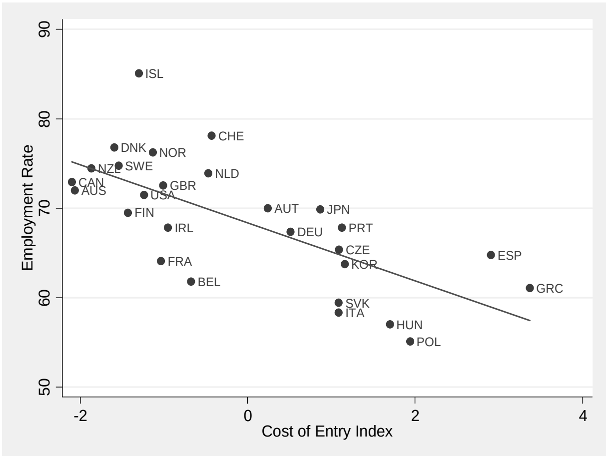
[51]Note that numerical results also show that consumption increases substantially, ranging from 1.17% of initial GDP to almost 3.9% (see the previous last line of panel A of Table 2). The rise in consumption comes from higher labor income and higher dividends paid by the employment agency to households.

product market parameters play a pivotal role in driving short-term and long-term effects of a deregulation episode. Countries with higher worker bargaining power, smaller unemployment benefits and stringent anti-competitive product market regulation would experience larger benefits from improving competitive conditions in goods market.

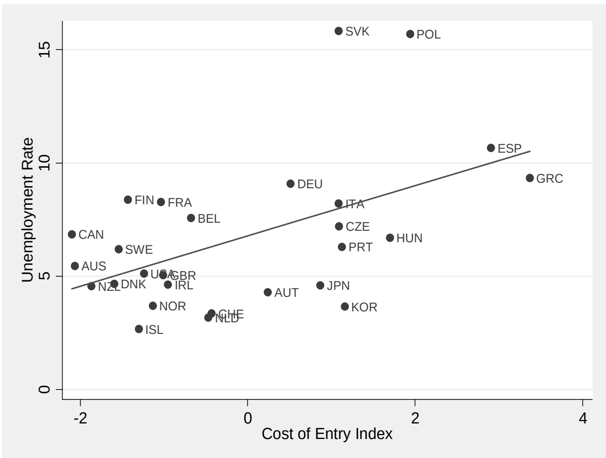
Numerical simulations stress four major points. First, a deregulation shock in product markets reflected by a fall in the markup by three percentage points would lower the steady-state unemployment rate by 0.17 percentage point in a standard European economy while the unemployment would be reduced by only 0.07 percentage point in the US due to a larger job destruction rate that moderates long-run employment growth. On impact, numerical experiments show that the unemployment rate rises substantially in the short-run and remains higher than its original level over about two years, before decreasing below its original level. Second, endogenous labor force participation decision plays a key role in driving down the unemployment rate. We find numerically that the decline in the unemployment rate when the labor market participation is endogenous is almost three times larger than that when labor force is fixed as the multiplicative employment effect is larger. Considering different calibrations, the decline in the unemployment rate ranges from a low of 0.06 percentage point (if labor force is fixed) to a high of 0.36 percentage point (if labor force participation decision is endogenous and worker bargaining power is high). Third, numerical results show that labor share increases substantially in the short-run but remains almost unchanged in the long-run. Finally, deregulation in product markets produces substantial welfare gains by triggering a positive wealth effect which raises consumption.



(a) Rate of Activity against Cost of Entry

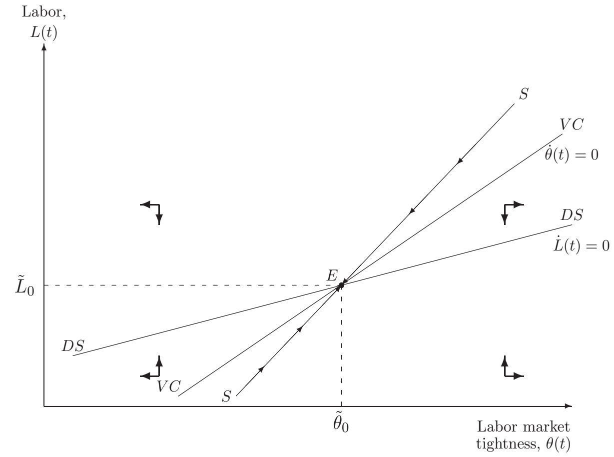


(b) Employment Rate against Cost of Entry

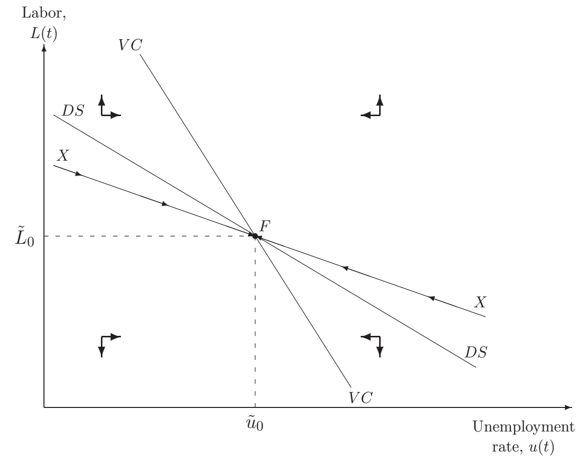


(c) Unemployment Rate against Cost of Entry

Figure 1: Cost of Entry against Participation Rate, Employment Rate and Unemployment Rate. Notes: Our sample includes 27 OECD countries over the period 2004-2008. We proxy the cost of entry with the ease of starting up a business provided by the Doing Business database. While the ease of starting up business includes three variables (the number of steps, the time it takes on average, and the cost as a percentage of GNP per capita), we recourse to a principal component analysis in order to have one overall indicator encompassing all the dimensions of the cost of entry. Rate of activity, employment rate and unemployment rate are taken from the OECD database.

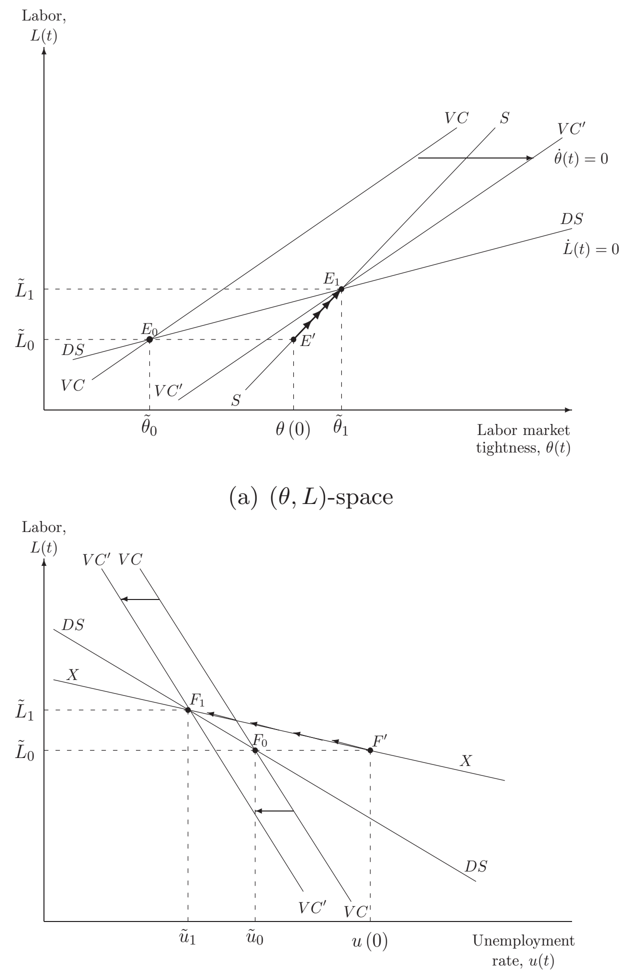


(a) (θ, L)-space



(b) (u, L)-space

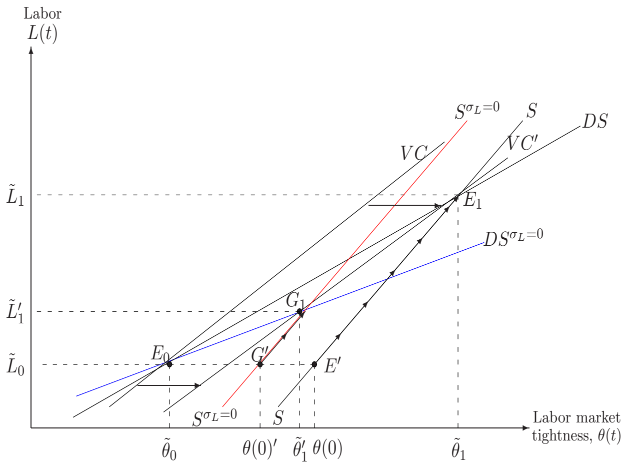
Figure 2: Phase Diagrams



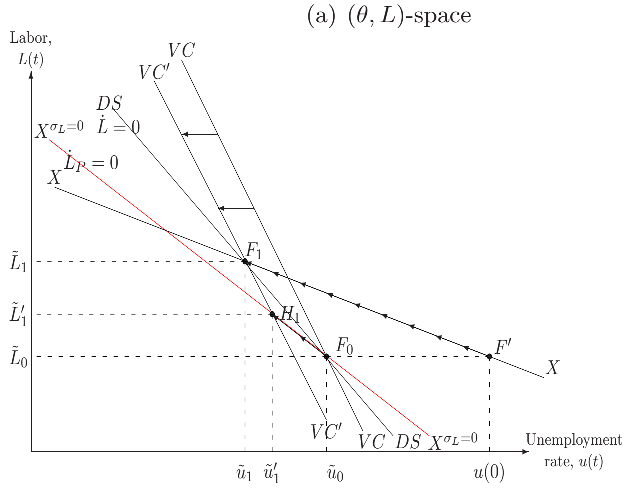
(a) (θ, L)-space

(b) (u, L)-space

Figure 3: Effects of a Deregulation Shock and the Stable Adjustment



(a) (θ, L)-space



(b) (u, L)-space

Figure 4: Effects of a Deregulation Shock when Labor Force is Fixed ($\sigma_L = 0$) or Endogenous ($\sigma_L > 0$)

Table 1: The Impact of Product Market Regulation on Price-cost Margin

Dependent variable	Price-cost Margin			
Specification	(1)	(2)	(3)	(4)
Period	85-03	85-03	85-00	85-00
Product market regulation	0.02882***	0.03321***	0.05175***	
	(0.008)	(0.008)	(0.007)	
Public ownership				0.04577***
				(0.007)
Cost of entry				-0.00190
				(0.011)
Δ Sectoral inflation	-0.00004	-0.00005	-0.00365***	-0.00319***
	(0.000)	(0.000)	(0.001)	(0.001)
Sectoral output gap	0.16497	0.19178	-0.08930	0.01233
	(0.137)	(0.139)	(0.121)	(0.169)
Tax wedge		0.14284	-0.00810	-0.11845
		(0.235)	(0.162)	(0.159)
Employ. protec. legislation		-0.03294***	-0.05639**	-0.05404*
		(0.012)	(0.025)	(0.027)
Replacement rate		0.00183**	0.00419*	0.00607**
		(0.001)	(0.002)	(0.003)
Bargaining coverage			-0.00319***	-0.00426***
			(0.001)	(0.001)
Coordination index			-0.02199	-0.01967
			(0.021)	(0.025)
Observations	586	586	114	114
Number of countries	16	16	16	16
Number of sectors	2	2	2	2

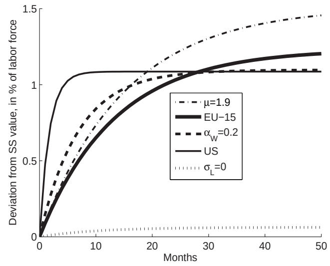
Notes: Fixed effects (sector-country) regressions, using Driscoll-Kraay standard errors in parentheses; ⋆ significant at 10%; ⋆⋆ significant at 5%; ⋆ ⋆ ⋆ significant at 1%.

Table 2: Quantitative Effects of a Deregulation Shock in Product Markets (in %)

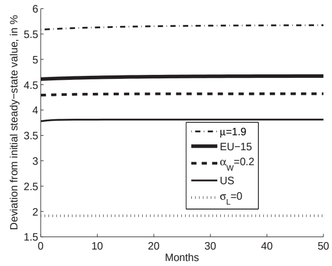
Variables	Europe (15)							U.S.
	Bench EU (15)	Low Bargaining power	High Bargaining power	Weakly competitive	Fixed L_P	Small σ_L	High σ_L	Bench US
	$\tilde{u}_0 = 10\%$	$(\alpha_W = 0.2)$	$(\alpha_W = 0.9)$	$(\mu = 1.9)$	$(\sigma_L = 0)$	$(\sigma_L = 0.1)$	$(\sigma_L = 1)$	$\tilde{u}_0 = 5\%$
A.Long-Term								
Employment, $d\tilde{L}$	1.10	1.04	1.30	1.33	0.06	0.29	2.71	1.03
Labor force, $d\tilde{L}_P$	1.04	1.00	1.17	1.25	0.00	0.17	2.77	1.01
Job vacancies, $d\tilde{V}$	0.14	0.40	0.05	0.14	0.07	0.09	0.24	0.10
Labor market tight., $d\tilde{\theta}$	4.67	4.32	5.77	5.68	1.92	3.80	6.19	3.81
Job seekers, $d\tilde{U}$	-0.06	-0.03	-0.13	-0.08	-0.06	-0.12	0.06	-0.02
Unemployment rate, $d\tilde{u}$	-0.17	-0.09	-0.36	-0.23	-0.06	-0.14	-0.22	-0.07
Nash barg. wage, $d\tilde{w}$	2.14	2.04	2.50	2.58	1.67	1.74	2.84	2.00
Labor share	-0.01	-0.02	0.00	-0.01	0.01	-0.01	-0.01	0.00
Firm entry, $d\tilde{N}$	5.95	6.08	5.23	8.65	7.53	7.06	4.80	6.46
Consumption, $d\tilde{C}$	2.28	2.00	2.78	2.01	1.17	1.42	3.88	2.14
Welfare, $d\Upsilon$	2.72	2.58	2.90	3.51	2.20	2.36	3.27	2.84
B.Impact								
Labor force, $dL_P(0)$	1.03	1.00	1.15	1.23	0.00	0.17	2.68	1.00
Job vacancies, $dV(0)$	0.53	2.46	0.11	0.46	0.10	0.19	1.11	0.67
Labor market tight., $d\theta(0)$	4.61	4.29	5.66	5.59	1.91	3.78	5.99	3.78
Job seekers, $dU(0)$	1.03	1.00	1.15	1.23	0.00	0.17	2.68	1.00
Unemployment rate, $du(0)$	0.91	0.94	0.92	1.09	0.00	0.15	2.40	0.95
Nash barg. wage, $dw(0)$	2.10	2.02	2.42	2.52	1.67	1.73	2.69	1.96
Labor share	0.37	1.88	0.08	0.44	0.05	0.09	0.90	0.52

Notes: We consider a fall in fixed costs which lowers the markup by 0.03, i.e. from 1.4 to 1.37 in the baseline scenario. Impact and steady-state deviations are scaled by initial labor force, except initial and long-run changes of labor market tightness and Nash bargaining wage which are scaled by their initial steady-state values. Steady-state change of consumption is scaled by GDP. Firm entry corresponds the deviation of the number of firms from steady-state value. Effects on welfare are equivalent variation measures, calculated as the percentage change in consumption necessary to equate the initial level of welfare to what it would be following the shock. In the benchmark scenario, main parameters are set as follows: $\alpha_W = 0.6$ and $\sigma_L = 0.5$; ϵ, ω are chosen to target $\mu = 1.4$.

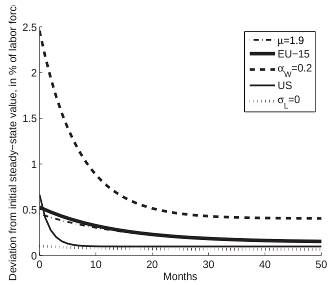
(a) Employment



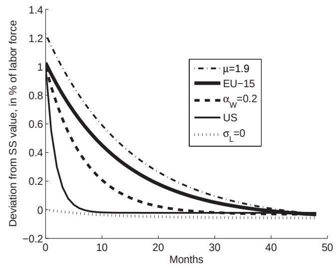
(b) Labor market tightness



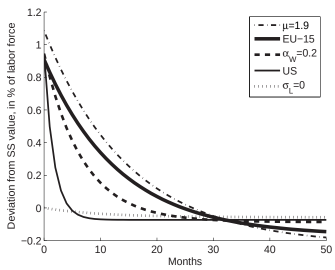
(c) Job vacancies



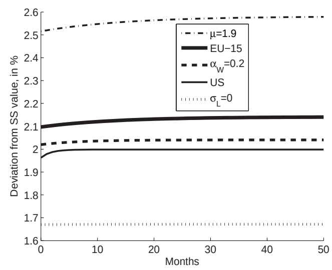
(d) Job seekers



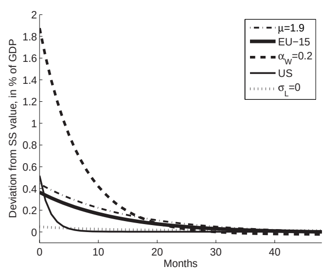
(e) Unemployment rate



(f) Nash bargaining wage



(g) Labor share



(h) Firm size

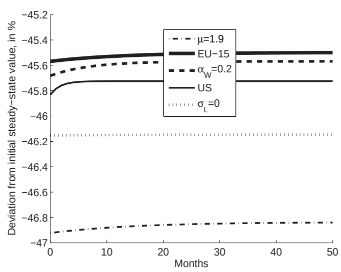


Figure 5: Computed transitional paths

A Data Description

A.1 Data for Scatter-Plots (Figure 1)

Coverage: Our sample consists of a panel of 27 countries over 5 years (2004-2008): AUS, AUT, BEL, CAN, CHE, CZE, DEU, DNK, ESP, FIN, FRA, GBR, GRC, HUN, IRL, ISL, ITA, JPN, KOR, NLD, NOR, NZL, POL, PRT, SVK, SWE, USA.

Regulation in product market index: Our proxy measure of regulation stems from the Doing Business database from the World Bank, as accessed during April 2012. The Doing Business database offers various economic indicators on business regulation in a country, and ranges from 2003 to the present. The variables are either cost measures or other objective measures, such as waiting time for administrative steps, general regulations and their enforcement, and a synthetic ranking of countries based on a combined measure of 10 indices. In the present study, we have focused our attention on one particular aspect of regulation measures, namely the ease of setting up a business (including the number of procedures, the number of days to start a business, and the cost of launching a new business in % of GNP per capita). The reason is that we thought that among the ten business regulation measures available in the World Bank database, ease of starting a business reflects most closely the potential to foster competition in an economy, which is what we were looking for in our context. Furthermore, these variables are also those who are most exhaustive in the World Bank database, thus allowing us to have the best possible view of regulation across our set of countries.

Finally, we have had recourse to a principal component analysis to further reduce the dimensionality of our regulation variables (three variables on the ease of starting a business are available in the World Bank database). To do so, we selected a number of "significant" components, after having run our principal component analysis. Important in this regard has been to determine the significant components. We implemented Horn's test and also verified our results visually via a scree plot. Out of this, we selected the first component, which has been plotted in Figure 1, along the activity rate resp. employment rate, unemployment rate.

Data on Unemployment, rate of activity and rate of employment: Data on unemployment for our set of countries stems from the OECD database library. More particularly, we have focused our attention on the rate of unemployment as a percentage of civilian labor force (i.e. the population aged 16 to 64, employed or actively looking for a job). Similarly, the rate of activity is obtained by dividing the civilian labor force by the population aged 16 to 64 years while the employment rate represent persons in employment as a percentage of the population of working age (15-64 years).

A.2 Data for Empirical Analysis

Coverage: Our sample consists of a panel of 16 countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Netherlands, New Zealand, Norway, Spain, Sweden, United Kingdom, United States) and covers the period 1985-2003, for two 1-digit ISIC-rev.3 industries (Electricity, gas and water supply, and Transport, communication and storage).

Summary statistics of the data used in the empirical analysis are displayed in Table 3. The construction and sources are detailed below.

- Unemployment benefit replacement rate: Gross benefit replacement rates data which cover the period 1985-2003 with one observation every two years for each country. The OECD summary measure is defined as the average of the gross unemployment benefit replacement rates for two earnings levels, three family situations and three durations of unemployment. Source: OECD, Benefits and Wages Database.
- Price-cost margin: Computed as value added over total cost, both measured at current prices. Total cost is equal to the labor cost plus capital cost. To compute the price-cost margin, we use the following variables for:
  1. Value added at current prices. Source: OECD STAN database.
  2. Labor costs: Compensation of employees. Source: OECD STAN database.
  3. Cost of capital. Long-term interest rates minus inflation rate, plus assumed depreciation of 15%. Source: OECD Main Economic Indicators for long-term interest rates and consumer price index. Capital stocks have been calculated using the perpetual inventory method. Source: OECD STAN database.

- Tax wedge: This consists of the employment tax rate plus the direct tax rate. The employment tax rate is the ratio between employers' social security contributions and total compensation for employees net of employers' social security contributions. The direct tax is the ratio between the income tax plus employees' social security contributions and household current receipts. Source: Faggio and Nickell [2006].

- Employment protection legislation (EPL): This index, developed by the OECD, covers the period 1985-2003, and is designed as a multi-dimensional indicator of the strictness of legal protection against dismissals for permanent as well as temporary workers. The higher is EPL, the more restricted is a country's employment protection regulation. Source: OECD labour market statistics database.

- Collective bargaining coverage: The percentage of the employed labor force whose pay is determined by collective agreement. It ranges from 1985 to 2000, by 5-year period intervals. Source: Nickell et al. [2005] for 1985-1994 and OECD, Employment Outlook [2004] for 2000.

- Coordination of wage bargaining: This index describes the coordination level in the wage setting. It ranges from 1 to 5, and the most coordinated countries have index equal to 5. (5:economy-wide bargaining; 4:mixed industry and economy-wide bargaining; 3:industry bargaining; 2:mixed industry- and firm level bargaining; 1: fragmented bargaining, mostly at company level). It covers the period 1985-2003. Source: ICTWSS (Jelle Visser [2009]).

- Product market regulation (PMR): To capture the intensity of regulation over time, we use the time-series regulatory indicators in product market provided by OECD for seven non manufacturing industries. These regulatory indicators are measured on a scale from 0 to 6. The PMR indicators which are used to estimate the relationship (58) have been chosen because they are available over the whole period 1985-2003 for the 16 OECD countries of our sample, unlike the economy-wide indicator which covers only three years (1998, 2003, 2008). One drawback is that the PMR indicator covers only seven non-manufacturing industries (Airlines, Telecoms, Electricity, Gas, Post, Rail, Road). Since data for Gross fixed capital formation, necessary to calculate price-cost margins, are not available at such disaggregated level, we have decided to aggregate up from 2-digit to the following 1-digit ISIC-rev.3 industries: Electricity, gas and water supply, and Transport, communication and storage. Source: Conway, De Rosa, Nicoletti, and Steiner [2006].

- Change in sectoral inflation: Change in growth of the sectoral value added deflators. It covers the period 1985-2003. Source: KLEMS database [2009] and OECD STAN database (for NZL and NOR).

- Sectoral output gap: Deviation of sectoral output from trend. Sectoral value added in volume has been logged and detrended using an Hodrick-Prescott filter with the smoothing parameter set at 100. It covers the period 1985-2003. Source: KLEMS database [2009] and OECD STAN database (for NZL and NOR).

A.3 Data for Calibration

We now describe the data employed to calibrate the model. We use two calibrations aimed at capturing the European and the U.S. labor and product markets.

Coverage: The data consists of 16 countries, including the fifteen European countries and the U.S. and are averages of the period 1995-1998. Our sample covers Manufacturing including Energy and Business sector services. The data used in the numerical analysis are displayed in Table 4.

- Unemployment rate denoted by u: Unemployed (workers as share of the labor force), in %. Average EU-15 unemployment rate shown in Table 4 is the working age population weighted sum of fifteen EU members' unemployment rates. Source: OECD Main Economic Indicators.

- Job finding rate denoted by m: Monthly job finding rates come from Hobijn and Sahin [2009]. Average EU-15 job finding rate shown in Table 4 is the working age population weighted sum of fifteen EU members' job finding rates.

- Unemployment benefit net replacement rate denoted by τ^U: The net replacement rate measure is defined as the average of the net unemployment benefit (including social assistance and housing benefit) replacement rates for two earnings levels, three family situations. Average EU-15

Table 3: Descriptive Statistics (1985-2003)

	mean		s.d.	
Sector (ISIC-Rev.3)	E	I	E	I
Price-cost margin	1.29	1.13	0.37	0.17
Product market regulation	4.13	4.06	1.25	1.41
Cost of entry	4.38	3.96	1.64	1.66
Public ownership	3.46	4.79	1.56	1.27
Δ Inflation	-0.68	0.34	8.31	7.69
Output gap	0.00	0.00	0.05	0.03
Tax wedge	0.29	0.29	0.09	0.09
Empl. protect. legisl.	2.01	2.01	1.01	1.01
Replacement rate	29.77	29.77	13.04	13.04
Bargaining coverage	71.94	71.94	24.31	24.31
Coordination	3.01	3.01	1.36	1.36

Notes: E: Electricity, gas and water supply; I: Transport, storage and communications. The construction and sources are detailed in Appendix A.2.

Table 4: Data to Calibrate the Model (1995-1998)

Countries	Labor market			Markup
	u	m	τ^U	μ
AUT	4.3	15.61	58.2	1.08
BEL	9.5	3.45	63.2	1.30
DNK	5.8	9.64	81.9	1.26
FIN	13.5	13.36	73.9	1.32
FRA	11.2	6.69	58.2	1.26
DEU	8.8	6.98	63.9	1.19
GRE	9.9	5.28	32.2	2.33
IRL	10.3	3.98	64.8	1.74
ITA	11.2	2.58	16.2	1.66
LUX	2.8	8.51	60.2	1.55
NDL	5.8	4.68	69.1	1.29
PRT	6.5	3.88	57.8	1.32
SPA	17.0	3.98	50.3	1.37
SWE	9.1	25.17	70.4	1.34
GBR	7.3	11.27	47.9	1.34
EU-15	10.0	6.96	51.2	1.42
USA	5.1	56.30	28.3	1.50

Notes: u is the harmonized unemployment rate (source: OECD Main Economic Indicators); m is the monthly job finding rate (source: Hobijn and Sahin [2009]); τ^U is the unemployment benefit replacement rate (source: OECD Benefits and Wages Database and Van Vliet and Caminada [2012]); markup is the price-total cost margin (source: OECD). EU-15 represents (weighted) averages of the corresponding variables. The construction and sources are detailed in Appendix A.3.

benefit replacement rate shown in Table 4 is the working age population weighted sum of fifteen EU members' replacement rates. Since OECD data are available only from 2001, we have retropolated the series by using the net replacement rates provided by Van Vliet and Caminada [2012]. Source: OECD, Benefits and Wages Database; Van Vliet and Caminada [2012].

- Price-cost margin (PCM) denoted by μ: PCM is calculated as the ratio value added over total cost. Further details of calculation are described above. Average EU-15 price-cost margin shown in Table 4 is the value added weighted sum of fifteen EU members' price-cost margins. Source: OECD STAN database.

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DEREGULATION SHOCK IN PRODUCT MARKET AND UNEMPLOYMENT

TECHNICAL APPENDIX

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A First-Order Conditions

A.1 Households

Setting

$$X \equiv C + v(L+U), \tag{64}$$

the current-value Hamiltonian for the representative household's optimization problem writes as follows:

$$\mathcal{H}^H = \log X + \lambda\left[r^\star A(t) + wL(t) + B^U U - C(t) - T\right] + \xi'\left[mU - sL\right], \tag{65}$$

where A, L are state variables; λ, ξ' are the corresponding co-state variables; C and U are the control variables.

Assuming that the representative agent takes m as given, first-order conditions for households are:

$$\frac{1}{X} = \lambda, \tag{66a}$$

$$-\frac{v_{L_P}(L+U)}{X} = m\xi' + B^U\lambda, \tag{66b}$$

$$\dot{\lambda} = \lambda(\rho - r^\star), \tag{66c}$$

$$\dot{\xi}' = (s+\rho)\xi' - \left[\frac{v_{L_P}(L+U)}{X} + \lambda w\right], \tag{66d}$$

where ξ' is the utility value of the marginal job and λ the marginal utility of wealth.

Since ξ' represents the utility value from an additional job and $\bar{\lambda}$ corresponds to the marginal utility of wealth, the pecuniary value of the marginal job is $\xi(\tau) \equiv \frac{\xi'(\tau)}{\lambda}$ for $\tau \in [t,\infty)$. Using this definition, we can rewrite (66d) as follows:

$$\dot{\xi} = [s + r^\star + m(\theta)]\xi - \left(w - B^U\right). \tag{67}$$

where we substituted

$$-v_{L_P} = m(\theta)\xi + B^U. \tag{68}$$

Abstracting from search costs implies that the marginal rate of substitution between labor and consumption, $-v_{L_P}$, has to be equal to the wage rate w. In this case, the shadow price of employment ξ is null. As long as agents face search costs, the real wage rate must exceed the disutility from entering the labor force $-v_{L_P}$. Since the quantity $-v_{L_P}$ can be viewed as being the worker's reservation wage, we will refer to $w + v_{L_P}$ as the worker's surplus (by keeping in mind that $v_{L_P} < 0$).

Solving (67) forward and using the transversality condition $\lim_{t\to\infty} \xi L \exp\left(-\left(r^\star + s\right)t\right) = 0$, we get:

$$\xi(t) = \int_t^\infty \left[w(\tau) - w^R(\tau)\right] e^{(s+r^\star)(t-\tau)} \mathrm{d}\tau, \tag{69}$$

where w^R is the reservation wage equal to

$$w^R \equiv -v_{L_P} = m(\theta)\xi + B^U. \tag{70}$$

Differentiating $\gamma(t)L(t)$ w. r. t. time and substituting the law of motion for employment $\dot{L}(t)$ and the dynamic optimality condition (67) yields:

$$\begin{aligned}
\frac{\mathrm{d}}{\mathrm{d}t}(\xi L) &= \dot{\xi}L + \xi\dot{L} = (s+r^\star)\xi L - (v_{L_P} + w)L + \xi(mU - sL), \\
&= r^\star \xi L - \left[(v_{L_P} + w)L - \xi m U\right], \\
&= r^\star \xi L - \left(wL + B^U U + v_{L_P} L_P\right),
\end{aligned}$$

where we substituted $m\xi = -v_{L_P} - B^U$. Solving forward, making use of the transversality condition, we get:

$$\xi(t)L(t) = \int_t^\infty \left[\left(wL + B^U U\right) + v_{L_P} L_P\right] e^{-r^\star(\tau - t)} \mathrm{d}\tau. \tag{71}$$

Differentiating $-v_{L_P}(U+L) = m(\theta)\xi + B^U$ w. r. t. time and substituting $\dot{\xi} = [s + \rho + m(\theta)]\xi - (v_{L_P} + w)$, we can derive the dynamic equation for job seekers:

$$\begin{aligned}
-v_{L_P L_P}\dot{U} &= m(\theta)\dot{\xi} + \alpha_V m(\theta)\xi\frac{\dot{\theta}}{\theta} + v_{L_P L_P}\dot{L}, \\
&= \left[(s+r^\star) + \alpha_V\frac{\dot{\theta}}{\theta}\right] m(\theta)\xi - m(\theta)(w + v_{L_P}) + v_{L_P L_P}\dot{L}.
\end{aligned}$$

where we used the fact that $\frac{m'\theta}{m} = \alpha_V$. Substituting $m\xi = -\left(v_{L_P}(U+L) + B^U\right)$, we get:

$$v_{L_P L_P}\dot{U} = \left(v_{L_P} + B^U\right)\left[(s+r^\star) + \alpha_V \frac{\dot{\theta}}{\theta}\right] + m(\theta)(w + v_{L_P}) - v_{L_P L_P}\dot{L}. \tag{72}$$

A.2 Firms

Final output, Y, is produced in a competitive retail sector using a constant-returns-to-scale production function which aggregates a continuum measure one of sectoral goods:

$$Y = \left[\int_0^1 (\mathcal{Q}_j)^{\frac{\omega-1}{\omega}} \mathrm{d}j\right]^{\frac{\omega}{\omega-1}}, \tag{73}$$

where $\omega > 0$ represents the elasticity of substitution between any two different sectoral goods and $\mathcal{Q}_j$ stands for intermediate consumption of sector j variety. The final good producers behave competitively, and the households use the final good for consumption.

Denoting by P the price of the final output and $\mathcal{P}_j$ the price of the jth sectoral good, the profit of the final good producer writes as follows:

$$\pi^F = P\left[\int_0^1 (\mathcal{Q}_j)^{\frac{\omega-1}{\omega}} \mathrm{d}j\right]^{\frac{\omega}{\omega-1}} - \int_0^1 \mathcal{P}_j \mathcal{Q}_j \mathrm{d}j. \tag{74}$$

Solving the maximization problem, we obtain the demand for each intermediate input:

$$\mathcal{Q}_j = \left(\frac{\mathcal{P}_j}{P}\right)^{-\omega} Y, \tag{75}$$

where the price of the final output is:

$$P = \left(\int_0^1 \mathcal{P}_j^{1-\omega} \mathrm{d}j\right)^{\frac{1}{1-\omega}}. \tag{76}$$

In each of the j sectors, there are $N > 1$ firms producing differentiated goods that are aggregated into a sectoral good by a CES aggregating function. The output of sectoral good j writes as:[52]

$$\mathcal{Q}_j = N^{-\frac{1}{\epsilon-1}}\left[\int_0^N (\mathcal{X}_{i,j})^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}i\right]^{\frac{\epsilon}{\epsilon-1}}, \tag{77}$$

where $\mathcal{X}_{i,j}$ corresponds to output of firm i in sector j and ϵ is the elasticity of substitution between any two varieties.

Denoting by $\mathcal{P}_{i,j}$ the price of good i in sector j, the profit function for the jth sector good producer denoted by π_j^S is:

$$\pi_j^S \equiv \mathcal{P}_j N^{-\frac{1}{\epsilon-1}}\left(\int_0^N (\mathcal{X}_{i,j})^{\frac{\epsilon-1}{\epsilon}} \mathrm{d}i\right)^{\frac{\epsilon}{\epsilon-1}} - \int_0^N \mathcal{P}_{i,j}\mathcal{X}_{i,j}\mathrm{d}i. \tag{78}$$

The demand faced by each producer $\mathcal{X}_{i,j}$ is defined as :

$$\mathcal{X}_{i,j} = \left(\frac{\mathcal{P}_{i,j}}{\mathcal{P}_j}\right)^{-\epsilon} \frac{\mathcal{Q}_j}{N}, \tag{79}$$

and the price index of sector j is given by:

$$\mathcal{P}_j = N^{-\frac{1}{1-\epsilon}}\left(\int_0^N \mathcal{P}_{i,j}^{1-\epsilon} \mathrm{d}i\right)^{\frac{1}{1-\epsilon}}. \tag{80}$$

Combining (75) and (79), the demand for variety $\mathcal{X}_{i,j}$ can be expressed in terms of the relative price of the final good:

$$\mathcal{X}_{i,j} = \left(\frac{\mathcal{P}_{i,j}}{\mathcal{P}_j}\right)^{-\epsilon}\left(\frac{\mathcal{P}_j}{P}\right)^{-\omega} \frac{Y}{N}. \tag{81}$$

[52] Given the term $N^{-\frac{1}{\epsilon-1}}$ in (77), the analysis abstracts from the variety effect and concentrates solely on the effects of markup variation.

Intermediate output $\mathcal{X}_{i,j}$ is produced using labor $\mathcal{L}_{i,j}$:

$$\mathcal{X}_{i,j} = F\left(\mathcal{L}_{i,j}\right). \tag{82}$$

We allow for free entry of firms such that profits are driven down to zero instantaneously. A problem arises here because the surplus from employment of labor may be larger or smaller than the vacancy cost of the firm. We do not want the latter to contaminate the entry decision of firms. Thus, we will use an artificial construct of a firm that is divided between a production branch and a human resource branch. The production branch behaves as if it is paying all factors of production the markup-adjusted marginal product of labor. Each intermediate good producer faces a labor cost W per employee. Hence, the profit function of the intermediate good producer i in sector j denoted by $\pi^P_{i,j}$ is:

$$\pi^P_{i,j} \equiv \mathcal{P}_{i,j} F\left(\mathcal{L}_{i,j}\right) - \mathsf{W}\mathcal{L}_{i,j} - P\varphi. \tag{83}$$

Denoting the mark-up by $\mu \equiv \frac{e}{e-1}$ with e the price-elasticity of demand, first-order condition reads:

$$\mathcal{P}_{i,j} \frac{F_{\mathcal{L}}}{\mu} = \mathsf{W}. \tag{84}$$

Taking into account that output of one variety does not affect the general price index P, but influences the sectoral price level, in a symmetric equilibrium, the resulting price elasticity of demand is:

$$e\left(N\right) \equiv -\frac{\partial \mathcal{X}_{i,j}}{\partial \mathcal{P}_{i,j}} \frac{\mathcal{P}_{i,j}}{\mathcal{X}_{i,j}} = \epsilon - \frac{\left(\epsilon - \omega\right)}{N}, \quad N \in \left(1, \infty\right), \tag{85}$$

where we used the fact that $\frac{\partial P_j}{\partial \mathcal{P}_{i,j}} \frac{\mathcal{P}_{i,j}}{P_j} = \frac{1}{N}$.

We consider a symmetric equilibrium where all firms in the intermediate good sector produce the output level $\mathcal{X}_{i,j} = \mathcal{X}$ with the same quantity of labor $\mathcal{L}_{i,j} = \mathcal{L}$, set the same price $\mathcal{P}_{i,j} = \mathcal{P}$, and have the same profits $\pi^P_{i,j} = \pi^P$. Hence, the aggregate stock of employment is $L = N\mathcal{L}$. In equilibrium, eq. (84) rewrites as:

$$\mathcal{P} \frac{F_{\mathcal{L}}\left(L/N\right)}{\mu} = \mathsf{W}. \tag{86}$$

Additionally, at the symmetric equilibrium, the final output is equal to:

$$Y = NF\left(L/N\right) = N^{1-\alpha_L} L^{\alpha_L}. \tag{87}$$

Eq. (85) and the markup definition $\mu = \frac{e}{e-1}$ can be solved as follows:

$$e = e\left(N\right), \quad \mu = \mu\left(N\right), \tag{88}$$

where the partial derivatives of the price-elasticity of demand and the markup with respect to the number of firms are:

$$\eta_{e,N} = \frac{\partial e}{\partial N} \frac{N}{e} = \frac{\epsilon - \omega}{Ne} > 0, \quad \eta_{\mu,N} = \frac{\partial \mu}{\partial N} \frac{N}{\mu} = -\eta_{e,N} \frac{1}{e-1} < 0. \tag{89}$$

In each period, new intermediate good producers may enter. By normalizing the price of the final good P to unity and using the fact that $P = \mathcal{P}$, we have $\mathcal{P} = 1$. Hence, the free-entry condition on gross profits determines the equilibrium number of firms:

$$N^{1-\alpha_L} L^{\alpha_L} \left(1 - \frac{\alpha_L}{\mu\left(N\right)}\right) = N\varphi. \tag{90}$$

Assuming that the production function is linearly homogenous in labor, i.e. setting $\alpha_L = 1$, the zero-profit condition can be rewritten as:

$$L\left(1 - \frac{1}{\mu\left(N\right)}\right) = N\varphi. \tag{91}$$

We assume that a human resource arm posts vacancies and hires labor, receiving the mark-up adjusted marginal product of labor W and paying the wage w decided by the generalized Nash bargaining solution. The human resource arm maintains job vacancies $\mathcal{V}$ to hire workers, at a cost per vacancy

κ which is assumed to be constant and measured in terms of the final good (with $P = 1$). Assuming that the cost of hiring is symmetric across human resource arms, its profit denoted by π^H is:

$$\pi^H \equiv \mathsf{W}\mathcal{L} - w\mathcal{L} - \kappa P\mathcal{V}, \tag{92}$$

where $P\kappa$ represents the cost per job vacancy measured in terms of the final good. Denoting by f the rate at which a vacancy is matched with unemployed agents, the law of motion for labor is given by:

$$\dot{\mathcal{L}} = f(\theta)\,\mathcal{V} - s\mathcal{L}, \tag{93}$$

where $f\mathcal{V}$ represents the flow of job vacancies which are fulfilled; f decreases with labor tightness θ.

The current-value Hamiltonian for the employment agency optimization problem is:

$$\mathcal{H}^H = \mathsf{W}\mathcal{L} - w\mathcal{L} - \kappa P\mathcal{V} + \gamma\left[f(\theta)\,\mathcal{V} - s\mathcal{L}\right], \tag{94}$$

where γ is the co-state variable associated to the labor motion equation (93).

First-order conditions can be written as follows:

$$\gamma = \frac{P\kappa}{f(\theta)}, \tag{95a}$$

$$\dot{\gamma} = \gamma\left(r^\star + s\right) - \left(\mathsf{W} - w\right), \tag{95b}$$

where γ represents the pecuniary value of an additional job to the intermediate-good sector. This can be seen more formally by solving (95b) forward and using the appropriate transversality condition. This yields:

$$\gamma(t) = \int_t^\infty \left[\mathcal{P}\frac{F_{\mathcal{L}}}{\mu} - w(\tau))\right] e^{(s+r^\star)(t-\tau)}\mathrm{d}\tau. \tag{96}$$

Aggregating across symmetric human resource arms, overall labor is $L = N\mathcal{L}$ and total job vacancies are $V = N\mathcal{V}$. The employment accumulation equation can be rewritten as follows:

$$\dot{L} = f(\theta)\,V - sL. \tag{97}$$

Since the flows of workers in and out of employment are equal to each other in any symmetric equilibrium, i.e., we have $mU = fV$. Using this equality together with the accumulation equations of hours worked supplied by households $\dot{L}^S = mU - sL$ and demanded by agencies $\dot{L}^D = fV - sL$ indicate that the demand for labor indeed equates the supply.

Differentiating $\gamma(t)L(t)$ w. r. t. time and substituting the law of motion for employment $\dot{L}(t)$ together with the dynamic optimality condition (95b), we obtain:

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}t}\left(\gamma L\right) &= \dot{\gamma}L + \gamma\dot{L} = \gamma\left(r^\star + s\right)L - \left(\mathsf{W} - w\right)L + \gamma\left(fV - sL\right), \\ &= r^\star\gamma L - \left[\left(\mathsf{W} - w\right)L - \gamma fV\right].\end{aligned}$$

Using the first-order condition (95a) and solving forward, making use of the transversality condition, we get:

$$\gamma(t)L(t) = \int_t^\infty \left[\left(\mathsf{W} - w\right)L - \kappa PV\right] e^{-r^\star(\tau-t)}\mathrm{d}\tau, \tag{98}$$

where we used the fact that $\gamma f = P\kappa$. Keeping in mind that $P = 1$, first-order conditions can be rewritten as follows:

$$\gamma = \frac{\kappa}{f(\theta)}, \tag{99a}$$

$$\dot{\gamma} = \gamma\left(r^\star + s\right) - \left(\mathsf{W} - w\right). \tag{99b}$$

It is worthwhile noticing that a fall in the markup induces intermediate good producers to produce more and thereby to increase employment. Hence, labor demand rises which puts an upward pressure on the labor cost W. As the labor cost paid by intermediate-good producers increases, employment agencies receive a larger amount per worker which thereby stimulates hiring of additional workers. More precisely, the value of an additional worker γ increases on impact. Hence, the present discounted value of the surplus earned on the additional worker exceeds the marginal cost of hiring. As a consequence, the human resource arm posts new job vacancies.

B Derivation of the Wage Rate from Bargaining process

In this section, we derive the wage rate from a generalized Nash bargaining process. The employment agency posts job vacancies on behalf of each intermediate-good producer. Hence, we introduce the subscript k which indicates that we consider a particular pairing between an unemployed worker and a firm. We assume that the wage rate is derived from a bargaining between the agency and the worker; hence, w_k is set so as to maximize the following expression:

$$w_k(t) = \text{argmax}\mathcal{H}_k^W = \text{argmax}\left(\xi_k(t)\right)^{\alpha_W}\left(\gamma_k(t)\right)^{1-\alpha_W}, \quad 0 \leq \alpha_W \leq 1, \tag{100}$$

where α_W and $1-\alpha_W$ correspond to the bargaining power of the worker and the agency, respectively. Since all worker-agency pairings are identical and wages are renegotiated at each instant, the model is symmetric and the wage does not feature a pairing index k, i. e. $w_k = w$. The first-order condition determining the current wage, $w(t)$ writes as follows:

$$\frac{d\mathcal{H}^W}{dw(t)} = \frac{\alpha_W \mathcal{H}^W}{\xi(t)}\frac{\partial \xi(t)}{\partial w(t)} + \frac{\left(1-\alpha_W\right)\mathcal{H}^W}{\gamma(t)}\frac{\partial \gamma(t)}{\partial w(t)} = 0. \tag{101}$$

Using the fact that $\frac{\partial \xi(t)}{\partial w(t)} = 1$ and $\frac{\partial \gamma(t)}{\partial w(t)} = -1$, we get:

$$\alpha_W \gamma(t) = \left(1-\alpha_W\right)\xi(t). \tag{102}$$

By differentiating (102) w. r. t. time, using the fact that $\dot{\gamma} = (r^\star + s)\,\gamma - (\mathsf{W} - w)$ and $\dot{\xi} = (s+\rho)\,\xi - (v_{L_P} + w)$, recalling that $\gamma = \frac{1-\alpha_W}{\alpha_W}\xi$ and $\mathcal{P}\frac{AF_{\mathcal{L}}}{\mu} = \mathsf{W}$ (see (86)), rearranging terms, we obtain the wage rate:

$$w = \alpha_W \frac{\mathcal{P}F_{\mathcal{L}}}{\mu} + \left(1-\alpha_W\right)w^R, \tag{103}$$

where $w^R = -v_{L_P}$ represents the reservation wage.

An alternative expression for the reservation wage w^R which is equal to $-v_{L_P} = B^U + m\,(\theta)\,\xi$ can be derived as follows. Eliminating ξ from (66b) by making use of (102), the reservation wage is:

$$w^R \equiv w^R\,(\theta) = B^U + \frac{\alpha_W}{1-\alpha_W}\kappa\theta = -v_{L_P}, \tag{104}$$

C Short-Run Static Solutions

C.1 Short-Run Static Solution for Consumption-Side

In this subsection, we compute short-run static solution for consumption by making use of the first-order condition (66a):

$$C = C\left(\bar{\lambda}, L, U\right), \tag{105}$$

with

$$C_L = \frac{\partial C}{\partial L} = -v_{L_P} > 0, \quad C_U = \frac{\partial C}{\partial U} = -v_{L_P} > 0, \quad C_{\bar{\lambda}} = \frac{\partial C}{\partial \lambda} = -\frac{X}{\lambda} < 0, \tag{106}$$

where $X \equiv C - \frac{(L+U)^{1+1/\sigma_L}}{1+1/\sigma_L}$.

C.2 Short-Run Static Solutions for Production-Side

The zero profit condition can be solved for the number of intermediate producers:

$$N = N\left(L, \varphi\right), \tag{107}$$

where partial derivatives are given by:

$$\eta_{N,L} \equiv \frac{\hat{N}}{\hat{L}} = \frac{1}{1 - \frac{\eta_{\mu,N}}{\mu-\alpha_L}} > 0, \tag{108a}$$

$$\eta_{N,\varphi} \equiv \frac{\hat{N}}{\hat{\varphi}} = -\frac{1}{\alpha_L\left[1 - \frac{\eta_{\mu,N}}{(\mu-\alpha_L)}\right]} < 0. \tag{108b}$$

D Derivation of the Dynamic Equation of the Current Account

Using the fact that $A \equiv B+\gamma L$, differentiating with respect to time, noticing that $(\dot{\gamma L}) = r^\star \gamma L - N\pi^H$, the accumulation equation of traded bonds is given by:

$$\begin{aligned} \dot{B} &= \dot{A} - \dot{\gamma}(t)L(t) - \gamma(t)\dot{L}(t), \\ &= r^\star (A - \gamma L) + \mathsf{W}L + N\pi^P - C - \kappa V. \end{aligned}$$

Remembering that $N\pi^P + \mathsf{W}L = N^{1-\alpha_L} Y - N\varphi$ with $Y = N^{1-\alpha_L} L^{\alpha_L}$, the current account equation writes as follows:

$$\dot{B}(t) = r^\star B(t) + N(t)^{1-\alpha_L} L(t)^{\alpha_L} - C(t) - \kappa V(t) - N(t)\varphi. \tag{109}$$

E Equilibrium Dynamics and Formal Solutions

Dynamic System

Differentiating (95a) w. r. t. time, using (95b), eliminating γ by using (95a), and substituting the short-run static solution for the number of firms (107), we obtain the dynamic equation for labor market tightness θ:

$$\dot{\theta}(t) = \frac{\theta(t)}{(1-\alpha_V)} \left\{ (s + r^\star) - \frac{f\left(\theta(t)\right)(1-\alpha_W)}{\kappa} \Psi\left(L(t), U(t), \bar{\lambda}, \varphi\right) \right\}. \tag{110}$$

Before linearizing, it is convenient to set:

$$\begin{aligned} \Psi\left(L, U, \varphi\right) &\equiv \Xi\left(L, \varphi\right) + v_{L^P}\left(L(t) + U(t)\right) \\ &= \frac{F_{\mathcal{L}}\left[\frac{L}{N(L,\varphi)}\right]}{\mu\left[N\left(L,\varphi\right)\right]} + v_{L^P}\left(L + U\right), \end{aligned} \tag{111}$$

where Ψ represents the overall surplus from an additional employment and $\Xi\left(L,\varphi\right) = \frac{F_{\mathcal{L}}}{\mu}$ stands for the markup-adjusted marginal product of labor. Partial derivatives are given by:

$$\begin{aligned} \Psi_L &= \Xi_L + v_{L^P L^P}, \\ &= \frac{F_{\mathcal{L}\mathcal{L}}}{N\mu}\left(1 - \eta_{N,L}\right) - \frac{F_{\mathcal{L}}}{\mu L}\eta_{\mu,N}\eta_{N,L} + v_{L^P L^P}, \\ &= -\frac{F_{\mathcal{L}}}{L\mu}\left\{\left(1-\alpha_L\right)\left(1-\eta_{N,L}\right) + \eta_{\mu,N}\eta_{N,L}\right\} + v_{L^P L^P} \lesseqgtr 0, \end{aligned} \tag{112a}$$

$$\Psi_U = v_{L^P L^P} < 0, \tag{112b}$$

$$\begin{aligned} \Psi_\varphi &= \frac{N_\varphi}{\mu N}\left[-F_{\mathcal{L}\mathcal{L}}\frac{L}{N} - F_{\mathcal{L}}\eta_{\mu,N}\right] < 0, \\ &= \frac{F_{\mathcal{L}}}{\mu\varphi}\eta_{N,\varphi}\left\{\left(1-\alpha_L\right) - \eta_{\mu,N}\right\} < 0, \end{aligned} \tag{112c}$$

where $\alpha_L = -F_{\mathcal{L}\mathcal{L}}\mathcal{L}/F_{\mathcal{L}} > 0$.

The sign of Ξ_L which reflects the impact of labor L on the markup-adjusted marginal product of labor is unambiguously positive if the production function is linearly homogenous in labor, i.e. $\alpha_L = 1$. If $\alpha_L < 1$, we show below that Ξ_L is also unambiguously positive. To do so, we rewrite $\left(1-\alpha_L\right)\left(1-\eta_{N,L}\right) + \eta_{\mu,N}\eta_{N,L}$ as follows:

$$\begin{aligned} & \left(1-\alpha_L\right)\left(1-\eta_{N,L}\right) + \eta_{\mu,N}\eta_{N,L} \\ &= -\frac{\eta_{\mu,N}\left(1-\alpha_L\right)}{\left(\mu-\alpha_L\right) - \eta_{\mu,N}} + \frac{\eta_{\mu,N}\left(\mu-\alpha_L\right)}{\left(\mu-\alpha_L\right) - \eta_{\mu,N}} \\ &= \frac{\eta_{\mu,N}\left(\mu-1\right)}{\left(\mu-\alpha_L\right) - \eta_{\mu,N}} < 0, \end{aligned} \tag{113}$$

where we used the fact that $\eta_{N,L} = \frac{(\mu-\alpha_L)}{(\mu-\alpha_L)-\eta_{\mu,N}} > 0$. Since eq. (113) is negative, then Ξ_L is positive.

Linearizing the accumulation equation for labor (4a) and the dynamic equations for labor market tightness (110) and unemployment (72), we get in matrix form:

$$\left(\dot{L},\dot{\theta},\dot{U}\right)^{T} = J\left(L(t)-\tilde{L},\theta(t)-\tilde{\theta},U(t)-\tilde{U}\right)^{T}, \tag{114}$$

where J is given by

$$J \equiv \begin{pmatrix} -s & m'\tilde{U} & m\left(\tilde{\theta}\right) \\ -\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\tilde{\Psi}_L & (s+r^{\star}) & -\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\tilde{\Psi}_U \\ (2s+r^{\star})+\frac{\alpha_W\tilde{m}\tilde{\Psi}_L}{1-\alpha_V}\frac{1}{v_{L_PL_P}} & -m'\tilde{U} & (s+r^{\star})-\tilde{m}+\frac{\alpha_W\tilde{m}}{1-\alpha_V} \end{pmatrix}, \tag{115}$$

where we used the fact that $w-w^R=\alpha_W\left(\frac{F_{\mathcal{L}}}{\tilde{\mu}}-w^R\right)=\alpha_W\tilde{\Psi}$, $v_{L_P}+B^U=-\frac{\alpha_W\tilde{m}}{s+r^{\star}}\tilde{\Psi}$, $\tilde{\Psi}_U=v_{L_PL_P}$, and $\frac{\tilde{f}(1-\alpha_W)}{\kappa}\tilde{\Psi}=(s+r^{\star})$. Additionally, $\tilde{\Psi}_L \lesseqgtr 0$ and $\tilde{\Psi}_U<0$ correspond to Ψ_L and Ψ_U respectively evaluated at the steady-state.

The determinant denoted by Det of the linearized 3×3 matrix (115) displays an ambiguous sign:

$$\begin{aligned}\text{Det J} &= -(s+r^{\star})\Bigg\{(s+\tilde{m})(s+r^{\star})-m'\tilde{U}\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\left(\tilde{\Psi}_L-\tilde{\Psi}_U\right) \\ &\quad +\frac{\alpha_W\tilde{m}}{1-\alpha_V}\left(s+\tilde{m}\tilde{\Psi}_L\frac{1}{v_{L_PL_P}}\right)\Bigg\} \lesseqgtr 0,\end{aligned} \tag{116}$$

where $\left(\tilde{\Psi}_L-\tilde{\Psi}_U\right)=\tilde{\Xi}_L$. The trace denoted by Tr of the linearized 3×3 matrix (115) is given by:

$$\text{Tr J}=(s+r^{\star})+r^{\star}+\frac{\tilde{m}}{1-\alpha_V}\left[\alpha_W-(1-\alpha_V)\right]. \tag{117}$$

Setting α_L to unity, and assuming that $\alpha_W=1-\alpha_V$, we have:

$$\Psi_L=-\frac{\eta_{\mu,N}\eta_{N,L}}{L\mu}+v_{L_PL_P}=-\frac{\eta_{\mu,N}\eta_{N,L}}{L\mu}+\Psi_U.$$

Under these assumptions, the determinant of the Jacobian matrix rewrites as:

$$\begin{aligned}\frac{\text{Det J}}{s+r^{\star}} &= -\left\{(s+\tilde{m})(s+r^{\star})+\alpha_V\frac{s(s+r^{\star})}{(1-\alpha_V)\tilde{\Psi}}\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}+\frac{\tilde{m}}{\tilde{\Psi}_U}\left[(s+\tilde{m})\tilde{\Psi}_U-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}\frac{\tilde{m}}{\tilde{L}}\right]\right\}, \\ &= -\left\{(s+\tilde{m})(s+\tilde{m}+r^{\star})-s\tilde{m}\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}\left[\frac{\alpha_V}{\tilde{\chi}v_{L_P}}+\frac{1}{v_{L_PL_P}\tilde{U}}\right)\right\}, \\ &= -\left\{(s+\tilde{m})(s+\tilde{m}+r^{\star})-\frac{s\tilde{m}}{\tilde{u}\tilde{\chi}v_{L_P}}\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)\right\}, \\ &= -(s+\tilde{m})\left\{(s+\tilde{m}+r^{\star})-\frac{\tilde{m}}{\tilde{\chi}v_{L_P}}\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)\right\}, \\ &= -(s+\tilde{m})(s+r^{\star})\left\{\frac{(s+\tilde{m}+r^{\star})}{(s+r^{\star})}+\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}\frac{\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)}{(1-\alpha_V)\tilde{\Psi}}\right\} \lesseqgtr 0,\end{aligned} \tag{118}$$

where we used the fact that $\tilde{m}/\tilde{\theta}=\tilde{f}$, $\frac{\tilde{f}(1-\alpha_W)}{(s+r^{\star})\kappa}=\frac{1}{\tilde{\Psi}}$, $s\tilde{L}=\tilde{m}\tilde{U}$ to obtain the first line, $\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^{\star}}=\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}=-\tilde{\chi}v_{L_P}$ and $\Psi_U=v_{L_PL_P}$ to get the the second line, $\tilde{u}=\frac{\tilde{U}}{\tilde{L}_P}$ and $\frac{v_{L_P}}{v_{L_PL_P}\tilde{L}_P}=\sigma_L$ to get the third line, $\tilde{u}=\frac{s}{s+\tilde{m}}$ to get the fourth line, $\tilde{\chi}v_{L_P}=-\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^{\star}}$, $\alpha_V=1-\alpha_W$ and collecting terms to get the fifth line (118).

Inspection of eq. (118) shows that saddle-path stability requires that the following inequality holds:

$$\begin{aligned} &\frac{\frac{(s+\tilde{m}+r^{\star})}{(s+r^{\star})}(1-\alpha_V)\tilde{\Psi}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}} > \left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right), \\ \text{or}\quad &\frac{(1-\alpha_V)\tilde{\Psi}+\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^{\star}}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}} > \left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right).\end{aligned} \tag{119}$$

Inspection of (119) shows that inequality holds as long as the denominator in the LHS of the inequality is small. To build intuition in the text, it is convenient to rewrite this term as follows:

$$\begin{aligned} -\frac{\eta_{\mu,N}\eta_{N,L}}{\mu} &= \eta_{\mu,N}\left(\frac{\mu-1}{\mu}\right)\frac{1}{[(\mu-1)-\eta_{\mu,N}]}, \\ &= -\frac{(\epsilon-\omega)}{N\epsilon}\frac{1}{e}, \\ &= \frac{1}{e}-\frac{1}{\epsilon}, \end{aligned} \tag{120}$$

where we substituted $\eta_{\mu,L} = \frac{\mu-1}{(\mu-1)-\eta_{\mu,N}}$ given by eq. (108a) to get the first line, we substituted $\eta_{\mu,N} = -\frac{\epsilon-\omega}{Ne(e-1)}$ given by eq. (89), used the fact that $\left(\frac{\mu-1}{\mu}\right) = \frac{1}{e}$ to derive the second line, we used the expression of the price-elasticity of demand to rewrite $-\frac{(\epsilon-\omega)}{N}$ as $e-\epsilon$. If N is large, as assumed by Dixit and Stiglitz [1977], then e is equal to ϵ so that inequality (119) holds. As N becomes smaller, e decreases and turns out to be smaller than ϵ. More precisely, as N is reduced, the gap between $1/e$ and $1/\epsilon$ increases so that $-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}$ becomes larger. In a nutshell, for the inequality (119) to hold, N must be large enough to guarantee that e is not too small.

Setting α_L to unity, and assuming that $\alpha_W = 1-\alpha_V$, the trace reduces to:

$$\text{Tr J} = (s+r^\star)+r^\star. \tag{121}$$

Denoting by ν the eigenvalue, the characteristic equation for the matrix J (112) of the linearized system writes as follows:

$$(s+r^\star-\nu_i)\left\{\nu_i^2-\left\{r^\star+\frac{\tilde{m}}{1-\alpha_V}\left[\alpha_W-(1-\alpha_V)\right]\right\}\nu_i+\frac{DetJ}{s+r^\star}\right\}=0. \tag{122}$$

The characteristic roots obtained from the characteristic polynomial of degree two write as follows:

$$\nu_i \equiv \frac{1}{2}\left\{\text{Tr}J_1 \pm \sqrt{(\text{Tr}J_1)^2-4\text{Det}J_1}\right\} \gtrless 0, \quad i=1,2. \tag{123}$$

where $\text{Tr}J_1 = r^\star+\frac{\tilde{m}}{1-\alpha_V}\left[\alpha_W-(1-\alpha_V)\right]$ and $\text{Det}J_1 = \frac{DetJ}{s+r^\star}$. We denote by $\nu_1<0$ and $\nu_2>0$ the stable and unstable eigenvalues respectively which satisfy:

$$\nu_1 < 0 < \text{Tr}J_1 < \nu_2. \tag{124}$$

Let ν_3 be the second unstable characteristic root which writes as:

$$\nu_3 = s+r^\star > 0. \tag{125}$$

Since the system features one state variable, L, and one negative eigenvalue, two jump variables, θ and U, and two positive eigenvalues, the equilibrium yields a unique one-dimensional saddle-path.

Condition for Saddle-Path Stability for $\alpha_L \neq 1$

Condition for saddle-path stability (120) has been derived by assuming that the production function is linearly homogeneous in labor, as it is common in the literature investigating the effects of a deregulation shock. We now relax this assumption and derive the condition for saddle-path stability in a more general case where the production function is:

$$\mathcal{X} = (\mathcal{L})^{\alpha_L}. \tag{126}$$

Adopting the same procedure as described above, the determinant of the Jacobian matrix is given by:

$$\frac{\text{Det J}}{s+r^\star} = -(s+\tilde{m})(s+r^\star)\left\{\frac{(s+\tilde{m}+r^\star)}{(s+r^\star)}-\frac{\tilde{\Xi}_L\tilde{L}}{(1-\alpha_V)\tilde{\Psi}}\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)\right\} \lesseqgtr 0, \tag{127}$$

where

$$\tilde{\Xi}_L\tilde{L} \equiv -\frac{F_{\mathcal{L}}}{\mu}\frac{\eta_{\mu,N}(\mu-1)}{(\mu-\alpha_L)-\eta_{\mu,N}} > 0. \tag{128}$$

Similarly to a production function linearly homogeneous in labor, the sign of the determinant (285b) is ambiguous. The condition for saddle-path stability with real-valued roots is given by:

$$\frac{(1-\alpha_V)\tilde{\Psi}+\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^\star}}{\tilde{\Xi}_L\tilde{L}} > \left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right). \tag{129}$$

Hence whether the production function displays constant or decreasing returns to scale w.r.t. labor, the inequality (129) must hold to guarantee saddle-path stability with real-valued roots. This condition is similar to (119).

Condition for Saddle-Path Stability for $\alpha_W \neq 1-\alpha_V$

We now derive the saddle-path stability condition without imposing the Hosios condition. Adopting the same procedure to derive (118), the determinant of the Jacobian matrix is now given by:

$$\frac{\text{Det J}}{s+r^\star} = -\left(s+\tilde{m}\right)\left(s+r^\star\right)\left\{\frac{\left(s+r^\star+\frac{\alpha_W}{1-\alpha_V}\tilde{m}\right)}{\left(s+r^\star\right)} + \frac{\eta_{\mu,N}\eta_{N,L}}{\mu}\frac{\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)}{\left(1-\alpha_V\right)\tilde{\Psi}}\right\} \lessgtr 0, \tag{130}$$

The condition for saddle-path stability coincides with (119):

$$\begin{aligned} &\frac{\frac{\left(s+r^\star+\frac{\alpha_W}{1-\alpha_V}\tilde{m}\right)}{\left(s+r^\star\right)}\left(1-\alpha_V\right)\tilde{\Psi}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}} > \left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right), \\ \text{or}\quad &\frac{\left(1-\alpha_V\right)\tilde{\Psi}+\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^\star}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}} > \left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right), \\ \text{or}\quad &\frac{\left(1-\alpha_V\right)\tilde{\Psi}+\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^\star}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}} > \left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right). \end{aligned} \tag{131}$$

The numerical analysis reveals that as the worker bargaining power α_W increases, the condition for saddle-path stability (131) is less easily satisfied. Yet, the numerical analysis shows that α_W plays a minor role whereas the crucial parameter which can yield instability is the intensity of competition reflected by the markup. If product markets are highly regulated, the markup is large which can prevent inequality (131) to hold.

Formal Solutions for $\theta(t)$ and $U(t)$

Setting the constant $A_2 = 0$ to insure a converging adjustment for all macroeconomic aggregates, the stable paths are given by :

$$L(t)-\tilde{L} = A_1 e^{\nu_1 t} \tag{132a}$$

$$\theta(t)-\tilde{\theta} = \omega_2^1 A_1 e^{\nu_1 t}, \tag{132b}$$

$$U(t)-\tilde{U} = \omega_3^1 A_1 e^{\nu_1 t}, \tag{132c}$$

where $A_1 = L_0 - \tilde{L}$, and elements ω_2^1 and ω_3^1 of the eigenvector (associated with the stable eigenvalue ν_1) are given by:

$$\omega_2^1 = \frac{\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\left[\tilde{\Psi}_L+\tilde{\Psi}_U\left(\frac{s+\nu_1}{\tilde{m}}\right)\right]}{\left(s+r^\star-\nu_1\right)+\frac{1-\alpha_W}{1-\alpha_V}\frac{m'\tilde{U}}{\kappa}\tilde{\Psi}_U} \lessgtr 0, \tag{133a}$$

$$\omega_3^1 = \left(\frac{s+\nu_1}{\tilde{m}}\right) - \frac{m'\tilde{U}}{\tilde{m}}\omega_2^1, \gtrless 0. \tag{133b}$$

We have normalized ω_1^1 to unity. From (133a) and (133b), labor market tightness θ and unemployment are negatively correlated with employment along a stable transitional path.

E.1 Formal Solution for the Stock of Foreign Bonds $B(t)$

Substituting first the short-run static solutions for the number of firms and consumption and linearizing the current account equation yields:

$$\begin{aligned} \dot{B}(t) &= r^\star\left(B(t)-\tilde{B}\right)+\left\{\left[\left(1-\alpha_L\right)\left(\frac{\tilde{L}}{\tilde{N}}\right)^{\alpha_L}-\varphi\right]N_L+v_{L_P}+\alpha_L\left(\frac{\tilde{L}}{\tilde{N}}\right)^{-(1-\alpha_L)}\right\}\left(L(t)-\tilde{L}\right) \\ &\quad +\left(v_{L_P}-\kappa\tilde{\theta}\right)\left(U(t)-\tilde{U}\right)-\kappa\tilde{U}\left(\theta(t)-\tilde{\theta}\right). \end{aligned} \tag{134}$$

Solving the differential equation yields:

$$B(t) = \tilde{B}+\left[\left(B_0-\tilde{B}\right)-\frac{\tilde{\Lambda}A_1}{\nu_1-r^\star}\right]e^{r^\star t}+\frac{\tilde{\Lambda}A_1}{\nu_1-r^\star}e^{\nu_1 t}, \tag{135}$$

with

$$\tilde{\Lambda} = \left\{ \tilde{Y} \tilde{L} \left[\alpha_L + \eta_{NL} \left[(1-\alpha_L) - \omega_\varphi \right] \right] + v_{L_P} \right\} - \kappa \tilde{U} \omega_2^1 + \left(v_{L_P} - \kappa \tilde{\theta} \right) \omega_3^1, \tag{136}$$

where the sign of $\tilde{\Lambda}$ will be determined later.

Invoking the transversality condition for intertemporal solvency, we obtain the linearized version of the nation's intertemporal budget constraint:

$$B_0 - \tilde{B} = \Phi \left(L_0 - \tilde{L} \right) \tag{137}$$

with

$$\Phi \equiv \frac{\tilde{\Lambda}}{\nu_1 - r^\star} \lesseqgtr 0. \tag{138}$$

Equation (142) can be solved for the stock of foreign bonds:

$$\tilde{B} = B\left(\tilde{L}\right), \quad B_L = \Phi \lesseqgtr 0. \tag{139}$$

For the national intertemporal solvency to hold, the terms in brackets of equation (135) must be zero so the stable solution for net foreign assets finally reduces to:

$$B(t) - \tilde{B} = \Phi \left(L(t) - \tilde{L} \right). \tag{140}$$

E.2 Stable Transitional Paths for Key Economic Variables

Formal Solutions for the Unemployment Rate $u(t)$

We now turn to the dynamics of the unemployment rate. The unemployment rate is defined in the usual fashion as the proportion of job seekers in the labor force:

$$u(t) = \frac{U(t)}{U(t) + L(t)}, \tag{141}$$

where $U(t) + L(t) \equiv L_P$ stands for the labor force. Linearizing around the steady-state yields:

$$u(t) - \tilde{u} = \frac{1}{L_P} \left[(1-\tilde{u}) \left(U(t) - \tilde{U} \right) - \tilde{u} \left(L(t) - \tilde{L} \right) \right].$$

Substituting formal solutions for job seekers (132c) and employment (132a), yields the stable solution for the unemployment rate:

$$u(t) - \tilde{u} = \frac{1}{L_P} \left[(1-\tilde{u}) \omega_3^1 - \tilde{u} \right] A_1 e^{\nu_1 t}, \tag{142}$$

where $\left[(1-\tilde{u}) \omega_3^1 - \tilde{u} \right] < 0$.

Formal Solution for the Labor Force $L_P(t)$

Using the definition of labor force, i. e. $L_P(t) = L(t) + U(t)$, linearizing in the neighborhood of the steady-state and substituting the stable solution for job seekers, the labor force evolves along the following transitional path:

$$L_P(t) = \tilde{L}_P + \left(1 + \omega_3^1\right) \left(L(t) - \tilde{L} \right), \tag{143}$$

where $1 + \omega_3^1 \gtrless 0$.

Formal Solution for the Number of Firms $N(t)$

Linearizing yields the short-run static solution (107), we obtain the stable solution for the number of firms:

$$N(t) = \tilde{N} + N_L \left(L(t) - \tilde{L} \right) = \tilde{N} + \frac{\tilde{N}}{\tilde{L}} \eta_{N,L} A_1 e^{\nu_1 t}, \tag{144}$$

where $\eta_{N,L} > 0$.

Formal Solution for the Nash Bargaining Wage $w(t)$

Inserting first the short-run static solution for the number of firms (107) into equation (103), linearizing yields the stable solution for the wage rate:

$$\begin{aligned} w(t) &= \tilde{w} + \left[\alpha_W \tilde{\Xi}_L - (1-\alpha_W) v_{L_P L_P} \right] \left(L(t) - \tilde{L} \right) - (1-\alpha_W) v_{L_P L_P} \left(U(t) - \tilde{U} \right) \\ &= \tilde{w} + \left[\alpha_W \tilde{\Xi}_L - (1-\alpha_W) v_{L_P L_P} \left(1 + \omega_3^1\right) \right] \left(L(t) - \tilde{L} \right), \end{aligned} \tag{145}$$

where $\Xi_L > 0$ is given by (112).

Formal Solution for the Job Vacancies $V(t)$

Remembering that $V(t) = \theta(t)U(t)$, linearizing and substituting formal solutions for $\theta(t)$ and $U(t)$ yields the stable solution for job vacancies:

$$\begin{aligned} V(t) &= \tilde{V} + \tilde{\theta}\left(U(t) - \tilde{U}\right) + \tilde{U}\left(\theta(t) - \tilde{\theta}\right), \\ &= \tilde{V} + \tilde{V}\left[\frac{\omega_2^1}{\tilde{\theta}} + \frac{\omega_3^1}{\tilde{U}}\right]\left(L(t) - \tilde{L}\right), \end{aligned} \tag{146}$$

$\frac{\omega_2^1}{\tilde{\theta}} + \frac{\omega_3^1}{\tilde{U}} \lesseqgtr 0$.

F Graphical Apparatus

Before turning to the derivation of steady-state effects, we investigate graphically the long-run effects of a deregulation shock.

F.1 Isoclines and Stable Path in the (θ, L)-space

The model can be summarized graphically by Figure 2 that traces out two schedules in the (θ, L)-space. System (167a)-(167e) which is described below can be reduced to two equations. Eq. (167e) solves for a unique number of firms $\tilde{N} = N\left(\tilde{L}, \varphi\right)$, with $N_L > 0$ and $N_\varphi < 0$. We eliminate $\tilde{U}$ by using $\tilde{U} = \frac{s\tilde{L}}{\tilde{m}}$. Substituting these functions into eq. (50) and (51) yields:

$$\tilde{L} = \frac{\tilde{m}}{\tilde{m}+s}\left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right]^{\sigma_L}, \tag{147a}$$

$$\frac{\kappa}{f\left(\tilde{\theta}\right)} = \frac{(1-\alpha_W)}{(s+r^\star)}\Psi\left(\tilde{L}, \tilde{\theta}, \varphi\right), \tag{147b}$$

where $\tilde{m} = m\left(\tilde{\theta}\right)$ and $\tilde{f} = f\left(\tilde{\theta}\right)$; using the fact that steady-state labor force $\tilde{L}_P$ writes as $\left(\frac{s+\tilde{m}}{\tilde{m}}\tilde{L}\right)$, we set

$$\Psi\left(\tilde{L}, \tilde{\theta}, \varphi\right) \equiv \frac{1}{\mu\left[N\left(\tilde{L}, \varphi\right)\right]} - \left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right), \tag{148}$$

where use of $-v_{L_P}\left(\tilde{L}_P\right) = \left(\tilde{L}_P\right)^{1/\sigma_L} = \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U$ has been made. Partial derivatives of (148) are given by:

$$\frac{\partial\tilde{\Psi}}{\partial\tilde{L}} = -\frac{1}{\tilde{\mu}\tilde{L}}\eta_{\mu,N}\eta_{N,L} > 0, \tag{149a}$$

$$\frac{\partial\tilde{\Psi}}{\partial\tilde{\theta}} = -\frac{1}{\tilde{\theta}}\tilde{\chi}\left(\tilde{L}_P\right)^{1/\sigma_L} = \frac{1}{\tilde{\theta}}\tilde{\chi}v_{L_P} = -\frac{1}{\tilde{\theta}}\frac{\tilde{m}\alpha_W\tilde{\Psi}}{s+r^\star} < 0, \tag{149b}$$

$$\frac{\partial\tilde{\Psi}}{\partial\varphi} = -\frac{1}{\tilde{\mu}\varphi}\eta_{\mu,N}\eta_{N,\varphi} < 0, \tag{149c}$$

with $0 < \tilde{\chi} = \frac{\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}}{\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}+B^U} < 1$.

Totally differentiating eq. (147a) yields

$$\hat{\tilde{L}} = \left[\alpha_V\tilde{u} + \sigma_L\tilde{\chi}\right]\hat{\tilde{\theta}}, \tag{150}$$

where $\tilde{u} = \frac{s}{s+\tilde{m}}$. The slope of the $\dot{L} = 0$ schedule in the (θ, L)-space writes as:

$$\left.\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\right|_{\dot{L}=0} = \left[\alpha_V\tilde{u} + \sigma_L\tilde{\chi}\right] > 0. \tag{151}$$

Hence the decision of search (henceforth labelled DS) schedule is upward-sloping in the (θ, L)-space.

Totally differentiating eq. (147a) yields

$$\hat{\tilde{\theta}}\left[(1-\alpha_V)-\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}\right]=\frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}}\hat{\tilde{L}}+\frac{\tilde{\Psi}_\varphi\varphi}{\tilde{\Psi}}\hat{\varphi}, \tag{152}$$

with $\tilde{\Psi}_L>0$, $\tilde{\Psi}_\theta<0$, $\tilde{\Psi}_\varphi<0$. The slope of the $\dot{\theta}=0$ schedule in the (θ,L)-space writes as:

$$\left.\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\right|_{\dot{\theta}=0}=\frac{\left[(1-\alpha_V)-\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}\right]}{\frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}}}>0. \tag{153}$$

Hence the vacancy creation (henceforth labelled VC) schedule is also upward-sloping in the (θ,L)-space. Additionally, a fall in the fixed costs shifts to the right the VC-schedule. If the DS-schedule is steeper than the VC-schedule a fall in fixed costs produces a fall in both steady-state labor market tightness and employment. By contrast, if the VC-schedule is steeper than the DS-schedule, a deregulation shock raises both $\tilde{\theta}$ and $\tilde{L}$. For the the VC-schedule to be steeper, i.e. $\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\big|_{\dot{\theta}=0}>\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\big|_{\dot{L}=0}$, the following inequality must hold:

$$\left[-(1-\alpha_V)+\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}\right]+\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]\frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}}<0. \tag{154}$$

A steeper VC-schedule means that for a given increase in employment, the steady-state labor market tightness rises less to equalize the average cost of job vacancy with the additional surplus from an additional worker than to equalize the marginal cost with the marginal benefit from search. As long as the markup is weakly responsive to firm entry and/or the elasticity of labor force participation is not too high, inequality (154) holds. Inequality (154) corresponds to the condition for saddle-path stability (119).

As long as the VC-schedule is steeper than the DS-schedule, a fall in fixed costs yields beneficial effects in labor market outcomes. A deregulation shock lowers the markup which raises the surplus from an additional worker and thereby the employment agency is induced to post more job vacancies. As a consequence, labor market tightness increases. The consecutive increase in the reservation wage induces more agents to enter the labor force. Hence, employment increases.

Having determined the patterns of isoclines in the (θ,L)-space, we now analyze the slope of the eigenvector. To do so, we use the third line of the Jacobian matrix to rewrite the element ω_2^i of the eigenvector:

$$\omega_2^i=\frac{(2s+r^\star)+(s+r^\star-\nu_i)\left(\frac{s+\nu_i}{\tilde{m}}\right)+\frac{\tilde{m}\tilde{\Psi}_L}{\tilde{\Psi}_U}}{\frac{m'\tilde{U}}{\tilde{m}}(s+\tilde{m}+r^\star-\nu_i)}. \tag{155}$$

The first two terms in the numerator can be rewritten as follows:

$$(2s+r^\star)+(s+r^\star-\nu_i)\left(\frac{s+\nu_i}{s}\right)=s+\frac{(s+r^\star)(s+\tilde{m})+\nu_i(r^\star-\nu_i)}{\tilde{m}}, \tag{156}$$

where $\nu_i(r^\star-\nu_i)$ is equal to the determinant of the Jacobian matrix (116). To estimate the pattern of the stable path, we have to to estimate:

$$\frac{\frac{L(t)-\tilde{L}}{\tilde{L}}}{\frac{\theta(t)-\tilde{\theta}}{\tilde{\theta}}}=\frac{1}{\omega_2^1}\frac{\tilde{\theta}}{\tilde{L}}. \tag{157}$$

Substituting (118) into (156) and using the fact $\tilde{m}/\tilde{\theta}=\tilde{f}$ and $\frac{(1-\alpha_W)\tilde{f}}{\kappa(s+r^\star)}=\frac{1}{\tilde{\Psi}}$, the slope of the stable branch labelled SS in the (θ,L)-space rewrites as:

$$\left.\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\right|_{SS}=\frac{1}{\omega_2^1}\frac{\tilde{\theta}}{\tilde{L}}=\frac{\frac{(s+\tilde{m}+r^\star-\nu_1)}{(s+r^\star)}(1-\alpha_V)\tilde{\Psi}}{-\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}}, \tag{158}$$

where we denote by a hat the rate of change relative to initial steady-state. Since $\frac{(s+\tilde{m}+r^\star-\nu_1)}{(s+r^\star)}>\frac{(s+\tilde{m}+r^\star)}{(s+r^\star)}$, the SS-schedule is steeper than the VC-schedule (see Figure 2(a)).

F.2 Isoclines and Stable Path in the (u,L)-space

Since ultimately our aim is to evaluate the effects of deregulation in product markets on the unemployment rate, it is convenient to analyze the transitional adjustment in the (u,L)-space. To do so, we first determine the slopes of the isoclines $\dot{L}=0$ and $\dot{\theta}=0$ in the (u,L)-space. Hence, we first determine the relationship between labor market tightness and the unemployment rate by using the definition of the the latter, i.e. $\tilde{u}=\frac{s}{s+m(\tilde{\theta})}$. Totally differentiating $\tilde{u}=\frac{s}{s+m(\tilde{\theta})}$, we have:

$$\hat{\tilde{\theta}}=-\frac{1}{\alpha_V}\left(\frac{s+\tilde{m}}{\tilde{m}}\right)\hat{\tilde{u}}. \tag{159}$$

The slope of the $\dot{L}=0$ schedule in the (u,L)-space writes as:

$$\left.\frac{\hat{\tilde{L}}}{\hat{\tilde{u}}}\right|_{\dot{L}=0}=-\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]\frac{1}{\alpha_V}\left(\frac{s+\tilde{m}}{\tilde{m}}\right)<0. \tag{160}$$

Hence the DS-schedule is upward-sloping in the (u,L)-space.

The slope of the $\dot{\theta}=0$ schedule in the (θ,L)-space writes as:

$$\left.\frac{\hat{\tilde{L}}}{\hat{\tilde{u}}}\right|_{\dot{\theta}=0}=-\frac{\left[(1-\alpha_V)-\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}\right]}{\frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}}}\frac{1}{\alpha_V}\left(\frac{s+\tilde{m}}{\tilde{m}}\right)<0. \tag{161}$$

Hence the VC-schedule is also downward-sloping in the (u,L)-space. As long as inequality (119) holds, the VC-schedule is steeper than the DS-schedule, i.e. the slope of the VC-schedule is more negative than the DS-schedule.

Having determined that the patterns of isoclines, we turn now to the transitional adjustment along the stable path labelled XX by making use of (142):

$$\left.\frac{\frac{L(t)-\tilde{L}}{\tilde{L}}}{\frac{u(t)-\tilde{u}}{\tilde{u}}}\right|_{XX}=\frac{\tilde{U}}{\tilde{L}}\frac{1}{\left[(1-\tilde{u})\,\omega_3^1-\tilde{u}\right]}. \tag{162}$$

where we used the fact that $\tilde{L}_P\tilde{u}=\tilde{U}$. First, we have to sign $\left[(1-\tilde{u})\,\omega_3^1-\tilde{u}\right]$. Using (133b) and (155), this term rewrites as follows:

$$\begin{aligned}\tilde{l}\omega_3^1-\tilde{u} &= \tilde{l}\left(\frac{s+\nu_1}{\tilde{m}}\right)-\frac{m'\tilde{U}}{\tilde{m}}\left\{\frac{(2s+r^\star)+(s+r^\star-\nu_i)\left(\frac{s+\nu_i}{\tilde{m}}\right)+\frac{\tilde{m}\tilde{\Psi}_L}{\tilde{\Psi}_U}}{\frac{m'\tilde{U}}{\tilde{m}}\left(s+\tilde{m}+r^\star-\nu_i\right)}\right\},\\ &= \frac{-\left(s+\tilde{m}+r^\star-\nu_i\right)+\frac{\tilde{m}}{\tilde{\Psi}_U\tilde{L}_P}\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}}{\left(s+\tilde{m}+r^\star-\nu_i\right)}\end{aligned} \tag{163}$$

where we used the fact that $\tilde{l}=\tilde{L}/\tilde{L}_P$ and $\tilde{u}+\tilde{l}=1$. The numerator of eq. (163) has an ambiguous sign. Using the fact that $\tilde{\Psi}_U\tilde{L}_P=v_{L_PL_P}\tilde{L}_P=v_{L_P}/\sigma_L$, we are able to sign the numerator (163):

$$\begin{aligned}&-\left\{\left(s+\tilde{m}+r^\star-\nu_i\right)+\frac{\tilde{m}\sigma_L}{v_{L_P}}\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\right\}\\ &<-\left\{\left(s+\tilde{m}+r^\star\right)-\frac{\tilde{m}}{\tilde{\chi}v_{L_P}}\frac{\eta_{\mu,N}\eta_{N,L}}{\mu}\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)\right\}<0.\end{aligned} \tag{164}$$

Hence, the sign of eigenvector for $u(t)$ given by (163) is negative.

We now demonstrate that the slope of the eigenvector in the (u,L)-space is larger (i.e., less negative) than the slope of the DS-schedule:

$$\begin{aligned}&-\frac{\frac{s}{\tilde{m}}\left(s+\tilde{m}+r^\star-\nu_i\right)}{\left(s+\tilde{m}+r^\star-\nu_i\right)+\frac{\tilde{m}}{\tilde{\Psi}_U\tilde{L}_P}\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}}<-\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)\frac{1}{\alpha_V}\left(\frac{s+\tilde{m}}{\tilde{m}}\right),\\ &-\frac{\frac{s}{\tilde{m}}\left(s+\tilde{m}+r^\star-\nu_i\right)\frac{(1-\alpha_V)\tilde{\Psi}}{(s+r^\star)\tilde{\chi}\sigma_L}}{\left(s+\tilde{m}+r^\star-\nu_i\right)\frac{(1-\alpha_V)\tilde{\Psi}}{(s+r^\star)\tilde{\chi}\sigma_L}+\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}}<-\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)\frac{1}{\alpha_V}\left(\frac{s+\tilde{m}}{\tilde{m}}\right),\\ &\frac{\left(s+\tilde{m}+r^\star-\nu_i\right)}{\left(s+r^\star\right)}\left(1-\alpha_V\right)\tilde{\Psi}-\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right)>0,\end{aligned} \tag{165}$$

where we used the fact that $\tilde{U}/\tilde{L} = s/\tilde{m}$, $\tilde{\Psi}_U \tilde{L}_P = v_{L_P L_P} \tilde{L}_P = \frac{v_{L_P}}{\sigma_L} = -\frac{\tilde{m}(1-\alpha_V)\tilde{\Psi}}{(s+r^\star)\tilde{\chi}\sigma_L}$ to derive the second line, we divided the LHS and RHS terms by $s + \tilde{m}$, used the fact that $\frac{s}{s+\tilde{m}} = \tilde{u}$ to derive the third line. The sign of (165) is positive as long as the condition for saddle-path stability (119) holds. Hence stable branch which corresponds to the XX-schedule is flatter than the DS-schedule (see Figure 2(b)).

G Steady-State Effects of Deregulation

In this section, we derive the steady-state changes following a fall in fixed costs φ. Steady-state values are denoted with a tilde. Additionally, we denote by a hat the rate of change relative to initial steady-state.

G.1 The Case of Linearly Homogenous Production Function

Using (104), eq. (68) can be rewritten as:

$$-v_{L_P} = \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U. \tag{166}$$

The steady-state of the open economy is described by the following set of equations:

$$\tilde{C} - \frac{\left(\tilde{L}_P\right)^{1+\frac{1}{\sigma_L}}}{1+\frac{1}{\sigma_L}} = \frac{1}{\bar{\lambda}}, \tag{167a}$$

$$s\tilde{L} = m\left(\tilde{\theta}\right)\tilde{U}, \tag{167b}$$

$$\tilde{L}_P^{1/\sigma_L} = \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U, \tag{167c}$$

$$\kappa = \frac{f\left(\tilde{\theta}\right)(1-\alpha_W)}{s+r^\star}\left[\frac{1}{\mu\left(\tilde{N}\right)} - \left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right)\right], \tag{167d}$$

$$\tilde{N}\varphi = \tilde{L}\left[1 - \frac{1}{\mu\left(\tilde{N}\right)}\right], \tag{167e}$$

$$r^\star\tilde{B} + \frac{\tilde{L}}{\mu\left(\tilde{N}\right)} - \tilde{C} - \kappa\tilde{\theta}\tilde{U}, \tag{167f}$$

and the intertemporal solvency condition

$$\tilde{B} - B_0 = \Phi\left(\tilde{L} - L_0\right), \tag{167g}$$

where we used the fact that $V = U\theta$. The steady-state equilibrium defined by seven equations jointly determine $\tilde{C}$, $\tilde{L}$, $\tilde{U}$, $\tilde{\theta}$, $\tilde{N}$, $\tilde{B}$, $\bar{\lambda}$.

Eq. (167e) can be solved for the number of firms, with partial derivatives described by (108). Using (167b) to eliminate $\tilde{U}$, we can express steady-state consumption in terms of the shadow value of wealth, labor, and labor market tightness:

$$\tilde{C} = C\left(\tilde{L}, \tilde{\theta}, \bar{\lambda}\right), \tag{168}$$

where partial derivatives are given by:

$$\frac{\hat{\tilde{C}}}{\hat{\tilde{L}}} = -\frac{\tilde{L}}{\tilde{C}}\left(\frac{s+\tilde{m}}{\tilde{m}}\right)v_{L_P} = -\frac{\tilde{L}_P}{\tilde{C}}v_{L_P} > 0, \tag{169a}$$

$$\frac{\hat{\tilde{C}}}{\hat{\tilde{\theta}}} = \frac{\tilde{L}}{\tilde{C}}\frac{s}{\tilde{m}}\alpha_V v_{L_P} = \frac{\tilde{U}}{\tilde{C}}\alpha_V v_{L_P} < 0, \tag{169b}$$

$$\frac{\hat{\tilde{C}}}{\hat{\bar{\lambda}}} = -\frac{\tilde{X}}{\tilde{C}} < 0. \tag{169c}$$

Substituting the short-run static solutions for consumption and the number of firms which obviously holds in the long-run, i. e. eqs. (167a) and (107), and using (167b) to eliminate $\tilde{U}$, the steady-state described by (167) can be rewritten as:

$$
\begin{aligned}
\tilde{L} &= \frac{\tilde{m}}{\tilde{m}+s}\left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}+B^U\right]^{\sigma_L}, &\text{(170a)}\\
\frac{\kappa}{f\left(\tilde{\theta}\right)} &= \frac{(1-\alpha_W)}{(s+r^\star)}\left\{\frac{1}{\mu\left[N\left(\tilde{L},\varphi\right)\right]}-\left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}+B^U\right)\right\}, &\text{(170b)}\\
0 &= r^\star\tilde{B}+\frac{\tilde{L}}{\mu\left[N\left(\tilde{L},\varphi\right)\right]}-C\left(\tilde{L},\tilde{\theta},\bar{\lambda}\right)-\kappa\frac{s\tilde{L}}{f\left(\tilde{\theta}\right)}, &\text{(170c)}\\
\tilde{B}-B_0 &= \Phi\left(\tilde{L}-L_0\right). &\text{(170d)}
\end{aligned}
$$

Due to the specific form for the utility function, labor market variables are not affected by the marginal utility of wealth which affects only consumption and the stock of traded bonds. As it shall become clear later, it is convenient to first solve the steady-state without the intertemporal solvency condition, i.e. (167a)-(167e), which allows us to express the steady-state values in terms of the shadow value of wealth $\bar{\lambda}$ and fixed costs φ. Totally differentiating the system of equations (167a)-(167e) yields in matrix form:

$$
\begin{pmatrix}
1 & -\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right] & 0\\
\frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}} & \frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}-(1-\alpha_V) & 0\\
\left[\frac{(1-\eta_{\mu,N}\eta_{N,L})}{\tilde{\mu}}+\frac{v_{L_P}}{\tilde{l}}-\omega_V\right] & -\left[\alpha_V\frac{\tilde{u}}{\tilde{l}}v_{L_P}+\omega_V(1-\alpha_V)\right] & \omega_B
\end{pmatrix}
\begin{pmatrix}\hat{\tilde{L}}\\ \hat{\tilde{\theta}}\\ \hat{\tilde{B}}\end{pmatrix}
$$

$$
= \begin{pmatrix}
0\\
-\frac{\tilde{\Psi}_\varphi\varphi}{\tilde{\Psi}}\hat{\varphi}\\
-\frac{\tilde{X}}{\tilde{L}}\hat{\bar{\lambda}}+\frac{\eta_{N,\varphi}}{\tilde{\mu}}\eta_{N,\varphi}\hat{\varphi}
\end{pmatrix}, \tag{171}
$$

where we set $l = L/L_P$, $u = U/L_P$, $\omega_V = \frac{\kappa V}{Y}$, $\omega_B = \frac{r^\star B}{Y}$ and we have computed the following useful expressions:

$$
\begin{aligned}
\tilde{\Psi}_L\tilde{L} &= -\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}} > 0, &\text{(172a)}\\
\tilde{\Psi}_\theta\tilde{\theta} &= -\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} < 0, &\text{(172b)}\\
\tilde{\Psi}_\varphi\tilde{\varphi} &= -\frac{\eta_{\mu,N}\eta_{N,\varphi}}{\tilde{\mu}} = \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}} = -\tilde{\Psi}_L\tilde{L} < 0. &\text{(172c)}
\end{aligned}
$$

The determinant of (171) denoted by G is:

$$
G \equiv \omega_B\left\{\left[\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}-(1-\alpha_V)\right]+\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]\frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}}\right\} \lesseqgtr 0. \tag{173}
$$

In light of our discussion above in section G, determinant G is negative as long as inequality holds (119).

System (167a)-(167e) can be solved for steady-state employment, labor market tightness and stock of foreign assets as follows:

$$
\begin{aligned}
\tilde{L} &= L(\varphi), &\text{(174a)}\\
\tilde{\theta} &= \theta(\varphi), &\text{(174b)}\\
\tilde{B} &= B\left(\bar{\lambda},\varphi\right). &\text{(174c)}
\end{aligned}
$$

Hence, employment and labor market tightness are not affected by the marginal utility of wealth and depend only on the fixed costs.

Partial derivatives w. r. t. fixed costs φ are:

$$\eta_{\tilde{L},\varphi} \equiv \frac{\hat{\tilde{L}}}{\hat{\varphi}} = -\frac{\omega_B}{G}\frac{\tilde{\Psi}_{\varphi}\varphi}{\tilde{\Psi}}\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right] < 0, \tag{175a}$$

$$\eta_{\tilde{\theta},\varphi} \equiv \frac{\hat{\tilde{\theta}}}{\hat{\varphi}} = -\frac{\omega_B}{G}\frac{\tilde{\Psi}_{\varphi}\varphi}{\tilde{\Psi}} < 0, \tag{175b}$$

$$\eta_{\tilde{B},\varphi} \equiv \frac{\hat{\tilde{B}}}{\hat{\varphi}} = \frac{1}{G}\frac{\tilde{\Psi}_{\varphi}\varphi}{\tilde{\Psi}}\Bigg\{\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]\left[\frac{(1-\eta_{\mu,N}\eta_{N,L})}{\tilde{\mu}} + \frac{v_{L_P}}{\tilde{l}} - \omega_V\right] - \left[\alpha_V \frac{\tilde{u}}{\tilde{l}} v_{L_P} + \omega_V\left(1-\alpha_V\right)\right]\Bigg\} + \frac{\eta_{\mu,N}\eta_{N,\varphi}}{\tilde{\mu}\omega_B} > 0, \tag{175c}$$

$$\eta_{\tilde{B},\bar{\lambda}} \equiv \frac{\hat{\tilde{B}}}{\hat{\bar{\lambda}}} = -\frac{\tilde{X}}{\tilde{L}}\frac{1}{\omega_B} < 0, \tag{175d}$$

where $\tilde{\Psi}_{\varphi} < 0$ (see eq. (172c) and $G < 0$ as we assume that inequality (119) holds.

To derive **eqs. (56a) and (56b) in the text**, we substitute (173) and use (112c):

$$\frac{\hat{\tilde{L}}}{\hat{\varphi}} = \frac{\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]}{\left[(1-\alpha_V)\tilde{\Psi} + \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}\right] + \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]} < 0, \tag{176a}$$

$$\frac{\hat{\tilde{\theta}}}{\hat{\varphi}} = \frac{\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}}{\left[(1-\alpha_V)\tilde{\Psi} + \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}\right] + \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]} < 0, \tag{176b}$$

where $\tilde{\Psi} > 0$, $\tilde{\chi} > 0$, $\eta_{\mu,N} < 0$ and $\eta_{N,L} > 0$. As long as the saddle-path stability condition is fulfilled, a fall in φ raises $\tilde{L}$ and $\tilde{\theta}$ (eqs. (176a) and (176b) are both negative).

Using eq. (167b), the definition of the labor force, i.e. $L_P = L + U$, and the definition of job vacancies, we have:

$$\frac{\hat{\tilde{U}}}{\hat{\varphi}} = \frac{\hat{\tilde{L}}}{\hat{\varphi}} - \alpha_V \frac{\hat{\tilde{\theta}}}{\hat{\varphi}} = -\frac{\omega_B}{G}\frac{\tilde{\Psi}_{\varphi}\varphi}{\tilde{\Psi}}\left[\sigma_L \tilde{\chi} - \alpha_V\left(1-\tilde{u}\right)\right] \gtreqless 0, \tag{177a}$$

$$\frac{\hat{\tilde{L}}_P}{\hat{\varphi}} = \tilde{l}\frac{\hat{\tilde{L}}}{\hat{\varphi}} + \tilde{u}\frac{\hat{\tilde{U}}}{\hat{\varphi}} = -\frac{\omega_B}{G}\frac{\tilde{\Psi}_{\varphi}\varphi}{\tilde{\Psi}}\sigma_L \tilde{\chi} < 0, \tag{177b}$$

$$\frac{\hat{\tilde{V}}}{\hat{\varphi}} = \frac{\hat{\tilde{\theta}}}{\hat{\varphi}} + \frac{\hat{\tilde{U}}}{\hat{\varphi}} = -\frac{\omega_B}{G}\frac{\tilde{\Psi}_{\varphi}\varphi}{\tilde{\Psi}}\left[1 + \sigma_L \tilde{\chi} - \alpha_V\left(1-\tilde{u}\right)\right] < 0, \tag{177c}$$

where we used the fact that $\tilde{u} + \tilde{l} = 1$.

Using the fact that the steady-state unemployment rate $\tilde{u}$ is equal to $\frac{s}{s+m(\tilde{\theta})}$, substituting (175a) and solving for the long-run level of the unemployment rate yields:

$$\tilde{u} = u\left(\varphi\right), \tag{178}$$

with

$$\frac{\partial \tilde{u}}{\partial \varphi}\varphi = -\alpha_V \tilde{u}\tilde{m}\frac{\hat{\tilde{\theta}}}{\hat{\varphi}} < 0. \tag{179}$$

To determine the change in the equilibrium value of the marginal utility of wealth, substitute first steady-state functions (175) and (175b) into the intertemporal solvency condition, and totally differentiate:

$$\frac{\mathrm{d}\bar{\lambda}}{\mathrm{d}\varphi} = -\frac{\left[B_{\varphi} - \Phi L_{\varphi}\right]}{B_{\bar{\lambda}}}, \tag{180}$$

where $B_{\bar{\lambda}} < 0$, $B_{\varphi} > 0$, $L_{\varphi} < 0$, and $\Phi < 0$.

Finally, using the short-run static solution for consumption and the number of firms, i.e. eqs. (168) and (107), we determine their steady-state change:

$$\frac{\hat{\tilde{N}}}{\hat{\varphi}} = \eta_{N,L}\frac{\hat{\tilde{L}}}{\hat{\varphi}} + \eta_{N,\varphi} = \eta_{N,L}\left(\frac{\hat{\tilde{L}}}{\hat{\varphi}} - 1\right) = \eta_{N,L}\frac{\omega_B\left[(1-\alpha_V)\tilde{\Psi} - \tilde{\Psi}_{\theta}\tilde{\theta}\right]}{G\tilde{\Psi}} < 0, \tag{181a}$$

$$\frac{\hat{\tilde{C}}}{\hat{\varphi}} = \eta_{C,\bar{\lambda}}\frac{\hat{\bar{\lambda}}}{\hat{\varphi}} + \eta_{C,L}\frac{\hat{\tilde{L}}}{\hat{\varphi}} + \eta_{C,\theta}\frac{\hat{\tilde{\theta}}}{\hat{\varphi}}, \tag{181b}$$

where we used the fact that $\eta_{N,L} = -\eta_{N,\varphi}$ (as long as $\alpha_L = 1$) to obtain eq. (181a) and we computed the following expression to sign eq. (181b):

$$\eta_{C,L}\eta_{\tilde{L},\varphi} + \eta_{C,\theta}\eta_{\tilde{\theta},\varphi} = v_{L^P} \frac{\tilde{L}_P}{\tilde{C}} \frac{\omega_B}{G} \frac{\tilde{\Psi}_\varphi \varphi}{\tilde{\Psi}} \left[\sigma_L \tilde{\chi} - (1-\alpha_V)\,\tilde{u}\right] \lesseqgtr 0, \tag{182}$$

where the sign of (182) is negative as long as $\left[\sigma_L \tilde{\chi} - (1-\alpha_V)\,\tilde{u}\right] > 0$.

G.2 The Role of Decreasing Returns to scale: $\alpha_L < 1$

In this subsection, we relax the assumption of constant returns to scale in labor. Rather, we assume that each firm producing a variety within each sector has a production function given by;

$$\mathcal{X} = (\mathcal{L})^{\alpha_L}, \quad \alpha_L \leq 1. \tag{183}$$

The long-run effects of deregulation are now given by:

$$\frac{\hat{\tilde{L}}}{\hat{\varphi}} = \frac{-F_{\mathcal{L}} \frac{\eta_{N,L}}{\tilde{\mu}} \left[(1-\alpha_L) - \eta_{\mu,N}\right] \left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]}{\left[(1-\alpha_V)\,\tilde{\Psi} + \left(\tilde{L}_P\right)^{1/\sigma_L} \tilde{\chi}\right] + F_{\mathcal{L}} \left(\frac{\tilde{\mu}-1}{\tilde{\mu}-\alpha_L}\right) \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}} \left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]} < 0, \tag{184a}$$

$$\frac{\hat{\tilde{\theta}}}{\hat{\varphi}} = \frac{1}{\left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right]} \frac{\hat{\tilde{L}}}{\hat{\varphi}} < 0, \tag{184b}$$

where the signs of eqs. (184a)-(184b) hold as long as inequality (119) is satisfied. Assuming decreasing returns to scale in labor only modify quantitatively the long-run effects of a deregulation shock. Graphically, existence of decreasing returns to scale in labor rotates to the left the VC-schedule. The reason is that a rise in employment lowers the marginal product of labor $F_{\mathcal{L}}$ which moderates the positive effect of a lower markup on the surplus from hiring. As a consequence, improving competitive conditions in product markets should raise employment by a smaller amount when there are decreasing returns to scale in labor. Formally, this effect is reflected by the second term in the denominator of eq. (184a). As captured by the numerator of eq. (184a), as long as $\alpha_L < 1$, decreasing returns to scale in labor also amplifies the beneficial effects on labor market outcomes. Graphically, a fall in fixed costs moves the VC-schedule to a larger extent as α_L gets smaller. The reason is that a drop in φ raises the number of firms which reduces firm size in the long-run. As a consequence, the marginal product of labor increases. This effect amplifies the long-run rise in employment. Hence, we have to recourse to numerical experiments to determine the net overall effect of assuming $\alpha_L < 1$.

Relaxing the assumption of constant returns to scale in labor may amplify or moderate the effects of a deregulation shock. We find numerically that the reduction of fixed costs has larger effects when considering $\alpha_L < 1$. More precisely, the numerical results show that the beneficial effects are four times larger compared to the baseline scenario. The reason is that reducing fixed costs triggers firm entry and thereby reduces employment per firm. As a consequence, the marginal product of labor increases sharply which provides an incentive to hire more workers.[53]

G.3 Subsidizing Entries and Preferences Separable in Consumption and Labor

We now explore the case of subsidizing entries. Entries subsidies $\tau N \varphi$, unemployed benefits $B^U U$, and public spending G are covered by lump-sum taxes T. Hence eq. (33) can be rewritten as:

$$\tau^{\phi} N \varphi + G + B^U U = T. \tag{185}$$

Improving competitive conditions by subsidizing entries now produces a rise in lump-sum taxes T. When assuming Greenwood, Hercovitz and Huffman [1988]'s preferences, subsidizing entries does not affect the labor market variables since such preferences eliminate the wealth effect. Hence, assuming an exogenous decline in fixed costs or subsidizing entries would leads to identical effects on employment, job seekers, labor force, labor market tightness, and unemployment rate.

[53]Numerical results are available from the authors upon request.

In the following, we thus explore the case of subsidizing entries when assuming that preferences are separable in consumption and leisure:

$$\phi \equiv \ln C - \frac{L_P^{1+1/\sigma_L}}{1+1/\sigma_L}. \tag{186}$$

These preferences' specification implies that the wealth effect (reflected by a change in the marginal utility of wealth) now affects the labor market variables. We now explore the case of a a deregulation episode in product markets subsidized by the government so that the budget constraint is balanced.

The free-entry condition on gross profits determines the equilibrium number of firms:

$$N^{1-\alpha_L} L^{\alpha_L} \left(1 - \frac{\alpha_L}{\mu(N)}\right) = N\varphi(1-\tau). \tag{187}$$

The zero profit condition (187) can be solved for the number of intermediate producers:

$$N = N(L, \tau), \tag{188}$$

where partial derivatives are given by:

$$\eta_{N,L} \equiv \frac{\hat{N}}{\hat{L}} = \frac{1}{1 - \frac{\eta_{\mu,N}}{\mu - \alpha_L}} > 0, \tag{189a}$$

$$\eta_{N,\tau} \equiv \frac{\hat{N}}{\hat{\tau}} = -\frac{1}{\alpha_L \left[1 - \frac{\eta_{\mu,N}}{(\mu - \alpha_L)}\right]} < 0, \tag{189b}$$

where $\eta_{N,L} = \eta_{N,\tau}$ when $\alpha_L = 1$.

Condition for saddle-path stability remains unchanged. Unlike, the specification of preferences (186) modifies substantially the intertemporal solvency condition. The current account equation reads as:

$$\dot{B}(t) = r^\star B(t) + N(t)^{1-\alpha_L} L(t)^{\alpha_L} - C(t) - \kappa V(t) - N(t)\varphi. \tag{190}$$

Using the fact that $\tilde{C} = 1/\bar{\lambda}$, substituting the short-run static solution for the number of firms (188), linearizing the current account equation (190), solving and invoking the transversality condition for intertemporal solvency, we obtain the linearized version of the nation's intertemporal budget constraint:

$$B_0 - \tilde{B} = \Phi\left(L_0 - \tilde{L}\right) \tag{191}$$

with

$$\Phi \equiv \frac{\tilde{\Lambda}}{\nu_1 - r^\star} \lesseqgtr 0. \tag{192}$$

and

$$\tilde{\Lambda} = \frac{\tilde{Y}}{\tilde{L}} \left\{ \left[(1-\alpha_L) - \omega_\varphi\right] \eta_{N,L} + \alpha_L \right\} - \kappa \tilde{U} \omega_2^1 - \kappa \tilde{\theta} \omega_3^1. \tag{193}$$

Equation (191) can be solved for the stock of foreign bonds:

$$\tilde{B} = B\left(\tilde{L}\right), \quad B_L = \Phi \lesseqgtr 0. \tag{194}$$

Finally, the stable solution for net foreign assets is:

$$B(t) - \tilde{B} = \Phi\left(L(t) - \tilde{L}\right), \tag{195}$$

with Φ given by (192).

The steady-state (167) of the open economy is:

$$\tilde{C} = \frac{1}{\bar{\lambda}}, \tag{196a}$$

$$s\tilde{L} = m\left(\tilde{\theta}\right)\tilde{U}, \tag{196b}$$

$$\tilde{L}_P^{1/\sigma_L} = \bar{\lambda}\left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right], \tag{196c}$$

$$\kappa = \frac{f\left(\tilde{\theta}\right)(1-\alpha_W)}{s+r^\star}\left[\frac{1}{\mu\left(\tilde{N}\right)} - \left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right)\right], \tag{196d}$$

$$\tilde{N}\varphi(1-\tau) = \tilde{L}\left[1 - \frac{1}{\mu\left(\tilde{N}\right)}\right], \tag{196e}$$

$$r^\star\tilde{B} + \tilde{L} - \tilde{C} - \kappa\tilde{\theta}\tilde{U} - \tilde{N}\varphi, \tag{196f}$$

and the intertemporal solvency condition

$$\tilde{B} - B_0 = \Phi\left(\tilde{L} - L_0\right). \tag{196g}$$

Substituting the short-run static solutions the number of firms which obviously holds in the long-run, i. e. eq (188), eliminating consumption and job seekers by using (196a) and (196b) respectively, the steady-state described by (196) can be rewritten as:

$$\tilde{L} = \frac{\tilde{m}}{\tilde{m}+s}\bar{\lambda}^{\sigma_L}\left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right]^{\sigma_L}, \tag{197a}$$

$$\frac{\kappa}{f\left(\tilde{\theta}\right)} = \frac{(1-\alpha_W)}{(s+r^\star)}\left\{\frac{1}{\mu\left[N\left(\tilde{L},\varphi\right)\right]} - \left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right)\right\}, \tag{197b}$$

$$0 = r^\star\tilde{B} + \tilde{L} - \frac{1}{\bar{\lambda}} - \kappa\frac{s\tilde{L}}{f\left(\tilde{\theta}\right)} - N\left(\tilde{L},\tau\right)\varphi, \tag{197c}$$

$$\tilde{B} - B_0 = \Phi\left(\tilde{L} - L_0\right), \tag{197d}$$

where $\hat{N}/\hat{L} = \hat{N}/\hat{\tau}$ with $\hat{\tau} = \frac{d\tau}{1-\tau}$ as long as $\alpha_L = 1$.

We solve the steady-state without the intertemporal solvency condition, i.e. (197a)-(197c) which allows us to express the steady-state values in terms of the shadow value of wealth $\bar{\lambda}$ and the rate of entries subsidies τ. Totally differentiating the system of equations (197a)-(197c) yields in matrix form:

$$\begin{pmatrix} 1 & -\left[\alpha_V\tilde{u} + \sigma_L\tilde{\chi}\right] & 0 \\ \frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}} & \frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}} - (1-\alpha_V) & 0 \\ (1-\omega_V-\eta_{N,L}\omega_\varphi) & -\omega_V(1-\alpha_V) & \omega_B \end{pmatrix}\begin{pmatrix} \hat{\tilde{L}} \\ \hat{\tilde{\theta}} \\ \hat{\tilde{B}} \end{pmatrix} = \begin{pmatrix} \sigma_L\hat{\bar{\lambda}} \\ -\frac{\tilde{\Psi}_\tau(1-\tau)}{\tilde{\Psi}}\hat{\tau} \\ -\omega_C\hat{\bar{\lambda}} + \eta_{N,\tau}\omega_\varphi\hat{\tau} \end{pmatrix}, \tag{198}$$

where we set $l = L/L_P$, $u = U/L_P$, $\omega_V = \frac{\kappa V}{Y}$, $\omega_\varphi = N\varphi/Y$, $\omega_B = \frac{r^\star B}{Y}$, $\omega_C = C/Y$, and $\Psi_L\tilde{L} = \Psi_\tau(1-\tau) = -\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}} > 0$.

System (197a)-(197c) can be solved for steady-state employment, labor market tightness and stock of foreign assets as follows:

$$\tilde{L} = L\left(\tau,\bar{\lambda}\right), \tag{199a}$$

$$\tilde{\theta} = \theta\left(\tau,\bar{\lambda}\right), \tag{199b}$$

$$\tilde{B} = B\left(\tau,\bar{\lambda}\right). \tag{199c}$$

Hence, employment and labor market tightness are now affected by the marginal utility of wealth $\bar{\lambda}$ and the rate of entries subsidies τ.

Partial derivatives w. r. t. the rate of entries subsidies τ are:

$$\eta_{\tilde{L},\tau} \equiv \frac{\hat{\tilde{L}}}{\hat{\tau}} = -\frac{\omega_B}{G}\frac{\tilde{\Psi}_\tau(1-\tau)}{\tilde{\Psi}}\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right] > 0, \tag{200a}$$

$$\eta_{\tilde{\theta},\tau} \equiv \frac{\hat{\tilde{\theta}}}{\hat{\tau}} = -\frac{\omega_B}{G}\frac{\tilde{\Psi}_\tau(1-\tau)}{\tilde{\Psi}} > 0, \tag{200b}$$

$$\eta_{\tilde{B},\tau} \equiv \frac{\hat{\tilde{B}}}{\hat{\tau}} = \frac{1}{G}\Bigg\{\eta_{N,\tau}\omega_\varphi\left[\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}-(1-\alpha_V)\right] + \frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}}\left[(1-\omega_V)\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]-\omega_V(1-\alpha_V)\right]\Bigg\} \tag{200c}$$

where $\tilde{\Psi}_\tau > 0$ and G is given by (173); G is negative as we assume that inequality (119) holds (i.e., the saddle-path stability condition is fulfilled).

Partial derivatives w. r. t. the marginal utility of wealth $\bar{\lambda}$ are:

$$\eta_{\tilde{L},\bar{\lambda}} \equiv \frac{\hat{\tilde{L}}}{\hat{\bar{\lambda}}} = \frac{\omega_B}{G}\sigma_L\left[\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}-(1-\alpha_V)\right] > 0, \tag{201a}$$

$$\eta_{\tilde{\theta},\bar{\lambda}} \equiv \frac{\hat{\tilde{\theta}}}{\hat{\bar{\lambda}}} = -\frac{\omega_B}{G}\sigma_L\frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}} > 0, \tag{201b}$$

$$\eta_{\tilde{B},\bar{\lambda}} \equiv \frac{\hat{\tilde{B}}}{\hat{\bar{\lambda}}} = -\frac{\omega_C}{\omega_B} - \frac{\sigma_L}{G}\Bigg\{(1-\omega_V-\eta_{N,L}\omega_\varphi)\left[\frac{\tilde{\Psi}_\theta\tilde{\theta}}{\tilde{\Psi}}-(1-\alpha_V)\right] + \frac{\tilde{\Psi}_L\tilde{L}}{\tilde{\Psi}}\omega_V(1-\alpha_V)\Bigg\} < 0, \tag{201c}$$

where the change in the equilibrium value of the marginal utility of wealth is given by (180). While we cannot sign its expression, the numerical analysis shows that the marginal utility of wealth rises substantially as increased lump-sum taxes lower households' disposable income. Hence, the wealth effect reinforces the positive effect of the deregulation shock on labor market variables. While the fall in the cost of entry raises labor demand and thereby exerts a positive effect on $\tilde{L}$ and $\tilde{\theta}$, the negative wealth effect induces agents to supply more labor which in turn exerts a positive impact on employment and labor market tightness.

H The Role of Labor Force Participation Decision

In this section, we look at a special case of the model for which labor supply is exogenous, i.e. $\sigma_L = 0$, in order to highlight the role of endogenous labor force participation decision in driving the short-run and long-run effects of a deregulation shock. For clarity purpose, we assume that the production function is linearly homogenous in labor.

H.1 Equilibrium Dynamics when $\sigma_L = 0$

To begin with, we determine the dynamic system. Denoting by w_R the reservation wage, the first-order condition (66b) implies that $L_P \equiv L + U = w_R^{\sigma_L}$ with $w_R \equiv B^U + m(\theta)\xi$. Using the fact that $U = w_R^{\sigma_L} - L$, the dynamic equation for employment (2) can be rewritten as follows:

$$\dot{L} = m(\theta)\, w_R^{\sigma_L} - [s + (\theta)]\, L.$$

Assuming that labor force is fixed, then the equation above reads as:

$$\dot{L} = m(\theta) - [s + (\theta)]\, L. \tag{202}$$

Using the fact that $m(\theta)\xi = \frac{\alpha_W}{1-\alpha_W}\kappa\theta$ together with $-v_{L_P} = w_R$ and $w_R \equiv B^U + m(\theta)\xi$, the Nash bargaining wage can be rewritten as follows:

$$\begin{aligned} w &= \alpha_W\frac{1}{\mu} - (1-\alpha_W)\, v_{L_P}, \\ &= \alpha_W\left(\frac{1}{\mu}+\kappa\theta\right) + (1-\alpha_W)\, B^U. \end{aligned} \tag{203}$$

We now determine the dynamic equation for the labor market tightness. Plugging (203) into (110) yields:

$$\dot{\theta} = \frac{\theta}{(1-\alpha_V)} \left\{ (s+r^\star) - \frac{f(\theta)(1-\alpha_W)}{\kappa} \Psi(L,U,\varphi) \right\}. \tag{204}$$

where the overall surplus from an additional job Ψ is:

$$\Psi \equiv \left(\frac{1}{\mu} - B^U \right) - \frac{\alpha_W}{1-\alpha_W} \kappa\theta. \tag{205}$$

Linearizing the accumulation equation for labor (202) and the dynamic equation for labor market tightness (204), we get in matrix form:

$$\left(\dot{L}, \dot{\theta}\right)^T = J\left(L(t) - \tilde{L}, \theta(t) - \tilde{\theta}\right)^T, \tag{206}$$

where J is given by

$$J \equiv \begin{pmatrix} -(s+\tilde{m}) & m'\left(1-\tilde{L}\right) \\ \frac{\tilde{m}}{\kappa}\frac{1-\alpha_W}{1-\alpha_V}\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{L}\tilde{\mu}} & \left[(s+r^\star) + \tilde{m}\frac{\alpha_W}{1-\alpha_V}\right] \end{pmatrix}, \tag{207}$$

where $\tilde{m} = m\left(\tilde{\theta}\right)$, $\eta_{N,L} = \frac{1}{1-\frac{\eta_{\mu,N}}{\tilde{\mu}-1}} > 0$ and $\eta_{\mu,N} < 0$.

The determinant of the Jacobian matrix denoted by Det$J$ is:

$$\begin{aligned} \text{Det}J &= -(s+\tilde{m})(s+r^\star) \left\{ \frac{(s+\tilde{m}+r^\star)}{(s+r^\star)} + \frac{m'\left(1-\tilde{L}\right)}{(s+\tilde{m})(s+r^\star)} \frac{\tilde{m}}{\kappa} \frac{1-\alpha_W}{1-\alpha_V} \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{L}\tilde{\mu}} \right\}, \\ &= -(s+\tilde{m})(s+r^\star) \left\{ \frac{(s+\tilde{m}+r^\star)}{(s+r^\star)} + \frac{\alpha_V}{1-\alpha_V} \frac{\left(1-\tilde{L}\right)}{\tilde{L}_P} \frac{1}{\tilde{\Psi}} \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}} \right\}, \\ &= -(s+\tilde{m})(s+r^\star) \left\{ \frac{(s+\tilde{m}+r^\star)}{(s+r^\star)} + \frac{\alpha_V}{1-\alpha_V} \frac{\tilde{u}}{\tilde{\Psi}} \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}} \right\}, \end{aligned} \tag{208}$$

where we used the fact $\frac{\tilde{f}(1-\alpha_W)}{(s+r^\star)\kappa} = \frac{1}{\tilde{\Psi}}$, $\frac{m'\theta}{m} = \alpha_V$, $\frac{\tilde{m}}{s+\tilde{m}}\frac{1}{\tilde{L}} = \frac{1}{\tilde{L}_P}$ to get the second line, $\tilde{u} \equiv \frac{1-\tilde{L}}{\tilde{L}_P}$ to get (208).

The condition for saddle-path stability with real-valued roots is given by:

$$-\frac{(1-\alpha_V)\tilde{\Psi} + \frac{\alpha_W \tilde{m}\tilde{\Psi}}{s+r^\star}}{\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}} > \alpha_V \tilde{u}. \tag{209}$$

Note that inequality (209) is identical to (129) when $\sigma_L = 0$.

Using the fact that $V = \theta U$ and $U = 1 - L$, $C = 1/\bar{\lambda}$ and substituting the short-run static solution for the number of firms, the accumulation equation for traded bonds reads as:

$$\dot{B} = r^\star B + L - \frac{1}{\bar{\lambda}} - \kappa\theta(1-L) - N(L,\varphi)\varphi. \tag{210}$$

Linearizing the current account equation (210), solving and invoking the transversality condition for intertemporal solvency, we obtain the linearized version of the nation's intertemporal budget constraint:

$$B_0 - \tilde{B} = \Phi\left(L_0 - \tilde{L}\right) \tag{211}$$

with

$$\Phi \equiv \frac{\tilde{\Lambda}}{\nu_1 - r^\star} \lesseqgtr 0. \tag{212}$$

and

$$\tilde{\Lambda} = \left[1 + \kappa\tilde{\theta} - \eta_{N,L}\omega_\varphi - \kappa\left(1-\tilde{L}\right)\omega_2^1\right]. \tag{213}$$

Equation (211) can be solved for the stock of foreign bonds:

$$\tilde{B} = B\left(\tilde{L}\right), \quad B_L = \Phi \lesseqgtr 0. \tag{214}$$

Finally, the stable solution for net foreign assets is:

$$B(t) - \tilde{B} = \Phi\left(L(t) - \tilde{L}\right), \tag{215}$$

with Φ given by (212).

Finally, we derive isoclines and stable paths in the (θ, L)-space and the (u, L)-space. The slope of the $\dot{L} = 0$ schedule in the (θ, L)-space writes as:

$$\left.\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\right|_{\dot{L}=0}^{\sigma_L=0} = \alpha_V \tilde{u} < \left.\frac{\hat{\tilde{L}}}{\hat{\tilde{\theta}}}\right|_{\dot{L}>0}^{\sigma_L>0} = \left[\alpha_V \tilde{u} + \sigma_L \tilde{\chi}\right] > 0. \tag{216}$$

Hence the DS-schedule is upward-sloping in the (θ, L)-space but flatter than if $\sigma_L > 0$. The VC-schedule and the stable path SS remains unchanged and are given by eq. (153) and eq. (158), respectively.

To obtain the stable path in the (u, L)-space, we have to linearize the equation $u(t) = \frac{U(t)}{L_P} = (1 - L(t))$ where we used the fact that the labor force is fixed and equal to one. Linearizing around the steady-state, we get $u(t) - \tilde{u} = -\left(L(t) - \tilde{L}\right)$. The slope of the stable path SS coincides with the slope of the $\dot{L}_P = 0$ schedule (when $\sigma_L = 0$) in the (u, L)-space :

$$\left.\frac{\frac{L(t)-\tilde{L}}{\tilde{L}}}{\frac{u(t)-\tilde{u}}{\tilde{u}}}\right|_{XX}^{\sigma_L=0} = -\frac{\tilde{u}}{\tilde{L}} < 0 \tag{217}$$

When $\sigma_L = 0$, it is useful to determine the slope of the $\dot{L}_P = 0$ schedule in the (u, L)-space which writes as:

$$\left.\frac{\hat{\tilde{L}}}{\hat{\tilde{u}}}\right|_{\dot{L}_P=0} = -\frac{\tilde{u}}{\tilde{L}} < \left.\frac{\hat{\tilde{L}}}{\hat{\tilde{u}}}\right|_{\dot{L}=0}^{\sigma_L>0} = -\frac{\tilde{u}}{\tilde{l}} - \frac{\sigma_L \tilde{\chi}}{\alpha_V \tilde{l}}, \tag{218}$$

where we used the fact that $\tilde{L} = \frac{s+\tilde{m}}{\tilde{m}}$. Hence the DS-schedule is downward-sloping in the (u, L)-space but flatter than if $\sigma_L > 0$. The slope of the VC-schedule is unchanged and is given by eq. (161).

H.2 Steady-State Effects when $\sigma_L = 0$

Assuming that the labor force is fixed, the steady-state of the open economy is now described by the following set of equations:

$$\tilde{C} = \frac{1}{\bar{\lambda}}, \tag{219a}$$

$$\tilde{L} = \frac{m\left(\tilde{\theta}\right)}{s + m\left(\tilde{\theta}\right)}, \tag{219b}$$

$$\kappa = \frac{f\left(\tilde{\theta}\right)(1-\alpha_W)}{s + r^\star}\left[\frac{1}{\mu\left(\tilde{N}\right)} - \left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right)\right], \tag{219c}$$

$$\tilde{N}\varphi = \tilde{L}\left[1 - \frac{1}{\mu\left(\tilde{N}\right)}\right], \tag{219d}$$

$$r^\star \tilde{B} + \tilde{L} - \tilde{C} - \kappa\tilde{\theta}\left(1 - \tilde{L}\right) - \tilde{N}\varphi, \tag{219e}$$

and the intertemporal solvency condition

$$\tilde{B} - B_0 = \Phi\left(\tilde{L} - L_0\right), \tag{219f}$$

where we used the fact that $L_P = 1$ and $V = U\theta$. The steady-state equilibrium defined by six equations jointly determine $\tilde{C}$, $\tilde{L}$, $\tilde{\theta}$, $\tilde{N}$, $\tilde{B}$, $\bar{\lambda}$.

Using the fact that $\tilde{C} = 1/\bar{\lambda}$ and substituting the short-run static solution for the number of firms which obviously holds in the long-run, i. e. eq. (107), the steady-state described by (219) can be rewritten as:

$$\tilde{L} = \frac{\tilde{m}}{\tilde{m}+s}, \tag{220a}$$

$$\frac{\kappa}{f\left(\tilde{\theta}\right)} = \frac{(1-\alpha_W)}{(s+r^\star)} \left\{ \frac{1}{\mu\left[N\left(\tilde{L},\varphi\right)\right]} - \left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right) \right\}, \tag{220b}$$

$$0 = r^\star \tilde{B} + \tilde{L} - \frac{1}{\bar{\lambda}} - \kappa \frac{\tilde{\theta} s}{s+m\left(\tilde{\theta}\right)} - N\left(\tilde{L},\varphi\right)\varphi, \tag{220c}$$

$$\tilde{B} - B_0 = \Phi\left(\tilde{L} - L_0\right). \tag{220d}$$

Totally differentiating the system of equations (220a)-(220c) yields in matrix form:

$$\begin{pmatrix} 1 & -\alpha_V \tilde{u} & 0 \\ \frac{\tilde{\Psi}_L \tilde{L}}{\tilde{\Psi}} & \frac{\tilde{\Psi}_\theta \tilde{\theta}}{\tilde{\Psi}} - (1-\alpha_V) & 0 \\ (1-\omega_\varphi \eta_{N,L}) & -\kappa\omega_V\left(1-\tilde{L}\alpha_V\right) & \omega_B \end{pmatrix} \begin{pmatrix} \hat{\tilde{L}} \\ \hat{\tilde{\theta}} \\ \hat{\tilde{B}} \end{pmatrix} = \begin{pmatrix} 0 \\ -\frac{\tilde{\Psi}_\varphi \varphi}{\tilde{\Psi}}\hat{\varphi} \\ -\omega_C \hat{\bar{\lambda}} + \omega_\varphi (1-\eta_{N,L})\hat{\varphi} \end{pmatrix}, \tag{221}$$

where we set $\tilde{L} = \tilde{m}/s + \tilde{m}$, $u = U/L_P$, $\omega_V = \frac{\kappa V}{Y}$, $\omega_B = \frac{r^\star B}{Y}$, $\omega_C = C/Y$.

The determinant of (220d) denoted by G' is:

$$G' \equiv \omega_B \left\{ \left[\frac{\tilde{\Psi}_\theta \tilde{\theta}}{\tilde{\Psi}} - (1-\alpha_V)\right] + \alpha_V \tilde{u} \frac{\tilde{\Psi}_L \tilde{L}}{\tilde{\Psi}} \right\} \lesseqgtr 0. \tag{222}$$

Determinant G' is negative as long as inequality holds (209). Note that determinant G' given by (222) coincides with determinant G given by eq. (173) when $\sigma_L = 0$.

System (220a)-(220c) can be solved for steady-state employment, labor market tightness and stock of foreign assets as follows:

$$\tilde{L} = L(\varphi), \tag{223a}$$

$$\tilde{\theta} = \theta(\varphi), \tag{223b}$$

$$\tilde{B} = B\left(\bar{\lambda},\varphi\right). \tag{223c}$$

As previously, employment and labor market tightness are not affected by the marginal utility of wealth and depend only on the fixed costs.

Partial derivatives w. r. t. fixed costs φ are:

$$\eta_{\tilde{L},\varphi} \equiv \frac{\hat{\tilde{L}}}{\hat{\varphi}} = -\frac{\omega_B}{G'}\frac{\tilde{\Psi}_\varphi \varphi}{\tilde{\Psi}}\alpha_V \tilde{u} < 0, \tag{224a}$$

$$\eta_{\tilde{\theta},\varphi} \equiv \frac{\hat{\tilde{\theta}}}{\hat{\varphi}} = -\frac{\omega_B}{G'}\frac{\tilde{\Psi}_\varphi \varphi}{\tilde{\Psi}} < 0, \tag{224b}$$

$$\eta_{\tilde{B},\varphi} \equiv \frac{\hat{\tilde{B}}}{\hat{\varphi}} = \frac{\left[\tilde{\Psi}_\theta\tilde{\theta} - (1-\alpha_V)\tilde{\Psi}\right]\omega_\varphi(1-\eta_{N,L}) + \tilde{\Psi}_L \tilde{L}\kappa\omega_V\left(1-\tilde{L}\alpha_V\right)}{\tilde{\Psi}G'} > 0, \tag{224c}$$

$$\eta_{\tilde{B},\bar{\lambda}} \equiv \frac{\hat{\tilde{B}}}{\hat{\bar{\lambda}}} = -\frac{\omega_C}{\omega_B} < 0, \tag{224d}$$

where we assume that inequality (209) holds.

The deviation of employment and labor market tightness from their initial steady-state in percentage can be rewritten as follows:

$$\frac{\hat{\tilde{L}}}{\hat{\varphi}} = \frac{\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\alpha_V\tilde{u}}{\left[(1-\alpha_V)\tilde{\Psi} + \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}\right] + \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\alpha_V\tilde{u}} < 0, \tag{225a}$$

$$\frac{\hat{\tilde{\theta}}}{\hat{\varphi}} = \frac{\frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}}{\left[(1-\alpha_V)\tilde{\Psi} + \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}\right] + \frac{\eta_{\mu,N}\eta_{N,L}}{\tilde{\mu}}\alpha_V\tilde{u}} < 0, \tag{225b}$$

where $\tilde{\Psi} > 0$, $\eta_{\mu,N} < 0$ and $\eta_{N,L} > 0$.

Comparing eq. (176a) with eq. (225a) for employment, it is straightforward to see that $\tilde{L}$ increases less when labor force is fixed. More precisely, setting $\sigma_L = 0$ into eq. (176a) implies that the numerator is smaller while the denominator is larger. Comparing eq. (176b) with eq. (225b) for labor market tightness, we find that the labor market tightness increases less when labor force is fixed because the denominator is larger. The reason is that labor increases less which results in a smaller decline in the markup. As a result, job vacancies increase less so that $\tilde{\theta}$ rises by a smaller amount.

Using the fact that the steady-state unemployment rate $\tilde{u}$ is equal to $\frac{s}{s+m(\tilde{\theta})}$, substituting (223b) and solving for the long-run level of the unemployment rate yields:

$$\tilde{u} = u\left(\varphi\right), \tag{226}$$

with

$$\frac{\partial \tilde{u}}{\partial \varphi}\varphi = -\alpha_V \tilde{u}\tilde{m}\frac{\hat{\tilde{\theta}}}{\hat{\varphi}} < 0. \tag{227}$$

Since labor market tightness increases less when $\sigma_L = 0$, the unemployment rate decreases by a smaller amount.

I Welfare Analysis

In this section, we investigate the welfare effects of a deregulation shock in product markets. We consider two alternative preferences' specification: i) Greenwood, Hercovitz and Huffman (1988)'s preferences which eliminate the wealth effect in the household's labor force participation decision, and ii) preferences separable in consumption and labor which restores the influence of the wealth effect on household's labor force participation decision. Unfortunately, in the latter case, we are not able to derive steady-state changes of labor market variables since we cannot sign the change in the equilibrium value of the marginal utility of wealth.

I.1 Greenwood, Hercovitz and Huffman [1988]'s Preferences

We denote by ϕ instantaneous welfare:

$$\phi(t) = \ln X, \quad X \equiv C - \frac{L_P^{1+1/\sigma_L}}{1+1/\sigma_L}, \tag{228}$$

and by Υ its discounted value over an infinite horizon:

$$\Upsilon = \int_0^\infty \phi(t)\exp\left(-\rho t\right)\mathrm{d}t. \tag{229}$$

According to the first-order condition (66a), we have $\frac{1}{X} = \bar{\lambda}$. Since the marginal utility of wealth is constant, X must remain constant over time, i.e. $X(t) = \tilde{X} = 1/\bar{\lambda}$. Hence, transitional dynamics for instantaneous welfare degenerate:

$$\phi(t) = \tilde{\phi} = \ln\left(X(t)\right) = \ln\left(\tilde{X}\right) = -\ln\left(\bar{\lambda}\right). \tag{230}$$

In order to have a correct and comprehensive measure of welfare, we calculate the discounted value of instantaneous welfare over the entire planning horizon

$$\Upsilon = \frac{\tilde{\phi}}{\rho}. \tag{231}$$

The term on the RHS of (231) represents the capitalized value of instantaneous welfare evaluated at the steady-state. Using (231) together with $\rho = r^\star$, plugging (230) into (231), and differentiating yields the change of overall welfare:

$$\mathrm{d}\Upsilon = -\frac{\hat{\bar{\lambda}}}{r^\star} > 0. \tag{232}$$

Hence a deregulation shock yields welfare gains by raising households' disposable income and thereby triggering a positive wealth effect.

The effects on welfare reported in Table 2 are equivalent variation measures, calculated as the percentage change in the permanent flow of consumption C necessary to equate the initial level of welfare to what it would be following the shock. To do so, assume that the economy is initially in steady-state. Hence, overall welfare is given by:

$$\Upsilon\left(\tilde{C}_0, \tilde{L}_{P,0}\right) \equiv \int_0^\infty \tilde{\phi}_0 e^{-\rho t} \mathrm{d}t = \frac{\tilde{\phi}_0}{r^\star} \equiv \Upsilon_0, \tag{233}$$

where we used the fact that $\rho = r^\star$. Now consider an equilibrium transitional path. Along such a path:

$$\Upsilon\left(C(t), L_P(t)\right) \equiv \int_0^\infty \phi(t) e^{-\rho t} \mathrm{d}t = \int_0^\infty \tilde{\phi} e^{-\rho t} \mathrm{d}t = \frac{\tilde{\phi}}{r^\star} \equiv \tilde{\Upsilon}, \tag{234}$$

where we used the fact that dynamics for $\phi(t)$ degenerate.

As a means of comparing these two levels of utility, we determine the percentage change in the consumption flow over the entire path, such that the agent is indifferent between Υ_0 and $\tilde{\Upsilon}$. That is, we seek to find ζ such that

$$\tilde{\Upsilon} = \Upsilon\left(\zeta \tilde{C}_0, \tilde{L}_{P,0}\right). \tag{235}$$

Using the fact that $\tilde{\phi}_0 = \ln \tilde{X}_0$ and $\tilde{\phi} = \ln \tilde{X}$, we have:

$$\tilde{X}_0 \equiv \left[\zeta \tilde{C}_0 + v\left(\tilde{L}_{P,0}\right)\right] = \left[\tilde{C} + v\left(\tilde{L}_P\right)\right] \equiv \tilde{X}.$$

Subtracting $\tilde{C}_0$ from both sides, we get:

$$\zeta - 1 = \frac{\tilde{X} - \tilde{X}_0}{\tilde{C}_0} = -\frac{\tilde{X}_0}{\tilde{C}_0}\hat{\tilde{\lambda}} \tag{236}$$

where X is given by (228). Eq. (236) determines the change in consumption level that will enable the agent's base level of intertemporal welfare to equal that following the deregulation episode.

I.2 Preferences Separable in Consumption and Labor

Instantaneous welfare ϕ now reads:

$$\phi(t) \equiv u\left(C\right) + v\left(L_P\right) = \ln C - \frac{L_P^{1+1/\sigma_L}}{1+1/\sigma_L}, \tag{237}$$

The discounted value of utility flow over an infinite horizon denoted by Υ is:

$$\Upsilon = \int_0^\infty \phi(t) \exp\left(-\rho t\right) \mathrm{d}t. \tag{238}$$

Linearizing instantaneous welfare (237) in the neighborhood of the steady-state and substituting the stable solution for job seekers $U(t) - \tilde{U} = \omega_3^1 \left(L(t) - \tilde{L}\right)$ yields:

$$\phi(t) = \tilde{\phi} + v_{L_P}\left(1 + \omega_3^1\right)\left(L(t) - \tilde{L}\right), \tag{239}$$

with $\tilde{\phi}$ given by

$$\tilde{\phi} = -\ln \bar{\lambda} + v\left(\tilde{L}_P\right). \tag{240}$$

The steady-state change in instantaneous welfare is:

$$\mathrm{d}\tilde{\phi} = -\hat{\bar{\lambda}} + v_{L_P} \mathrm{d}\tilde{L}_P. \tag{241}$$

Since the rise in the marginal utility of wealth lowers consumption while labor force increases, steady-state instantaneous welfare unambiguously falls which enters in sharp contrast with the result we obtain when considering Greenwood, Hercovitz and Huffman (1988)'s preferences.

To address welfare effects in a convenient way within an intertemporal-maximizing framework, we have to evaluate the discounted value of (237) over the agent's infinite planning horizon. Whereas the change of overall welfare will be estimated numerically, we determine its measure along a transitional path after a deregulation shock when the government subsidies entries.

We first calculate the discounted value of instantaneous welfare over the entire planning horizon:

$$\begin{aligned}\Upsilon &= \frac{\tilde{\phi}}{r^{\star}} + \frac{v_{L_P}\left(1+\omega_3^1\right)}{r^{\star}-\nu_1}A_1 \\ &= \frac{\tilde{\phi}}{r^{\star}} + \frac{\phi(0)-\tilde{\phi}}{r^{\star}-\nu_1}A_1, \end{aligned} \tag{242}$$

where $v_{L_P} < 0$ and $A_1 \equiv L_0 - \tilde{L}$. The first term on the right hand-side of (242) represents the capitalized value of instantaneous welfare evaluated at the steady-state. The second term on the RHS of (242) vanishes when considering Greenwood, Hercovitz and Huffman (1988)'s preferences since the dynamics for instantaneous welfare degenerate. Rather, assuming preferences separable in consumption and labor force restores transitional dynamics. Since employment is a state variable, labor force does not react strongly on impact which implies that $\phi(0) - \tilde{\phi} > 0$ so that the transitional adjustment of the labor force exerts a positive impact on aggregate welfare.

Differentiating (242) w.r.t. to the rate of entries subsidies τ yields the change in aggregate welfare:

$$\frac{\mathrm{d}\Upsilon}{\mathrm{d}\tau} = \frac{\mathrm{d}\tilde{\phi}}{r^{\star}} - \frac{v_{L_P}\left(1+\omega_3^1\right)}{r^{\star}-\nu_1}\frac{\mathrm{d}\tilde{L}}{\mathrm{d}\tau} \lesseqgtr 0, \tag{243}$$

where the first term in the RHS of (243) is negative (since $\mathrm{d}\tilde{\phi} < 0$) and the second term on the RHS of (243) is positive since $\left(1+\omega_3^1\right) > 0$, $v_{L_P} < 0$ and $\mathrm{d}\tilde{L}/\mathrm{d}\tau > 0$.

The effects on welfare reported in Table 5 are equivalent variation measures, calculated as the percentage change in the permanent flow of consumption C necessary to equate the initial level of welfare to what it would be following the shock. To do so, assume that the economy is initially in steady-state. Hence, overall welfare is given by:

$$\Upsilon\left(\tilde{C}_0, \tilde{L}_{P,0}\right) \equiv \int_0^{\infty} \tilde{\phi}_0 e^{-\rho t}\mathrm{d}t = \frac{\tilde{\phi}_0}{r^{\star}} \equiv \Upsilon_0, \tag{244}$$

where we used the fact that $\rho = r^{\star}$. Now consider an equilibrium transitional path. Along such a path:

$$\Upsilon\left(C(t), L_P(t)\right) \equiv \int_0^{\infty} \phi(t) e^{-\rho t}\mathrm{d}t \equiv \Upsilon_t, \tag{245}$$

As a means of comparing these two levels of utility, we determine the percentage change in the consumption flow over the entire path, such that the agent is indifferent between Υ_t and Υ_0. That is, we seek to find ζ such that:

$$\Upsilon\left(C(t), L_P(t)\right) = \Upsilon\left(\zeta\tilde{C}_0, \tilde{L}_{P,0}\right). \tag{246}$$

Substituting (239) into (244), we get:

$$\Upsilon\left(\zeta\tilde{C}_0, \tilde{L}_{P,0}\right) = \frac{\ln\left(\zeta\tilde{C}_0\right) + v\left(L_{P,0}\right)}{r^{\star}} = \frac{\ln(\zeta)}{r^{\star}} + \Upsilon_0 = \Upsilon_t, \tag{247}$$

which gives

$$\zeta - 1 = \exp\left[r^{\star}\left(\Upsilon_t - \Upsilon_0\right)\right] - 1. \tag{248}$$

Eq. (248) determines the change in consumption level that will enable the agent's base level of intertemporal welfare to equal that following the deregulation episode.

The relative welfare gain at any instant of time t along the transitional path is calculated analogously, by

$$\zeta - 1 = \exp\left(\phi(t) - \phi_0\right) - 1. \tag{249}$$

where ϕ_0 corresponds to the initial steady-state level of instantaneous welfare.

J Quantitative Exploration of the Effects of Deregulation in Product Markets: Sensitivity Analysis w.r.t. Preferences

In this subsection, we now assess briefly to what extent our results depend on the assumptions regarding the specification of preferences and the financing scheme of the deregulation shock. To begin with, we note, so far, we have considered that the deregulation shock in product markets consists of reducing barriers of entry. An entrepreneur who decides to launch a new firm must undergo a number of legal procedures in order to start up a new activity. Cost of entry includes the number of steps entrepreneurs can expect to go through to launch, the time it takes on average, and the cost required. Deregulation can be achieved by simplifying legal procedures, reducing red tape or adopting related types of deregulation, and such reforms should not impose the need for collecting taxes. While enhancing competitive policies should not be costly for the government (and even could be less costly for the State by simplifying the procedures), we could alternatively consider that the government subsidizes entries. More precisely, governments often encourage firm entry by means of start-up grants, guaranteed loans, preferential tax treatments, or other forms of subsidies, as new entrants face upfront expenses for research and development, market search etc. Hence, rather than considering a deregulation in product markets reflected by an exogenous decline in fixed costs, we consider alternatively that the government subsidizes entries. We focus on entry subsidies that need to be financed by the government. The government subsidies entries at a rate τ, thus reducing fixed costs to $(1-\tau)\,N\varphi$. The zero-profit condition (30) which determines the number of firms can be rewritten as follows;

$$(1-\tau)\,N\varphi = L\left[1-\frac{1}{\mu\,(N)}\right]. \tag{250}$$

The zero profit condition can be solved for the number of intermediate producers:

$$N = N\,(L,\tau)\,, \tag{251}$$

where $N_L > 0$, $N_\tau > 0$. An increase in the rate of subsidy raises the number of firms by producing profit opportunities. We assume the government keeps balanced its budget. Hence, eq. (33) becomes:

$$B^U U + \tau N\varphi = T. \tag{252}$$

The rate of entries subsidies influences the macroeconomic aggregates through two channels: i) the decline in the cost of entry (like in a model considering an exogenous drop in fixed costs), ii) a negative wealth effect by raising lump-sum taxes T and thereby reducing households' real disposable income.

When considering Greenwood, Hercovitz and Huffman [1988]'s preferences (see eq. (1)), the wealth effect affects consumption and traded bonds holding but does not impinge on labor market variables which depends only on the rate of entries subsidies (see eqs. (174)):

$$\tilde{L} = L\,(\tau)\,, \tag{253a}$$
$$\tilde{\theta} = \theta\,(\tau)\,, \tag{253b}$$
$$\tilde{u} = u\,(\tau)\,, \tag{253c}$$
$$\tilde{B} = B\left(\bar{\lambda},\tau\right). \tag{253d}$$
$$\tilde{C} = C\left(\bar{\lambda},\tau\right). \tag{253e}$$

where $L_\tau > 0$, $\theta_\tau > 0$, and $u_\tau < 0$. While labor market effects remain unchanged, subsidizing entries may raise the marginal utility of wealth and thereby can lower consumption. More precisely, steady-state consumption is the result of two opposite forces: the rise in τ exerts a positive effect on $\tilde{C}$ by raising the disposable income, while the increase in $\bar{\lambda}$ lowers consumption due to higher lump-sum taxes. Additionally, the measure of the change in overall welfare that we repeat for convenience (see eq. (236))

$$\zeta - 1 = \frac{\tilde{X}-\tilde{X}_0}{\tilde{C}_0} = -\frac{\tilde{X}_0}{\tilde{C}_0}\hat{\bar{\lambda}} \tag{254}$$

shows that if the marginal utility of wealth increases, welfare falls.

In panel A and B of Table 5, we report numerical results for long-run and short-run effects of a deregulation shock. The first column shows results in the baseline scenario, considering an exogenous decline in fixed costs. The second column shows results when subsidizing firm entry at a rate τ. A deregulation shock reducing the markup by 3 percentage points requires a rate of subsidy τ of 0.5 (i.e., τ increases from zero to 0.5) producing a wealth effect which is too large as the model is linearized around the steady-state. Hence, we consider a decline in fixed costs (first column) or alternatively a rate of subsidy (second column) which reduces the markup by 1 percentage point. In line with analytical predictions, numerical results show that labor market effects remain unchanged. As shown in the 12th line of panel A of Table 5, the marginal utility of wealth $\bar{\lambda}$ increases as lump-sum taxes increases, thus reducing households' disposable income. The negative wealth effect produces a fall in consumption $\tilde{C}$ a decline in overall welfare (measured by (254)), as shown in the last line of panel A of Table 5.

We also conduct a sensitivity analysis with respect of the specification of preferences. More precisely, we consider preferences separable in consumption and labor (see eq. (237)). In this case, the labor market variables depends on the marginal utility of wealth and thereby are affected by the wealth effect, as shown by eqs. (199). This is illustrated in Table 5 which reports results for three scenarios: i) an exogenous decline in fixed costs φ, ii) subsidizing entries at a rate τ financed by a rise in lump-sum taxes, iii) subsidizing entries financed by a rise in lump-sum taxes while the government levies labor taxes on producers (denoted by τ^F) and households (denoted by τ^H).

The first scenario shown in the third column of Table 5 indicates the positive wealth effect reflected by a decline in the marginal utility of wealth $\bar{\lambda}$ (shown in the 12th line of panel A) is large enough to drive down both employment and labor force. The reason is that the positive wealth effect now induces agents to leave the labor force. While firms post more job vacancies and labor market tightness increases, thus reflecting an increase in labor demand, the decline in labor supply yields a drop in employment. While employment falls, the fall in the number of job seekers lowers the unemployment rate. Note that the fall in employment following a deregulation shock in product markets is at odds with empirical evidence, in particular those provided by Fiori et al. [2012].

The second scenario shown in the fourth column considers that preferences are separable in consumption and labor, and the government subsidies entries at a rate τ. Since the government wishes to keep balanced the budget, lump-sum taxes increase which in turn reduce households'disposable income. As shown in the 12th line, the marginal utility of wealth now increases which in turn amplifies the increase in the labor force and thereby in employment.

The third scenario shown in the fifth column considers that preferences are separable in consumption and labor, the government subsidies entries at a rate τ, and levies taxes at rate τ^F on labor cost paid by producers and at rate τ^H on wage income paid by households. Hence $w\left(1-\tau^H\right)$ corresponds to after-tax wage while $w\left(1+\tau^F\right)$ is the labor cost faced by producers equal to the wage rate plus the employer's part of labor taxes. The balanced budget (33) becomes:

$$B^U U + \tau N \varphi = T + \left(\tau^F + \tau^H\right) wL, \tag{255}$$

where the Nash bargaining wage now reads:

$$w = \frac{\alpha_W}{1+\tau^F}\frac{1}{\mu(N)} - \frac{1-\alpha_W}{1-\tau^H}\frac{v_{L_P}}{\bar{\lambda}}. \tag{256}$$

As expected, the rise in employment raises tax revenues (see the RHS of eq. (255) and thereby moderates the increase in the marginal utility of wealth shown in the 12th line of panel A of Table 5. As a result, employment increases less than that in the second scenario shown in the fourth column. Note that the unemployment rate falls substantially in the last scenario compared with its decline in the second scenario. The reason is that the unemployment rate is initially large when considering labor taxes.

K Entry and Exit

This setup of the model is similar to the one developed by Bilbiie, Ghironi and Melitz [2010]. We assume that there is a mass of $N(t)$ firms producing intermediate goods and an unbounded mass of prospective entrants. Prospective entrants compute the expected value of entry $\psi(t)$. The number of firms that enter in period t is denoted by $E(t)$. A proportion δ of existing firms exists exogenously. Hence, the number of existing firms at each date t evolves according to the law of motion:

$$\dot{N}(t) = E(t) - \delta N(t). \tag{257}$$

K.1 Households

Households supply $L(t)$ units of labor services for which they receive the wage rate $w(t)$. They accumulate internationally traded bonds, $B(t)$, that yields net interest rate earnings $r^{\star}B(t)$, expressed in terms of the foreign good. They receive dividends from their equity holdings,

Table 5: Quantitative Effects of a Deregulation Shock in Product Markets (in %): Sensitivity Analysis w.r.t. Preferences and w.r.t. Financing

Variables	GHH's [1988] preferences		Pref. separable in C and L		
	Bench	Subsidies	Bench	Subsidies	Subsidies and Labor Tax
	Bench	($\tau = 0.158$)	Bench	($\tau = 0.195$)	($\tau = 0.195, \tau^j$)
A.Long-Term					
Markup, $d\tilde{\mu}$	-1.00	-1.00	-1.00	-1.00	-1.30
Employment, $d\tilde{L}$	0.37	0.37	-0.03	3.76	3.57
Labor force, $d\tilde{L}_P$	0.34	0.34	-0.09	4.13	3.90
Surplus from hiring, $d\tilde{\Psi}$	0.92	0.92	0.91	0.93	2.85
Job vacancies, $d\tilde{V}$	0.05	0.05	0.03	0.19	0.14
Labor market tight., $d\tilde{\theta}$	1.54	1.54	1.53	1.55	4.79
Job seekers, $d\tilde{U}$	-0.02	-0.02	-0.07	0.37	0.33
Unemployment rate, $d\tilde{u}$	-0.06	-0.06	-0.06	-0.06	-0.23
Nash barg. wage, $d\tilde{w}$	0.71	0.71	0.70	0.71	0.88
Labor share	0.00	0.00	0.00	0.00	-0.02
Firm entry, $d\tilde{N}$	1.20	1.20	2.49	2.53	1.97
Marg. ut. of Wealth, $d\bar{\lambda}$	-1.49	17.27	-0.86	7.69	7.10
Consumption, $d\tilde{C}$	0.75	-4.71	0.47	-3.86	-3.88
Welfare, $d\Upsilon$	0.89	-8.71	0.99	-12.21	-9.28
B.Impact					
Labor force, $dL_P(0)$	0.34	0.34	-0.09	4.10	3.86
Surplus from hiring, $d\Psi(0)$	0.83	0.83	0.92	0.28	1.33
Job vacancies, $dV(0)$	0.17	0.17	0.02	1.46	0.60
Labor market tight., $d\theta(0)$	1.52	1.52	1.53	1.40	4.33
Job seekers, $dU(0)$	0.34	0.34	-0.09	4.10	3.86
Unemployment rate, $du(0)$	0.30	0.30	-0.08	3.67	3.31
Nash barg. wage, $dw(0)$	0.69	0.69	0.70	0.60	0.74
Labor share	0.12	0.12	-0.01	1.27	0.52

Notes: We consider a fall in fixed costs or a rise in the rate of entries subsidies τ which lowers the markup by 1 percentage point, i.e. from 1.4 to 1.39 in the baseline scenario. When introducing labor taxes, the increase in the rate of entries subsidies is equal to that when abstracting from labor taxes. Impact and steady-state deviations are scaled by initial labor force, except initial and long-run changes of overall surplus from hiring, labor market tightness, Nash bargaining wage which are scaled by their initial steady-state values. Steady-state change of consumption is scaled by GDP. Firm entry corresponds the deviation of the number of firms from steady-state value. Effects on welfare are equivalent variation measures, calculated as the percentage change in consumption necessary to equate the initial level of welfare to what it would be following the shock. In the benchmark scenario, main parameters are set as follows: $\alpha_W = 0.6$ and $\sigma_L = 0.5$; ϵ, ω are chosen to target $\mu = 1.4$.

$N\pi^P + \Pi^H$. They buy new firms $E(t)$ at price $q(t)$. Denoting by T the lump-sum taxes, the flow budget constraint writes as:

$$\dot{B}(t) = r^\star B(t) + w(t)L(t) + N(t)\pi^P(t) + \Pi^H(t) + B^U U(t) - C(t) - q(t)E(t) - T, \quad (258)$$

where B^U stands for unemployment benefits received by job seekers and C represents consumption expenditure.

The current-value Hamiltonian for the representative household's optimization problem writes as follows:

$$\begin{aligned} \mathcal{H}^H &= \log X + \lambda \left[r^\star B + wL + N\pi^P + \pi^H + B^U U - C - T - qE \right] + \xi' \left[mU - sL \right] \\ &+ \psi' \left[E - \delta N \right], \end{aligned} \quad (259)$$

where B, L, N are state variables; λ, ξ', ψ' are the corresponding co-state variables; C, U and E are the control variables.

First-order conditions for households are:

$$\frac{1}{X} = \lambda, \quad (260a)$$

$$-\frac{v_{L^P}(L+U)}{X} = m\xi' + B^U \lambda, \quad (260b)$$

$$q = \frac{\psi'}{\lambda}, \quad (260c)$$

$$\dot{\lambda} = \lambda (\rho - r^\star), \quad (260d)$$

$$\dot{\xi}' = (s+\rho)\xi' - \left[\frac{v_{L^P}(L+U)}{X} + \lambda w \right], \quad (260e)$$

$$\dot{\psi}' = (\delta + \rho)\psi' - \lambda \pi^P, \quad (260f)$$

where ξ' is the utility value of the marginal job, λ the marginal utility of wealth, and ψ' the shadow price of setting up a new firm.

Differentiating (260c) w.r.t. time, substituting (260d), eq. (260f) can be rewritten as:

$$\dot{\psi} = (\delta + r^\star)\psi - \pi^P. \quad (261)$$

K.2 Entry Decision and Firm Profits

Solving (261) forward and using the transversality condition $\lim_{t\to\infty} \psi N \exp\left(-(r^\star+\delta)t\right) = 0$, we get:

$$\psi(t) = \int_t^\infty \pi^P(\tau) e^{(\delta + r^\star)(t-\tau)} \mathrm{d}\tau. \quad (262)$$

According to eq. (262), the expected post-entry value, i.e. $\psi(t)$, equals to the present discounted value of the expected flow of profits.

To found a firm, an entrepreneur pays an entry cost φ_E in terms of final output. Entry occurs until firm value is equalized with the entry cost. The entrepreneur sells the firm to the household at price $\psi(t)$ defined by (262). The optimal level of entry is determined by the following entry condition:

$$\psi(t) = \varphi_E(t). \quad (263)$$

In order to obtain a well-defined steady-state, we assume that the cost of entry φ_E increases with the number of entries:[54]

$$\varphi_E = \beta E(t), \quad (264)$$

where β can be seen as the cost to setup a new firm.

[54] See e.g. Datta and Dixon [2002].

Differentiating (263) w.r.t. time, using (264), yields the law of motion of entries:

$$\dot{E}(t) = (r^\star + \delta) E(t) - \frac{\pi^P(t)}{\beta}. \tag{265}$$

Differentiating $N(t)\psi(t)$ w. r. t. time, substituting (257) and (261), solving for the differential equation by invoking the transversality condition, yields the net present value of incumbency:

$$N(t)\psi(t) = \int_0^\infty \left[N(t)\pi^P(t) - E(t)\varphi_E(t)\right] e^{-r^\star(\tau-t)}\mathrm{d}\tau, \tag{266}$$

where we used the free entry condition $\varphi_E = \psi$.

Profit of the ith-intermediate good producer in the jth-sector (we drop subscript i and j as we consider a symmetric equilibrium) is:

$$\pi^P(t) = F\left(\frac{L(t)}{N(t)}\right)\left(1 - \frac{\alpha_L}{\mu\left(N(t)\right)}\right) - \varphi, \tag{267}$$

where $L/N = \mathcal{L}$. We can solve for the firm profits as follows:

$$\pi^P = \pi^P\left(L, N, \varphi\right), \tag{268}$$

where

$$\pi^P_L = \frac{\partial \pi^P}{\partial L} = \frac{1}{L}\frac{1}{\mu}F\left(\frac{L}{N}\right)\alpha_L\left(\mu - \alpha_L\right) > 0, \tag{269a}$$

$$\pi^P_N = \frac{\partial \pi^P}{\partial N} = -\frac{\alpha_L}{N\mu}F\left(\frac{L}{N}\right)\left[\left(\mu - \alpha_L\right) - \eta_{\mu,N}\right] < 0, \tag{269b}$$

$$\pi^P_\varphi = \frac{\partial \pi^P}{\partial \varphi} = -1, \tag{269c}$$

where $\alpha_L = \frac{F_{\mathcal{L}} L/N}{F(L/N)}$.

K.3 Derivation of the Current Account Equation with Entry Costs

Using the government budget constraint (24), i. e. $T = B^U U$, substituting profits $N\pi^P + \Pi^H$ which are equal to $\left[N^{1-\alpha_L}L^{\alpha_L} - \mathsf{W}L - N\varphi\right] + \left[\left(\mathsf{W} - w\right)L - \kappa V\right]$ into eq. (258), the accumulation equation of traded bonds writes as:

$$\dot{B}(t) = r^\star B(t) + N^{1-\alpha_L}F\left(L(t)\right) - C(t) - \kappa V(t) - \beta E^2(t) - N\varphi. \tag{270}$$

K.4 Equilibrium Dynamics

The dynamic system comprises five equations:

$$\dot{\theta}(t) = \frac{\theta(t)}{\left(1-\alpha_V\right)}\left\{\left(s + r^\star\right) - \frac{f\left(\theta\right)\left(1-\alpha_W\right)}{\kappa}\Psi\left(L(t), N(t), U(t)\right)\right\}, \tag{271a}$$

$$\dot{N}(t) = E(t) - \delta N(t), \tag{271b}$$

$$\dot{E}(t) = \left(r^\star + \delta\right)E(t) - \frac{\pi^P\left(L(t), N(t), \varphi\right)}{\beta}, \tag{271c}$$

plus the law of motion of employment given by (4a), and the dynamic equation for job seekers given by (72). The contribution to the surplus of an additional worker can be solved as follows:

$$\Psi \equiv \Psi\left(L, N, U\right) = \Xi\left(L, N\right) + v_{L^P} = \frac{F_{\mathcal{L}}\left(\frac{L}{N}\right)}{\mu\left(N\right)} + v_{L^P}\left(L + U\right), \tag{272}$$

where Ψ_U is given by (112b) and other partial derivatives are:

$$\Psi_L = \Xi_L + v_{L_P L_P} = \frac{F_{\mathcal{L}\mathcal{L}}}{N\mu} + v_{L_P L_P} < 0, \tag{273a}$$

$$\Psi_N = \Xi_N = \frac{F_{\mathcal{L}}}{N\mu}\left[(1-\alpha_L) - \eta_{\mu,N}\right] > 0, \tag{273b}$$

where $F_{\mathcal{L}} = F_{\mathcal{L}}\left(\frac{L}{N}\right)$.

Linearizing the equation of the number of firms (271b), the dynamic equation for entry (271c), the accumulation equation for labor (4a), the dynamic equations for labor market tightness (271a) and job seekers (72), we get in matrix form:

$$\left(\dot{N}, \dot{E}, \dot{L}, \dot{\theta}, \dot{U}\right)^T = J' \left(N(t) - \tilde{N}, E(t) - \tilde{E}, L(t) - \tilde{L}, \theta(t) - \tilde{\theta}, U(t) - \tilde{U}\right)^T, \tag{274}$$

where J is given by

$$J' \equiv \begin{pmatrix} -\delta & 1 & 0 & 0 & 0 \\ -\frac{\pi_N^P}{\beta} & (r^\star + \delta) & -\frac{\pi_L^P}{\beta} & 0 & 0 \\ 0 & 0 & -s & m'\tilde{U} & m\left(\tilde{\theta}\right) \\ -\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\tilde{\Psi}_N & 0 & -\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\tilde{\Psi}_L & (s+r^\star) & -\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\tilde{\Psi}_U \\ \frac{\alpha_W \tilde{m}\tilde{\Psi}_N}{1-\alpha_V}\frac{1}{v_{L_P L_P}} & 0 & (2s + r^\star) + \frac{\alpha_W \tilde{m}\tilde{\Psi}_L}{1-\alpha_V}\frac{1}{v_{L_P L_P}} & -m'\tilde{U} & (s + r^\star) - \tilde{m} + \frac{\alpha_W \tilde{m}}{1-\alpha_V} \end{pmatrix}. \tag{275}$$

Denoting by ν the eigenvalue, the characteristic equation for the matrix J' (275) of the linearized system writes as follows:

$$(s + r^\star - \nu_i)\left[\nu_i^4 + b_1\nu_i^3 + b_2\nu_i^2 + b_3\nu_i + b_4\right] = 0, \tag{276}$$

with

$$b_1 = -r^\star - \text{Tr}J = -\left\{2r^\star + \frac{\tilde{m}}{1-\alpha_V}\left[\alpha_W - (1-\alpha_V)\right]\right\} < 0, \tag{277a}$$

$$b_2 = r^\star \text{Tr}J + \frac{\text{Det}J}{s+r^\star} + \left[\frac{\pi_N^P}{\beta} - \delta\left(r^\star + \delta\right)\right] \lesseqgtr 0, \tag{277b}$$

$$b_3 = -\left\{r^\star\frac{\text{Det}J}{s+r^\star} + \left[\frac{\pi_N^P}{\beta} - \delta\left(r^\star+\delta\right)\right]\text{Tr}J\right\} > 0, \tag{277c}$$

$$\begin{aligned} b_4 &= \frac{\text{Det}J}{s+r^\star}\left[\frac{\pi_N^P}{\beta} - \delta\left(\delta + r^\star\right)\right] - \frac{\pi_L^P}{\beta}\tilde{\Psi}_N\left[m'\tilde{U}\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa} - \tilde{m}\frac{\alpha_W\tilde{m}}{1-\alpha_V}\frac{1}{v_{L_P L_P}}\right], \\ &= -\frac{1}{\beta}\Big\{\left(s+\tilde{m}\right)\left(s+r^\star\right)\pi_N^P - m'\tilde{U}\frac{1-\alpha_W}{1-\alpha_V}\frac{\tilde{m}}{\kappa}\left[\left(\Psi_L - \Psi_U\right)\pi_N^P - \pi_L^P\Psi_N\right] \\ &\quad + \frac{\alpha_W\tilde{m}}{1-\alpha_V}\left[s\pi_N^P + \tilde{m}\frac{1}{v_{L_P L_P}}\left(\Psi_L\pi_N^P - \Psi_N\pi_L^P\right)\right]\Big\} \gtreqless 0. \end{aligned} \tag{277d}$$

Eigenvalues, Eigenvectors and Formal Solutions

To be able to determine the saddle-path stability condition, we have to assume that the worker's relative bargaining power α_W equals the elasticity of the matching function $1-\alpha_V$. We set this assumption from now thereon; b_1 and b_2 reduce to:

$$b_1 = -2r^\star, \tag{278a}$$

$$b_2 = (r^\star)^2 - \frac{b_3}{r^\star}. \tag{278b}$$

The characteristic polynomial of degree four can be rewritten as a characteristic polynomial of second degree:

$$\eta^2 + \frac{b_3}{r^\star}\eta + b_4 \qquad \text{with} \quad \eta = \nu\left(r^\star - \nu\right). \tag{279}$$

By evaluating first the eigenvalues η from the second order polynomial and then calculating ν from the definition of η, the four eigenvalues of the upper-left four by four submatrix in the Jacobian are given by

$$\nu_i \equiv \frac{1}{2}\left\{ r^\star \pm \sqrt{(r^\star)^2 + 2\left(\frac{b_3}{r^\star} \pm \sqrt{\left(\frac{b_3}{r^\star}\right)^2 - 4b_4}\right)}\right\}, \qquad i = 1,2,3,4. \tag{280}$$

Eigenvalues satisfy the following inequalities:

$$\nu_1 < \nu_2 < 0 < r^\star < \nu_3 < \nu_4. \tag{281}$$

together with the following properties

$$r^\star - \nu_1 = \nu_4, \quad r^\star - \nu_2 = \nu_3. \tag{282}$$

Let rewrite b_4 as follows:

$$\begin{aligned} b_4 &= \frac{1}{\tilde{N}\beta}\left\{ \frac{\text{Det J}}{s+r^\star}\left(\tilde{\pi}_N^P \tilde{N} - \tilde{\pi}^P\right) + \tilde{\pi}_L^P \tilde{L}\tilde{\Psi}_N \tilde{N} \frac{\tilde{m}\,(s+\tilde{m})}{\tilde{\chi} v_L}\left(\alpha_V \tilde{u} + \tilde{\chi}\sigma_L\right)\right\}, \qquad (283)\\ &= -\frac{(s+\tilde{m})\,(s+r^\star)}{\tilde{N}\beta\,(1-\alpha_V)\,\tilde{\Psi}}\left\{\left[(1-\alpha_V)\,\tilde{\Psi} - \tilde{\Psi}_\theta\tilde{\theta}\right]\left(\tilde{\pi}_N^P\tilde{N} - \tilde{\pi}^P\right) + \tilde{\pi}_L^P\tilde{L}\tilde{\Psi}_N\tilde{N}\left(\alpha_V\tilde{u} + \tilde{\chi}\sigma_L\right)\right\} \lesseqgtr 0, \end{aligned}$$

where we used the fact that $\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}$, $\alpha_V = 1-\alpha_W$, $\sigma_L = \frac{v_{L^P}}{v_{L^P L^P} L^P}$, $\tilde{u} = \frac{\tilde{U}}{\tilde{L}_P} = \frac{s}{s+\tilde{m}}$ to get the first line, the fact that $\frac{\text{Det J}}{s+r^\star} = -\frac{(s+\tilde{m})(s+r^\star)}{(1-\alpha_V)\tilde{\Psi}}\left[(1-\alpha_V)\,\tilde{\Psi} - \tilde{\Psi}_\theta\tilde{\theta}\right]$ and $-\tilde{\chi}v_{L_P} = \frac{(1-\alpha_V)}{s+r^\star}\tilde{m}\tilde{\Psi}$.

The element b_4 given by eq. (283) is positive if the following inequality holds:

$$-\left[(1-\alpha_V)\,\tilde{\Psi} - \tilde{\Psi}_\theta\tilde{\theta}\right]\left(\tilde{\pi}_N^P\tilde{N} - \tilde{\pi}^P\right) > \tilde{\pi}_L^P\tilde{L}\tilde{\Psi}_N\tilde{N}\left(\alpha_V\tilde{u} + \tilde{\chi}\sigma_L\right) \tag{284}$$

If inequality (284) holds, $b_4 > 0$ is consistent with there being either 2 negative and 2 positive roots, 4 positive, or 4 negative roots. Since the trace is equal to $2r^\star = -b_1$, which is positive, and the trace is equal to the sum of eigenvalues, only the first two cases must be considered. By Descartes rule of signs, necessary and sufficient conditions for the characteristic equation to have just two positive roots is that either $b_2 < 0$ or $b_3 > 0$. From (277c), $b_3 > 0$ as long as $\text{Det}J < 0$ (which unambiguously holds), so we can exclude the case of four positive roots. Since the system features two state variables, L and N, and three jump variables, E, θ, U, the equilibrium yields a unique stable saddle-path as we have two negative roots and three positive roots.

Following Dockner and Feichtinger [1991], the necessary and sufficient conditions for saddle-point stability with real roots are:

$$\frac{b_3}{r^\star} > 0, \tag{285a}$$

$$0 < 4b_4 \leq \left(\frac{b_3}{r^\star}\right)^2. \tag{285b}$$

This condition will be checked numerically.

The fifth root denoted by ν_5 is positive and is given by:

$$\nu_5 = (s + r^\star) > 0. \tag{286}$$

Formal Solutions

Setting the constants $A_3 = A_4 = 0$ to insure a converging adjustment for all macroeconomic aggregates, the stable paths are given by:

$$\begin{aligned}
N(t) - \tilde{N} &= A_1 e^{\nu_1 t} + A_2 e^{\nu_2 t}, && (287a)\\
E(t) - \tilde{E} &= \omega_2^1 A_1 e^{\nu_1 t} + \omega_2^2 A_2 e^{\nu_2 t}, && (287b)\\
L(t) - \tilde{L} &= \omega_3^1 A_1 e^{\nu_1 t} + \omega_3^2 A_2 e^{\nu_2 t}, && (287c)\\
\theta(t) - \tilde{\theta} &= \omega_4^1 A_1 e^{\nu_1 t} + \omega_4^2 A_2 e^{\nu_2 t}, && (287d)\\
U(t) - \tilde{U} &= \omega_5^1 A_1 e^{\nu_1 t} + \omega_5^2 A_2 e^{\nu_2 t}, && (287e)\\
& && (287f)
\end{aligned}$$

where the eigenvectors ω_j^i associated with eigenvalue ν_i are given by

$$\begin{aligned}
\omega_2^i &= (\delta + \nu_i), && (288a)\\
\omega_3^i &= \frac{(\delta + \nu_i)(r^\star + \delta - \nu_i) - \frac{\pi_N^P}{\beta}}{\frac{\pi_L^P}{\beta}}, && (288b)\\
\omega_4^i &= \frac{\tilde{m}\frac{\tilde{\Psi}_N}{\tilde{\Psi}_U} + \omega_3^i \left[(2s + r^\star) + + \tilde{m}\frac{\tilde{\Psi}_L}{\tilde{\Psi}_U} + (s + r^\star - \nu_i)\left(\frac{s+\nu_i}{\tilde{m}}\right)\right]}{\frac{m'\tilde{U}}{\tilde{m}}(s + r^\star + \tilde{m} - \nu_i)}, && (288c)\\
\omega_5^i &= \frac{s + \nu_i}{\tilde{m}}\omega_3^i - \frac{m'\tilde{U}}{\tilde{m}}\omega_4^i, && (288d)
\end{aligned}$$

where we normalized ω_1^i to unity. The two constants write as follows:

$$A_1 = \frac{\mathrm{d}\tilde{L} - \omega_3^2 \mathrm{d}\tilde{N}}{\omega_3^2 - \omega_3^1}, \qquad A_2 = \frac{\omega_3^1 \mathrm{d}\tilde{N} - \mathrm{d}\tilde{L}}{\omega_3^2 - \omega_3^1}. \tag{289}$$

K.5 Formal Solution for the Stock of Traded Bonds

Linearizing equation (270) around the steady-state yields:

$$\begin{aligned}
\dot{B}(t) &= r^\star\left(B(t) - \tilde{B}\right) + \left(\tilde{N}^{1-\alpha_L}F_L + v_{L_P}\right)\left(L(t) - \tilde{L}\right) + \left[(1-\alpha_L)\tilde{N}^{-\alpha_L}F\left(\tilde{L}\right) - \varphi\right]\left(N(t) - \tilde{N}\right)\\
&\quad + \left(v_{L_P} - \kappa\tilde{\theta}\right)\left(U(t) - \tilde{U}\right) - \kappa\tilde{U}\left(\theta(t) - \tilde{\theta}\right) - 2\beta\delta\tilde{N}\left(E(t) - \tilde{E}\right), && (290)
\end{aligned}$$

where we used the fact that $C_L = C_U = -v_{L_P} > 0$ and $\tilde{E} = \delta\tilde{N}$.

Inserting stable solutions (287), solving the differential equation, invoking the transversality condition for intertemporal solvency, we obtain the linearized version of the nation's intertemporal budget constraint:

$$B_0 - \tilde{B} = \frac{\tilde{\Lambda}_1 A_1}{\nu_1 - r^\star} + \frac{\tilde{\Lambda}_2 A_2}{\nu_2 - r^\star}. \tag{291}$$

The stable solution for the stock of foreign bonds finally reduces to:

$$B(t) - \tilde{B} = \frac{\tilde{\Lambda}_1 A_1}{\nu_1 - r^\star}e^{\nu_1 t} + \frac{\tilde{\Lambda}_2 A_2}{\nu_2 - r^\star}e^{\nu_2 t}, \tag{292}$$

where

$$\begin{aligned}
\tilde{\Lambda}_1 &= \left[\Omega_N + \Omega_L\omega_3^1 + \Omega_U\omega_5^1 - \kappa\tilde{\theta}\omega_4^1\right], && (293a)\\
\tilde{\Lambda}_2 &= \left[\Omega_N + \Omega_L\omega_3^2 + \Omega_U\omega_5^2 - \kappa\tilde{\theta}\omega_4^2\right], && (293b)
\end{aligned}$$

with

$$\Omega_N = \left[(1-\alpha_L)\tilde{N}^{-\alpha_L}F\left(\tilde{L}\right) - \varphi\right], \tag{294a}$$

$$\Omega_L = \left(\tilde{N}^{1-\alpha_L}F_L + v_{L_P}\right), \tag{294b}$$

$$\Omega_U = \left(v_{L_P} - \kappa\tilde{\theta}\right) < 0. \tag{294c}$$

For the case $\alpha_L = 1$, $\Omega_N = -\varphi < 0$, $\Omega_L = 1 + v_{L_P}$ (since $1 > -v_{L_P}$ because $\tilde{\Psi} = \frac{1}{\tilde{\mu}} + v_{L_P} > 0$), $\Omega_U = v_{L_P} - \kappa\tilde{\theta} < 0$.

Inserting the values for the constants A_1 and A_2 given by equations (289), we obtain the linearized version of the nation's intertemporal budget constraint expressed as a function of initial employment and operating firms:

$$\tilde{B} - B_0 = \Phi_2\left(\tilde{N} - N_0\right) + \Phi_1\left(\tilde{L} - L_0\right), \tag{295}$$

with

$$\Phi_1 = \frac{(\nu_1 - r^\star)\tilde{\Lambda}_2 - (\nu_2 - r^\star)\tilde{\Lambda}_1}{(\nu_1 - r^\star)(\nu_2 - r^\star)\left(\omega_3^2 - \omega_3^1\right)}, \tag{296a}$$

$$\Phi_2 = \frac{(\nu_2 - r^\star)\omega_3^2\tilde{\Lambda}_1 - (\nu_1 - r^\star)\omega_3^1\tilde{\Lambda}_2}{(\nu_1 - r^\star)(\nu_2 - r^\star)\left(\omega_3^2 - \omega_3^1\right)}. \tag{296b}$$

K.6 Steady-State Effects of a Deregulation Shock

In this section, we derive steady-state changes following alternatively a fall in the cost of entry.

The steady-state of the open economy is described by the following set of equations:

$$\tilde{C} - \frac{\left(\tilde{L}_P\right)^{1+\frac{1}{\sigma_L}}}{1+\frac{1}{\sigma_L}} = \frac{1}{\bar{\lambda}}, \tag{297a}$$

$$s\tilde{L} = m\left(\tilde{\theta}\right)\tilde{U}, \tag{297b}$$

$$\tilde{L}_P^{1/\sigma_L} = \frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U, \tag{297c}$$

$$\kappa = \frac{f\left(\tilde{\theta}\right)(1-\alpha_W)}{s + r^\star}\left[\frac{1}{\mu\left(\tilde{N}\right)} - \left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta} + B^U\right)\right], \tag{297d}$$

$$\frac{\tilde{L}}{\tilde{N}}\left(1 - \frac{1}{\mu\left(\tilde{N}\right)}\right) - \phi = (\delta + r^\star)\beta\delta\tilde{N}, \tag{297e}$$

$$r^\star\tilde{B} + \tilde{L} - \tilde{C} - \kappa\tilde{V} - \beta\left(\delta\tilde{N}\right)^2 - \tilde{N}\varphi = 0, \tag{297f}$$

and the intertemporal solvency condition

$$\tilde{B} - \Phi_2\tilde{N} - \Phi_1\tilde{L} = B_0 - \Phi_2 N_0 - \Phi_1 L_0, \tag{297g}$$

where we used the fact that $\tilde{E} = \delta\tilde{N}$, $V = U\theta$. The steady-state equilibrium defined by seven equations jointly determine $\tilde{C}$, $\tilde{L}$, $\tilde{U}$, $\tilde{\theta}$, $\tilde{N}$, $\tilde{B}$, $\bar{\lambda}$.

Substituting the short-run static solution for consumption (i.e., eq. (168)), and using

(297b) to eliminate $\tilde{U}$, the steady-state described by (297) can be rewritten as:

$$\tilde{L} = \frac{\tilde{m}}{\tilde{m}+s}\left[\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}+B^U\right]^{\sigma_L}, \tag{298a}$$

$$\frac{\kappa}{f\left(\tilde{\theta}\right)} = \frac{(1-\alpha_W)}{(s+r^\star)}\left\{\frac{1}{\mu\left(\tilde{N}\right)}-\left(\frac{\alpha_W}{1-\alpha_W}\kappa\tilde{\theta}+B^U\right)^{1/\sigma_L}\right\}, \tag{298b}$$

$$\frac{\tilde{L}}{\tilde{N}}\left(1-\frac{1}{\mu\left(\tilde{N}\right)}\right)-\phi = (\delta+r^\star)\,\beta\delta\tilde{N}, \tag{298c}$$

$$r^\star\tilde{B}+\tilde{L}-C\left(\tilde{L},\tilde{\theta},\bar{\lambda}\right)-\kappa\frac{s\tilde{L}}{f\left(\tilde{\theta}\right)}-\beta\left(\delta\tilde{N}\right)^2-\tilde{N}\varphi=0, \tag{298d}$$

$$\tilde{B}-\Phi_2\tilde{N}-\Phi_1\tilde{L}=B_0-\Phi_2N_0-\Phi_1L_0, \tag{298e}$$

Due to the specific form for the utility function, labor market variables are not affected by the marginal utility of wealth (hence by the wealth effect) which influences only consumption and the stock of traded bonds. Hence, we first solve the steady-state without the intertemporal solvency condition, i.e., (298a)-(298d), which allows us to express the steady-state values in terms of the shadow value of wealth $\bar{\lambda}$, fixed costs φ and the cost of entry parameter β. Totally differentiating the system of equations (298a)-(298d) yields in matrix form:

$$\begin{pmatrix} 1 & -\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right] & 0 & 0 \\ 0 & \tilde{\Psi}_\theta\tilde{\theta}-(1-\alpha_V)\,\tilde{\Psi} & \tilde{\Psi}_N\tilde{N} & 0 \\ \tilde{\pi}^P_L\tilde{L} & 0 & \left(\tilde{\pi}^P_N\tilde{N}-\tilde{\pi}^P\right) & 0 \\ \left[1+\frac{v_{L_P}}{\tilde{l}}-\omega_V\right] & -\left[\alpha_V\frac{\tilde{u}}{\tilde{l}}v_{L_P}+\omega_V(1-\alpha_V)\right] & -(2\omega_E+\omega_\varphi) & \omega_B \end{pmatrix}\begin{pmatrix}\hat{\tilde{L}}\\ \hat{\tilde{\theta}}\\ \hat{\tilde{N}}\\ \hat{\tilde{B}}\end{pmatrix}$$
$$= \begin{pmatrix} 0 \\ 0 \\ \left(\tilde{\pi}^P_L\tilde{L}-\tilde{\pi}^P\right)\hat{\varphi}+\tilde{\pi}^P\hat{\beta} \\ -\frac{\tilde{X}}{\tilde{L}}\hat{\bar{\lambda}}+\omega_\varphi\hat{\varphi}+\omega_E\hat{\beta}\end{pmatrix}, \tag{299}$$

where we set $l=L/L_P$, $u=U/L_P$, $\omega_V=\frac{\kappa V}{Y}$, $\omega_B=\frac{r^\star B}{Y}$, $\omega_\varphi=\frac{N\varphi}{Y}$, $\omega_E=\frac{\beta E^2}{Y}$; we used the fact that $\varphi=\pi^P_L L-\pi^P$ and $\tilde{\pi}^P=(\delta+r^\star)\,\beta\delta\tilde{N}$.

The determinant of (299) denoted by G'' is:

$$G''\equiv\omega_B\left\{\left(\tilde{\pi}^P_N\tilde{N}-\tilde{\pi}^P\right)\left[\tilde{\Psi}_\theta\tilde{\theta}-(1-\alpha_V)\,\tilde{\Psi}\right]-\tilde{\Psi}_N\tilde{N}\tilde{\pi}^P_L\tilde{L}\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]\right\}\gtrless 0. \tag{300}$$

In light of our discussion above, determinant G'' is positive as long as the condition for saddle-path stability with real-valued roots (283) holds.

System (298a)-(298d) can be solved for steady-state employment, labor market tightness and the stock of foreign assets as follows:

$$\tilde{L} = L(\varphi,\beta), \tag{301a}$$
$$\tilde{\theta} = \theta(\varphi,\beta), \tag{301b}$$
$$\tilde{N} = N(\varphi,\beta), \tag{301c}$$
$$\tilde{B} = B\left(\bar{\lambda},\varphi,\beta\right). \tag{301d}$$

Partial derivatives are given by:

$$\frac{\hat{\tilde{L}}}{\hat{\varphi}} = -\frac{\omega_B}{G''}\tilde{\Psi}_N\tilde{N}\left(\tilde{\pi}_L^P\tilde{L}-\tilde{\pi}^P\right)\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]<0, \tag{302a}$$

$$\frac{\hat{\tilde{L}}}{\hat{\beta}} = -\frac{\omega_B}{G''}\tilde{\Psi}_N\tilde{N}\tilde{\pi}^P\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]<0, \tag{302b}$$

$$\hat{\tilde{\theta}} = \frac{1}{\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]}\hat{\tilde{L}}, \tag{302c}$$

$$\hat{\tilde{N}} = \frac{\left[\left(1-\alpha_V\right)\tilde{\Psi}-\tilde{\Psi}_\theta\tilde{\theta}\right]}{\tilde{\Psi}_N\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]}\hat{\tilde{L}}, \tag{302d}$$

where the signs rely upon the condition for saddle-path stability.

K.7 Analytical Comparison with Instantaneous Entry Model

In section G, we computed the saddle-path stability condition and steady-state changes by assuming instantaneous entry. In this subsection, we show that the condition for saddle-path stability derived in the entry-exit model is similar to that derived in the instantaneous entry model. To be able to compare saddle-path stability condition and steady-state changes when entry is instantaneous with those when entry is sluggish, we rewrite the partial derivatives of the short-run static solution for the number of firms (107) by using the notations introduced in section K:

$$\eta_{N,L} = -\frac{\pi_L^P L}{\pi_N^P N}>0, \quad \eta_{N,\varphi}=\frac{\pi_L^P L}{\pi_N^P N}<0. \tag{303}$$

Use the fact that $\tilde{\Psi}_N\tilde{N}=-\frac{\eta_{\mu,N}}{\tilde{\mu}}$ and $-\tilde{\Psi}_\theta\tilde{\theta}=\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^\star}$ to rewrite inequality (284) (derived in the entry-exit model):

$$\frac{\left(1-\alpha_V\right)\tilde{\Psi}+\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^\star}}{\frac{\eta_{\mu,N}}{\mu}\frac{\tilde{\pi}_L^P\tilde{L}}{\left(\tilde{\pi}_N^P\tilde{N}-\tilde{\pi}^P\right)}}>\left(\alpha_V\tilde{u}+\tilde{\chi}\sigma_L\right), \tag{304}$$

where $\eta_{\mu,N}<0$ and

Using (303), inequality (119) derived in the instantaneous entry model can be rewritten as follows:

$$\frac{\left(1-\alpha_V\right)\tilde{\Psi}+\frac{\alpha_W\tilde{m}\tilde{\Psi}}{s+r^\star}}{\frac{\eta_{\mu,N}}{\mu}\frac{\tilde{\pi}_L^P\tilde{L}}{\tilde{\pi}_N^P\tilde{N}}}>\left(\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right). \tag{305}$$

Inequalities (304) and (305) would be identical if the cost of entry β was set to zero since it would imply that $\tilde{\pi}^P=0$. When $\beta>0$, since $\tilde{\pi}_N^P\tilde{N}-\tilde{\pi}^P<\tilde{\pi}_N^P<0$, the condition for saddle-path stability is more easily satisfied. The reason is that the elasticity of the markup to a rise in employment is smaller due to the congestion effect which raises the cost of entry as more firms enter the market.

Using (303), the steady-state change of employment after a fall in fixed cost rewrites as:

$$\frac{\hat{\tilde{L}}}{\hat{\varphi}} = -\frac{\frac{\tilde{\pi}_L^P\tilde{L}}{\tilde{\pi}_N^P\tilde{N}}\frac{\eta_{\mu,N}}{\tilde{\mu}}\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]}{\left[\left(1-\alpha_V\right)\tilde{\Psi}-\tilde{\Psi}_\theta\tilde{\theta}\right]-\frac{\tilde{\pi}_L^P\tilde{L}}{\tilde{\pi}_N^P\tilde{N}}\frac{\eta_{\mu,N}}{\tilde{\mu}}\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]}<0. \tag{306}$$

Assuming entry and exit for firms, eq. (302a) can be rewritten as:

$$\frac{\hat{\tilde{L}}}{\hat{\varphi}} = -\frac{\left(\frac{\tilde{\pi}_L^P\tilde{L}-\tilde{\pi}^P}{\tilde{\pi}_N^P\tilde{N}-\tilde{\pi}^P}\right)\frac{\eta_{\mu,N}}{\tilde{\mu}}\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]}{\left[\left(1-\alpha_V\right)\tilde{\Psi}-\tilde{\Psi}_\theta\tilde{\theta}\right]-\frac{\tilde{\pi}_L^P\tilde{L}}{\left(\tilde{\pi}_N^P\tilde{N}-\tilde{\pi}^P\right)}\frac{\eta_{\mu,N}}{\tilde{\mu}}\left[\alpha_V\tilde{u}+\sigma_L\tilde{\chi}\right]}<0. \tag{307}$$

As long as inequality (283) holds and since $\tilde{\pi}_N^P \tilde{N} - \tilde{\pi}^P < \tilde{\pi}_N^P \tilde{N} < 0$, the steady-state rise in employment after a drop in fixed costs is smaller if firm entry is sluggish than if entry is instantaneous. The reason is that in the former case (i.e. in the firm entry-exit model), the cost of entry increases due to the congestion effect which results in a smaller fall in the markup. As a consequence, the beneficial effects on labor market outcomes with sluggish entry are smaller than those with instantaneous entry.

K.8 Quantitative Comparison with Instantaneous Entry Model

We assess briefly numerically to what extent our results depend on the assumption related to instantaneous entry. In panel A and B of Table 6, we report numerical results for long-run and short-run effects of a deregulation shock. The first column shows results when assuming instantaneous entry and considering an exogenous decline in fixed costs. The second column shown results when assuming entry and exit of firms.

Panel A shows long-run effects. While both models yields similar labor market effects, in line with theoretical predictions, the entry and exit model predicts a substantial increase in the labor share while the instantaneous entry model predicts an unchanged labor share in the long-run. The reason is that in a model with entry and exit of firms, profits are positive initially and decline substantially in the long-run as a result of the drop in the markup triggered by the fall in the cost of entry. Unlike, in a model assuming instantaneous entry, profits are zero at each moment of time.

Additionally, while a model assuming instantaneous entry produces a welfare gain as a result of the positive wealth effect, a model assuming entry and exit of firm yields a welfare loss. The reason is that in the latter framework, firm entry acts like physical investment which deteriorates the current account by such an amount that the marginal utility of wealth increases which lowers consumption and thereby welfare.

Panel B shows impact effects. In a model with entry and exit of firms, the number of firms N becomes a state variable. Hence, the fall in the markup is achieved only gradually. On impact, the markup remains unchanged so that the overall surplus from hiring an additional worker ($d\Psi(0)$) falls as the reservation wage increases. Unlike Blanchard and Giavazzi [2003] who use a static framework, employment agencies look over the future and thereby expect perfectly that labor demand will increase in the future. As a consequence, more job vacancies are posted on impact which raises the labor market tightness and thereby the reservation wage. However, the rise in the reservation wage is moderated in model with entry and exit of firms which results in a smaller increase in the labor force and thereby in the unemployment rate on impact.

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Table 6: Quantitative Effects of a Deregulation Shock in Product Markets (in %): Comparing Instantaneous Entry with Entry and Exit of Firms

	Instantaneous entry	Entry and Exit
A.Long-Term		
Employment, $d\tilde{L}$	1.10	1.03
Labor force, $d\tilde{L}_P$	1.04	0.97
Job vacancies, $d\tilde{V}$	0.14	0.13
Labor market tight., $d\tilde{\theta}$	4.67	4.36
Job seekers, $d\tilde{U}$	-0.06	-0.06
Unemployment rate, $d\tilde{u}$	-0.17	-0.16
Nash barg. wage, $d\tilde{w}$	2.14	2.00
Labor share	-0.01	11.90
Firm entry, $d\tilde{N}$	5.95	1.91
Marg. ut. of wealth, $d\bar{\lambda}$	-4.39	10.83
Consumption, $d\tilde{C}$	2.28	-2.06
Welfare, $d\Upsilon$	2.72	-6.48
B.Impact		
Labor force, $dL_P(0)$	1.03	0.24
Surplus from hiring, $d\Psi(0)$	2.51	-11.43
Job vacancies, $dV(0)$	0.53	0.12
Labor market tight., $d\theta(0)$	4.61	1.10
Job seekers, $dU(0)$	1.03	2.28
Unemployment rate, $du(0)$	0.91	0.22
Nash barg. wage, $dw(0)$	2.10	-0.39
Labor share	0.37	0.88

Notes: We consider a fall in fixed costs (first column) and the cost of entry (second column) which lowers the markup by 0.03, i.e. from 1.4 to 1.37. Impact and steady-state deviations are scaled by initial labor force, except initial and long-run changes of overall surplus from hiring an additional worker, labor market tightness and Nash bargaining wage which are scaled by their initial steady-state values. Steady-state change of consumption is scaled by GDP. Firm entry corresponds the deviation of the number of firms from steady-state value. Effects on welfare are equivalent variation measures, calculated as the percentage change in consumption necessary to equate the initial level of welfare to what it would be following the shock. In the benchmark scenario, main parameters are set as follows: $\alpha_W = 0.6$ and $\sigma_L = 0.5$; ϵ, ω are chosen to target $\mu = 1.4$.